COMMISSION INTERNATIONALE
POUR L'EXPLORATION SCIENTIFIQUE
DE LA MER MÉDITERRANÉE

RAPPORT DU 40e CONGRÈS DE LA CIESM

40th CIESM CONGRESS PROCEEDINGS

Marseille (France) 2013 Volume 40

Ce volume présente sous la forme d'articles synthétiques toutes les communications scientifiques présentées lors du 40ème Congrès de la CIESM. Les articles incluent chacun un résumé et des références bibliographiques. Comme ce sont plus de 900 chercheurs originaires de 40 pays qui se sont rassemblés en octobre 2013 à Marseille, l'ensemble offre un vaste panorama, très représentatif des recherches marines menées actuellement en Méditerranée et en mer Noire.

Les articles présentés dans le cadre des six comités scientifiques sont édités sous la responsabilité du Président de comité concerné. Seules les communications physiquement présentées par leur auteur lors du Congrès ont été retenues pour cette publication. Pour leur part, les rapports des modérateurs des sessions ont été édités par mes soins.

Frédéric Briand
Directeur Général, CIESM

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Les Présidents des comités scientifiques de la CIESM, 2010-2013
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Références bibliographiques
Rapp. Comm. int. Mer Médit., 40

Ex :
de Lange G., Slomp C., Erba E., Corselli C., Thomson J., Anastasakis G., Michard A. and C. Vale 2013. Sapropel S1 : basin-wide isochronous formation and preservation in the Eastern Mediterranean. Rapp. Comm. int. Mer Médit., 40 : 12.

C I E S M
16, bd de Suisse MC 98000 – Monaco
Tèl. : +377 9330 3879 Fax : +377 9216 1195
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COMITÉ 1

Géosciences marines

Président : Gert J. de Lange

Rapports des modérateurs

Biogeochemical cycles, past and present

Maria Triantaphyllou, Greece

Résumé

A short introduction to the subject was given by the moderator, mainly addressing a series of questions that are featured in current research on biogeochemical cycles, dealing with how the geosphere and biosphere have evolved through time and the role of humans in pushing the geochemistry and geobiology of the Earth Surface System towards a potential tipping point.

A 30 minute debate followed the interesting 3 min presentations of the participants. During this fruitful and frank discussion between speakers and audience, a series of questions were addressed focused on: the timing of Black Sea inflow in the Mediterranean, carbonate chemistry within sapropel S1 deposition, physics of anoxia during S1 deposition, productivity and preservation during sapropel times, amount of total organic carbon accumulated during the S1 anoxic event in various Mediterranean basin depths, carbonate chemistry effects and the role of possibly limiting factors (temperature, salinity, depth) on coral growth in Mediterranean sites, coccolithophore flux variability in Mediterranean basins and possible occurrence of different Emiliania huxleyi morphotypes in the Black Sea coccolithophore assemblages.

Deep Sedimentary Processes

Stéphanie Dupré, Ifremer, France

Résumé

The 'Deep Sedimentary Processes' session with 8 presentations covered a wide range of geological setting from lacustrine to marine environments. Challenges in studying deep sedimentary processes imply the best view of the depth window which is involved, and this from the seabed expressions to the deeper signatures. The time window of these processes is obviously crucial, and complex to approach when combining geological and human time scales, the case for climate issues. Most of the presented studies concern natural resources (water, oil and gas) and risks (water pollution, landslides). A key player in these processes, to be considered as the sediments are, is the fluid (e.g. water, gas). Some of the discussions focused on the importance of the deep -tectonic- control of seabed manifestations, e.g. the role of the Messinian salt layer in relation with fluid systems initiation and occurrence, namely the Eastern Mediterranean Sea (e.g. the Nile Deep Sea Fan) versus the Western Mediterranean Sea. The wide panel of geographic studied sites, the Dead Sea, Bafa Lake, the Black Sea, the Mediterranean Sea (Western and Eastern Mediterranean and Adriatic seas) did put in light the relevance to study deep sedimentary processes in 'enclosed' areas.

Geo-archeology and sea level change

Hulya Caner, Turkey

Résumé

Four speakers intend in the session of geo-archeology and sea level change . Name of speakers ;

Nathaniel Bensoussan, Stello Petrakis, Matteo Vacchi, Hulya Caner

First presentation is about potential impacts of climate change on coastal benthic ecosystems and developed an original strategy for the definition of warming scenarios in coastal habitats. At the same time their potential impacts on key benthic species.

Second presentation is about AKTAIA research project which aims to investigate the impacts of climate change upon the coastal zone.

Other presentation is about the MEDFLOOD project . Main objectives of this project are

- to forecast future climate trends
- to examine the climate change impact
- to develop new methods
- possible socio-economic change

The last presentation is about paleoenvironmental changes and the cultural sequence of the ancient Theodosius Harbor (Istanbul Marmaray tube tunnel) using palynology . Flash presentations admitted more time to discussions and efficiently.

Marine canyons

Sandro Carniel, CNR-ISMAR, Venice, Italy

Résumé

Following the communications, a general, active discussion started. About 50 people were present at that time, and about 10 participants were involved in the question time and discussion, which concerned the following topics :

- possible links between the cascading processes and the deep water formation in the Eastern Mediterranean basin;
- relations between small scale processes and larger scale phenomena in marine canyons (e.g. cascading processes);
- new concepts emerging from recent advances on sea technology (high-resolution measurements multibeam, ROV, AUVs?);
- availability of new coupled numerical models linking atmospheric-oceanic-wave processes and their capability in describing spatial-temporal scale of cascading events and depicting bottom features;
- need of more objective ways to measure bottom sediment resuspension;
- origin and evolution of marine canyons;
- canyons development speed during the Messinian period;
- case studies in the Med area and their peculiarities with respect to ocean regions;
- quantitative estimate of the transfer of organic matter to the deep sea:;role of measurements and modeling;
- link between physical/abiotic processes and biogeochemical/biotic aspects;

Marine Geohazards

Stéphanie Dupré, Ifremer, France

Résumé

The entire Mediterranean Sea from its western to eastern shores and to the Sea of Marmara is characterized by natural risks involving catastrophic tsunamis, earthquakes and major landslides. These phenomena are well known through the entire human history. Geohazards are the subject of numerous studies as attested by CIESM workshops - see CIESM Workshop Monograph n°42 (192 p.) "Marine geo-hazards in the Mediterranean?; or CIESM Workshop Monograph n°24 (152 p.) "Human records of recent geological evolution in the Mediterranean Basin - historical and archaeological evidence".

In order to better understand the geological processes that lead to these short-term duration risk-associated events and to better define the triggers, the analytical approach requires a multi-data and multi-parameter integration, e.g. including the meteorological input into the sedimentary system and cycle or questioning the role of fluid migration with regard to sedimentary instabilities and earth-shaking. Combining onland and offshore studies is definitively an asset as looking at past activity of risks-associated events together with most recent ones. Assessing natural risks is a very challenging issue.

Marine organic pollutants

N/A

Résumé

Modérateur absent

Messinian salinity crisis

Johana Lofi, France

Résumé

About 6 million years ago the Mediterranean Sea was transformed into a giant saline basin. This event, commonly referred to as the Messinian salinity crisis (MSC), changed the chemistry of the global ocean and had a permanent impact on both the terrestrial and marine ecosystems of a huge area surrounding the Mediterranean area. Since the first MSC scenario has been proposed following DSDP Leg XIII in the 1970s the Messinian event remains one of the longest-living controversies in Earth Science. A few years ago a deep revision of our knowledge of the Messinian event was performed during a CIESM Workshop (The Messinian Salinity Crisis from megadeposits to microbiology - A Consensus report, 2008. N° 33 in CIESM Workshop Monographs (F. Briand Ed.), 168 pages, Monaco). A number of open questions were identified concerning the cause, nature, timing and consequences of the Messinian Salinity Crisis.

This session embraced several of these open questions through oral presentations. Thanks to a new multidisciplinary study on the DSDP Leg 23 cores, Caruso et al. proposed that the Red Sea and the Mediterranean Sea were still connected during the Late Messinian. De Lange et al. presented a mechanism in which gypsum formation and preservation occurred in shallow sedimentary settings while anoxic organic matter degradation processes in the deep basin formed dolomite. A series of presentations were also dedicated to the record of

the MSC event, thanks to seismic reflexion and borehole data. On the Egyptian margin, Abdel-Fattah et al. recognized downstepping fluvial terraces that can be used to reconstruct a relative sea level curve during the MSC. On the Eastern Sardinia margin, Lymer et al. mapped the MSC seismic markers, allowing to reconstruct the paleo-geography of the area ~5.6 My ago and to refine the timing of the rifting in this area. Driussi et al. also used these seismic markers to assess the post-MSC tectonic deformation of the Balearic promontory. Lofi presented the publication project of a second volume of a "Seismic atlas of the Messinian Salinity Crisis markers in the Mediterranean and Black seas?". The MSC session concluded by a presentation by Camerlenghi et al. of the DREAM project (Deep-sea Record of Mediterranean Messinian events) dedicated to the drilling of the MSC offshore records in the Mediterranean basin.

A general, constructive discussion followed the presentations, addressing the various topics presented and in particular the implications of a possible connection with the Red Sea during the Messinian, and the use of the MSC markers to assess the post-Messinian deformation due to tectonics.Since we are lacking at present stratigraphic and lithological control on up to 95% of the offshore Messinian records, the participants also discussed the critical need of offshore drillings in the deep basins (including the Black sea) to answer some questions still open concerning the Messinian event.

Metal distribution in sediments

Mohamed Bouhamadouche, Faculté des Sciences de la Terre, USTHB, Alger, Algérie

Résumé

The theme of the session was very well identified and nine communications presented the extent of metal occurrence (Cr, Mn, Cd, Al-, Co, Nor, Cu, Zn, Mb, and Pb) in various areas where they can reach worrying, if not alarming, levels, particularly in certain regions of Algeria, Turkey, or Egypt.

The contamination level of heavy metals was assessed by using the Igeo geoaccumulation index and metallic pollution indicators (MPI). A question particularly discussed was the particle size fraction of the marine sediment most affected by heavy metals pollution.

The debate that followed the communications was a good initiative as it has enriched several talks, concerning future methods and approaches such as the systematic study of metal isotopes, or metal contamination of major fouling species such as barnacles with interesting recommendations to be taken in future studies.

Sedimentary and chemical processes

N/A

Résumé

Modérateur absent

Shoreline dynamics

Muhammet Duman, Turkey

Résumé

This session on Shoreline Dynamics successfully unfolded, covering a diversity of topics that ranged from shoreline activities, modeling, hydrodynamics, Holocene deposits, deltaic structures, and seabed features. For young scientists this was a valuable and often the first opportunity to present their findings in front of an international audience.

The general debate saw specific questions and more general concluding remarks mainly on shoreline activities, hydrodynamics and seabed features.

Session

Biogeochemical cycles, past and present

Modérateur : **Maria Triantaphyllou**

SAPROPEL S1: BASIN-WIDE ISOCHRONOUS FORMATION AND PRESERVATION IN THE EASTERN MEDITERRANEAN

G. de Lange [1]*, C. Slomp [1], E. Erba [2], C. Corselli [3], J. Thomson [4], G. Anastasakis [5], A. Michard [6] and C. Vale [7]
[1] Geosciences - Utrecht University - gdelange@geo.uu.nl
[2] University Milano, IT
[3] University Milano Bicocca
[4] Southampton, UK
[5] University Athens
[6] CEREGE, FR
[7] Marine institute Lisbon, PT

Abstract
The occurrence of the most recent sapropel S1 appears predomoinantly controlled by its synchronous initial deposition and preservation at a basin-wide scale. A marked Mn-rich sediment bed formed basin-wide 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, thus variable per investigated site.. Our basin-wide approach further elucidates that the watercolumn below ~ 1.8 km must have remained predominantly anoxic during sapropel S1 deposition.

Keywords: Paleoceanography, Sapropel, Redox, Geochemical cycles, South-Eastern Mediterranean

Clear cyclic compositional patterns occur in all Mediterranean marine deposits found on land and at the seafloor. These large-scale patterns appear 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]. 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 ^{14}C ky BP, sapropel S1 formed basin-wide synchronously between 9.8 and 5.7 ^{14}C 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; [5,10]). Using the S1 as a case study similar features can be recognized in older sapropel units.

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GEOCHEMICAL AND PHYSICAL CONSTRAINTS FOR THE OCCURRENCE OF LIVING COLD-WATER CORALS

Sascha Flögel [1], Wolf-Christian F. A. Dullo [1]*, Andres Rüggeberg [1] and Mienis Furu [2]
[1] GEOMAR Helmholtz Centre for Ocean Research - cdullo@geomar.de
[2] Royal Netherlands Institute for Sea Research (NIOZ)

Abstract

Cold-water coral communities cover a wide range of possible habitats in terms of latitude, ocean basins, and depth. Ongoing studies and exploration are currently discovering additional occurrences in various regions of the global ocean. A range of factors determines the formation of cold-water coral reefs such as physical, hydrochemical, and biological (e. g. food supply) ones. Environmental niche factor analysis (ENFA) has been used to predict areas of suitable habitats. However, only few studies made an attempt to characterize the underlying suite of hydro –biogeo- chemical and physical constraints of cold-water coral reefs and to differentiate between pristine reef growth versus sites with reduced or no coral occurrences.

Keywords: Carbon, Cnidaria, Deep sea corals, Ionian Sea, Gulf of Cadiz

The analysis of physical and hydrochemical water mass properties from cold water coral (CWC) bearing locations in the NE Atlantic and the Mediterranean has revealed distinctive patterns. Firstly, the presented data compilation confirms the proposed control of temperature and [1] as well as sea-water density [2] on CWC growth. We found that DIC and desity of the sea water have a considerable influence on CWC in the investigated localities. Among all constituents of the carbonate system, DIC is one parameter that defines healthy, pristine, and large scale occurrences compared to just single colonies or even non-existent recent growth. The presented data indicate that DIC values below 2170 mmol kg^{-1} characterize healthy growth like in Norwegian, Irish, or Scottish waters while reduced abundances or even declined CWC reefs have higher values as seen in the Gulf of Cadiz, off Mauretania, and in the Mediterranean. This sharp separation is supported by the poor occurrences in the Oslo Fjord (2170 mmol kg^{-1}) and parts of the Bay of Biscay (Pagès Escarpment with 2170 mmol kg^{-1}). We speculate that CWCs are limited in their calcification process if DIC values in ambient sea water exceed 2170 mmol kg^{-1}. However, the carbon for calcification might originate from DIC of the ambient sea water. While it was suggested that CWCs can increase their internal DIC concentration [3]. it is possible that strongly elevated values cannot be regulated by metabolic/calcification processes. A closer look at the CO_2 system explains the overall reasons for changes in DIC.

Our data plot into two distinct clusters when plotted in a DIC-TA graph. The position of the Mediterranean data can be explained by the excess alkalinity. This likely reflects alkalinity inputs to coastal areas close to regions of deep and intermediate water formation. An alkalinity budget shows that main alkalinity inputs come from the Black Sea and from rivers, whereas the Strait of Gibraltar is a net sink [4]. The fast overturning circulation in the Mediterranean Sea has led to an overall invasion of the anthropogenic CO_2 in the basin. New results show that the Mediterranean Sea has taken up a large amount of C_{ant} on both a per-volume and a per-area basis, compared to estimates of the global oceans [5]. However, the position of the Gulf of Cadiz and Mauretanian samples can be explained by increased respiration rates at the sea-floor.

The results indicate that a DIC of 2170 mmol kg^{-1} represents a tipping point for the formation of pristine CWC reefs. This goes along with increasing knowledge of the present global carbon cycle. This is important for our ability to understand and predict the future carbon cycle and global climate. Because about 50% of the anthropogenic carbon released to the atmosphere from the burning of fossil fuels is stored in the ocean. The estimates of anthropogenic carbon (C_{ant}) in the oceans remain prone to error arising from (i) a need to estimate preindustrial reference concentrations of carbon for different oceanic regions, and (ii) differing behavior of transient ocean tracers used to infer C_{ant}. An empirical approach [6] revealed that more C_{ant} is stored in the deep ocean than shown previously. This has possible implications for future carbon uptake and deep-ocean carbonate dissolution. This approach showed that both, the DIC concentration and the aragonite saturation horizon increase and shoal continuously in the North Atlantic since preindustrial times. If the potential tipping point of 2170 mmol kg^{-1} is indeed a limit for healthy and pristine reefs, we can interpret the observed increase in DIC of about 20 mmol kg^{-1} over the past 20 years [7]] as an indication for an increase in the decline of CWC reefs and mounds during this period.

The presented data compilation of physical and hydrochemical parameters of the ambient water masses of CWC sites with *Lophelia pertusa* in the NE Atlantic and the Mediterranean sheds new light on the boundary conditions for pristine CWC growth and occurrences. We were able to extent and confirm existent data sets [2] regarding a potential density envelope. Furthermore, our new results of hydrochemical parameters reveal a distinct tipping point with respect to DIC. We show that pristine CWC occurrences are limited to bottom waters with DIC values < 2170 mmol kg^{-1}.

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HIGH-RESOLUTION PALEOENVIRONMENTAL STUDY IN THE SOUTH AEGEAN SEA FOCUSING ON SAPROPEL S1 FORMATION

Amalia Filippidi [1]*, G.J. de Lange [1], Maria Triantaphyllou [2] and G. Roussakis [3]
[1] Institute of Earth Sciences-Geosciences Utrecht University - a.filippidi@students.uu.nl
[2] Faculty of Geology & Geoenvironment, University of Athens, Greece
[3] Institute of Oceanography, Hellenic Center for Marine Research, Greece

Abstract
The Aegean Sea is a semi-enclosed basin extremely sensitive to climate variability. Geochemical evidence from a high-sedimentation rate core from the South Aegean Sea demonstrates high frequency climate oscillations that were active prior, during and after sapropel (S1) deposition. These oscillations are thought to be linked to bottom water oxygenation, which in turn is strongly influenced by ventilation and climate change.

Keywords: Sapropel, Paleoceanography, Geochemistry, North-Central Mediterranean

Deposition of sapropels in the Mediterranean Sea, is associated with orbital climate forcing [3] and depicts the strong response of the basin to climate variability. The most recent sapropel (S1) was deposited between 9.8-5.7ka ^{14}C BP [4] and its formation is related to significant changes in the water circulation pattern. Despite the different mechanisms and processes described to be responsible for the formation of sapropels, elevated productivity as well as conditions favorable for the preservation of organic matter is widely accepted to prevail during sapropel deposition. The enhanced preservation of organic matter is thought to be related to restricted bottom water oxygenation and associated redox conditions at the water/sediment interface. In a high-sedimentation rate core (KN3) retrieved in 2008 (R/V Aegaeo) between Kos and Nisyros islands (Greece; 36^{o}40',636 - 27^{o}12',040, 607m depth) detailed (0.5cm resolution) geochemical and micropaleontological analyses have been performed. The results show that high frequency variability occurs in geochemical paleoproductivity proxies (e.g. C_{org} content and Ba/Al ratio) and trace elements. Fluctuations such as those in manganese content point to re-ventilation during S1 formation, at least in the Aegean Sea. The development of productivity in the deeper photic zone (high abundance of coccolithophore *Florisphaera profunda*) reflects increased stratification of the water column; although with several fluctuations. The practical absence of *Emiliania huxleyi* moderately calcified morphotypes implies elevated SSTs. Furthermore, this study provides evidence for more than one interruption during S1 formation, when the organic matter formation either was significantly reduced or the conditions were not favorable for its preservation. Trace elemental fluctuations used as indicators for anoxic/dysoxic conditions in surface sediments [1] advocate reduced oxygen conditions rather than a completely stagnant basin. High frequency cyclicity has been recorded also in micropaleontological and isotopic compositional data [2] implying restricted ventilation conditions but not a complete cessation of bottom water formation in Aegean Sea. Finally, the aforementioned proxies used for the reconstruction of the paleonvironmental conditions prevailing during S1 deposition in the South Aegean Sea, have been compared with results from other cores from within and from outside the Aegean Sea. Despite differences related to local environmental conditions, the general feature of variability within S1 as observed in Aegean core KN3 are confirmed. These observations strongly support the idea of the Aegean Sea not being a fully anoxic basin during S1 formation, but evolving under diminished oxygen conditions with potential episodes of re-ventilation. Additional studies are needed to more precisely set timing, distribution, and potential synchronicity of observed events.

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MODELING THE BIOGEOCHEMICAL CYCLING OF NITROGEN AND PHOSPHORUS IN THE EASTERN MEDITERRANEAN SEA: 1950-2000

Helen R. Powley [1]*, Michael Krom [2], Philippe Van Cappellen [1] and Kay-Christian Emeis [3]
[1] Department of Earth and Environmental Sciences, University of Waterloo, Canada - hrpowley@uwaterloo.ca
[2] School of Earth and Environment, University of Leeds, UK
[3] Institute for Biogeochemistry and Marine Chemistry, University of Hamburg, Germany

Abstract
The unusual nutrient cycling of the Eastern Mediterranean Sea (EMS) has been described by a coupled nitrogen and phosphorus mass balance biogeochemical model. The model is calibrated by independent nutrient measurements and is used to simulate changes in primary productivity and nutrient distributions within the EMS between 1950 and 2000. Despite threefold increases in the supply of nitrogen and phosphorus to the EMS during the second half of the 20th century the model only predicts a 22% increase in primary productivity, primarily due to efficient nutrient removal by the anti-estuarine circulation of the EMS.

Keywords: Nutrients, Ionian Sea, Levantine Basin, Geochemical cycles, Models

The unusual nutrient cycling of the Eastern Mediterranean Sea (EMS) is characterized by low nutrient concentrations and high nitrate to phosphate ratios. A coupled nitrogen (N) and phosphorus (P) biogeochemical model was developed for the EMS to describe and understand this cycling. The model domain consists of the EMS excluding the Adriatic and Aegean Seas. The water column is divided into three water layers; surface water (0-200m); Levantine Intermediate Water (200-500m) and deep water (>500m). The 1-D model accounts for fluxes between the water layers and for the anti-estuarine circulation of the EMS. It is assumed that the N and P cycles were at (near-) steady state in 1950 [1] and that annual primary production is phosphorus limited [2]. The N and P cycles are coupled together through the Redfield ratio (NO_3:PO_4=16:1) for primary production [3]. Estimations of the concentrations of soluble inorganic and organic forms, as well as particulate organic forms of N and P are based mainly on [4]. Inputs of nutrients to the EMS include atmospheric deposition, riverine supply, and inflows from adjacent basins (Adriatic, Aegean and Western Mediterranean Seas) whilst outputs include burial of particulate organic matter, denitrification and outflows to adjacent basins. Nutrient inputs between 1950 and 2000 were estimated using a combination of historical nutrient records from alpine ice cores [5,6], measured atmospheric deposition rates [7], and measured riverine concentrations [8]. The initial 1950 conditions were obtained by spinning up the model to steady state.

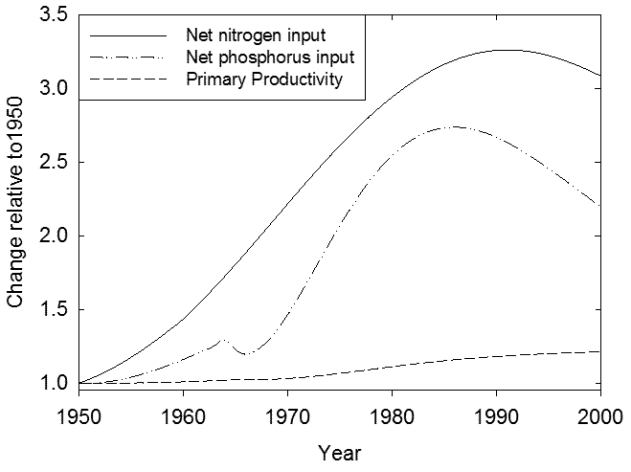

Fig. 1. Net nitrogen and phosphorus inputs to the EMS between 1950 and 2000, and the model predicted response of primary productivity, relative to 1950. Net inputs include the net flow of N and P between adjacent basins (Western Mediterranean, Adriatic and Aegean Seas), atmospheric deposition and riverine supply of N and P.

Despite major increases in the net supply of nutrients to the EMS, up to factors of 3.25 and 2.7 for N and P, respectively, modeled primary productivity during the 1950-2000 period only increases by 22% (Figure 1). The Western Mediterranean Sea (WMS) provides up to 67% of phosphorus input to the EMS, primarily as dissolved organic P. The model calculations indicate that 40% of nutrients supplied to the EMS between 1950 and 2000 are exported from the basin with over 25% to the WMS through the Straits of Sicily. Up to 20% of nutrient inputs are stored as inorganic nutrients in the deep water reservoir but the changes in deep water nitrate and phosphate concentrations between 1950 and 2000 are relatively small. The predicted nutrient concentrations in 2000 are consistent with the concentration ranges reported by [9]. The recycling efficiency of nutrients is very high with over 90% of phosphorus recycled within the surface waters. In conclusion, results indicate that the anti-estuarine circulation, exporting nutrients out of the EMS to the WMS through the Straits of Sicily, helps maintain the ultra-oligotrophic nature of the EMS and the phosphorus limited nature of the system.

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COCCOLITHOPHORE EXPORT PRODUCTION FROM EASTERN MEDITERRANEAN AND BLACK SEA SITES: BIOGEOGRAPHIC TRENDS AND BIOGENIC CARBONATE FLUXES

M. Triantaphyllou [1]*, E. Malinverno [2], M. Dimiza [1], A. Gogou [3], E. Thanassoura [1], I. Stavrakaki [3], M. Athanasiou [1], D. Tselenti [1], S. Stavrakakis [3], V. Lykousis [3] and C. Corselli [2]
[1] University of Athens - mtriant@geol.uoa.gr
[2] University of Milano Bicocca
[3] Hellenic Center for Marine Research

Abstract
The export production of coccolithophores has been measured from Black Sea, North Aegean Sea, Cretan Sea, South Cretan margin and Ionian Sea, and compared in order to define the spatial and seasonal variability in their assemblage composition. Furthermore, the contribution of coccolithophores to the total carbonate flux is calculated.

Keywords: Biogeography, Coccolithophores, Black Sea, North-Eastern Mediterranean

A sediment trap mooring has been deployed for one year (10/2007- 9/2008) at 1000 m water depth, in western Black Sea. The maximum coccosphere fluxes, with almost monospecific assemblage of *Emiliania huxleyi*, have been recorded during May and June. The seasonally controlled coccolithophore patterns are strongly related to those of sea surface temperature and accumulated rainfall in the area, triggering riverine nutrient input.

Coccosphere fluxes in North Aegean Sea have been calculated from a sediment trap deployment at 500 m (1/2011-12/2011). *E. huxleyi* is the dominant species, followed by *Syracosphaera pulchra*, *Rhabdosphaera clavigera* as minor assemblage components. Maximum fluxes have been observed in between May-June.

A single mooring with two sediment traps (500 and 1700 m) was deployed at the southern margin of the Cretan Sea (1/2001-2/2002) [1]. The results obtained from 500 m depth show that the highest productivity season was recorded from January till late September with the highest flux values observed between late March to late June. During this period the pattern was characterized by three main phases that correlate well with the gradual increase in SST from January till September. Coccosphere sinking assemblages were characterized by high abundances of *E. huxleyi*, followed by *Florisphaera profunda*, *R. clavigera* and *Syracosphaera* spp.

Six moorings have been deployed at different sites along the south–west margin of Crete, providing a total of eight sediment-trap time series (6/2005-5/2006) [2]. Maximum coccosphere fluxes were recorded in between March to June, featured by dominance of *E. huxleyi* and subordinate *Helicosphaera carteri*, *Umbilicosphaera* spp. and *S. pulchra*; intermediate fluxes from June to November, with high abundance of the deep photic zone species *Algirosphaera robusta*, *F. profunda*, *Gladiolithus flabellatus*; and low fluxes from November to February, with high flux of *A. robusta*, *S. pulchra* and *Syracosphaera* spp. These three periods correspond to the seasonal changes in sea surface temperature and surface mixed layer depth.

Coccolithophore fluxes from the central part of the Ionian Sea have been studied from a sediment trap mooring (9/1999-6/2001) at 500 and 2800 m water depth [3]. Peak coccolithophore export production is observed in May, a secondary peak is observed in September-October. The assemblages is dominated year-round by the cosmopolitan species *E. huxleyi*, followed by the deep-dwelling *F. profunda* and by several minor species (*Syracosphaera pulchra*, *R. clavigera*, *A. robusta*, *G. flabellatus*, *Calcidiscus leptoporus*, *Umbellosphaera tenuis* and small *Syracosphaera* spp.) which are most abundant during the summer period of upper water column stratification.

A high seasonal pattern characterizes the coccolithophore assemblages from all the investigated areas of eastern Mediterranean and Black seas. The export production and biogenic carbonate fluxes are strongly dependent on the nutrient influx, the vertical mixing and sea surface temperatures of the water column, in a north-south and east-west transient.

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HIGH RESOLUTION RECORD OF THE SAPROPEL S1 DEPOSITION IN THE NE AEGEAN SEA (SOUTH LIMNOS BASIN): PALEOCEANOGRAPHIC AND PALEOCLIMATOLOGICAL EVIDENCE

S. Kostopoulou [1], M. Triantaphyllou [1]*, M. Dimiza [1], A. Gogou [2], I. Bouloubassi [3], G. Roussakis [2], C. Parinos [2], M. Geraga [4], A. Diamantopoulou [4] and V. Lykousis [2]
[1] University of Athens - mtriant@geol.uoa.gr
[2] Hellenic Center for Marine Research
[3] LOCEAN, Universite Pierre et marie Curie
[4] University of Patras

Abstract
The paleoenviromental conditions during the high sedimentation rate depositional interval of sapropel S1 in the northeastern Aegean (gravity core M-4, length 2.53 m; south Limnos basin) have been studied, based on quantitative micropaleontological (benthic and planktonic foraminifera), geochemical (OC, δ^{13}Corg) and $U^{k'}_{37}$ sea surface temperature analyses. Our study points that sapropelic layer S1a has been deposited in more dysoxic conditions in respect to S1b. An interruption of the sapropelic conditions at 8.0 Ka BP, which is mainly characterized by the increase of agglutinated foraminiferal forms, confirms higher oxygen bottom conditions. From ~ 8.0 to 7.7 Ka BP, enhanced freshwater inputs along with the supply of terrestrial matter are probably associated with the inflow of Black Sea waters.

Keywords: Sapropel, Foraminifera, Geochemistry, Aegean Sea, North-Eastern Mediterranean

Gravity core M-4 has been recovered in South Limnos basin from water depth 216 m, at 39º 38.662'N, 25º 35.165'E. Sapropel S1 is very well exposed with overall thickness reaching 96 cm. S1a interval is characterized by the intense presence of anoxic/dysoxic benthic species, such as *Chilostomella mediterranensis*, *Globobulimina affinis* and *Cassidulinoides bradyi* together with *Bulimina* spp. (*B. aculeata*, *B. marginata* and *B. costata*), and the presence of *Bolivina spathulata*, *B. striatula* and *B. alata*. However, the presence of *Uvigerina mediterranea*, *Gyroidinoides* spp. indicates mesotrophic to eutrophic environments and higher oxygen conditions. Therefore, less severe dysoxia has been developed in South Limnos basin during the deposition of layer S1a, in respect to what has been documented before for other Aegean basins [1], [2], [3]. Higher values of OC during the deposition of S1a than those of S1b, indicate highest organic matter production and preservation in S1a, supporting previous results in the Aegean area [2], [4], [5]. The almost constant values of δ^{13}Corg, shifted towards marine end-member values during S1a, confirm the hypothesis that the deposition of sapropel S1 has been caused by enhanced primary productivity along with extended preservation of organic matter, when compared to the present-day levels in the north Aegean [5]. During S1a and S1b depositional intervals the dominant planktonic foraminiferal species are *Turborotalita quinqueloba* and *Globigerina bulloides*. Their abundant presence suggests the development of a low salinity sur?cial layer rich in nutrients over South Limnos basin during the deposition of S1a and S1b. The interruption of sapropel S1 at 8.0 Ka BP is probably associated with the northern hemisphere cold event at 8.2 Ka BP. During this interval, the increase of agglutinated forms confirms both higher oxygen bottom conditions and freshwater input. This is accompanied by decrease in OC and the presence of planktonic foraminifera assemblages (*Globorotalia inflata* and Neogloboquadrinds) which suggest stronger mixing of the water column at least during winter. The more negative values of δ^{13}Corg identified at ~7.7 Ka BP are indicative of terrigenous organic matter [5], that may caused high value of OC, during the interruption interval, probably associated with the inflow of Black Sea waters. Within the sapropelic layer S1b dysoxic foraminiferal species abundances are once more increased but to a lesser degree when comparing with S1a; in accordance with OC values. *U. mediterranea*, *Hyalinea balthica*, miliolids and agglutinants are increased, supporting even less dysoxia for S1b interval in respect to S1a. All acquired data records present rapid simultaneous fluctuations, suggesting short term paleoceanographic and palaeoclimatic changes in the studied area. Rapid palaeoclimatic changes during the discussed interval have been also reported in pollen records from N. Aegean Sea [6], [7].

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Session

Deep sedimentary processes

Modérateur : **Stéphanie Dupré**

FILLING GAPS ON THE SHRINKING/SWELLING TALE OF THE DEAD SEA BASIN (DSB) DURING THE LATE QUATERNARY THROUGH CONTINENTAL DRILLING

D. Ariztegui [1]*, M. Stein [2], Z. Ben-Avraham [3], S. L. Goldstein [4] and N. D Waldmann [5]
[1] Earth & Environmental Sciences University of Geneva - daniel.ariztegui@unige.ch
[2] Geological Survey of Israel, Jerusalem, Israel
[3] Department of Geophysics and Planetary Sciences, Tel Aviv University, Ramat Aviv, Israel
[4] Lamont-Doherty Earth Observatory of Columbia University, Palisades, N. Y., USA
[5] Department of Marine Geosciences Charney School of Marine Sciences, University of Haifa, Israel

Abstract

The Dead Sea is located on the boundary between the Sahara and the Mediterranean climatic zones. Its extension has substantially changed throughout time alternately expanding during ice ages and contracting during interglacials. The changing size of the successive lakes triggered changes in the chemical composition of their waters and, thus, their sediments are reflecting the climatic-hydrologic history of the region. The basin is located in an active tectonic region often affected by earthquakes that are preserved throughout the lacustrine sequence. Their identification and dating allows developing an event stratigraphy. Constraining the existing climatic and tectonic reconstructions for this area will help to disentangle the impact of these changes in the development and migration path of peoples from Paleolithic to modern times.

Keywords: Global change, Levantine Basin

The Dead Sea Basin (DSB) is the largest and deepest continental pull-apart basin formed along the Dead Sea Transform Fault, as well as along other continental transform faults [1]. During the Miocene (ca. 23 Ma), the basin was filled by fluvio-lacustrine deposits of the Hazeva Formation. Later during the Pliocene (ca. 5 Ma), the Mediterranean Sea intruded the basin forming the Sedom lagoon that deposited thick sequences of salts. After the disconnection of the lagoon from the open sea, terminal lacustrine bodies successively occupied the basin: the middle to late Pleistocene lake Amora (>740-130 ka), the last interglacial Lake Samra (~135-75 ka), the last glacial Lake Lisan (~75-17.7 ka), and the Holocene Dead Sea. The last glacial Lake Lisan and the Holocene Dead Sea have been widely studied during the past few decades providing significant archives of paleoenvironmental changes [2,3,4]. The Lisan Formation is comprised of up to ~40 meters of sediment deposited over nearly 60,000 years (~75 to ~17.7 ka), and records ice age conditions with seasonal time-resolution, due to regular deposition of thin (~1 mm thick) layers of precipitated inorganic carbonate during dry seasons (from lake evaporation) and detritus during wet seasons (from erosion of the marginal highlands and wind-blown dust) [2]. It also includes clastic layers associated with storms or lake level drops, gypsum layers associated with extreme dry periods and lake level drops, and jumbled "mixed layers" caused by earthquakes. The carbonate layers have been dated by U-series and ^{14}C, and the combination of radiometric dating and layer counting affords the opportunity to unravel the Near East hydrological-climatic and tectonic history at up to seasonal time resolution [2, 4]. The Lisan Formation overlies deposits from Lakes Amora and Samra, representing previous ice age high lake levels extending back at least 740 ka. But these past glacial and interglacial predecessors are fragmentary exposed along the shores of the current Dead Sea. Filling these existing gaps in the history of the basin is now possible with information obtained from cores retrieved from the central and deeper parts of the present lake. They improve our understanding of the behavior of the described water bodies evolving in the DSB as well unlock the climatic and tectonic mechanisms that shaped the region during past interglacial and glacial cycles [5] .

From November 2010 to March 2011 an international team of scientits (*) drilled the Dead Sea as part of an International Continental Scientific Drilling Program (ICDP) sponsored project [5]. The retrieved sedimentary cores are filling-in known (and estimated) gaps in the outcrop sediments and provide a nearly continuous and undisturbed record, that judging from changes in dominant lithology, are covering at least the past two glacial-interglacial cycles (ca. 200 ka). The sedimentary record can be divided into two dominant lithologies: salt layers interbedded with laminated mud, and massive and laminated marl interbedded with thin salt layers. Silt and sand (and gravel) levels indicate intervals of extremely low lake level (see slides). Additionally, a preliminary inspection of the material show spectacular sedimentary structures that are witnessing tectonic activity that has been registered in the lake sediments. Preliminary results indicate an average sedimentation rate more than double than the land deposits since salt deposition intervals (interglacials periods) are much thicker than the aragonite-detritus laminae that characterize the glacial intervals. In addition, the whole record becomes thicker due to the large thicknesses of the encountered slump sediments that have been most probably triggered by earthquakes of various ages. Once the chronology of these major events will be established, it may be possible to develop a regional event stratigraphy leading to an estimation of the frequency of earthquakes in this tectonically active area. The latter may help planning mitigation strategies of major societal impact.

A striking discovery is a mud-free layer of rounded pebbles more than 230 meters deep in the core taken from the deep basin, deposited at an age provisionally estimated to be the last interglacial. The pebble layer appears to be a beach deposit and nothing else like it has been found at other places in the cores. It overlies about 40 meters of mainly salt, and together they indicate an extreme lake level drop during that time. Today the Dead Sea level is falling fast because no fresh water is entering it due to the fact that most of the runoff is being used by the surrounding population. If the hypothesis that Dead Sea dry down is confirmed it means that in the geological past without human intervention, the runoff severely declined or almost stopped. This is critical since global climate models predict that in the near future this region will be more arid with higher mean temperatures implying that this precious resource, already fully used, will become scarcer.

*** DSDDP principal investigators**

M. Stein, Z. Ben-Avraham, A. Agnon (Israel); A. Brauer (Germany); D. Ariztegui, G. Haug (Switzerland); Y. Yasuda, H. Kitagawa (Japan); S. Goldstein, E. Ito (USA).

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DENSE WATER CASCADING AS DRIVER FOR SOUTH WEST ADRIATIC MARGIN RESHAPE

D. Bonaldo [1]*, A. Benetazzo [1], E. Campiani [1], S. Carniel [1], F. Foglini [1], M. Sclavo [1] and F. Trincardi [1]
[1] CNR-ISMAR - davide.bonaldo@ve.ismar.cnr.it

Abstract
Dense shelf waters nowadays originate in the northern Adriatic sea progressively move to the South, impacting the slope sea floor with velocities greater than 1 m/s and generating a wide variety of depositional and erosional features including muddy and sandy sediment waves. We merge the results of numerical runs, based on dedicated scenarios inferred from geological and paleoclimatology evidences - with most recent evidences from dedicated geological surveys - aiming at a detailed definition of the sediment fluxes driving the evolution of southern Adriatic mud waves.

Keywords: South Adriatic Sea, Continental margin, Bathymetry, Deep sea processes, Circulation models

After the end of the last glacial, the North Adriatic shelf was progressively drowned due to the eustatic rise generating a shallow shelf region which is now one of the Mediterranean key sites for the formation of dense shelf waters through wind-forced winter cooling. Once formed, the dense waters move to the south, along the western side of the Adriatic, and reach the South Adriatic slope across which they cascade generating a wide variety of depositional and erosional features such as muddy and sandy sediment waves. Moreover, several fields of dominantly muddy sediment waves have a patchy distribution and appear to reflect the interaction between the down-slope path of the dense water and the presence of both morphological constraints to accelerate the flows and mobile sediment to be casted into large-scale bedforms (Trincardi et al, 2007). Given the dominant role of seabed morphology in controlling such process, a detailed bathymetric characterization is necessary for an appropriate understanding of the hydrodynamic and geological processes. Recent advancements in geological survey technologies allow a very high-definition knowledge of the sea bottom geometry and sedimentology, providing a robust experimental basis for modeling inferences. At the same time, numerical models for ocean circulation have been developed and improved up to allow a refined description, at an adequate space- and time- resolution, of the formation and flow of dense water masses in the Adriatic basin until the South Adriatic slope (Benetazzo et al., 2013).

In this work we merge the results of numerical runs, based on dedicated scenarios inferred from geological and paleoclimatological evidence, with most recent evidences from dedicated geological surveys carried out on R/V URANIA operated by the Italian National Council of Research (C.N.R.). The findings provides a sound background for a coupled hydrodynamic and sediment transport modelling effort, based on a complete in-situ sedimentological characterization and aiming to a detailed definition of driving processes and sediment fluxes involved in the evolution of southern Adriatic mud waves since the last glacial-interglacial transition, and in particular since the early Holocene, when stable-isotope studies suggest an enhanced bottom-water formation and circulation (Piva et al., 2008).

The modeling performed under different scenarios accounts for both the erosional and depositional features observed, assessing how the process of dense shelf water cascading can concur to a marked reshape of the sea floor landscape. The model results indicate that the downslope-cascading bottom currents are highly correlated with the orientation and spatial distribution of the observed bedforms.

The work done paves the way to new modeling efforts under past oceanographic scenarios and at a sub-feature scale, with the aim to investigate if and how the dense water cascading is consistent, by strenght and location, with the generation and evolution of the observed bedforms.

This work has been partially funded by the Flagship Project RITMARE - The Italian Research for the Sea - coordinated by the Italian National Research Council and funded by the Italian Ministry of Education, University and Research within the National Research Program 2011-2013.

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GEOPHYSICAL SIGNATURE OF SEEPAGE ACTIVITY AT AN EXCEPTIONAL SITE OF BRINE, GAS AND MUD EXPULSIONS IN THE NILE DEEP SEA FAN

S. Dupré [1]*, L. Brosolo [2], J. Mascle [2], C. Pierre [3], J. Woodside [4], F. Harmegnies [1], V. Mastarlerz [5], G. Bayon [1], G. de Lange [5] and J. P. Foucher [1]

[1] IFREMER - stephanie.dupre@ifremer.fr

[2] Géosciences Azur

[3] LOCEAN, UPMC

[4] Vrije Universiteit, Amsterdam

[5] Utrecht University

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?*. Near bottom geophysical investigations were conducted with the use of the *Victor* ROV (Remotely Operated Vehicle). We present here, in the view of the seepage activity, the geophysical characterization of a large mud volcano caldera complex called Menes located in the Western Nile Province.

Keywords: Mud volcanoes, Tectonics, South-Eastern Mediterranean, Nile Fan, Brine pools

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 (Bayon et al., 2009; Dupré et al., 2007; Huguen et al., 2009; Loncke et al., 2004). During the MEDECO2 expedition (HERMES Program), some of these seeps were investigated with the research vessel Pourquoi pas? (Foucher et al., 2009). Near bottom geophysical investigations were conducted with the use of the Victor 6000 ROV (Remotely Operated Vehicle). Victor was equipped with 1) a Reson 7125 multibeam system operated at 400 kHz for high-resolution bathymetry and backscatter seafloor imagery and 2) an OTUS camera for long range optical black and white imaging. We present here, in the view of the seepage activity, the geophysical characterization of a large mud volcano caldera complex called Menes located in the Western Nile Province. 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.

Chephren Mud Volcano

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 along a vertical profile of ~250m below the seabed. 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 attract 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.

Cheops Mud Volcano

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, 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.

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GEOPHYSICAL, GEOLOGICAL AND LYMNOLOGIC STUDIES OF BAFA LAKE, AN ANCIENT GULF OF THE AEGEAN SEA

Can Eytemiz [1]* and Erdeniz Ozel [1]
[1] Dokuz Eylul University, Institute of Marine Science and Technology - can.eytemiz@deu.edu.tr

Abstract
Lakes are perfect constituents of climatic, environmental and geologic changes and geophysical lake studies are exceptionally important to reveal their formation process. Lakes may record regional responses about some environmental processes and a combination of such records about origin of lake can contribute to a better understanding variations about shore studies. Bafa Lake in Mugla, Turkey is among the best examples of such an alluvial set lake in the Aegean Sea and it is one of the least spoiled watery areas at the shore, in Turkey.

Keywords: Geophysics, Hydrography, Aegean Sea, Sedimentation

Bafa Lake was one of the busiest bays of the Aegean Sea (Gulf of Latmos) in the seventh century B.C. [1]. The sediments brought to the lake is initially fed by the floods from the Big Meander River (Büyük Menderes) slowly pull away the bay from the Aegean sea by the first century A.C. [2]. From late antiquity, alluvials that brought by Big Meander River is closed the connection of the Latmos Gulf step by step and transformed the gulf to a lake (Fig. 1) [3]. Bafa Lake is one of Turkey's most important historical and protected area which also has cultural and archaeological resource value by having the ancient city of Latmos. So this area is under protection of the government as an open air museum and a nature park.

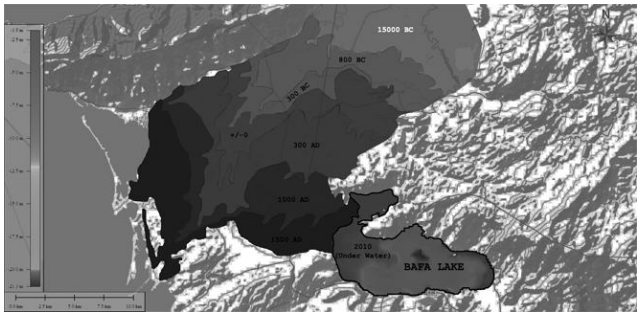

Fig. 1. Periodic progression of the Big Meander River Delta

We examined the Lake in geophysical, geomorphological and physico-chemical aspects. In this context, depth measurements and bathymetric mapping, side scan sonar studies which used to determined the morphology of the lake, water column physicochemical parameters and microbiological assays and sediment grab samples to determine bottom sediments were studied (Fig. 2).

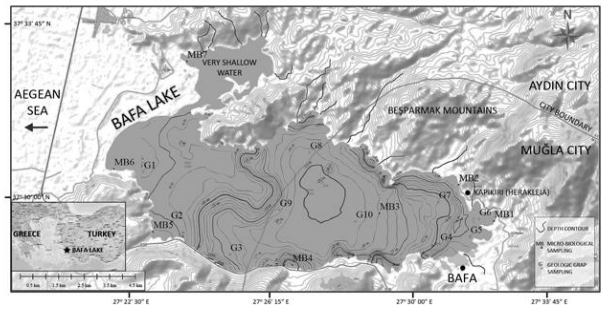

Fig. 2. Representation of Bafa Lake's location and depth contours with sediment sampling locations.

Results showed us how a river can transform a gulf into a lake by changing it's geology, morphology and echology and gave us a huge knowledge about similarly affected environments future, destinies.

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THE DISTAL DANUBE DEEP-SEA FAN IS THE LAST "SINK" OF ITS EPONYMOUS RIVER BASIN:

Gilles Lericolais [1]*, Julien Bourget [2], Stephan Jorry [1] and Irina Popescu [3]
[1] IFREMER - gilles.lericolais@ifremer.fr
[2] Centre for Petroleum Geoscience, School of Earth and Environment, The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia
[3] GeoEcoMar, Bucarest, Roumanie

Abstract
The Danube River Basin and the Black Sea represent a unique natural laboratory for studying source to sink and global change. In the last decade, many of the geosciences studies carried out in the Black Sea have focused on the Holocene marine transgression. This topic has been fully discussed and is still a matter of debate. Since the DSDP drillings, the lithology and mineralogy of deep sediments from the Black Sea have been well studied. However, only few recent studies have focused on the deep-sea morphology and turbidite sedimentation in the western Black Sea basin, where the main depositional feature is the Danube submarine fan. Recent oceanographic surveys demonstrate that the deep basin deposits bear the record of the Late Quaternary paleoenvironmental changes.

Keywords: Deep sea basins, Sediment transport, Canyons, Swath mapping, Black Sea

This study focuses on the deep water architecture of the western Black Sea deep basin and its sedimentological characteristics. The Late Quaternary Danube turbidite system (to the North) displays a well-constructed morphology, underlined by several channel-levee systems associated with distal lobe complexes, reaching the 2200 m isobaths. The adjacent deposits, onlaping the Danube Turbidite System distal lobes in the deep basin, show a linear, drape-like morphology, represented by thick continuous reflections on seismic profiles. They generally consist of distal turbidite deposits supplied from the Turkish margin. Most of these turbidite sequences show a thick upper unit composed by homogeneous clastic clays, thus forming thick mud turbidites. Following previous work in similar basin settings, we interpret these facies to result from large volume unchannelized turbidity currents generated by successive mass-wasting events. The abrupt break of slope at the bathyal plain transition enhances the rapid deposition of coarse-grained material and limits channel development in the bathyal plain. We relate the origin of these deposits with the very high seismic activity of the North Anatolian Fault on the Turkish margin. This work is based on data collected at the boundary of influence of the Danube Turbidite System and the Turkish margin, and provides a new record of the changes in sedimentary supply, climate and sea level that occurred in the Black Sea region since the last ~ 25 ka. The deep basin deposits bear the record of the Late Quaternary paleoenvironmental changes (Lericolais et al., 2012). The Last Glacial Maximum Period (~25 to 18 ka BP) was characterized by an important and relatively stable sediment supply with sediment transferred to the deep basin from both the northern Danube Turbidite System and the southern Turkish margin. The relative stable LGM period was followed by an increase of sediment transport to the deep basin, which is locally illustrated by progradation of lobe deposits from the Danube turbidite system in the deep basin, downlaping the Turkish deposits. Influx of meltwater to the Black Sea resulted in a early highstand sea level. The following Bolling Allerod Preboreal warm period and the Younger Dryas cold event have experienced alternative sea level lowstands and highstands that are not clearly underlain in the deep basin sediments (Lericolais et al., 2012). The onset of sea-level highstand after the Holocene marine invasion (~ 9 kyr BP) (Lericolais et al., 2012; Soulet et al., 2011) induced the end of the activity of the Danube Turbidite System whereas the gravity supply from the Turkish margin remained active throughout the Holocene. We conclude that the western Black Sea basin constitute an asymmetric subsident basin bordered by a northern passive margin with confined mid-size, mud-rich turbidite systems, and a southern turbidite ramp built in a tectonically active margin setting.

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FLUID-ESCAPE STRUCTURES ON THE CENTRAL NILE DEEP-SEA FAN: RESULTS FROM INTEGRATED SWATH BATHYMETRY AND 3D SEISMIC DATA

F. Mary [1]*, S. Migeon [1], E. Cauquil [2], J. Mascle [3] and P. Imbert [4]
[1] Géoazur, Valbonne, France - flmary@geoazur.unice.fr
[2] Total, Paris La Defense, France
[3] Observatoire de Villefranche sur Mer, France
[4] Total, Pau, France

Abstract
Fluid seepages are observed on almost every continental margin where detailed surveys have been conducted. They exhibit different morphologies at the seafloor, but pockmarks, mounds, and mud volcanoes are predominant. In the Central Nile Deep-Sea Fan (NDSF), an integrated approach, based on bathymetry and seismic investigations of the seafloor and of the sedimentary column reveal that pockmarks fields, mud volcanoes and shallow networks of cracks are associated with various geological features such as normal faults, faulted anticline, buried turbidite channels and mass-transport deposits.

Keywords: South-Eastern Mediterranean, Nile Delta, Bathymetry, Seismics, Mud volcanoes

Fluid emissions at the seafloor of continental margins have been recognized in a large range of settings. The most commonly described expression of fluid seepages are commonly pockmarks, carbonate mounds, mud volcanoes (MV) and/or gas chimneys; they may result from migration of thermogenic fluids along tectonic conduits, dissociation of gas hydrates and dewatering of turbidite channels or of mass-transport deposits (MTDs). Fluid seepages constitute thus a potential window on deep reservoirs and constitute part of geohazards affecting continental-slope environments. A great variety of fluid seepages have already been described over the NDSF. They are also recorded by patches of high acoustic backscatter indicating pockmarks and/or small carbonate mounds [1; 2]. Submersible observations have shown the high-backscatter patches to coincide with authigenic carbonate pavements [3]. Some of them were thought to be active during the Holocene. A new dataset used in this study includes multibeam bathymetry and backscatter data, as well as Chirp and seismic-reflection profiles (Géoazur laboratory) mixed together with the upper section of 3D seismic data (Total Company); it helps to better constrain the characteristics of already-known structures and to identify new ones within the central NDSF. Some 2000 additional pockmarks, identified between 300-1300 m water depths, appear either isolated or grouped in clusters. On seismic data, they are expressed at the seafloor as concave-up high-amplitude reflections lying on top of vertical pipes with incoherent facies at depth. Seven MV (conical, flat, circular in shape; 1.5-4 km in diameter; up to 70 m high) already identified between 100-1100 m water depths, are imaged in better details. The new observations reveal abundant mud flows at the seafloor, suggesting recent fluid activity. Newly identified emission centers consist of either low-elevation domes, with concentric ridges, or chimney-like structures merging in a large caldera. Such morphological differences may indicate variations in both nature and viscosity of fluid emissions. Radiating networks of lineaments, interpreted as small-scale fractures, are seen on the seafloor and at depth around some MVs and may indicate fluid intrusion processes within the pre-existing deposits. On seismic data, MVs exhibit either a "christmas-tree" pattern up to 300-ms penetration below the seafloor, or thinner construction lying at the seafloor, suggesting different fluid/mud emission cyclicity scales and initiation ages. Dendritic networks of curved cracks (0.1-3 km long, 5-10 m deep) are present at various locations between 800-1400 m water depths. They affect the first 50 ms below the seafloor and appear anchored on top of sub-vertical conduits with concave-up reflections. Over the studied area the spatial organization of pockmarks, MVs and cracks is constrained by several types of structures identified on the seafloor and at depth. In most cases, MVs are associated with networks of normal deep faults that in some case affect the present-day seafloor, for example Rosetta fault, as already indicated and which is therefore an active fault. Pockmark fields are superimposed to buried normal faults and on a faulted anticline, but can also be observed at the base of fault scarps affecting the seafloor. More surprisingly, some pockmark fields mimic relatively deeply buried turbidite channels and MTDs located up to 550 ms below the seafloor; and they likely result from dewatering processes strong enough to impact the seafloor; similar relationships were established in the Congo basin and on the Niger submarine delta [4]. Finally, shallow networks of cracks are located on top of buried MTDs. Their origin is still unclear but their orientation is nearly similar to the organization of MTDs internal thrust faults as shown on 3D seismic time slices. It is thus believed that dewatering of MTDs, guided by thrust faults, could generate overpressures within the overlying deposits and then extensional structures that propagate upward to the seafloor.

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A MORPHOSTRUCTURAL AND GEOLOGICAL SYNTHESIS OF THE MEDITERRANEAN DOMAIN

Jean Mascle [1]*, Georges Mascle [2], Laetitia Brosolo [3] and Laurent Camera [4]
[1] Observatoire Océanologique de Villefranche - mascle@obs-vlfr.fr
[2] Formerly Université J. Fourrier Grenoble
[3] CNRS-INSU DT Meudon
[4] Geoazur , Sophia-Antipolis

Abstract
A recently published morpho-bathymetric map of the Mediterranean Sea, constitutes the background support for the first morpho-tectonic map of the Mediterranean domain ever published. This compilation made under "Arcgis", includes a peri-mediterranean geological synthesis in which the various geological units have been assembled according to their implications with respect to the Alpine orogenic evolution. For the marine domain several characteristics, have been selected and successively mapped in distinct layers integrated to produce the final synthesis; among the selected layers: the nature and age of the deep basins, the distribution of messinian basins, of active tectonics and of large fluid seepage processes such as mud volcanoes.

Keywords: Bathymetry, Geomorphology, Swath mapping, Tectonics, North-Central Mediterranean

Onshore the map has been mainly constructed using the contours of the IGME 5000 Map [1], completed by information extracted from numerous publications The geodynamic evolution of the Mediterranean area being intimately related to the one of the Alpine realm, the various geological units have been assembled accordingly to their implications within the Alpine orogenic evolution; since the beginning of the Alpine history correlates with the end of the Variscan one, more or less at the limit between Carboniferous and Permian (300 Ma), all geological units older than Permian (Proterozoic and pre-Permian Paleozoic) have therefore been considered as basement; the Variscan magmatism (prior to 300 Ma) has however been distinguished to better highlight the Variscan basement. All others formations (younger than 300 Ma) have been characterized considering their implication within the Alpine structures and the different lithology, which constitute large tectonic units, are represented by a dedicated colour. Recent (Oligo-Miocene to Quaternary) sedimentary basins have been distinguished in two categories: flexural basins and others types (cratonic, rifts…). Oceanic-type rocks (i.e. ophiolites), that underline ancient suture zones, Neogene to Recent alkaline volcanoes (areas of crustal thinning or of hot spot activity) and subduction-related magmatism (former active margins), have been distinguished. All others formations, sedimentary, volcanic, or metamorphic (alpine metamorphism) dated from Permian to Oligocene (or to late Miocene depending of the area), have been grouped together, and shown by a single colour stressing their location within the Alpine realm. The compilation of a homogenous morpho-tectonic map of the Mediterranean Sea is still an unrealistic challenge. This is the reason why we selected a series of major characteristics and specificities, which appear common to the two Western and Eastern Mediterranean deep basins. These are for example the probable extension of the thick (up to 20km) continental crust, and of the different oceanic crust-floored deep basins whose age have also been indicated; similarly the various types of magmatism occurring in the basin are shown. The deep, and thick, Messinian basins, evidenced on seismic reflection grounds and on their impacts on the morphology of the sea floor, have also been mapped as well as the various halokinetic deformations resulting from the Messinian salt mobility such as diapirs (chiefly detected in the Western basin) and gravity tectonic related features (mainly evidenced in the Eastern basin); major brine lakes and mud volcano fields and belts, which constitute one of the specificities of the Eastern Mediterranean sea, are shown. The main active (or recent) tectonic features (faults, folds, thrusts, etc,..), induced by the geodynamic context of the Mediterranean Sea, are also indicated; their interpolated tracing has been made using their imprints on the seabed morphology as derived from details from swath bathymetric data, particularly in the Tyrrhenian Sea and in Eastern Mediterranean Sea. Finally the location of seism epicentres, from 1974 to 2011, and with magnitude between 4 and 8 (from the Us Geological Survey), is indicated since these earthquakes underline, offshore and onshore, one of the fundamental processes resulting from the geodynamic of the Mediterranean Sea The resulting synthesis map, constructed in an "Arcgis" digital environment, results from the superposition of more than twenty layers, each of them representative of a specific characteristic of the submarine domain and drawn from a compilation of numerous data extracted from many various publications. These layers are shown superposed on a general morpho-bathymetric background derived from the recent Morpho-bathymetric map of the Mediterranean Sea [2]. The various layers are syntheses made from numerous publications.

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Session

Geo-archeology and sea level change

Modérateur : **Hulya Caner**

CLIMATE CHANGE IMPACTS ON COASTAL BENTHIC ECOSYSTEMS IN THE NW MEDITERRANEAN SEA: ASSESSING POTENTIAL RISK FROM FIELD, LABORATORY AND NUMERICAL EXPERIMENTS

N. Bensoussan [1]*, I. Pairaud [2], P. Garreau [3], S. Somot [4] and J. Garrabou [5]
[1] IPSO FACTO, 10 ru Guy Fabre, 13001 Marseille - nathaniel.bensoussan@ips-o.fr
[2] LER PAC, Centre Ifremer Méditerranée, zone portuaire de Brégaillon - BP 330, 83507 La Seyne sur Mer Cedex, France
[3] DYNECO/PHYSED, Centre IFREMER de Bretagne, BP 70, 29280 Plouzané, France
[4] CNRM/GAME, Centre National de Recherches Météorologiques,42 av. Gaspard Coriolis, 31057 Toulouse Cedex, France.
[5] Institute of Marine Sciences (ICM/CSIC), passeig Maritim de la Barceloneta 37-49, 08003 Barcelona, Spain

Abstract
Our main aim was to assess the potential impacts of climate change on coastal benthic ecosystems by the end of the 21st century at sub-regional scale: the North Western Mediterranean Sea. We developed an original strategy for the definition of warming scenarios in coastal habitats and their potential sub-lethal to lethal impacts on key benthic species. This was achieved by combining high resolution numerical simulations under IPCC scenarios with field observations and thermotolerance experiments. First, model validation for 2001-2010 was conducted in contrasted sensitive coastal areas. Forecasts run were performed under IPCC scenarios to explore changes in stratification. These simulations were qualified with species distribution and thermotolerance functions to explore present risk level and potential impacts by the end of the century.

Keywords: Coastal systems, Global change, Biodiversity, Temperature, North-Western Mediterranean

Introduction
The Mediterranean Sea is extremely responsive to climate change and dramatic impacts are expected to occur in benthic coastal ecosystems which are among the most exposed to the current trends and extreme events [1]. In this semi enclosed microtidal sea with seasonal stratification up to 15°C, the influence of (sub)meso scale dynamics (eg. upwelling, downwelling) is crucial in modulating local thermal regimes and potential impacts of climate change at local scale [2,3]. Developing more precise/realistic scenarios of coastal habitats warming and potential impact on ecosystems is crucial for setting up sound management and conservation plans of the rich Mediterranean biodiversity and thus recognized as a priority theme of international programs (eg. CIESM, MEDPAN, MERMEX). Within the CLIMCARES project (http://climcares.medrecover.org), we specifically addressed the risk of mass mortality driven by thermal stress in rocky benthic ecosystems of the NW Mediterranean (NW Med) [4,5].

Materials and methods
We conducted a multidisciplinary approach combining hydrodynamic simulations at large geographic scale, physical and biological coastal observations, and thermo-tolerance experiments:
Temperature profiles (5-40m) have been monitored hourly over the past 10 years in different coastal areas of Spain, France and Corsica (T-mednet initiative, http://www.t-mednet.org). Observations from 10 contrasted stations were compared with simulations for the last decade for two different models: the high resolution hydrodynamical model addressing (sub) mesoscale processes MARS3D/MENOR (horizontal resolution 1.2 km) and NEMO-MED8 (ca. 13 km resolution) [6]. We evaluated statistically bias and errors to qualify the models and define local corrections. Forecast simulations were run under the IPCC A2 scenario and both models were considered for comparison.
Upper thermotolerance limits of key benthic species were compiled from *in situ* temperature records obtained during 1999, 2003 and 2006 mass mortality events, allowing correlation analysis of the degree of mortality and temperature conditions. Besides, thermotolerance experiments were conducted on some of the affected species. Finally, a data base on species distribution and upper distribution limit was also compiled.
The vulnerability scenarios were obtained by combining warming scenarios, biological responses to warming and upper distribution limit as fully described in [3].

Results and Discussion
Models comparison with coastal temperature series for 2001-2010 showed the good model performances of MENOR (bias, RMSD and correlation) even if extremes were underestimated in subsurface layers. The regional model also yielded good performances for monthly to seasonal statistics at these very near to coast stations. Thus both approaches - local correction of regional model and high resolution downscaling with MENOR - were considered complementary and used to explore respectively long term trends in stratification and extreme events by the end of the century. The thermotolerance response functions to warming compiled from field observations and experiments shared the same pattern for the sponges, anthozoans and cnidarians tested: mortality arose after sustained "moderate" increase in temperature (24-26°C) or stronger short overheating (27-28°C), at typical time scales from several weeks to day respectively.
The modeled temperatures were extracted along the NW Mediterranean coastlines and combined with thermo-tolerance and upper distribution limit of populations. This information was used to build risk and potential impact models. First based on hindcasts to evaluate species and areas of high conservation concern in the NW Med [3], highlighting the concomitant and/or repeated occurrence of a range of (sub)lethal conditions depending on the area considered during the past decade. Then on forecasts to explore potential impacts of climate change by the end of the century at specific, but also multi-specific level.

Acknowledgements
This work was made in the framework of the CLIMCARES project funded by the TOTAL foundation and of the action ICOCE of the MERMEX program.

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PALEOENVIRONMENTAL CHANGES AND THE CULTURAL SEQUENCE OF THE ANCIENT THEODOSIUS HARBOUR (YENIKAPI-ISTANBUL):PALYNOLOGICAL EVIDENCES

H. Caner [1]*, E. Kirci-Elmas [1], D. Ongan [1], E. Sari [1] and O. Algan [1]
[1] University of Istanbul The Institute of Marine Sciences and Management - hcaner@istanbul.edu.tr

Abstract
As the capital of two world empires Istanbul is located at the crossroads of the waterway connecting the Mediterranean and the Black Sea. Project in due to build a tube tunnel under the sea between Asian and European parts of the city, an ancient Byzantium Harbor (Theodosius H. 4th century) was brought out at Yenikapi within the "historical peninsula". Geological and archaeological evidences in the sedimentary sequence exposed to daylight at the excavation site have revealed significant new data enabling for the first time to correlate the Holocene sea level change, paleoenvironmental changes and the cultural sequence of the region. This study include results of the polen analysis in the one of the sedimentary sequence which is collected from Marmaray excavation area.

Keywords: Paleoceanography, Marmara Sea

As the capital of two world empires Istanbul is located at the crossroads of the waterway connecting the Mediterranean and the Black Sea as well as the land route connecting Asia and Europe has contributed greatly to the cultural development and wealth of the city. It has been the setting for many civilizations since early times. During the preliminary construction works of a large scale Marmaray Tube Tunnel Project in due to build a tube tunnel under the sea between Asian and European parts of the city, an ancient Byzantium Harbor (Theodosius H. 4th century) was brought out at Yenikapi within the "historical peninsula". Geological and archaeological evidences in the sedimentary sequence exposed to daylight at the excavation site have revealed significant new data enabling for the first time to correlate the Holocene sea level change, paleoenvironmental changes and the cultural sequence of the region. This study include results of the polen analysis in the one of the sedimentary sequence which is collected from Marmaray excavation area. The sequence has a length of 270 cm. The litology of its consist of mainly blackish clay deposit (1) . It possibly formed in a small swamp. The interval between 220-222cm and 200 202 cm are yielded 7592-+44 BP and 7305-+47. 0.4–1 ml of sediments were sub-sampled from core 1 for palynological analysis. Sub-samples were treated with $Na_4P_2O_7$, HCl, HF, and HCl, then sieved through 125 and 10 µm screens. Numbers of microfossils per ml of wet sediment were calculated with the initial addition of *Lycopodium* tablets. Pollen residues were mounted in glycerol. Palynomorphs were identified at magnifications of 500X (routinely) and 1000X (special identification). All terrestrial and aquatic pollen grains were included in determining concentration. The pollen percentages are based on total pollen, excluding spores (2). The diagram of this sequence was divided into four local pollen assemblage zones.LPZ 4 (between 270-240 cm) was represented by low pollen values particularly *Sordaria* shows highest values (3). LPZ 3 (240-160 cm) , total pollen values increase (reaching 40%). Compositae *and* Chenopodiaceae appear in this zone and reaches highest values. . *Liquidambar oriantalis* L. exists on this zone. LPZ 2 (160-70 cm), pollen sum reaches its highest value in this zone. *Pterocarya* appeares whereas *Juglans*, *Juniperus* and Chenopodiaceae disappear.. LPZ 1 (70-10 cm) , *Acer, Olea, Tilia* and *Betula*disappaear upper part of this zone.

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THE DEVELOPMENT OF NEW METHODOLOGIES FOR THE QUANTIFICATION AND MITIGATION OF THE CLIMATIC CHANGE IMPACT ON THE E. CRETAN COAST, S. AEGEAN SEA (PROJECT AKTAIA)

S. Poulos [1], A. Velegrakis [2], N. Kampanis [3], G. Ghionis [3], M. Vousdoukas [4], A. Karditsa [1], G. Alexandrakis [3], O. Andreadis [2], S. Petrakis [1]*, D. Sifnioti [1], D. Giannouli [1], M. Lipakis [5], E. Marinos [5] and T. Manganas [5]
[1] Faculty of Geology & Geoenvironment, National & Kapodistrian University of Athens - spetrakis@geol.uoa.gr
[2] Department of Marine Sciences, School of Environment, University of Aegean, Greece
[3] Institute of Applied and Computational Mathematics, Foundation for Research and Technology, Hellas
[4] Forschungszentrum Küste. Hannover, Germany
[5] Organization for the Development of Eastern Crete

Abstract
The scope of the present contribution is to present the outlines of the AKTAIA research project that is currently implemented through the cooperation of the associated organizations. The project aims to investigate the impacts of the climatic change upon the coastal zone of eastern Crete with specific emphasis on beaches, developing new methodologies for continuous monitoring and a protocol for the mitigation of the anticipated sea level rise

Keywords: Aegean Sea, Shoreline evolution, Monitoring, Coastal processes, Coastal management

Introduction
One of the most significant impacts of climate change, both at a national and an international level, is the shoreline retreat, which is particularly intense in the case of beaches due to their low relief and composition (i.e. unconsolidated sediments). Climatic change induces coastal erosion through sea level rise, increased occurrence of extreme meteorological events and reduction of riverine sediment transport due to reduced rainfall. Moreover, erosion maybe related to human intervention (marinas, piers, coastal roads).

Scope and objectives
The on-going AKTAIA project investigates climate change manifestation and its influence on the stability and evolution of the coastal landforms along the shoreline of eastern Crete (some 757 km) (Fig.1), taking into account also the various aspects of human intervention.

Fig. 1. Location map of the study area.

The main objectives of the AKTAIA project are: (i) to forecast future climatic trends for the area of Crete (e.g. rainfall, wind, sea-level rise); (ii) to examine the climate change impact on the basis of collection of environmental data (meteorological, geomorphological, sedimentological and oceanographic) that are directly related to the climatic change; (iii) to develop new methods and indices for the assessment of Cretan coast's vulnerability; and (iv) to assess the socio-economic impacts and in particularly those related to the loss of coastal land. Project's materialization has been based on the synergy of four research groups established in Organization for the Development of Eastern Crete (Coordinator), the Institute of Applied Computational Mathematics (Foundation for Research and Technology in Crete), the Department of Marine Sciences (School of Environment, University of Aegean) and the Faculty of Geology & Geoenvironment (National & Kapodistrian University of Athens).

Methods and preliminary results
Aerial photographs, satellite images and orthophotomaps have been used to produce a detailed coastline map and to study the morphological characteristics of the coastal zone of Eastern Crete. More than 100 beach zones (with shoreline length >100m) have been visited during the three field campaigns, that have been conducted so far, including geomorphological and human intervention mapping, topographic, meteorological and oceanographic measurements and sedimentological sampling and observations. In addition, coastal video monitoring system accompanied by a meteorological station and a nearshore tide-wave gauge station have been installed in two pilot sites (Amoudara beach on the north and Koutsounari on the south) (fig.2); in these two sites coastal imaging [1] and nearshore oceanographic processes will be tested and adjusted to localised conditions, in order morphodynamic models to be calibrated.

Fig. 2. Monitoring system, meteorological station and D-GPS station, installed on-site.

Expected results
The coast of the eastern Crete consists mostly of rocky costs (71.5%), beaches (either sandy or pebbly) 18.2%, coastal landforms formed by wave erosion (2.5%), while the remaining 7.7% represents artificial coasts (e.g. marinas, groins etc). The development of a unified GIS-based environmental database incorporating all gathered data and existing information (i.e. coastal geomorphology, meteorological conditions, wave regime, beach material, human construction) will be then related to the forecasting climate trends (ENSEMBLE, http://ensemblesrt3.dmi.dk/) for the next decades in the area of Crete, in order the impacts of the climate change to be assessed, with respect to coastal zone evolution; this includes also the application of a coastal vulnerability index and an index suitable for beach zone vulnerability assessment. On the basis of the above, a protocol for the mitigation of the various impacts of climate change will be developed, towards a more successful management of Cretan's coast.

Acknowledgements
The project is supported by the Action "Cooperation 2007-2013" (09SYN-31-711 "AKTAIA") of the Operational Program "Competitiveness and Entrepreneurship" co-funded by the European Regional Development Fund (ERDF) and the General Secretariat for Research and Technology (Hellenic Ministry of Education).

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ASSESSING VARIABILITY OF MEDITERRANEAN FUTURE SEA LEVEL SCENARIOS USING RELATIVE SEA LEVEL DATABASES

Matteo Vacchi [1]* and Alessio Rovere [2]
[1] OT-Med Labex, Europole de l'Arbois, batiment du CEREGE, Aix-En-Provence, France - matteo.vacchi@gmail.com
[2] Lamont Doherty Earth Observatory, Columbia University, NY, USA

Abstract
Relative Sea Level databases have proved useful to assess coastal vulnerability to sea level rise and to quantify the coastal vertical displacement. In the Mediterranean, much greater amounts of SL published data exists and such literature, still rapidly growing, has led to the obvious consequence of fragmented information. The importance of a standardized review of Mediterranean SL data was recently raised by the Medflood project (www.medflood.org). With this study, we tried to organically review the sea level data available in two complex areas of the Mediterranean with respect to tectonic setting.

Keywords: Sea level, Aegean Sea, Ligurian Sea, Geohazards, Coastal processes

Introduction
The reconstruction of past relative sea levels (RSL) has several implications, ranging from the investigation of crustal movements to the calibration of earth rheology models and ice sheet reconstructions. Recently, INQUA has funded a 4-years multidisciplinary project, named MEDFLOOD aimed at build a spatially explicit database of relative sea level markers for the Mediterranean and to use this resource to model risk and help project future flooding in and around the Mediterranean basin We contributed to the MEDFLOOD project with the construction of RSL database in two Mediterranean areas [4] . In Liguria (NW Mediterranean) we created a database of the Late Quaternary (i.e. last 125.0 ky BP) RSL changes in order to assess their spatial along the two rivieras. In NE Aegean Sea (Eastern Mediterranean), we analyzed the role of the North Anatolic Fault in controlling the RSL sea level changes in the last 12.0 ky BP. In addition, we presented our best estimates for the late-Holocene sea level rise. These data are essential in order to verify if relative sea level fluctuations were superimposed on the general rising trend, which is in turn central to predict the patterns of future sea level change.

Methods
The database included a wide range of geological RSL indicators (geomorphological and biological markers as well as marshy organic material and peats derived from sediment cores) as well as geo-archeological sea level data [1]. In the cases where a sample indicated formation or deposition in freshwater or marine environments, it was classified as a limiting date [2]. Therefore, reconstructed RSL must fall below freshwater limiting dates and above marine limiting dates. Ages of geological samples were estimated using radiometric dating of organic material of salt and fresh water marshes or marine shells.

Results and discussions
In Liguria, shorelines attributed to MIS 5.5 are present along the entire region, but dated shorelines occur only in the westernmost or easternmost part. This affects the interpretation of the neotectonic setting, but the analysis of the altimetric distribution of shorelines attributed to MIS 5.5 (Fig.1) allows to extend to the entire region the conclusion of several authors, who hypothesized that the western part of the region is in stable to slowly uplift, while the eastern part is to be considered in moderate uplift during Late Quaternary.

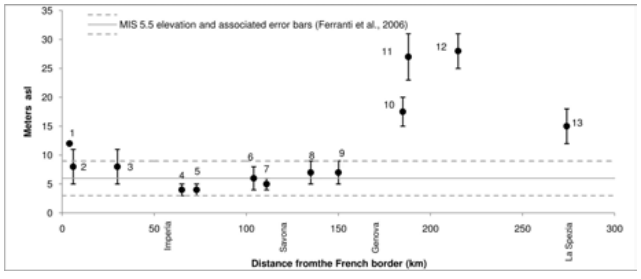

Fig. 1. Spatial variability of M.I.S. 5 shorelines along the Ligurian coast.

In NE Aegean, the analysis of the database brings a contribution to the open debate about the mid-Holocene RSL highstand in this sector of the Mediterranean Sea [3].
Even if with different rates, data provided by our database are consistent with a continuous RSL rise in the last 6.0 ky BP in the whole NE Aegean Sea (Fig. 2). Thus, our results do not support the hypothesis of a relative mid-Holocene sea level highstand, which partly reached or even slightly exceeded present MSL. The short records of tidal gauge RSL trends in the area did not allow a fair comparison between late-Holocene RSL and 20th century rising trends. We made an attempt in Izmir bay defining an acceleration of rising rates by ~0.6 mm/y-1 in the past century.

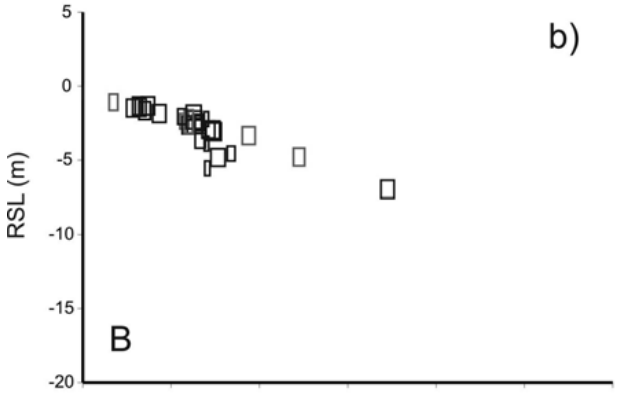

Fig. 2. RSL history along a part of the NE Aegean coast plotted as calibrated age against change in sea level relative to present (m). RSL data are plotted as boxes with 2s vertical and calibrated age errors. Grey boxes are virtually incompressible samples.

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Session

Marine canyons

Modérateur : **Sandro Carniel**

DENSE WATER CURRENTS AND SEDIMENT TRANSPORT IN THE SOUTHERN ADRIATIC SEA DURING THE COLD WINTER 2012

S. Carniel [1]*, L. Langone [2], A. Benetazzo [1], A. Bergamasco [1], D. Bonaldo [1], M. Borghini [3], F. Falcieri [1], S. Miserocchi [2], A. Russo [4], K. Schroeder [1], M. Sclavo [1] and J. C. Warner [5]
[1] CNR-ISMAR Venice, Italy - sandro.carniel@ismar.cnr.it
[2] CNR-ISMAR Bologna, Italy
[3] CNR-ISMAR La Spezia, Italy
[4] Dept. of Life and Env. Sciences, Univ. Pol. delle Marche, Ancona
[5] USGS Woods Hole, USA

Abstract
During the exceptionally cold winter 2012, dense shelf waters originated in the northern Adriatic sea progressively moved into the southern region, where they impacted the local complex canyons bathymetry with a series of deep-reaching cascading pulses.This complex dynamics was investigated using a coupled wave-current-sediment numerical modeling approach (COAWST), validated by means of observations acquired during two dedicated cruises (CTD, XBT and currents) and by data resulting from five moorings deployed in deep hot-spots of complex bathymetry, that allowed to build upon an existing time series of temperature, salinity, currents and downward particle fluxes.

Keywords: South Adriatic Sea, Water transport, Deep sea sediments

Northern Adriatic Sea is an area where dense shelf waters (NAdDW) form during winters characterized by favorable conditions: high salinities, mainly deriving by low river water discharge (Po *in primis*) during previous months, and low temperatures, mainly deriving from violent, cold and dry Bora wind events blowing from NE (Carniel et al., 2009). Resulting dense waters progressively move away and then sink in the southern regions by successive cascading events. Both NAdDW favorable conditions characterized the winter 2012, when, following several months of low Po River runoff, a very cold Bora blew long (from end of January until mid-February). Consequently, the temperature of northern Adriatic Sea waters dropped to about 6° C and exceptional densities (exceeding 1030 kg/m^3) were reached (Mihanovic et al., 2013). The production and spreading mechanisms of dense water in the Adriatic Sea have been modeled by means of the COAWST (Coupled-Ocean-Atmosphere-Wave-Sediment-Transport system) system. It builds upon an eddy resolving, high-resolution (1 km), fully 3-D hydrodynamic model (ROMS), the wave model SWAN (Simulating Waves Nearshore) and the CSTMS (Community Sediment Transport Module System) sediment routines, driven by atmospheric forcings provided by the meteorological model COSMO-I7.

The dataset used to assess model outputs encompasses three fixed observational sites in the northern Adriatic and part of the measurements taken during the sea-truth campaign "Operation Dense Water (ODW)" (a set of two rapid response cruises carried out in southern Adriatic and which hot-spots measurement in terms of CTDs, L-ADCP and XBT measurements were acquired according to an adaptive sampling strategy "model-driven"). Moreover, in the region of open slope in front of the Gargano Cape, in the moat area north of the Dauno seamount (1200 m deep), in the Bari canyon and in the sediment wave field down-current of the canyon, where the occurrence of very energetic currents were inferred by depositional and erosive bedforms, five mooring arrays were maintained and/or deployed in order to allow the continuous acquisition of temperature, salinity, currents and downward particle fluxes, providing a rather thorough description of the intense hydrodynamic events and suspended sediment transport that characterized the winter-spring 2012. Results from the integrated data-model approach allow to suggest new insights on dense waters propagation and fate and how, triggered also by tidal forcing, can be constrained by bathymetric features and cascade into the Southern Adriatic Pit area (Figure 1). Additionally, COAWST capability to couple different numerical models allowed to disentangle the relative importance of different aspects on dense water generation and propagation (e.g. the role of continental runoffs, the effect of deep energetic pulses on movable bottom sediments, the wave forcing terms on ocean circulation, mixing, and bulk fluxes). In addition to this, additional light was shed on the transport pathways on the shelf and to determine the different steps characterizing the sediment transport dynamics in the area (e.g. related to storms, cascading pulses, currents), in this benefiting from unprecedented spatial resolution and a new bathymetry reflecting very high resolution data acquired via multi-beam techniques.

This work has been partially funded by the Flagship Project RITMARE - The Italian Research for the Sea - coordinated by the Italian National Research Council and funded by the Italian Ministry of Education, University and Research within the National Research Program 2011-2013 and by the FIRB Project "DECALOGO", code RBFR08D828.

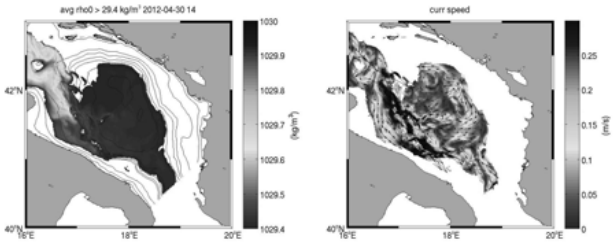

Fig. 1. COAWST model results. Sea bottom water density (left) and current speed (right) in the southern Adriatic Pit on April 30, 2012.

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SANDY SUBAQUEOUS DUNES ON THE MURCIA CONTINENTAL SHELF (WESTERN MEDITERRANEAN SEA)

R. Durán [1]*, J. Rivera [2], J. Guillén [1], E. De Cárdenas [3], A. Muñoz [4] and J. Acosta [2]
[1] Insituto de Ciencias del Mar (CSIC), Pg. Maritim de la Barceloneta, 37-49, 08003 Barcelona, Spain - rduran@icm.csic.es
[2] Instituto Español de Oceanografia, IEO, Corazón de María, 8, 28002 Madrid, Spain
[3] Secretaría General de Pesca, C/José Ortega y Gasset, 57, 28006 Madrid, Spain
[4] Tragsa-SGP, C/Julián Camarillo 6B, 28037 Madrid, Spain

Abstract
High-resolution multibeam data, sub-bottom seismic profiles and sediment samples have been acquired in the Murcia continental shelf (Western Mediterranean Sea) to characterize a field of subaqueous dunes observed in the middle to outer shelf. Bedforms are composed of sandy sediments and display asymmetric morphology, with crest to crest spacing ranging from 20 to 1400 m and an estimated height up to 1 m. Dune asymmetry and orientation reveal unidirectional along-shelf currents that are consistent with the regional circulation of the margin. This suggests that these bedforms could be formed by the action of the predominant geostrophic current flowing southwards along the shelf break and slope.

Keywords: Continental shelf, Swath mapping, Sediment transport, North-Western Mediterranean

Large subaqueous dunes have been observed in continental shelves worldwide, mainly in response to strong tidal [1, 2] or geostrophic currents [3, 4]. In the Murcia continental shelf (Western Mediterranean Sea), a large field of subaqueous dunes was observed in the middle to outer shelf off Águilas [5]. To further analyze this dune field, a cruise was carried out on board the R/V Angeles Alvariño in 2013. Swath bathymetry was collected using the Simrad EM 710 system (Fig. 1).

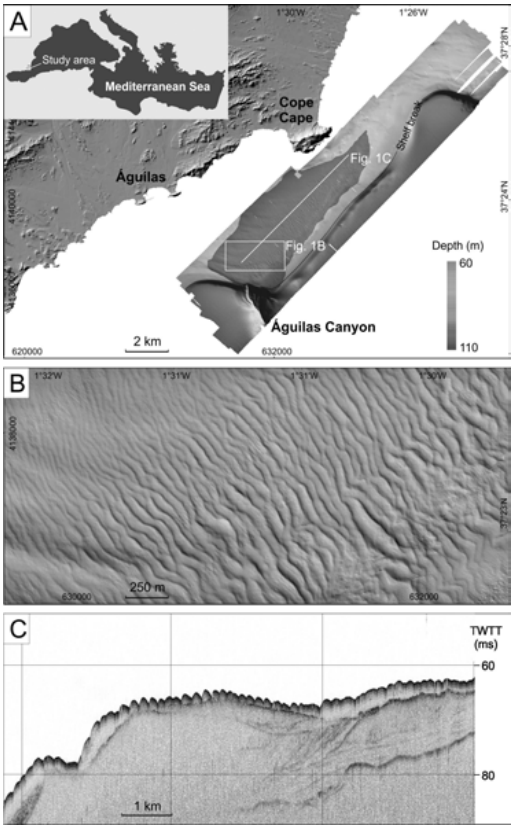

Fig. 1. (A) Bathymetry of the Murcia continental shelf showing the dunes field (grey shadowing). (B) Shaded relief image and (C) sub-bottom seismic profile of the subaqueous dunes.

Data were compared with those obtained in 2001 on board the R/V Emma Bardán using a Simrad EM-3000D system. Widely-spaced sub-bottom seismic profiles were acquired using a TOPAS PS 18 system. Additionally, twenty sediment samples were collected from the dune field (on the slope, crest and though of dunes) and the surrounding using a Box Corer.

In this work, we present the very detailed morphologic and sedimentological analysis of these features with the aim to discuss their possible mechanism of formation; and to assess their potential activity by comparing the present bathymetry with a previous survey in 2001. Dunes are widely distributed between 60 and 110 m depth covering an area of 23 km2 (Fig. 1). Dunes range from 20 to 1400 m in wavelength and from 0.2 to 1 m in height. They correspond to medium and large subaqueous dunes [6]. They display asymmetrical and slightly symmetrical (SI between 0.55 and 0.85) morphology with the lee side oriented towards the SW. Sea-bed samples collected from this area indicates that the bottom sediments are medium- to coarse-grained sands. The asymmetry of the dunes indicates unidirectional along-shelf currents that are consistent with the geostrophic flow described on the Murcia margin [7] suggesting that these features may be controlled by the regional circulation pattern. It is still an open question whether these bedforms remain actives at present. To investigate the long-term dynamics of dunes, two datasets of successive bathymetric surveys (2001 and 2013) will be compared together with time-series analysis of near-bottom currents.

Acknowledgements
This work is a contribution to the Spanish project FORMED (CGL2012-33989). We thanks Secretariat General of the Sea and Tragsa for the 2001 Project Espace data set, and to the Spanish Oceanographic Institute for the ship time of the Copesands cruise. Ruth Durán thanks the Consejo Superior de Investigaciones Científicas (CSIC) for a JAE-Doc research contract.

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TRANSFER OF SEDIMENTS AND ORGANIC MATTER BY A MARINE STORM IN THE CAP DE CREUS CANYON (GULF OF LION, NW MEDITERRANEAN SEA)

M. Higueras [1]*, P. Kerhervé [1], A. Calafat [2], A. Sanchez-Vidal [2], X. Durrieu de Madron [1], R. Buscail [1], J. Martin [3], N. Delsaut [1], C. Menniti [1], S. Heussner [1] and M. Canals [2]

[1] Univ. Perpignan Via Domitia, CEFREM, Perpignan, France - marina.higueras@univ-perp.fr

[2] GRC Geociències Marines, Universitat de Barcelona, Catalonia, Spain

[3] Institut de Ciències del Mar (ICM), CSIC, Barcelona, Spain

Abstract

In the Mediterranean basin, marine storms, often associated with flash floods of coastal rivers, are episodic and intense physical processes that are capable of transferring terrestrial organic matter to the continental shelf and up to the deep sea by strong bottom currents along submarine canyons. In order to study accurately a such event, an oceanographic cruise (CASCADE) was performed in the Gulf of Lion (NW Mediterranean Sea) in winter 2011. Two mooring lines equipped with a near-bottom sediment trap (25 m above bottom) were deployed at 290m and 365m water depth on the southern flank of the Cap de Creus Canyon. In order to characterize and to assess the origin of the particulate matter fluxes, the total mass flux, amino acids, opal, particulate organic carbon (POC) , as well as its stable isotopic ratio ($d^{13}C$) were determined.

Keywords: Canyons, Organic matter, Stable isotopes, Gulf of Lyon, North-Western Mediterranean

In the Mediterranean basin, marine storms are episodic and intense physical processes that are often associated with flash floods of coastal rivers. These events are capable of transferring terrestrial organic matter to the continental shelf and up to the deep sea by strong bottom currents along submarine canyons. With the aim of improving our knowledge on the transfer of material during extreme meteorological conditions, an oceanographic cruise (CASCADE) was performed in the Gulf of Lion (NW Mediterranean Sea) in winter 2011 [1]. This period is favorable for the study of intense meteoclimatic events and the resulting hydrodynamic processes such as dense shelf water cascading or storm events. During the CASCADE cruise, two mooring lines equipped with a near-bottom sediment trap (25 m above bottom) and a current-meter profiler, were deployed at 290m (Trap 1) and 365m (Trap 2) water depth on the southern flank of the Cap de Creus Canyon (Gulf of Lion) from the 4th to the 21st March 2011 (sampling interval of 35h) (**Fig.1**). In order to characterize particulate matter transfers, the total mass flux (TMF), amino acids, opal, particulate organic carbon (POC) , as well as its stable isotopic ratio ($d^{13}C$) were determined from the trapped material.

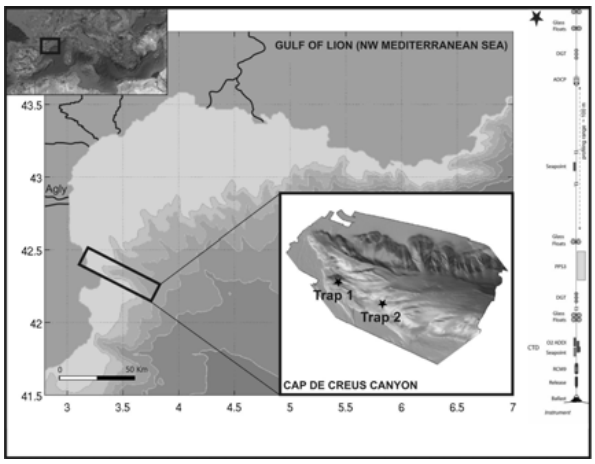

Fig. 1. Location of the Study Area and CASCADE mooring line model

An intense marine storm occurred during the cruise (from the 12th to 16th March 2011) with, simultaneously, flash floods at several nearby coastal rivers (e.g Agly River: flood peak of 1089 $m^3 s^{-1}$ with a return period of 15 years, for information the averaged runoff is 6.5 $m^3 s^{-1}$). At the peak of the storm, sediment traps collected around 150-200 g $m^{-2} d^{-1}$ of POC and opal depleted materials. The grain size distribution of the trapped material showed that settling particles were predominantly (around 75%) composed of silts (4-63 µm), although a slight increase of clays (<4µm) was observed during the storm. Moreover, the $d^{13}C$ values of bulk material varied slightly according to the TMF.

In order to improve our study on the trapped material, samples were fractionated into 3 size fractions: >63mm, 4-63mm and <4mm [2]. In the marine storm samples (cups # 7,8 and 9), the POC-richest grain size fraction was surprisingly the coarse material (POC≈ 4%), followed by clays (POC≈ 2%) and silt (POC≈ 1%) which tend to prove that organic-rich aggregates or biological debris were associated to the coarse lithogenic material. The $d^{13}C$ values of each of the grain size fractions were relatively constant within the silt and coarse fractions (between -25‰ and -24‰). In contrast, an isotopic $d^{13}C$ discrepancy occurred within the clay fraction of trap 1, more exactly in cups # 7, 8 ,9 and 11, which exhibited a more terrestrial isotopic signature (around -27‰). Terrestrial clays deposited into continental shelf sediments and the southern canyon flank were likely resuspended during the hydrodinamical processes of the storm which explain the ^{13}C-depleted values obtained during this period. On the other hand, the ^{13}C-depleted obtained after the peak flood (cup #11) may indicate a more direct transfer of riverine organic matter absorbed on clays.

This study show that the quality (nature and origin) of the trapped organic material during a storm changes according to the size of particles. Further grain size studies should be performed on the trapped material during low mass fluxes in order to get an overall view on the off-shelf export of particulate organic material hrough canyons of the NW Mediterranean Sea.

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SEDIMENT TRANSPORT DOWN TO THE BARI CANYON (SOUTHERN ADRIATIC): PROCESSES INVOLVED IN TRANSFERRING PARTICULATE MATTER TO THE DEEP BASIN

L. Langone [1]*, I. Conese [1], S. Miserocchi [1], A. Boldrin [1] and M. Turchetto [1]
[1] CNR-ISMAR, Institute of Marine Sciences - leonardo.langone@ismar.cnr.it

Abstract
Time-series of particle fluxes and hydrological data acquired on moorings deployed between 2004-05 and 2009-2012, document that dense shelf water cascading (shallow or deep) exerts first order control on the particulate fluxes through the Bari canyon system.

Keywords: Sediment transport, Deep sea processes, Bari Canyon

The Bari canyon is an area of dense shelf water (DSW) cascading. Particle fluxes and hydrodynamics were monitored by deploying 3 moorings in both branches of the Bari canyon and on the adjacent open slope from March 2004 to April 2005. Late March of both years were characterized by colder bottom waters, a notable intensification of bottom currents and increased particle fluxes, which indicated intense episodes of dense shelf water cascading. (Turchetto et al., 2007). The Bari canyon was thus showed to be an efficient conduit in delivering suspended sediment from shelf to deep basin. The origin of particles was a mix of marine material by biological production and sediment resuspended from the canyon head and upper slope (Tesi et al., 2008).

Nevertheless, further questions remain, such as: Cascading process occurs every year? Cascading is the only process driving the particle transfer across the South Adriatic margin? On a long time scale, the frequency of cascading events is decreasing due to global warming? To answer these issues, further observations were necessary. In March 2009, a new instrumented mooring (mooring DD) at 860 m water depth was deployed in a field of sediment waves situated down current to the Bari canyon. In March 2010, a second mooring was installed in the northern channel of the canyon mooring BB), in the same position of mooring B deployed in 2004.

Winters 2009-2011 were mild and wet. The Po river discharge remained relatively high throughout the whole winter. In winter 2012, the North Adriatic experienced a severe cold spell with Bora winds and reduced fresh water input from the Po river. The impact of these extreme weather conditions was the formation of extremely dense shelf water. During 2009-2011, trap fluxes showed much lower values with regards to the 2004-2005 experiment. Nevertheless, they varied both seasonally (spring peaks) and interannually. Very low near-bottom currents, never exceeding 20 cm s^{-1}, were recorded at both mooring sites. In addition, the water turbidity showed small amplitude peaks and the water temperature showed only minor decreases. In the canyon, fluxes were higher than those measured on the sediment wave field. In 2012, dense shelf water cascading enhanced mass fluxes up to 11 g m^{-2} d^{-1}. Total mass increased specially in the offshore station, where they were up to 5 times higher than peaks of previous years. In the canyon station, currents exceeded 70 cm s^{-1} and temperature dropped to 12.2°C at the near bottom. Surprisingly, the total mass peak occurred between 16 Feb-1 March, 3-4 weeks ahead of arrival of the North Adriatic Dense Water, suggesting the delivery of dense shelf water from another source area, maybe the Middle Adriatic Sea.

While is apparent that deep cascading of dense shelf water is the main process driving the particle transfer thought the Bari canyon in 2004-2005 and 2012, other processes, such as open ocean convection, storm-driven shelf-to-canyon particle transport, or shallow dense water cascading, were examined as forcing of the enhanced particle transfer during 2009-2011 springs.

No evidence was found to support the open ocean convection since peak fluxes were characterized by particles with low organic carbon contents, while high biological productivity would be expected from enhanced nutrient availability by the convective mixing. In addition, periods of high Chlorophyl-a by satellite images were not linked neither to periods of high TMF, nor to periods with higher OC contents.

The maximum significant wave height recorded at the Monopoli buoy was 4.78 m, but peaks of TMF and wave heights were only sometimes in phase. Hence, resuspension on the shelf by storm events and sediment transport down the canyon can be only a concause of increasing particles fluxes during springs.

In springs 2009-2011, the absence of signal of colder water at the near-bottom of the Bari canyon and in the sediment wave field, accompanied by weak currents, suggest the occurrence of shallow DSW cascading, which caused small-amplitude TMF peaks. In this condition, the poorly dense shelf water detaches from the sea bottom at its neutral buoyancy level and particles vertically sink from the intermediate nepheloid layer.

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ROCK OUTCROPS FROM FRENCH MEDITERRANEAN CANYONS: OBSERVATIONS FROM AAMP MEDSEACAN AND CORSEACAN EXPLORATION SURVEYS

M. Fourt [1], A. Goujard [1], J. Mascle [2]*, P. Watremez [3], P. Chevaldonné [4] and B. Daniel [5]
[1] GIS Posidonie, OSU Pythéas, Aix-Marseille Université, Campus de Luminy, Case 901,13288 Marseille, France
[2] Observatoire Océanologique, Université P. & M. Curie, Port de la darse, 06250 Villefranche/mer, France - mascle@obs-vlfr.fr
[3] Agence des aires marines protégées, Site Ifremer, Centre de Brest, BP 70, 29280 Plouzané, France
[4] UMR CNRS 7263, IMBE, Aix-Marseille Université, Station Marine d'Endoume, Rue de la Batterie des Lions, 13007 Marseille, France
[5] Agence des aires marines protégées, Antenne Méditerranée, 26 rue de la République, 13 001 Marseille, France

Abstract
Outcrops of rocks, directly exposed along the upper steep slopes (roughly between the shelf break and down to 800m) of several canyons and on deep rocky banks along southern France and western Corsica continental margins, have been observed during ROV explorations performed by Comex, from late 2008 to mid 2010, under the sponsorship of the French Marine Protected Areas Agency (AAMP). Video observations of these outcrops (unhappily not sampled) show several types of rocks ranging from thinly laminated white marls, massive conglomerates and sandstones, to probably aerially eroded metamorphic, magmatic and granitic rocks. In addition numerous fossil oysters banks have been observed on the Maures, Esterel and Corsica upper slopes by depth ranging between 240 and 750 m water depths.

Keywords: North-Western Mediterranean, Canyons, Continental slope, Rhone Fan

Between late 2008 and mid 2010 the French Marine Protected Area Agency (AAMP) has conducted, with the technical support of Comex SA, systematic explorations of 43 sites located within 13 areas of the French Mediterranean upper continental margins from the Spanish to the Italian borders (30 sites) and west of Corsica (13 sites). The aims of this program were chiefly to obtain states of reference concerning the local/regional environment variability, the protected, and potentially commercial, biological species, and to evaluate the potential various human impacts along the upper continental slope (from the shelf break to locally 800m), particularly within canyons heads and on several deep rocky banks. An unexpected, but not surprising, result from these explorations has been the observation of numerous rock outcrops, which in turn reflect the variability of the geological strata in which these canyons have been cut since the creation of the Western Mediterranean basin in Oligocene times. Off the Gulf of Lions coasts and with the exception of the "*rech Lacaze-Duthiers"*, all canyons appear entailed within Pliocene to Quaternary soft marls [1]. Off Provence, from the *Planier* to the *Blauquieres* banks, the upper continental slope is dissecting hard rocks, which show evidence of aerial erosion, and are presumed to be massive limestone similar to the nearby onshore *Calanques* karstic massifs. Aerial erosion is similarly believed to have shaped most of the likely metamorphic rock outcrops seen in a wide area from Toulon to Levant Island. Blocs of geometrically shaped formations, likely made of sandstone, or siltstone, probably of upper Oligocene/Miocene age, have been observed on the *Magaud* bank along the southern side of the *Stoechades* canyon, where such formations had previously been discovered and sampled [2]. Off Nice, in the *Paillon* canyon, massive conglomerates, of probable Pliocene age, and various marls, also already observed during several previous surveys [3] are locally outcropping by water depth between 400 and 660m. Finally the several ROV surveys, made in various canyons off western Corsica, have mainly shown massive hard rocks, whose nature is difficult to asses without sampling, but which seem to be made of aerially-eroded granite (St Florent to Calvi), rhyolites (of Galeria) and maybe volcanics. Off Propriano, along the *Valinco* and *des Moines* canyons slopes, white indurated marls are observed between 300 and 500m; they may tentatively be attributed to early Pliocene marine deposits. As for the southern french coasts, unfortunately no sampling was performed and therefore our geological attributions remain speculative. In many of the "rocky" canyons, off Provence, Maures, Esterel and Corsica, linear narrow banks of dead, or fossil, big oysters, already locally described in some areas of the Western Mediterranean, and dated around 3500 BC [4], have been observed by water depths ranging between 240m (Galeria canyon) and 700m (off Levant island).

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PROCESSES ON THE PRECIPICE: SEAFLOOR DYNAMICS ACROSS THE UPPER MALTA-SICILY ESCARPMENT.

A. Micallef [1]*, A. Georgiopoulou [2], T. Le Bas [3], J. Mountjoy [4], V. Huvenne [3] and C. Lo Iacono [3]
[1] University of Malta - aaron.micallef@um.edu.mt
[2] University College Dublin
[3] National Oceanography Centre
[4] National Institute of Water and Atmospheric Research

Abstract
The Malta-Sicily Escarpment (MSE) is a steep, sediment-undersupplied, carbonate escarpment incised by a series of submarine canyons. In this study we present data acquired from the upper MSE during the Eurofleets-funded CUMECS cruise to document a complex seafloor morphology comprising gullies, canyon heads, mass movement scars, channels, contourites and escarpments. The evolution of the upper MSE has been driven by the interaction of fault activity, sedimentary activity related to hemipelagic, pelagic and contouritic sedimentation, and seafloor incision by bottom current activity. Submarine mass movements play a key role in canyon development – they control the extent of lateral and headward extension, facilitate tributary development, remove material from the continental shelf and slope, and feed sediment into the canyons.

Keywords: Canyons, Geomorphology, Sediment transport, South-Central Mediterranean

The Malta-Sicily Escarpment (MSE) is a dominant morphological feature of the central Mediterranean, comprising a steep, 3 km high, NNW-SSE trending carbonate escarpment that extends 250 km southwards from the east coast of Sicily [1-2]. The MSE may be classified as a sediment-undersupplied margin because of the low estimated post-Messinian sedimentation rates in the region (~6 cm ka^{-1} [3-4]), as well as its isolation from terrestrial and coastal sedimentary inputs after the Messinian Salinity Crisis [5]. Studies carried out in the 1980s demonstrated that the MSE is also incised by a series of submarine canyons [2]. In June 2012, the Eurofleets-funded CUMECS cruise acquired multibeam echosounder data, high resolution seismic profiles and gravity cores from across 500 km^2 of seafloor across the upper MSE. These data reveal a complex and diverse seafloor morphology, which comprises: (i) A dense network of gullies and distinct larger and wider channels that extend all the way from the heads of the canyons to the shelf break. (ii) Four channels in the deepest part of the outer Malta Plateau. The longest channel (12 km long) dominates the northern part of the study area and its steeper northern wall is covered by a contourite. (iii) 67 mass movements, ranging from translational slides to debris flows, which affect the outer Malta Plateau and upper MSE. (iv) Elongated escarpments, some of which are colonised by *Antipatharia*, encrusting sponges and hydroids. These observations indicate that the upper MSE has been an active area of seafloor, and that its evolution has been determined by the interaction of: (i) fault activity, (ii) sedimentary activity, driven by hemipelagic, pelagic and contouritic sedimentation, (iii) seafloor incision, related to bottom current activity, and (iv) slope instability. The MSE presents an excellent study area to understand how mass movements and canyon processes may be interrelated. The mass movements are likely triggered by loss of support associated to channel and gully incision, canyon head retreat or retrogressive landslide development. The mass movements control the extent of lateral and headward extension of the canyons across the continental slope and shelf, as well as facilitate tributary development. They also remove material from the continental shelf and slope, feeding sediment and driving its transport down-canyon.

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Session

Marine Geohazards

Modérateur : **Jean Mascle**

TSUNAMI EFFECTS ON THE EASTERN COAST OF SAROS BAY, TURKEY

Y. Altinok [1]*, B. Alpar [2], C. Yaltirak [3], N. G. Kiyak [4] and C. Zabci [3]
[1] Istanbul University Engineering Faculty - yaltinok@istanbul.edu.tr
[2] Istanbul University, Institute Marine Sciences and Management, Istanbul
[3] Istanbul Technical University, Mining Faculty, Geological Engineering Department, Istanbul
[4] Isik University, Faculty of Science and Arts, Physics Department, Istanbul

Abstract
Four tsunami layers (S7, S8B, S10 and S11) have been defined on the coastal deposits of the Saros Bay, North-eastern Aegean Sea. The sample S7 corresponds to 330 BC tsunamigenic earthquake. S8B and S10 may correspond to the events 394, 476 or 484, while S11 to 1437, 1456 or 1471.

Keywords: Saros Bay, Geohazards

Introduction:

The study area is located on the western extension of the northern branch of North Anatolian Fault Zone (KAFZ). More than 40 earthquakes of M≥6.0 magnitudes, 10 of which in or near the Saros Bay, occurred in the northern Aegean region from 479 BC to present. Even their historical data is extremely scarce, some of these earthquakes have resulted in tsunamis (Figure 1).

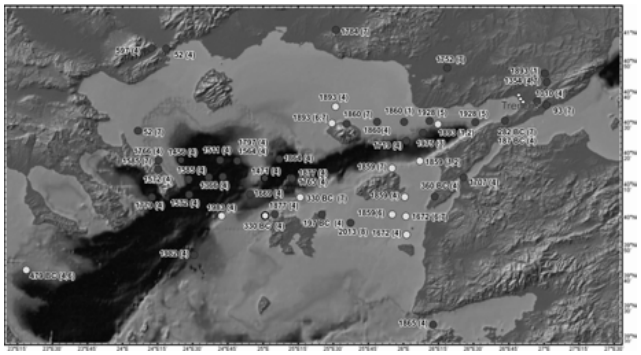

Fig. 1. Earthquakes of M≥6.0 magnitudes which affected the Saros Bay.

Experimental details:

We opened 15 trenches (S1 to S15) in the eastern part of the Saros Bay within the scope of EU project "Tsunami Risk And Strategies For the European Region" (TRANSFER). On the basis of stratigraphic setting, some candidate tsunami deposit samples have been collected for elementary analyses and also for age determination using Optically Stimulated Luminescence (OSL) method.

Results:

Many traces of liquefaction have been detected in the trenches of S12 (levels A and B), S13, S14, S15 (level B) and S15 (level C). Depending on their OSL ages, the sample S13 (1755±54) may be related to the one of the earthquakes occurred in 1659, 1719, 1730, 1752 or 1756, while the sample S14 (1458±37) may correspond to 1402 or 1456 events. None of these liquefaction events correspond to available tsunami records.

The sample S7 dates back to 327±150 BC, corresponding to 330 BC earthquake. The samples of S8 (level B) and S10 date back to 436±98 and 525±132, respectively. The dates of these two samples cover the time span of the earthquakes 394, 476 and 484. The sample S11, on the other hand, dates back to 1454±48, which may correspond to one of the earthquakes occurred in 1437, 1456 and 1471. The only earthquake whose tsunami data has been accurately documented is 330 BC. The study area deserves further paleotsunami studies and numerical tsunami modelling.

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WIDE SPREAD GAS EMISSIONS IN THE SEA OF MARMARA, RESULTS FROM SYSTEMATIC SHIP-BORNE MULTIBEAM ECHOSOUNDER WATER COLUMN IMAGERIES

S. Dupré [1]*, C. Scalabrin [1], L. Géli [1], J. Augustin [1], P. Henry [2], C. Grall [2], N. Çagatay [3], N. Görür [3] and C. Imren [3]
[1] IFREMER, France - stephanie.dupre@ifremer.fr
[2] CEREGE, France
[3] Istanbul Technical University, Turkey

Abstract
The Sea of Marmara located on the transform plate boundary between the Eurasian and Anatolian plates is characterized by an intense seismic activity causing catastrophic earthquakes (Ambraseys and Jackson, 2000). The understanding of the evolution of the fluid-fault coupling processes during the earthquake cycle is a challenge and the acoustic detection of gas emissions through the seabed may provide new insights on these processes. Fluid escapes are known to occur at the seabed in the Sea of Marmara (Zitter et al , 2008). The primary goals of the conducted study were to 1) establish an accurate spatial distribution of the seeps at the scale of the entire sea and 2) investigate the relationship with the fault network and the sedimentary environment.

Keywords: Acoustics, Geohazards, Tectonics, Marmara Sea

The submerged section of the North Anatolian Fault system within the Sea of Marmara is characterized by an intense seismic activity, but also by an intense fluid activity at the seabed. The understanding of the evolution of the fluid-fault coupling processes during the earthquake cycle is a challenge and the acoustic detection of gas emissions through the seabed may provide new insights on these processes.

The water column above the submerged section of the North Anatolian Fault within the Marmara Sea was investigated in 2000 and 2007 using side-scan and single beam sonars, acoustic techniques along a few, unevenly distributed profiles (Géli et al, 2008). Most gas emissions in the water column were found near the surface expression of known active faults. However, the effect of a possible bias related to profile implementation could not be entirely discarded. A systematic survey of the deepest areas of the Sea of Marmara (> 300 m), was thus conducted in 2009, using a ship-borne, multibeam echosounder, in order to establish an accurate spatial distribution of the seeps at the scale of the entire sea and to investigate the relationship with the fault network and the sedimentary environment.

Gas emissions clearly appear to be controlled by a combination of factors, including the tectonic activity, but also the presence or not of deep gas reservoirs and the nature of sediment cover. The multibeam, acoustic dataset provides an unique, unprecedented picture of the gas distribution within the deepest parts of the Sea of Marmara, that may usefully contribute to help understand some of the complexities of the tectonic history of the present-day North-Anatolian Fault. The distribution of gas emissions suggests that the Thrace Basin gas province is bounded by the Main Marmara Fault to the south and by the Thrace-Eskisehir Fault to the east and supports the idea that the area that gave birth to the present-day Sea of Marmara, is a broad shear zone, which has been characterized by a succession of episodes of strain localization and of strain partitioning.

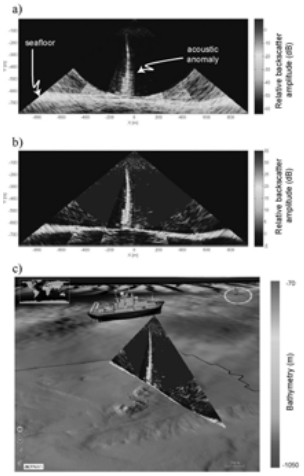

Fig. 1. A) b) Raw and processed polar echograms from EM302 multibeam echosounder water column data (Sonarscope © Ifremer). The acoustic anomaly recorded at 660 m waterdepth is located in the Western High above an active mud volcano located close to the North Anatolian fault (650 m). The acoustic imprint of the plume reaches almost the surface with an height of 600 m above the seabed. c) 3D view (Sonarscope 3DViewer © Ifremer) of the seabed with georeferenced processed polar echogram displayed in Fig. b. Note the R/V L'Atalante (courtesy of Altran) is not to scale. The background bathymetry was acquired in 2000 (Marmara expedition) with a Simrad EM300 multibeam echosounder while high-resolution bathymetry was recorded in 2009 (Marmesonet expedition) with a EM2000 echosounder mounted on the Aster^X AUV (Ifremer).

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SHORT TERM MORPHOLOGY EVOLUTION OF NICE CONTINENTAL SLOPE (LIGURIAN SEA)

Maëlle Kelner [1]*, Sebastien Migeon [1] and Emmanuel Tric [1]
[1] Géoazur - kelner@geoazur.unice.fr

Abstract
Time series bathymetric data acquired between 1991 and 2011 have been used to evaluate the morphological evolution of Nice continental slope (South East of France, Ligurian Sea). This quantitative analysis highlights alternation between low morphological variations and erosional events with consequent volumes lost at shallow water depth (0-200m). On the basis of local seismic data, hydrogeological analysis and previous sedimentological analysis, we try to define the triggering erosive mechanism on a few years period.

Keywords: Ligurian Sea, Geohazards, Bathymetry, Continental slope, Geomorphology

Due to the urbanisation growth in the coastline, a greater assessment and predictive risk ability is becoming paramount regarding natural hazard generated in marine environment. Erosion and evolution of continental slopes through time are mainly due to sedimentary process such as submarine failures. This fast morphological evolution is featured by large landslides scars and deposits (volumes can exceed several hundreds of km3). Those large-scale failures have a strong impact but their return period is about several thousand years or more [1]. At smaller time scales, small failures with a volume of several hundreds of m3 are much more common. These failures lead to: (a) regressive motion of continental slope towards the coastline and (b) the deposition of high-frequency turbidites in the deep basins. This small-scale phenomenon acting on short time scale is significant, but is still difficult to detect.

The continental slope offshore the city of Nice (South East of France, Ligurian Sea) has been studied to address the problems of small-scale failures morphology, recent landslides triggering and volumes that could be remobilised during a failure event. Nice is located between the Southern Alps flank and the Northern continental slope of Ligurian sea (western Mediterranean). Cohesionless sediments on oversteepening slopes are affected by moderate seismicity and anthropogenic constructions extended offshore. Moreover, the few but violent Mediterranean rainfalls have an impact on sediments stability because of groundwater outflow. Such as a natural laboratory, this Ligurian margin is characterized by numerous submarine landslides [1]. The most recent and mediatized was initiated in October 16th 1979. This event partially destroyed the new international airport complex of Nice and triggered a 2m tsunami. Thus we focused our study on this high vulnerability area affected by recent instability to define and understand actual erosion process.

Identification of potential areas where slope movements could be triggered requires data with high spatial resolution. For this purpose we have used all the very high resolution multibeam bathymetry dataset acquired between 1991 and 2011. HD Bathymetric data was collected in the frame of different projects: EM1000 Ifremer (spatial resolution 10m, 1991), Creocean (1m, 1999), AUVGEO (2m, 2006), Haligure (1m, 2009) and MRIS (1m, 2011). The covered zone varies according to each of these cruise but data are common on an area from the coastline to 300m seaward and comprise the 1979 scars in front of Nice-côte-d'Azur Airport. Maps comparisons have been done for each time step, using two different techniques: (a) ArcGIS 3D analysis tools "Cut fill" which calculates the volume change between two surfaces pixel by pixel, and (b) an isobaths location comparison each 10m deep to highlight the regressive erosion.

Those methods have revealed the current evolution in space and time of the submarine morphology at shallow water depth (0-200m). Moreover it has provided the specific background to quantify erosion processes of the last 20yrs. Regarding to space evolution, areas of major sedimentation are principally located on gentle slopes (<7°). Moreover, our analysis shows some exceptions of sedimentation on bigger slopes for example the infilling of former thin channels and slide scars. They are rapidly filled and failure morphology could disappear from the sea floor in less than 5years. Biscara et al. (2012) [2] had the same filling results for Gabon slope in about 15-20years. Areas of major erosion failures have been determined mostly on slopes bigger than 10°. They define a scarp and its associated evacuation channel. The airport contours and the 1979 scarp show slow erosion processes. Nevertheless the main repartition of sedimentation/erosion leads us to say that the 1979 scar is still slowly moving. However, it appears that it is not currently the most active zone on the top slope. With these investigations we have established a high-precision quantification of sedimentation and erosion rates along different time intervals. Between 1991 and 2011, alternation between periods of low morphological variations and periods of failure events with consequent volume losses is clearly visible: erosion volumes are multiplied by a factor of 10 during fast periods. Similar small failure event with a return periods of around 5years were highlighted by Smith et al. (2007) [3] in upper Monterey Canyon (California).

Interpretations in term of triggering processes are still in progress using hydrogeological data, regional catalogue of seismic activity and previous sedimentological analysis. Actually such short time variation may be explained: (a) by specific local characteristics such as the presence of sensitive sediment layers reacting to freshwater phreatic inflow due to intense storms on the watershed [4]. For this purpose we are looking at hydrogeological data: rainfall, volumetric flow rates, groundwater outflow. (b) It is also possible that ground motion generated by moderate size earthquakes during the analysed period had a key role in the failure acceleration. In order to analyse this we are using seismological location and PGA values. Finally, (c) sedimentation rates, overload and critical slope can play a fundamental role. It will be initially studied with previous geological and geotechnical research.

These observations and quantifications reveal failure processes that are still quite active and significant over very short periods of time. This whole study is a next step in term of current stability evaluation of the Nice submarine slope which requires the precise identification of slope instabilities, evaluation of their recent and past activity and discrimination of triggering factors.

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ACTIVE SEABED PROCESSES AND POTENTIAL GEOHAZARDS IN THE CENTRAL NILE DEEP-SEA FAN FROM INTEGRATED SWATH BATHYMETRY AND 3D SEISMIC DATA

F. Mary [1]*, S. Migeon [1], E. Cauquil [2], J. Mascle [3] and P. Imbert [4]
[1] Géoazur, Valbonne, France - flmary@geoazur.unice.fr
[2] Total, Paris La Defense, France
[3] Observatoire de Villefranche sur Mer, France
[4] Total, Pau, France

Abstract
Geohazards are consequences of geological processes. If not identified, they may put at risk industrial activity such as subsea installation or drilling, with potential impact on safety and environment. Previous studies showed that the Central Nile Deep-Sea Fan (NDSF) is characterized by a rough and chaotic seabed surface and affected by numerous gravitational instabilities such as landslides as well as by fluid seepages [1]. Mapping this area from swath bathymetric and seismic investigation of the seafloor allowed identify several features directly on the seabed such as active fault scarp, fluid seepages, mass-wasting and mass-flow, or detected in subsurface sedimentary layers such as shallow fault, buried channels, mass transport deposits (MTDs), and shallow gas-charged sediments, which may induce potential and considerable geohazards.

Keywords: South-Eastern Mediterranean, Nile Delta, Bathymetry, Geohazards

Different types of geological geohazards are known to affect continental margin environments. Following a nomenclature defined by Stauffer et al (1999) [2], they can be divided into seabed geohazards (fault scarp, fluid venting, landslides, debris flows) and subsurface geohazards (shallow faults, buried channels and landslides, shallow gas-charged sediments). Among these processes, submarine landslides are among the most abundant and are the main causes for remobilization and transfer of large volumes of sediments on continental margins. Slope destabilizations may cause destruction of infrastructures like drilling platforms, posed or anchored at the seafloor, and may also induce tsunamis in coastal areas. In marine environments, geohazard and risk assessments are thus requiring valuable identification of the different geohazard-related structures and of their signatures, as well as a tentative evaluation of their recent and past activity. This study focuses on the Central NSDF where numerous shallow submarine landslides and abundant fluid seepages have already been identified [3; 4]. Based on a dataset including multibeam bathymetry and backscatter, Chirp and seismic-reflection profiles (Géoazur laboratory) together with 3D seismic data (Total Company), a detailed mapping of the main geohazard-related structures has been established for the study area. On the seabed, failure-related structures are the most abundant and cover up to 25% of the surface of the studied area. Three types of mass-wasting and mass-flow events were observed on the continental slope: (a) Debris flows, characterized by 25-50 km long and 3-5 km wide bodies elongated in the main slope-angle direction; these features were triggered along the upper part of the continental slope where they left spoon-shaped scarps 25 m high. Some debris flows exhibit hundreds of scattered blocks (up to 3 m high and 40-100 m wide) rafted on top of the flows and arranged into linear segments. (b) Slumps are mainly located on the upper slope between 300-435 m water depths; they show as scarps (5 m high) followed downstream by lobate remobilized deposits (3-6 km long, 0.3-1.5 km wide). (c) Finally seabed sedimentary undulations are observed in the northwestern part of the study area, by water depths greater than 1200 m, and cover about 15% of the studied area. These features are 0.05-3 km long and oriented W/E to N-NW/S-SE. On seismic data, they are seen as overlying MTDs. We interpret them either as creeping/extensional features associated with shallow rotational faults or as sediment waves as described elsewhere [5]. Dendritic network of curved grooves lies on the upper continental slope around 900-1100 m water depths; they represent about 5% of the studied area. They are also seen on top of buried MTDs and are interpreted as extensional seabed fractures. Fluid seepage areas, which include large fields of pockmarks and seven mud volcanoes (MV) represent about 5% of the surface of the studied area. Some MVs exhibit recent activity markers such as mud flows. Finally, normal fault scarps, up to 70 m high and few kilometers long, were observed. They are oriented N/S to W/E. On seismic profiles, they can be recognized up to more than 1 s penetration below seafloor and clearly affect deep sedimentary layers; they are believed to be part of the deep Rosetta Fault system. Most of these structures exhibit a well-developed expression at the seafloor, suggesting they have been triggered/deposited (failure-related structures), active (fluid seepages) and/or rejuvenated (fault scarps) during recent times. From 3D seismic, shallow fault, buried channels, MTDs, and shallow gas-charged sediments, were identified within the first 300 ms below the seafloor. The different types of processes affecting the present-day seafloor should thus have had a recurrent activity for a long time period of time. Because of their number and of their distribution, mass-wasting and mass-flow events represent the strongest geohazard within the studied area. Together with fluid ventings, they could have a high hazard potential. Since only few historical earthquakes are known on the Egyptian margin, faulting should represent by opposition a relatively low hazard potential. Our interpretations should however be confirmed by attempts of dating of these processes.

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GEOACOUSTIC CHARACTERIZATION OF THE MARMARA ISLANDS SHELF MARGIN, TURKEY

Kurultay Öztürk [1]*, Denizhan Vardar [1] and Bedri Alpar [1]
[1] I.Ü. Institute of Marine Sciences and Management - kurultay@istanbul.edu.tr

Abstract
Acoustic properties of the sea bottom and its dominating structural features have been detected in the vicinity of the Marmara islands, SW part of the Sea of Marmara. Based on new high-resolution chirp seismic reflection data collected in 2010, a series of W-E trending faults bounding the Marmara Island to the south caused characteristic deformative structures on the sea floor. The fault lineation outlined in this study by the aid of distribution of earthquake epicenters were interpreted as antithetic faults, whose sense of displacement is opposite to its associated major fault; namely the northern branch of the North Anatolian fault. Parallel to the global sea level rise, they must be active during the recent evolution of this archipelago within the regional framework of extensional tectonic regime.

Keywords: Marmara Sea, Seismics

Introduction The study area covers the shelf area of the Marmara Islands which are an archipelago in the Sea of Marmara, located in its mid-west portion, off the Kapidag Peninsula on the Asian coast. Among other smaller islands Ekinlik, Koyun, Hayirsiz, Fener, Yer, Tavan and Mamali, the Marmara Island is the highest (710 m) and biggest with a surface area of 117 km^2 [1]. The region has been affected by two moderate-scale earthquakes occurred in the years 1265 and 1935, both representing similar characteristics. Both of them were shallow and affected the western side of the Marmara Island mostly [2]. The main scope of this study is to identify shallow active tectonic features on the sea floor and define seismotectonic characteristic of the region.

Material and Method Chirp seismic experiments are effective and feasible ways for the characterization of the sea bottom structures. We have collected 350-km-line chirp data using Bathy 2010P™ Chirp sub-bottom profiler with 4 transducers, each producing 2-8 kHz simultaneous chirp signals, in array configurations to provide full power capability. Peak signal detection allowed the system to provide high performance sub-bottom survey capability. The depths were obtained using a typical interval velocity of 1500 m/s, which has been found to be appropriate for both the water column and near-surface siliciclastic sediments. We obtained a depth resolution of 0.2 meters with 50-60 meters of bottom penetration, depending on the bottom type and selected pulse length. Kogeo Seismic Toolkit 2.7 was used for elementary data processing.

Results and Discussion Knowledge of the acoustic properties of the sea bottom is necessary in every aspect of marine sciences. The seismic data we gathered represents a series of faults mostly extend east to west and parallel to the southern coast of the Marmara Island, in addition to rapidly changing deformative structures on the sea floor and slump-like features behind these faults (Fig. 1). Stratigraphically the structural elements are evidently small-scale secondary faults with normal-to-oblique character, at the western extension of the boundary fault along the northern shores of the Kapidag Peninsula.

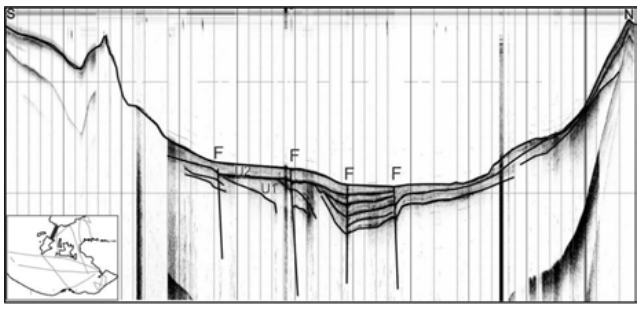

Fig. 1. Succession of normal faults between the Marmara islands

The sediments within the basin are lengthened by these antithetic normal faults possibly dying in a major synthetic curve fault limiting the hanging wall in downdip direction. These are believed to be active faults, which may have been triggered or re-activated by bigger earthquakes (M>7.0) occurring on the main fault cutting through the deep basins of the Sea of Marmara. The distribution of the instrumental earthquakes (Ms≥3) occurred between the years of 1930 and 2012 [3] also reveals this secondary fault activity within the study area (Fig. 2). In conclusion, the structural elements outlined in the study area are directly related with the antithetic faults of the northern branch of the North Anatolian fault, and controlled the development of the shelf area between the Marmara islands.

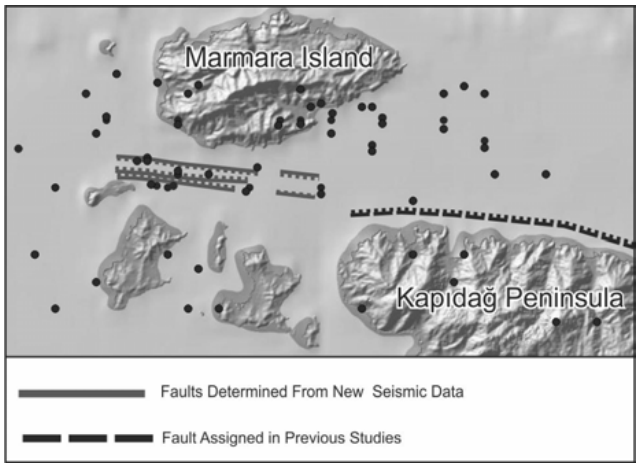

Fig. 2. The comparison of the faults defined in this study with the epicentral locations of the earthquakes (Ms≥3)

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LATE QUATERNARY ACTIVE TECTONICS AROUND THE SOUTEASTERN AEGEAN SEA

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

Abstract
The high resolution seismic data has been obtained in order to reveal the tectonic activity around the southeastern Aegean Sea. The region is very important in terms of its location in the major plate boundary near the intersection between the Hellenic and Cyprus arcs. A number of active faults have been detected on the seismic profiles that related to this active tectonism.

Keywords: Tectonics, Seismics, Aegean Sea

Introduction
The southern Aegean Sea is a very important region in terms of its seismicity and morphotectonic features. The region has important tectonic significance due to its location in the major plate boundary within the eastern Mediterranean collision zone, near the intersection between the Hellenic and Cyprus arcs. The collision between the Arabian and African plates with Eurasia and the westward motion of Anatolian plate relative to Eurasian plate give rise to N-S extension of the southern section ([1]). This tectonic structure comprises E-W oriented grabens since the Miocene times ([2]). Epicentral distribution of the earthquakes shows a high seismic activity in this region.

Study area
The study area is located in the southeastern Aegean Sea, including Gökova and Hisarönü Gulfs which are bordered by the Bodrum Peninsula to the north and the Bozburun Peninsula to the south (Fig.1). The Gökova Gulf is characterized by wide eastern shelves, narrow southern and northern shelves. Datça Peninsula is bounded by E-W directed fault system located in its both northern and southern border. In the eastern Hisarönü shelf, seafloor gradients are lower than 0.4º ([3]).

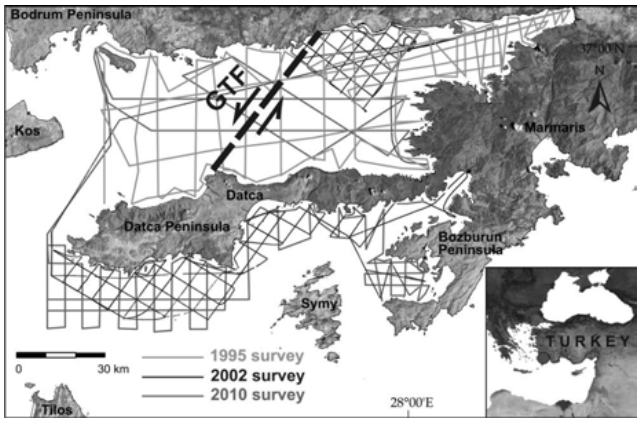

Fig. 1. The location map of study area and seismic lines. GTF: Gökova Transfer Fault.

Materials and Methods
This high-resolution seismic survey was carried out by using 40 in3 Airgun source and 3.5 kHz Subbottom Profiler and Chirp systems in 1995, 2002 and 2010 during a cruise of R/V K. Piri Reis of Institute of Marine Science and Technology (Fig. 1).

Results
The high resolution seismic data have been collected at the southeast Aegean Sea in order to investigate the late Quaternary tectonic activity. A large number of active faults have been detected on the seismic profiles. Overall fault pattern of Gulf of Gökova shows a significant distinction between the western and eastern sectors which separated by Gökova Transfer Fault (GTF, [4]) (Fig. 1). A number of earthquakes were occurred on GTF zone in 2004, in contrast to known E-W direction fault system. This active basin which is associated with strong earthquakes may continue to produce destruction and coastal subsidence. A numerous faults were detected in the western Datça Peninsula ([3]) and Gökova Gulf (Fig. 2). The traces of destructive seismic activity can be seen in the ancient Knidos city. The ongoing tectonic movement of the southeastern Aegean Sea and its surrounding area was always important and should be considered as a region which has the potential to produce earthquakes.

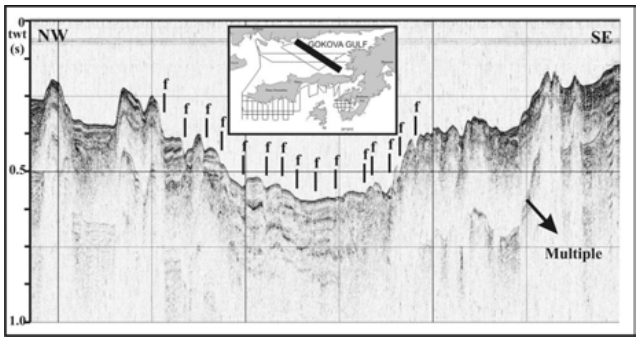

Fig. 2. Airgun seismic reflection profile from Gökova Gulf. f: Fault. Bold line shows the location.

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Session

Marine organic pollutants

Modérateur : **Gert J. de Lange**

POLYCYCLIC AROMATIC HYDROCARBONS IN SEDIMENTS FROM CYPRUS

E. Darilmaz [1]*, A. Kontas [1], E. Uluturhan [1], I. Akçali [1] and O. Altay [1]
[1] DEU, Institute of Marine Sciences and Technology Baku bulvari No:100 Inciralti-Balcova - enis.darilmaz@deu.edu.tr

Abstract
This study presents 16 US EPA polycyclic aromatic hydrocarbons (PAHs) in 23 surface sediments from Cyprus, Mediterranean. The concentrations of total PAHs were ranged between 4.9-76 ng/g and could be generally considered to be low. The results showed that Naphthalene was the predominant species among the analyzed compounds. PAHs with two and three rings were generally the most abundant, both contributing 50–90% to the sum.

Keywords: Pah, Sediments, North-Eastern Mediterranean

Introduction
Polycyclic aromatic hydrocarbons (PAHs) are well known as environmental pollutants. They are dangerous even at low concentrations and included in the priority pollutant list of the European Union and US Environmental Protection Agency (EPA) due to their mutagenic and carcinogenic properties [1], [2]. The island of Cyprus is located in the Mediterranean Sea and maritime transportation, tourism, treated or untreated domestic and industrial wastewater discharges, oil spills, agricultural wastes reaching the sea by rivers and also mining activities are the main reasons of pollution along the coast of Cyprus.

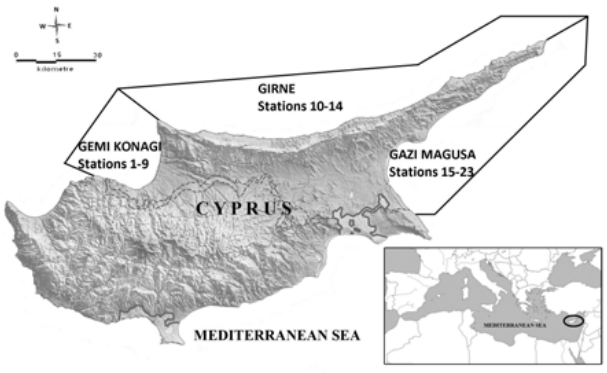

Fig. 1. Sampling areas of Cyprus

Materials and Methods
Surface sediment samples were collected from 23 stations using box core during a cruise of the R/V K. Piri Reis in 2010. This study founded by the Turkish Scientific and Technological Research Council TUBITAK/111Y160. All sampling procedures followed according to internationally well established guideline [3]. Sediment samples were freeze-dryed, sieved (250 μm) and extracted using the microwave system. Extracts were analyzed using an Agilent GC-MS.

Results
Sixteen parent PAHs (naphthalene: Nap; acenaphthylene: Acy; acenaphthene: Ace; fluorine: Flu; phenanthrene: Phe; anthracene: Ant; fluoranthene: Flt; pyrene: Pyr; benz[a]anthracene: BaA; chrysene: Chr; benzo [b]fluoranthene: BbF; benzo[k]fluoranthene: BkF; benzo[a]pyrene: BaP; indeno [1,2,3-cd]pyrene: InP; dibenz[a,h]anthracene: DA; benzo[g,h,i]perylene: BPer) were analysed in sediments. Individual PAH concentrations (ng/g) in sediments ranged between 3-42 for Nap; 0,41-3.55 for Acy; 0.01—0.53 for Ace; 0.02-3.61 for Flu; 0.51-15.3 for Phe; 0.52-12.2 for Ant; 0.25-11.1 for Flt; 0.14-8.39 for Pyr; nd-3.56 for BaA; nd-6.24 for Chr. BbF and BkF were detected only two stations and BaP, InP, DA, and BPer were not detected. Among the all analyzed compounds, Naphthalene was the predominant species. PAHs with two and three rings were generally the most abundant, both contributing 50–90% to the sum. The minimum concentrations of Nap, Acy, Flu, Phe, Ant, Flt, Pyr, BaA and Chr were detected at Gemi Konagi area (Station 7). The maximum concentrations of Ace and Phe were obtained at Girne area besides the highest Nap, Flu, Ant, Flt and Pyr were found at Gazi Magusa area. It is explained that the relatively high individual PAHs and total PAH concentrations at Girne and Gazi Magusa areas depend on shipping, port and maritime activities. Total PAH concentrations ranged from 4.9 to 76 ng/g in sediment from Cyprus. The minimum total PAH level was found at station 7. According to Baumard et al. [4], levels of PAHs can be generally considered to be low.

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MARINE ORGANIC POLLUTANTS IN SURFACE SEDIMENTS FROM THE EASTERN AEGEAN COAST

Tolga Gonul [1], Filiz Kucuksezgin [1] and Idil Pazi [1]*
[1] Institute of Marine Sciences and Technology - idil.erden@deu.edu.tr

Abstract
Aliphatic and polycyclic aromatic hydrocarbons, organochlorinated compounds were determined in surficial sediments from the Aegean Sea in 2008. Total aliphatic hydrocarbons ranged from 330 to 2,660 ngg^{-1} dwt, while aromatics varied between 73.5 and 2,170 ngg^{-1} dwt. Total concentrations of OCPs and PCBs in sediments ranged from bdl to 17.8, bdl to 26.1ng g^{-1} dwt, respectively. Based on the sediment quality guidelines, PAH levels at all sites were below the effects range-low (ERL) and effects range-median (ERM) values except fluorene.

Keywords: Aegean Sea, Sediments, Pollution, Pesticides, Petroleum

Introduction
Organochlorines (OCs), such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs), represent an important group of POPs that have caused worldwide concern as toxic environmental contaminants. Among organic pollutants, polycyclic aromatic hydrocarbons (PAHs) are the most ubiquitous and constitute a major group of marine environmental contaminants. The Aegean Sea is part of the Eastern Mediterranean. There are a number of rivers along the Eastern and Western coast of the Aegean Sea through which a large amount of contaminants is being transported into the marine ecosystem thereby causing a great concern for marine pollution. The main objectives of this study are to investigate the occurrence and distribution patterns of OCPs, PCBs, aliphatics and aromatic hydrocarbons in sediments, which gave the information about status of contamination, provide a better understanding of recent distribution, possible sources as well as potential biological risk of DDTs, PCBs and PAHs in the study area.

Material and Methods
14 surface sediment samples with 3 replicates were collected from the Eastern Aegean coasts in July 2008. Meric River Estuary, Dardanelles Strait entrance, Edremit, Dikili, Candarli and Izmir Bays were sampled along the Northern Aegean coast, while Datca, Menderes Region, Kusadasi, Akbuk, Gokova and Marmaris Bays were located in the southern coast. Marine sediment samples were analysed according to [1] for petroleum hydrocarbons, [2] for OCPs and PCBs, respectively.

Results and Discussion
Aliphatic hydrocarbons consisted mainly of C10-C34 *n*-alkanes with total concentrations ranging from 0.25 to 2.37 μgg^{-1} dwt. The total concentrations of 19 PAH ranged from 73.5 ngg^{-1} to 2,170 ngg^{-1}. The highest level was observed at Izmir Inner Bay, which is close to the Metropolitan of Izmir. In the present study perylene, indicating a diagenetic origin was found in all sediment samples and its concentration varied from 9.8 to 85 ngg^{-1}. The entire investigated samples exhibited pyrolytic input except Dardanelles and Izmir Inner Bay. Concentrations of ΣDDT ranged from bdl to 17.3 ngg^{-1} dwt. The concentrations of ΣCyclodienes (including heptachlor, aldrin, dieldrin, endrin) in the sediments were bdl-0.82 ngg^{-1} dwt. The results showed that sediments were mainly under oxic conditions. Also, findings of this study indicated that early DDT influxes and, by implication, non-existing DDT use throughout the region. PCBs concentrations did not exceed the ERM or PEL values, with the exception of sites Candarli Bay and Izmir Inner Bay, which showed concentrations above the ERL and TEL values.

Conclusions
PAHs in the study area tend to be derived predominantly from pyrolytic sources. The sediments from the entire sampling sites except Izmir Inner Bay should have no potential biological impact. The results indicated that the DDTs were the predominant contaminant in the sediments. PCBs were only measured at Candarli Bay and Izmir Inner Bay. The OCP contamination was mainly from the aged and weathered agricultural soils in all sampling stations in the western part of the Turkish coastal zone. Based on the sediment quality guidelines, DDTs and heptachlor would be more concerned for the ecotoxicological risk in the study area. The sediments from Candarli and Izmir Inner Bay could potentially cause acute biological impairment.

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A SPATIAL ASSESSMENT ON CHEMICAL CONTAMINATION IN THE MARMARA SEA (TURKEY) SEDIMENTS

Leyla Tolun [1]*, Fatma T. Karakoc [1], Hakan Atabay [1] and Bilge Tutak [1]
[1] TUBITAK Marmara Research Center - Leyla.Tolun@tubitak.gov.tr

Abstract
The study presents a spatial assessment on pollutants such as organic carbon, poly -aromatic hydrocarbons(t-PAHs), Polychlorinated Biphenyls(PCB's) and heavy metals in sediment and biota from the Marmara Sea marine and coastal environment based on the MIM project results (MIM 2011). The contents of 6 elements in 67 samples establish that surface sediments in Istanbul and southern shelf and Izmit Bay display significant enrichments in heavy metals associated with high concentrations of total organic carbon, t-PAH and t-PCBs. The highest contamination of the organic pollutants were found in Izmit Bay.

Keywords: Sediments, Marmara Sea

Introduction
One of the main pressures affecting the marine environment results from chemical pollution. Contamination of the marine environment by chemical substances gives rise to considerable concern as it may result in serious adverse effects on ecosystem functions. WFD(2000/60/EC) and MSFD(2008/56/EC) considering the sustainability of waters, combine the efforts in achieving near background values of the Priority hazardous substances. Monitoring the environmental status of marine/coastal waters is essential since it allows an assessment of weather measures is effective. Chemical monitoring of the Marmara Sea marine environment has done in sediment and biota under the national monitoring program (2011 MIM proje). In this study the results of a limited number of contaminants in sediments such as t- PAH, PCBs and heavy metals were assessed. Enrichment factors were used for the assessment of heavy metal accumulation in sediments. This assessment results will be an initial step in determination of the environmental status of the Marmara Sea.

Material and Methods
67 surfaces sediments were collected from 46 different locations of Marmara Sea using a van Veen - type grab samplerin August 2011. Samples were analysed for their heavy metals(Al, As, Cu, Cd, Cr, Pb and Zn), total PAHs and PCBs contents by means of ICPMS + AAS, HPLC and HRGC respectively. Organic carbon (Corg) contents were measured by means of high temperature combustion method using Elemental Analyzer.

Results and Discussion
The mean organic carbon (Corg %) content for sediment is around 2.03% while the range changes between %0.57 - %5.67 (Figure 1). The Corg values are generally higher in enclosed bays compared to the mean of Marmara Sea. The highest Corg% mean values are recorded at the Izmit Bay. Following Izmit Bay, Kocasu River, South shelf, Bandirma Bay and Gemlik Bay have the highest Corg% mean values respectively. T-PAH concentrations ranged between 2-2547 mg/kg dry weight while the highest values were recorded at the mid and inner stations of Izmit Bay with 2547 and 847 mg/kg dry weight. It is well known that petrochemistry industries and refineries are located in the region. Regional means also support the previous finding with highest mean values recorded at Izmit Bay. Following Izmit Bay, Istanbul, Bandirma Bay and south shelf have the highest mean concentration of PAHs, respectively. According to the sediment quality evaluation approach (Long et al. 1995). All the bays in Marmara Sea are high risk regions in terms of PAH pollution. The highest value of total PBC (28, 31, 138, 153,and 180) was observed in Izmit Bay at IZ-22 station (0.167 µg/kg).Following Izmit Bay, Bandirma Bay and the mouth of Susurluk River showed high concentrations of PCBs. In general, the northern shelf sediments contain slightly lower metal values compared to those of the southern shelf. Total Zinc (Zn) content values in all the samples are above the shale average of 90 mg/kg. Highest Zn content values are observed in Izmit Bay. For all the samples the Arsenic (As) content was found to be above the shale mean of 10 mg/kg. The enrichment factors indicate the anthropogenic effects dominated in Istanbul and southern shelves and Izmit, Bandirma and Erdek Bays .

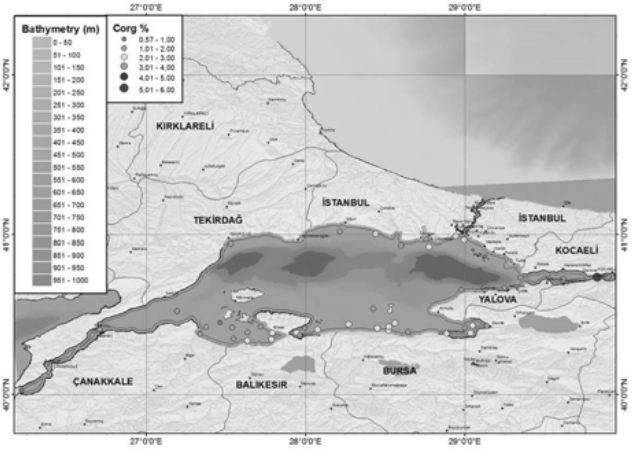

Fig. 1. Spatial distribution of total organic carbon (TOC, Corg%) in the Marmara Sea surface sediments

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ÉTUDE DU POUVOIR AUTOEPURATEUR DES SEDIMENTS DE LA BAIE DE SFAX (TUNISIE) VIS-A VIS D'HYDROCARBURES PETROLIERS

Hatem Zaghden [1]*, Jean Oudot [2], Alain Saliot [1] and Sami Sayadi [3]
[1] L.O.C.E.A.N., UMR CNRS 7159, IPSL/IRD/UPMC/MNHN, Université Pierre et Marie Curie, Paris, France - hatem.zaghden@gmail.com
[2] Lab. des Ecosystèmes et Interactions Toxiques, USM 0505, MNHN, Paris, France
[3] Lab. des Bioprocédés Environnementaux, Pôle d'Excellence Régional (PER, AUF), Centre de Biotechnologie de Sfax, Univ. de Sfax, Tunisie

Abstract
Certaines espèces de microorganismes présentes dans les sédiments peuvent contribuer à la biodégradation des différentes fractions hydrocarbures qui font partie du pétrole. Des sédiments ont été prélevés dans deux sites de la baie de Sfax. C'est principalement la fraction des composés saturés qui est biodégradée, la fraction des aromatiques est uniquement affectée dans le cas des sédiments présentant le pouvoir autoépurateur plus élevé et cultivés dans de l'eau de mer enrichie, le milieu de culture qui enregistre les taux de biodégradation les plus importants.

Keywords: Gulf of Tunis, Geochemistry

Introduction: La biodégradation est le principal processus auto-épurateur du milieu marin. Dans les eaux et les sédiments on peut trouver plus de 30 genres et 100 espèces de microorganismes capables de dégrader les hydrocarbures (Louati, 2003). La biodégradation étant un processus ayant une finalité énergétique, les microorganismes utilisent les hydrocarbures comme source de carbone et d'energie pour leur métabolisme, même si cela implique une dépense initiale d'énergie considérable (Chaillan, 2005).

Materiels et méthodes: Les sédiments avec lesquels on a travaillé ont été prélevés à marée basse pendant le mois d'avril 2006 dans deux sites du littoral tunisien. Une radiale avait été décrite depuis la baie de la ville de Sfax jusqu'aux îles de Kerkennah, situées à une distance de 23 km de Sfax. Ainsi, on a obtenu des sédiments d'une extrémité de la radiale, où se trouve le cap Sidi Mansour, et de l'autre extrémité, correspondant aux îles de Kerkennah. L'objectif de nos expériences est d'estimer le pouvoir auto épurateur des sédiments côtiers susceptibles de recevoir les flux de polluants pétroliers résultant des activités économiques et industrielles dans les alentours. Le but est de vérifier s'il y a dans les sédiments prélevés des microorganismes capables de dégrader les hydrocarbures. Afin d'atteindre cet objectif, on détermine un protocole de traitement de ces sédiments. On prépare deux types de milieux de culture où on laissera incuber les sédiments ; un premier Milieu Minéral et un deuxième milieu correspondant à de l'Eau de Mer Synthétique Enrichie.

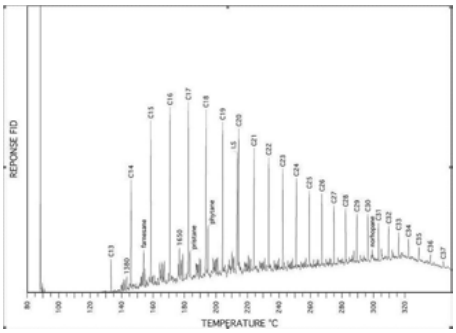

Fig. 1. Chromatogramme du pétrole brut (BAL 150) GC-FID.

Résultats et discussions: Le but de nos travaux au laboratoire était d'estimer la réaction de ces sédiments à une contamination éventuelle par le pétrole, donc leur capacité d'autoépuration. Si on compare le chromatogramme du pétrole BAL-150 (Figure 1) à ceux du pétrole de nos fioles témoins on peut observer une disparition des composés les plus légers, correspondants aux n-alcanes de la gamme C7 à C17. Ainsi, après une période de 26 jours, la plus forte biodégradation a été remarquée dans les échantillons A, correspondant au milieu Eau de Mer Enrichie et au sédiment Sidi Mansour, suivie par le taux observé dans les fioles B, qui se composaient de Milieu Minéral et du même sédiment Sidi Mansour. On peut ainsi déduire que ces sédiments ont une capacité d'autoépuration importante. On pourrait aussi affirmer que le milieu de culture en A, l'Eau de Mer Enrichie, permet une biodégradation plus prononcée car on a aussi observé que, à la différence des autres cas, la fraction aromatique était également dégradée. Ainsi, d'après nos résultats et nos observations, on peut établir que le milieu de culture eau de mer enrichie permet un développement plus intensif des microorganismes présents dans le sédiment que le milieu minéral ; d'autre part, ce sont les sédiments de la zone de Sidi Mansour qui présentent le plus fort pouvoir autoépurateur (Figure 2).

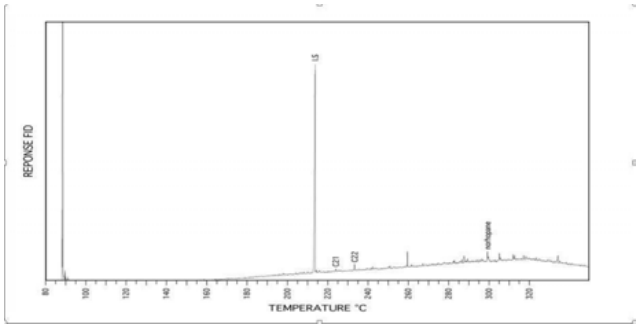

Fig. 2. Chromatogramme de l'échantillon A après 26j d'incubation.

Conclusions: La biodisponibilité des hydrocarbures n'a pas été limitée dans ces essais puisque les composés connus pour être biodégradables ont été totalement assimilés par les microorganismes. Un autre point à souligner est que la population microbienne des sédiments contaminés ramassés sur les plages du littoral de Sfax (Sidi mansour) et sur les îles de Kerkennah contient des souches indigènes aptes à la biodégradation des Hydrocarbures. Cette expérience a démontré que les sédiments du Golfe de Gabès, même non pollués actuellement ou antérieurement par des produits pétroliers, présentent un pouvoir autoépurateur élevé vis-à-vis des hydrocarbures qui leur permettrait une décontamination efficace en cas de pollution pétrolière de la zone.

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Session

Messinian salinity crisis

Modérateur : **Johanna Lofi**

MESSINIAN CRISIS: SEISMIC STRATIGRAPHIC VIEW FROM THE EGYPTIAN CLASTIC COASTAL PLAIN

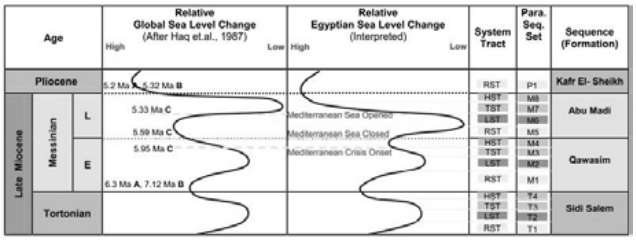
John D. Pigott [1] and Mohamed I. Abdel-Fattah [2]*
[1] ConocoPhillips School of Geology and Geophysics, University of Oklahoma, Norman, USA
[2] Geology Department, Faculty of Science, Suez Canal University, Ismailia, Egypt - mohamed_ibrahim@science.suez.edu.eg

Abstract
A new interpretation of 1100 km of 2D seismic with 18 boreholes constrains the sequence stratigraphy of the Messinian Coastal Plain of the Nile Delta. Detailed seismic facies analysis coupled with depositional log motifs allows the identification of downstepping fluvial terraces within incised valleys. These fluvial terraces represent the preservation of Regressive Systems Tracts (RST) of [1] which record the fall of relative fluvial base level (sea level). Construction of a relative sea level curve (Tab. 1) from these observations shows that prior to closure, the global and Mediterranean relative sea level curves were coincident, but with Messinian isolation, the relative sea level curves are antithetic.

Keywords: Messinian, Sea level, Seismics, Stratigraphy, Nile Delta

The Egyptian Late Miocene stratigraphy directly record the fluvial channel cut and fill stages which bracket the Messinian crisis. Figure 1 illustrates in one reflection seismic line three channels with a downcut valley which record these stages. During the early Messinian, owing to a global sea level fall, the Qawasim sequence records the Nile delta progradation and channel downcutting on the coastal plain with deposition of fluvial RST M1 terraces. At its lowest level, Lowstand Systems Tract (LST) M2 channel lags occur. With a subsequent global sea level rise, as the Mediterranean is still connected, the Nile delta retrogrades with subsequent channel flooding with transgressive systems tract (TST) M3 shales culminating with a Highstand Systems Tract (HST) M4 shale. At around 5.95 Ma, the global and Egyptian sea level curves begin to diverge and at 5.59 the Egyptian Sea Level begins to fall which is recorded by the Late Messinian Abu Madi Sequence (Tab. 1).

Tab. 1. Global sea level change [2] and interpreted Nile Delta sea level change of the Messinian age in Egypt. The ages of the onset, opening and closing of the Mediterranean Sea are from [3]. Stratigraphic ages are from A: [1], B: [4], and C: [3]



As the Mediterranean Sea continues to lower Nile fluvial base levels, channels downcut with Abu Madi M5 terraces ending with M6 channel lags. Suddenly at about 5.33 Ma, the Egyptian sea level curve begins a rapid rise with the Nile Delta rapidly retrograding and the deposition of M7 transgressive prodelta shales which culminate with M8 widespread marine shale deposition accompanying the reconnection of the Mediterranean with the global ocean. These TST events ending with widespread HST shales provide excellent seals for hydrocarbon entrapment in the preserved fluvial terraces as evidenced by commercial gas production within. The construction of an Egyptian Messinian sea level curve which brackets the Messinian Crisis provides potential utility for correlation to other Mediterranean depositional systems if similar high resolution sequence defined relative sea level curves are constructed (e.g. correlations by [5]). However, much work remains to be done in specifying the absolute ages of relative sea level excursions for better temporal constraint upon future correlations documenting this extraordinary event in the Earth's history.

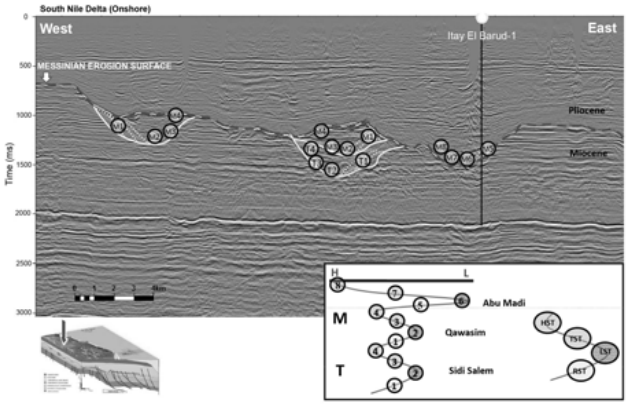


Fig. 1. Interpreted seismic line showing 1. RST deposits of Tortonian (T) Sidi Salem and early Messinian (M) Qawasim channels, 2. The Miocene/Pliocene boundary defined by Messinian sub-aerial surface in the southern part of the onshore Nile Delta area. Approximate depth range corresponding to the two way time scale is from the surface to 3200m.

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DEEP-SEA RECORD OF MEDITERRANEAN MESSINIAN EVENTS (DREAM)

A. Camerlenghi [1]*, J. Lofi [2], G. de Lange [3], R. Flecker [4], D. Garcia-Castellanos [5], C. Hubscher [6], W. Krijgsman [3], S. Lugli [7], V. Manzi [8], T. McGenity [9], G. Panieri [10], M. Rabineau [11], M. Roveri [8] and F. Sierro [12]

[1] OGS Ist. Naz. Oceanografia e Geofisica Sperimentale - acamerlenghi@ogs.trieste.it

[2] Géosciences Montpellier, University of Montpellier 2, montpellier, France

[3] Department of Earth Sciences, Utrecht University, Utrecht, Netherlands

[4] School of Geographical Sciences, University of Bristol, Bristol, United Kingdom

[5] ICTJA - CSIC, Barcelon, Barcelona, Spain

[6] Institute of Geophysics, University of Hamburg, Hamburg, Germany

[7] Department of Earth Sciences, University of Modena, Modena, Italy

[8] Department of Earth Sciences, University of Parma, Parma, Italy

[9] School of Biological Sciences, University of Essex, Essex, United Kingdom

[10] ISMAR, CNR, Bologna, Italy

[11] Domaines océaniques, University of Brest, Brest, France

[12] University of Salamanca, Salamanca, Spain

Abstract

The DREAM workshop has been held in May 2013 in the framework of the MagellanPlus Workshop Series Program. The objective was to identify drill sites in the Mediterranean Sea that would test enduring hypotheses concerning the cause, nature, timing and consequences of a recent, rapid, extreme environmental event, the Messinian Salinity Crisis (MSC).

Keywords: Messinian, Seismics, Evaporites, Levantine Basin, North-Western Mediterranean

The discovery of the Messinian evaporites in the Mediterranean is probably one of the major achievements of the DSDP program. During the 40 years that have passed since the formulation of Messinian salinity crisis (MSC) scenario, many works have been dedicated to this event. Analysis of the onshore outcrops, of offshore seismic records and scattered samples from DSDP and ODP drillings, as well as the substantial effort of climate, chemical and geophysical modelling, have however not been able to provide a unified conclusive interpretation of the Messinian event, so that causes and chronology of the MSC are not yet fully understood. Certainly, the ongoing discussion is mainly linked to the fact that so far, due to technical limitations and safety issues (non-riser drilling vessel), only the few upper meters of the deep buried basin sequence has been recovered. The greater part of the Messinian succession that could provide a unique entire record of the MSC still lacks lithological and stratigraphical calibrations. In 2007, a deep revision of the knowledge of the Messinian event was performed in Almeria (Spain). A number of open question were identified and the need for ultra-deep drilling was stressed as: "… effort must be made to identify drill sites that intersect the most complete evaporite sequences and those that retain their sedimentological characteristics, i.e. avoiding successions that have been strongly modified by salt flow". In addition, many researchers suggested that, the full understanding of the Messinian event, will come from the drilling of different depositional settings, with specific emphasis on the Western versus Eastern basins. In this context, the DREAM proposal has been submitted to the ECORD MagellanPlus Workshop Series Program. The purpose of DREAM was to organise in May 2013 a workshop gathering three generations of scientists (those who participated in the discovery, those who are presently actively involved in research, and the next generation) in order to identify locations for multiple-site drilling (including riser-drilling) in the Mediterranean Sea that would allow to solve the several open questions still existing about the causes, processes, timing and consequence at local and planetary scale of a outstanding case of natural environmental change in the recent Earth history: the Messinian salinity crisis (MSC). The product of the workshop has been the identification of the embryonic structure of an experimental design of site characterization, riser-less an riser drilling, sampling, measurements, and down-hole experiments that will be the core for at least one compelling and feasible scientific proposal. Particular focus has been given to reviewing seismic site survey data available from different research groups at pan-Mediterranean basin scale, and on the need for additional site survey activity including 3D seismics.

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THE MESSINIAN SALINITY CRISIS AND THE CATASTROPHIC ZANCLEAN FLOODING OF THE DESICCATED MEDITERRANEAN : THE RED SEA RECORD

A. Caruso [1]*, M. B. Cita [1], M. Marino [2], P. Maiorano [3], G. Scopelliti [1] and M. M. Blanc-Valleron [4]
[1] Dipartimento di Scienze della Terra e del Mare – Università degli di studi di Palermo - antonio.caruso@unipa.it
[2] Dipartimento di Scienze della Terra e Geoambientali – Università degli di studi di Bari
[3] Dipartimento di Scienze della Terra e Geoambientali – Università degli di studi di Bari
[4] 4UMR 7207 CNRS, MNHN, Univ Paris 06, 57 rue Cuvier, CP48, F-75005, Paris, France

Abstract
The DSDP Leg 23 was the only oceanographic cruise dedicated to the Red Sea that permitted to discover the presence of evaporites below the hemipelagic sediments of the Plio-Pleistocene. In the last 40 years the advanced researches in biostratigraphy have permitted to improve the geological dataset for the paleoceanographic reconstructions. In order to understand if the evaporites found in the Red Sea were comparable with those of MSC, new analysis have been carried out on 30 samples collected from cores (26-10) of Site 225A. The new multidisciplinary study has permitted to assume that during the late Messinian the Red Sea was connected to the Mediterranean Sea. Finally, during the Piacenzian the progressive phase of rifting of the Red Sea favoured the seafloor spreading, permitting the connection between the Red sea to the Indian Ocean.

Keywords: Evaporites, Red Sea, Foraminifera, Coccolithophores, Stable isotopes

DSDP Leg 23 was the only drilling cruise in the Red Sea which found evaporites below 170 metre-deep of hemipelagic sediments from the Plio-Pleistocene. Two years later the discovery of Messinian Evaporites in the Mediterranean Basin was made (Ryan et al., 1973). Six sites were drilled in the Red Sea. One of these (Site 225) was cored to a depth of 230 m (Whitmarsh et al., 1974) ending with several meters of anhydrite overlying halite. A strong seismic reflecting horizon (Horizon S) separates the Late Miocene evaporites from the early Pliocene ooze. In the original report, no mention was made of a correlation with the Messinian Mediterranean Salinity Crisis (MSC), which later became the subject of considerable discussion in the scientific community. Over the last 40 years, more advanced research into biostratigraphy and biochronology have allowed the original geological dataset to be improved thereby making if more useful for paleoceanographic and paleoecological reconstructions. Thus, in order to establish whetheher if the evaporites found in the Red Sea are comparable with those of the MSC, a new analysis of the 30 samples collected from cores (26-10) of Site 225A has been carried out here. Results from this multidisciplinary study using micropaleontology, mineralogy and geochemistry indicate that the cores studied span the interval from late Messinian to upper Pliocene. Samples from the late Messinian (cores 26-23) were characterized by strong variations in both on $d^{13}C$ and $d^{18}O$. In particular, samples from core 23 yielded the lowest values of $d^{18}O$ (-5.25‰; -4.95‰) and the presence of specimens of *Ammonia tepida* and *A. beccarii*. The tests of these two species were frequently deformed, indicating stress conditions at the bottom of the Red Sea. Similar assemblages, with low $d^{18}O$ values, typical of "Lago-Mare" conditions have been reported in several Mediterranean outcrops from the late Messinian as well as in the reference section of Eraclea Minoa (GSSP Messinian-Zanclean). Furthermore, specimens of planktonic foraminifera were not found demonstrating that the Indian Ocean was not connected to the Red Sea during that period. In the lowermost part of the Pliocene (cores 22-20), planktonic foraminifera were not yet present, while benthic foraminiferal assemblages were typical of hyposoxic conditions. Calcareous nannofossil assemblages contained *Reticulofenestra cisnerosii*, *Ceratolithus acutus*, and *Sphenolithus abies*. Pyrite and Fe-dolomite were abundant in this interval. The improvement in the environmental conditions started in samples of core 19, demonstrated by the occurrence of several species of planktonic foraminifera (*Candeina nitida*) and coccolithophorids (discoasterids, *Pseudoemiliania lacunosa*, *Helicosphaera sellii*, and small *Geophyrocaspa*. This drastic change in calcareous plankton and in their relative abundance coincides with more stable marine conditions with $d^{18}O$ values between -1.1 and 0.5‰. In the Pliocene, Mediterranean marine fossil records demonstrate that the species *C. nitida* have never been present there, while it is a species typical of the Indian Ocean. The newly obtained data indicates that during the late Messinian the Red Sea was connected to the Mediterranean Sea, with environments characterized by strong variations in salinity similar to those described in the "Lago-Mare" facies. Furthermore, the co-occurrence of *C. nitida*, the drastic increase in other species of calcareous plankton (coccolitophorids and foraminifera) and more stable values of $d^{18}O$, suggest an inflow of water from the Indian Ocean into the Red Sea. Finally, during the lowermost part of the Piacenzian, the progressive phase of rifting of the Red Sea favoured seafloor spreading, opening a connection between the Red sea and the Indian Ocean.

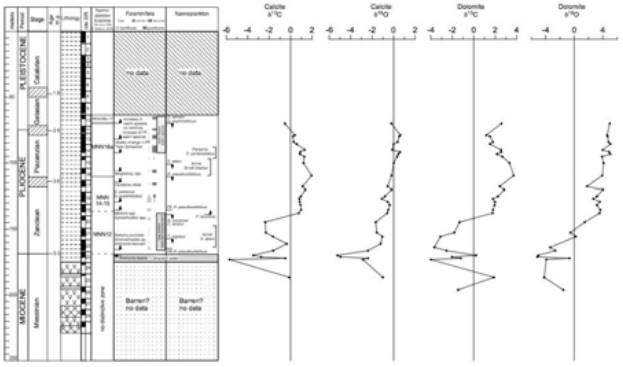

Fig. 1. Calcareous plankton biostratigraphy and stable isotope compositions of calcite and dolomite along the Site 225 stratigraphic sequence

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PRIMARY MESSINIAN SALINITY CRISIS SHALLOW GYPSUM VS. DEEP DOLOMITE FORMATION: A UNIFYING BIOGEOCHEMICAL MECHANISM

Wout Krijgsman [1] and Gert J. de Lange [2*]
[1] Paleomagn.Lab., Geosciences Utrecht; NL
[2] Marine Geochemistry; Geosciences Utrecht, NL. - gdelange@geo.uu.nl

Abstract
The Messinian Salinity Crisis (MSC) is a dramatic event that took place ~ 5.9 Ma ago, and resulted in the deposition of 0.3-3 km thick evaporites at the Mediterranean seafloor (1-2). A considerable and long-lasting controversy existed on the modes of their formation. However, during the CIESM Almeria Workshop, a concensus has been reached on several aspects (3). In addition, remaining issues to be solved were identified, such as for the observed shallow gypsum versus deep dolostone deposits for the early phase of the MSC (4). 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. In contrast, ongoing anoxic organic matter degradation processes in the deep basin result in the formation of dolomite.

Keywords: Evaporites, Geochemistry, Paleoceanography, Messinian, North-Central Mediterranean

A recently proposed scenario for the Lower Gypsum units of the Mediterranean Messinian salinity crisis infers that primary gypsum only formed in silled marginal basins while dolostones are found at deeper settings. We agree with these observations but reject the suggested coincidental presence of similar sills for all marginal basins as being too fortuitous. 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 (4-7). 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 biogeochemical 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 each. The following important processes have to be considered: 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 in particular c. Gypsum precipitation is controlled by the product of Ca2+ and SO42- concentrations d. The evaporation stage and related deep-water ventilation rate Gypsum precipitation in evaporating seawater takes place at 3-7 times concentrated seawater (8); 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 (10). As a consequence one would expect a bath tub rim of gypsum at all shallow depths but gypsum 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 sea-level 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 (e.g. 5). 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 (4).

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DÉFORMATION RÉCENTE ET MARQUEURS MESSINIENS : LE PROJET SIMBAD DANS LA RÉGION BALÉARES

O. Driussi [1]*, A. Maillard [1], A. Briais [1], J. Lofi [2], F. Chanier [3], V. Gaullier [4], F. Sierro [5], D. Ochoa [5], M. Garcia [6], F. Sage [7] and R. Bourillot [8]

[1] GET-OMP-UMR5563 - olivier.driussi@get.obs-mip.fr
[2] Geosciences Montpellier UMR5243
[3] Géosystèmes Université Lille 1
[4] Université de Perpignan, LEGEM
[5] Université de Salamanque
[6] Université de Grenade
[7] Géoazur, Université de Nice-Sophia-Antipolis
[8] ENSEGID, Université de Bordeaux

Abstract

Le projet SIMBAD est dédié à l'acquisition de sismique réflexion haute-résolution ainsi que des données de terrain dans les îles Baléares dans le but d'étudier les dépôts associés à la crise de Salinité Messinienne (CSM) pour contraindre leur variabilité spatiale et quantifier la réactivation post-Messinienne des Baléares. Les marqueurs Messiniens sont ubiquistes dans la région: à terre où des évaporites sont forées vers Palma et en mer dans le bassin Algérien où on trouve du sel. Entre ces deux extrêmes, on trouve des dépôts fins reliés à la CSM qui enregistrent des déformations verticales récentes. Cette déformation est caractérisée par des plis et failles remobilisant aussi des blocs basculés ou chevauchements, de la flexure grande-échelle et une bascule régionale vers le bassin Algérien.

Keywords: Messinian, Balearic Islands, Tectonics

Le promontoire Baléares est un haut continental orienté NE-SO formant la terminaison orientale de la cordillère Bétiques dans le bassin occidental de la Méditerranée. Il est limité par deux bassins extensifs : le Bassin de Valence au Nord qui est un rift avorté Oligo-Miocène et le Bassin Algérien au Sud qui est de nature océanique. Cette configuration tectonique complexe est le résultat de phases extensive et compressive de même direction qui ont commencé à l'Oligo-Miocène et qui continuent aujourd'hui. La campagne SIMBAD (sur le N.O Téthys en janvier 2013) a permis l'acquisition de 1700km de données sismiques haute-résolution pour réaliser une étude comparative des dépôts sédimentaires reliés à la CSM sur promontoire et dans les bassins adjacents. Le but est de comprendre les relations spatio-temporelles entre les dépôts peu profonds sur le Promontoire et les évaporites des bassins profonds. Ces relations sont intimement dépendantes de la réactivation tectonique post-Messinienne du promontoire [2].

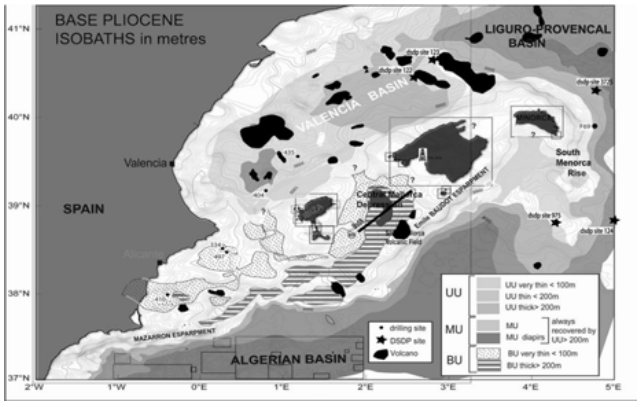

Fig. 1. Carte de répartition des dépôts Messiniens du Promontoire Baléares et localisation de la figure 2

Les résultats préliminaires de la campagne SIMBAD montrent que les marqueurs Messiniens sont ubiquistes dans la région (Fig.1). On les retrouve à des profondeurs variables : à Terre où ils ont été forés dans le cadre d'une étude hydrogéologique dans la zone de Palma de Majorque et se présentent sous forme de couches de gypse, en Mer, des dépôts épais et salifère (UU et MU) sont connus dans tout le bassin Algérien. Entre ces deux types de dépôts, les données de sismique réflexion montrent que des dépôts Messiniens existent partout (BU) sauf sur la plateforme continentale. Ils sont répartis en petits bassins dont on questionne la continuité. En effet ces dépôts Messiniens enregistrent des déformations verticales depuis la CSM jusqu'à aujourd'hui. D'une part, des évidences de compression récente s'expriment par des petits plis et failles locales qui remodèlent la bathymétrie ou les surfaces topographiques comme sur l'île d'Ibiza. Il s'agit parfois de rejeux des structures héritées [1] (anciens blocs basculés liés au rifting de Valence ou de l'extension Algérienne ou des anciens chevauchements bétiques). D'autre part, on observe de nombreuses failles normales mettant en évidence une activité extensive récente. A plus grande échelle, on peut observer une flexure relativement importante des bassins sédimentaires du promontoire Baléares (Fig.2). Enfin, on peut observer une bascule à l'échelle régionale des unités sédimentaires dans l'ensemble du bassin Algérien. Le décalage observé de l'unité Messinienne est de l'ordre du kilomètre entre le Promontoire et le bassin Algérien.

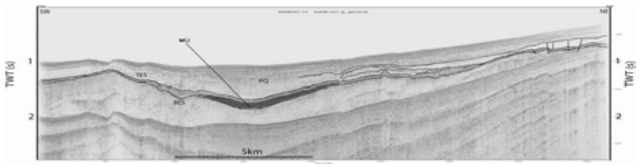

Fig. 2. Profil BA08 montrant la structure de la depression centrale de Majorque avec son bassin salifère flexuré

Nos observations montrent que la répartition des marqueurs Messiniens entre le promontoire Baléares et les bassins adjacents pourrait être continue, ce qui questionne la notion de bassins périphériques et profonds. Les données montrent aussi une forte activité tectonique : d'une part, l'inversion du promontoire Baléares marqué par une déformation compressive et un soulèvement et d'autre part, une extension dont l'origine n'est pas encore identifiée. D'où une question majeure : comment se fait le transfert de contraintes entre la marge Algérienne inversée et le promontoire Baléares à travers la croûte océanique du bassin Algérien?

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SESIMIC ATLAS OF THE "MESSINIAN SALINITY CRISIS" MARKERS IN THE MEDITERRANEAN AND BLACK SEAS - VOLUME 2

Johanna Lofi [1]*
[1] UMR 5243-Géosciences Montpellier Université de Montpellier 2 - johanna.lofi@gm.univ-montp2.fr

Abstract
The Seismic atlas of the "Messinian Salinity Crisis" markers in the Mediterranean and Black seas – Volume 2 is a publication project in the framework of the study of the Messinian Salinity Crisis. It follows the publication of a first volume in 2011 (see Editors' websites: http://ccgm.free.fr & http://sgfr.free.fr) and aims to illustrate the seismic characteristics of the MSC markers over news study areas. This publication project is open to anybody from industry and academia willing to contribute.

Keywords: Messinian, Seismics, Mapping, South-Eastern Mediterranean, South-Western Mediterranean

The Messinian Salinity Crisis is a huge outstanding succession of events that deeply modified the Mediterranean area within a short time span at the geological scale.

In 2011, a seismic atlas of the Messinian markers in the Mediterranean and Black seas has been published [1]. This collective work summarizes, in one publication with a common format, the most relevant seismic features related to this exceptional event in the offshore domain. It also proposes a new global and consistent terminology for the MSC markers in the entire offshore Mediterranean area in order to avoid nomenclatural problems. Throughout 13 study areas, the seismic facies, geometry and extend of the Messinian markers (bounding surfaces and depositional units) are described. The Atlas however does not provide a complete description of all what that is known about the MSC and about the geology of each study area. Accordingly, illustrations in the Atlas should be used for a global description of the offshore imprints of the MSC at a broad scale, or for local information or site-specific general interpretations. Interpreted seismic data were carefully selected according to their quality, position and significance. Raw and interpreted seismic profiles are available on CD-Rom.

Volume 2 is currently under preparation with the objectives : (1) to image the Messinian seismic marker from margins and basins that have not been illustrated in the first volume and (2) to complete the extension map of the MSC markers in the offshore and onshore domains at the Mediterranean scale. As the first volume, volume 2 will also aim to share the geological interpretation of seismic reflection data imaging Messinian markers, to make this information accessible to the non geophysician community and to be a reference work that can be used by teachers and future researchers working on the Messinian event. This publication project is open to anybody from industry and academia willing to contribute. At the present time, 16 new sites have been identified [FIG. 1]. Publication of the Seismic atlas of the "Messinian Salinity Crisis" markers in the Mediterranean and Black seas – Volume 2 is planned for Fall 2014. For more details, contact presenting author J. Lofi (atlas coordinator).

This contribution has been funded by the Actions Marges French research program.

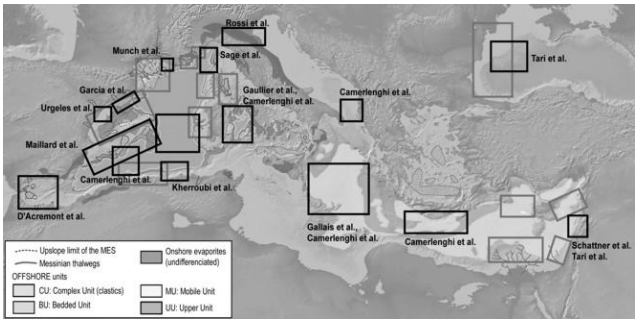

Fig. 1. Distribution map of the Messinian seismic markers in the Mediterranean and Black Seas (work in progress). Grey boxes illustrates areas illustrated in the volume 1 of the atlas. Black boxes highlight areas planned in volume 2.

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THE SEISMIC MARKERS OF THE MESSINIAN SALINITY CRISIS ALONG THE EAST-SARDINIAN MARGIN : NEW CONSTRAINTS ON THE MARGIN'S GEODYNAMIC EVOLUTION

G. Lymer [1]*, J. Lofi [2], V. Gaullier [3], A. Maillard [4], I. Thinon [5], F. Sage [6], F. Chanier [1], B. C Vendeville [1] and L. Loncke [3]
[1] UMR 8217 - Géosystèmes - Lille1 - gael.lymer@ed.univ-lille1.fr
[2] UMR 5243-Géosciences Montpellier
[3] UMR 5110-CEFREM-UPVD
[4] GET-OMP-Université Paul Sabatier
[5] BRGM-DGR/GBS
[6] UMR 7329-Géoazur

Abstract
Rifting along the East-Sardinian margin (Tyrrhenian basin) started during Tortonian times in response to the migration of the subducting zone towards its present day position (Calabrian arc, SE Tyrrhenian basin) [1]. The structuring of the margin is partly coeval with the MSC. The margin present-day morphology comprises a succession of eastward-deepening basins bounded by N-S-trending structural highs. The "METYSS" (Messinian Event in the Tyrrhenian from Seismic Study) project is part of a broader, multi-site, integrated scientific study of the MSC seismic markers [2] and aims at better delineating the crustal tectonics, salt tectonics, and sedimentation along the East-Sardinian margin since the MSC.

Keywords: Messinian, Crust structure, Diapirs, Seismics, Tyrrhenian Sea

Since 2009, we acquired 2400 km of seismic-reflection data during the METYSS cruises, off the East-Sardinian margin [FIG. 1 and 2], as part of an integrated multi-site comparative study of the MSC seismic markers at the Mediterranean scale [2]. Interpretation of these data allowed us to identify the following Messinian markers, typical of the Western Mediterranean [FIG. 1] [3] : the Margin Erosion Surface (MES), a polyphased surface commonly found along the margins, the Mobile Unit (MU) made of halite, and the overlying unit (Upper Unit, UU), which comprises alternating dolomitic marls and evaporites [FIG. 1]. Our interpretation has confirmed that MSC units (MU and UU) deposited in the East-Sardinia Basin and on the Cornaglia Terrace, forming topographic lows, whereas the continental slope and the structural highs between these basins were affected by erosion (MES) [FIG. 1 et 2]. In addition, the MSC deposits in the East-Sardinia Basin are thinner than those on the Cornaglia Terrace, that are locally as thick as 800 m for UU and 1000 m for MU, and affected by a vigorous salt tectonics.The salt tectonics and the distribution and thicknesses of the Messinian units provide information about the timing of the opening of the basins. Thus, in the proximal areas (continental slope, East-Sardinia Basin and North Cornaglia Terrace [FIG. 2]), the UU are isopachous, suggesting that the rifting ended prior to the MSC. Conversely, in the South Cornaglia Terrace [FIG. 2], thick MSC deposits and vigorous salt diapirism show that this area was still subject to rifting during the Messinian. The thinning of UU and the absence of MU in the easternmost Cornaglia Terrace [FIG. 2] indicate that this area was only partly opened. Our observations thus confirm that rifting of the East-Sardinian margin has controlled the distribution of the MSC markers. They can also provide some information about the paleo-morphology of the area during the MSC, and some constraints about the timing of rifting between what were, at that time, the margin's proximal and distal regions.

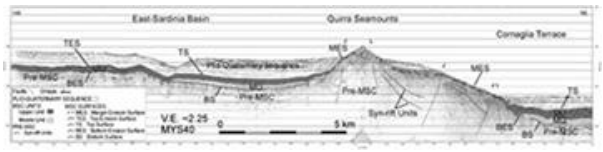

Fig. 1. Seismic profile Mys40 illustrating MSC seismic markers along the East-Sardinian margin (East-Sardinia Basin and Cornaglia Terrace). See location in Figure 2.

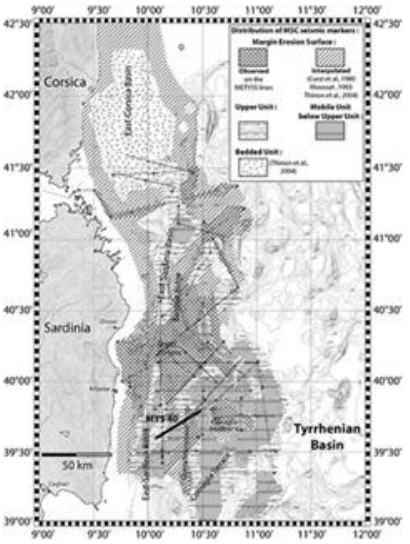

Fig. 2. Geographic distribution of the MSC seismic markers along the East-Sardinian margin. Black line indicate the location of profile illustrated in Fig. 1.

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Session

Metal distribution in sediments

Modérateur : **Mohamed Bouhmadouche**

RADIONUCLIDE POLLUTION IN SEDIMENTS OF BODRUM (AEGEAN SEA)

Serpil Aközcan [1]*
[1] Kirklareli University - sakozcan35@yahoo.com

Abstract
The great interest expressed worldwide for the study of radionuclide and environmental radioactivity has led to the performance of extensive surveys in many countries of the world. Radionuclides pollution of the marine environment have been recognized as a serious environmental concern. The natural and artificial radionuclides ^{238}U, ^{232}Th, ^{40}K, ^{226}Ra and ^{137}Cs are found in varying concentration in sand, sediment, sea water and naturally occurring water. In this study, determination of anthropogenic and natural radionuclides in marine sediment taken from Bodrum Aegean Sea has been performed by gamma spectrometry. In general, the distribution of activity concentrations in the study area were in the same order as international levels.

Keywords: Radionuclides, Aegean Sea, Sediments, Monitoring

Sampling and sample preparation
Surface sediment samples were collected from Bodrum in the June 2009- June 2010 the sampling stations are given in Fig. 1. Samples were collected for seasonal. Sediment samples were oven dried at a temperature of 105 ^{o}C for 12 h and sieved through a 250 mesh. The dried samples were transferred to polyethylene Marinelli beakers of 1000 ml capacity. Each sediment sample was left for at least 5 weeks to reach secular equilibrium between radium and thorium, and their progenies. Gamma spectrometry measurements were determined by gamma spectrometer, using HPGe detector. A mixed gamma referance calibration source containing the radionuclides (^{241}Am, ^{109}Cd, ^{57}Co, ^{123m}Te, ^{51}Cr, ^{113}Sn, ^{85}Sr, ^{137}Cs, ^{88}Y, ^{60}Co) in 1 L Marinelli is used for the full-energy peak (FEP) efficiency calibration, produced at the Isotope product Laboratories. The counting time of 150000 s was set for activity of each sediment samples and background.

Fig. 1. Sampling Location

Results and discussion
The activity concentration of ^{226}Ra, ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs in sediments collected from two different locations in Aegean Sea coast has been determined. The highest activity concentrations of ^{238}U and ^{40}K were observed in sediments from Bodrum. The results of this study can be used as a baseline for future research and the data obtained in study may be useful for radiological map of the study area.

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INVESTIGATION OF METAL ACCUMULATION IN SURFACE SEDIMENT IN SÜRMENE BAY OF THE EASTERN BLACK SEA

Nigar Alkan [1]* and Volkan Örnek [1]
[1] Karadeniz Technical University - anigar@gmail.com

Abstract
The objective of this surface sediment study was to determine the concentration levels of metals (Cr, Mn, Al, Co, Ni, Cu, Zn, As, Mo and Pb) in spatial extent and relationship with other potential causative factors (sediment grain size, other physical and chemical characteristics of the sediment). These current metal levels were compared with the ground values to determine the status of the metal enrichment in Sürmene Bay surface sediments (located between 40º57'27" N - 40º17'15" E and 40º56'05" N - 40º 04'56" E is in the Trabzon city of the Eastern Black Sea Region).

Keywords: Black Sea, Metals, Sediments, Pollution

Introduction
Sediment is a natural contaminant accumulation area in marine environment. Contaminants from various sources are transported to the coastal area and finally accumulate on sediment layer [1]. Pollutants have some catastrophic effects on aquatic life and living organisms as they can cause to transition and accumulation of metal contents in oceanic environment. This situation can lead to elevated metal concentration in surface sediments and known as metal enrichment mechanism. This elevated concentrations are generally well correlated with particle grain size distribution [2].

Material and Methods
Sediment samples were collected from 17 stations located on Sürmene Bay in December, 2011 and composed of samples after subsampled from the top 2 cm from each stations (Figure 1). All sediment samples were preserved at -18 °C. Grain size were classified according to Folk [3], pH and Oxidation Reduction Potantial (ORP) were measured using a Hach Lange HQ40D multi meter. Total Organic Carbon (TOC) was determined by using modified Walkley-Black titration method [4], Carbonate levels were measured by Piper method [5], Enrichment Factor (EF) was computed by applying Cukrov method [2]. Metal analysis (Cr, Mn, Al, Co, Ni, Cu, Zn, As, Mo and Pb) was performed using sediment passed through a sieve with 63-micron in this study. Analysis after digestion in the closed microwave digestion system were determined using ICP-MS (inductively coupled plasma mass spectrometry) The Collosion Reaction Interface (CRI) was used during the determination of As. Both Sc and In (50 ppb) were added to all standards, blanks and samples and acted as internal standards. All data were given mg/kg dry weight (dw). In this study spearman correlation was performed to evaluate variables.

Results and Discussion
The silt fractions were generally dominant (50%) according to distribution of grain size in sediment samples. Minimum and maximum values were determined for carbonate as 8.54-18.05%, for total organic carbon as 0.26-2.43%, for pH as 6.91-8.24 and for ORP as 159-269 mV. Sediment metal levels (mg/kg dry weight) were determined for Cr as 13.4-82.3, for Mn as 200-447, for Al; 19965-48723; for Co as 8.0-32.8, for Ni as 9.8-26, for Cu as 24.9-3107, for Zn as 102-4259, for As as 5.4-58, for Mo as 0.21-20, for Pb as 15.5-208. Results were compared with earth's crust and the average shale values. Concentrations of Al, Cr, Mn and Ni were found to be higher than the earth's crust and the average shale values while concentrations of Co, Cu, Zn, Mo and Pb were characterized with relatively lower figures. Based on calculated EF values deficiency low enrichment values were found for Cr, Mn, Co and Ni, moderate enrichment value was found for Pb, significant enrichment values were found for Zn, As and Mo, and very high enrichment value was found for Cu in the study area.

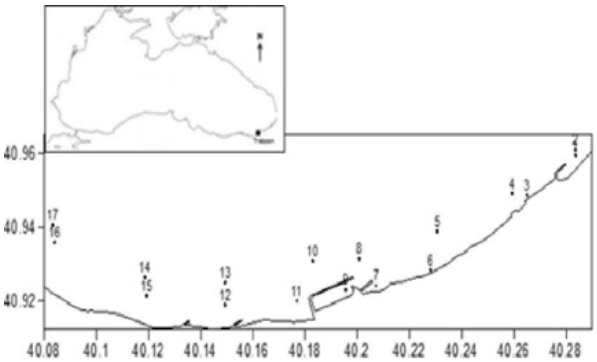

Fig. 1. Map of the sampling area

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MISE EN ÉVIDENCE DU DIACHRONISME DES SÉDIMENTS SUPERFICIELS ET DES MÉTAUX LOURDS EN BAIE D'ALGER (ALGÉRIE).

Farid Atroune [1]*
[1] Faculté des Sciences de la terre/USTHB Bab Ezzouar - faridatroune@gmail.com

Abstract
L'objectif est la quantification de la pollution engendrée par l'Oued El Harrach qui débouche en baie d'Alger et de voir l'évolution des sédiments superficiels en baie d'Alger. La pollution par les métaux lourds dans les sédiments superficiels de la baie d'Alger montre un degré de contamination important et inquiétant. Les fortes teneurs en métaux présents dans les sédiments superficiels se localisent dans le secteur ouest de la baie d'Alger et à proximité de l'embouchure de l'Oued El Harrach. Les analyses sédimentologiques ont évolués, en ce sens que la carte des facies établis par Maouche en 1987 s'est envasée du côté oriental de la baie. La carte établie, montre que durant une vingtaine d'années, l'oued El Harrach n'a pas cessé ses apports en sédiments fins.

Keywords: Sediments, Algerian Basin

Introduction
La pollution par les métaux lourds des sédiments superficiels, charriés par l'oued El Harrach se répartissent sur la baie d'Alger d'une manière diversifiée. En effet Ces sédiments ont généralement une grande affinité pour les sédiments à granulométrie fine. [4] a montré que la fraction inférieure à 40µm occupe plus de 75% des sédiments superficiels de la baie d'Alger ; les métaux lourds sont habituellement associés à la fraction fine. Le bassin versant de l'Oued El Harrach appartient au grand bassin versant côtier Algérois. Il couvre une superficie de 1270 km^2. Il s'étend du Nord au Sud sur 51 Km et de l'Est à l'Ouest sur 31 km.

Matériels et méthodes
Dans la baie d'Alger L'échantillonnage des sédiments de surface a été réalisé en décembre 2008 dans l'Oued El Harrach (Tab 1). Pour la baie d'Alger, les prélèvements ont été pris, à l'aide d'une benne van Veen (mission septembre 2009) à bord d'une embarcation nautique, le plan de positionnement a été calquer sur la mission effectué en 1985. Les métaux (Cu, Zn, Ni, Fe, Pb et Hg) ont été dosés à l'aide d'un spectromètre d'absorption atomique).

Résultats et discussion

Tab 1: Evolution des métaux lourds (en µg/g) en Baie d'Alger

	Cr	Mn	Fe	Cu	Zn	Pb
Maouche, 1987		250-316	3.8-4.8	24-51	123-231	20-161
Chouikhi et al., 1991	11-84	109-350			72-222	18-117
Atroune et al 2012	38-105	258-425	11,3-13,4	22-98	128-375	33-154

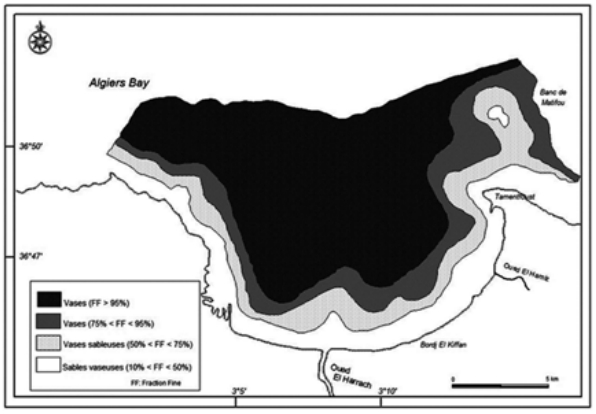

Fig. 1. Carte des facies de la baie d'Alger

A partir de la répartition spatiale (fig1) de ces éléments métalliques on peut déjà constater que, les fortes teneurs en métaux lourds présents dans les sédiments superficiels de la baie d'Alger se localisent dans le secteur ouest de la baie entre le port (rejets d'hydrocarbures, produits chimiques) et à proximité immédiate de l'embouchure (rejets des affluents domestiques et industriels). Les fortes concentrations des métaux lourds s'associent généralement avec des sédiments fins de nature vaseuse et riche en matière organique. Les concentrations faibles se trouvent localisées dans le secteur de la baie, où prédominent des sédiments relativement grossiers par rapport au secteur Est de la baie. Les analyses sédimentologiques ont particulièrement évolués, en ce sens que la carte des facies s'est considérablement envasée du côté orientale de la baie. La carte que nous avons établie, montre que durant une vingtaine d'années, l'oued El Harrach n'a pas cessé de cracher des sédiments fins. De plus la carte des argiles a aussi également sensiblement changé. Nous admettons, à partir de l'analyse des paramètres physico-chimiques que la pollution de l'Oued El Harrach est le résultat de l'absence de traitement des déchets industriels et domestiques.

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ORIGINE ET DISTRIBUTION DES MINÉRAUX LOURDS MARINS DU LITTORAL DE BOUMERDES (ALGÉRIE)

Mohamed Bouhmadouche [1]*
[1] labo Géoenvironnement USTHB/FSTGAT BP 32 EL-ALIA Bab-Ezzouar - mbouhamadouche@gmail.com

Abstract
L'étude des minéraux lourds et leurs répartitions dans les sédiments superficiels du plateau continental de Boumerdes a été opérée sur trois fractions granulométriques de sables (80-160µm), (160-400µm) et (400-800µm). Les résultats obtenus montrent la présence d'une fraction lourde comprenant tourmaline, hématite, biotite, sphène et zircon et une fraction légère englobant quartz, muscovite, orthose, calcite et une phase biogène. La distribution de ces minéraux lourds au débouché de l'oued Boumerdes et de l'oued Boudouaou indique que ces minéraux proviendraient du complexe éruptif de Thénia drainés par l'oued Boumerdes. <\/div>

Keywords: Sediment transport, Mineralogy, Algerian Sea

Introduction
Nous nous sommes attachés à caractériser les cortèges minéralogiques (minéraux lourds et légers) transitant par les différents oueds et aboutissant en dépôts marins-littoraux. Les fluctuations des concentrations des minéraux lourds dans les sédiments superficiels terrigènes de la plate forme continentale peuvent être dues à plusieurs facteurs tels que, la source d'apport, les processus sédimentaires d'altération et de transport [1],[2].

1. **Nature et répartition des minéraux lourds** : De manière générale, le cortège minéralogique lourd-léger des sables de Boumerdes présente une certaine monotonie que cela soit du côté qualitatif ou quantitatif. En effet, l'uniformité observée ne nous permet pas d'élaborer des cartes d'iso teneurs de tel ou tel minéral. Toutefois, dans le cas des 2 auréoles de Boumerdes et de Boudouaou, nous donnerons les cortèges minéralogiques particuliers à ces deux zones. Tourmaline, biotite, hématite, Sphène et zircon sont les composants majeurs du spectre des minéraux lourds. L'olivine, épidote, orthopyroxène et clinopyroxène sont très rares. La Tourmaline est le minéral le plus caractéristique du cortège minéralogique lourd représente à lui seul 20 à 60 % des 3 fractions étudiées. Elle est de couleur verte essentiellement mais apparait parfois brune. L'Hématite représente 20 à 40 %, la Biotite représente 10 à 30 % de la fraction lourde. Les minéraux accessoires sont représentés par le Sphène (1 à 8 %) et le Zircon (1 à 5 %) (Tab.1). Les minéraux légers sont représentés par un cortège varié de minéraux où le quartz occupe prés de 60 % de la fraction détritique, ces minéraux se retrouvent tres fréquents dans les falaises côtières du Corso. Les Feldspaths sont représentés par l'Orthose et les micas par de la Muscovite très abondante (20 à 30 %) et présente dans tous les échantillons prélevés à Boumerdes. La phase biogène caractérise l'essentiel de la fraction carbonatée de la région d'étude.

Tab. 1: Distribution de la fraction minérale "lourde et légère" devant oued Boudouaou, oued Boumerdes et de la zone centrale (pourcentage en poids).

Minéraux lourds	Oued Boudouaou	zone centrale	Oued Boumerdes
Tourmaline	15	3	20
Hématite	12	2	10
Biotite	5	4	7
Sphène	1	0	1
Zircon	0-1	0	0-1
Minéraux légers			
Quartz	40	60	30
Muscovite	10	10	1
Orthose	1	1	2
Calcite	8	10	5
Phase biogène	8	10	10

2**. Distribution de la fraction minérale lourde totale** La répartition des minéraux lourds (fig.1) montre des teneurs variant en moyenne entre 1 et 20 % avec 2 maxima de 28 % . Ces teneurs importantes sont en fait localisées exclusivement aux alentours immédiats des embouchures des oueds Boumerdes et Boudouaou traduisant ainsi une origine des apports et un transit côtier résultant depuis la source jusqu'au milieu de dépôt.

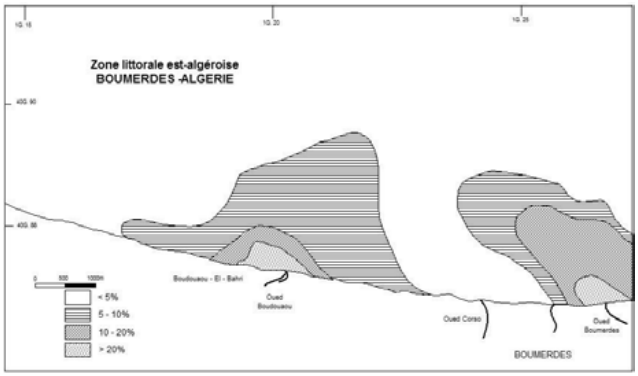

Fig. 1. Répartition de la fraction totale des minéraux lourds

La fraction granulométrique 160-80 µm est caractérisée par des teneurs nettement supérieures aux 2 fractions précédentes; c'est la plus riche en minéraux lourds du sédiment détritique grossier.

Conclusion
En résumé de l'observation de ces 3 fractions nous pourrons déduire que plus la taille des grains diminue, plus la teneur en minéraux lourds augmente contrairement à d'autres régions où l'inverse a été constaté [3]. Cette importance en minéraux lourds dans la fraction la plus fine s'explique logiquement avec les résultats de l'étude en lames minces, qui a montré des minéraux dont la taille est réduite dans la roche mère (Granit de Thénia, micaschistes du « Rocher Noir »).

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A CASE STUDY ON TRACE METALS IN SURFACE SEDIMENTS OF CYPRUS

A. Kontas [1], E. Uluturhan süzer [1], I. Akçali [1], E. Darilmaz [1]* and O. Altay [1]
[1] DEU, Institute of Marine Sciences and Technology Baku bulvari No:100 Inciralti-Balcova - enis.darilmaz@deu.edu.tr

Abstract
The heavy metal (Hg, Cd, Pb, Cr, Cu, Mn, Zn, Ni, Fe, and Al) concentrations in sediment were investigated in Cyprus from Mediterranean. The surface sediments were collected from 23 stations in April-May 2010. The results showed that Gemi Konagi area was polluted with Cu and Zn besides Girne and Gazi Magusa areas were polluted with Pb and Cr. All of the Hg, Cd and Pb levels were lower than the Mediterranean backgrounds. The Cu and Zn concentrations at Gemi Konagi area and all of the Cr values were higher than the Mediterranean backgrounds.

Keywords: Metals, Sediments, Pollution, North-Eastern Mediterranean

Introduction
Heavy metals are entering the coastal environment as contaminants, although metals are present naturally in the environment, from anthropogenic sources such as industrial processes, including untreated waste water, municipal sewage effluent, and surface run-off [1]. There is little information about heavy metal contaminations at sediment from Cyprus. The aim of this study is to describe the spatial distribution of heavy metals in sediments from Cyprus.

Materials and Methods
Surface sediment samples (23 stations) were collected using box-core from Cyprus as part of a cruise of the R/V K. Piri Reis (April-May 2010). This study founded by the Turkish Scientific and Technological Research Council (TUBITAK/111Y160). Sediments were placed in acid-cleaned polyethylene bottles and frozen (-20oC). Samples were dried in an oven at 50ºC, and then sieved to pass 63 ?m. All sediments were digested in microwave digestion system (Milestone 1200) with a HNO3-HF-HClO4-HCl acid mixture solutions [2,3]. The levels of mercury and cadmium were obtained by using cold vapour and graphite furnace with AAS, respectively. The concentrations of Pb, Cr, Cu, Mn, Fe, Ni, Al and Zn in sediment were measured by flame atomization (air-acetylene) AAS, using the manufacturer's conditions and with background correction.

Results
The results of heavy metals in sediments were compared with the mean crustal values, Mediterranean background and TEL-PEL values. Comparison of the metal concentrations with mean crustal values revealed that Gemi Konagi area was polluted with Cu and Zn besides Girne and Gazi Magusa areas were polluted with Pb and Cr. The maximum pollution for Cd was found at Girne area. All of the Hg, Cd and Pb levels were lower than Mediterranean backgrounds. The Cu and Zn concentrations at Gemi Konagi area and all of the Cr values were higher than Mediterranean backgrounds.
Metal concentrations ranged between 0.02-0.07 for Hg, 0.03-0.32 for Cd, 1.12-23.8 for Pb, 54.7-144 for Cr, 9.29-127 for Cu, 29.3-128 for Zn, 112-990 for Mn, 43.8-245 for Ni, 10634-50972 for Fe, 6670-56051 µg/g for Al. The maximum concentrations of Hg, Cd and Ni were detected at Girne area besides the highest Pb, Cr and Mn levels were found at Gazi Magusa area. The minimum values of Hg, Cd, Pb, Cr, Mn, and Ni were obtained at Gemi Konagi area. Adversely, the maximum Cu, Zn, Fe and Al values were measured at the same area. Cr levels at all sampling areas and Cu concentrations at Gemi Konagi area were exceeded the numerical TEL values. All of the Ni values were above the TEL and PEL values. The results have been shown that the pollution in sediments from Cyprus was mainly sourced from mining activities, wheathering and erosion of ophiolithic rocks and other sources (agriculture and untreated sewage discharges, maritime activities).

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HEAVY METAL CONCENTRATIONS IN SURFICIAL AND CORE SEDIMENTS FROM IZMIR BAY: IMPLICATIONS FOR ANTHROPOGENIC AND LITHOGENIC IMPACT

Müge Atalar [1], Muhammet Duman [1]*, Filiz Küçüksezgin [1] and Lutfi T. Gönül [1]
[1] Dokuz Eylul University Institute of Marine Science and Technology - muhammet.duman@deu.edu.tr

Abstract
The levels of heavy metals were determined in surface and core sediments from the Izmir Bay in 2009. Marine pollution in Izmir Bay is investigated using inorganic and organic geochemical data from surface sediments. The concentrations of 32 elements in 18 samples and three core samples established that surface sediments in Inner Izmir Bay display significant enrichments in As,Al, Cr, Cu, Cd, Fe, Mn, Ni, Pb and Zn associated with notably high concentrations of total organic carbon and sulphur.The zone of moderate enrichment of Cr, Mn, Pb, Zn, Cu and As in the bay seems to be driven by anthropogenic sources.

Keywords: Metals, Sediments, Pollution, Izmir Bay

Introduction
Izmir Bay is one of the great natural bays of the Mediterranean Sea, whose shoreline is dominated by Izmir Metropolitan Municipality (Fig.1). It is divided into four parts: Gülbahçe Bay, Outer, Central and Inner Izmir Bays. It has a total surface area of over 500 km2, a total length of 64 km and opens in the Aegean Sea. Major indicators of pollution in aquatic environments are contaminated sediments that can be defined as soils, sand, organic matter, or minerals accumulated at the bottom of a water body (USEPA, 1998) [1]. Inputs creating pollution in the Izmir Bay consist of the following components; i) domestic waste waters produced by a population of nearly three million people; ii) industrial waste waters; iii) pollutant loads of Gediz river and other streams flowing into the bay; iv) agricultural drainage; v) port activities and sea traffic; vi) atmosferic inputs; vii) upflux from bottom sediments into the water column; viii) material transfer between the bay and the open sea [2].

Material and Methods
The surface sediment samples were collected using a Van Veen type grab sampler and the sediment core samples were obtained using a gravity corer from Izmir Bay during the cruise of R/V K. Piri Reis. Concentrations of metals were determined in the digested phase by inductively coupled plasma–mass spectrometer (ICP-ES/ICP–MS) analysis (ACME Analytical Labs, Vancouver, BC, Canada). Levels of heavy metal pollution in Izmir Bay. The amount of organic carbon (%) was determined by spectrophotometrically in dried sediment samples following the sulfochromic oxidation method.

Conclusion
In general particle size is fining in the sampling area except stations 1 and 4. Bottom sediments in these stations were relatively coarse with 84-96 % sand along the northwest coast of the outer bay while other stations were generally consists of clayey silt in the sampling area. Comparison of the metal concentrations with average crustal values revealed that most of the samples from the outermiddle, inner parts of the bay were polluted with As, Ni, Pb and As, Cr, Cu, Ni, Pb, Zn, respectively. The contamination factors (Cf) were between low and moderate for Mn (0.46-1.53), Cu (0.30-1.60), Co (0.40-1.20), Cr (0.38-1.43), and As (0.38-1.48) and between moderate and considerable for Pb (0.62-6.31) according to the Hakanson (1980) [3] classification in the bay. An EF value of 1.5 indicates that the given element has principally originated from lithogenic source. These results indicated that Cr, Mn, Pb, Zn, Cu and As (EFs > 1.5) came from human impacts. Gediz River discharge, and atmospheric inputs.

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ASSESSMENT OF HEAVY METAL DISTRIBUTION IN THE MONTENEGRIN COAST

Danijela Joksimovic [1]* and Zoran Kljajic [1]
[1] Institute of Marine biology, Montenegro - djoksimovic@ibmk.org

Abstract
The aim of the study was to determine the levels and distribution of heavy metals in the sediments in the Montenegrin coast, and also to assess the extent of anthropogenic impact using geo-accumulation index (I*geo*) and metal pollution index (MPI). Surface samples were taken from 10 locations. Grain size and trace element (Fe, Mn, Zn, Cu, Co, Ni, Pb, Cd, As and Hg) variations were analyzed, and MPI as well as Igeo calculated to understand the contamination level of the study area.

Keywords: Metals, Sediments, South Adriatic Sea

Introduction

Pollution of the natural environment by trace metals is a world-wide problem. Trace elements from natural and anthropogenic sources continuously enter the aquatic ecosystem where they pose a serious threat because of their toxicity, long time persistence and bioaccumulation ([1]). Also as other areas on Montenegrin coast is also under a great impact of anthropogenic factors and the activities on the shore. Sediments show a high capacity to accumulate and eventually integrate the low concentrations of trace elements usually found in water. In order to better interpret the results of any contaminant analysis some concepts have been suggested, such as the study of spatial and temporal variance in the objective area using multiple repeated sampling over an extended period of time [2].

Material and Methods

Samples of bottom sediments were taken from a depth of 15-20 cm using an internal diameter plastic gravity corer. The sampling was done in autumn of 2005 and 2006 at 10 stations in the Montenegrin coast, Fig.1. Dry sample (about 0.5 g) were digested with 2 ml of HNO3 (65%), 6 ml HC1 (37%) in a microwave digestion system (CEM. Corporation, MDS-2100) for 30 min and diluted to 25 ml with deionized water and stored in polyethylene bottles until analysis. A blank digest was performed in the same way.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 hollow cathode lamps were used for all elements except arsenic, for which a Electrodes Discharge (EDLs) lamp was used. Each sample was analyzed in triplicate.

Fig. 1. Map of investigation area

Result and Discussion

The Montenegrin coast, as a direct recipient of pollutants of anthropogenic origin from the area, showed the higher contents of heavy metals in bottom sediments in 2005 compared to 2006 when values for those heavy metals on every examined locations was much lower ([3], [4]). The contents of investigated metals in both years are: Fe>Mn>Ni>Zn>Cu>Co>As>Pb>Cd>Hg. The values of microelements in sediments of Boka Kotorska Bay are much higher than on the locations which are under the influence of open sea, except on locations Rt Djeran and Ada Bojana in both seasons. The increase of lead, cadmium, arsenic and mercury on one station in Boka Kotorska Bay can be explained by the fact that this area is under great impact of industry and huge medical complex. Based on the values of MPI, on each location pollution is detected. Comparing seasons 2005 and 2006, MPI is higher in 2005 (1.39-3.04) than in 2006 (1.46-2.63). Locations with higher values of MPI in both seasons are Ada Bojana and Rt Djeran (open sea) and Kukuljina (Boka Kotorska Bay), because this locations has higher content of microelements in sediment. The locations with higher values Igeo are Bar (1.85) and Kukuljina (3.79) for Cd, and Bar (3.2) for Hg. The main reasons of higher contamination are anthropogenic factor, harbor activates and anti-corrosion treatment for vessels.

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THE COMPARISION OF THE HEAVY METAL LEVELS IN TWO DIFFERENT BARNACLE SPECIES FROM THE LEVENT MARINA, IZMIR

Sinem Aydin-onen [1], Ferah Kocak [1] and Filiz Kucuksezgin [1]*
[1] Dokuz Eylul University Institute of Marine Sciences and Technology - filiz.ksezgin@deu.edu.tr

Abstract
The biomonitoring study presents the comparison of distribution of heavy metals in seawater and the soft tissues of two major fouling species *Amphibalanus amphitrite* (Darwin, 1854) and *Amphibalanus eburneus* (Gould, 1841) collected from Levent Marina (Izmir) in Autumn 2008 and in Spring 2009. The results showed that two studied species of barnacles are excellent biomonitors and have the ability to accumulate Cu, Fe and Zn in a higher degree than seawater.

Keywords: Metals, Bio-accumulation, Bio-indicators, Izmir Bay

Introduction
The relative contamination of coastal environments can be measured by using suitable biomonitors. Especially mussels and barnacles, key components of the local sublittoral benthos, are used to address the question of metal bioavailabilities [1]. To the best of our knowledge following a literature survey, no previous monitoring of metal contaminants has been carried out in barnacle species from the Aegean coast. The main aim of the present study is to compare the heavy metals using seawater samples and the soft tissue of barnacles, *A. amphitrite* and *A. eburneus*. Materials and Methods Seawater, *A. amphitrite* and *A. eburneus* were collected from the intertidal zone at Levent Marina in Autumn 2008 and Spring 2009 (Fig. 1). For water samples analyses were performed by flame AAS (Varian Spectraa-300 plus) for Cd, Pb, Cr, Cu, Mn, Zn and Fe and by anodic stripping voltammeter (ASV) at the rotating gold electrode for Hg and for barnacle analyses were performed by flame (Cu, Fe, Mn and Zn), cold vapour (Hg) and graphite furnace technique (Cd, Cr and Pb) in AAS by using the manufacturer's conditions and with background correction according to UNEP [2,3].

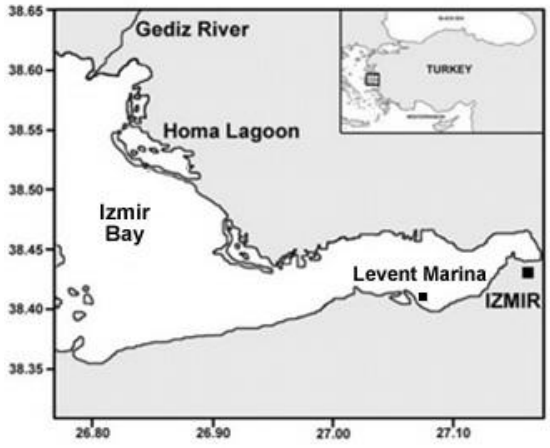

Fig. 1. Location of sampling station in Izmir Bay

Results and Discussion
Among the heavy metals, Cu, Mn, Zn and Fe levels were found higher in the tissue of *A. amphitrite* and *A. eburneus* as compared to seawater samples during autumn (2.41, 1.81, 7.06, 14.10 µg/l) and spring (0.94, 2.31, 0.81, 4.60 µg/l) periods, respectively. Availability of high autumn and spring metal concentrations in the soft tissues of *A. amphitrite* was foundas following ranking Fe>Cu>Zn>Mn. Furthermore, measured high autumn and spring metal levels in *A. eburneus* decreased in the following order Fe, Cu, Zn, Mn and Zn, Fe, Cu, Mn, respectively. Comparing the concentrations of heavy metals in the tissue for each species, *A. amphitrite* was accumulated Cu (208.33 µg/g) in a higher degree in autumn. In contrast, *A. eburneus* was accumulated Fe (389 µg/g), Zn (321.48 µg/g). Concerning the detected metal levels in spring period, higher Cu (378.76 µg/g) and Fe (317.47 µg/g) were recorded in the tissue's of *A. amphitrite* whilehigher Zn level (494.11 µg/g) was measured *in A. eburneus*.

The results of this study showed that *A. amphitrite* and *A. eburneus* has high accumulation capacity for Cu, Zn and Fe. These high accumulated values could be explained due to the high concentration of these metals in the water body and the role of these metals as essential element for the physiological and biological activities of the studied animals [4]. Based on contamination factor [CF is the ratio of metal concentration in the barnacle (ìg g^{-1} dry wt) to the concentration of metal in seawater (mg l^{-1})], barnacles have the ability to accumulate Cu, Zn and Fe in their tissues several times more than sea water (Tab. 1). Comparatively, the levels found in barnacle tissue are generally lower than those reported from contaminated regions in the world [5].

Tab. 1. Concentration factors for heavy metals in *Amphibalanus amphrite* and *Amphibalanus eburneus* in the Levent Marina

	Seasons	Hg	Cd	Pb	Cr	Cu	Mn	Zn	Fe
A. amphitrite	Autumn	1.8×10^{3}	3.5×10^{4}	3.3×10^{3}	8.3×10^{3}	8.7×10^{4}	9.0×10^{3}	2.8×10^{4}	2.2×10^{4}
	Spring	3.2×10^{3}	4.7×10^{4}	2.7×10^{3}	4.4×10^{4}	4.0×10^{5}	8.1×10^{3}	2.5×10^{5}	6.9×10^{4}
A. eburneus	Autumn	1.7×10^{4}	3.4×10^{4}	2.3×10^{3}	2.7×10^{4}	7.7×10^{4}	1.5×10^{4}	4.6×10^{4}	2.8×10^{4}
	Spring	1.5×10^{4}	7.6×10^{4}	6.5×10^{3}	5.9×10^{4}	1.4×10^{5}	1.5×10^{4}	6.1×10^{5}	3.2×10^{5}

Conclusions
In conclusion, Zn, Cu and Fe were the most abundant elements in the soft tissues of *A. amphitrite* and *A. eburneus*. The high levels of heavy metals recorded in the water samples of Levent Marina confirmed the presence of high concentrations of heavy metals in barnacle tissue. These accumulations may relate to their very efficient storage detoxification systems and/or due to the biological needs of animals. The present study concluded that both barnacle species are suitable candidates to be used in biomonitoring surveys for Cu, Zn and Fe particularly at the Aegean coast.

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COMPREHENSIVE ASSESSMENT OF HEAVY METALS CONTAMINATION IN SEDIMENTS OF THE SOUTHEASTERN MEDITERRANEAN SEA, EGYPT

Samir Nasr [1]*, Mohamed A. Khairy [2], Mohamed Okbah [3] and Naglaa F. Soliman [4]
[1] Department of Environmental Studies, Institute of Graduate Studies & Research, Alexandria University, 163 Elhorreya Avenue, Alexandria, Egypt. - samir_nasr@yahoo.com
[2] Graduate School of Oceanography, University of Rhode Island, 215 South Ferry Road, Narragansett, RI 02882, United States
[3] National Institute of Oceanography and Fisheries, Qayet Bay, Alexandria, Egypt
[4] Department of Environmental Studies, Institute of Graduate Studies & Research, Alexandria University, 163 Elhorreya Avenue, Alexandria, Egypt.

Abstract
Numerous indices have been developed to assess environmental risk of heavy metals in surface sediments, including the total content based geo-accumulation index (Igeo), exchangeable fraction based risk assessment code (RAC), and biological toxicity test based sediment quality guidelines (SQGs). In this study, the three indices were applied to surface sediments from 20 stations along the Egyptian Mediterranean Sea, to assess the environmental risks of heavy metals (Cd, Cr, Cu, Co, Pb, Ni, Mn, Fe, and Zn) and to understand discrepancies of the risk assessment indices.

Keywords: Sediments, South-Eastern Mediterranean, Metals

Introduction
Heavy metals are of considerable environmental concern due to their toxicity, wide sources, non-biodegradable properties and accumulative behaviors [1]. The evaluation of metal distribution in surface sediments is useful to assess pollution in the marine environment. Therefore, the assessment of sediment environmental quality is an essential component of environmental quality assessment of aquatic ecosystems. Several risk assessment indices of sediment environmental quality for heavy metals have been developed on different bases, such as geo-accumulation index (Igeo) on the basis of total content [2,3], risk assessment code (RAC) on the basis of availability [4,5], sediment quality guidelines (SQGs) on the basis of biological toxicity [6], and multiple variant approach [7]. In this study, the heavy metal contamination, chemical speciation and the associated ecological risk in the Egyptian Mediterranean Sea sediments were assessed using different indices i.e. enrichment level (total content, Igeo), availability level (weakly bounded fraction, RAC), and biological toxicity level (Threshold Effect Level (TEL), Probable effects Levels (PEL). The three indices were widely used and accepted for characterizing heavy metal contamination in literature and mandatory regulations.

Materials & Methods
Analysis of total heavy metal concentrations:
A concentrated acid digestion protocol according to Oregioni and Aston [8] was followed and the digested solution was diluted accordingly and measured for Cd, Cr, Co, Cu, Mn, Fe, Pb, Cd, and Zn using an atomic absorption spectrophotometer (AA6650, SHIMADZU, Kyoto,Japan). Reagent blanks, parallel replicates, and a standard reference material (IAEA-405: estuarine sediment, International Atomic Energy Agency, Vienna, Austria) were incorporated in each digestion batch for quality control and quality assurance. Recovery rates of the selected metals ranged from 90.3% to 104%.
Sequential extraction of selected metals:
In the present study, heavy metals (Fe, Mn, Zn, Ni, Cr and Pb) were sequentially extracted following the five step method proposed by Tessier et al. [9] into operationally defined as exchangeable (F1), Carbonate (F2), Fe-Mn hydroxide (Reducible) (F3), organic (F4) and residual (F5). These fractions may be considered to decrease in lability from exchangeable to residual. After each successive extraction, samples were centrifuged at 4000 rpm for 20 min to separate the extracted from the sediments. The concentrations of Fe, Mn, Zn, Ni, Cr and Pb in each of the leachates were determined by AAS (SHIMADZU 6650, Kyoto, Japan) in flame mode.

Results & Discussion
Results showed that based on the average Igeo of target elements, the Egyptian Mediterranean Sea has to be considered not polluted with Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn (Igeo$\leq$ 0%). On the other hand, over than 95% of the samples are lower than the threshold effect level (TEL) of SQGs for Cd, Zn, Pb and Cu. Risk assessment code analysis showed that Fe has no risk to local environment; Cr, Mn, Ni and Zn have posed low risk while Pb was at medium risk level. The study point out that although there were slight variations in the results of the three indices, the combination of the three indices gave us a comprehensive understanding of heavy metal risks in the surface sediments of the Egyptian Mediterranean coast.

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Session

Sedimentary and chemical processes

Modérateur : **Gert J. de Lange**

SULFATE-OXYGEN ISOTOPE INSIGHT INTO ANAEROBIC METHANE OXIDATION IN ESTUARINE SEDIMENT (EAST MEDITERRANEAN)

G. Antler [1]*, A. V Turchyn [1], A. Davies [1], M. Adler [2], V. Rennie [1], B. Herut [3] and O. Sivan [2]
[1] Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ, UK. - ga307@cam.ac.uk
[2] Department of Geological and Environmental Sciences, Ben Gurion University, Beer Sheva 84105, Israel.
[3] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa 31080, Israel.

Abstract

Measurements of sulfur and oxygen isotope composition of aqueous sulfate consumed through anaerobic methane oxidation (AOM) coupled to bacterial sulfate reduction (BSR) were used to enhance our understanding of this critical process. We sampled sediment cores at two highly stratified estuaries in the coastal area of the eastern Mediterranean (Yarkon and Qishon) in which sulfate is rapidly consumed and methane concentrations subsequently increase suggesting a coupling between the two. Although the pore fluid geochemistry are similar at the studied sites, the isotope geochemistry is fundamentally different indicating that the mechanism of BSR differs among the studied sites.

Keywords: Redox, South-Eastern Mediterranean, Sediments, Estuaries

Natural global methane production is driven by the microbially mediated process of methanogenesis, during which organic carbon is reduced to methane (e.g. [1]). Organic carbon in marine and marginal marine sediments can be oxidized both aerobically (through oxygen) and anaerobically, through the respiration of various electron acceptors. These other electron acceptors are used in order of decreasing chemical potential, beginning with nitrate, and proceeding through manganese and iron oxides, sulfate [2]. Organic matter that is not oxidized aerobically or anaerobically can undergo further reduction, leading to the formation of methane. Upwardly diffusing methane is oxidized microbially (methanotrophy), both aerobically and anaerobically (anaerobic oxidation of methane – AOM). AOM has been identified in marine and marginal marine sediments mainly coupled to sulfate reduction:

$$SO_4^{2-} + CH_4 \rightarrow HCO_3^- + HS^- + H_2O \quad (1)$$

Methane in marine sediments is almost entirely consumed by anaerobic methane oxidation (AOM) coupled largely to bacterial sulfate reduction [3]. The fact that virtually all methane in marine sediments is oxidized through AOM means that the earth's vast oceans are prevented from becoming a major source of this potent greenhouse gas.

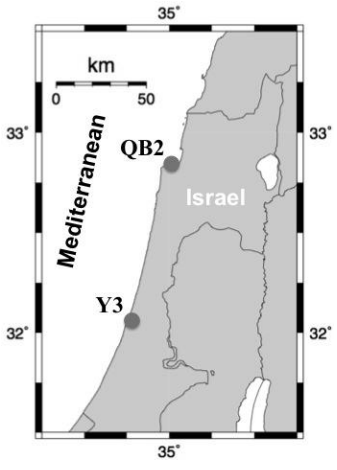

Fig. 1. Map of the study areas in a map of the Eastern Mediterranean region. The dots and the corresponding labels indicate the site locations and names, respectively.

To explore the coupling of bacterial sulfate reduction to AOM, this study focuses on highly stratified estuaries in the coastal area of Israel (The Yarkon and the Qishon-- Figure 1). The estuaries contain high organic carbon load from up-stream and a lower water mass impacted by seawater penetration. At both sites, the geochemisty of the pore fluids indicates rapid depletion of sulfate and intensive production of methane beneath, making these sites ideal locations for studying sulfate driven AOM in the upper sedimentary column. We use coupled carbon isotopes in dissolved inorganic carbon, sulfur and oxygen isotopes in pore fluid sulfate, sulfur isotopes in sedimentary sulfide and carbon isotopes in pore fluid methane to explore these processes in this marginal marine environment. The data is used to elucidate new pathways in the cycling of these environmentally important species, and the findings are applicable the broader marine environment.

Our geochemical measurements in the Yarqon in the Qishon estuarine sediments indicate that although there is similarity in the pore fluid sulfate and dissolved inorganic carbon concentration profiles, the isotopes ($\delta^{18}O_{SO4}$ vs. $\delta^{34}S_{SO4}$-- Figure 2) in the pore fluids are fundamentally different between these two sites. We suggest that this difference exists because the two estuarine sediments consist of different depth distribution of the microbial activity. This is elusive from the concentrations profiles, but easily identified by the isotopes profiles.

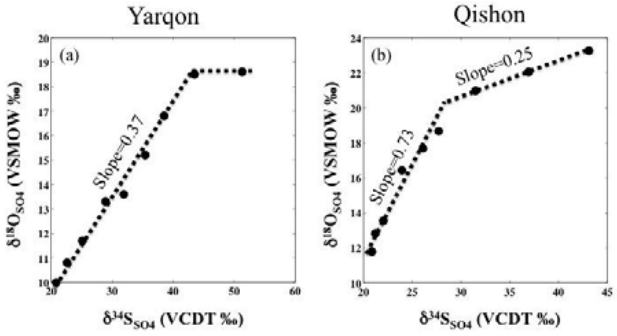

Fig. 2. $\delta^{18}O_{SO4}$ vs. $\delta^{34}S_{SO4}$ data in pore fluid sulfate from the Yarqon (a) and the Qishon (b).

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DISTRIBUTION OF PARTICULATE ORGANIC MATTER IN SEDIMENTS AND IN WATER COLUMN IN THE NORTHEAST MEDITERRANEAN (MERSIN BAY)

Emine Erdogan [1]*, Süleyman Tugrul [2] and Özden Bastürk [1]
[1] Mersin University, Faculty of Fisheries - emineerdogan@mersin.edu.tr
[2] Middle East Technical University, Institue of Marine Sciences, Erdemli 33731, Mersin, Turkey

Abstract
In the present study, 4 field studies were performed to collect surface sediments and water samples in the Mersin Bay between February 2009-October 2009. Spatial and seasonal variations of particulate organic carbon (POC), nitrogen (PON) concentrations were measured in the sediments and bulk POM filtered from water samples. In the nearshore waters (< 20 m), POC and PON values of bulk particulates in the bay waters ranged between 20-63 µM and 2.6-7.7 µM, respectively. The POC and PON concentrations of surface sediments at the inshore stations varied between 0.34-0.66 mmol-C/g (dry weight) and 0.05-0.06 mmol-N/g, decreasing to levels of 0.23- 0.61 mmol-C/g and 0.03-0.04 mmol-N/g in the offshore sediments (N/P ratio:7- 10).

Keywords: Sediments, Organic matter, Eutrophication, Mersin Bay

The coastal ecosystem of the NE oligotrophic eastern Mediterranean is impacted by the land-based inputs, mainly by riverine and domestic wastewater discharge [1]. Primary production is potentially limited by phosphorus in the coastal waters due to large N/P ratios in the regional rivers, rain waters and its deep waters [2]. Particulate organic carbon and nitrogen (POC and PON) in the surface sediments reflects the composition of POM sinking from the productive surface layer [3]. POC/PON ratios in the bulk POM ranged seasonally from 6-9 in the inner to 7-10 in the offshore waters. In the eutrophic nearshore waters (SDD ranged between 2-4 m), chlorophyll-a (CHL) concentrations were relatively high (0.92-3.5 µg/L). The POC-CHL ratio estimated from the regression analysis of bulk POM data ranged between 97 in winter-spring and 350 in the less productive summer-autumn period. POC and PON concentrations of the surface sediment varied between 0.34-0.66 mmol-C/g (dry weight) and 0.05-0.06 mmol-N/g (dry weight) in the nearshore zone, with the higher values in the winter-spring period due the increased nutrient inputs by the rivers. In surface sediments of the nearshore zone, POC and PON values varied seasonally between 0.42-0.64 mmol-/g (dry weight) and 0.05-0.06 mmol-/g (dry weight), whereas the offshore surface sediments contained less organic matter 0.23-0.61 mmol-C/g (dry weight) and 0.03-0.04 mmol-N/g (dry weight). The C/N ratios of the nearshore sediments were relatively lower(6.03-7.2) in spring, consistent with the ratios of bulk POM in the water column. However, the sediment N/P ratios increased to levels of 10-12.7 in the summer-autumn samples from the same locations, showing the selective decay of nitrogenous organic matter in the POM in the surface sediments when the POM supply from the surface layer decreased.

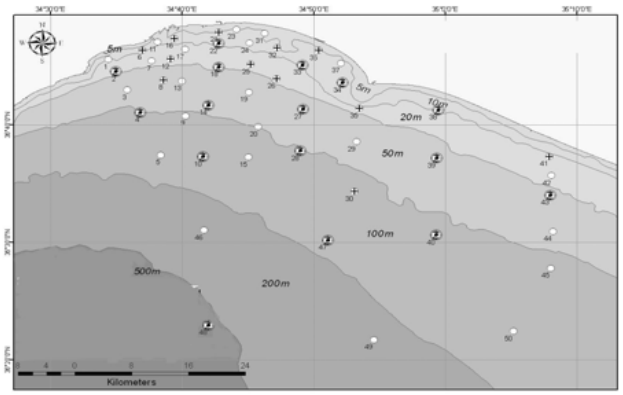

Fig. 1. Locations of Eutrophication monitoring Stations in the Nearshore Zone of TARAL-Mersin Bay

Acknowledgements This study was supported by TUBITAK within 107G066 (SINHA) research project. We would like to thank R/V Bilim crew and METU-IMS technical personnel who helped in field studies and chemical analysis.

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COMPOSITION AND ORIGIN OF THE NOVIGRAD SEA SEDIMENTS, EASTERN ADRIATIC COAST

Željka Fiket [1]*, Nevenka Mikac [1] and Goran Kniewald [1]
[1] Ruder Boškovic Institute - zeljka.fiket@irb.hr

Abstract
Composition of the sediments, their origin and deposition conditions in the Novigrad Sea, a small bay in the central part of the eastern Adriatic coast, was studied.

Keywords: Estuaries, Geochemistry, Sedimentation, Central Adriatic Sea

Introduction
The Novigrad Sea is a small, semi-closed bay located in the central part of the eastern Adriatic coast. The main characteristics of sediments of the wider area of the Novigrad Sea, including Zrmanja River and bay of the Karin Sea, were investigated. The Zrmanja River is a small karstic river which discharges in eastern part of the Novigrad Sea forming highly stratified estuary [1]. Geochemical, sedimentological and mineralogical analyses of sediments were carried out in order to gain insight into the composition of the sediments, the origin of materials and the deposition conditions in the Novigrad Sea.

Sampling and methods
For purposes of this study, sediment cores were taken at several locations including Zrmanja River, Novigrad Sea, Karin Sea and Velebit channel. Each core was cut into 2 cm subsamples prior to further analysis. Identification of the mineral composition of sediments was performed by X-ray powder diffraction (XRD). Sediment samples were granulometrically characterized by wet sieving.
The content of carbonates was determined volumetrically. Multielemental characterization of sediments after total digestion was performed by high resolution inductively coupled plasma mass spectrometry (HR ICP-MS). Analysis included determination of major, trace and rare earth elements.

Results and Discussion
Results indicate that the bulk samples are predominantly made up of carbonates, quartz and halite, while clay minerals occur as minor phases. Granulometric characteristics of the sediments indicate an increase in silty component (from 24% to 87%) downstream of Zrmanja River toward the deeper part of the Novigrad Sea. Share of carbonates also decreases from the river (64%) to the estuarine sediments (19%). Sediments with highest clay content and consequently highest metal content were collected from the deepest parts of the Novigrad Sea. Based on the results of statistical analysis three main components of the sediments can be distinguished: 1) lithogenic component - elements bound to clay minerals, 2) authigenic component – elements bound to Fe-Mn hydroxides, 3) biogenic component - elements bound to carbonates.
The vertical distribution of elements in sediment cores reflects source rock geochemistry, hydrogeological conditions, early diagenetic transformations and possible anthropogenic influence. Enrichment of sediments with metals downstream of the Zrmanja River and within the Novigrad Sea is related to salt-induced coagulation of colloidal materials and precipitation of Fe-Mn oxyhydroxides and clay particles. The sedimentation processes in the Novigrad Sea are therefore predominantly influenced by Zrmanja River. Smaller streams, as well as water inflow from the Karin Sea have less pronounced but still important influence on sedimentation in this basin.

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CHARACTERIZATION OF MICRON AND SUBMICRON-SIZED MINERAL PARTICLES FROM FOUR DISTINCT MARINE ENVIRONMENTS OF THE ADRIATIC SEA

M. Ivanic [1]*, I. Jurina [1], S. D. Skapin [2], N. Vdovic [1] and I. Sondi [3]
[1] Ruder Boskovic Institute, Zagreb, Croatia - mivanic@irb.hr
[2] Jožef Stefan Institute, Ljubljana, Slovenia
[3] Faculty of Mining, Geology and Petroleum Engineering, Zagreb, Croatia

Abstract
Mineralogical, surface physico-chemical, morphological and structural characteristics of micron and submicron-sized mineral particles separated from different sedimentological environments of the eastern Adriatic coast were determined. The physico-chemical characterization revealed a significant increase in cation exchange capacity (CEC) and specific surface area (SSA) with decreasing particle size. Mineralogical, morphological and structural analysis showed that the fractions with higher amount of aluminosilicate, oxide and oxyhydroxide particles exhibit significantly higher values of SSA and CEC, and consequently, increased reactivity of sediments in biogeochemical processes in the marine environment.

Keywords: Sediments, Mineralogy, North Adriatic Sea, Central Adriatic Sea, South Adriatic Sea

Introduction
Coastal sediments are considered as the main sink for contaminants. The most reactive sediment phases are micron and submicron mineral particles due to their exceptionally high surface area and sorption properties. They govern biogeochemical processes and are responsible for transfer of contaminants from water to sediment. This research aims to determine the composition of micron and submicron-sized mineral particles and elucidate their role in biogeochemical processes with respect to their surface physico-chemical, morphological and structural properties.

Study area
Four distinct marine environments were chosen for studying considering their different sedimentological characteristics. The Po receiving basin (1, Fig. 1) is an area under influence of the Po river and receives a fine-grained part of the river load; the open sea location (2, Fig. 1) is an area of deep sea that is not influenced by coastal sedimentation processes; the Malo jezero on the island of Mljet (3, Fig. 1) is a karstic marine lake characterized by precipitation and sedimentation of aragonite [1], and the Risan bay (4, Fig.1) is a very indented marine environment characterized by sedimentation of clayey particles.

Fig. 1. Map showing locations of sampling.

Materials and Methods
Surface sediments were retrieved using Uwitec gravity corer or Van Veen grab sampler. Organic matter was removed by sodium hypochlorite treatment, modified after Kaiser [2]. Different size fractions were separated by gravitational settling, confirmed by laser diffraction, and freeze-dried. Physico-chemical characterization of mineral surfaces (SSA, CEC) was performed, and mineralogical composition (XRD) and morphology determined (FE-SEM).

Results and Discussion
The removal of organic matter significantly increased the share of the clay fraction and values of CEC and SSA in all investigated sediments. Accordingly, the loss of the organic coatings and disintegration of mineral aggregates enlarges the surface area of mineral particles available for interaction with the environment. In addition, this study exemplifies that the SSA and CEC values in different sediment fractions rise significantly with decreasing size (Fig. 2). The fractions with the highest values of SSA and CEC were mainly composed of aluminosilicate, oxide and oxyhydroxide particles.
The highest values for SSA and CEC were determined in sediment samples from locations 2 and 4 (Fig. 2), which also had the highest amount of aluminosilicate, oxide and oxyhydroxide particles. In samples from location 1, SSA and CEC values determined for micron and submicron fractions were still high, while for the original sediment sample they were slightly lower compared to other locations. This could be attributed to the prevalence of quartz, feldspars, and carbonates in the coarser sediment fraction. The lowest values were determined in the sediments with predominately carbonate sedimentation (location 3), revealing lower surface reactivity of carbonate minerals.
The submicron-sized aluminosilicates, oxides and oxyhydroxides represent the most reactive particles that are responsible for removal and transport of contaminants in aquatic environments. Even when they are not the primary constituent of sediments, they still have a significant impact on their surface reactivity.

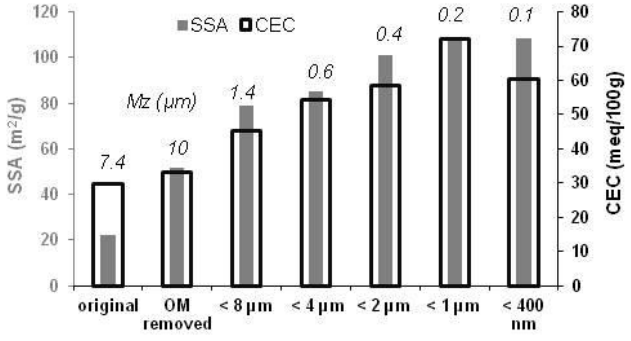

Fig. 2. CEC, SSA and mean sizes (Mz) of fractions separated from location 4.

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MANGANESE AND BIOGENIC SILICA ASSOCIATION IN IZMIR BAY SEDIMENT (TURKEY, EASTERN AEGEAN SEA)

Ebru Y. Ozkan [1]*, Hasan B. Buyukisik [1] and Ugur Sunlu [1]
[1] Ege University, Fisheries Faculty, Department of Hydrobiology - ebru.yesim.koksal@ege.edu.tr

Abstract
Biogenic silica (BSi), pore water silica and other biogeochemical paramaters in sediment were investigated by using factor analysis in Izmir Bay.

Keywords: Eutrophication, Benthic-pelagic coupling, Aegean Sea

Biogenic silica (BSi) plays an active role in marine biogeochemical cycles. It is an important mineral found in many marine sediments due to primarily produced by planktonic organisms living in the surface ocean. Also, BSi is a chemical determination of the amount of amorphous silica which can be comprised of different component mainly of biological origin such as diatoms, phytoliths, radiolarians, silicoflagellates and sponge spicules (1). Accumulation of biogenic silica continues as the biosiliceous debris through the water column. In this study, two different methods which are Si/Al and Si/time were used. Si/Al method was calculated according to (2), Si/time was calculated according to (3). Biogenic silica (BSi) of samples via timed dissolution method were determined by plotting extracted silica against time and extrapolation of linear partion of the curve back to the zero time. BSi values of samples were determined by plotting extracted silica against Al and extrapolation of regression back to the zero Al value. In Si/time method, the BSi values were highly correlated with clay-silica, indicating that the dissolution of clay but Si/Al method did not. Therefore it was chosen Si/Al method to represent true BSi. The data set has been subjected to factor analysis. The results showed that 5 factors have been extracted. One of these factors includes the strong association of the BSi in sediment, pore water silica and the manganese. It was observed that aggregate from North (Bostanli) which was not cemented and Neogene aged carbonate rocks from South (Inciralti) are moved towards the inner bay through rivers together with Fe and Mn. Carbonate minerals have dilution effect on clay minerals here. Therefore, it is not possible to mention biogenic silicata since there is no diatom bloom in area where there are stations 4, 5, 6, 7, 14, 15 and 16 (Fig. 1).

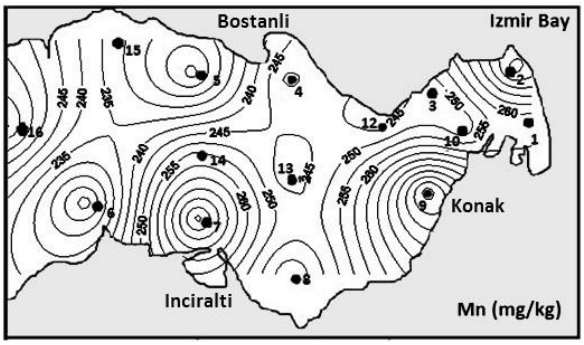

Fig. 1. Distribution of BSi (%) in sediment

On the other hand, when the existence of cold water in Hisar Castle which existed around 1650's in the district of Konak (sta. 8, 9 and 10), it can be thought that this water may enable diatom dominance due to dissolved silicate in deepwater. Infact, it is stated that there source which provide water for the fountain in Agora goes underground till Konak district. Due to bay water which was hypereutrophic before treatment plant (before 2001), in the sediment which contain hydrogen sulfide, Fe^{+3} and Mn^{+4} reduce to as Fe^{+2} and Mn^{+2} dissolved phases. And then these reduced species mobilize to sediment surface and overlying water. As it is seen in Figure 2, there is manganese only at the mouth of river and apart from inner bay. In the retention of manganese in sediment, the importance of the BSi as the carrier phase and the importance of the diatom productivity in the water column might be of paramount. This situation was expressed upon as one of the point that should be investigated in details.

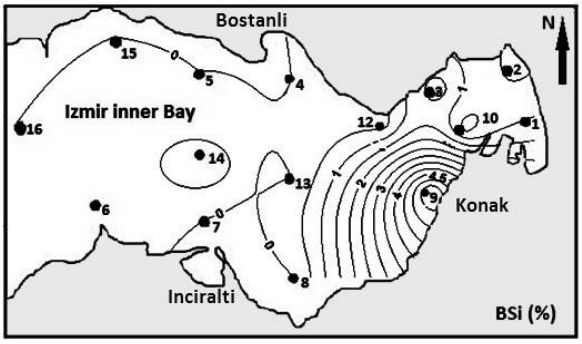

Fig. 2. Distribution of manganese (mg/kg) in sediment

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Session

Shoreline dynamics

Modérateur : **Muhammet Duman**

PLANNED STUDIES FOR THE INVESTIGATION OF GEOTHERMAL POTENTIAL IN THE SIGACIK GULF (SEFERIHISAR)

Ozde Bakak [1]* and Erdeniz Ozel [2]
[1] Department of Geothermal Energy, Dokuz Eylul University, Izmir-Turkey - ozde.badur@deu.edu.tr
[2] Institute of Marine Science and Technology, Dokuz Eylul University, Izmir-Turkey

Abstract
The Sigacik Gulf is located in between Teke and Doganbey Bay in the south of Karaburun peninsula in the western Anatolia. This paper give to information about the preliminary results of the single channel seismic survey and consists of the planned studies for the investigation of geothermal potential in the Sigacik Gulf (West Anatolia) within the scope of a PhD Project.

Keywords: Geophysics, Seismics, Aegean Sea, Hydrothermal vents

Introduction
The study area is located in the region between Doganbey and Teke Bay in the south of Izmir Gulf (Fig.1). Sigacik Gulf's surroundings are covered by Mio-Pliocene and younger units. Pre-Miocene basement consists of Silurian, Carboniferous, Triassic, and Cretaceous rocks, and its crops out along high elevated areas such as Karaburun, Seferihisar, and Kusadasi ridges [1]. The geological map of area's surroundings is again worked out using ArcGIS (GIS-based) software from 1/500.000 scale of the geological map of Izmir-Turkey.

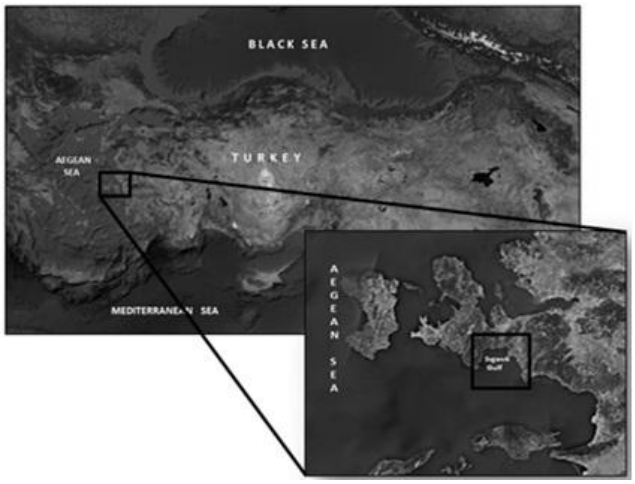

Fig. 1. The location of Sigacik Gulf

Methods
The Single Channel Seismic, Magnetic, Heat Flow, CTD and using ROV for monitoring of seafloor have been planned to investigation of geothermal potential in Gulf of Sigacik. During the single channel survey used to sparker system, which have 1 channel and 12 hydrophone with 17 m long streamer, as a seismic source and seismic data acquisition were carried out on board Dokuz Eylül-1 which is research vessel Dokuz Eylül University (Izmir-Turkey) in 10-12 October 2012. Approximately 250km data were acquired along the total of 27 seismic lines which compose of the 14 DB direction and 13 KG direction seismic lines. The seismic data processing was made using Promax program in the Seismic Laboratuary in the Institute of Marine Science and Technology. Some data processing steps were applied to seismic data such as, data load, geometric load, band pass filter, top mute, trace mixing, and time migration. However, the Sigacik Gulf's map of sea floor depth were obtained from a single channel seismic sections using the Kingdom Suite program (Fig.2).

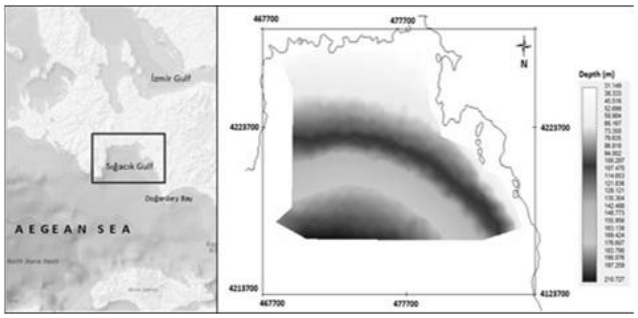

Fig. 2. The Sigacik Gulf's map of sea floor depth

Conclusions
The shallow seismic studies (Sparker) have been applied in Sigacik Gulf in 10-12 October 2012, also Magnetic, Side Scan Sonar, Heat Flow, CTD (Conductivity, Temperature, Depth) and ROV (Remotely Operated Vehicle) have been planned in terms of giving more information about the geothermal potential, in the content of the PhD project.

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MODELING HYDRODYNAMICS AND SEDIMENT RESUSPENSION ON ARTIFICIAL REEF SYSTEMS IN THE GULF OF VENICE

M. Sclavo [1], A. Benetazzo [1], A. Bergamasco [1], D. Bonaldo [1]*, S. Carniel [1], F. M. Falcieri [1], M. Aurighi [2] and F. Fiorani [2]
[1] Institute of Marine Sciences (CNR-ISMAR) Venice - davide.bonaldo@ve.ismar.cnr.it
[2] Geology and Geo-Resources Dept., Water Protection Unit, Regione Veneto, Venice, Italy

Abstract
Natural outcropping rock systems (*Tegnùe* in local language) along the northern Adriatic littoral zone represent important sites for biodiversity, protected from the mechanical effects of trawl fishing by artificial reef structures deployed in the surroundings. We describe the modelling approach to characterize the hydrodynamic and sediment transport in the proximity of such artificial reefs The numerical tool was used for investigating the impacts of different monolith systems in terms of increase in local suspended sediments concentration, providing a support for ecological design of such interventions.

Keywords: Coastal management, Gulf of Venice

The coastal zone of the Gulf of Venice (Italy) is characterized by the presence on its sandy-silty seabed of a number of outcropping rocky systems, named *Tegnùe* by local fishermen. These formations represent important biodiversity spots for the northern Adriatic sea; in order to enhance sealife settlement and protect the sites from the mechanical effects of trawl fishing, the Regional government has decided the deployment of monolithic artificial reef clusters in their surroundings. Within the MARINA Project, funded by the Veneto Regional government as a part of the Regional policy for coastal zone protection (*Legge Regionale* 15/2007), CNR-ISMAR was committed to the investigation of the effects of artificial reef systems on hydrodynamic and sediment transport. In particular, the main scope of the activity was to determine whether such structures may determine a turbidity increase (and therefore a water quality degradation) close to the deployment zones, and also to suggest an optimal strategy for future deployments.

A multi-step modelling activity at different time and space scales was carried out. Firstly, a statistical characterization of hydrodynamic conditions on the northern Adriatic sea was provided by means of a basin scale high-resolution (500 m) state-of-the-art, fully 3D numerical model run with reference to a typical year. The ocean hydrodynamic conditions were computed by the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) modelling system, based on the ocean model ROMS, the wave model SWAN, and the CSTMS routines (Carniel et al., 2011). The hydrodynamic quantities thus obtained were then used for implementing a set of super-high resolution (from 0.15 to 4.00 m mesh size) 3-D hydrodynamic and sediment transport simulations, carried out via the numerical model MIKE-3, providing a broad description of velocity and suspended sediment concentration (SSC) fields close to a single submerged monolith covering the whole range of environmental (hydrodynamic, geometric and granulometric) conditions on the *Tegnùe* zones. Numerical output results were made available to the end-users and policy makers via a THREDDS Data Server (TDS, Bergamasco et al., 2012).
Lastly, results of idealized single-structure runs were then assembled in order to describe real systems: these informations were made available by means of a dedicated graphical query tool (MUD-App).

The main findings show that the SSC increase induced by artificial reef systems is generally negligible (<1%) compared to the background concentration. Only during particularly severe storms (return time one year longer) a stronger increase in SSC (eventually of the same order of magnitude as the background concentration) can take place in the very proximity of the monoliths, rapidly decreasing to less than 10% this value at a 10 m distance from the structures.

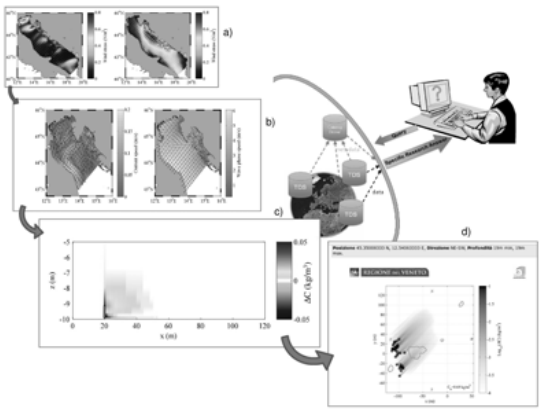

Fig. 1. From atmospheric forcings to sediment transport analysis on artificial reef systems. a) surface stress on the Adriatic sea under different wind conditions; b) current and wave patterns on the northern basin; c) SSC increase close to a single monolith; d) screenshot from the MUD-App representing SSC increase on a real artificial reef system. Results were loaded into a TDS.

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CARACTÉRISTIQUES GRANULOMETRIQUES ACTUELLES DE LA LAGUNE MELLAH (ALGÉRIE NORD-EST): EFFETS DE COLMATAGE DU CHENAL DE COMMUNICATION AVEC LA MER

Brahim Draredja [1]*, Khalil Melouah [1] and Hayet Beldi [1]
[1] Université d'Annaba - draredjab@yahoo.fr

Abstract
La granulométrie de la lagune Mellah s'organise de façon concentrique ; allant des sables fins purs près des berges, aux vases pures au centre de la lagune. En effet, la fraction pélitique s'accroît avec la profondeur, où l'extension de celle-ci a augmenté dans la lagune, vingt deux ans après l'opération d'aménagement du chenal de communication avec la mer.

Keywords: Lagoons, Sediments, Sediment transport, South-Western Mediterranean

Introduction

La lagune Mellah est située à l'extrême Est algérien (8°20' E et 36°54' N) et totalise une superficie de 865 hectares, avec une profondeur maximale qui ne dépasse pas 5,2 m. Elle est l'unique lagune en Algérie, de ce fait elle a suscité des études scientifiques ([1], [2], [3], [4]). Ce milieu à vocation aquacole a connu une chute remarquable de sa production halieutique durant les années 80 [5]. C'est ainsi qu'à la fin de 1988, des experts de la FAO ont établi un plan d'aménagement du chenal de communication avec la mer [6], afin d'améliorer les échanges mer - lagune et faciliter la migration des poissons entre les deux milieux. La présente étude est une actualisation des caractéristiques granulométriques de la lagune vingt deux ans après l'opération d'aménagement du chenal.

Matériel et méthodes

La lagune Mellah est une étendue d'eau saumâtre dont la salinité varie entre 23,50 et 35,25 [7], communique avec la mer grâce à un chenal long (900 m) et étroit (2 à 10 m). L'échantillonnage systématique du sédiment a été effectué en mars 2010 à partir de 33 stations. Une analyse granulométrique de la couche superficielle du substrat a été réalisée après une séparation entre les deux fractions fine et grossière à une limite de 63 µm.

Résultats et discussion

Les résultats de l'analyse sédimentaire montrent que, dans la lagune Mellah comme dans la majorité des lagunes méditerranéennes, la granulométrie s'organise d'une façon concentrique ; c'est-à-dire que la taille des grains diminue régulièrement des rives au centre de l'étendue. Ce phénomène serait dû au processus d'accumulation des particules fines dans la cuvette centrale, suite à une forte agitation à la périphérie, puis le courant s'affaiblit vers le centre de la lagune [2]. En effet, les berges du Mellah sont formées de sables fins purs et au fur et à mesure qu'on se dirige vers les grandes profondeurs la fraction pélitique a tendance à augmenter (Fig. 1). Par ailleurs, cette étude nous a permis de mettre en évidence cinq zones lithologiques allant des sables purs près des rives aux vases pures au centre, en passant par les sables légèrement envasés, les vases sableuses et les vases légèrement ensablées (Fig. 1). On signale également la présence d'une forte densité d'herbier à *Ruppia* sp., sur les rives jusqu'à une profondeur de 1,50 m ; ceci participe au maintien de la bande sableuse le long des côtes de la lagune. En comparaison avec les études antérieures ([1], [2], [3]), le taux des pélites a sensiblement augmenté de la périphérie jusqu'au centre de la lagune. Cette situation serait en relation avec le faible hydrodynamisme, suite à l'état du colmatage du chenal, favorisant ainsi la décantation des particules fines surtout au centre de l'étendue, la zone la plus profonde.

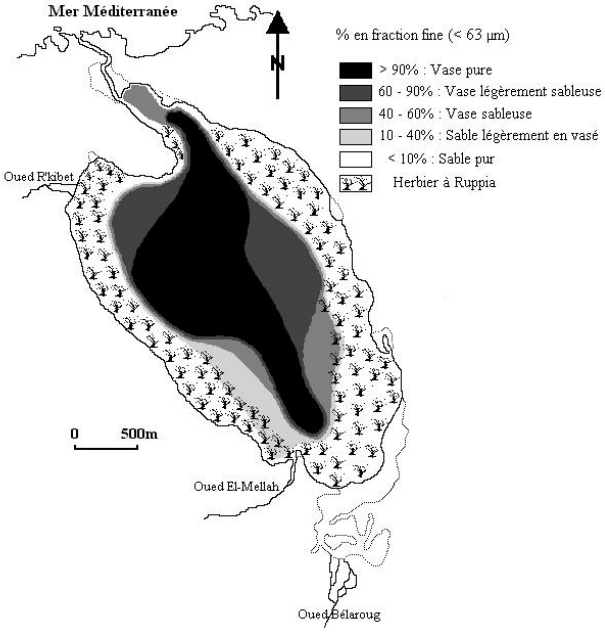

Fig. 1. Couverture sédimentaire de la lagune Mellah.

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CONTEMPORARY AND LATE QUATERNARY EVOLUTION OF IZMIR BAY (WESTERN TURKEY) AND INVESTIGATION OF MORPHOSEDIMENTARY SEABED FEATURES

M. Duman [1]*, B. Akçali [1], G. Dumanoglu [1], C. Eytemiz [1] and T. Ilhan [1]
[1] Dokuz Eylul University Institute of Marine Science and Technology - muhammet.duman@deu.edu.tr

Abstract
This article presents data from high-resolution shallow seismic profiles, side scan sonar, scanning sonar, surficial sediment data and video data for the sedimentary history, characterization and process-description of the Izmir Bay (western Turkey).Rate in sea level rise, seabed morphology, sediment supply, hydrodynamic regime are the main controlling factors of general infill pattern. Inspection by diver video of pockmark like seabed features are showed that some of these features are partly related with the scouring at wreck sites and controlled by the orientation of the wreck structure relative to the prevailing hydrodynamic conditions.

Keywords: Deltas, Sea level, Stratigraphy, Sediments, Izmir Bay

Introduction
Over the last decade, numerous works has been carried out on sedimentary coastal wedges in order to portray their pattern and evolution in relation to the last post-glacial sea level rise, and to estimate their future behavior. High resolution shallow seismic investigation complemented with side scan sonar and gravity coring and radiocarbon dating has been widely performed in many coastal settings around the world. Such detailed studies have been limited around the Turkish coastal areas of eastern Mediterranean and especially inner Gulf of Izmir [1] needs more representative work. In this study, the quaternary growth of Gediz delta in Izmir Bay is described and its relationship to tectonic and sea level change is interpreted. Additionally morphosedimentary seabed features are investigated with sonar and video recordings.
Material and Methods
The seismic, side scan sonar and diver video data that constitute the basis of this work were collected from the research vessel of the Institute of Marine Sciences and Technology in 2010, 2013. Data were recorded and processed using Triton SB Logger-Interpreter. Seismic profiles are divided seismic stratigraphic units, using the technique that described in Allen and Posamentier [2]. Conclusions
The shelf and basin slope area of Izmir Bay is underlain by superimposed deltaic sequences. Following the Holocene post glacial transgression, deltas were re-established deep in ancestral bays and little sedimentation took place on the shelf. The main architecture change occurred at ca. 7000 BP, i.e. when the sea-level rise slowed down comparably. The TST built up during the phase of rapid rise. It is poorly preserved and overlain by the HST that developed during the mid- to late Holocene. Rate of sea-level rise, sediment supply, basement hypsometry and hydrodynamic regime appear therefore as key-factors controlling the general geometry, preservation and nature of the sedimentary infilling. It appears in particular, that wave and current dominated bodies can be preserved in the infill of microtidal bay settings characterized by erosional seabed morphology especially in southern part of the bay. Isopach mapping shows that the thickest sediment sequences on the continental shelf are developed in bay near the limit of delta progradation. According to Aksu et al., [1] the pre-Miocene tectonic framework of the area around Izmir is characterized by north-northeast trending faults. Processed high resolution seismic profiling data show that there is no indication of active faulting and all fault like structures are related with acoustic basement morphology. This pattern is contrary the proposed tectonic models of recent works for Izmir Bay [3], [4]. Individual objects, artefacts or wrecks may act as nuclei to promote scour at local scale. Seismic, sonar and video data showed that scouring at such sites is controlled by the orientation of the wreck structure relative to the prevailing hydrographic regime, bathymetry and geological environment of the site.

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MARINE HABITAT MAPPING AND SEA- FLOOR SURFACE STRUCTURES USING SIDE SCAN SONAR AND VISUAL DATA: NORTHERN CYPRUS SHELF SURVEY

T. Ilhan [1]*, B. Akçali [1], M. Atalar [1], R. Kavcioglu [1], Ö. Yegrek [1] and M. Duman [1]
[1] D.E.U Institute of Marine Sciences and Technology - tarik.ilhan@deu.edu.tr

Abstract
The aim of this study, to map seafloor surface structures and benthic areas by using side scan sonar supported with underwater photography and video recordings. In the Northern Cyprus Shelf the outcrop of basement rocks, sedimentary boundaries, habitat areas and the other local targets have been mapped at using SSS records.SSS records have been specify by mosaic maps which are created and possible sediment boundaries of biota have been defined as matching locations with visual data. The resulting morphologic and seabed classification maps were combined to plot the distribution of the predominant habitats in the coastal waters of Northern Cyprus, some of which are of high conservation value.

Keywords: Geophysics, Instruments and techniques, Sampling methods, Sediments, North-Eastern Mediterranean

Introduction
The Mediterranean Sea, especially the eastern Basin, is a unique environment whose structure and function is poorly known. It is considered to be one of the most oligotrophic regions in the world with an overall nutrient deficit that develops towards the east. The Levantine Sea is bordered on the north by Crete, the Dodecanese Islands and Turkey. On the east it is bordered by Syria, Lebanon and Israel and to the south by Egypt and Libya. The island of Cyprus is located in the northeast quadrant of the basin (Fig.1). The margin of the basin includes an island arc from Crete through the Dodecanese Island to Rhodes. The remaining basin margins are of the less complex types consisting of continental shelves, slopes, rises and associated features. The predominant topographic feature of this region is the ‘‘Mediterranean Rise’’ (Carter et al., 1972). The Cilician Basin lies in the northeastern part of the Mediterranean, between Northern Cyprus and the Turkish mainland. The smaller scale bathymetric features of the Levantine Basin are the Lattakia (1000–1500 m) and Cilician (1000 m). The relatively shallow Lattakia and Cilician Basins communicate with each other through a narrow channel of 700 m depth located nearly midway between the sills extending from the northeastern tip of Cyprus to the mouth of the Gulf of Iskenderun. Cyprus is the third largest island in the Mediterranean Sea, located west of Syria and south of Turkey. The island has a maximum length of about 220 km from Cape Andreas in the northeast to the western extremity of the island. Its maximum width, from Cape Gáta in the south to Cape Kormakiti in the north, is about 90 km. The total area of the country is 9.251 km. The surface samples were collected using a Van Veen type grab sampler in November 2011 and 36 surface sediment samples were sampled from three regions (Eastern Cyprus-Kumyali ‘‘K’’, Northern Cyprus; Zeyko ‘‘Z’’ and Arpa Ambari ‘‘AA’’, Western Cyprus; Yedi Dalga ‘‘YD’’) and dried, homogenized and reduced fine powder (Fig.1).

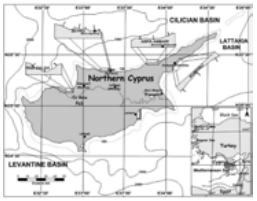

Fig. 1. Location of surface sediment sampling stations from Yedi Dalga, Zeyko, Arpa Ambari and Kumyali regions. Sample locations with three transects (black dots) from each area and labeled water depths.

Materials and Methods
During survey, Side Scan Sonar records had been collected with Imagenex Yellowfin Model 872, at 330 mHz frequency .In every single track, coverage area is 50 m wide at bottom for each side. A set of Hemisphere Crescent A100 D-GPS used for collecting synchronised on-time GPS data. Figure 2 shows mosaic maps after processing of those digital SSS records of tracks by locations. In general, underwater topographic structures of sites that slightly rough near shorline, becomes almost flatten gradually by increased soundings towards offshore. SSS images expose both strong and weak backscattering configurations alog the area. This refletion model is found associated with discrete granular ground at the shallow area and, both acoustic base unit cropped out on the bottom surface and avaliability of spread area of P.oceanica meadows in moderate and deeper sites. Mentioned areas along the sites exhaustively identified with mosaic projection, that prepared by interpreting both Sediment analysis results and applied seismic profiles (Fig.2) Technically it can determined precisely different character and structure metallic non-metallic sunken debris(i.e. shipwrecks, ammo and other navy wreckages, underwater mines , ancient lagans, their pieces, anchors, metal sticks etc) throughout the deepest Subbottom level where waves reach. However, in all of three sites, there is no deterrent material could be detected in bottom or sub-bottom.

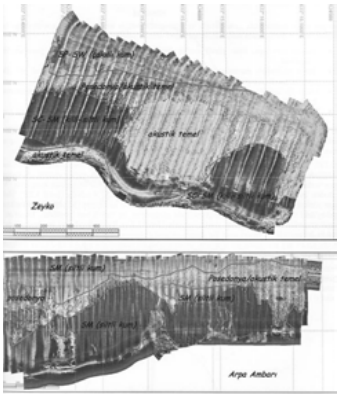

Fig. 2. Zeyko and Arpa Ambari areas Side Scan Sonar Mosaic Map and some structures of seafloor basement.

Results
It is aimed that mapping and classification of biota and sedimentary along studied sites; Protected seagrass meadows that should be concern before engineering application in area is determined by location with visual data.

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SHORE-LINE DYNAMICS OF ANAPA ACCUMULATIVE COAST

Marina Krylenko [1]* and Viacheslav Krylenko [1]
[1] Southern Branch of Institute of Oceanology RAS - krylenko@mail.ru

Abstract
For the solution of the practical problems arising during economic development of the coast, frequently it is required to receive quickly the information on dynamics of coast, especially of the accumulative one. The use of space pictures allows estimating dynamics of accumulative coastal forms of any scale and giving a complete picture of the area coast changes. The resort Anapa (Russia) has been used as test area.

Keywords: Beach, Coastal processes, Remote sensing, Black Sea

Introduction
The solution of Black Sea coastal zone complex management problems is impossible without the full information of coasts current condition. The development of coastal natural systems is always accompanied by changes of coastal line planimetric position. Processes occurring at the coast essentially influence functioning of economic complexes. Prevention or minimization of coastal dynamics negative consequences for the economy is the important component of the sea coastal zone management. Therefore countries pay the big attention to the monitoring of the coast modern condition and to the forecast of their development under the change of the climate and the anthropogenic impact.

Materials and methods
The most part of data about the Black Sea coastal line variability available to the present time was received by measuring the width of beaches on stationary section lines or, less often, by the comparative analysis of separate topographical and aerial mappings. However, field tool observation data acquisition demands long expeditionary works and time for the subsequent office processing of results. Traditional methods of topographical survey can't operatively reflect the coastal line change [1]. Use of space pictures allows receiving the periodic information for all studied territory, estimating dynamics of coastal forms of any scale and giving the complete picture of the area coast changes.
Authors of the paper have made the analysis of space series for made at different time pictures of Anapa beaches (Russia) for the long period. While studying dynamics of Anapa bay-bar coastal line for binding the remote sensing contemporary records, the coastal line GPS-tracks and GeoEye high resolution survey of the chosen area were used. It was possible to reference to GeoEye picture the II World War times Luftwaffe (Germany) air photographs of program CORONA (USA) 1966 [2].

Results
Anapa bay-bar is an accumulative sandy body having the length of 47 km, located in a northwest part of the Black Sea Russian coast. Width of the bay-bar makes from 100 m in the northern part up to 1.5 km in the southern. The continuous strip of sandy beaches having the width of 50-200 m has huge recreational value.
In the last some decades the recession of Anapa bay-bar coastal line has been noted repeatedly in the literature [3]. Several hypotheses, about the reasons of reduction of beaches were put forward: hydraulic engineering constructions of port Anapa, groin and seawall at quay, withdrawal of sand from beaches. Meanwhile, comparison of the available photographs covering the period from about 1900th till our time also has shown that the beach on the considered site of coast remains stable while the scope of within- and inter-annual fluctuations water line position reaches 15-20 m.
The interesting information has been received at comparison of the aerial photographs made by the German secret service during II-WW, and satellite pictures for the period from 1966 till present time. It has been found, that at the length of 3 km of the bay-bar most southern part the coastal line has kept former position. The recession of coast is noticeable to the north; the size of this recession quickly increases to the north, reaching 70-80 m that coordinates with the data received by direct measurements. Comparison with CORONA pictures for 1966 has shown that from 1944 till 1966 the Anapa bay-bar coastal line was in rather stable condition; the recession of the coast has begun later. We shall note that fluctuation of the water line noted after severe storms reaches 10-15 m. It is connected with fluctuations of the sea level and complex structure of the underwater slope.

Conclusion
Chronological series of the high resolution satellite pictures is a reliable basis for monitoring fast changes of the coastal line and other elements of the coastal zone, especially on very dynamical accumulative coast. Their analysis has allowed to receive the detailed information about changes of Anapa bay-bar coastal zone for last decades and to connect them with natural and anthropogenic impact on the coastal zone. The conducted work has shown that space pictures application for studying the Black Sea coast of Russia is very perspective. The further researches will promote perfection of monitoring observations methods in the Russia coastal zone.

Acknowledgements
The work has been done under support of Russian Foundation for Basic Research, Grant 13-05-00466, 12-05-00587.

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MAN MADE DELTAS

Vittorio Maselli [1]* and Fabio Trincardi [1]
[1] Istituto di Scienze Marine ISMAR-CNR - vittorio.maselli@bo.ismar.cnr.it

Abstract
The review of geochronological and historical data documents that the four major northern Mediterranean and Black Sea deltas (Ebro, Rhone, Po and Danube) formed during two short and synchronous intervals when human activities and change of land-use, impacted on their catchments overshooting the effects of climate forcing. These major growth phases occurred under contrasting climatic regimes, respectively during the Roman Empire and the Little Ice Age, and were both followed by generalized delta retreat, driven by two markedly different factors: after the Romans, the fall of the population and new afforestation let soil erosion in river catchments return to natural background levels; since the industrial revolution, instead, flow regulation through river dams overkilled the still increasing sediment production in catchment basins.

Keywords: Deltas, Shoreline evolution, Sediment transport, North-Central Mediterranean, Black Sea

Understanding the life cycle of modern delta systems since the maximum marine ingression is crucial for disentangling the role of natural vs. anthropic forcing, an open issue that bears substantial implications on our full awareness on the management of the coastal zone [1]. By underpinning the timing of the main phases of delta growth with respect to the natural environmental forcing, it is possible to define how pervasively have human populations modified landscapes and to predict delta stability during forthcoming environmental changes [2]. During the last decades, dozens of scientific publications provided new insights on the evolution of modern Mediterranean delta systems by integrating geophysical, sedimentological, paleoenvironmental and geochronological data with key information from historical records, in the form of ancient maps and chronicles (Figure 1).

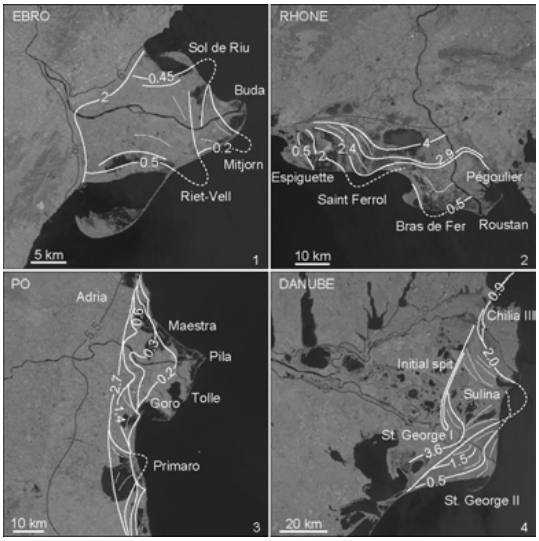

Fig. 1. Satellite views of modern deltas (from the Landsat Archive and the Global Land Survey), with red lines representing their embryonic stages, during the last phases of post-glacial sea level rise (between 9 and 5.5 kyr BP), and the white lines representing the main dated progradational events of delta growth.

The review of geochronological and historical data documents that the bulk of the four largest northern Mediterranean and Black Sea deltas (Ebro, Rhone, Po and Danube) formed during two short and synchronous intervals during which population growth and enhanced human activity overwhelmed the effects of climate forcing. Since the late Iron Age, the rise of classical civilizations and the spread of agricultural activities led to an increase in population and to significant deforestation in central and western Europe [3], reaching the maximum diffusion at the apex of the Roman Empire (around 250 yr AD). This important anthropic control on the environment at European scale resulted in a substantial increase in soil erosion and in the first major burst in the outbuilding of river-dominated deltas. Since the Barbarian invasions, the collapse of the Roman Empire led to a new phase of afforestation and reduced soil erosion that was reflected in a generalized delta retreat at Mediterranean scale, that lasted until the second half of the Little Ice Age. Since the 1650 yr AD, human population begun to growth exponentially, favoured by urbanization and industrialization, leading to important land-use changes. The resulting regional modifications in hydrology and climate, through changes in vegetation cover and runoff, determined a dramatic increase in sediment production, sustaining a major and synchronous progradational phase of all southern European deltas. Following the industrial revolution, flow regulation through river dams, channel diversions and construction of artificial levees, overkilled the still increasing sediment production in catchment basins, and leading to a dramatic decrease in the supply of coarse-grained material to the coasts (Figure 2).

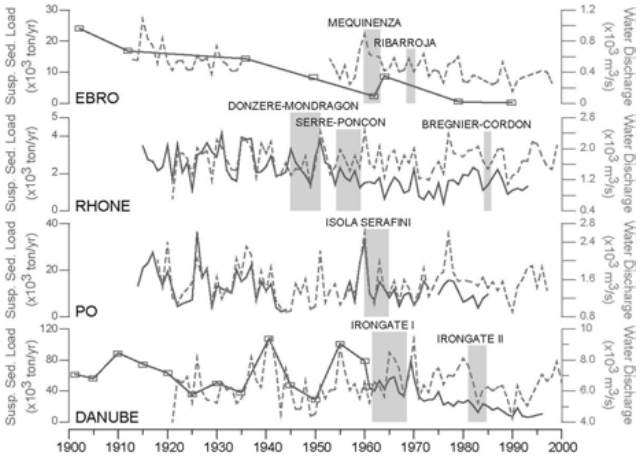

Fig. 2. Coupled diagram of suspend sediment load (continuous) and fresh water (dashed line) demonstrating the impact of anthropic reservoirs on river discharge in all four Mediterranean deltas; gray stripes highlight the timing of construction of major dams.

Delta systems become, therefore, more vulnerable to the action of marine processes, as reflected by a generalized phase of delta erosion and retreat. The chronological constraints available for Mediterranean and black sea deltas indicate how natural systems respond "instantaneously" to human perturbations, and this should be taken into account in any management attempt of the coastal zones.

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SEARCHING FOR MARINE AGGREGATES DEPOSITS IN THE AFANDOU BAY (RHODES ISLAND, GREECE)

V. Kapsimalis [1], G. Rousakis [1], G. Hatiris [1], S. Kalogirou [1], T. Hasiotis [2], A. Karditsa [3], S. Petrakis [3], S. E Poulos [3]* and M. Stamatakis [3]

[1] Institute of Oceanography Hellenic Centre for Marine Research

[2] Department of Marine ciences, University of Aegean

[3] Faculty of Geology and Geoencironment, National and Kapodistrian University of Athens - poulos@geol.uoa.gr

Abstract

The present study investigates a marine aggregate deposit offshore the Bay of Afandou (Rhodos Island, Greece) in order to be used for beach nourishment. The dimensions, internal structure and sediment properties of the deposit have been designated by the use of a multibeam echo sounder, a sub-bottom profiler and a Smith-McIntyre grab. Preliminary results show that the detected sandy deposit comprises a thick (up to 3 m) surficial formation on the seabed located at water depths between 13 and 35 m with a volume of approximately 1.3-2.0x10^6 m^3.

Keywords: Sediments, Swath mapping, Coastal engineering, Aegean Sea

Afandou Bay is located on the N.E. Rhodos Island coast. The beach morphology is characterized as relatively smooth [1] [2]. The broader area has been subjected to major uplifting tectonic movements (2.9 to 3.7 m) during the Holocene [3] [4]. A Reson Dual-Head Seabat-7125 multibeam system and a Geoacoustics GeoPulse subbottom profiler were used for the detailed mapping and profiling of the seabed, respectively.12 surficial sediment samples were taken along three vertical to the shoreline transects at water depths of 12 to 47 m, for granulometric, geochemical, mineralogic and benthic analyses (fig. 1).

Fig. 1. Bathymetry, seismic tracks and sampling positions in the Afandou Bay

Two main morphological features are present in the Afandou Bay: A submarine canyon at the northeastern part of the bay and a rocky shoal at the southern part. In the central part of the bay, the bottom deepens gradually having the shelf-break at depths of 75 – 90 m. The broader area of the bay consists of medium to fine sand at water depths of 15-35 m, with mud increasing its percentage, but remaining always lower than sand, in greater water depths. No *Posidonia oceanica* meadows were detected, but sparse appearances of the invasive green alga *Caulerpa racemosa* var. *cylindracea* were found. At the central part of the Afandou Bay, acoustic tomography has depicted a sub-surficial sedimentary formation with sigmoid clinoforms at depths of up to 40 m below mean sea level, which evolves to an oblique parallel layer formation in greater depths. (fig.2).

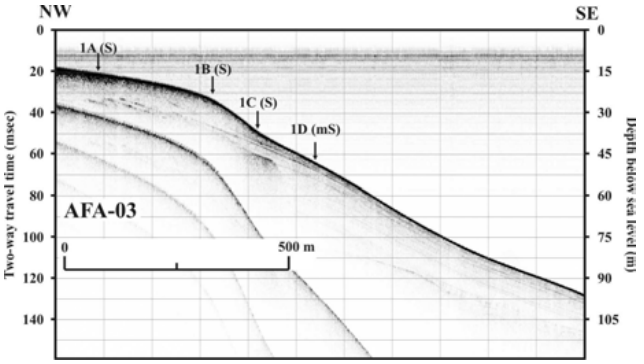

Fig. 2. High resolution seismic profile, showing the extention of the sandy deposit in the Afandou Bay. Arrows indicate the sampling positions of sediments. S: sand; mS: muddy sand.

Based on the above internal structure and sediment configuration, it is estimated that the thickness of the sand deposit is sufficient (1-7 m) in water depths from 13 to 35 m, with the thickest deposits being at depths of 17 to 25 m. The surface of the area under investigation is about 0.65x106 m2, thus, in case that the average thickness of the sand that can be extracted is 2-3 m., the volume of the aggregate can reach up to 1.3-2.0x10^6 m^3.

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HIGH RESOLUTION GEOPHYSICAL TECHNIQUES FOR AN INSIGHT TO THE FORMATION OF THE DUNE FIELD OF THE CENTRAL KYPARISSIAKOS GULF, (GREECE).

J. D. Alexopoulos [1], S. Dilalos [1], S. Poulos [2]*, G. Ghionis [2], S. Petrakis [2], D. Giannouli [2] and D. Michelioudakis [1]
[1] University of Athens, Faculty of Geology and Geoenvironment, Department of Geophysics-Geothermy
[2] University of Athens, Faculty of Geology and Geoenvironment, Department of Geography and Climatology - poulos@geol.uoa.gr

Abstract
The scope of the present contribution is to investigate the formation and evolution of the Kyparissiakos coastal dune field, during the last transgression (Holocene), on the basis of geophysical techniques (ERT, VES), detailed morphological mapping and existing geoenvironmental information.

Keywords: Geophysics, Coastal processes, Shoreline evolution, Lagoons, Ionian Sea

Introduction
The Kyparissiakos Gulf is part of the western coast of Peloponnesus (Greece), facing the Ionian Sea and has a total coastline length of approximately 70 km. The coastal zone is composed of sandy or gravelly sandy sediments, backed by coastal dunes and alluvial plains that have formed on a post-Alpine (i.e. Neogene and Quaternary) siliciclastic sequence, which locally exceeds 400 m in thickness [1]. The upper part of this sequence (Upper Pliocene) is composed of alluvial and lacustrine sediments that have accumulated mainly in the central part of the Kyparissiakos Gulf. The transition from Pliocene to Pleistocene occurred without any interruption of sedimentation and, therefore, it is very difficult (in some cases, impossible) to differentiate between the relevant deposits [1].

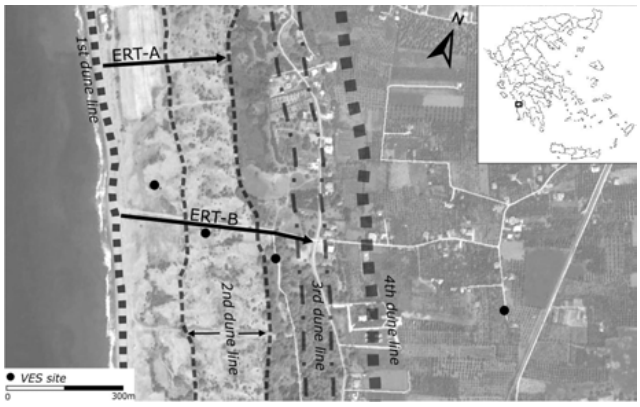

Fig. 1. Satellite image of the study area with annotation showing the dune lines, the geophysical sections and soundings.

The dune field of Kyparissiakos Gulf includes four dune lines (Fig.1) that lie at distances of 650m (4th), 450-470 (3rd), 140-180m (2nd) and 30-40m (1st) from the shoreline. Elevations in the dune field vary between 2 m and 13 m, with the highest corresponding to the 3rd dune line. With the exception of the most recently formed 1st dune line which is a typical foredune, the rest of the dune lines present characteristics similar to those of parabolic dunes, aligned to the prevailing onshore W and SW winds [2], [3].

Methodology
For the needs of the present investigation, a geophysical survey was carried out with the application of geoelectrical methods. Two (2) resistivity sections (ERT) were carried out, perpendicular to the general direction of the dune lines, to provide detailed information of the subsurface resistivity distribution up to 40-50m depth. In addition, four (4) geoelectrical soundings (VES) were carried out, for a deeper investigation of the subsurface lithological structure [4] (for locations see Figure 1).

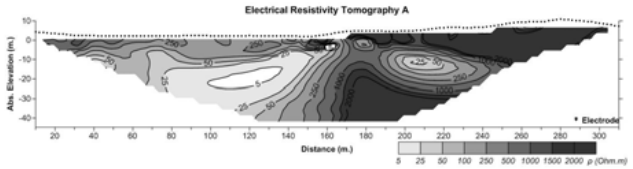

Fig. 2. Electrical Resistivity Tomography A (inversion model)

A detailed morphological map of the dune field was also produced using the technique of high-accuracy real-time kinematic differential GPS.

Discussion
The dune field consists of medium sand, well sorted due to its Aeolian origin [2]. The dune field has developed on the top of an extensive complex of beach barriers incorporating shallow lagoons. These upper Holocene formations, that are regarded as the base on top of which the dune field has been developed, overly an Upper Pleistocene formation of shallow marine/lagoonal deposits; which incorporates layers rich in beach material (i.e. sand, pebbles, gravels) and sandy clay. The geophysical survey indicates that this formation, having an average thickness of 35 m, should have been exposed to subaerial erosion during the last regression of sea level (prior to 21.000 years BP). In addition, this formation, which overlies non-permeable marly Pleistocene deposits, hosts fresh water aquifers that vary in volume seasonally.
The analysis and evaluation of the results of the geophysical survey in the dune field area, has provided information capable of adumbrating these aquifers (5-100 Ohm.m) under the 1st and 2nd dune lines (Fig. 2). As a result, it is concluded that the depicted geophysical structures are equivalent to the previously mentioned lagoonal deposits.
Finally, on the basis of morphological measurements and comparison with previously collected data, it seems that the 1st dune line is under erosion, mainly due to storm wave activity.

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DANUBE DELTA'S COASTAL MORPHOLOGY AS A COMPONENT IN SPATIAL PLANNING FOR SPATIAL AND TIME BALANCING ACTIONS

Cristian Trifanov [1]*, Marian Mierla [1] and Iulian Nichersu [1]
[1] Danube Delta National Institute - kris@indd.tim.ro

Abstract
This study presents the geomorphologic evolution of the Sulina's coastline by analyzing reliable map databases and comparative examination considering the spatial planning future actions through ICZM framework. In this low sector, the actual modeling processes are obvious through progression and regression that have direct consequences on the coast. The evolution of the shoreline, analyzed through its actual dynamic perspective is the outcome of the conjugate action of natural factors complex with the active and diversified human intervention.

Keywords: Coastal systems, Black Sea

Introduction
The relative stability of the coastline in the studied area reveals processes of erosion and/or deposition of sediments from Danube River corresponding to their historical periods. These processes were accelerated by the human pressure/activities. Phenomena related with constant or repeated energy fluctuations are inducing modifications to the natural environment in the area. The main repercussions can be observed in the ratio between the marine and the deltaic surfaces and also on vegetation [1]. The main actors shaping this area are: the Danube River system that discharges an average 60 millions of tons of river deposits and 200 milliards of m^3 of water per year, the Black Sea's NE-SW currents, the position at 45^o latitude in northern hemisphere that generates the alternation of temperatures, the climate change, sea level variation (Fig. 1) and the omnipresence of the human pressures impact. Therefore coastal area of Danube Delta suffered major modifications in the past decades which lead to a morphodynamic imbalance. Due to major coastal morphological changes induced by hydrotechnical works on the upper Danube but mainly the ones inside the water complex of the Danube Delta, triggered numerous field activities in monitoring and investigation that developed into a heterogeneous database.

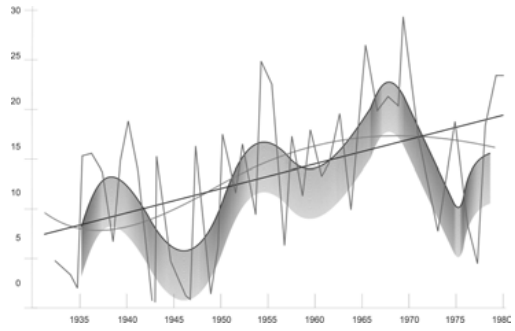

Fig. 1. Level variation of the Black Sea in Constanta harbour during 1933-1980 by Eng. P. leabu IGFCOT 1981 according to the only maregraph available.

Anthropogenic impact - prone to high risk
River regulation by cutting meanders of Danube's main branches has increased the water flow and the discharges (naturally distributed) have been modified. Thus the accelerated alluvial processes have repercussion on the previously formed Sacalin Island, expanding south of the St. Gheorghe branch. Hydrotechnical development of the "Litoral Belt" also known as Tataru channel parallel to the coastline that connects Sulina in the north and St. Gheorghe in the south lead to disconnection of the Rosu-Puiu water complex from the purging system towards Black Sea affecting the water circulation inside the complex and also defragmenting the coastal landscape. During 1862 and 1902 the Sulina branch suffered heavy river regulation favoring transportation and other economic activities. Thus, from 93 Km was reduced to 64 Km plus the embankment works at the shedding led to heavy impoundment of the coast towards the south. The anthropic pressure via investment projects, tourism and the necessity for expanding despite the lack of strict regulation concerning ethics and conduit have led to disruption of this sensitive area, destabilization of the existing habitats, a defective land cover and land use management and chaotic development of economic activities inside a Biosphere Reserve. The increasing environmental risks are based on climate instability, changes in seawater temperature and salinity, particular or unpredictable occurrence of storms, sea level variations, and coastal waters eutrophication [1].

Coastal processes analysis
The most important energetic drivers in evolution of the coastal shore are the currents and the waves. Mostly acting together, the mechanical imprint of these drivers share the same genetic element - the wind, an extremely important factor in development of the abrasive process. The hydrological component that has the most important effects in the dynamics of the shoreline is the combination of variation of the sea level and the waves[2]. The long term evolution of the shoreline is hard to predict however if the genesis hypothesis of the Danube Delta is taken into account along with the fact that sea level of the Black Sea is rising results the statement that the whole accumulation front is under a process of regression. The analysis of the shoreline evolution can be done on a 100 years period based on existing cartographic documents and debates. In this sense there were used documents like "Major State of the Army" dating from 1880 compared with two editions of Gauss projections printed in 1952 and 1972, European Commission of the Danube printed the Danube Map in 1870 under Ch. Hartley and published at Leipzig in 1887, the hydrographic map of D.D. in 1910 and topographic map of D.D. by Geography Institute in 1983 [2]. By comparing all the historical documents using modern GIS techniques can be established shoreline sectors under impoundment or marine abrasion processes therefore a progression or a regression of the coast's shoreline.

Interdisciplinary approach
Sustainability is the quality of human activities to develop without exhausting available resources and without destroying the environment, therefore without compromising the ability to meet the needs of future generations. World Conference on the Environment in Rio de Janeiro in 1992 paid special attention to this concept, which involves establishing a balance between economic growth and environmental protection and finding alternative resources. When referring to the overall economic development of a country or region the synonym usually preferred is durable development [3]. The importance of coastal morphology as a component to spatial planning studies is reflected in the sustainability indicators. As long as the coastal morphodynamic processes are taken into account for future development projects the loss of environmental and economic assets will decrease to a point of sustainable balance between landforms, economic growth and environmental conservation.

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COMITÉ 2

Physique et climat de l'océan

Président : Miroslav Gacic

Rapports des modérateurs

Basin wide multi-ship surveys

Toste Tanhua, GEOMAR, Kiel, Germany

Résumé

An introduction to multi-ship surveys on a global basis was given by the moderator, Toste Tanhua, with emphasis on the World Ocean Circulation Experiment (WOCE), GEOTRACES and GO-SHIP, as well as its Mediterranean version - MED-SHIP. This was put into context of multi-ship surveys carried out in the Mediterranean Sea, such as POEM (Physical Oceanography in the Eastern Mediterranean). The introduction summarized the benefit of multi-ship surveys, but also some of the requirements for successful multi-ship surveys such as common methodologies and data reporting formats for consistency and interoperability, and a focused data collection and synthesizing routine. During the session several presentations were given that presented results from multi-ship surveys, including results from argo floats that can in some sense be regarded a fleet of ships (platforms), see the individual abstracts for this session.

The discussion after the presentations highlighted some issues with data availability from multi-ship surveys. Particular attention was given to data availability. The audience debated on whether or not some data portals were public or not, and which data sets were publically available, or not. Even the perception of publically available data sets is different; some investigators commented that the data are publically available on a ?just send me an email and I send you the data? basis. Other scientists were of the view that a publically available data set should be available by mouse-click from a data portal. One particular issue with the Mediterranean Sea data is that there is a multitude of data centers available, very often these are formed by projects with a time-horizon; after the end of the project the data might not be available to a data repository. There was also some discussion on which data repositories should be used for Mediterranean data, at least seven different data centers were mentioned during the discussion. There was a consensus that a more structured data archival structure would be desirable for the Mediterranean Sea science.

Coastal / open waters exchange - 1

Miroslav Gacic, OGS, Trieste, Italy

Résumé

The presentations mainly focused on the functioning of semi-enclosed bays and lagoons. Lagoons and their water and sediment exchange with the adjacent sea are mainly controlled by tidal variability. This issue was addressed by both experimental and modelling techniques which enabled rather good estimation of the water and sediment balance (Mancero et al., Lerrede et al.). On the other hand, semi-enclosed relatively deep bays exchange and communicate with the adjacent sea under wind and coastal circulation forcing. Here both experimental and numerical approach were discussed (Napolitano et al., Zambianchi et al.). An interesting Lagrangian experiment was also presented in an semienclosed bay.

Sediment transport is often determined by the strong longshore current (Bourrin et al.) and possible accident and its consequences on the hydrosedimentary conditions in a semienclosed environment was also addressed (Duffa et al.). Mediterranean coastal areas are rich in submarine freshwater sources and an interesting study (Rodellas) was presented estimating the importance of these sources in the overall freshwater balance in the Mediterranean, showing that their contribution is comparable to the annual riverine discharge. Estuaries are very sensible coastal environments subject to wave and current impact and some works were presented in this session as well (Abdallah and Cerralbo). Finally thermal conditions and possible flooding events in coastal areas and channels were addressed (Pasaric et al., Altiok et al.)

Coastal / open waters exchange - 2

Xavier Durrieu de Madron, France

Résumé

Full room. This popular session (full room) comprised nine presentations dealing with a wide range of topics covering different regions of the Mediterranean and the Black Sea. The session focused on processes at play for the exchanges between the coastal zone and the open ocean as well as between different sub-basins (straits). Several presentations concerned the influence of wind-induced and mesoscale processes on the shelf-slope exchanges, and the characterization of tidal flows. The discussion highlighted the importance of using both observations and modelling to better understand the processes and define the main features at play, and also the need of sharing the available observations within the community.

Mesoscale variability

Sana Ben Ismail, INSTM, Tunisie

Résumé

The session on mesoscale variability comprised ten presentations covering a wide range of circulation features with horizontal ranging from few km to few tens/hundred of km, with vertical scales ranging from tens to thousand meters and temporal scale from few days to several week/months. Difficulty in studying and modeling ocean dynamics is due to the complexity of mesoscale processes and their continuous interplay with the general circulation. The study of eddies, filaments, fronts and upwelling requires a combination of measurements, satellite observation, altimetry and models.

Most of the presentations concerned main mesoscale processes (Alboran Gyre, Irapetra eddy, Sicily Channel fronts, Ligurian dispersion) and combined analysis based on high resolution model, altimetry, satellite data, glider, in situ measurements. Discussions focused on the importance of a very high resolution model to give a new insight on the dynamics of the Mediterranean and Black Sea. The importance of temporal scales of variability and the large panel of geographic regions studied such as Gibraltar Strait, Algerian basin, Sicily Channel, Ionian Sea, Cretan Sea, Levantine Basin and Black Sea show the relevance to study mesoscale processes in the Mediterranean and Black Sea.

Operational oceanography

Joaquin Tintore, Spain

Résumé

The room was completely full with more than 10-15 persons standing up.

The session was introduced by the moderator, Joaquín Tintoré who presented some initial ideas on the state of the art of operational oceanography, the appropriate time now for enhancing operational oceanography given the significant scientific, technological and computing power advances and the challenge of integration of observing and forecasting systems in a semi-enclosed sea such as the Mediterranean.

Nine well structured and clear presentations where made, addressing some of the key scientific questions that are at the heart of operational oceanography: water masses formation and dynamic effects, atmosphere-ocean interactions, downscaling modelling initiatives addressing consistency between regional and local simulations biogeochemical fluxes and physical-biological coupling, physical and biogeochemical data assimilation, results from new observing technologies such as HF radar, gliders, as well as tools for decision support. An interesting and lively discussion followed addressing both specific questions on the above mentioned topics as well as on more general issues such as reliability of models, integration between the different observing platforms (in particular between gliders and HF radar), data availability, etc.

Physical and biogeochemical modelling

Javier Ruiz, Spain

Résumé

The coupling of physics and biology is the backbone of marine ecosystem functioning. It is, therefore, at the core of the knowledge-based management of the marine environment. The session evidenced this key role of physical-biological coupling in providing advice for management in the case of a coastal lagoon and a marine protected area. It also contained presentations that analyzed the coupling at different scales and trophic levels, including primary production in the Gulf of Lion and fisheries in the Alborán Sea. Unfortunately we missed a speaker to talk on quality control for models, a subject that had raised expectation owing to previous debates at CIESM plenary sessions on the dangers involved in the present obsession of the scientific community to accumulate publications rather than knowledge. It is the moderator's opinion that the attendants enjoyed the session both for the interesting presentations and for the subsequent live debate. This subject (physical-biological coupling) might be more neatly identified in future congresses to draw the attention of a larger number of speakers.

Sub-mesoscale variability

Nadia Mkhinini, ENSTA, Paris, France

Résumé

Most of the sub-mesoscale studies are located on the upper ocean where sub-mesoscale processes are in particular dominant due to the presence of lateral density gradients, vertical shear, weak stratification and also the presence of a surface boundary. The

sub-mesoscale mechanisms were described in this session, using observational, modelling and analytical studies.

The presentations included studies of coastal dynamics (Forget et al., Fusco et al.), the use of various datasets acquired by radar or Doppler profiler, and eddies' formation (Bosse et al., Mkhinini et al.). Resolving sub-mesoscale dynamics, where the relative vertical vorticity - contrary to mesoscale dynamics - equals or exceeds the planetary vorticity, by using the mesoscale field is a challenge for models and observations.

Thermohaline cells and biochemical status - 1

Samuel Somot, Météo-France / CNRM, Centre National de Recherches Météorologiques, Toulouse, France

Résumé

Most of the talks were oriented towards physical ocean science targeting the monitoring, modelling, and finally understanding of the Mediterranean ThermoHaline Cell (MTHC) focusing on the three main water mass formation areas (NW Mediterranean Sea, Adriatic Sea, Aegean Sea).

Three main topics were discussed following the poster short presentations :

1. The decadal variability of the Eastern Mediterranean basin involving the Adriatic Sea, the North Ionian Sea, the Levantine Basin and the Aegean Sea. The main signature is the fluctuation of the salinity in those seas but impact can reach activation of different deep-water formation areas, change in thermohaline intensity and impact on biogeochemistry and upper-traphic level status. Recently named BIOS (bimodal oscillation), this decadal variability is still not fully known and understood. In particular, the relative role of the internal variability versus the externally forced variability by air-sea fluxes is not clear yet. In addition, the modelling of this variability is far from being achieved. This raises the need for improving the modelling of the interannual to decadal variability of the MTHC. Velaoras, Gacic, Civitarese, Malanotte-Rizzoli, Josey and Somot were the main participants to the discussion.

2. The modelling of the exceptionnal Winter 2011-2012 in the Adriatic Sea was then discussed. This very cold winter sees the formation of very dense water (up to 29.5 kg/m3) formed in the Northern part of the Adriatic and was well monitored. Up to now, only one model was used to try to simulate this event. He is only able to qualitatively reproduce this phenomena but the quantitative reproduction is not reached yet. The understanding of the relative role of the key factors leading to such phenomena is only possible if models are able to reproduce them first. This underlines the need for modelling exercise of golden (interesting and well-observed) case study in a multi-model coordinated framework. The discussion was mainly leaded by Chiaggato and Somot.

3. The last discussion topic was not fully debated (time limit) and started from a question by Querin : « What is the best resolution in the ocean and in the atmosphere to ideally simulate the Mediterranean Sea ? » This question can be enlarged in a wider question : 'What are the open key challenges and current limits of the Mediterranean Sea physical modelling community ? '

Thermohaline cells and biochemical status - 2

Chiara Santinelli, Italy

Résumé

The Mediterranean Sea can be considered an ideal basin to study the main physical and biogeochemical processes occurring in the oceans. The main goal of this session was to assess how physical processes can explain the peculiar biogeochemical features of the Basin.

Presentations focused on the impact of deep water formation on the oxygen, nutrient distribution and N/P ratio at the Dyfamed station (L. Coppola and O. de Fommervault), in the MEDOC area (T. Severin) and in the Otranto Strait (E. Souvermezoglu) and on the effect of mesoscale activity on surface DOC distribution in the Tyrrhenian Sea (C. Santinelli). The importance of atmospheric input was shown for the Eastern Mediterranean Sea (P. Pitta), while the impact of terrestrial input on biogeochemical processes was discussed for the northern Adriatic Sea (R. Precali) and the Mersin Bay (E. Erdogan). Finally the importance of modelling effort (Arsouze T.) combined with in situ data (DOC, C. Santinelli) was highlighted.

The discussion focused on: (i) the processes that could explain the high DOC concentrations observed in the anticyclonic gyres, (ii) the role of deep water formation in C export to depth, in the oxygen distribution and in N/P ratio and (iii) the impact of atmospheric input on biogeochemical processes in the Eastern and Western Mediterranean Sea. The importance of temporal series of biogeochemical properties at fixed stations was stressed. Finally, it was highlighted that a huge amount of data are now available for the Mediterranean Sea, so a multidisciplinary and interdisciplinary effort appears crucial in order to assess the link between the main physical and biogeochemical processes occurring in the Basin. Modeling efforts, in situ-data and the information coming from the satellite should be combined in order to address the main unresolved questions for the basin.

Variability on climatic scales - 1

Sergiu Dov Rosen, Israel Oceanographic & Limnological Research, Israel

Résumé

Climate variability takes place on various time scales: paleoclimatic, interdecadal to centennial, seasonal to interannual, and intra-seasonal. Climate variations happen as well on all spatial scales, from the regional to the global. Seven presentations covering both observational and model assessment of variability in regional and whole Mediterranean, on seasonal to decadal and centennial scales were presented, aiming to improve our understanding of natural and human-induced climate patterns, as well as the linkages between large-scale and regional climate variability. An element which appeared significant in regard to the IPCC 5th Assessment report of Group 1 is the fact that the model results presented did not account for the flow through Suez Canal, increased since the beginning of 1990s following its deepening and widening, fact which seems to contribute significantly to the trend of increasing salinity in the Eastern Mediterranean (demonstrated by a faster measured sea level rise there) and through it to the whole water circulation in the Mediterranean and in the Atlantic.

Variability on climatic scales - 2

Katrin Schroeder, Italy

Résumé

During the second session on Variability on Climatic Scales the conveners discussed a variety of topics, ranging from impacts of extreme winter atmospheric conditions on decadal oceanic oscillations, to assessments of sea level and sea surface temperatures rises in different parts of the Mediterranean and related mass mortalities, up to the suggestion of the building of a control barrage at the Strait of Gibraltar.

Thus, variability on climatic scales has been interpreted and discussed from the point of view of a number of interrelated disciplines: physics (oceanographic and atmospheric), biology and even engineering. Further, the temporal scales and frequencies of ?variability on climatic scales? have been described in many different ways: as oscillations, seasonality, trends, interannual variability. This leads of course to consider the variability also on a wide range of spatial scales, that interact with each other.

Modern oceanographic disciplines are no longer dedicated to the definition on ?how the ocean is?, but more and more ?how the ocean varies?. But ?variability? is a very wide topic, and the range of themes that were touched during the session demonstrates how complex the problem of detecting and describing it is, even restricting the field only on the climatic scales.

Ventilation transients

Manuel Bensi, OGS, Trieste, Italy

Résumé

Six presentations were given in this scientific session, all focusing on a single general theme: the thermohaline variability of the water masses formed by processes of ventilation.

Two presentations focused on the long-term variability of the Levantine Intermediate Water in the easternmost part of the Med Sea, others on the variability observed in the deep layers of the Gulf of Lion, Adriatic and Aegean Seas. Additionally, important issues such as the combination of numerical models and in-situ data, and the study of changes in ventilation in a view of transient tracers were discussed here. The final debate focused on several arguments: firstly, the reliability of numerical models in the Med. Sea and their capacity to reproduce the observed variability of the water masses, taking into account also contributions from the Nile and Suez Channel runoff; secondly, the importance of a more complete approach in studying the dense water formation, considering the effects of the geostrophy in the spreading of the newly formed dense water (the example of a stream-tube model applied to the Aegean Sea was presented and briefly discussed). Finally, the discussion focused on the importance of the preconditioning factors for the dense water formation, such as the thermohaline properties (i.e. salt content) which can favor or reduce the possibility that a large winter heat loss could produce the ventilation of a basin.

Session

Basin wide multi-ship surveys

Modérateur : **Toste Tanhua**

THE CO2 SYSTEM IN THE MEDITERRANEAN SEA: A BASIN-WIDE PRESPECTIVE

M. Álvarez [1]*, A. Luchetta [2], H. Sanleón [1], L. Mintrop [3], T. Tanhua [4] and G. Civitarese [5]
[1] Instituto Español de Oceanografía - marta.alvarez@co.ieo.es
[2] ISMAR, Trieste
[3] MARIANDA, Kiel
[4] Geomar, Kiel
[5] OGS, Trieste

Abstract
During April-May 2011 two cruises (M84/3, RV Meteor, Istambul-Vigo, and EF11, RV Urania, Bari –La Spezia) overdetermined the CO_2 system in the MedSea for the first time. The internal consistency analysis for pH, alkalinity and total inorganic carbon confirmed the use of CO2 constants from Mehrbach et al. (1973) [1] and others [2] and [3]. This analysis reveals some insights about the peculiar physico-chemical characteristics of MedSea waters. Vertical distributions of these properties will be presented and discussed along with property-property plots to characterize the different water masses in the MedSea subbasins. The sensitivity of MedSea waters to CO2 increase will be discussed using the vertical distribution of buffer factors and the saturation state for calcite and aragonite

Keywords: Chemical speciation, South-Western Mediterranean, South-Eastern Mediterranean, Tyrrhenian Sea, Ionian Sea

Introduction

The studies about CO_2 variables in the MedSea are relatively scarce [4] despite its relevance as a small laboratory for ocean processes [5] and its significant contribution to the storage of anthropogenic carbon [6]. In this study will present the first internal consistency analysis for CO_2 measurements in the MedSea although partial, using pH, alkalinity (TA) and dissolved inorganic carbon (DIC) data collected during the M84/3 and EF11 cruise, some interesting results related with the peculiarity of the MedSea waters are obtained. Additionally, basin-wide and subbasin vertical distributions of CO_2 species will be presented. The sensitivity to the CO_2 increase in the atmosphere will be studied using several buffer factors [7] and the saturation state for calcite and aragonite.

Methods

During the M84/3 (on board) and EF11 (at lab) cruises (Figure 1) pH was measured spectrophotometrically following [8], TA with potentiometric methods [9] and [10] and DIC was also measured with a S

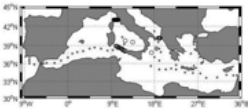

Fig. 1. Figure 1. Mediterranean Sea map with the stations sampled during the Meteor M84/3 (dots) and Urania EF11 (circles) cruises.

OMMA coulometric method. Certified reference materials were used to control the quality of our measurements.

Results and discussion

Using data from M84/3 the preferred combination of constants is the following: for CO_2 those from Merhbach et al. (1973) refitted [1], for sulphate [2] and for total borate the equation by [3]. This is also the preferred option for global synthesis studies as GLODAP or CARINA. In studying the relationship between the residuals (measured minus calculated values) for pH and TA a clear distinct relation is detected for high salinity waters in the MedSea.

Deep waters under 500 dbar in the eastern MedSea present a quite homogeneous pH25T, TA and DIC distribution, 7.966±0.004, 2614±4 umol/kg and 2310±5 umol/kg, respectively, while in the western basin are more variable 7.907±0.045, 2525±9, 2264±8, respectively. In the pressure range between 150 and 500 dbar, Levantine Intermediate water evolves in the eastern basin for pH25T, TA and DIC values from 7.982±0.02, 2626±7, 2308±13 to 7.891±0.02, 2576±13, 2319±14 in the western basin, respectively.

We studied different buffer factors [7], which quantify the sensitivity of MedSea waters CO_2, pH and carbonate saturation state to changes in DIC (at constant TA, e.g., air-sea CO_2 exchange) and TA (at constant DIC, addition of strong acid or base). We found that MedSea waters are more resistant to changes in DIC and/or TA than Atlantic waters to the west of the Strait of Gibraltar, because any buffer factor is lower in the Atlantic. The CO_2 system in the western basin is in general more sensitive to changes in DIC and/or TA than the eastern part, buffer factors are lower in the western MedSea.

The CO_2 sensitivity to changes in DIC at constant TA (air-sea CO_2 exchange) is the highest, then the change in the saturation state due to additions of a strong acid or base, then the change in the saturation state due to air-sea CO_2 exchange, then the change in pH due to the air-sea CO_2 exchange (equivalent to the change in CO_2 due to a strong acid /base addition). Finally, MedSea waters are able to buffer changes in pH due to strong acid/base additions.

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VARIABILITY OF OCEANOGRAPHIC PROPERTIES IN THE EASTERN MEDITERRANEAN DURING THE LAST THREE DECADES

V. Cardin [1]*, G. Civitarese [1], D. Hainbucher [2], M. Bensi [1] and A. Rubino [3]
[1] Ist Naz. di Ocean e di Geof. Sperimentale - OGS - vcardin@ogs.trieste.it
[2] Institute fur Meereskunde Univ Hamburg
[3] Università Ca' Foscari Venezia

Abstract
We present temperature, salinity and oxygen data on an east-west transect through the eastern Mediterranean Sea collected during METEOR cruise M84/3 in April 2011. These data together with data gained on previous cruises during the period 1985-2011 are analysed in terms of regional aspects of the evolution of water mass properties and heat and salt content variations. Special attention is given to the variability of thermohaline properties of the LIW and AdDW. Results are evaluated considering pre and post-EMT situation in the eastern Mediterranean to elucidate which is the present state of the hydrography the Eastern Mediterranean.

Keywords: Hydrography, Circulation, Intermediate waters, Salinity, Levantine Basin

Several changes in the circulation, temperature (T) and salinity (S) patterns have occurred in the last three decades in the Eastern Mediterranean. A number of cruises (such as METEOR cruises as M4-1987, M31-1995, M44-1999, M51-2001, M71-2007, and the latest M84/3-2011, POSEIDON 298, MERIAN MSM13/2, MERIAN15/4) have been accomplished to help understanding the processes involved. Hydrographic observations conducted in April 2011 assess the present status of circulation in the eastern Mediterranean. These observations highlight the importance of intense spreading of the intermediate waters. The highly saline Levantine surface(LSW)/Intermediate Waters (LIW) dominate the upper water column of the easternmost area of the Levantine, spreading towards west and occupying the upper 500m (figure 1). The permanent Rhodes Gyre breaks the main salinity tongue with the outcrops of the isohalines. This pattern seems to be a further evolution from the situation already present in 2008 when a maximum value of 39.34 was measured in the formation area being now extended more westward. The westernmost part of the transect is always occupied by the AW (Atlantic Water) being very reduced spatially. However, its intrusion into the Levantine is very variable and may depend on the circulation present in the Ionian (Gacic et al. 2010) .

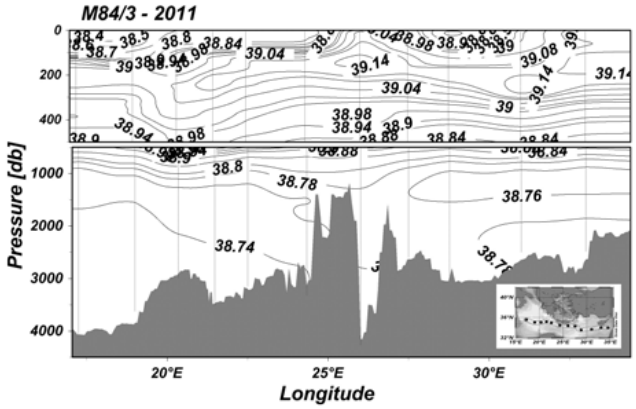

Fig. 1. Salinity distribution during April 2011 (METEOR Cruise M84/3)

Data from the 1987 Meteor cruise M5/6 permitted to study the hydrographic conditions prior to the EMT (Eastern Mediterranean Transient) in the Ionian and Levantine basins when the AdDW (Adriatic Deep Water) was clearly the main contributor to the EMDW (Eastern Mediterranean Deep Water). At that time, the deep layer was characterised by salinities lower that 38.68 along the whole transect. Observations conducted in 1995 and 1999 (figure 2) during the EMT phase clearly show Aegean high salinity waters outside the Cretan Passage. Enhanced salinity (values higher than 38.84) relative to 1987 was ubiquitous already in early 1995 (Roether et al. 2007), except than in the western Ionian deep layer that was still occupied by low salinity waters (<38.68). These high salinity waters were still present in the easternmost part of the Levantine basin in 2001, blocked by the bathymetry constraint of the Herodotus Trough.

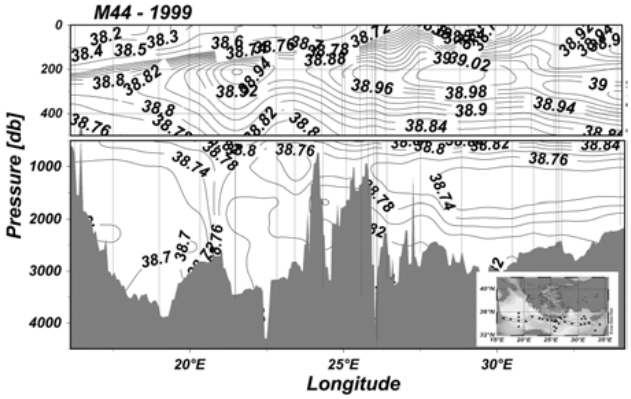

Fig. 2. Salinity distribution during April-May 1999 (METEOR Cruise M44/4)

A further major change occurred between 1999 and 2003 in the abyssal part of the Ionian basin, where AdDW return to be the principal contributor to the EMDW. However, its properties profoundly differred from the pre EMT situation being warmer and saltier than ever (Rubino and Hainbucher, 2007). Our data collected In 2011 confirm the persistence of the above oceanographic characteristics and the expected changes, hypothesized by Bensi et al. (2012) are still to happen.

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LE SYSTÈME D'INFORMATION DU CHANTIER MISTRALS

L. Fleury [1]*, J. L. Boichard [1], G. Brissebrat [1], L. Brosolo [2], S. Cloché [3], J. Descloitres [4], H. Ferré [1], L. Focsa [4], N. Henriot [4], L. Labatut [5], L. Mastrorillo [1], A. Mière [1], L. Petit De La Villéon [6], K. Ramage [3], C. Schmechtig [7] and A. Vermeulen [4]
[1] SEDOO, Service de Données Observatoire Midi-Pyrénées, Toulouse, France - laurence.fleury@obs-mip.fr
[2] DT INSU, CNRS, Brest, France
[3] ESPRI, IPSL Data Service, Palaiseau, France
[4] ICARE Data and Services Center, Lille, France
[5] URA GAME Météo-France / CNRS, Toulouse, France
[6] Ifremer / Sismer, Brest, France
[7] UMS 0829, Observatoire Océanologique de Villefranche sur Mer, France

Abstract
Le système d'information MISTRALS vise à faciliter la communication des observations et des produits scientifiques entre les différentes équipes et disciplines du chantier, et à diffuser ces informations à l'ensemble de la communauté scientifique. Son portail offre un catalogue et des interfaces simples de sélection et de téléchargement de données fortement hétérogènes (observations de terrain, produits satellite, résultats de simulations numériques...) et gérées dans plusieurs centres de données. Tout chercheur intéressé par le bassin méditerranéen est invité à le visiter : http://mistrals.sedoo.fr .

Keywords: Time series, Vertical profile, Remote sensing, North-Western Mediterranean, Circulation models

MISTRALS (Mediterranean Integrated STudies at Regional And Local Scales) est un chantier décennal de recherche et d'observations systématiques, dédié à la compréhension du fonctionnement environnemental du bassin méditerranéen et de son évolution sous la pression des changements globaux de la planète. Il est fondé sur sept programmes interdisciplinaires de recherche, parmi lesquels HyMeX (Hydrological cycle in the Mediterranean eXperiment), ChArMEx (Chemistry-Aerosol Mediterranean eXperiment) et MERMeX (Marine Mediterranean eXperiment) s'intéressent particulièrement aux phénomènes marins physiques, chimiques et biogéochimiques, et à leurs interactions avec les autres compartiments du système terre (atmosphère, fleuves, littoral, surfaces continentales...). Etudiant d'autres échelles de temps le projet PaleoMeX (Paleo Mediterranean eXperiment) comprend aussi des prélèvements en milieu marin. Les différents projets bénéficient des mesures d'observatoires de l'environnement sur le long terme, dont notamment le programme MOOSE (Mediterranean Ocean Observing System on Environment), l'observatoire atmosphérique CORSICA (Centre d'Observation Régional pour la Surveillance du Climat et de l'environnement Atmosphérique et océanographique en Méditerranée occidentale ») ou la composante Sciences de l'Environnement du projet MEUST (Mediterranean Eurocentre for Underwater Sciences and Technologies).

Les données générées ou utilisées par les programmes de MISTRALS sont non seulement issues de différentes disciplines, mais également de natures (format, volume, nombre de dimensions spatiales, représentativité...) très hétérogènes : mesures issues de campagnes intensives, suivi sur le long terme des paramètres environnementaux, observations opérationnelles *in situ* et satellite, résultats de simulations numériques, enquêtes de terrain qualitatives... Dans ce contexte, le système d'information MISTRALS constitue un outil transverse aux différents programmes et vise à faciliter les échanges entre les communautés de recherche.

Un portail d'accès à l'ensemble des données scientifiques utiles ou produites par ces programmes a été mis en place : http://mistrals.sedoo.fr/ . Les informations sur les différents jeux de données (métadonnées) sont homogènes et conformes aux normes en vigueur (ISO19115, directive INSPIRE, indexation basée sur le *thesaurus* Global Change Master Directory). Le portail offre des outils de recherche dans ce catalogue par mots clés ou par sélection d'un ou plusieurs critères (période, zone géographique, type d'instrument...). Il permet d'accéder directement à des jeux de données de toute nature, gérés par différents centres de données (CORIOLIS, ESPRI, ICARE, SEDOO), grâce à la mise en place de protocoles d'interopérabilité (voir figure 1).

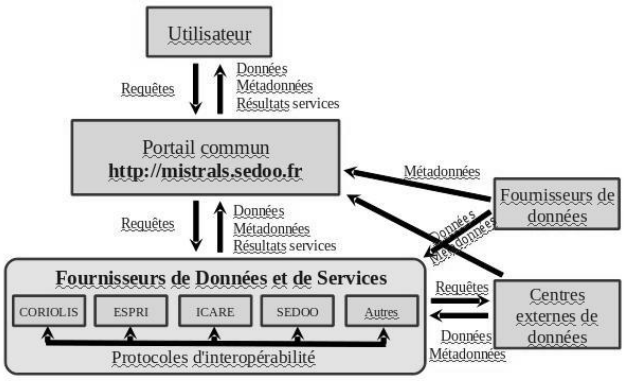

Fig. 1. Structure du portail MISTRALS

Le portail MISTRALS donne déjà accès à plusieurs centaines de jeux et s'enrichit quotidiennement de nouvelles données, issues notamment des campagnes intensives 2012 et 2013 des programmes HyMeX, ChArMEx et MERMeX. Chaque jeu de données est disponible dans son format natif, et les plus recherchés sont retraités et homogénéisés (format, unités, flags de qualité...) afin de faciliter leur utilisation par tous. Le système d'information MISTRALS est en constante évolution et se dotera prochainement de fonctionnalités avancées, de type SIG, visant à servir les besoins recherche, mais également à diffuser des produits à l'ensemble de la société civile.

Le portail MISTRALS est un outil à la disposition de tous les scientifiques intéressés par le bassin Méditerranéen. N'hésitez pas à consulter le catalogue en libre accès et à remplir le formulaire d'enregistrement pour accéder aux données. Le portail MISTRALS est également susceptible d'accueillir les données de nouveaux projets ou de remplir des missions de sauvetage de données anciennes. Merci de contacter mistrals-contact@sedoo.fr si vous avez ce type de besoin.

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METHYLMERCURY DISTRIBUTIONS IN CONTRASTED BASINS – RESULTS OF THE 2011 MEDITERRANEAN GOSHIP CRUISE

L. Heimburger [1]*, J. E. Sonke [1], D. Point [1], L. Laffont [1], C. Lagane [1], F. Candaudap [1], D. Cossa [2], B. Thomas [3], E. Stathopoulou [4] and T. Tanhua [5]

[1] Geosciences Environment Toulouse Midi-Pyerenees Observatory - CNRS - heimburger@get.obs-mip.fr

[2] IFREMER, 83507 La Seyne-sur-Mer, FRANCE

[3] IFREMER, 92138 Nantes, FRANCE

[4] University of Athens, 15771 Panepistimiopolis, Zografou, GREECE

[5] IFM-GEOMAR, Kiel, GERMANY

Abstract

Toxic monomethylmercury (MMHg) accumulates to harmful levels along the marine food chain and presents a health risk at a global scale. The origin of MMHg in the marine water column is under debate. Bacterial methylation of inorganic Hg in sediments and in the oceanic water column may be in play. We investigated MMHg distributions in the contrasted basins of the Mediterranean Sea as part of the GOSHIP cruise M84/3 on RV Meteor. The 8 full depth vertical profiles cover a West-East transect from oligotrophic to ultra-oligotrophic waters. MeHg concentrations were generally higher in the more productive Western Basin. Our findings suggest that quantity and the quality of phytoplankton may influence the production of MeHg in the oceanic water column.

Keywords: Mercury, Open sea, South-Central Mediterranean, South-Western Mediterranean, South-Eastern Mediterranean

Monomethylmercury (MMHg) accumulates to harmful levels along the marine food chain and presents a health risk at a global scale. The origin of MMHg in the open ocean marine water column is under debate. Bacterial methylation of inorganic Hg in shelf sediments and subsequent advection to open ocean waters has been suggested to be the major pathway. Repeated evidences hint that in situ production in the oceanic water column may be equally if not more important. Determinations of MMHg in sea-water are still scarce mainly due to analytical limitations that did not allow detecting ultra-trace concentration levels, in the femtomolar range. Three techniques are used today to measure MMHg in sea-water and of which all imply a derivatization step: cryofocussing hydrate generation (Stoichev et al., 2002), ethylation (Bloom, 1989) and propylation (Monperrus et al., 2005). Determination of MMHg in sea-water by species-specific isotope dilution, derivatization by propylation, and detection via gas chromatography–inductively coupled plasma mass spectrometry (ID-GC-ICP-MS) was shown to be most promising (Monperrus et al., 2005). At the GET laboratory we improved the performance of this method by optimizing the coupling between a gas chromatograph and a high resolution sector field inductively coupled plasma mass spectrometry (Element XR). We applied this method to samples from the GOSHIP cruise M84/3 on RV Meteor to the Mediterranean Sea (04/2011). A total of 83 samples were taken in pre-cleaned 250mL Savillex PFA Teflon bottles. Pre-cleaning in a class 100 clean lab involved soaking the bottles for 24h in concentrated (10N) and diluted (1N) bidistilled HCl at 120°C. Bottles were double bagged and all handling was done in an ultra-trace clean manner. On board, each bottle was rinsed 3 times with the sample from the GoFlo bottle, filled to the top, acidified with bidistilled HCl to 0.4% (v:v) and tightly capped. Acidification converts dimethylmercury (DMHg) to MMHg. The measured MMHg is therefore the sum of both species. Sub-samples were double bagged and stored in the dark at 4°C until analysis in the home laboratories. Samples were taken at 8 stations along the East-West transect. The set of samples was split in a way that the samples were analyzed in the 3 partner laboratories: 1) GET laboratory in Toulouse, France, IFREMER, 2) IFREMER Nantes, France and 3) University of Athens, Greece. Triplicates were taken at several stations to provide an intercomparison.

1) MeHg (MMHg+DMHg) was analyzed at the GET laboratory *via* isotopic dilution gas chromatography sector field inductively coupled plasma mass spectrometry (GC-SF-ICP-MS) after derivatization with propylborate and extraction into hexane. The 8 full depth vertical profiles consist of 83 samples (stations 292, 297, 306, 313, 319, 324, 331, 340). MeHg distributions show typical vertical profiles (Heimbürger et al., 2010) with very low surface concentration and highest concentration in the oxygen minimum zone and generally higher in the more productive Western Basin (mean=252±130fmol/L, range=11(LOD)-723fmol/L, n=83).

2) MeHg (MMHg+DMHg) was analyzed at the IFREMER Nantes laboratory *via* cryofocussing hydrate generation followed by cold vapour atomic fluorescence spectrometry (CVAFS (Cossa et al., 2003; Stoichev et al., 2002). The 4 full depth vertical profiles consist of 47 samples (stations 297, 313, 319, 340; mean=143±116fmol/L, range=40(LOD) to 467fmol/L, n=47). Those are the same samples that were measured at the GET laboratory and both measurements compare well.

3) Another 4 profiles were analyzed at the University of Greece *via* ethylation followed by CVAFS using a MERX automated analyzer (Brooks Rand).

We will present and compare the results of the different applied MeHg determination methods and put our results in context with previous work. Our findings suggest that quantity and the quality of phytoplankton may influence the in situ production of MeHg in the oceanic water column. This is important as global change may alter the trophic regime of the future Mediterranean Sea and therefore marine Hg dynamics. Changes anthropogenic Hg emissions may also alter the marine biogeochemical Hg cycling. Repeated basin wide ship surveys are required to monitor both Hg and its most toxic form, MeHg, in mediterranean waters at appropriate spatio-temporal scales.

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CENTRAL MEDITERRANEAN IN 2010-2013 AS SEEN FROM THE ARGO FLOATS

V. Kovacevic [1]*, L. Ursella [1], G. Notarstefano [1], M. Menna [1], M. Bensi [1] and P. Poulain [1]
[1] Ist. Nazionale di Oceanog. e di Geof. Sperim. OGS - vkovacevic@ogs.trieste.it

Abstract
The set of Argo floats navigating inside the Central Mediterranean Sea (Ionian Sea, and adjacent southern Adriatic Sea) in the period 2010-2013 is analysed. Description of differences and similarities during the observed period is limited to the intermediate and deep layers.

Keywords: Temperature, Salinity, Deep waters, Intermediate waters, Ionian Sea

The deep Argo float profiles provide measurements of temperature and salinity down to 2000 m. Moreover, the float parking depth at 350 m allows tracking the major pathways of the intermediate waters (mainly the Levantine Intermediate Water, LIW), together with associated thermohaline properties. The float trajectories show that some of them either follow the perimeter of the Ionian or cross the basin, and some of them enter/exit from the Adriatic Sea. In addition to the intermediate layer, the deep horizon (1000 - 1300 m) has been chosen as indicative of the sources of the dense waters formed in the surrounding basins (i.e. the Adriatic Sea) and their possible spreading paths. Our approach does not take into account the exact time-space collocation of the data, but rather gives a comprehensive view of the properties, as smoothed in time and space. Generally, the meso-scale and sub-basin scale variability are characterized by a number of permanent, semi-permanent and transient eddies. The most persisting one is a central Ionian anti-cyclone, whose footprint is observed throughout the period from the absolute dynamic topography of the sea surface, and whose influence protrudes down to the deep. Its position (18-20 °E, 35-37 °N) is in the vicinity of the deepest Ionian trough (> 4000 m). Other anti-cyclonic mesoscale eddies are observed along the outer edge of the Ionian, as for example the Pelops anti-cyclone on the eastern side. A relatively steady circulation characterizes the north-western periphery of the Ionian, where the intermediate paths follow the isobaths prevalently in the southward direction. The destiny of these floats is to cross the Ionian toward its southern end (like in 2011) or toward the centre (2013), or to escape toward the Sicily Channel (like in 2010). The northern Ionian, adjacent to the Strait of Otranto, is characterized by a variable mesoscale activity: the anti-cyclonic veering may turn into cyclonic, preventing the escape of the floats into the Adriatic like in 2011. On the contrary, as seen at the end of 2012, a very intense intermediate flow in a narrow band along the eastern flank brings back into the Southern Adriatic the float that exited from there. All such features are observed when following each float individually.

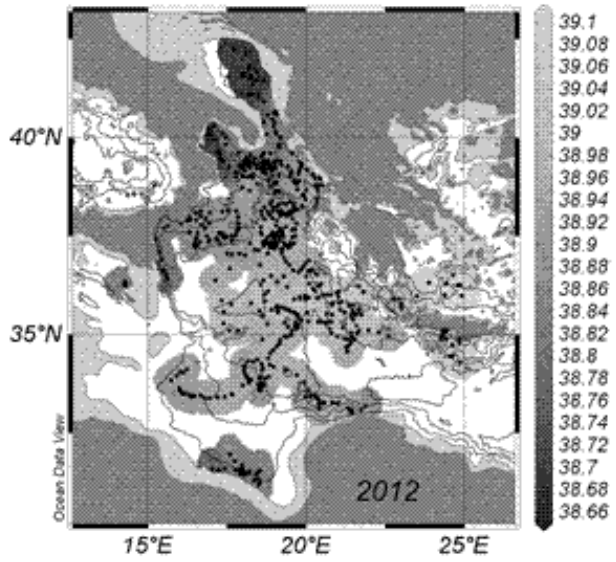

Fig. 1. Salinity distribution at 350 m horizon in 2012

As far as the thermohaline properties are concerned, the 350 m horizon is characterized by lower salinity along the north-western perimeter of the Ionian (Fig. 1), associated with the southward flow, while on the eastern side, higher salinity is associated with the northward flow. The most remarkable feature of the year-to-year variability concerns the Adriatic Dense Water (AdDW). Due to the particularly severe winter conditions in 2012 ([1]) AdDW attained large density and by the end of 2012 showed up as a cold tongue overflowing the sill in the Strait of Otranto, and filling the deep layers of the northern Ionian (Fig. 2). Almost simultaneously, a salty LIW protrudes along the eastern flank into the Southern Adriatic (Fig. 1).

Acknowledgement These data were collected and made freely available by the Coriolis project and programmes that contribute to it (http://www.coriolis.eu.org).

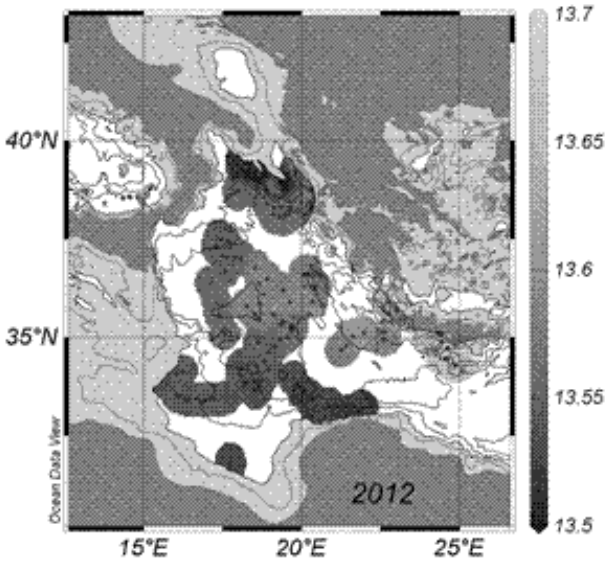

Fig. 2. Potential temperature distribution at 1300 m horizon in 2012.

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ALMOST SYNOPTIC OBSERVATIONS OF MEDITERRANEAN SEA PROPERTIES DURING SPRING OF 2011

T. Tanhua [1]*, D. Hainbucher [2], K. Schroeder [3], V. Cardin [4], M. Álvarez [5] and G. Civitarese [4]
[1] GEOMAR Helmholtz Centre for Ocean Research Kiel - ttanhua@geomar.de
[2] ZMAW, Institut für Meereskunde, University of Hamburg, Bundesstraße 53, 20146 Hamburg, Germany
[3] CNR – ISMAR, Institute for Marine Science, Arsenale - Tesa 104 Castello 2737/F, 30122 Venezia, Italy
[4] OGS – Istituto Nazionale di Oceanografia e di Geofisica Sperimentale. Borgo Grotta Gigante 42/c, 34018 Sgonico (Trieste) Italy
[5] IEO, Instituto Español de Oceanografía, Centro de A Coruña, Apdo. 130, 15001 A Coruña, Spain

Abstract
During spring of 2011, three oceanographic cruises were conducted in a coordinated fashion in order to produce base-line data of important physical and biogeochemical parameters that can be compared to historic data and be used as reference for future observational campaigns. Here we will present an overview of important results from these three cruises, and will put this in context of "repeat hydrography" and how that can be applied to the Mediterranean Sea system in the future. We will show a set of sections showing the large-scale distributions of physical and chemical properties along the full length of the Mediterranean Sea.

Keywords: Carbon, Nutrients, Salinity, Levantine Basin

The Mediterranean is a semi-enclosed Sea characterized by high salinities, temperatures and densities. The net evaporation exceeds the precipitation, driving an anti-estuarine circulation through the Strait of Gibraltar, contributing to very low nutrient concentrations. The Mediterranean Sea has an active overturning circulation, one shallow cell that communicates directly with the Atlantic Ocean, and two deep overturning cells, one in each of the two main basins. It is surrounded by populated areas and is thus sensitive to anthropogenic forcing. Several dramatic changes in the oceanographic and biogeochemical conditions have been observed during the past several decades, emphasizing the need to better monitor and understand the changing conditions and their drivers. In order to document the current change of the Mediterranean Sea, and to quantify changes in physical and biogeochemical properties across the whole Mediterranean Sea System, the cruise on the German RV Meteor was carried out in 2011. This cruise covered all major basins and most sub-basins of the Mediterranean Sea, and measurements of several key physical, chemical and biological parameters were carried out. The cruise was planned to repeat stations that have been sampled in the past, and to fit into the concept of repeat hydrography, as defined by the GO-SHIP panel. Later, an initiative called by the CIESM, a suggestion for a GO-SHIP like program in the Mediterranean Sea was presented, i.e. MED-SHIP. The M84/3 cruise was coordinated with two other, shorter, cruises that were carried out almost synoptically in the Mediterranean Sea. Several stations were selected to be inter-comparison stations to facilitate the use of the full data set from all three cruises. The other two cruises were: 1) the cruise on the German Poseidon, cruise 414, that focused the investigations on identifying and quantifying the routes and entrainment rates of the Adriatic Deep Water into the Ionian Sea and to investigate the spatial and temporal variability of the spreading and mixing of the Ionian Deep Water, and 2) the cruise on the Italian ship Urania that focused on development of a dynamic calibration procedure for oceanographic sensors, the continuation of the long-term monitoring of straits, as well as an update of the knowledge on the oceanographic conditions in the Ionian/Tyrrhenian Sea area. The quasi-synoptic data set is an example of international cooperation needed to carry out observations fit to document changes and variability of interior ocean properties. Here we will present some results from the cruise, focusing on the large scale distribution of properties across the whole Mediterranean Sea System. This presentation is based on a manuscript submitted to the special issue on "physical, chemical and biological oceanography of the Mediterranean Sea" in the journal Ocean Science (Tanhua et al., 2013).

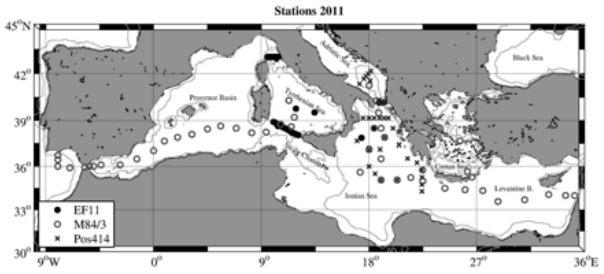

Fig. 1. Map of the station net-work during spring of 2011.

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Session

Coastal / open waters exchange - 1

Modérateur : **Miroslav Gacic**

STUDY OF SEA WAVES AND LONGSHORE CURRENT OFF ROSETTA PROMONTORY

AbdAllah M. AbdAllah [1]*, Ahmed A. Elgindy [1] and Magdy M. Farag [2]
[1] Prof of physical Oceanography - drabd77@yahoo.com
[2] Assistant Prof of Physical Oc.

Abstract

Wave observations in Abu-Quir Bay were used to study wave characteristics in the Bay and to simulate longshore current along Rosetta promontory using BOUSS2D model under different wave conditions that may be encountered in the region. These observations were obtained by using Cassette Acquisition system (CAS) during 1986 at 18m depth contour.
Statistical analysis of wave observation showed that: - Extreme NW waves have a height of 4.4m and peak period of 8sec. Maximum wave height and peak period of N waves are 4m and 8sec respectively. NE waves propagate in extreme conditions with height of 3.9m and peak period of 8sec. This extreme wave values were used to simulate longshore current along Rosetta promontory using the BOUSS2D model. This model results showed a good agreement with field observations

Keywords: Coastal processes, South-Eastern Mediterranean

Introduction

Rosetta promontory is located on the eastern side of Abu-Quir bay (figure 1). The Rosetta promontory is suffering from erosion problems caused mainly by the combined action of waves and longshore current. Understanding of wave characteristics and longshore current regime off Rosetta coast is very important to deal with this problem.

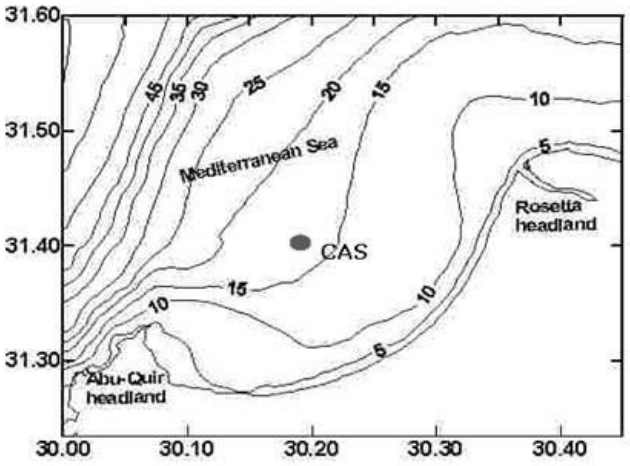

Fig. 1. Location of CAS system in Abu-Quir.

In the present work BOUSS2D model (Okey and Zeki,2001) was used to simulate the nearshore current regime off Rosetta promonotiryin . This model is a comprehensive numerical model for simulating the propagation and transformation of waves in coastal regions and harbors based on a time-domain solution of Boussinesq-type equations.

Tab. 1. seasonal and annual variations of significant wave characteristics measured at 18m depth in Abu Quir Bay during 1986. (D is the standard deviation of the data)

Season	Significant wave height			Significant wave period		
	Mean (m)	D (m)	Max (m)	Mean (sec)	D (sec)	Max (sec)
Winter	0.91	0.59	2.62	7	2.6	10.7
Spring	0.94	0.56	2.63	5.8	1.63	9.1
Summer	0.90	0.38	1.91	6.2	1.3	10.7
Autumn	0.98	0.84	4.19	6.6	1.8	10.7
Annual	0.93	0.56	4.19	6.3	1.60	10.7

Analysis of the observed wave data in Abu-Quir Bay(Table1)at.18m depth contour during 1986 show that:

1- Maximum wave height was 4.19m.
2- There are seasonal variations in available wave data characteristics associated with seasonal variation in wind regime.
3- Predominant wave direction is NW. This is due to the prevailing wind direction from this sector.
4- The peak wave period is 8sec. The maximum of the significant wave period at 18m depth during 1986, 10.7 sec, was found in NW, N and NE wave sectors.

Using BOUSS2D model, the longshore current regime off Rosetta promontory was studied for 5 different wave events at deep water to discuss the wave induced current in the study area at the extreme wave condition. These events include 5 wave conditions with wave approach directions (300º, 330º, 360º, 30º and 60º), wave period (Tp=8 sec) with incident wave height 4m. For the western side, the predominant direction of the predicted longshore current is from north to south. This is due to the effect of NW, N and NE wave action. For the eastern side, the predominant direction of this current move from west to east due to the effect of N and NW wave action. This current reverses its direction to west due to the effect of NE wave action. The maximum value of longshore current was 1.2 m/sec. Generally the model simulations agree with the observations.

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DAILY VARIATIONS IN SEA SURFACE TEMPERATURE AND EFFECT OF ATMOSPHERIC CONDITIONS ON WATER STRATIFICATION

Husne Altiok [1]*, Sabri Mutlu [1] and Lalehan Can [2]
[1] Istanbul University Institute and Marine Science and Management - altiokh@istanbul.edu.tr
[2] Isik University

Abstract
The diurnal change of the atmosphere-sea interaction will be investigated by using in situ and synchronized measurements of the atmospheric and oceanographic parameters in the Marmara Sea, having a two layered stratification. Surface currents, temperature, salinity and pressure in the water column will be measured for 10 minutes intervals during one year period by using a buoy system. Air temperature and pressure, wind speed and direction, solar radiation and humidity will also be measured. The diurnal cycle of the physical processes on the sea surface which is essential for the marine ecosystem by investigating the sea-atmosphere interaction for a two-layered system with an integrated approach.

Keywords: Air-sea interactions, Stratification, Heat budget, Marmara Sea

Sea surface temperature (SST) shows fluctuations during daytime due to solar radiation and reaches its maximum value in the afternoon. In addition to the solar radiation, wind also effects the temperature changes of the surface water in two mechanisms. Firstly, as the wind stress increases the heat exchange between the seawater and the atmosphere increases. The other mechanism is the vertical and the horizontal movements in the seawater that develop as a result of the impulse driven by the wind stres (1). In the stratified seas, like the boundary of the atmosphere-surface water interface, the transition interface between the upper and lower layers also forms a boundary. By investigating the diurnal sea surface temperature changes, it is possible to reach more detailed information about the atmosphere-sea interaction and to calculate the heat exchange in the most accurate way. Such studies were performed primarily in the tropical regions where the heat transfer between the atmosphere and the sea and the sea surface temperature variations are highest. Afterwards in the subtropical regions, especially for determining the biologic and chemical processes and calculating the acoustic propagation, researches are needed to calculate the diurnal sea surface temperature changes. Recently, in a study about global variations of diurnal warming by using 10 years of global infrared satellite data, it is showed that the diurnal warming each year were observed in large regions in the tropics and midlatitudes (2). In this study, diurnal SSTvariations and atmosphere-sea interaction will be investigate by using buoy system located in Izmit Bay in the Marmara Sea (3). Temperature and salinity profiles indicate two layer structure in the Bay (Figure 1) throughout the year. The salinity of the upper layer has a small change

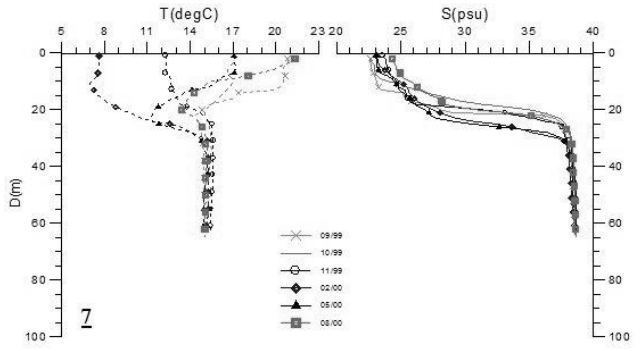

Fig. 1. Temperature and salinity profiles in the buoy location.

whereas its temperature reflects seasonal variation accordance with atmosphere. The data obtained from sensors arrays from buoy system will be transferred to the data process center located on land in real time. Appropriate filtrations will be applied to the obtained data for quality control. The quality checked time series data obtained from these filtrations will be analyzed using spectral analysis methods and variation frequencies of each parameter will be determined. Therefore, the hourly, daily and monthly changes of the parameters measured in the water column in short time intervals will be averaged and the atmospheric influence to the stratification in the water column will be clarified. Besides the determination of the diurnal cycle, the most important result that will be obtained from this study will be the collection of the precise, frequent, in situ and synchronized data set of atmospheric and oceanographic parameters representing the Marmara Sea which can be used in modeling of the aquatic ecosystem and acoustic propagation.

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STATISTICAL ANALYSIS OF INTERACTION BETWEEN THE BLACK SEA AND THE MARMARA SEA BY TEMPERATURE AND SALINITY TIME SERIES

Melih Kayisoglu [1] and Husne Altiok [1]*
[1] Istanbul University Institute and Marine Science and Management - altiokh@istanbul.edu.tr

Abstract
The purpose of this study is to investigate the interactions of the water masses between the Black Sea and the Marmara Sea by using CTD measurements in the both ends and the vicinity of the Strait of Istanbul. The statistical analyses of the monthly variations of the temperature and salinity data collected in the period of 1997-2010 are evaluated. The results showed that not only annual changes but also short term changes play a significant role on the modification of the water masses.

Keywords: Time series, Temperature, Salinity, Black Sea, Marmara Sea

The Strait of Istanbul is a narrow (0.7-3.5km), long (~31km) and shallow (30-100m) channel that connects the Black Sea and the Marmara Sea. It has a two-layered flow system, and this is fundamentally important for the water exchange between both of the seas. The upper layer flows from the Black Sea with a salinity of about 18psu, and the lower layer flows from the Marmara Sea with a salinity of about 38psu (Ünlüata et al., 1990; Yüce 1996). The layers have short term changes in physical, chemical and biological parameters due to hydrodynamic characteristics of the strait system. Monitoring of physical characteristics of these water masses assists in understanding the interaction between these two seas.

The statistically analyzed CTD data, which is used 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). The qualities of the temperature and salinity data at each station were controlled, and missing data were interpolated to obtain whole time series. After examining the time series of the temperature and salinity profiles, representative depth for the layers was chosen. 5 meters depth was chosen at all stations for the upper layer. For the lower layer, 40meters depth was chosen at Marmara Sea stations, it is 3 meters above the bottom depth at the stations Strait of Istanbul and the Black Sea.

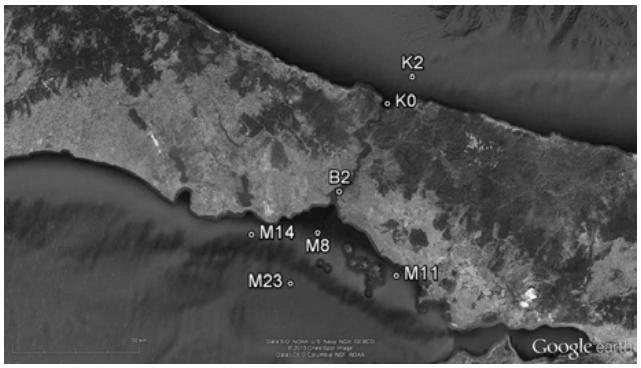

Fig. 1. Station locations

The temperature of the upper layer between the Black Sea and the Marmara Sea were significantly correlated and the minimum coefficient is 0.96, whereas the upper layer salinity between these seas were not strongly correlated, it is about 0.24. On the other hand, the lower layer temperature correlation coefficient was weak and they decreased from South to North. The correlations of the lower layer salinity between the Marmara Sea and strait stations indicated important result. The correlation between the Marmara Sea and the northern exit of the strait was higher than the correlation between the Marmara Sea and the southern exit of the strait. This can be explained by irregularities in the strait such as upper and lower layer blockages.

The annual average of the upper layer temperature at all stations indicates seasonal variations but their salinity change in seasonally only at the stations in the Marmara Sea (Figure 2a). The salinity rates of the upper layer increased by the distance from the strait in the Marmara Sea. The annual average of the lower layer temperature and salinity indicates the seasonal changes at the stations in the strait and its Black Sea exit (Figure 2b).

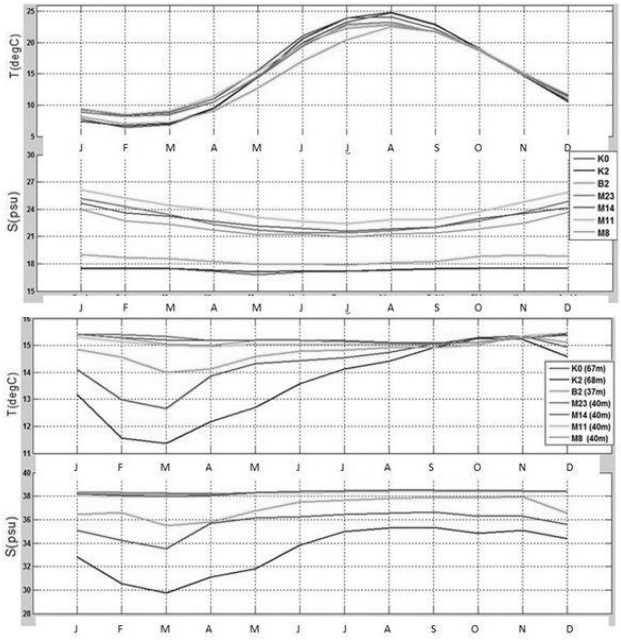

Fig. 2. The annual temperature and salinity for upper (a), and lower (b) layers

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SUSPENDED SEDIMENT CHARACTERISTICS IN COASTAL WATERS OF THE GULF OF LIONS OBSERVED FROM FIXED AND MOVING PLATFORMS

François Bourrin [1]*, Xavier Durrieu De Madron [1], Laurent Beguery [2] and Stéphane Kunesch [1]
[1] CEFREM UPVD - fbourrin@univ-perp.fr
[2] DT INSU

Abstract
Suspended sediment characteristics such as concentration, size, shape and nature were obtained from both optical and acoustical sensors installed on buoys, mooring lines, gliders and ship-based measurements during various meteorological conditions in 2011 and 2013 on the continental shelf of the Gulf of Lions. Such measurements permitted to characterize suspended particles properties at different time and space-scales in the western Mediterranean Sea. Autonomous platforms such as gliders would be useful to complement coastal observatories between fixed platforms.

Keywords: Coastal waters, Gulf of Lyon, North-Western Mediterranean, Sediments, Particulates

Suspended particles characteristics measurements are essential for estimate suspended sediment fluxes from source (rivers) to sink (open sea) in the coastal zone. Most of suspended sediment transport occurs during extreme meteorological events. Since few measurements are available during floods and storms, there is a need to collect new data across the whole shelf to better understand the sediment dynamics and suspended particles transport during energetic conditions.

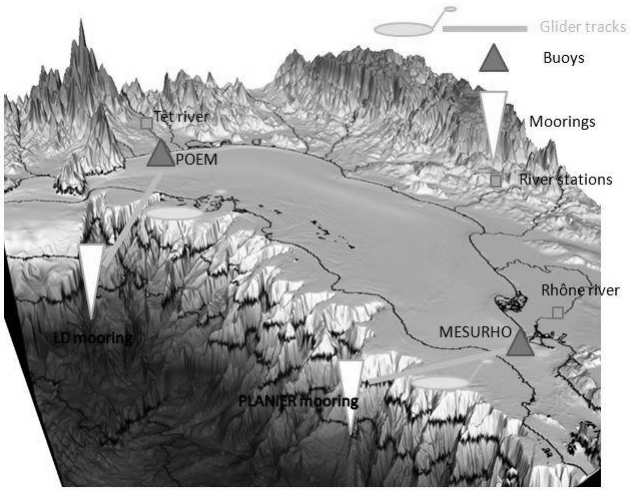

Fig. 1. Glider deployment strategy at the scale of the continental shelf of the Gulf of Lions between existing fixed platforms.

Suspended sediment characteristics such as concentration, size, shape and nature were obtained from both optical and acoustical sensors installed on buoys, mooring lines at fixed location under various weather conditions and from ship-based measurement during fair-weather conditions in 2011 and 2013 on the continental shelf of the Gulf of Lions. Moreover, we successfully deployed gliders equipped with optical sensors (cdom, fluorescence and backscattering sensors at various wavelength) in the coastal area between 30 and 200m. Such autonomous platforms regularly cruised closed to these fixed platforms allowing comparison/calibration between measurements (Fig. 1).

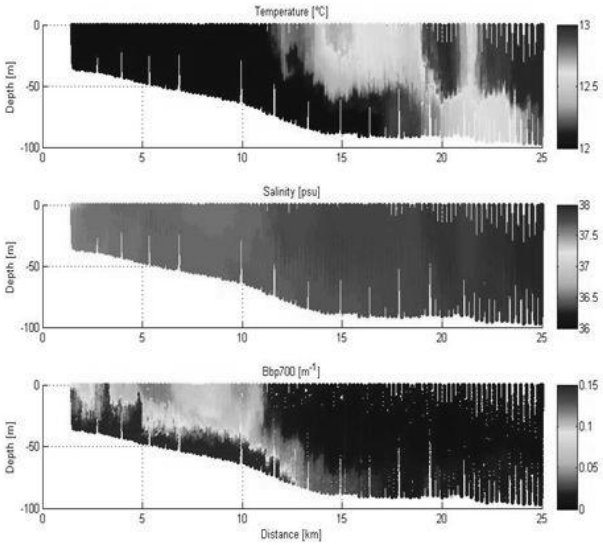

Fig. 2. Glider transect during a typical Mediterranean storm in March 2011between POEm buoy and LACAZE-DUTHIERS mooring.

Observations permitted to measure optical properties of suspended particles during various events such as floods, storms, winter dense water formation and spring bloom. Glider measurements showed that sediment resuspension can occur down to depth of 80m during strong storms and resuspension is predominant along the mid-shelf bud belt (Fig. 2). Optical measurements also permitted to distinguish suspended river-born particles and sea bottom resuspended sediments [1]. These observations will provide useful quantitative data to improve sediment transport models

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TIDAL PROPAGATION IN A MEDITERRANEAN MICROTIDAL ESTUARY

Pablo Cerralbo [1]*, Manel Grifoll [1], Arnoldo Valle-Levinson [2] and Manuel Espino [1]
[1] Universitat Politecnica de Catalunya (UPC) - pablo.cerralbo@upc.edu
[2] Department of Civil and Coastal Engineering, Florida (USA)

Abstract
A set of numerical experiments has been designed to study the tidal propagation in Alfacs Bay (Delta de l'Ebre), a microtidal Spanish estuary in the Mediterranean. Results showed amplification of tidal amplitudes around 8% toward the head of the bay. Numerical simulations investigated whether the tidal behaviour was caused by coastal morphology or by bathymetry. Results suggested that geometrical effects are more influential than those from bottom friction. The tidal propagation was consistent with that derived from a linear analytical model. Although the tidal amplitude is a few tens of centimeters, its effect on the circulation seems relevant.

Keywords: Tides, Ebro Delta, Coastal models

Introduction
The Ebro Delta is characterized by the presence of two semi-enclosed bays, (Alfacs and Fangar bay, Fig. 1). Both bays receive direct freshwater input from drain channels of rice fields in the surrounding area during 9 to 10 months in the year. Alfacs Bay is about 11km long by 4km wide with an average depth of about 3.1 m (maximum of 6.5 m in the middle). The mouth is about 2.5 km wide.

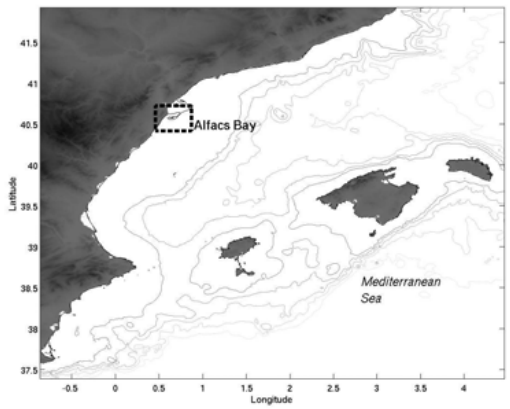

Fig. 1. Alfacs bay delimited by dotted box.

The non-tidal flow in the area has been studied in the past [1], showing a persistent structure during most of the year: a salty layer in the bottom and freshwater layer on top due to freshwater input. The bay is microtidal, with a mixed tidal regime (Form ratio=1.1), being K1, M2, O1, P1, S2 and N2 the main harmonics (ordered by importance).

Methods and Results
A set of numerical experiments has been designed to study the tidal propagation for different scenarios. The numerical model is the Regional Ocean Modeling System [ROMS, 2]. Three different approximations were implemented. The first one is a geometrical simplification of the bay (constant depth of 6m with a rectangular schematization of the coastline). The second configuration included the effects of the coastline (coastal effects). The third and realistic configuration used real bathymetry and coastal line (Fig.2 left images). The free surface elevation has been imposed as an astronomic wave made of the main harmonics described before. A total of 210 days of simulation were performed in order to analyze the amplitudes and phases using T_TIDE software [3]. Moreover, some tests with wave frequencies close to natural resonance of the bay has been done.

Initial results show how the amplitude of each harmonic increases toward the head of the bay in a range of 2-8% of its amplitude at the mouth (Fig 2. right images). These results are in agreement with similar studies using analytical models [4]. Comparison of the different approximations shows the effects of bathymetry and coastline constraints, being the latter the main contributor to these amplifications. A field campaign during summer 2013 has been designed in order to confirm the results revealed by the numerical experiments and the analytical model.

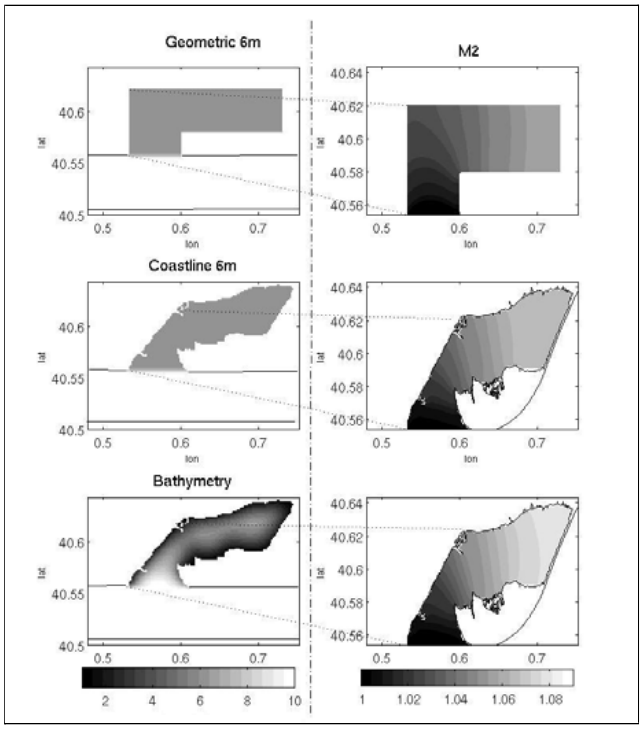

Fig. 2. On the left, the domains used in each test case. Right images shows the relative amplification of the M2 amplitude to the amplitude on the open sea for each case.

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HYDROSEDIMENTARY MODELING AS PART OF MARINE RADIOLOGICAL POST-ACCIDENTAL MANAGEMENT TOOLS: THE BAY OF TOULON CASE STUDY

Christiane Dufresne [1] and Céline Duffa [1]*
[1] Institut de Radioprotectioon et de Sureté Nucléaire (IRSN) - celine.duffa@irsn.fr

Abstract
As part of its research programs, IRSN carries out research on the consequences of a possible accidental release of radionuclides into the marine environment. Hydrodynamic and sediment modeling are necessary tools to provide radionuclide dispersion and sediment trapping simulations. An integrated hydrosedimentary model is developed on Toulon area since it is the home port of many French nuclear vessels.

Keywords: Instruments and techniques, North-Western Mediterranean, Models

Introduction
IRSN develops tools to support experts and decision makers in post-accidental situation. The Fukushima nuclear accident in 2011 has shown that significant marine environment contamination must be taken into account. Dedicated tools are necessary to be able to provide radionuclide dispersion forecast.
Hydrodynamic modeling enables to calculate advection and diffusion of tracers. Coupling it with sedimentary behavior modeling provides an adapted tool to simulate radionuclides future, dealing both with dissolve and particulate phases.
Toulon harbour, which presents a complex hydrodynamic situation, is situated in the Little Bay of Toulon. This area is half-closed by a 1km long seawall, which divides the Little Bay from the Large Bay, open to the Mediterranean Sea. Therefore, a dedicated model has been implemented from Cap Sicié in the west to the Presqu'île de Giens in the east (Longitude: 05.832° to 06.132°; Latitude: 43.04° to 43.13°) [1].

Method
We need to reproduce hydrodynamic and sedimentation phenomena in this specific area as accurately as possible. Circulation modeling was performed using the operational MARS-3D code (3D hydrodynamical Model for Applications at Regional Scale), a three-dimensional model with reduced vertical coordinates based on the resolution of the Navier-Stokes equations [2]. This is a finite difference model for free surface based on solving Navier-Stockes equations. For our application, two domains are nested off-line. Lateral incoming fluxes (salt, momentum and temperature) and elevations at the open boundaries of the finner domain is provided by a coarser model (NORMED) simulating the Northern Mediterranean Basin (its southern open boundary is located at 39.5°N) and validated with both temperatures from AVHRR imagery and in-situ data [3].
The effect of waves and currents on the sea bottom and, in particular, sediment resuspension phenomena, is taken into account. The sea bottom affects waves due to variations in depth at scales greater than wavelength scale. Therefore, WW3 wave's model [4] is implemented on this area. The sediment inputs due to river discharges have to be taken into account. They are estimated by dedicated in-situ devices moored in the two main rivers (water height, turbidity, suspension matter grain size).

Results
Calculated currents have been compared with ADCP (Acoustic Doppler Current Profiler) in situ measurements for the period 2009-2012, showing a good agreement [5]. An exemple of modelled currents is presented on Figure 1.
Radionuclides are introduced into the model as tracers. Based on the sedimentation model developed here, two high assumptions can be made: the radionuclides are only carried by clays and the balance between liquid and solid phase concentrations is always consistent (conditional upon the Kd). Next, the radionuclides adsorbed by clay particles will follow the same course as these clay particles: sedimentation, resuspension and advective transfer.

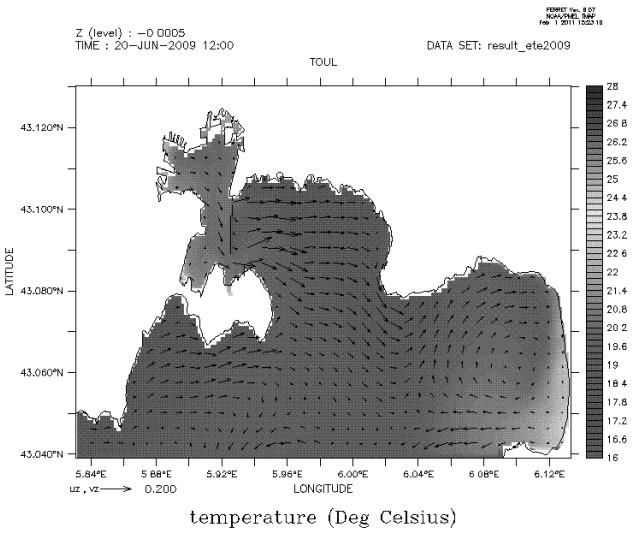

Fig. 1. Simulated surface current and temperature on July 20th 2009

Conclusion
In the event of a nuclear incident or accident involving a vessel either at sea or in dock, the use of a dedicated dispersion model is essential. In particular, such an assessment will form the basis of decisions regarding different sampling strategies, aimed at targeting any measures to be implemented.

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WATER EXCHANGES BETWEEN THE THAU LAGOON AND ITS SHOREFACE: NUMERICAL MODELING, HYDRODYNAMIC AND HYDROLOGICAL MEASUREMENTS

Y. Leredde [1]*, E. Berthebaud [1], S. Falguières [1], C. Lauer-Leredde [1], S. Mas [2], E. LeFloc'h [2], D. Parin [2], B. Mostajir [2], M. Tournoud [3], C. Salles [3], C. Rodier [3] and A. Jouon [4]

[1] Géosciences Montpellier, Université Montpellier 2, CNRS. - yann.leredde@univ-montp2.fr

[2] Ecologie des Systèmes Marins côtiers, Université Montpellier 2, CNRS, IRD, IFREMER, Université Montpellier 1

[3] Université Montpellier 2, CNRS, Hydrosciences Montpellier

[4] Rivages Pro Tech, Lyonnaise des Eaux

Abstract

Water exchanges between the Thau lagoon and the Mediterranean Sea are studied by numerical modeling and in-situ measurements. ADCP currentmeters and multi-parameter probes at sea, in the lagoon, in the channels and on the catchment, allow monitoring the system at high frequency. A first experiment, in 2012, permits to highlight some storm events. A numerical model of the hydrodynamics of the lagoon and its shoreface is also used to show that level differences between the sea and the lagoon have a high impact on the exchanges through the channels. The elevation of the sea during storms causes episodes of filling/emptying likely to modify the hydrological characteristics of the lagoon.

Keywords: Lagoons, Coastal waters, North-Western Mediterranean

Coastal environments, including coastal lagoons, are areas of high biological productivity supporting many economic activities. Coastal marine ecosystems are at the interface between the continent and the offshore sea. This position leads to significant variability of physicochemical (e.g. temperature, salinity, nutrient concentration) and biological (freshwater vs. marine species) variables affecting the functioning of these ecosystems. The increased use of coastal marine environments (e.g. fishing, aquaculture) and the anthropization of catchments (e.g. urbanization of the coastline and the hinterland) concomitant to global changes can amplify this variability. This leads to significant changes on hydrology, nutrient fluxes from superficial and ground waters, currents, productivity, and littoral exploitation, which ultimately affect all the ecosystemic services provided by this environment and its habitability.

In this communication, we focus on the case of the Thau lagoon and its shoreface. The Thau lagoon is one of the largest French Mediterranean lagoon. With an average depth of 4 m, this lagoon is connected to the Mediterranean Sea through two narrow channels. Its hydrodynamics has been widely studied [1] and many biological aspects have been explored [2]. The effect of floods was also particularly investigated [3].

We focus here on the exchanges between the sea and the lagoon and on their hydrological implications (temperature, salinity). The implications for biogeochemistry and ecology will not be discussed. The installation of monitoring stations at long-term and high-frequency, part of the "Marine Observatory of Sète" of the OSU OREME, comes up to these objectives. We point out some episodes of observed sea-storms (ADCP and multi-parameters probe) and their effects on the circulations in the channels (3 ADCP) and in the lagoon (multi-parameters probes). Hydrological data on the Vène river are also available. These measurements highlight the link and the time lag between each of these stations, the lagoon acting as a buffer with respect to the open sea. These data are also used to validate a numerical model implemented on the Thau lagoon and its shoreface (see Figure 1). The numerical model is a direct application of the latest works of Michaud et al [4] including the effect of forcing waves in the Symphony model, which works by nesting domains from the offshore to the coastal scales [5]. The computation of the sea level takes into account both classical forcings (tide, dynamic height, wind, atmospheric pressure) and significant setup induced by waves. Indeed this sea level and its difference with the level in the lagoon regulate exchanges between the lagoon and its shoreface. Normally, the exchanges through the channels are driven by the semi-diurnal tide. During storms, the exchanges are re-enforced leading to a filling/emptying system. This extreme situation completely changes the hydrological characteristics within the lagoon but also in the shoreface submitted to the plume of discharged waters from the lagoon. Different episodes of measurements confirm this scenario. The numerical model also shows a massive input of water into the lagoon at the rising of the storms and then its output to the open sea at the falling of the storms. In order to illustrate the emptying phase, we show here a result of modeling for a passive tracer initially in the lagoon and exported outside and for the trajectory of a particle initially in the lagoon and also exported to the open sea (Figure 1).

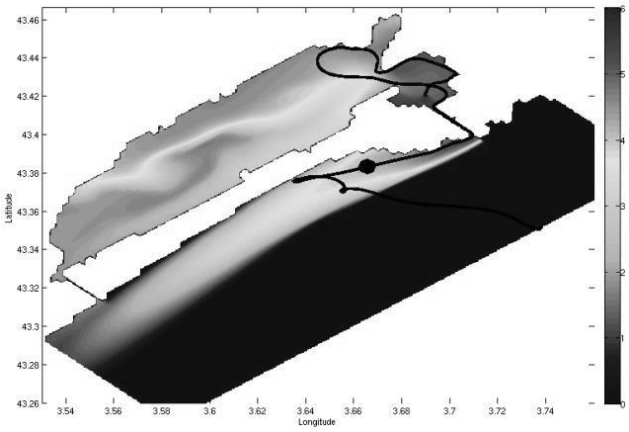

Fig. 1. Concentration (logarithmic scale) of a passive tracer regularly produced at the entrance of the lagoon simulated on 2008, 01/05, 0. am. Lagrangian trajectory of a simulated surface buoy from 2008, 01/01, 0. am to 2008, 01/08, 0. am., with its position (black dot) on 2008, 01/05, 0. am.

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ANALYSIS OF THE INLET CURRENTS OF GRADO-MARANO LAGOON SYSTEM AND COMPARISON WITH THE VENETIAN LAGOON (NORTHERN ADRIATIC SEA)

I. Mancero Mosquera [1]*, V. Kovacevic [1], M. Lipizer [2], A. Triches [2], F. Arena [1], R. Villalta [2], G. Fontolan [3] and M. Gacic [1]
[1] Istituto di Oceanografia e Geofisica Sperimentale - imancero@ogs.trieste.it
[2] Regione Autonoma Friuli Venezia-Giulia
[3] Università degli Studi di Trieste, Dipartimento di Geoscienze

Abstract

The flow through the Grado-Marano lagoon inlets is tidally driven: more than 90% of the energy is due to the astronomical forcing [1]. The second source of variability is due to the Adriatic seiches accounting for 7% of the total kinetic energy. Local winds are responsible of the variability in the ,residual currents (tides and seiches removed). NE Bora wind increases the residual inflow into the lagoon through the easternmost inlet and favouring the outflow through the westernmost inlet. Such a behaviour is similar to what has been reported for another Northern Adriatic lagoon, namely the Venetian lagoon.

Keywords: Lagoons, North Adriatic Sea, Coastal systems, Currents, Wind

Introduction

In order to assess the main characteristics of the water exchange between the lagoon and the open sea, and hence, the possible consequences on the transport of the suspended solid matter, bottom-mounted Acoustic Doppler Current Profilers were employed to take measurements of water velocities in the two inlets of the Grado-Marano lagoon, Grado (390 m wide) and Lignano (310 m wide), both with about 11 m depth. The measurements were performed in the framework of the monitoring programme under the auspices of the "Regione Friuli Venezia Giulia, Direzione Centrale ambiente, energia e politiche per la montagna" and lasted from July 2010 through September 2011. The relative narrowness and shallowness of the inlets make the flow almost rectilinear and mainly vertically homogeneous.

Methods

Principal Component Analysis (PCA) was applied in order to quantify the along channel flow variability. Harmonic Analysis was used to study the tidal oscillations present in the flow. The Fourier-based methods were employed to find out the seiche signal. Wavelet methods allowed to study the nature of the remaining (no tides and no seiches) variability. Finally, PCA of the local wind velocity time series is utilised to assess the current flow regime under different wind conditions.

Results and discussion

PCA shows that more than 99% of energy is contained in the principal component aligned with the along channel axis. Further analyses were thus carried out with the principal component of the vertically-averaged current series. Tidal forcing accounts for about 90% of the energy in the flow, with the semidiurnal group (S2, M2, N2, K2) prevailing over the diurnal one (K1, P1, O1). M2 and S2 alone contribute over the 75% of the variability while the strongest diurnal K1 contribution is about 7.5%. These results resemble the results from previous research conducted in the nearby Venetian lagoon [2] where the contribution of M2 and S2 was estimated to be between 70 and 78% of the total energy. The semi-diurnal group shows an in-phase behaviour with time lag of about 20 seconds, while the diurnal group shows a time lag of 10 minutes.

Fourier spectra of the de-tided series show significant energy remaining at the frequencies corresponding to the Adriatic seiches. In addition to the two main modes of 21.1 h and 10.9 h, spectral methods revealed high coherence peaks at the frequencies of higher harmonics: 7.04, 5.24, 4.29 and 3.59 hours. This study thus confirms four of the several high-order Seiche harmonics reported in [3]. Further analysis carried out with the Wavelet transform yields an estimation of energy contribution by seiche signal of about 84% in Grado and 77% in Lignano; hence, about 8% of the total energy.

Removal of the seiche oscillations is achieved by the least squares fit of the Wavelet scales enclosing Adriatic Seiche periodicities and subtracting them from the non-tidal time series. The residual time series thus obtained is classified according to a simultaneous record of wind velocities in a nearby meteorological station. Wind data is decomposed into Principal components: the wind variance is mainly due to the winds from the North-East, *i.e.*, the Bora wind (PC1), and from the South-East, scirocco wind (PC2). Each wind principal component is partitioned in classes 5 m/s large starting form -15 m/s to 20 m/s. Moreover, a "Calm" state was defined when the wind speed was less than 3 m/s. The effect of the wind PC1 on the currents is studied while the PC2 is in a calm state, and vice versa [1]. The response of Grado and Lignano residual currents ("Y") to the strongest wind component (PC1) is of exponential nature, following the model $Y = Ae^{(b*PC1)}$ strongly resembling the results achieved for the Venetian lagoon. The exponential rate "b" is estimated to be about -0.15 and -0.13, and the coefficient "A" is -0.0049 and 0.0107 in the inlets of Grado and Lignano, respectively. The wind PC1 thus exerts similar effect but with opposite sign in the two inlets, Grado and Lignano. The exponential rates in Venice were0.12 and 0.1 in Lido and Chioggia (Venice lagoon) [4] whilr "A" was estimated to be -0.0207 and 0.0332 in Lido and Chioggia, respectively.

Conclusions

Major similarities have been found between the two biggest Adriatic lagoons, i.e. the Venetian lagoon and the Grado-Marano lagoon system. Both have similar inlet flow regimes. Astronomical tide is the main driving force in the inlets. The semi-diurnal group is prevalent. While the main seiches modes exist in both lagoon systems, there is a strong evidence of the presence of higher harmonic seiches in Grado and Lignano inlets. The residual currents are affected by winds, mainly the PC1, in an exponential manner. Hence, an event of Bora (observable in PC1) of 10 m/s speed would increase the average out-flowing in Lignano by about 360%, and the inflowing in Grado by almost 450% with respect to the Calm conditions. Therefore, the effect of the wind PC1 is significant in the Grado-Marano lagoon as well as in the Venetian lagoon [4].

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HIGH-RESOLUTION MODEL STUDIES OF THE CIRCULATION IN COASTAL AREAS OF THE TYRRHENIAN SEA (INCLUDING THE GULF OF NAPLES)

P. De Ruggiero [1], E. Napolitano [2]*, R. Iacono [2], S. Pierini [1] and G. Spezie [1]
[1] Università Parthenope
[2] ENEA - ernesto.napolitano@enea.it

Abstract
A very high-resolution, sigma-coordinate, primitive equation model of the circulation in the coastal area of Campania has been developed. The model is nested with a regional model of the whole Tyrrhenian Sea circulation. Here we describe the main features of the coastal model, and the first test simulations performed, including that of a Kelvin wave propagation episode whose signature had been observed near Capri in June 2003.

Keywords: Coastal models, Tyrrhenian Sea

1.The model The coastal area of Campania, including the Gulf of Naples, is an interesting region, not only from a physical oceanographic viewpoint, but also in a more general environmental perspective, because of the strong impact of human activities on the marine ecosystem. We have implemented a very high-resolution, three-dimensional primitive equation numerical model (1/144° of horizontal resolution and 40 sigma-levels) of the circulation in this area (see Figure 1), based on the Princeton Ocean Model (POM). Our coastal model (COSM hereafter) is one-way nested with a model of the Tyrrhenian Sea circulation (TYREM, see [1]), having a horizontal resolution of 1/48°, which is in turn nested with a coarser resolution model of the whole Mediterranean Sea circulation [2].

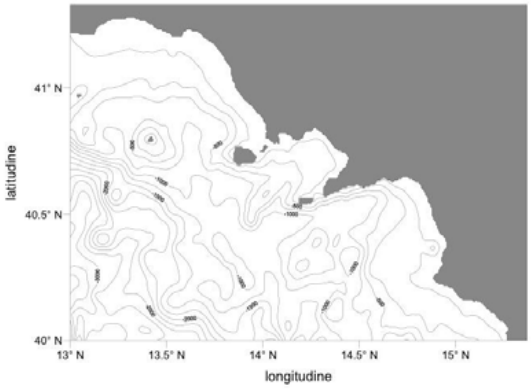

Fig. 1. Model domain and bathymetry

The model bathymetry is interpolated from the 30" GEBCO dataset (General Bathymetric Chart of the Oceans). Thanks to the small grid spacing, a very weak smoothing is needed to keep the pressure gradient error under control. This gives the very realistic topography shown in Figure 1. The surface forcing is provided by ECMWF wind data. Test cases in different seasonal scenarios have been performed, showing that the nesting is working correctly, and is crucial for a correct representation of the interaction between the coastal dynamics and the large-scale circulation of the Tyrrhenian Sea (details will be given in [3]).

2. A Kelvin wave propagation case study In June 2003, the current data measured by a current-meter moored in the Bocca Piccola of Capri suggested a possible coastal wave episode, that could be related to a strong wind event occurred a few days before. A process-oriented study by Pierini et al. (2005) [4], using a simplified three-layer model, provided evidence that the observations were consistent with the propagation of an energetic internal Kelvin wave resulting from the relaxation of a strong upwelling produced by the wind event. We have therefore sought to reproduce this episode with COSM, performing a series of simulations of increasing degree of realism, with the purpose of identifying the key elements of the dynamics.

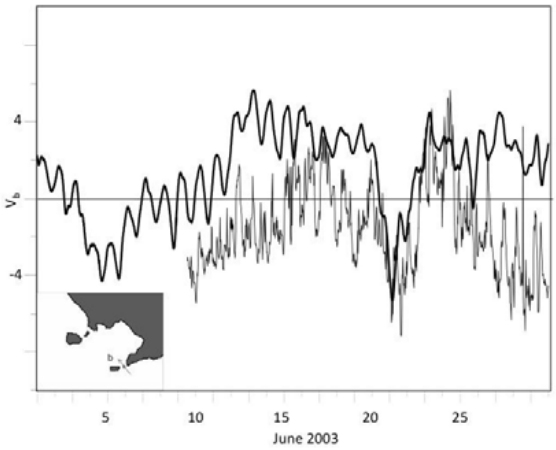

Fig. 2. Time series of the current at 25 m of depth at the mooring location (b). Thick (fine) line denotes values from the numerical simulation (observations).

Experiments have shown that a realistic stratification in the initial conditions is needed to capture the Kelvin wave phase speed and cross-shore structure. The best result, obtained with the June 2003 stratification, is shown in Figure 2, where the lower curve shows the current measurements, and the thicker line shows the current simulated by the model at the same location. The difference between observations and model simulation before t=20 June and after t=25 June is to be accounted for by the poor spatial resolution of the surface winds used to force the model.

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WHY HAS NORTHERN ADRIATIC RECENTLY BEEN EXPOSED TO INCREASED FLOODING?

Miroslava Pasaric [1]*
[1] Andrija Mohorovicic Geophysical Institute Faculty of Science, University of Zagreb - mpasaric@gfz.hr

Abstract
Hourly sea-level data at Bakar are used to examine the flooding of the Northern Adriatic coast in the period [1951-2012]. An increase in the frequency of moderate and especially of extreme floods, as well as in their duration, is evident from 2008 onwards. The trend in relative sea level can explain the increase of moderate events; for extreme events the increase is partly attributed to the trend, but also to recent changes in the frequency and/or intensity of storm surges.

Keywords: Sea level, Geohazards, Air-sea interactions, North Adriatic Sea

In recent years Northern Adriatic has repeatedly been exposed to exceptional storm surges and coastal flooding. At Bakar, which is the second longest operating tide gauge on the eastern Adriatic coast and has been uninterruptedly recording since 1949, during the last four years the absolutely highest sea level was surpassed on two occasions - on 1 December 2008 and again on 1 November 2012.

Hourly sea-level data recorded at Bakar in the period [1951-2012] are used to examine the occurrence of extreme sea levels in the Northern Adriatic in the last sixty or so years. We define an event as every occurrence of hourly sea level exceeding a selected percentile value - 99.90th for moderate and 99.99th percentile for extreme events. Flood is defined as an uninterrupted series of consecutive events.

The data reveal that the eleven highest events took place in the period from 1 December 2008 onwards. There is an interdecadal variability in the occurrence of extreme events, but from 2008 onwards an increase in frequency of moderate and especially of extreme events, is evident. Furthermore, the extreme floods have increased not only in their number, but also in their duration. One may examine values of the selected percentiles when calculated over shorter (8.9 years) time intervals (Figure 1, full line): the values for the last interval are markedly higher than those for the entire period.

The recent increase in the frequency and intensity of flooding may be related to relative sea-level rise but also to long-term changes in atmospheric forcing. To distinguish between the two processes, linear trend in sea level is calculated. In this, a well-established relationship of 2 cm/hPa between monthly anomalies of sea level in the Northern Adriatic and those of air pressure [1] is used to eliminate the effects of air pressure and wind [2] on the sea-level trend. The atmospherically-corrected sea level at Bakar displays, over the [1951-2012] interval, a linear trend of 1.2 mm/yr.

In order to investigate the effects of sea-level rise on the occurrence of extreme sea levels, we subtract the obtained trend from the original hourly sea-level data. The percentile values for the detrended data (Figure 1, dashed line) indicate that the increased flooding due to moderate (> 99.90th percentile) events in recent years may be explained by the trend in relative sea level. However, even upon removal of the linear trend, the 99.99th percentile value for the most recent interval is 8 cm higher than the long-term one. This suggests that the increase of the extreme events cannot be attributed only to the sea-level rise, but also to recent changes in the frequency and/or intensity of storm surges.

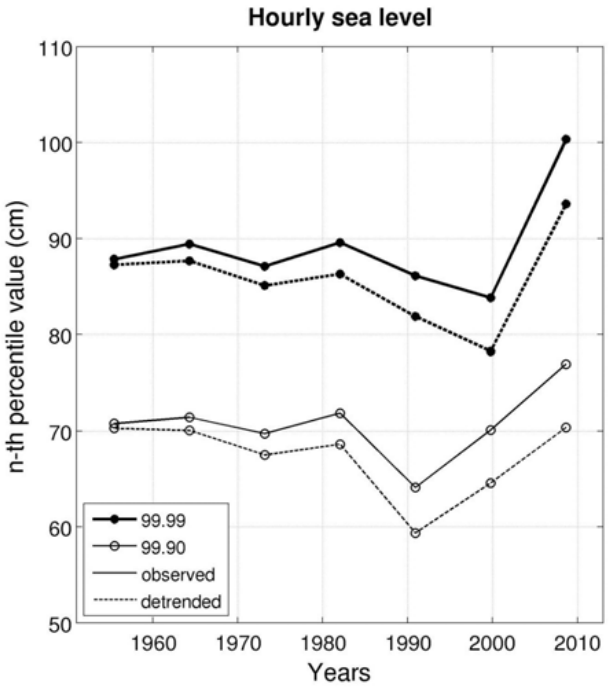

Fig. 1. Hourly sea level data at Bakar (Northern Adriatic) in the [1951 - 2012] period: 99.90th (thin line) and 99.99th (thick line) percentile values, calculated over seven consecutive windows of 8.9-years length. Full line denotes percentiles for original data, and dashed line for sea level data, from which linear trend has been subtracted.

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SUBMARINE GROUNDWATER DISCHARGE INTO THE ENTIRE MEDITERRANEAN SEA

V. Rodellas [1]*, J. Garcia-Orellana [1], M. Feldman [2], P. Masqué [1] and Y. Weinstein [2]
[1] Inst. Ciència i Tecnologia Ambientals - Dept. Física. Universitat Autònoma de Barcelona. Spain - valenti.rodellas@uab.cat
[2] Dept. Geography & Environment. Bar-Ilan University. Israel

Abstract
In this work we aim to estimate the magnitude of Submarine Groundwater Discharge (SGD), encompassing both fresh groundwater and recirculated seawater, into the entire Mediterranean Sea through a mass balance based on the inventory of ^{228}Ra in surface water. Our preliminary results suggest a SGD flow on the order of ~ 10^{11} $m^3 \cdot yr^{-1}$, which is comparable to the freshwater inflow from rivers. Thus, SGD may represent a major pathway for the delivery of terrestrial compounds (i.e. nutrients, metals, carbon), which may significantly impact biogeochemical coastal cycles of the Mediterranean Sea.

Keywords: Coastal waters, Radionuclides, Hydrology, Water transport, North-Central Mediterranean

Introduction & Methods

Submarine Groundwater Discharge (SGD), encompassing fresh groundwater and recirculated seawater, has been recognized as an important component of the hydrological cycle and a dominant vector of its associated chemical constituents to the coastal sea. The biogeochemical reactions occurring in the subterranean estuary result in enhanced concentrations of dissolved land-derived compounds (i.e. nutrients, metals, carbon, pollutants) in SGD, being typically much higher than in receiving coastal waters. Thus, SGD inputs may have a significant impact on coastal biogeochemical cycles.

In this study, we aim to estimate the SGD flow into the entire Mediterranean Sea based on the distribution of ^{228}Ra in surface water. ^{228}Ra is an appropriate tracer of SGD to the whole Mediterranean mainly because (i) its primary sink is its radioactive decay and (ii) its removal must be balanced by an input term that is due almost entirely to inputs from continental margins [1]. Assuming other sources are constrained, SGD ^{228}Ra fluxes can be determined and converted to SGD water flows using the ^{228}Ra content in brackish coastal groundwater.

During the M84/3 (April 2011) and MedSeA (May 2013) cruises onboard of the R/V Meteor and the B/O Ángeles Alvariño, respectively, more than 50 surface water samples distributed throughout the Mediterranean Sea were collected (Fig. 1). ^{228}Ra concentrations were determined through RaDeCC measurements (via ^{224}Ra ingrowth from ^{228}Ra) [2] and gamma spectrometry [3].

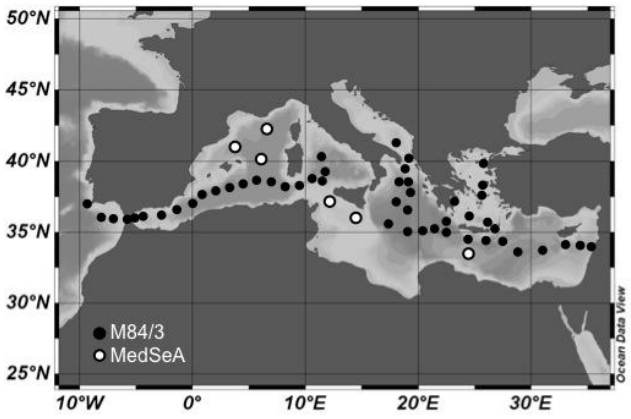

Fig. 1. Map of the surface samples collected during the M84/3 (April 2011; solid circles) and MedSeA (May 2013; empty circles) cruises onboard of the R/V Meteor and the B/O Ángeles Alvariño, respectively.

Results & Discussion

Preliminary results obtained via RaDeCC measurements showed typical ^{228}Ra concentrations, ranging from 6 to 35 $dpm.m^{-3}$ in surface waters of the Mediterranean Sea. Here we develop a preliminary approach to estimate the SGD to the Mediterranean Sea. Assuming a relatively homogeneous concentration of 15 $dpm \cdot m^{-3}$ throughout the surface Mediterranean waters (~150 m depth; winter mixed surface layer in Levantine Mediterranean [4]), the total inventory of ^{228}Ra equals ~ $6 \cdot 10^{15}$ dpm. Considering steady state and that radioactive decay is the main removal mechanism, the loss by ^{228}Ra decay (λ=0.12 yr^{-1}) should be balanced by ^{228}Ra inputs. Potential major sources of ^{228}Ra to the upper Mediterranean Sea are riverine inputs, atmospheric dust, release from continental shelf and slope sediments, seawater inflowing through the straits of Gibraltar and Bosphorous, and SGD. All these terms must be thoroughly constrained in order to determine the inputs that can be attributed to SGD. While this is not yet available, we are following a previous study conducted at the Atlantic Ocean that revealed that more than half of the ^{228}Ra inputs were derived from SGD [1]. Assuming that in the Mediterranean Sea, SGD supplies also half of the ^{228}Ra input, it results in a rough ^{228}Ra-derived SGD flux of ~ $3 \cdot 10^{14}$ $dpm \cdot yr^{-1}$. Considering an average SGD ^{228}Ra concentration of 1400 $dpm \cdot m^{-3}$ (as determined for the Atlantic; [1]), our preliminary interpretation suggests a total SGD flow on the order of 100 $Gm^3 \cdot yr\text{-}1$ (~ 10^{11} $m^3 \cdot yr^{-1}$). Although it is a preliminary attempt and it is subject to large uncertainties, our results show that the magnitude of SGD is comparable to the riverine inputs (2 - $4 \cdot 10^{11}$ $m^3 \cdot yr^{-1}$; [5]). Since the concentrations of dissolved chemicals (e.g. nutrients, metals, carbon) in SGD usually exceed those in rivers, SGD is probably a major conveyor of terrestrial compounds and contaminants to the sea, which could result in significant impacts on coastal Mediterranean biogeochemical cycles.

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SURFACE CIRCULATION IN THE GULF OF NAPLES DURING THE GELATO 2012 EXPERIMENT

E. Zambianchi [1]*, P. Poulain [2], P. Zang [3], A. Kalampokis [4], M. Berta [5], M. Borghini [5], B. Buonocore [1], D. Cianelli [1], P. Falco [1], R. Gerin [2], I. Iermano [1], C. Mantovani [5], G. Nicolaides [6], T. Ozhokmen [3], S. Sofianos [7], M. Uttieri [1] and V. Zervakis [4]
[1] DiSAm, Università Parthenope, Napoli, Italy - enrico.zambianchi@uniparthenope.it
[2] OGS, Trieste, Italy
[3] RSMAS. University of Miami, USA
[4] University of the Aegean, Lesvos, Greece
[5] ISMAR-CNR, La Spezia, Italy
[6] TEI, Piraeus, Greece
[7] IASA, University of Athens, Greece

Abstract
We present selected results of an experiment carried out in the Gulf of Naples (GoN) in the summer of 2012. Different aspects of the surface circulation in the Gulf, a coastal area of the South-Eastern Tyrrhenian Sea were targeted during the experiment. An assessment of the importance of the local wind forcing in the case of summer breeze regime is illustrated, as well as results regarding relative dispersion and the detection of surface transport barriers (Lagrangian Coherent Structures) developing in the area.

Keywords: Currents, Coastal processes, Water transport, Gulf of Napoli, Tyrrhenian Sea

Introduction
In the framework of the MED TOSCA (Tracking Oil Spill and Coastal Awareness network) project, a field experiment was conducted in the summer of 2012 in the Gulf of Naples, organized by DiSAm and ISMAR, with the cooperation of OGS, UAegean, TEI, IASA and RSMAS (see above, authors' list). The goals of the GELaTo (Gulfofnaples Eulerian/LAgrangian TOsca) 2012 experiment carried out between July 27th and August 6th, were: i. The study of the surface circulation in the area, ii. The validation of HF radar data, iii. The assessment of relative dispersion regimes in the area (at submesoscale), iv. The test of novel drifter designs and the intercalibration of different near-surface lagrangian instruments, v. The identification of connectivity paths within the area, in terms of Lagrangian Coherent Structures.

Materials and methods
The GoN is a very intensively monitored coastal area. In particular, since 2004 a 3-antenna HF radar system has been providing hourly surface current data at 1 km spatial resolution over the entire Gulf area.
Moreover, in the framework of the TOSCA project a circulation model of the GoN was set up, namely a local implementation of the Regional Ocean Modeling System (ROMS) with 300 m horizontal resolution, forced by the SKIRON atmospheric model (0.05°, 1h resolution) and by the Mediterranean ocean Forecasting System (1/16° deg with SLA,SST, T/S profiles assimilation) ocean model at the open boundary conditions.
The GELaTo experiment implied a very intensive drifter deployment, recovery and redeployment activity in the Gulf, as well as continuous HF radar measurement of surface currents. During GELaTo 46 drifters of different designs were deployed in the GoN (divisible into two broad categories, current-following and oil spill-following units), their trajectories resulting in the spaghetti diagram shown in fig. 1.
Radar data were acquired continuously and shared, together with the drifter trajectories, in near-real time among the participants as well as with the MPO Division of the RSMAS - University of Miami, that handled the data processing for Lagrangian Coherent Structure identification on the basis of Finite Time Lyapunov Exponents.
Moreover, during GELaTo the ROMS circulation model was utilized in forecast mode, utilizing the SKIRON forecast data.

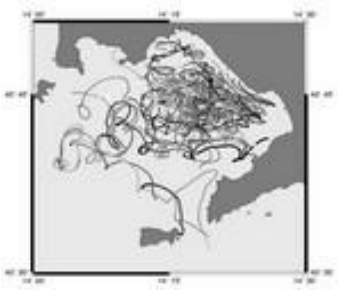

Fig. 1. Trajectories of drifters deployed during the GELaTo 2012 experiment

Results
In this communication we focus on points (i), (iii) and (v) of the main goals of the GELaTo 2012 experiment. Drifter trajectories, HF radar data as well as numerical simulations showed that the typical surface circulation in the GoN is dominated by the oceanic response to the forcing breeze regime. As a consequence, the overall current patterns rotates the entire 360° over the 24 hours, clockwise. Separation of drifter triplets is seen to kick in after a time of the order of 2-3 days. Lagrangian Coherent Structures have proved tricky to sample, mainly for logistical reasons (transmission of HF radar data time delay and ship relocation time necessities); however, a targeted experiment in a specific subarea of the Gulf allowed to point out their presence, which may have important consequences on pollutant retention and water renewal in the GoN.

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Session

Coastal / open waters exchange - 2

Modérateur : **Xavier Durrieu de Madron**

INTERNAL TIDES DISTRIBUTION IN THE CENTRAL MEDITERRANEAN SEA

Jihene Abdennadher [1]* and Moncef Boukthir [1]
[1] UR11ES88,Institut Préparatoire aux Etudes d'Ingénieur de Tunis, University of Tunis - jihene.abdennadher@ipeit.rnu.tn

Abstract
We have investigated the spatial distribution of the internal tides in the central mediterranean sea using a very high-resolution of the Regional Ocean Modelling System (ROMS). The main potential sites of internal tides generation were identified. Enhanced energy conversion occurs close to the generation sites which may lead to strong mixing in these area.

Keywords: Tides, Continental slope, Sicily Channel, Adventure Bank, Messina Strait

1. Introduction

The Sicilian Channel has been extensively studied during the last years[1-2]. However, very few is known about the generation of the internal tide in this channel. Indeed, except sparse observations [3-4], the vertical structure has not been sufficiently addressed. In this study we try to clarify the distribution of the K_1 and M_2 internal tides in Sicilian Channel as well as their energetics. The horizontal resolution is about 1.4 km in both longitudinal and latitudinal directions.

2. Results

Assuming that the advection of baroclinic energy is negligible, the integration of the energy equation over a given domain and taking the average over one tidal period (denoted by an overbar) yields to:

$$\iiint g\,\overline{\rho' w_{bt}} dV = \iint \overline{p_i \vec{u}_i} \vec{dS} + \iiint \bar{D} dV$$

where ρ' is the water density perturbation, wbt is the vertical velocity induced by the barotropic tide flow, ui is the baroclinic velocity, p_i is the internal pressure perturbation, D denotes the dissipation. In this equation, $p_i \vec{u}_i$ is the energy flux that is associated with the propagation of internal tide, and $g\rho' w_{bt}$ represents the conversion rate from surface to internal tide energy.

The dissipation of the internal tides is numerically estimated from the previous equation by subtracting energy flux divergence from the energy conversion.

The maximums of the depth-integrated conversion rate from the surface to internal tidal energy depicts different generation sites for M_2 and K_1 internal tides (Fig 1 and 2). For M_2, Three main generation sites were identified, namely, the Messina strait, the narrowest passage through the western sill of the Adventure Bank, the northwest of Sicily and the northwest of the Pantelleria isle. In the Sicilian Channel the baroclinic energy flux depicts a propagation of the M_2 internal tide toward the north and southwest from the most efficient generation site. On the other hand, the K_1 internal tide enrgy is totally dissipated close the main generation regions namely, the Adventure Bank's edge, the surrounding of Pantelleria isle, the south east of the Malta plateau and the Messina strait. This result is coherent with the fact that K_1 frequency is subinertial at these latitudes and so K_1 cannot propagate. Finally, it is important to note that K_1 internal tide is globally less energetic than M_2 in the whole model domain and particularly in the Sicilian Channel.

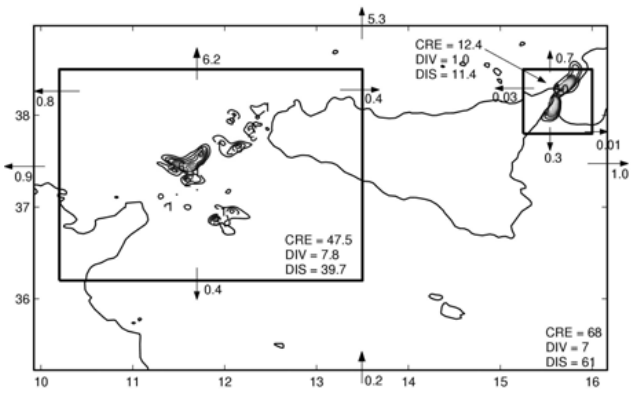

Fig. 1. Model predicted distribution of the depth integrated conversion rate from the M_2 surface to internal tide. Integrated baroclinic energy flux across the bounding transects is given in MW. Conversion(CRE),dissipation(DIS) and flux divregence(DIV) are in MW

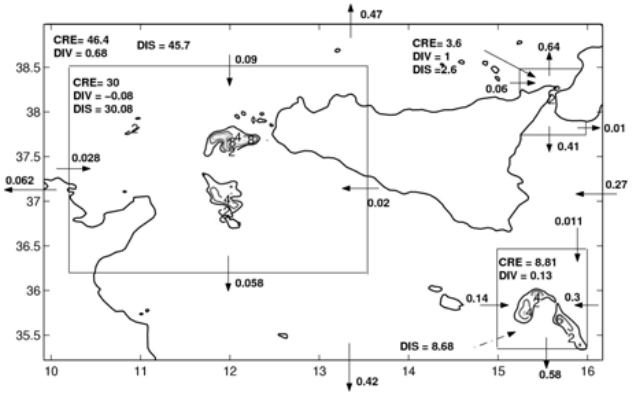

Fig. 2. Model predicted distribution of the depth integrated conversion rate from the K_1 surface to internal tide. Integrated baroclinic energy flux across the bounding transects is given in MW. Conversion (CRE),dissipation(DIS) and flux divregence are in MW

A sensitivity study to the initial stratification were established. The K_1 (M_2) internal energy with summer stratification is 30% (18%) greater than that obtained with winter stratification. Moreover, the M_2 energy ray slope depends strongly on stratification. Indeed, in the Sicilian Channel, the energy ray bends slightly toward the east with winter stratification compared to that obtained with summer one.

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SEASONAL VARIABILITY OF THE ATLANTIC TUNISIAN CURRENT DERIVED FROM A HIGH RESOLUTION MODEL

Imene Ben Jaber [1]*, Jihene Abdennadher [1] and Moncef Boukthir [1]
[1] UR11ES88,Institut Préparatoire aux Etudes d'Ingénieur de Tunis, University of Tunis - imen.ben_jaber@yahoo.fr

Abstract
A high resolution eddy-resolving primitive equation numerical model (ROMS), is used to study the variability of the Atlantic current along the Tunisian coast. The seasonal variability of the two MAW flows crossing the Sicily Channel is significantly different. The main flow along the Tunisian coast, which gives rise to the Atlantic Tunisian Current (ATC) is stronger than the Atlantic Ionian Stream (AIS) from fall to winter. The ATC, which seems to be present during the year, is characterised by high spatial and temporal variability as suggested from model results and also from the analysis of eleven years of combined maps of TOPEX/Poseidon and ERS-1/2 altimeter data.

Keywords: Circulation, Mesoscale phenomena, Sicily Channel

1. Introduction

The Seasonal circulation of the central Mediterranean Sea was investigated by many authors [1-3]. It is important to note that very few data have been collected along the African coasts which imply a substantial under sampling of Tunisian and Libyan waters on the shelf slope and on the continental shelf. The current off Cap Bon [4] may be truncated by the sampling [5]. Although these efforts allowed understanding a lot about this circulation, some interrogations remain without convincing answers. One of the main objectives of this work is to examine the time and spatial variability of the Atlantic Tunisian Current (ATC), which is not well documented. Moreover, its long-term variability in space and time is only inferred from surface drifters [6] and SST satellite images [7]. To this end, we have investigated the seasonal variations of the surface circulation in the central Mediterranean Sea from a high resolution eddy-resolving primitive equation numerical model (ROMS) and from eleven years of combined maps of TOPEX/Poseidon and ERS-1/2 altimeter data.

2. Model set up

The model used in this study is based on the Regional Oceanic Modelling System (ROMS), a three-dimensional primitive equation, finite difference hydrodynamic model. The horizontal grid resolution is chosen to be about 2.8 km and the model was initialized with realistic temperature and salinity fields. At the four open boundaries, temperature, salinity and velocity fields are fully specified by a bilinear interpolation of the coarse resolution model fields (MED12) onto the high resolution model grid (ROMS).

3. Results

The model is able to simulate the major water masses and the circulation patterns in the central Mediterranean Sea. The AW and LIW paths as well as the cyclonic and anticyclonic features deduced from models [2,5] and from observations [1, 7-8] are quite reproduced. The path of the Atlantic Tunisian Current and its variability are clarified, particularly south of Lampedusa. The ATC flows eastward mainly along the 200 m isobath. South of Lampedusa, it splits into two branches. The first branch directly flows toward the southern part of the Levantine basin, while the second flowing over the Tunisian shelf. The latter divides into two branches, the first one invades the Tunisian shelf in the Gulf of Gabes and recirculates anticyclonally on the shelf, while the second continues flowing southeastward as an important coastal current and comes close to the Libyan coast, giving rise to a strong coastal jet near the Libyan current. This scheme is different from an earlier ones estimated from models of coarse resolution and it is in agreement with the recent one [9]. A small cyclonic vortex develops downstream Cape Bon and it seems that it constrains the AW towards the Tunisian slope increasing its velocity [9]. However, the existence of this mesoscale feature should be confirmed by oceanographic surveys. The ATC is stronger than the AIS from fall to winter. In January, the AIS is close to the Sicilian coast, and the ATC to the Tunisian coast. The AW is colder in the AIS than in the ATC due to mixing with upwelled waters [5]. In July, the AIS meandered, whereas the ATC appears weak or not present at all, in agreement with previous studies [2-3]. Nevertheless, our results show that the ATC is clearly present in July for year 2006, suggesting a possible interannual variability of this current. We believe that the ATC is present during the year, although it is difficult to be identified in July, because of the recirculation in the Sicily Channel. Surface geostrophic current anomalies computed from eleven years of combined maps of TOPEX/Poseidon and ERS-1/2 surface altimetric slope anomalies, particularly confirmed the observed high spatial and temporal variability of the sea surface circulation. This result is very encouraging for reconstructing the total current which is the sum of the geostrophic current anomalies, the mean current, and the Ekman current. The available long time series of satellites data in addition to their high spatial coverage make now possible a monitoring of the main eddies in the eastern Mediterranean Sea, which was not possible from *in situ* measurements.

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INTERACTION OF DENSE SHELF WATER CASCADING AND OPEN-SEA CONVECTION IN THE NORTHWESTERN MEDITERRANEAN DURING WINTER 2012

X. Durrieu de Madron [1]*, L. Houpert [1], P. Puig [2], A. Sanchez-Vidal [3], P. Testor [4], A. Bosse [5], C. Estournel [6], S. Somot [7], C. Cassou [8] and .. Others (#) [1]

[1] CEFREM,CNRS-Université de Perpignan, Perpignan, France - demadron@univ-perp.fr

[2] ICM-CSIC, Barcelona, Spain

[3] GRCGM-UB, Barcelona, Spain

[4] LOCEAN, CNRS-IRD-UMPC-MNHN, Paris France

[5] LOCEAN, UPMC, Paris, France

[6] LA, CNRS-UPS, Toulouse, France

[7] CNRM-GAME, Météo-France-CNRS, Toulouse, France

[8] CERFACS-CNRS, Toulouse, France

Abstract

The winter of 2012 experienced peculiar atmospheric conditions that triggered a massive formation of dense water on the continental shelf and in the deep basin of the Gulf of Lions. New observations highlight the interaction of these processes and their role to the progressive modification of the NW Mediterranean deep waters.

Keywords: Deep waters, Water convection, Time series, Gulf of Lyon

In the Gulf of Lions, dense water formation shows a high interannual variability. Although open-sea convection is the main mechanism for the renewal of the Western Mediterranean Deep Water, the influence of dense shelf water cascading has been suggested by several studies. Analysis of historical temperature-salinity profiles from the late 1960s suggested mixing of deep cascading and convection dense waters, with a subdecadal recurrence [1], the winters 2005 and 2006 being the last major events [2].

A comprehensive set of hydrological and hydrodynamical observations- including an array of moorings, a glider repeat section and an hydrological survey - was collected during the winter and summer 2012 that provide new insights on the propagation and mixing of both type of the dense shelf waters, and their influence on the modification of the Western Mediterranean Deep Water [3].

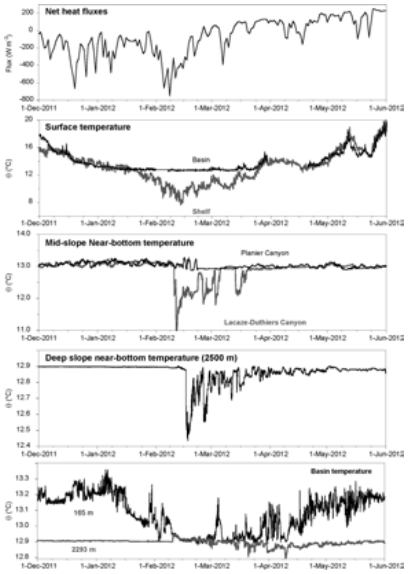

Fig. 1. Time series of net heat flux and surface temperature on the shelf and in the basin, potential temperature on the slope and in the basin during the winter and spring 2012 in the Gulf of Lions

Strong northern wind during winter 2012 induced strong heat losses both on the shelf and in the basin. From an atmospheric point of view, winter 2012 can be considered as exceptional over the North-Atlantic and Europe region with the predominance of the Atlantic Ridge (AR) atmospheric regime [4]. This regime, characterised by an anticyclonic anomaly in the North Atlantic and a cyclonic anomaly over the Baltic Sea, is particularly favourable to strong, cold and dry northerly winds over the Gulf of Lions enhancing air-sea heat fluxes. Most of the winters with large positive anomalies of the number of AR days generally correspond to years when thermo-haline anomalies indicative of intense shelf and open-sea convections were observed in the basin .

The production rate of dense water formed by open-sea convection during the winter 2012, estimated to ~1.1×10^6 m^3 s^{-1}, was about one order of magnitude larger than the mean flux of dense shelf water exported beyond 1000 m depth (~0.07×10^6 m^3 s^{-1}). In summer, the dense water of coastal origin created a distinct bottom layer up to a few hundreds of meters thick over the central part of the NW Mediterranean basin, which was overlaid by a layer of newly formed deep water produced by open-sea convection. The large increase of the volume of bottom water in the basin, with respect to that of the dense water exported from the shelf, implied a large entrainment of ambient waters during its propagation down the slope and in the basin, including newly formed deep water. This event significantly altered the thermohaline characteristics of the deep basin, hence contributing to amplify the Western Mediterranean Transition [5].

(#) F. Bourrin, M.N. Bouin, M. Beauverger, L. Beguery, A. Calafat, M. Canals, L. Coppola, D. Dausse, F. D'Ortenzio, J. Font, S. Heussner, S. Kunesch, D. Lefevre, H. Le Goff, J. Martín, L. Mortier, A. Palanques, P. Raimbault.

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GEOSTROPHIC CURRENTS AND KINETIC ENERGIES IN THE BLACK SEA

Milena Menna [1]* and Pierre M. Poulain [1]
[1] OGS - mmenna@ogs.trieste.it

Abstract
Drifter measurements and satellite altimetry data are combined to investigate the surface geostrophic circulation of the Black Sea in the period 1999-2009. Seasonal and interannual variability of currents and kinetic energy fields are described with particular attention to the mesoscale and sub-basin coastal eddies.

Keywords: Black Sea, Circulation, Surface waters

The upper-layer circulation of the Black Sea derives from a complex interaction among different and multi-scale processes. The main characteristics of the basin, sub-basin and mesoscale patterns are analysed using drifter data combined with satellite sea level anomalies.

The combination of these two independent datasets allows to remove the biases that arise from the irregular sampling of drifters and to enhance the accuracy of satellite data in the coastal areas. Regression models are used to remove the currents directly induced by the winds from the drifter velocities and to combine drifter and satellite altimetry data, following the methods of [1] and [2].

The combined dataset is used to estimate pseudo-Eulerian velocity statistics for different time periods and to describe the spatio-temporal variability of the surface circulation in different regions of the Black Sea. The pseudo-Eulerian statistics computed with the combined geostrophic currents are defined as 'unbiased' because they are less affected by the non-uniform drifter sampling ([1]; [2]).

The Rim Current is stronger in winter/spring (mean speeds of about 20-25 cm/s; maximum values larger than 40 cm/s along the Anatolia and Crimea coasts; Fig.1), forming a cyclonic loop that surrounds the Western and Eastern Gyres (speeds less than 15 cm/s). In summer/fall the Rim Current is weaker, with mean speeds of about 15-20 cm/s (Fig. 2).

The sub-basin Batumi Eddy is usually anticyclonic with a diameter of ~ 100 km and is located in the south-east corner of the basin (between 41°-42°N and 39.5°-42°E; Fig. 2). Periods of intense activity are observed in 2006 and 2008, when this structure shows higher dimensions (diameter of ~ 200 km) and speeds larger than 30 cm/s; occasional seasonal inversions of the circulation in the Batumi region, from anticyclonic to cyclonic pathway are observed in winter 2001-2002 and fall 2004, 2006 and 2008. The sub-basin Sevastopol Eddy, located off the western side of Crimea peninsula, has a less periodic nature with respect to the Batumi Eddy; it is usually observed in spring and summer with speeds of about 15-20 cm/s.

The interannual variability of mesoscale eddies located along the Anatolia, Caucasus and Crimea coasts is described in terms of kinetic energy of velocity residuals (KE). These eddies are permanent (Crimea, Sinop and Kizilirmak eddies), quasi-permanent (Bosphorus, Bartin, Sukhumi eddies) or intermittent (Caucasus, Sakarya, Kerch eddies) features and can interact and merge with each other showing values of KE between 200 cm^2/s^2 and 600 cm^2/s^2.

Results are compared to those in [3] based only on drifter data.

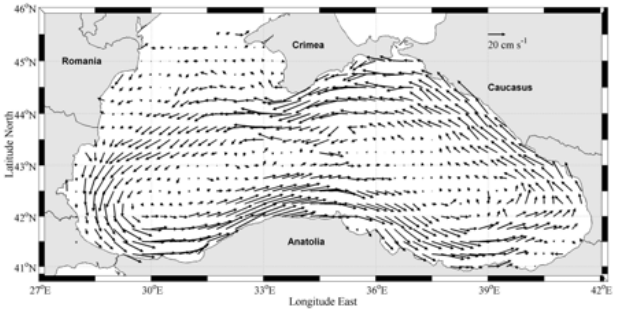

Fig. 1. Unbiased estimates of the surface geostrophic circulation in the Black Sea during winter/spring (December-May).

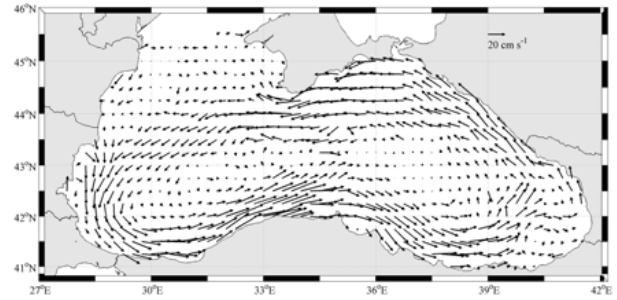

Fig. 2. Unbiased estimates of the surface geostrophic circulation in the Black Sea during summer/fall (June-November).

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VORTICITY DISTRIBUTION, VARIABILITY AND SOURCES IN THE BLACKSEA

Milena Menna [1]*, Gian L. Eusebi Borzelli [1], Pierre M. Poulain [1] and Giulio Notarstefano [1]
[1] OGS - mmenna@ogs.trieste.it

Abstract
The vorticity balance in the upper layer of the Black Sea is analyzed using several data sources (drifter data, Argo float CTD profiles, satellite sea level anomalies and ocean surface wind velocities) in order to estimate the respective contribution of each term in the vorticity equation. The tube stretching term induces positive vorticity in all the regions of the Black Sea and seems to play an important role in the vorticity balance of the basin.

Keywords: Black Sea, Wind, Circulation

Vorticity is an important descriptive feature of ocean dynamics, whose variations are related to the balance of external forcing, associated with wind-stress, and internal processes. Internal processes produce vorticity variations through adjustment of internal pressure gradients (i.e. baroclinic adjustment) and/or through variations in the depth of the tube flow (tube stretching).

The Black Sea is a typical marginal, semi-enclosed, dilution basin characterized by a stable stratification, a simple basin geometry and a smooth bottom topography; therefore, it is the ideal location to study the relative contribution of the different terms to the vorticity balance in the ocean and to analyze fundamental hydrodynamic interactions common to different areas of the World Ocean.

The large scale structure of the Black Sea upper-layer dynamic is predominantly cyclonic (i.e. positive vorticity) with some anticyclonic rotations (i.e. negative vorticity) located in the coastal areas of the north-west and south-east sectors. According to the previous studies cyclonic circulation of the basin is maintained by wind-stress curl ([4]), although input due to winds is not able to reproduce the observed vorticity levels ([3]).

This consideration opens the issue of analysing the relative contribution of the individual terms that concur to the vorticity balance of the basin. The Black Sea is divided in four sectors, following the spatial distribution of prevailing winds, and the mean values of the vorticity equation terms over the period 1999-2008 are estimated for each sector.

In Table 1 the main results of this analysis are presented. The vorticity of the geostrophic currents is positive in the North-East, South-West and South-East sectors and slightly negative in the North-West sector. The wind stress works against the current vorticity in all sectors except in the North-East sector, with values of order 10^{-13} s^{-2}. The tube stretching terms induce a positive vorticity in all the sectors of the Black Sea, with larger values in the North-East and South-West areas and magnitudes comparable with the wind stress terms. Also the baroclinic terms prompt the cyclonic vorticity of the upper layer circulation, but their contributions are three/two orders of magnitude smaller than the wind stress and the tube stretching terms.

These considerations suggest that the tube stretching terms plays an important role in the vorticity balance of the Black Sea. The predominant role of the tube stretching term is supported by significant yearly variations in the upper layer thickness of the basin, as estimated from the phase speed of the internal gravity waves, and by the increment of freshwater inflow in the basin during the period considered ([1]; [2]).

Table 1. Mean amplitude of geostrophic currents, relative vorticity field associated with surface circulation, wind vorticity input, tube stretching and baroclinic terms estimated in each sector of the Black Sea.

	NW	NE	SW	SE
Mean geostrophic currents (cm/s)	9.3	15.8	15.8	12.4
Relative vorticity (s^{-1})	-3e-8	1.7e-6	2.3e-6	9.1e-7
Wind vorticity term (s^{-2})	-0.7e-13	0.12e-13	-4.4e-13	-0.6e-13
Tube stretching term (s^{-2})	3e-12	5.2e-12	5.3e-12	4.1e-12
Baroclinic term (s^{-2})	0.88e-15	2.5e-15	2.5e-15	1.6e-15

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COASTAL CIRCULATION IN THE GULF OF LION, THE INFLUENCE OF MESOSCALE PROCESSES ON INTERREGIONAL EXCHANGES.

A. A. Petrenko [1]*, M. Kersalé [1], F. Nencioli [1], F. d'Ovidio [2], J. Gatti [3], A. M. Doglioli [1] and I. Dekeyser [1]
[1] Aix-Marseille Université, Université du Sud Toulon-Var, CNRS/INSU, IRD, MIO, UM 110, 13288, Marseille, Cedex 09, France - anne.petrenko@univ-amu.fr
[2] LOCEAN, IPSL, Paris
[3] SSIS Mer, IFREMER, Centre Bretagne, Plouzané, France

Abstract
The coastal circulation of the Gulf of Lion has been studied over a ten year period with *in situ*, remote sensing and numerical data. Intrusions, eddies, transient structures and frontal jets can strongly influence water fluxes in and out of the gulf. Transport fluxes as well as horizontal and vertical diffusivities are being assessed with data from varions *in situ* platforms. All these results bring new understanding on the influence of mesoscale processes on cross-shelf and interregional exchanges.

Keywords: Circulation experiments, Circulation models, Coastal processes, Gulf of Lyon, Mesoscale phenomena

The circulation of the Gulf of Lion (GoL), northwestern Mediterranean Sea, is complex and highly variable [1]. It is strongly influenced by the Northern Current, generally considered to constitute a dynamical barrier along the shelf. Exchanges between the GoL and offshore waters are thought to be induced by processes associated with the Northern Current [2,3]. This paper focuses on mesoscale processes at the eastern and western sides of the GoL.

The coastal circulation of the GoL has been studied over a ten year period with *in situ*, remote sensing and numerical data. The present study includes *in situ* data acquired during SARHYGOL (2000-2001), GOLTS (2002-2005) and LATEX (2007-2011). A realistic 3D numerical model Symphonie is run from 2001 to 2010 at high resolution (1 km) [4].

On the eastern side of the gulf, during specific conditions, a vein of the Northern Current (up to 1/3 of its measured flux) can intrude on the shelf. On the western side, wind conditions can affect whether the current enters or exits the gulf [5]. During stratified summer conditions, elliptical, shallow, anticyclonic eddies are observed north of Cape Creus [6,7], following northwestern wind events [8]. Two different generation processes can create them [9,7]. Generally eddies are associated with water retention; but transient structures can also detach from them and rapidly exit the gulf [7].

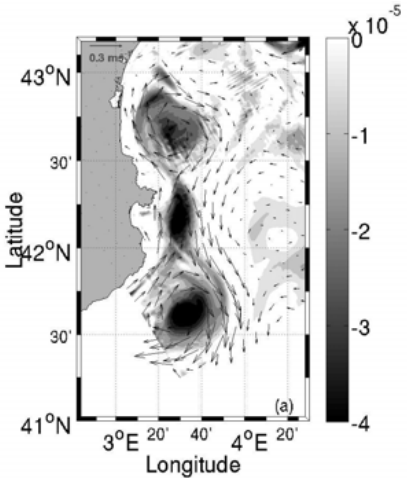

Fig. 1. Modeled relative vorticity [s^{-1}] and current velocity field at 20 m depth on September 3, 2010. From north to south: eddy in the western part of the Gulf of Lion, transient structure, eddy in the Catalan basin.

During the LATEX 2010 cruise, Lagrangian Coherent Structures derived from in situ data exhibit a frontal jet by which coastal waters escape from the GoL [10]. Transport fluxes are assessed, as well as horizontal diffusivities, using two approaches: i) combining stirring rates estimated from Lagrangian drifters with surface temperature gradients; ii) mapping a passive tracer's dispersion.

These mesocale processes (intrusions, eddies, transient structures, fronts) have an influence on interregional exchanges that can have strong impacts on biogeochemical and biological systems.

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PARTICULATE ORGANIC CARBON IN THE RHÔNE RIVER DELTA: ITS ORIGIN AND MINERALIZATION UNDER DIFFERENT FLOW REGIMES INCLUDING FLOOD AND STORMS

F. Toussaint [1], C. Rabouille [1]*, N. Tisnérat-Laborde [1], C. Cathalot [2], B. Lansard [1], B. Bombled [1], P. Kerhervé [3], R. Buscail [3], R. Verney [2] and I. Pairaud [4]

[1] Lab. des Sciences du Climat et de l'Environnement UMR CEA-CNRS-UVSQ et IPSL - rabouill@lsce.ipsl.fr

[2] IFREMER, Centre de Brest, Plouzané, France

[3] CEFREM, Univ Perpignan et CNRS, Perpignan, France

[4] IFREMER, La Seyne, France

Abstract

The Rhône River has a major influence on the biogeochemistry of the Gulf of Lions in the Western Mediterranean Sea. The biogeochemical fate of the Rhone River organic particles was investigated over several years within the Mermex programme using two approaches: (i) the tracking of organic particles origin using carbon paired isotopes ($^{13}C/^{14}C$) on density fractionated particles and (ii) the estimation of sediment mineralization using a fixed benthic station and a microprofiler with oxygen micro-electrodes at the Mesurho Buoy near the Rhône River mouth and the adjacent shelf. We combine spatial and temporal variability of organic matter mineralization in the Rhône River delta.

Keywords: Deltas, Sediments, Carbon, Gulf of Lyon

Coastal zones are a major compartment in System Earth and play a crucial role in the biogeochemical carbon cycle. Within coastal seas, deltas are critical interfaces between land and the coastal area, as they receive most of the particulate input from the rivers and act as buffer for organic matter (OM) fluxes. Due to the extreme variability of estuaries and deltas, on both spatial and temporal scales (hydrology, production-respiration balance, coastal circulation...), the balance between deposition, burial and consumption of particulate organic matter by the benthic ecosystem is largely unknown, making this zone the most uncertain in the marine realm with regards to CO_2 uptake or release[1]. Large quantities of terrestrial OM inputs can be buried or mineralized depending on their origin, reactivity and deposition pattern. At the same time, flood inputs with their extreme sedimentation rates or intense resuspension during storms with particulate matter recirculation may play a major role in defining the fate of particulate organic matter. We approached the question of the fate of Rhône River organic inputs in the delta using two distinct methodologies:

- we used a combination of two in situ techniques measuring oxygen microprofiles in the sediments and defining the diffusive oxygen uptake of the sediment, to estimate the biogeochemical transformations of particulate organic carbon in the Rhône delta and its spatial and temporal variability.
- we measured carbon isotopes ($D^{14}C$, $\delta^{13}C$) in the bulk and density-fractionated sediments in order to assess the origin and reactivity (residence time) of particulate organic carbon.

Oxygen micro-profiles and calculations of diffusive oxygen uptake (DOU) were obtained by two *in situ* techniques: i) an oxygen micro-profiler deployed on an array of stations[2] ii) a new benthic station equipped with oxygen micro-electrodes and environmental sensors. This new device performs daily measurements of oxygen microprofiles, with a potential for high frequency measurements (4 per day) during special events. Time series typically encompass periods of 1-3 months. The micro-profiler complemented these time series with a spatial coverage of oxygen demand at selected seasons. We deployed the benthic station at the Mesurho station near the Rhône River mouth together with the oxygen micro-profiler with the ultimate goal of studying the mineralisation of particulate organic matter delivered during floods. The first results obtained during low flow conditions and low turbidity showed that the measurement system is stable over time allowing temporal variation and floods to be recorded. During the turbidity events of spring 2012, oxygen demand rises by a factor of 3-4. We discuss the importance of flood events and resuspension in controlling the variability of DOU in this system.

Radiocarbon and $\delta^{13}C$ in four different fractions[3] of sediments obtained by density fractionation were measured in order to isolate different natures of OM. Previous studies based on bulk ^{14}C analysis of surface sediment of Rhône delta (Fig. 1) have shown an aging of the OM and a decreasing proportion of terrigenous OM with increasing distance off the river. The first results indicate that the signature in $\delta^{13}C_{OM}$ and $D^{14}C_{OM}$ of the density-fractionated material show a similar pattern as the bulk sediment, with a general aging of each density fraction and a progressive loss of the terrestrial signature with the distance offshore. This may be attributable to retention of terrestrial large and light particles (such as vegetal debris) in the prodelta (the nearshore region of the subaqueous delta), large mineralization of the labile fractions associated to aggregates or minerals and recirculation/mixing of continental shelf particles.

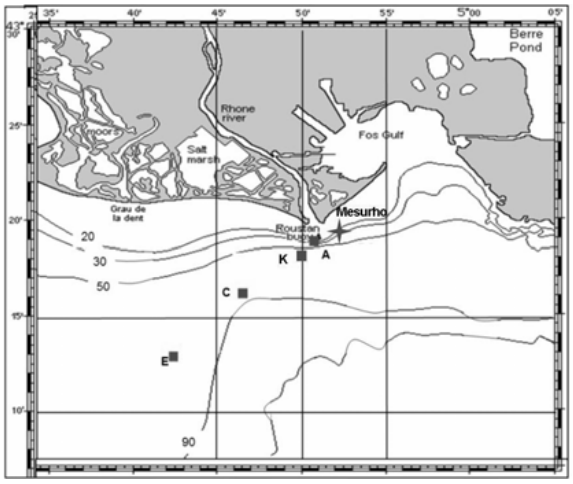

Fig. 1. Position of the station investigated. Squares are regular sampling stations during Mermex-River cruises and star is the the Mesurho station.

Overall, the two techniques used in this study indicate that retention and mineralization of terrestrial particles mostly occur in the prodelta with relative accumulation of refractory organic carbon in continental shelf sediments. Although the deltaic biogeochemical system is stable over time, disturbing events such as large resuspension events or floods[4] have an internal dynamics that can profoundly affect the fate of organic matter in this region.

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MODELING THE TURKISH STRAITS SYSTEM: A GRAND CHALLENGE FOR MEDITERRANEAN AND BLACK SEAS CLIMATE STUDIES - BOSPHORUS AND DARDANELLES STRAITS COUPLING

Gianmaria Sannino [1]*, Adil Sözer [2] and Emin Özsoy [2]
[1] ENEA - UTMEA.CLIM - gianmaria.sannino@enea.it
[2] Institute of Marine Sciences, Physical Oceanography, Mersin, Turkey

Abstract
An all-time modeling challenge aims to establish a sound understanding of the high energy environment of the Turkish Straits System, relating to inter-basin water and material transports and their influence on the sensitive ecosystems of the adjacent seas. As a first step in this direction, well resolved, high level, physically representative predictive models of the Bosphorus Strait exchange flow hydrodynamics are developed, adequately representing its complex topography, hydraulic controls, dissipative hydraulic jumps, mixing and turbulence mechanisms, with the application of appropriate basin boundary and initial conditions and judiciously selected numerical and physical model options. Moreover preliminary results from an ambitious multi-scale coastal ocean model representing the entire Turkish Straits System will be discussed.

Keywords: Circulation models, Bosphorus Strait, Dardanelles, Marmara Sea

The scientific questions on the role of the Turkish Straits System (hereinafter TSS) in coupling the adjacent basins of the Mediterranean and Black Seas with highly contrasting properties, in a region of high climatic variability and materials transport depending critically on the cycle of water can only be answered by model predictions of the processes that determine the integral properties of the coupled sub-systems. This can only be achieved if the entire TSS is modeled as a finely resolved integral system that accounts for the high contrasts in seawater properties, steep topography, hydraulic controls, fine and meso-scale turbulence (Özsoy et al. 2001), nonlinear and non-hydrostatic effects (Ilicak et al. 2009), thermodynamic states and an active free-surface in the fullest extent, based on well represented fluid dynamical principles. As a first step to approach coupled modeling of the TSS, a well resolved, physically representative predictive model is developed of the Bosphorus Strait hydrodynamics, including the effects of complex topography, hydraulic controls, turbulent mixing with the application of appropriate basin boundary and initial conditions. The results for idealized and real geometry model configurations provide a deeper understanding of the establishment of the maximum exchange regime of inter-basin transports, and comparisons with a series of detailed observations provides an enlightened view on the climatic and short-term variability of the system. Asymmetrical and nonlinear behavior of the strait dynamics is observed as a result of the various controls and turbulent dissipation. Results obtained independently from ROMS and MITgcm models for almost identical configurations for the Bosphorus Strait indicate similar satisfactory performance in predicting the basic elements of the flows. The possible impacts of these essential features of the TSS system on the mixing and transport processes and coupling of regional seas are discussed.

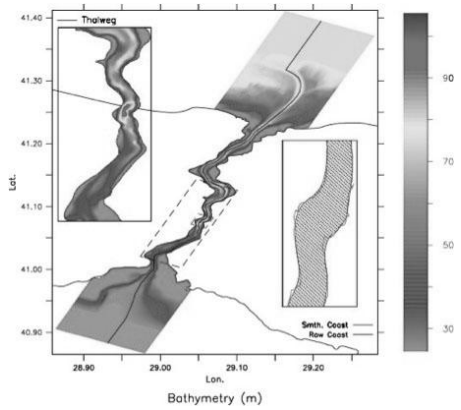

Fig. 1. Bosphorus model grid and bathymetry.

As a second step in modeling the TSS, an ultra high-resolution, physical representative model is developed for the entire system: Dardanelles-Marmara Sea-Bosphorus.
The extreme environment has been represented as a whole and with the full details of its highly contrasting properties. The huge computing resources needed to run such an ambitious model have been provided by the EU initiative PRACE (Partnership for Advanced Computing in Europe). The numerical model used is based on the non-hydrostatic MITgcm. The MITgcm solves the Boussinesq form of the Navier-Stokes equations for an incompressible fluid fully non-hydrostatic with a spatial finite-volume discretization on a curvilinear computational grid. Moreover it has been formulated with an implicit free-surface, and partial step topography. A non-uniform curvilinear orthogonal grid covers the entire model domain. The maximum horizontal resolution (about 50 m) is reached in the Bosporus and Dardanelles Straits. To adequately resolve the complex hydraulic dynamics of TSS, the model grid is made by 72 vertical z-levels, and the formulation adopted is non-hydrostatic (Sanchez-Garrido et al. 2011). It should be noted that such a model configuration represents a novelty respect to any other model implemented in the same region in the past. Preliminary results obtained from a climatological initialized configuration indicate satisfactory performance in reproducing the main features of the flow exchange between the Aegean Sea and Black Sea. Results are discussed in terms of mixing, hydraulic control and transport processes.

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ATTENUATION OF UVR AND PAR IN IN SURFACE COASTAL WATERS OF THE NORTHWESTERN MEDITERRANEAN SEA DURING MERMEX PROJECT

RIchard Sempéré [1]*, Julien Para [1], Bruno Charrière [1] and Marc Tedetti [1]
[1] MIO, Marseille - richard.sempere@univ-amu.fr

Abstract

Radiometric and chromophoric dissolved organic matter (CDOM) measurements were performed monthly between November 2007 and December 2008 at the SOFCOM coastal station in the Northwestern Mediterranean Sea during MERMEX project. The values indicated that the waters were highly transparent throughout the year. The relationships between CDOM absorption and Kd in this oligotrophic system suggested that CDOM contributed to UVR attenuation in the UVA domain, but also played a significant role in PAR attenuation.

Keywords: Organic matter, Ocean colours, North-Western Mediterranean

Due to its weak cloud cover, the Mediterranean atmosphere is characterized by higher solar radiation levels than those found at similar latitudes in the Atlantic Ocean (Mermex group, 2011 and references therein. The Mediterranean Sea, which is known as a low chlorophyll low nutrient (LNLC) oligotrophic system, is characterized by a blue color that does not extend as deep as predicted by its Chlorophyll content alone. This discrepancy between ocean color and Chlorophyll concentration was suggested to be attributed to either an "excessive" level of CDOM (Morel and Gentili, 2009) or to the presence of Saharan dust in the upper layer may also cause this discrepancy (Claustre et al; 2002). Solar radiation strongly influences biogeochemical cycles and ecosystem functions in the ocean. Photosynthetically available radiation (PAR: 400-700 nm) provides energy for photosynthesis and induces primary production, which all marine food webs ultimately depend on. In contrast, energetic ultraviolet radiation (UVR: 280-400 nm) has numerous deleterious effects on living organisms that inhibit photosynthetic activity and damage DNA. Here we report that surface irradiance strongly varied with season (particularly for UVR-B) and was from 0.14 to 4.6, 12 to 59 and 30 to 159 $\mu W\ cm^{-2}$ for UVR-B (305 nm), UVR-A (340 nm) and PAR (490 nm), respectively. Examination of the UVR-B/UVR-A, UVR-B/PAR and UVR-A/PAR surface irradiance ratios indicated that UVR-A and PAR were similar and evolved temporally. In contrast, the UVR-B increased 7 to 8 fold more than its UVR-A and PAR counterparts during the summer. The strong temporal variability of UVR-B may be explained by its higher dependence on direct/diffuse irradiance ratios than UVR-A and PAR. The diffuse attenuation coefficients for downward irradiance [$K_d(\lambda)$] of UVR-B, UVR-A and PAR were from 0.21 to 0.48, 0.16 to 0.27 and from 0.04 to 0.09 m^{-1}, respectively. These values indicated that the waters were highly transparent throughout the year. The relationships between CDOM absorption and $K_d(\lambda)$ in this oligotrophic system suggested that CDOM contributed to UVR attenuation in the UVA domain, but also played a significant role in PAR attenuation.

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TIDAL VARIABILITY IN THE STRAIT OF OTRANTO

Laura Ursella [1]*, Vedrana Kovacevic [1] and Miroslav Gacic [1]
[1] Ist. Naz. di Oceanografia e di Geofisica Sperim. - lursella@ogs.trieste.it

Abstract
Various current data, collected in the Strait of Otranto during the period 1994-2007, have been analysed with the aim of describing the characteristics of the tidal motions and their contribution to the total flow variance.

Keywords: Currents, Tides, Otranto Strait, Waves

The principal tidal constituents in the area were the semi-diurnal (M2) and the diurnal (K1), with the latter one predominant. The total flow was, in general, more energetic along the flanks than in the middle of the Strait. Specifically, it was most energetic over the western shelf and in the upper layer along the eastern flank. In spite of the generally low velocities (a few cm/s) of the principal tidal constituents, the tidal variance has a pattern similar to that of the total flow variance, that is, it was large over the western shelf and low in the middle. The proportion of non-tidal (comprising the inertial and sub-inertial low-frequency bands) to tidal flow variances was quite variable in both time and space. The contribution of the low-frequency motions predominated over the tidal and inertial ones in the eastern portion of the strait during the major part of the year, particularly in the upper and intermediate layers. In the deep, near-bottom, layer the variance was evenly distributed between the low frequency, diurnal and semi-diurnal bands. A prominent exception was observed near the western shelf break during the summer season when the contribution of the tidal signal alone to the total variance reached 77 %. This high contribution was mainly due to the intensification of the diurnal signal at that location in the proximity of both the surface and bottom layers (velocities of about 10 cm/s) (Fig.1). The largest amplitude of the diurnal constituent appeared in the deepest layer and this is explained in terms of the first baroclinic mode pattern.

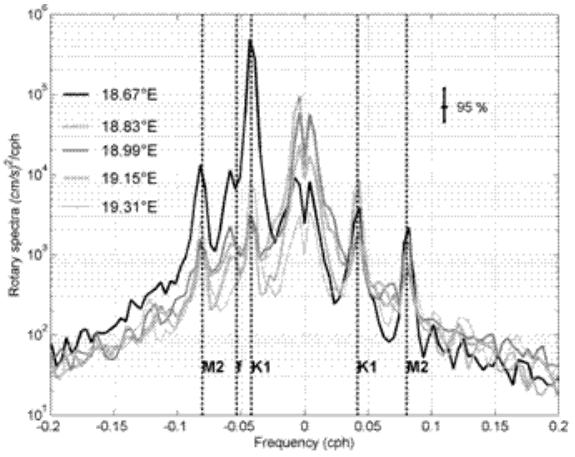

Fig. 1. Rotary spectral analysis in the near bottom layer along the Otranto section (39.85°N) for the summer period from OTRANTO/OGEX project. The 95% confidence level is indicated.

Beckenbach and Terril (2008) [1], studied a similar phenomena and explained this intensification in terms of a baroclinic internal tide generated through the interaction of a barotropic tide with topography. In these circumstances, subinertial internal waves can exist beyond the critical latitude and explain a consistent part of the variance. Orlic et al. (2011) [2] and Mihanovic et al. (2009) [3] found that summertime stratification occasionally generates internal coastal waves that travel daily around an island in the southern Adriatic Sea, creating the conditions for resonant excitation of the diurnal frequency by sea breeze and/or diurnal tides. Local wind obtained from ECMWF (European Centre for Medium-range Weather Forecast) and sea level data from the tide gauge located in Otranto (40.1471°N - Rete Mareografica Nazionale, http://www.mareografico.it/)were thus analysed and compared with the flow to find the possible origin of this diurnal intensification. No evidence of significant diurnal signal in wind and sea level were found (Fig. 2) Having excluded the sea-breeze impact on the intensification of the diurnal tidal signal, the most likely cause remains the generation of the topographically trapped internal waves and the diurnal resonance in the tidal response. These waves were sometimes generated by the barotropic tidal signal in the presence of summer stratification. The presence of the internal diurnal waves was confirmed by the phase shift between the diurnal signal in the coastal sea level and in the currents at the station over the shelf break. However, these waves were not continuously generated (Fig. 2), and did not generate amplification on the on-shore side of the shelf break in the similar stratification conditions. This indicates that the topographic slope as well as the density stratification is the necessary element for the resonance. This phenomenon may stimulate the diapycnal mixing during the stratified season and enhance ventilation of the near-bottom layers.

Acknowledgement We greatly acknowledge the technical and scientific staffs of the OGS and of the former establishment SACLANTCEN of the Centre for Maritime Research and Experimentation (CMRE), Italy, as well as of the Hellenic Centre for Marine Research, Greece.

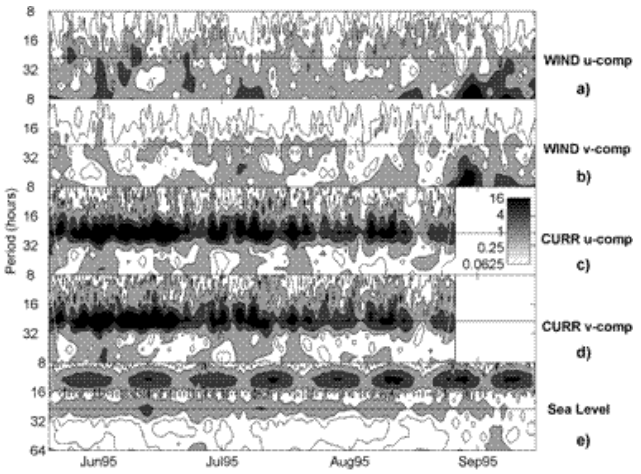

Fig. 2. Wavelet spectrum as a function of time and scale (period) for wind velocity components (a and b) and bottom current components (c and d) at the shelf break, and sea level at Otranto (e) during summer period. Diurnal scale (24 hours) is indicated by a black line.

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STRANDING OF *NYCTIPHANES COUCHII* (BELL, 1853) (CRUSTACEA, EUPHAUSIACEA) IN THE NORTH-WESTERN SICILIAN COAST (CENTRAL MEDITERRANEAN)

S. Vitale [1]*, D. Massi [1], A. Titone [1], S. Gancitano [1], F. Bignami [2] and F. Fiorentino [1]
[1] Consiglio Nazionale delle Ricerche, Istituto per l'Ambiente Marino Costiero (CNR-IAMC), Detached Unit of Mazara del Vallo, Italy - sergio.vitale@cnr.it
[2] Consiglio Nazionale delle Ricerche, Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Roma, Italy

Abstract
One massive stranding of Euphausiid *Nyctiphanes couchii* was recorded along the north-western Sicilian coast of "S. Vito Lo Capo" between March 17th 2013 night and March 18th morning. Random samples were collected in order to obtain the size structure of the specimens. Considering the knowledge on the species biology and meteo-marine conditions, it has been suggested that the unusual phenomenon is due to intense upwellings in the area.

Keywords: Crustacea, Water transport, Tyrrhenian Sea

Nyctiphanes couchii (Bell, 1853) is a neritic species common in the shelf-seas of the NE Atlantic, W Mediterranean, but also in the Adriatic and Aegean Sea [1]. It provides a large fraction of plankton biomass throughout the year, constituting an important key species in the food webs for several fishes and cetaceans [2,3]. Adults total length (TL) ranging between 12 and 17 mm with an observed length at first maturity of about 12 mm. *N. couchii* breeding at age of one year, during spring and summer, with females that are able to carry about 50 eggs attached to the thoracic legs [4]. The species makes diel migrations to the surface waters at night [3], but the rate, time and amplitude of these migration are essentially unknown in the investigated area. A massive beaching of this euphausiids occurred in "S. Vito Lo Capo", a shallow bay located in the north-western Sicilian coast, between March 17th 2013 night and March 18th morning (Fig. 1).

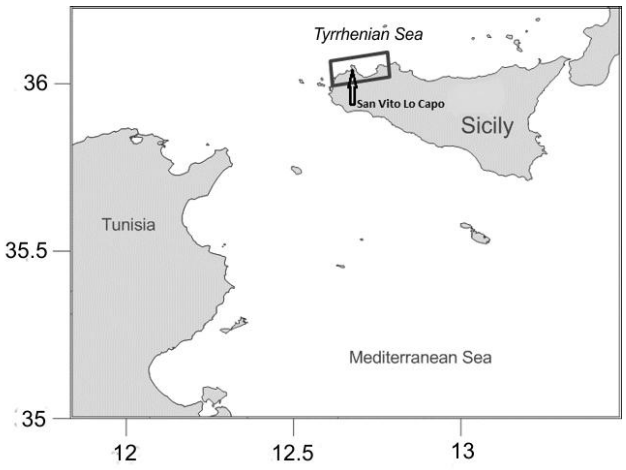

Fig. 1. Position of "S. Vito Lo Capo" bay, located along the north-western Sicilian coast.

The local Office of Coast Guard informed our Institute about the stranding, highlighting a very large patch of pink color (reporting "neonatal crustaceans") along 1 km of beach (Fig. 2). An inspection of our researchers identified the species *N. couchii* along the beach as well as the pools on rocky shores. Random samples of the specimens were collected in order to obtain a length frequency distribution (LFD). Each individual of a random sub-sample was photographed by digital camera connected with a stereomicroscope with a magnification of 8X (Leica DC 200, software Leica IM 50) and measured as carapace length (CL) (software Image Pro Plus Vers. 4.1. Media Cybernetics). Weather conditions and satellite images were verified in the three days before the stranding.

A total of 509 specimens were measured with CLs ranging between 2.2 and 5.4 mm. The shape of the distribution was unimodal with a peak of frequencies at 4 mm CL, although a sign of a component of smaller individuals could be recognized (Fig. 2).

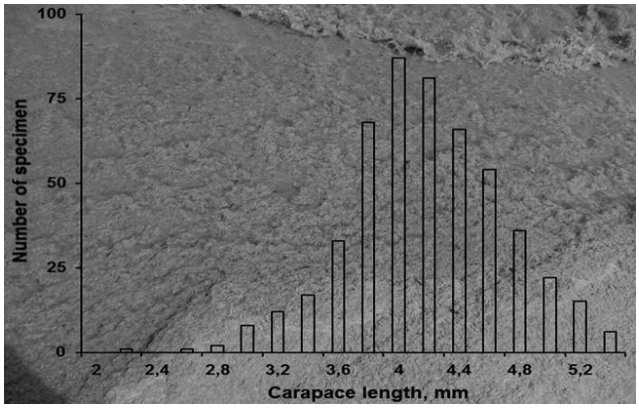

Fig. 2. Length Frequency Distribution of stranded Nyctiphanes couchii, overlapped to the photo of straddling specimens on the shoreline.

Although the cloudy sky did not allow to analyzed the satellite image of sea surface, the strong wind from SE, blowing at about 70 km/h, favorable to upwelling in the area, followed by rough sea from MW, supports the hypothesis that *N. couchii*, with a poor swimming ability, was stranded as consequence of oceanographic adverse condition. The stranding of small shrimps was repeatedly reported along the coasts of the "Maddalena Archipelagos" (Sardinia, central Tyrrhenian sea), being the more recent occurred on March 12th 2013 [5]; however, according to the information collected by fishermen, the massive stranding of this species was recorded for the first time in the S. Vito Lo Capo Bay.

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Session

Mesoscale variability

Modérateur : **Sana Ben Ismail**

THERMOHALINE STRUCTURE AND COLD INTERMEDIATE LAYER PROPERTIES OF THE BLACK SEA AS INFERRED FROM ARGO FLOATS

Anil Akpinar [1]*, Bettina Fach [1] and Temel Oguz [1]
[1] Institute of Marine Sciences,Middle East Technical University - anil@ims.metu.edu.tr

Abstract
The thermohaline structure of the oxygen-rich cold intermediate layer (CIL) with temperatures below 8ºC in the Black Sea is of great importance due to the oxygen deficiency of the water column below the biologically productive euphotic zone. The long-term data compiled from the Argo float profiles document temporal and spatial variability of its distribution and the likely mechanisms leading to its formation.

Keywords: Hydrography, Black Sea, Water convection, Temperature, Vertical profile

Data from seven ARGO profiling floats operating in the Black Sea between 2002-2009 have been used in this study. Three of these floats were located at the parking depth of 1550m, and the rest at 200m, 500m, 750m and 1000m depths. All of them collected vertical profiles of temperature and salinity from 1550m depth to the surface once a week. Both the CTD data and position data have been used to examine temporal changes in the horizontal current velocity [1] and temperature and salinity at the floats parking depths. Sea surface height anomaly data from AVISO have been used as supplementary data set in order to identify the mesoscale features provided by the float data. In this work the CIL thickness and lower boundaries are considered as an indicator for the intensity of ventilation of subsurface waters in the Black Sea (Table.1-Fig.1). A thick CIL is generally observed in March, but there is no seasonal cycle or a specific parameter affecting CIL thickness. The results suggest that CIL is thicker and deeper in anticyclones whereas it is thinner and is at shallower depths in cyclones. Simultaneous observations in cyclonic and anticyclonic patterns reveal an 80m difference in the lower boundary of CIL and a 60m difference in CIL thickness. Among the average thickness values obtained from the floats, the smallest value is ~29m due to its location in the cyclonic Western Gyre. CIL is observed as an isothermal layer formed when the cold water formation at the surface merges with the already existing old CIL, prefarably in the cyclones during February-March. Its formation in the cyclonic gyres emphasizes importance of the uplift of the pycnocline and the upwelling of the old CIL to the surface rather than generation of cold water as a result of convection only. Cold water formation seems to be affected by mesoscale processes as well.

Tab. 1. Average depth, temperature, salinity, sigma-theta and thickness of CIL for each float

Float no.	Mean Depth (m)	Mean Temperature (°C)	Mean Salinity (psu)	Mean Sigma-theta (kg/m3)	Average Thickness (m)
BS0587	61.10	7.46	18.62	14.50	44.66
BS0631	66.62	7.42	18.62	14.50	54.61
BS0634	62.24	7.47	18.60	14.48	46.63
BS1325	73.86	7.57	18.83	14.65	43.56
BS1550	59.46	7.54	18.75	14.59	47.16
BS2206	51.24	7.65	18.84	14.65	29.37
BS2619	70.07	7.67	18.64	14.49	42.09
Overall					**44.16**

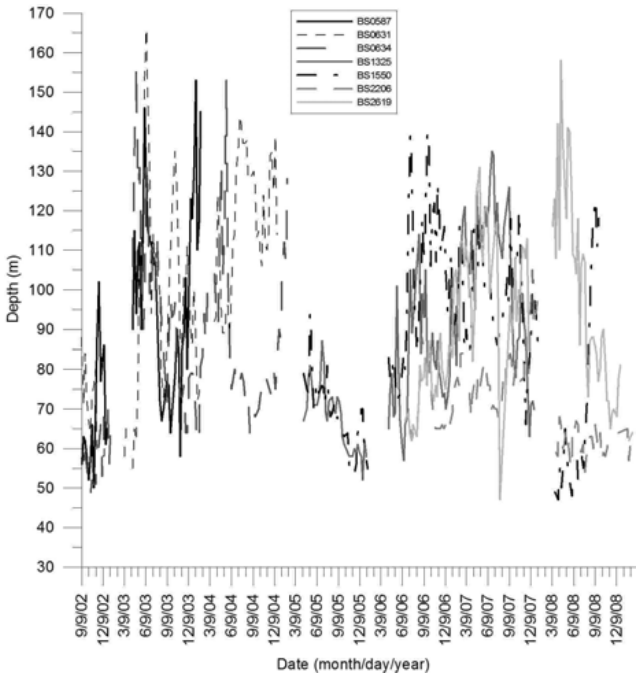

Fig. 1. Distribution of CIL lower boundary over time. Each line represents data from a different float

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NEW WATER MASSES AT INTERMEDIATE DEPTHS ON THE TUNISIAN SIDE OF THE SICILY CHANNEL

S. Ben Ismail [1]*, K. Béranger [2], C. Sammari [1], M. Brahim [1] and G. Gasparini [3]
[1] INSTM 28 rue 2 mars 1934 - sana.benismail@instm.rnrt.tn
[2] ENSTA-ParisTech
[3] CNR/ISMAR La Spezia, Italy

Abstract
This study used data collected during six hydrographic cruises in the western half of the Cap Bon – Mazara del Vallo section during 2003. The analyses of transects reveals the presence of Western Intermediate Water (WIW) in April and Ionian Water (IW) in March-April on the Tunisian side of the channel in a transitional layer between Atlantic Water (AW) and Levantine Intermediate Water (LIW). The conclusions on seasonal and mesoscale variability are confirmed by a high resolution numerical simulation.

Keywords: Mesoscale phenomena, Circulation models, Sicily Channel, Vertical profile

Introduction

The Sicily Channel (SC) is located at the junction between the eastern and the western Mediterranean. At depth the SC is composed of two narrow passages, the Tunisian passage to the west and the Sicilian passage to the east and are separated by sub-marine mountains. The SC large scale circulation can be schematized as a two-layer system composed of a surface layer of fresher water flowing eastward (mainly composed of AW) and a salty bottom layer (mainly composed of LIW) flowing westward [1]. Our study highlights the presence of transitional waters intermittently observed between AW and LIW, in the Tunisian passage. There are the WIW and the IW. The WIW forms during winter in the northwestern Mediterranean due to the surface cooling of AW and has been recorded in the Algerian Basin by [2], flowing eastwards below the AW in the Algerian Current through the Channel of Sardinia. The WIW is characterized by a relative minimum of temperature. The IW flows above the LIW towards the Tyrrhenian Sea, and is characterized by a relative maximum of temperature close to the Sicilian shelf [3]. The detailed pathways of these water masses is not well documented in the central Mediterranean. Then to assess the mesoscale and seasonal variability of these water masses in this area, we compare high sampling *in situ* data with a high resolution numerical simulation.

Data and model

We used results from several transects made in 2003 with a high sampling (5 km) in the Tunisian passage in 2003. The data highlight transitional waters between AW and LIW with intermittent signatures [4]. The measurements are compared to results from a high resolution ocean simulation MED16 [5] using OPA model in a regional configuration forced by ECMWF atmospheric fields from 1998 to 2008.

Results

According to the in situ data, a transitional layer is observed at the interface of AW and LIW and evidences specific patterns, mainly characterized by temperature anomalies both horizontally and vertically. Along the April transect in the Tunisian passage, at about 170 m depth, a temperature minimum (WIW) is observed near Tunisia while a temperature maximum (IW) is found in the eastern part of the section (Fig. 1a). The WIW is then observed in May 2003 between 100 and 200 m depths (T=13.85 °C, S=38.20, at 175 m) whereas the upper AW is warmer by about 0.5°C. The WIW core is delimited by the isotherm T=14°C, corresponding to an extent of about 14 km from the coast. A strong signature of IW is observed during March and April 2003 (Fig. 1a) between 100 and 200 m depths (T=14.8°C, S=38.5, at 150m depth**)** whereas a lower one is noticed during the second half of the year.

In the model (Fig. 1b), the two water masses are well identified in April 2003. But temperature values in the intermediate layer are higher than in *in situ* data. The IW is also particularly well identified in March and the WIW is located very close to the Tunisian shelf especially in April, May and June. These characteristics and the two-layer schema are sometimes changed due to anticyclonic mesoscale eddies which can occupied the center of the SC [4].

Conclusion

This study highlights the presence of new water masses in the Tunisian passage, the western part of the Sicily Channel. The observations show, for the first time, the presence of WIW in the SC and confirm the path of IW initially recognized by [3]. The comparison with the model outputs has revealed local recirculation occurring in spring and summer on the Tunisian side of the SC, that could explain a weakening in the ATC.

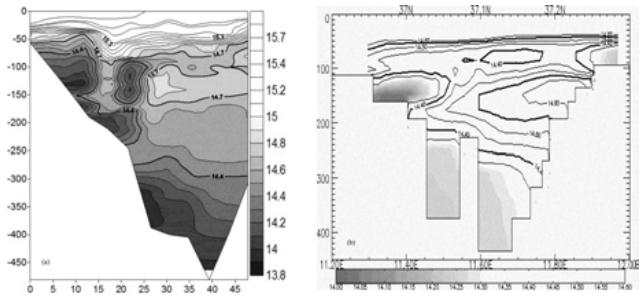

Fig. 1. Vertical section of temperature in April 2003: (a) observations in the Tunisian Channel, (b) model in the Channel of Sicily (with the Tunisian Channel on the left of the figure).

Acknowledgments - Hydrographic data was conducted on board INSTM research vessel N/o Hannibal. Modeling work was supported by Mercator Ocean. Computations were made at IDRIS from the CNRS (project i010227).

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NEW INSIGHTS ON THE IERAPETRA EDDY GENERATION

Karine Béranger [1]*, Bahjat Alhammoud [1], Isabelle Taupier-Letage [2] and Chantal Claud [3]
[1] ENSTA-ParisTech - karine.beranger@ensta-paristech.fr
[2] MIO
[3] LMD

Abstract

The paper present results of a 23-year high resolution simulation of the Mediterranean simulation obtained by running the OPA rigid-lid model forced by ECMWF fields several times. The detailed study of a particular eddy highlights the main simultaneous roles played by the Cretan outflow through the Kassos Strait and by the Asia Minor Current instabilities.

Keywords: Circulation models, Mesoscale phenomena, Cretan Arc, Levantine Basin

Introduction - The Ierapetra eddy (IE) is a well-known feature of the circulation in the Levantine basin, the most eastern part of the Mediterranean Sea, which was first pointed out by the analysis of POEM observations, as an anticyclonic structure located south-east of Crete. This pattern has then been called by [1] as the Ierapetra anticyclone. Several hypotheses for the IE generation have been proposed concerning the roles of the wind [2], of the Mid Mediterranean Jet variations [1] and of the Cretan outflow [3]. But some questions remain open concerning the main processes triggering the IE. In this paper, we focus on the generation process of IE, using a high resolution ocean simulation MED16 [4] forced by ECMWF atmospheric fields, repeated several times. In particular, the strategy of the simulation allows to investigate two different ocean circulations forced by the same winds.

Results - We compare the model outputs for years corresponding to the ECMWF atmospheric forcing of year 2000. The generation of IE is modeled in August of year 20 whereas no generation of IE is noticed during year 11. The circulation features are then checked before the beginning of the generation for this particular sets of results, according to maps of the circulation at 56 m depth. During year 20, the Asia Minor Current (AMC) meanders regularly and small anticyclonic vortices appear embedded in the current. These anticyclonic eddies of about 50 km diameter and of thin vertical shape have a short life-time and are often mixed again with the AMC several kilometers forwards. In July, the AMC highlights a large meander and a small anticyclonic circulation is captured at the south-east corner of Crete. The anticyclonic circulation is sandwiched between Crete and Kassos islands. In August (Fig. 1a), the previous small anticyclonic circulation is still centered at the south-east corner of Crete and, at the same time, subsurface saline Cretan waters outflow through the Kassos Strait. The flow of Cretan waters is deviated around the northeast rim of the anticyclonic circulation in an anticyclonic pathway. It consequences an enhancement of negative vorticity inside the anticyclonic circulation. The IE is now well defined with a strong vertical shape and a core of saline waters at subsurface.

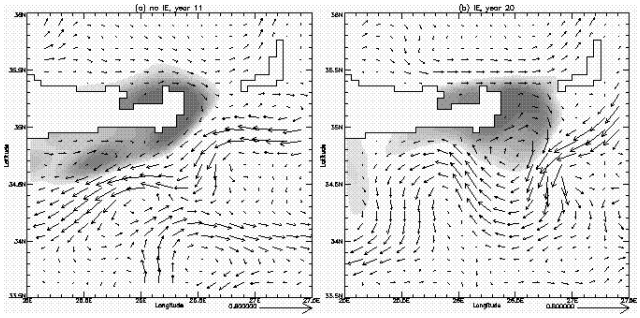

Fig. 1. Currents at 56 m depth in August (a) of year 11 and (b) 20 of the simulation. Salinities higher than 39 are shaded in grey. One vector over two is plotted.

During year 11, the Asia Minor Current follows closely the northern coast and meanders are few and of low amplitude. The Cretan Water outflow remains close to the Cretan shelf. No anticyclonic eddy is noticed close to the Kassos Strait (Fig. 1b).

Conclusion - We argue that the condition to have the generation of an Ierapetra eddy in the model needs two ingredients at the same time: (i) the presence of an anticyclonic vortices generated and bring by the Asia Minor Current between Crete and Kassos islands, and, (ii) the outflow of saline Cretan waters winding round the initial anticyclonic eddy. This result has been confirmed by the analysis of other eddies in the simulation. Thus, the wind role, in the model, is not a sufficient ingredient to generate an Ierapetra eddy.

Acknowledgments - Modeling work was supported by SHOM and Mercator Ocean. Atmospheric forcing was made available by the ECMWF. Computations were made at IDRIS from the CNRS (project i010227).

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A PILOT EXPERIMENT ON THE TEMPORAL VARIABILITY OF THE NEPHELOID AND DYNAMICAL STRUCTURES IN THE BESOS CANYON (NW MEDITERRANEAN SEA)

M. Emelianov [1]*, J. Font [1], P. Puig [1], J. Martín [1], E. García Ladona [1], J. Salat [1], A. Ostrovskii [2], A. Zatsepin [2], V. Kremenetskiy [2], V. Soloviev [2], A. Tsibulskiy [2] and D. Shvoev [2]
[1] Institut de Ciencies del Mar CSIC - mikhail@icm.csic.es
[2] P. P. Shirshov Institute of Oceanology, Russian Academy of Sciences

Abstract
A pilot experiment aiming at investigating the small scale dynamics and variability of the seawater fine thermohaline structure, the processes of vertical exchange of momentum and mass, and mechanisms of the nepheloid layer formation in the Besòs submarine canyon, situated in the continental slope close to Barcelona, was carried out by using the prototype moored profiler "Aqualog".

Keywords: Instruments and techniques, North-Western Mediterranean

Oceanographic conditions in the NW Mediterranean are characterized by high mesoscale variability determined by the dynamics of the alongslope Northern current [1]. A high variability of the baroclinic front associated with this current, the intense lateral exchange between different water masses, the interaction between the current and irregular bottom relief and mesoscale eddies generated by the instability of the current, determine the complicated spatial distribution of water masses [2]. In recent years important anomalies were observed in the thermohaline characteristics and dynamics of the water masses in the Western Mediterranean [3, 4]. A detailed study of the short period variability helps clarifying the formation mechanisms of the observed anomalies and to better understanding the mechanisms of nepheloide layering observed in submarine canyons [5].

A mooring was deployed at the depth of 808 m at the canyon axis on March 23, 2012. The mooring system included two AANDERAA RCM current meters with Seapoint turbidimeters at fixed depths: one below the subsurface floatation at the depth of 42 m and the other one at 4-5 m above the bottom anchor. An "Aqualog" profiler (prototype from P.P. Shirshov Institute) moved down and up at 0.17-0.18 m/s along the mooring line within the depth range of 60-792 m. The profiling cycles were preprogrammed to start every 4 hours from 16:00 on March 23. The profiler carried one Nortek Aquadopp acoustic Doppler current meter, one SBE 52MP CTD probe and one Seapoint turbidimeter. When the carrier was moving, profiles of pressure, conductivity, temperature and turbidity were measured with a vertical resolution of 0.17-0.18 m, while the vertical resolution of the current velocity and the acoustic backscatter was about 1.05 m. The profiler operated until 14:00 of April 3. The total profiled length was about 92 km.

Comparison of the current meter data obtained by the profiler at the topmost profiling depth with those of the upper RCM showed very good correlation both for the current speed and direction. The current speed usually differed by less than 0.02 m/s within the subsurface layer at 40-80 m depth. The current structure of the bottom layer was much more complex. No evidence of the bottom Ekman spiral was observed; at 790-792 m and 803-804 m, the currents were usually directed coherently either northwestward or southeastward. The upper layer dynamics was dominated by inertial oscillations. In the pycnocline at 300-600 m depth, interpycnocline eddies were observed at a time scale of about 2 days. The nepheloid structure became evident in the acoustic backscatter profiles. It should be noted that the vertical distribution of the acoustic backscatter was in agreement with the turbidity profile, being at minimum in the cold intermediate layer. The lower boundary of this layer underwent huge oscillations with amplitude of up to 250 m (Fig.1,2). The amount of the sound backscatterers suspended in the water was usually largest at 400-600 m. In one occasion the eddy carried a large amount of particulate matter from the near-surface layer throughout the deep sea. Several times the amount of the suspended sediments increased for 12 h or so at 600-800 m depth.

The obtained results allow to better understanding the nepheloid layers forming processes in the submarine canyons of the NW Mediterranean.

This joint CSIC-RFBR research project was funded by CSIC grant 2010RU0063 and Russian Fund for Basic Research grant 11-05-93982-INIS.

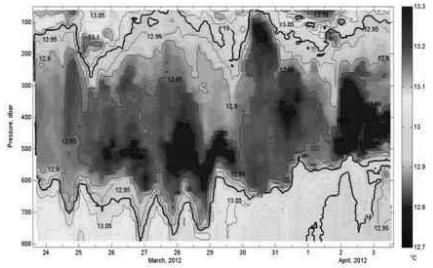

Fig. 1. Temporal temperature variability

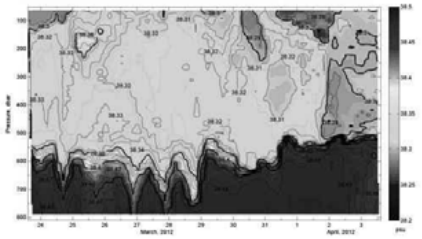

Fig. 2. Temporal salinity variability

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THE LIGURIAN DISPERSION EXPERIMENT 2010 (LIDEX10): SATELLITE, DRIFTER AND GLIDER PRELIMINARY RESULTS.

Elena Mauri [1]*, Riccardo Gerin [1], Isaac Mancero [1] and Pierre-Marie Poulain [1]
[1] OGS, Borgo Grotta Gigante, 42/c, Sgonico, Trieste, Italy - emauri@inogs.it

Abstract
Surface drifters and a glider with physical and biogeochemical sensors were deployed in the southern Ligurian Sea in July 2010 to study the surface dispersion and explore the mesoscale and submesocale 3D features associated with it. Following the drifters, the glider sampled the southern Ligurian Sea and the Corsica Channel. The drifter and glider data were analysed in concert with MODIS surface temperature and chlorophyll concentration satellite maps. The sampled coastal and open sea areas showed different behaviours. The shallow area near the Italian coast was characterised by an offshore-flowing filament evolving quite fast while the open sea, close to the Corsica coast, was dominated by mesoscale gyres with longer time evolution.

Keywords: Ligurian Sea, Mesoscale phenomena, Ocean colours, Hydrography

Introduction
During the LIgurian Dispersion EXperiment (LIDEX10) performed in the southern Ligurian Sea and the Corsica Channel, between 3 and 21 July 2010 a Slocum glider was deployed in conjunction with low-cost satellite-tracked CODE drifters. The main focus of the experiment was to contribute the understanding of the surface dispersion in a coastal area. In this work the shallow area and the open sea mesoscale features are described using MODIS (Moderate Resolution Imaging Spectroradiometer) satellite images, glider and drifter data.

Materials and Methods
In the framework of the LIDEX10 experiment [1], small clusters of drifters were released in the vicinity of a front associated with the Arno River Plume to study the properties of local submesoscale to mesoscale dynamics. The drifter deployment locations were fine-tuned by using the information derived from in-situ CTD casts, the MODIS satellite images and the outputs of a circulation model. A shallow (200-m) Slocum glider was deployed in the vicinity of the drifters and was piloted for the first 18 days of the experiment. Frequent surfacings and continuous route modifications were performed to steer the glider in order to collect nearly contemporaneous information of the water column below the majority of drifters. The glider sampled temperature, salinity, oxygen, CDOM fluorescence and backscatter at 553 and 880 nm along the water column between the surface and 200 m depth. Diurnal MODIS chlorophyll concentration (Chl) and nocturnal Sea Surface Temperature (SST) data, with 1 km nominal resolution, were downloaded from the NASA dedicated web page. They were mapped and projected to obtain images of Chl and SST. Glider and drifter tracks and daily track segments were overlaid on the respective daily images in order to illustrate the motion of the mesoscale features.

Results
The 18-day drifter tracks show a clockwise current starting in front of the Arno River mouth, following the Italian cost and then heading west, north of Elba Island. Chl images show filaments detaching from the coasts partially followed by the drifters. The glider was steered to sample some of the mesoscale features. Fig.1 displays a MODIS Chl image on 12 July 2010 superimposed with the drifter (white) and glider (blue) tracks for the entire campaign. Temperature, salinity and oxygen distributions show two different environmental characteristics: 1) One more coastal with lower salinity at the surface originating from the Italian rivers Arno and Cecina. Satellite images show the rapid evolution of the filaments marked by high optically active components in the surface water. 2) A more open sea environment characterised by a vein of low salinity probably due to the AW (Atlantic water) intruding in the basin from the south (Fig.2). Several small eddies are evidenced in the satellite Chl and SST images close to the Corsica coast. The signal of the mesoscale structures is also captured in the glider data with higher temperature, lower salinity and oxygen than the surrounding waters. From the analysis of the SST images the entire campaign was characterized by a gradual increase of SST also present in the glider data. An intrusion of relatively cold water north of Corsica is also evident in conjunction with a lower satellite-derived Chl. The CDOM concentration in the entire basin is lower in the upper 50-m layer than in the deeper area, while the backscattering at 880 nm seems higher close to the bottom in the shallow costal area due to the re-suspension and below the filaments detached from the coast.

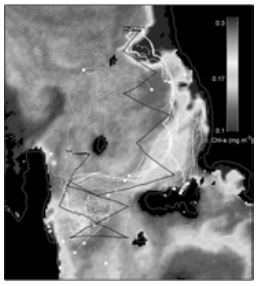

Fig. 1. MODIS Chl image on 12 July 2010 with drifter tracks (white) and glider tracks (black) overlaid for the entire campaign.

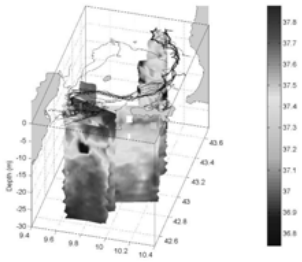

Fig. 2. 3D plot of the salinity sampled by the glider and drifters tracks during the entire campaign zoomed between 0 and 30 m depth.

Acknowledgments
Thanks to the Captain and Crew of the R/V Maria Grazia, to M. Borghini, P. Falco, K. Shroeder and K. Mahiouz for helping with the drifter and glider operations during LIDEX10. We are grateful to L. Mortier, P. Testor and L. Beguery for allowing us to operate the Tenuse glider and to E. Zambianchi, A. Griffa, J. Chiggiato and P. Zanasca for sharing their drifter data with us.

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FIRST CTD MEASUREMENTS WITH TOWED UNDULATING VEHICLE IN CROATIAN COASTAL WATERS

Zoran Pasaric [1]*, Iva Medugorac [1] and Mirko Orlic [1]
[1] Andrija Mohorovicic Geophysical Institute Faculty of Science, University of Zagreb - pasaric@irb.hr

Abstract
Quasi-synoptic 3D measurements of hydrographic properties are performed in the vicinity of the Cetina river mouth (16º41'E, 43º26'N) at the eastern Adriatic coast. The shallow fresh-water plume slightly warmer than the surrounding sea is revealed. The plume is surface-advected rather than bottom-advected, with anticyclonic, cyclostrophic gyre formed in front of the mouth and a narrow coastal current extending downstream.

Keywords: Coastal waters, River input, Salinity, Temperature, Central Adriatic Sea

Detailed hydrographic measurements were performed on 5 September 2012 in the Middle Adriatic coastal area in front of the Cetina river mouth (Figure 1). The river itself is of major importance for various human activities including water supply, agriculture and electric energy production. Its natural hydrological-cycle regime at the lower part of watercourse is significantly changed by numerous hydrotechnical works including several power plants and reservoirs. Because of prolonged stay in reservoirs, the water at the river mouth is warmer in summer than it would be in natural conditions. The average outflow into the sea, strongly controlled by the electricity production, is slightly above 100 m^3/s. From the river mouth the sea bottom sharply slopes to form a wide plateau at a depth of some 50 m.

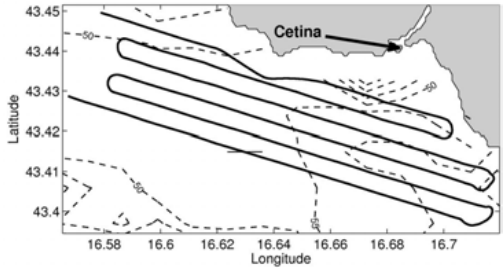

Fig. 1. The ship path (full) and the bottom depth (dashed).

The measurements were preformed by towed, light weight, computer controlled undulating vehicle (manufactured by Sea Sciences Inc.). The towing speed was 5 knots with undulations covering the water column from near surface to some 35 m depth. With 4 to 5 undulations per kilometer, typical horizontal resolution was about 200 m along the ship track. In present application the payload included only the SBE 49 CTD probe. With sampling rate of 16 Hz the vertical resolution was typically better than 0.1 m. Time, GPS position, the vehicle and bottom depths, temperature and conductivity were monitored and continuously recorded by on-board computers in real time. The ship path is shown in Figure 1. The survey covered the area of some 11 by 2.5 km, with approximately 500 m between along-shore passes.

Basic check revealed excellent data quality with only one few-second gap in more than 7 hour long record. As a first step, thanks to the high vertical resolution, all the data are linearly interpolated at regular depths (every 0.1 m) along the vehicle path. Subsequently, the whole water column is divided into 1 m thick layers. Averaging is performed within each layer resulting in a nearly regular 2D grid, depending on where the vehicle path intersects particular layer. The first layer is discarded due to reduced raw data availability close to the surface. Finally, triangle-based linear interpolation is performed in each layer separately, resulting in regular 3D grid of all quantities.

The Cetina plume is shown to be relatively shallow, extending approximately 5 m below the surface (not shown). It is seen as a water mass of reduced salinity and slightly increased temperature in comparison with the surrounding sea water. It is the salinity that has the dominant influence on the density (Figure 2). The plume is obviously surface-advected rather than bottom-advected, the equilibrium depth being much smaller than the coastal-wall depth [1]. The distribution of properties at a depth of about 5 m suggests that there is an anticyclonic, cyclostrophic gyre in front of the Cetina mouth and a narrow coastal current extending in the direction of Kelvin wave propagation, the inertial length scale being larger than the width of river mouth [2].

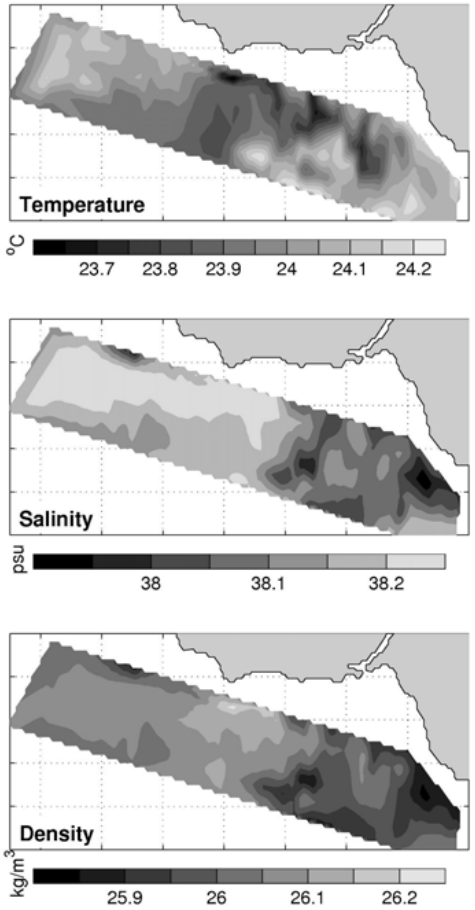

Fig. 2. Temperature (top), salinity (middle) and density (bottom) at 4-5 m depth.

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SATELLITE AND FIELD OBSERVATIONS OF A SEA SURFACE COLD FILAMENT OFF CAPE PASSERO (SOUTH OF SICILY, CENTRAL MEDITERRANEAN SEA)

Ettore Salusti [1]* and Francesco Bignami [1]
[1] ISAC-CNR - ettore.salusti@gmail.com

Abstract
We here analyse thermal satellite images, Quik SCAT wind data, CTD and ADCP transects crossing a cold filament off Cape Passero, the southern tip of Sicily, sampled during the SYMPLEX 99 cruise (November 1999). Its width is ≈ 25 km, its length is ≈ 200 Km, the lateral thermal anomaly is $DT \approx 2$ °C and it is seen to be mostly flowing over a 100-120 m deep sea bottom. It is best identified by its temperature low values in the filament core (upper 50 m), with outcropping isothermals, but also its salinity and bottom turbidity data are of interest. It shows weak along-flow widening, indicating low entrainment of surrounding waters. Among other effectes, this supports the idea that filaments has to be seen as a set of streamlines of high potential vorticity.

Keywords: Currents, Sicily Channel, Mesoscale phenomena, Coastal processes

INTRODUCTION

Cold filaments are short-lived dynamical structures which are characterized by properties (salinity, temperature,..) that may significantly differ from the adjacent waters. They have the shape of elongated shelf-rooted tongues and are generally governed by non-linear dynamics. The fillament space scales are about 100-300 km in length, 10-20 km in width, 30-50 m in thickness while the resulting time scales are of one-two weeks and typical geostrophic velocities are 10-50 cm/s. We here analyze one among the cold filaments observed off the southern tip of Sicily (Cape Passero) in the Channel of Sicily (Central Mediterranean Sea), sampled during the SYMPLEX 99 cruise (24 Oct. – 6 Nov. 1999). Satellite thermal images in relation with Quik SCAT wind data, and 84 CTD and a few ADCP transects, crossing this cold filament, allow us to investigate its peculiar dynamics.

IN SITU HYDROLOGIC OBSERVATIONS

Conductivity, temperature, and pressure were recorded at 32 Hz and logged on nine-track tape at sea. Absolute calibration of salinity is based upon in situ bottle sampling while temperature calibration is based upon measurements from reversing thermometers . Significant relative changes for temperature and salinity are conservatively estimated to be 0.01 °C and 0,001 respectively. During post-cruise processing conductivity data are filtered with a low-pass digital filter with an effective analog time constant of 0.1 s. This time constant was found to minimize salinity spiking in most sections of the records, although some residual spikes remain.

Hydrologic transects:

Among more than 212 CTD stations of the SYMPLEX 99 cruise, we focus our attention on 5 east-west transects. The northernmost transect is called A (~ 36° 20' N). The second is B (~ 36° 00' N), then C (~ 35° 40' N), D (~ 35° 40' N) and finally E (~ 35° 00' N). Although some of the A-E transects cross only partially the filament, all are nevertheless analyzed here to teach some insight on the filament evolution. We here discuss just one among these transects the nearest to Sicily.

Transect A The maximum sampling depth of CTD casts is 3490 m. Such casts where made between 14° 44' and 15° 47' E (with an average spacing of 18 Km). The overall salinity field has a complicated structure with local maxima and minima. In addition a rather sharp shelf-trapped salinity front (15° 15 ' and 15°.30' N) confines the Ionian waters to the east of the shelf break. The intersection of the filament and the CTD transect has a salinity absolute minimum S = 37.27 (at z ~ - 32 m and 15° 00' E) in a larger patch characterized by S < 37.76. This salinity core is trapped over a shelf only ~ 100 deep. The surface salinity is as low as 37.79 over the filament core and increases to 37.80 -37.83 in the adjacent stations. The temperature of the filament centre is ~ 18.63°C. The transect A surface temperature is minimal ~ 22.79°C in station 007, ~ 20 Km east the salinity core. Then it increases to 23.43-23.66°C in the surface of adjacent stations. At 40-100 m depth one has a temperature front around 15°.22' E, but near the salinity core one has a rising of the isotherms of ~ 20 m for T = 17.94°C and 50 m for T = 14.60°C at 100-150 depth. Finally the density has a more regular behaviour, that reminds that of T since the water is mainly thermally stratified. The density of the filament core is ~ 28.86 where dissolved oxygen is 5.23 ml/l. Deeper than 100 m, at ~ 15° 20' E there is again a front while in the 0-100 m surface layer density increases slightly towards East. Around 40-50 m depth the density is 27.09 , slight larger than in the adjacent stations. The isopycnals also show a mild uplift of ~ 10 m in the salinity core region, such that the integral of such excess density at station 007 between the sea surface and the salinity core is ~ 5.2 m.

In synthesis from these observation we see a cold surface filament, most flowing over a 100-120 m deep sea bottom, contored by fresher MAW masses, then it flows following the general circulation. Along the region of our observations, it is characterized by a small evolution of its hydrologic characteristics, which supports its identification with a set of high potential vorticity streamlines, a kind of particularly stable and regular flow, which analysis finally is the goal of this study.

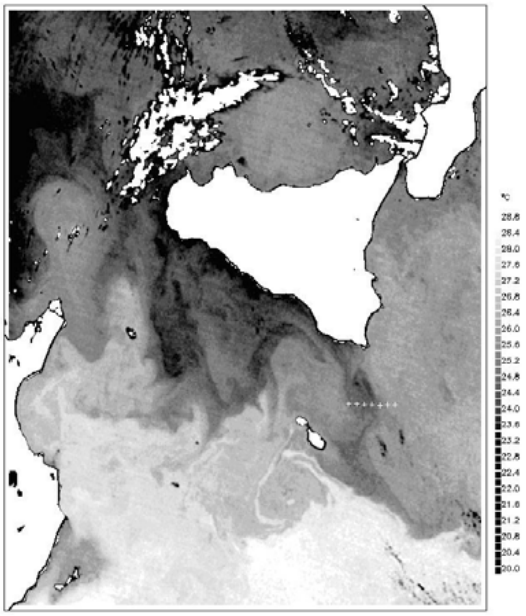

Fig. 1. Satellite view

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ON THE RELEVANCE OF TIDAL FORCING ON THE SIMULATED MEDITERRANEAN TERMOHALINE CIRCULATION

Gianmaria Sannino [1]*, Adriana Carillo [1] and Cristina Naranjo Rosa [2]
[1] ENEA-UTMEA-CLIM ROMA - gianmaria.sannino@enea.it
[2] Physical Oceanography Group, University of Malaga, SPAIN

Abstract
An eddy-permitting tidal model of variable resolution is implemented covering the whole Mediterranean Sea. The good agreement found between the model circulation and most of the available observations confirms both the robustness and effectiveness of the grid refinement technique. The effects produced on the Mediterranean circulation by the tidal forcing are investigated through the comparison of two simulations differing only in the presence of the tidal forcing. Even though the main characteristics of the thermohaline circulation appear similar in the two simulations, some quantitative and qualitative differences are observed: the main differences found in the Strait of Gibraltar propagate into the whole basin, have an impact on the water column stratification, and consequently on the convection events.

Keywords: Tides, Circulation models, Circulation experiments, Water convection, Gibraltar Strait

The Mediterranean Sea is a semi-enclosed basin displaying an active thermohaline circulation (MTHC) that is sustained by the atmospheric forcing and controlled by the narrow and shallow Strait of Gibraltar (hereinafter SoG). Within the SoG the MTHC takes the form of a two-way exchange: an upper layer of fresh and relatively warm Atlantic water spreads in the Mediterranean basin, and a lower layer of colder and saltier Mediterranean water sinks as a tongue in the North Atlantic at intermediate depths. The interaction between the intense tidal forcing (Candela et al. [1990]) and the complex geometry of the SoG influences the two-way exchange via hydraulic control (Bryden and Stommel [1984], Sannino et al. 2009). The exchange is subject to vigorous mixing and entrainment (Wesson and Gregg [1994]) as well as intermittent hydraulic controls over the main sills and in its narrowest sections (Sannino et al. [2007, 2009]). In the last 15 years several numerical models were implemented to reproduce and understand the Mediterranean circulation and its variability. The main features were reproduced by coarse resolution models, characterized by a horizontal grid space of 20–25 km. Further understanding regarding the physical mechanisms driving the mesoscale variability of the Mediterranean circulation has been achieved only recently by means of eddy-permitting/resolving models having a horizontal grid space spanning from 5 to 15 km. However, even in the last aforementioned modelling studies the horizontal resolution cannot be yet considered sufficient to fully reproduce the physical mechanisms of the two-way exchange of the SoG. In most of the previous models the Strait is approximated by a rectangular pipe having a cross-section wider than the real dimension, in general more than double, and a flat bathymetry. Moreover, none of the previous models took into account explicit tidal forcing. In this work, we investigate the effects produced on the simulated MTHC by the explicit application of tidal forcing. To this end, results from two numerical experiments reproducing the actual climate conditions, performed with and without tidal forcing are presented, and their differences discussed. The numerical model used for the present work is based on the MITgcm. The model domain extends over the entire Mediterranean Sea including the Gulf of Cadiz at west in the Atlantic Ocean. It is covered by a nonuniform curvilinear orthogonal grid characterized by a maximum horizontal resolution of about 1/200°reached in the SoG. From the Strait the resolution smoothly degrades toward 1/16° in the rest of the model domain. Such a model configuration represents a novelty respect to any other model implemented in the same region in the past. To adequately resolve the dynamics of the different water masses in the Mediterranean 73 vertical z-levels were used. They are unevenly spaced and have a thickness ranging from 3 m at the surface to 300 m at the ocean bottom. The depth of the first level is 1.5m and that of the deepest is 5300 m. In order to properly represent the hydraulic behavior of the Strait as suggested by Sannino et al. (2007, 2009) the model includes also the tidal forcing, both internal (equilibrium tides) and lateral (coming from the western open boundary). The inclusion of tidal forcing in a fully baroclinic Mediterranean model represents another novelty respect to any other model implemented in the same region in the past. The model is forced at the surface through the specification of wind stress and heat fluxes from the ERA40 reanalysis database provided by the ECMWF. The general surface and the intermediate circulation given by the models reproduced quite well the main features of the basin-scale circulation. The simulated volume transport through the main straits and channels of the Mediterranean were in good agreement with most of the available in situ observations. The hydrographic analysis of the model results revealed that the characteristics and the distribution of salinity and temperature in the basin were in good agreement with observations. However, even though the main characteristics of the MTHC appeared similar in the two simulations, some differences were observed. The tidal simulation represented in a realistic way the two-way exchange in SoG in terms of mixing, fluxes and velocity fields. This influenced the characteristics of the inflowing MAW and outflowing MOW in terms of thickness and depth profiles; in particular the MAW was thinner, shallower and faster in the tidal experiments. These differences propagate into the whole basin, having an impact on the water column stratification, and consequently on the characteristics of the main convection events.

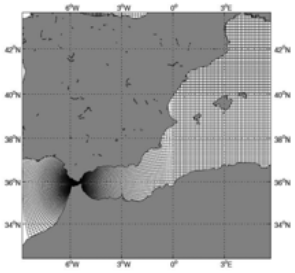

Fig. 1. Model grid over the Western Mediterranean Sea

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VERTICAL AND HORIZONTAL MIXING ESTIMATES THROUGH A LAGRANGIAN EXPERIMENT IN THE NORTH AEGEAN

Elina Tragou [1] and Vassilis Zervakis [1*]
[1] Department of Marine Sciences University of the Aegean - zervakis@marine.aegean.gr

Abstract
The vertical and horizontal turbulent diffusion coefficients in the mixed layer can be estimated via Lagrangian sampling. Our method is tested on data taken during a Lagrangian experiment aiming to record Black Sea water outflowing in the North Aegean, in April 2008. Hydrographic records from drifters, CTD and thermosalinograph are combined to assess the temporal rate of change of water properties, as well as their spatial gradients on a Lagrangian frame of reference. The method gave vertical eddy diffusivities ranging from 10^{-3} to 10^{-2} m^2 s^{-1}, and horizontal diffusivities ranging from 10^3 to 10^4 m^2 s^{-1}.

Keywords: Circulation experiments, Turbulence, Aegean Sea

Assessment of the horizontal and vertical mixing in the ocean is not trivial. Horizontal mixing requires either the measurement of the relative dispersion from drifter clusters [1], or the evaluation of absolute dispersion via the estimation of Lagrangian decorrelation scales of long drifter tracks [2]. Vertical mixing requires either the direct measurement of vertical shear of horizontal velocity using expensive and demanding microstructure profilers, or the indirect assessment through either budget estimates [3] or density overturn analyses [4]. In this work we present a method to assess both horizontal and vertical mixing simultaneously, through fast sampling of the horizontal and vertical distribution of hydrographic characteristics in the vicinity of a Lagrangian drifter, and the temporal evolution of these properties. A Lagrangian experiment was scheduled aiming to record the evolution of the surface plankton community in the Black Sea waters outflowing in the Aegean Sea [5]. In such an experiment, Lagrangian sampling is preferred to Eulerian, due to the absence of hard to measure advection terms. In the case of a Lagrangian frame of reference, advection is not an issue; the fluxes involved in modifying hydrographic and biogeochemical properties correspond to turbulent lateral and vertical mixing. Thus, a carefully planned Lagrangian experiment would be based on recording (a) the temporal evolution of properties following the same water body and (b) the horizontal and vertical gradients affecting the turbulent fluxes. In the April 2008 experiment a drifting sediment trap and a surface drifter were released in the Black Sea outflow and followed a nearly circular path around an anticyclone in the North Aegean. The R/V Aegaeo followed a meandering path around the drifter tracks, thus recording the horizontal gradients of T/S properties in the surface layer. The horizontal information was gridded to provide estimates of horizontal gradients along the path of the drifters. Vertical gradients were recorded via successive CTD casts during periodic sampling at the drifter positions. Air-sea fluxes were determined using direct measurements from the Poseidon buoy at the Athos site, to the northwest of Lemnos island. Thus, the equations of heat and salt in the surface mixed layer, balancing the rate of change of temperature and salinity to the divergence of air-sea and turbulent fluxes, define a linear system which can be solved for the vertical and horizontal diffusivities, K_v and K_h respectively.

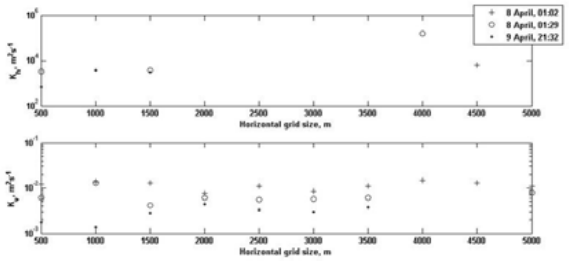

Fig. 1. Sensitivity test results for horizontal (top) and vertical (bottom) eddy diffusivity estimates as a function of spatial grid cell-size in assessing horizontal gradients.

Applying the above method to our observation gave estimates of K_v ranging from 10^{-3} to 10^{-2} m^2 s^{-1}, and K_h from 10^2 to 10^4 m^2 s^{-1}, with one extreme value of 10^5 m^2 s^{-1}. We should note here that the horizontal diffusivity values in particular depend on the scale of the horizontal T and S gradient estimation, as revealed by the sensitivity test's presented in figure 1. Missing horizontal diffusivity estimates on the above figure correspond to negative diffusivity values, i.e. areas of converging flow. This is not surprising for this area, as it is mainly characterized by strong thermohaline frontal features between adjacent water masses of distinctly different temperature and salinity properties.
An experiment was also performed excluding the air-sea fluxes from the heat and salt equations. The results were very similar to the present ones, indicating the minor role of air-sea exchanges in the evolution of the thermohaline properties of the surface layer for this particular stage of Black Sea outflow in the Aegean. However, it should be noted that the experimental period was very mild in terms of weather and fluxes were rather weak due to the transition from winter to summer conditions.

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THE FLOW FEATURES OF THE SE LEVANTINE-LONG TERM IN-SITU MONITORING 1995-2012

G. Zodiatis [1]*, D. Hayes [1], I. Gertman [2], P. Poulain [3] and M. Milena Menna [3]
[1] Oceanography Center University of Cyprus - gzodiac@ucy.ac.cy
[2] 2Israel Oceanographic and Limnological Research
[3] 3Istituto di Oceanografia e Geofisica Sperimentale

Abstract
The knowledge of the hydrodynamic features of the Levantine substantially increased during the POEM cruises. The hydrographic survey of the area between 1995-2012, during the CYBO and HaiSec cruises, along with data from CYCLOPS, MSM/14 and from floats, drifters and gliders (NEMED,YPOKINOUMODA,GROOM) have provided insight on the flow features in the SE Levantine. Namely, the two eddies of Cyprus and Shikmona, and the offshore cross basin flow jet (MMJ). It is well-documented that the Cyprus eddy is the most influential feature in the area, while the generation of the Shikmona eddy was observed for the first time and with the Shikmona gyre to re-established during periods when the above eddies co-exist.

Keywords: Hydrography, Circulation, Levantine Basin

Preface The general anticlockwise circulation along the coastline of the Eastern Mediterranean Levantine was first proposed by Nilsen [1], while half a century later Ovchinnikov et. al . [2], during several cruises between 1960s and 1970s, showed a similar schematic of the circulation, enriched with sub-basin flow structures, such as the Rhodos gyre. In 1980s, during the cruises of POEM group [3], it was first defined a more detailed structure of the circulation, consisted by several alternative cyclonic and anticyclonic eddies and gyres and an offshore cross basin jet named as the Mid Mediterranean jet-MMJ. Moreover, the Shikmona gyre was defined as a non-permanent multi-pole gyre, consisted by three eddies, of which the Cyprus warm core one the most well pronounced [4]. With the development of the ocean predictions-hindcasts and the possibility of assimilation of in-situ and satellite data, the Mediterranean Forecasting System-MFS depicted an improved pattern of the circulation in the Eastern Mediterranean Levantine, showing the co-existence of the anticlockwise along shore and the offshore cross basin currents [5]. The same period Millot and Taupier-Letage [6] using SST satellite imagery arguing a simplifier flow pattern similar to that proposed by Nilsen [1]. The present work aims to provide new strong evidence about the circulation in the Eastern Mediterranean Levantine Basin, using high spatial resolution synoptic in-situ data obtained the last 10-15th years from various in-situ observing platforms, such as ship cruises, gliders and floats missions, XBTs, drifters. **Discussion and Results** Renewed in-situ investigations in the South-eastern Levantine Basin, in the framework of CYBO, MFSTEP, CYCLOPS, HaiSec, YPOKINOUMODA, MSM/14, GROOM, NEMED made possible to give new strong evidences about the seasonal and inter-annual fluctuation of the MMJ, the Cyprus warm eddy variability, the Shikmona eddy generation and the periodical re-establishment of the Shikmona gyre [7,8,9]. The long term seasonally collected in-situ data sets reveal that the dominant flow features 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, it was found the establishment of a secondary warm eddy in the most SE part of the area, the Shikmona eddy, during periods when the Cyprus eddy became weaker, as was shifted westward or southward from Eratosthenes SM and when the strong northward current, flowing usually along the Israel-Lebanese coast, becomes unstable. The latter is evidently also from the drifters trajectories, gathered by the NEMED project showed that this eddy is detached away from the northward current towards the area of the secondary eddy, as observed by CYBO cruises. During theses long term observing campaigns-missions it was found periodically the re-establishment of the Shikmona gyre, when the co-existence of the Cyprus and Shikmona eddies were observed, particularly, during certain short periods, which are related to the mechanism of the generation and destruction of the warm core eddies circulated within the Shikmona gyre, when is present. The pathway of the AW in the area, especially along the northern periphery of the Cyprus warm core eddy provide an additional evidence about the MMJ been a cross basin current. The in-situ data sets obtained in the SE Levantine from 1995-2012, provide a clear definition of the mesoscale variability of the circulation in the SE Levantine, where: a) the Cyprus and Shikmona eddies, as well the MMJ are the dominant flow features; b) the Cyprus warm eddy undertakes strong spatial and temporal variability; c) the variability of the spatial displacement of the Cyprus warm eddy affects the MMJ and the eastward transfer of the AW; d) The Shikmona eddy found to be established for certain periods when the Cyprus warm eddy shifts to the west, south-west; e) the MMJ flows along the northern periphery of the Cyprus warm eddy and is the major current transferring the AW in the area and f) close offshore to Egypt there is a westward re-current too.

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Session

Operational oceanography

Modérateur : **Joaquin Tintore**

SEA SURFACE CURRENTS BY HF RADAR IN THE MALTA CHANNEL

A. Drago [1], J. Azzopardi [1], A. Gauci [1], R. Tarasova [1], G. Ciraolo [2], F. Capodici [2], S. Cosoli [3]* and M. Gacic [3]
[1] Physical Oceanography Unit, University of Malta
[2] Universita' degli Studi di Palermo
[3] Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste - scosoli@ogs.trieste.it

Abstract
An HF radar observing system composed of CODAR SeaSondes is providing real-time surface current pseudo-Eulerian maps every hour in the strip of sea dividing Malta and Sicily. This initiative forms part of the CALYPSO project that aims to support the efficient response against marine oil spills in this busy area of maritime transportation in the Mediterranean. Besides servicing Maltese and Sicilian public entities responsible for civil and environmental protection, surveillance, security and response to hazards, the HF radar data are also shedding distinctive information on the surface circulation variability in the area at meso and seasonal scales.

Keywords: Circulation, Malta Channel

In a joint effort conducted by Maltese and Sicilian partners, the CALYPSO project is funding the setting up of an HF radar network to monitor sea surface currents in the Malta Channel. The two radar units on the Malta side, at Ta' Sopu in Gozo and Ta' Barkat in Malta, are already in operation since Summer 2012, while a third unit at Pozzallo harbour will be added to complete the coverage closer to the Sicilian coast. The CALYPSO radar network engages the latest technology to extend the coverage performance with use of multi-static data processing software at the radar site in Malta. In combination to numerical models, the radar data are intended to primarily support applications to optimise intervention in case of oil spill response as well as to endow tools for search and rescue, security, safer navigation, improved meteo-marine forecasts, monitoring of sea conditions in critical areas such as proximity to ports, and better management of the marine space between Malta and Sicily.

The spatial coverage and high temporal resolution of the HF radar data collected since September 2012 is permitting a unique and detailed characterization of the surface circulation in the Maltese shelf area. The data are organized in time series of hourly averaged velocity vectors at each radar measurement grid point on a regular spatial matrix of 47 x 40 points spanning 13.84356º to 15.37942ºE in longitude and 35.7454º to 36.7988ºN in latitude. Statistical diagnostics include the mean flow, the variance, the mean kinetic energy and the eddy kinetic energy at each grid point calculated over different time scales, and combined in space by means of pseudo-Eulerian 2D plots for each statistical parameter. Fig. 1 shows the mean surface circulation over the period September 2012 to March 2013, confirming the presence of the energetic and meandering Atlantic Ionian Stream (AIS) [1] in the central part of the channel, characterised by currents reaching 30-40 cm/s, and directed towards SE as it exits into the Ionian.

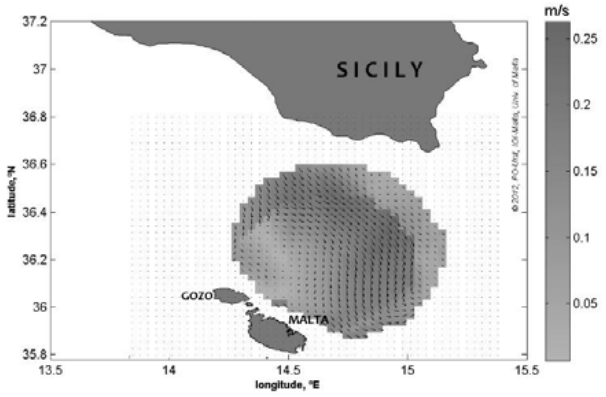

Fig. 1. **Mean surface velocity field (Sept 2012 – Mar 2013)**

The circulation in the Malta Channel and sea around the Maltese Islands is characterized by a strong mesoscale variability that has been studied by numerical models [2]; the eddy field component is significant and is known to depend both on internal dynamical processes as well as on the influence of the synoptic scale atmospheric forcing [3]. The fine grid resolution of the radar data permits a detailed representation of these main mesoscale signals. Substantial eddy field structures are generated along the AIS and over the shallow bathymetry in particular around the Maltese Islands. Besides trapping water and particulates, these eddies have associated vertical motions that influence phytoplankton biomass distributions and thus bear important links to biological processes, in particular to the location of fisheries. When the AIS flow shifts closer to the island (Fig. 2(1)) the SE flow is particularly intense. The currents closer to the coast tend to swerve against the SE tip of Malta as a swift flow; the currents further offshore continue to flow away from Malta. When the AIS vein is displaced away from the coast, a mesoscale anticyclonic eddy formation comes into action and tends to reverse the flow to a NW direction closer to the coast (Fig. 2(2)). These eddy formations can become even more complex when the AIS is weaker.

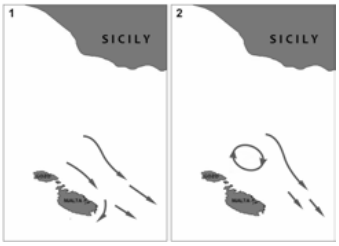

Fig. 2. Schematic circulation patterns near the Maltese Islands

Acknowledgements The CALYPSO project is partly financed by the EU under the Operational Programme Italia-Malta 2007-2013. Besides the authors and institutions of this paper, the project is further conducted by six other partners: Transport Malta (Capt. R. Gabriele & Galea G.), Civil Protection Department, Malta (P. Murgo & Grech S.), Armed Forces of Malta (M. Mangion & O Neill, C.), ARPA Sicilia (M. Antoci & Garretto A.), Istituto per l'Ambiente Marino Costiero uos di Capo Granitola, CNR (G. Buscaino) and Universita' degli Studi di Catania, CUTGANA (C. Grasso & Russo A.).

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OIL SPILL RISK ASSESSMENT ON THE MALTESE COASTAL AREAS

A. Gauci [1]*, A. Drago [1], J. Azzopardi [1], A. Deidun [1] and A. Bonnici [1]
[1] University of Malta - adam.gauci@um.edu.mt

Abstract
A significant percentage of the global oil transport goes through the Mediterranean sea. Most of the maritime traffic carrying oil and other dangerous liquid substances travels across the Malta Channel. The risk of marine spillages within the stretch of sea between Malta and Sicily is very high and beaching on the Maltese shores can cause irreversible environmental damage at the detriment of important economic resources. The aim of this work is to determine the probability and volume percentage of oil that would reach the coast in case of an accident in the proximity of the Maltese Islands. Various spill scenarios are considered to get a realistic estimate as much as possible.

Keywords: Models, Malta Channel, Circulation models

In this work the MEDSLIK Oil Spill Model is used to perform an assessment on the vulnerability of the Maltese coast to potential impacts of marine oil spillages. Although similar risk analysis have been performed in other regions, quantitative assessments are still lacking for the Maltese Islands. Moreover, such studies necessarily rely on the availability of data that can well represent meteo-marine conditions in the area. In this study, data derived from marine and atmospheric models run by the Physical Oceanography Unit of the University of Malta over a period of one whole year was used. A regular grid of points representing spill origins around the Maltese Islands was considered (Figure 1). Simulations each of 120 hours duration (5 days) were run for every point for every day for the year 2011 (365 days), and 500 tons of light oil was assumed to instantaneously leak at midnight for each simulation. The oil spill vulnerability index was set on the basis of the spill origin, the location of beaching, and the time taken for the oil to reach the coast.

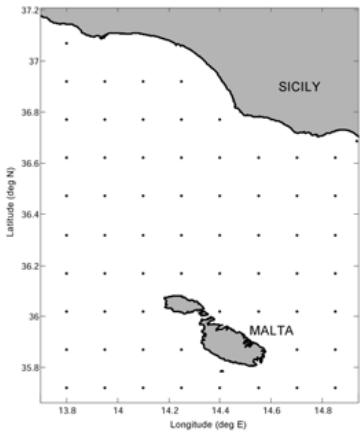

Fig. 1. Points on a regular grid considered for oil spill origin in the simulations.

For each oil spill simulation, the percentage of oil reaching the coast was determined. In order to have a clearer indication of the damage and the effected resources, the coastline regions corresponding to major bays, ports, reverse osmosis and fish farms were initially identified and treated separately. Such areas cover most of the important Northern and Southern regions of the main island (Malta), the smaller island Gozo as well as Comino (Figure 2). The MEDSLIK input files consist of averaged fields updated every 6 hours and describing the marine conditions produced by the ROSARIO96 forecasting system. These fields extend over the Malta Shelf Area, with a spatial resolution of 1/96°, and prepared operationally through the daily re-initialization from the Sicily Channel Regional Model (SCRM) that produces daily averaged forecasts with a resolution of 1/32° [1]. Surface forcing is derived from the hourly high resolution forecast fields by the SKIRON atmospheric model which is run on a daily basis by the University of Athens [2].

Before carrying out the risk assessment analysis, the performance of the MEDSLIK oil spill model was validated. The ROSARIO96 forecast sea surface currents were compared to vectors recorded by the HF radar network that was recently installed in the region as part of the CALYPSO project [3]. The trajectory module of MEDSLIK was also used and the results were compared with the recorded and transmitted positions of six MetOcean iSVP drifters. Such equipment was deployed in the Malta Sicily in December 2012 as a joint effort between CALYPSO, the Argo-Italy programme [4] and the WP3 of the EU FP7 SIDERI project [5].

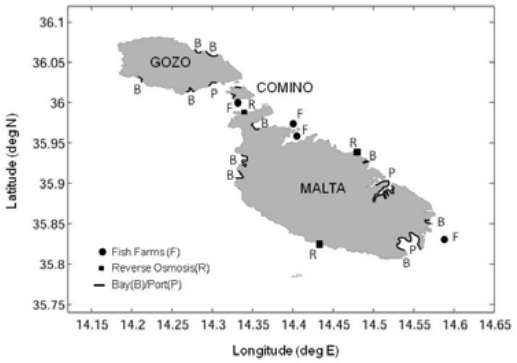

Fig. 2. Location of bays, ports, reverse osmosis and fish farms on the Maltese Islands.

A large number of runs were required and although script files were written to automate the process, the MEDSLIK model still needed a reasonable time to run simulations over the required timelines. The regions that are most prone to oil spill impacts were determined on the basis of the percentage of beached oil. The coastal sea area around the Maltese Islands was divided into regions and the typical timeframe for a spill within each region to reach the coast was determined.

Acknowledgements: This work was conducted within the framework of the MEDESS4MS (Mediterranean Decision Support System for Marine Safety) project partly co-financed by the European Regional Development Fund within the Med Programme for Strategic Projects.

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DESCENTE D'ÉCHELLE DES MODÈLES DE CIRCULATION OCÉANIQUE VERS LES MODÈLES CÔTIERS PAR RAPPEL SPECTRAL.

Gaelle Herbert [1]*, Pierre Garreau [1], Franck Dumas [1] and Valérie Garnier [1]
[1] IFREMER/ centre de Brest DYNECO/PHYSED - gaelle.herbert@ifremer.fr

Abstract
L'efficacité du "rappel spectral" est évaluée en utilisant un modèle hydrodynamique (MARS3D) forcé par un modèle de circulation générale (MFS/MOON). Cette technique permet de réduire les dérives entre le modèle global et le modèle régional, aux échelles de la circulation globale. Pour cela, la température et la salinité du modèle régional sont spectralement rappelées vers la solution du modèle global en intégrant un terme de rappel dans les équations des traceurs. Afin d'estimer les paramètres de rappel les mieux adaptés, plusieurs simulations-test sont effectuées en Mediterranée. Les champs de salinité et température sont ensuite confrontés aux observations. Les résultats montrent que le rappel spectral est capable d'atténuer les erreurs de la circulation grande échelle sans réduire de manière significative l'activité méso-échelle.

Keywords: Circulation models, North-Western Mediterranean, Coastal models

Les systèmes d'analyse et de prévision à haute résolution (i.e sub kilométrique) pour l'océanographie côtière comme PREVIMER couvrent des régions limitées de l'océan et sont de ce fait imbriqués dans des systèmes hauturiers globaux à plus basse résolution (typiquement de 3 à 10 km). Dans un contexte opérationnel il est cependant essentiel de maintenir la cohérence entre les solutions hauturières et côtière au cours du temps pour assurer aux utilisateurs des systèmes un continuum côte/large. Par ailleurs, un maintien de cette cohérence à faible coût permettra de se passer, dans les systèmes côtiers, d'assimilation de données contrôlant la circulation à grande échelle, cette circulation étant bien contrôlée dans les systèmes hauturiers. En sciences de l'atmosphère, [6] et [7] décrivent des méthodes pour le downscalling d'une solution globale sur des modèles à aires limitées et démontrent la possibilité de conserver un accord statistique entre solution globale et locale. En Océanographie physique, on ne trouve pas à l'heure actuelle le même genre de démarche. Il existe cependant des approches similaires pour des solutions numériques de cas-test [5] afin d'évaluer finement ce type de méthode ou dans le cadre de modélisations de grande échelle afin d'obtenir des solutions numériques statistiquement en accord avec les observations synthétisées [5] ou non [4] en climatologie.

Dans cette étude nous examinons et évaluons l'usage d'une méthode peu couteuse (i.e sans assimilation de données sophistiquées) : le rappel spectral. La méthode s'appuie sur la méthode semi-prognostique proposée par [1] puis revisitée par [3]. Elle consiste à construire un terme de rappel introduit dans les équations thermodynamiques (rappel sur la température et la salinité) qui influence directement la solution du modèle dans les bandes de fréquence et de nombre d'ondes prescrit, laissant les variations à l'extérieur de ces bandes libres d'évoluer de façon prognostique. Ce terme est construit à partir d'un incrément d'analyse qui, une fois filtré temporellement et spatialement, est réintroduit au cours d'une seconde simulation de la fenêtre temporelle considérée. Le modèle hydrodynamique utilisé est MARS3D (Model for Applications at Regional Scale) développé à l'IFREMER. Le code est décrit en détail par [2]. Le modèle couvre la zone comprise entre 39.5°N – 44.5°N et 0°E-16°E avec une résolution horizontale de 1.2 km. Les conditions aux limites sont issues de la solution globale MFS/MOON qui a une résolution horizontale de 6 km.

Afin d'estimer les paramètres du nudging les mieux adaptés au maintien de la cohérence des systèmes hauturier/côtier, plusieurs simulations-test en mer Méditerranée sont effectuées sur l'année 2010. L'impact du spectral nudging sur le réalisme des solutions numériques est ensuite évalué par comparaisons des champs de T et S simulés aux observations satellites et in situ. La figure 1 montre un exemple de comparaison effectuée entre la SST fournie par le satellite SEVIRI, moyennée sur le mois d'octobre, la SST simulée par l'un des modèles rappelés (pour lequel le spectral nudging a été appliqué) et celle simulée par la simulation équivalente sans rappel (dite "simulation libre"). Les résultats montrent un meilleur accord entre les observations et le modèle une fois le spectral nudging appliqué. En particulier, on observe la disparition du biais chaud dans la région du Golfe du Lion. Par ailleurs, des calculs d'énergie cinétique turbulente ont montré que le spectral nudging n'était pas responsable d'une diminution significative de l'énergie associée aux petites et moyennes échelles.

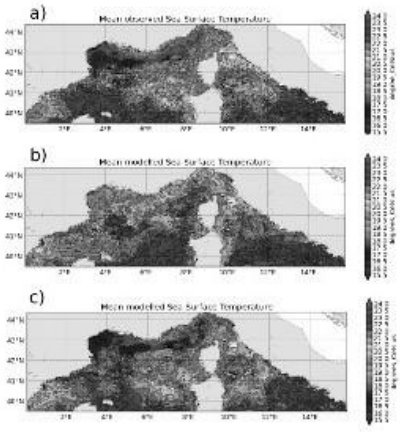

Fig. 1. Moyenne de la Température de surface (°C) sur le mois d'octobre 2010 d'après le satellite SEVIRI (a), le modèle régional MARS3D "libre" (i.e sans rappel spectral) (b) et après application du rappel spectral (fenêtre temporelle choisie: 7 jours) (c).

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ESTIMATION OF MEAN DYNAMIC TOPOGRAPHY FROM HF RADAR MEASUREMENTS

Zoi Kokkini [1]* and Vassilis Zervakis [1]
[1] University of the Aegean, Dep. of Marine Sciences - mar01045@mar.aegean.gr

Abstract
Current velocity measurements from a WERA HF radar system are used to estimate Mean Dynamic Topography. The HF radar is installed on the eastern part of Lemnos island, facing the Dardanelles Strait exit in the Aegean, with the aim of monitoring and quantifying the Black Sea outflow into the Mediterranean. A one-year long data set is analyzed in an effort to isolate the barotropic geostrophic component of the flow, as a first step in evaluating the mean dynamic topography.

Keywords: Currents, Aegean Sea, Dardanelles, Surface waters

High Frequency radars have become a major tool in coastal oceanography and monitoring (Paduan and Graber, 1997). The University of the Aegean, in collaboration with the Hellenic Centre for Marine Research, have deployed an HF radar at the eastern coast of the Greek island of Lemnos, facing the Dardanelles exit in the Aegean, in an effort to assess and monitor the Black Sea outflow. The sea-surface circulation in the region east of Lemnos is measured by a four antenna dual site HF WEllen RAdar (WERA) (Gurgel et al., 1999). The radar transmits at a central frequency around 13.45 MHz, and the azimuthal information is retrieved through a direction finding technique. Radial current maps are obtained for 17 minutes and then averaged to produce semi-hourly maps of radial currents .The range of the coverage area is about 70 km, with a resolution of 1.5 km, after interpolation throughout the field. This work is an attempt to retrieve the shape of the mean dynamic topography in the area covered by HF radar. The challenge in our method is to extract the barotropic geostrophic current from the variable surface circulation. The latter contains wind-forced, tidal currents, inertial oscillations and possibly other wave motions. Extracting the mean currents by averaging over large time periods (monthly averaging) would efficiently remove wave and tidal motions. However, the wind-forced component of the currents would remain in the velocity signal, especially if the period of consideration is characterized by a relatively constant wind field. So, we decided to isolate periods with very low wind-speeds (lower than 2m per second), in order to attempt to remove the directly wind-forced velocity from our record. Once data from windy periods are removed, long temporal averages of the velocity fields provide maps of coastal geostrophic currents. It is then possible to obtain an estimate of the mean-dynamic topography of the sea-surface, by integrating horizontally the $u = +\frac{g}{f}\frac{\partial \eta}{\partial y}$ and $v = -\frac{g}{f}\frac{\partial \eta}{\partial x}$, with η the surface slope, *u*,*v* the current components measured by the radar and *f* the Coriolis (Liu et all 2012). The integration can be performed in two ways: starting from about the middle of the measurement domain, at a point (x_0, y_0), we can integrate zonally first along a latitude line, to obtain $\eta(x, y_0)$. Afterwards we integrate meridionally, starting from the latitude defined by (x, y_0).

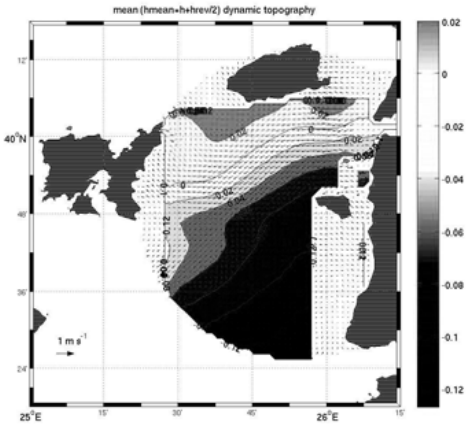

Fig. 1. Mean Dynamic Topography estimate for summer 2010, from the Dardanos HF radar data

The second method of integration is done in a similar way, however the meridional integration of equation precedes the zonal integration. Using the above two integration methods, we obtain two estimates of the MDT. We can consider the mean of the two estimates, $\langle\eta\rangle = 0.5\,(\eta_A+\eta_B)$ as our best estimate for the MDT, while the difference $\delta\eta = \eta_A-\eta_B$ is considered as an assessment of the integration error.

Due to the scarcity of periods without wind, it is only possible to estimate velocity fields from calm days over seasonal periods, in order to obtain enought velocity records to subtract the wave and inertial variability. As an example, the mean dynamic topography from summer 2010 is presented in the following image.

The dynamic topography field obtained with this method is compatible to the general circulation observed in the region, and can be a source of high-resolution dynamic topography information for further use.

Acknowledgements
This study was co-funded by the European Union (European Social Fund) and national resources under the Act 'Enhancement of research man power through the implementation of thesis –HERACLITUS II 'of the Operational Programme" Education and Lifelong Learning.

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THE MESURHO MULTI-PARAMETER MOORED OBSERVATORY FOR MONITORING OF RIVER INPUTS AND EXTREME EVENTS AT THE RHONE RIVER MOUTH

I. Pairaud [1]*, M. Répécaud [2], J. Lachaise [1], C. Ravel [1], M. Arnaud [3], C. Rabouille [4], F. Toussaint [4], F. Garcia [5], P. Raimbault [5], R. Verney [2], S. Meulé [6], P. Gaufrès [7] and J. F. Cadiou [2]
[1] IFREMER, LER PAC, France - ivane.pairaud@ifremer.fr
[2] IFREMER REM/RDT, Brest, France
[3] IRSN, La Seyne sur Mer, France
[4] LSCE, Gif sur Yvette, France
[5] MIO, Marseille, France
[6] CEREGE, Aix-en-Provence, France
[7] CETMEF, France

Abstract
The Rhone River is the largest source of fresh water discharge to the Mediterranean Sea. As it is also an important source of particles, it constitutes a key forcing for the ecosystems of the Gulf of Lions in the northern part of the western basin. In order to assess the input and fate of suspended material at the Rhone River mouth and the influence of extreme events, a multidisciplinary oceanographic moored observatory has been installed in 2009 for high frequency measurements. Data are collected and sent in near real time to an onshore data centre. Data are available for the scientific community and addition of new sensors is still ongoing in the framework of the MOOSE, MERMEX, AMORAD and PERSEUS programs.

Keywords: Rhone Delta, Instruments and techniques, River input, Gulf of Lyon, Monitoring

The Rhone River accounts for one third of the average total freshwater input to the Mediterranean Sea. Draining an industrialized catchment, it is an important source of nutrients, suspended particle matter (SPM), carbon and other chemicals including contaminants [1]. These inputs strongly influence the ecosystems of the gulf of Lions [2]. A good knowledge of i) the quantity of water, suspended particulate matter, nutrients and contaminants brought from the Rhone River to the sea and ii) the resuspension by extreme meteorological events is thus needed to understand and model physical and biogeochemical processes in this area.

In addition to the SORA station located in Arles 50 km upstream from the sea, the MesuRho instrumented platform was installed at the Rhone River mouth (East Roustan buoy : 43°19.2N, 4°52E, 20 meters of water depth) in order to provide data at sea in the fresh/saline water transition zone. Since June 2009, the MesuRho station (fig.1) provides near real time high frequency measurements.
The system was initially equipped with two multi-parameter probes (one below the subsurface and one close to the sea bottom), a meteorological station, a photosynthetic active radiation sensor (PAR), an Acoustic Doppler Current Profiler (ADCP). Sampling and transmission interval has been set to 0.5 hour for all sensors. In 2012, a nitrates sensor and a fixed benthic station with oxygen micro-electrodes for sediment mineralization studies were added. The 3 year experience of operating the system in various weather conditions has demonstrated the interest of the use of an immersed flotation buoy as a plateform for installing sensors. In the near future, a subsurface and an atmospheric sensors will be added for radioactivity monitoring.

Complementary data acquired during surveys from 2010 to 2013 were used to qualify and when possible to correct the temperature, salinity, fluorescence and turbidity time series. As the plume salinity strongly varies away from the coast, specific surveys were conducted very close to the buoy. Data from the subsurface and bottom multi-parameter probes are compared to data profiles from a CTD sensor including a turbidity sensor and a fluorometer. Water samples also allow for SPM and Chlorophyll-a quantification.

This observation system is part of the coastal operational oceanography in situ network of the North Western Mediterranean Sea. Data are transmitted six times per day (each four hours) to the Coriolis *in situ* data centre (www.coriolis.eu.org), which provides an interface for data visualization and download. This interface can be used to check the instrument fair working.
Temperature and salinity data were made available for the MyOcean community and served for operational model validation purpose [3].

The long time series recorded at the MesuRho buoy show the impact of extreme events. Strong floods caused a salinity decrease down to the subsurface sensor associated with a possible increase of turbidity. At the bottom, turbidity increase were recorded under south-east swells associated with sediment resuspension events [4]. An example is shown for spring 2012 (fig.1). First results from the benthic station dedicated to the study of the fate of particulate organic matter delivered during floods showed that during the turbidity events of spring 2012, oxygen demand rises by a factor of 3-4.

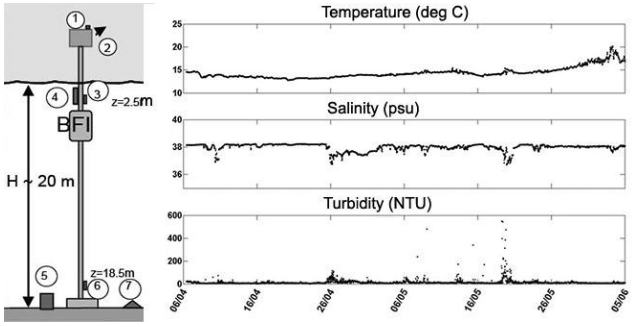

Fig. 1. (left) MesuRho observatory instrumentation : meteorological station + PAR (1), ABIN control and transmission (2), multi-parameter probes (temperature, pressure, conductivity, turbidity, fluorescence, dissolved oxygen) (3, 6), ISUS nitrate sensor (4), benthic station(5)
(right) Time series measured by the bottom multi-parameter probe in april-may 2012 : temperature (top), salinity (middle) and turbidity (bottom). The high turbidity event of 20 May occured under south-east winds.

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JERICO : A JOINT EUROPEAN RESEARCH INFRASTRUCTURE NETWORK FOR COASTAL OBSERVATORIES SUPPORTING MARINE RESEARCH IN THE MEDITERRANEAN SEA

I. Puillat [1]*, S. Sparnocchia [2], P. Farcy [1], R. Bozzano [2], M. Borghini [2], L. Coppola [3], S. Cusi [4], N. Medeot [5], R. Nair [5], M. Ntoumas [6], A. Olita [2], S. Pensieri [2], G. Petihakis [6], A. Ribotti [2], S. Ruiz [4], K. Schroeder [2] and J. Tintore [4]
[1] Ifremer Centre de Brest, FR, jerico@ifremer.fr - ingrid.puillat@ifremer.fr
[2] CNR ISMAR, IAMC and ISSIA, La Spezia, Genoa, Oristano, Trieste and Venice, IT, stefania.sparnocchia@ts.ismar.cnr.it
[3] CNRS Observatoire Océanographique de Villefranche, FR
[4] CSIC-UIB/IMEDEA and SOCIB, Mallorca, SP
[5] OGS, Trieste, IT
[6] HCMR, Heraklion, GR

Abstract
Existing coastal observatories in European waters are composed of platforms such as moored buoys, piles, profiling systems, gliders, 'ferryboxes' and automated systems on of board ships of opportunity. JERICO project strives to integrate existing infrastructures and provides a platform for the identification and dissemination of best practices for the design, implementation, operation and maintenance of observing systems and the dissemination of data. In order to reach these objectives several kinds of actions are undertaken, amongst which the offer of Trans-National Access (TNA) to a number of coastal observatories and calibration facilities for international research and technology development. This presentation will give a short overview of the selected Mediterranean TNA proposals and a focus will be drawn on some of the TNA results.

Keywords: Instruments and techniques, Coastal engineering, Ligurian Sea, South-Western Mediterranean, North-Western Mediterranean

Coastal observatories dotted along Europe's coastlines deliver a wealth of information on the state of its seas. These observatories are composed of moored buoys, piles, profiling systems, gliders, shore-based HF radars, 'ferryboxes' and automated systems on board ships of opportunity (e.g. fishing boats). JERICO strives to integrate these observatories at the European level, and provides a platform for the identification and dissemination of best practices from the design to the operation and maintenance of observing systems and the dissemination of data. It aids in the optimization of the use of existing infrastructures and in the promotion of interoperability. It has also initiated research to advance the state of the art, and has invited the international scientific community to access key infrastructures. In order to reach these objectives several kinds of actions are undertaken, amongst which the offer of Trans-National Access (TNA) to a selection of coastal observatories and calibration facilities operated by the JERICO Consortium for international research and technology development. A primary objective is to mobilize scientists and engineers across Europe, encouraging firstly those who haven't such facilities at their disposal in their countries. The access offered by JERICO includes ferryboxes, fixed platforms, gliders, and associated support calibration laboratories and a dozen of them are located in the Mediterranean Sea. This presentation will give a short overview of four Mediterranean TNA experiments selected after the first TNA call in 2012 and will focus on a selection of scientific results introduced hereafter. Two of them address calibration and the other two explore scientific themes of interest for the Mediterranean community.

Calibrating sensors regularly is the prime requirement for getting reliable data from coastal observatories and ensuring their long-term relevance as viable providers of information on the marine environment. The OGS-Oceanographic Calibration Centre in Trieste and the calibration facilities at the HCMR Thalassocosmos complex in Crete hosted users for calibration experiments. The first one was accessed by a HCMR team that wished to improve their experience in calibrating high-quality oceanographic temperature sensors using primary ITS-90 reference standards. The experiment involved full calibrations of two SBE 35 thermometers from Sea-Bird Electronics, Inc. owned by the HCMR that will be used as reference sensors for temperature measurements in their calibration laboratory in Crete (Greece). The second one was accessed by a team from CNR-ISSIA with the purpose of enhance the accuracy of dissolved oxygen, chlorophyll-a and turbidity probes used for *in-situ* observations on a long term basis in the W1-M3A off-shore observing system in the Ligurian basin. The performed experiment allowed obtaining an extremely accurate laboratory calibration and a test at sea for oxygen and fluorescence sensors.

Gliders make oceanographic measurements traditionally collected by research vessels or moored instruments, but at a fraction of the costs. The CSIC/IMEDEA gliders infrastructure was accessed by a team from CNR/IAMC Oristano to study the central part of the Algero-Provencal sub-basin, representing a buffer area between the northern Provencal sub-basin and the southern Algerian one, characterized by the presence and action of the Balearic front. The experiment is midway, and a first mission was just concluded, with the deployment of a Seaglider which flew from the surface to about 1000 m following a route between the Balearic Islands and Sardinia. A second mission is planned in early Autumn 2013. This transect is also annually monitored by CNR with CTD and LADCP during oceanographic cruises. The data collected during the glider missions and oceanographic cruises will help to assess the inter-annual variability of physical and biochemical properties of water masses and to understand the exchanges of salt and heat through the sub-basins in the western Mediterranean.

Fixed platforms allow long term -sensor testing and -measurements. The presented experiment is led by CNRS/OBS-VLFR and consists in the implementation of automatic Dissolved Oxygen (DO) measurements in the mooring operated by CNR/ISMAR in the Corsica Channel (Ligurian Sea). The deployment began in November 2012 and is planned to last for twelve months under the aegis of JERICO TNA, then it will continue for at least other six months as a collaboration of CNR/ISMAR, CNRS/OBS-VLFR and the Mediterranean Institute of Oceanography. The final purpose of the research is to integrate the DO concentration in the long term time series data in the Ligurian basin to track and evaluate the water mass variability and to estimate the time lag between the eastern and the western part of the Ligurian Sea. Further observations regularly acquired by sensors installed on the mooring and data collected during the periodic maintenance cruises, will be available for completing the study.

The development of high-quality and comprehensive coastal observing systems has only recently moved forward, principally at national and regional level. In this overall context, the JERICO project aims at creating a solid and transparent organization towards an operational service for the continuous and sustainable delivery of high quality environmental data and information products related to the marine environment in European coastal and shelf seas. It promotes joint research initiatives and standardisation as illustrated by TNA experiments.

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APPLICATION OF A 3D VARIATIONAL SCHEME FOR THE ASSIMILATION OF SURFACE CHLOROPHYLL IN THE FORECAST SYSTEM FOR THE MEDITERRANEAN SEA BIOGEOCHEMISTRY

Anna Teruzzi [1]*, Gianpiero Cossarini [1], Srdjan Dobricic [2] and Cosimo Solidoro [1]
[1] OGS Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - ateruzzi@ogs.trieste.it
[2] CMCC Centro Euro-Mediterraneo sui Cambiamenti Climatici

Abstract
A 3D-variational (3DVAR) scheme is applied to the operational forecast system of the Mediterranean Sea for the assimilation of surface chlorophyll concentration. The core of the 3DVAR scheme is the background error covariance matrix that is decomposed in a series of operators that account for different dynamics of the marine ecosystem. The results show that the assimilation scheme improves the model skill in reproducing observed values and spatial patterns of the chlorophyll and nutrient fields. Moreover, it is shown that the method is modular and capable to be continuously improved, and suitable for implementation in an operational framework.

Keywords: Models, North-Western Mediterranean

Introduction
The use of a three-dimensional variational approach for the operational biogeochemical assimilation may present some advantages compared to other sequential approaches: it is computationally efficient and it does not require the inversion of the background error covariance matrix or of the observational operators [1]. Moreover the background error covariance can be decomposed in a sequence of linear operators that account for different components of the covariance matrix, and the modular structure of the decomposition is particularly suitable for operational applications.

Matherial and methods
In the present study, the assimilation of surface chlorophyll is used to constrain the three-dimensional fields of phytoplankton variables in the biogeochemical forecasting system of the Mediterranean Sea. The numerical model OPATM-BFM is the coupling of properly modified versions of the OPA transport model [2] and the BFM model [3]. The observations consist of satellite surface chlorophyll maps, which are obtained from MODIS optical data by means of an algorithm specifically developed for the Mediterranean Sea [4]. The definition of the background error covariance matrix B is a crucial aspect of the 3DVAR scheme. B is defined in terms of a matrix product $B=VV^T$, where the definition of V can be based on a priori knowledge of the covariance matrix B [1]. And V can be decomposed into a sequential linear multiplication of a number of linear operators Vi. For the assimilation of surface chlorophyll concentration, the decomposition of V is defined as VvVhVb, which is designed to describe the vertical error covariance of the chlorophyll fields (Vb), the horizontal error covariance (Vh) and the state variable error covariance (Vb). In particular Vb provides covariance among the variables which describe the four types of phytoplankton simulated by the model. Moreover, the solution of the assimilation is defined in a reduced order space, where the inversion of B is not required.

Results and discussion
We compared the results of a run that uses the 3DVAR assimilation scheme (AR), with a control run (CR) without assimilation. The results demonstrate that the skill performances of the forecast system are improved by the assimilation of surface chlorophyll. The AR run has better skill in reproducing observed values and spatial patterns of the chlorophyll and nutrient fields than the CR run. For instance, Fig. 1 shows the time series of the mean surface chlorophyll concentration in the CR, AR and satellite for two sub-regions (North Western Mediterranean and Levantine basin, NWM and LEV). For both the sub-regions, the assimilation provides the largest improvement of model performances in reproducing the bloom events from December to March.
However, the results of the NWM indicate that a bloom event, which is not reproduced by the CR in April, is partially corrected by the assimilation. The low efficiency of assimilationhas to be sought in the model formulation and dynamics. More specifically, it has to be ascribed to the low vertical mixing conditions. The absence of the appropriate conditions of vertical mixing implies that nutrients are not transported to the surface layer, and thus the chlorophyll synthesis is strongly limited by the nutrients lack. This result showed the necessity for a further improvement of the error covariance matrix B. A new formulation of the Vb operator that takes into account the missed mixing conditions, has been developed and successfully tested. The present study shows that 3DVAR approach is suitable for the application in the biogeochemical operational forecasting, because the modular structure of the Vi operators allows for continuous improvement of the assimilation scheme.

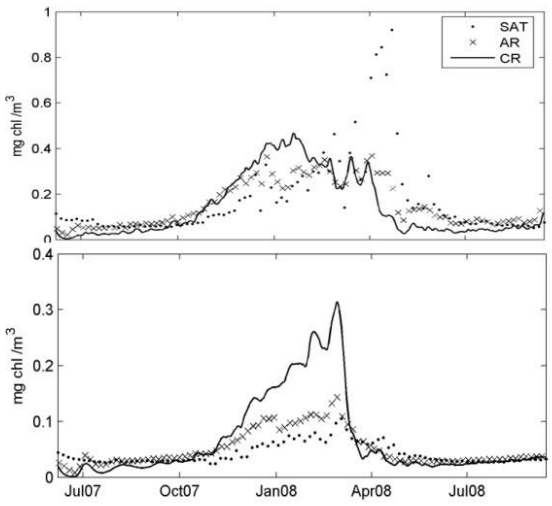

Fig. 1. Time series of surface chlorophyll concentration as observed by satellite (SAT) and modelled in the CR and AR. Spatial mean over the NWM (upper panel) and LEV (bottom panel).

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THE IMPACT OF NEW MULTI-PLATFORM OBSERVING SYSTEMS IN SCIENCE, TECHNOLOGY DEVELOPMENT AND RESPONSE TO SOCIETY NEEDS; FROM SMALL TO LARGE SCALES…

Joaquin Tintoré [1]* and SOCIB/IMEDEA science&technology team [2]
[1] SOCIB and IMEDEA (CSIC-UIB) - jtintore@socib.es
[2] SOCIB and IMEDEA (CSIC-UIB)

Abstract
New technologies are key components of recent observing systems that enhance the capabilities to characterise ocean state and variability in quasi real time today. The challenge for the next decade is the integration of theses technologies and multiplatform observing and forecasting systems to (a) monitor the variability at small scales (e.g. mesoscale/weeks) to (b) resolve the sub-basin/seasonal and inter-annual variability and by this (c) establish the decadal variability, understand the associated biases and correct them. Recent studies from SOCIB have shown the importance of this new small to large-scale multi-platform approach in ocean observation. Some examples will be discussed together with initial ideas on the new capabilities to respond to science priorities, technology development and response to strategic society needs.

Keywords: Mesoscale phenomena, Balearic Islands, Coastal systems, Coastal management

New technologies and small scales. New monitoring technologies are progressively implemented in the world oceans leading to major changes in our understanding of their variability. Gliders, soon to become fleets of gliders, are an example of theses new technologies implemented in coastal to open ocean regions allowing repeated high resolution monitoring of specific areas, by this showing the dynamical relevance of new features, such as for example sub-mesoscale eddies characterised by strong horizontal gradients and intense vertical motions. These eddies, that could not be routinely monitored before, interact with the underlying mean flows, and can block the general circulation in key ocean regions; or they can give rise to enhanced upper ocean biogeochemical exchanges modifying the ecosystem response at a scale that was not previously observable on a routine basis. These are just two examples of the contribution of new technologies to address and better understand state of the art oceanic questions of worldwide relevance in a climate change context.

Multi-platform integrated systems. When different types of these new monitoring technologies are implemented and used together with more traditional platforms, we are then confronted with the new multi-platform integrated observing systems –also called ocean observatories- that are being established in the world oceans. Theses new observing systems respond to a twofold **change of paradigm** in ocean observation that, following Delaney and Barga (2009) will be presented and discussed. These observing systems can in turn be integrated with powerful modelling and forecasting systems available today, giving rise to the new multiplatform observing and forecasting systems that can allow us to describe the three-dimensional oceanic structures and understand the underlying processes of multiple interacting spatial and temporal scales that characterise the variability of our oceans. Theses systems are already providing answers to state of the art scientific questions, enhancing technology development and increasing our capability for knowledge-based response to society needs. This is the mainstream activity of SOCIB and IMEDEA (CSIC-UIB) in the frame of ongoing EC funded initiatives such as PERSEUS, JERICO, GROOM, E-AIMS, TOSCA, MEDES4MS, or MyOcean2 among others and is also at the core of the new EC initiatives on Marine Research infrastructures.

SOCIB. The **B**alearic **I**slands **C**oastal Ocean **O**bserving and Forecasting **S**ystem, is one such ocean observatories, a new multiplatform observing and forecasting system, a facility of facilities extending from the nearshore to the open sea. SOCIB provides streams of oceanographic data and modelling services to support operational oceanography in a European and international framework, therefore also contributing to the needs of marine and coastal research in a global change context. SOCIB benefits from the strategic position of the Balearic Islands, an Atlantic/Mediterranean transition area, one of the 'hot spots' of biodiversity in the world's oceans and was the logical step to more than 25 years of work in physical oceanography in the Balearic Islands. SOCIB (Tintoré et al., 2013), is unique among the new observing and forecasting systems in that its mission and objectives are science, technology and society driven. Together with NANOOS it is one of the few examples that run from the coastline to the open ocean. Seven major **Observing Facilitie**s are now operational: a 12 MHz long range HF radar system in the Ibiza channel, coastal and open ocean gliders, coastal moorings and fixed stations, Argo profilers and surface drifters, a nearshore monitoring system of selected beaches and a new coastal catamaran (24 m LOA). The **Modelling Facility** is presently running an operational ROMS model for ocean currents (WMOP, nested to MONGOOS/MFS system), a wave operational system (established together with *Puertos del Estado*), as well as a pre-operational meteo-tsunami system to support Balearic harbours authority. The **Data Centre Facility** is the core of SOCIB and is developing and implementing a data management system following international standards of quality assurance and inter-operability. It is also performing specific developments and tools for the different facilities. Its main functions and capabilities range from data reception to its distribution and visualization (via web services and THREDDS/OPeNDAP protocols), passing through processing, quality control, documentation, standardization and archiving (NetCDF format and CF conventions), and data discovery (based on OGC protocols).

Key challenges. The challenge for the next decade is the integration of new technologies and multiplatform systems selecting key control sections in coastal/open ocean regions, major straits or channels for routine monitoring of these control or choke points (following Heslop et al., 2012) to establish ocean state and variability, evaluating for example the relevance of mesoscale activity, shelf/slope exchanges, water masses formation, etc. The impact of these new systems cannot be overlooked and it is important we face and prepare the forthcoming generations and ourselves. These types of new marine infrastructures are presently establishing new ways of international cooperation that will lead to major science breakthroughs, innovations in oceanographic instrumentation and new ways of science based coastal and ocean management.

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Session

Physical and biogeochemical modelling

Modérateur : **Javier Ruiz**

DEVELOPMENT OF A NOVEL TOOL TO PREDICT DIFFERENT WATER QUALITY SCENARIOS WITHIN A MARINE PROTECTED AREA (MPA) IN THE MALTESE ISLANDS: THE 2D SHYFEM-BFM MODEL

A. Cucco [1], G. Umgiesser [2], A. Deidun [3]*, R. Tarasova [3], J. Azzopardi [3] and A. Gauci [3]
[1] IAMC-CNR, TorreGrande loc. Sa Mardini, 09170 Oristano, Italy
[2] Institute of Marine Science - National Research Council (ISMAR-CNR), Venice, Italy
[3] IOI-MOC University of Malta - alan.deidun@um.edu.mt

Abstract
Effective operational marine conservation and management is thwarted by a lack of financial and human resources. A coupled 2D hydrodynamic (SHYFEM) and ecological (BFM) model was developed in the current study as a Decision Support System (DSS) to spearhead good governance of a Marine Protected Area (MPA) in Dwejra (Maltese Islands) in the Central Mediterranean. Two scenarios were considered – one with the current levels of nutrient runoff from land and one in which such levels are increased as a result of a greater human activity within the area. Although the developed numerical modeling platform needs to be refined and to be run for a longer time-frame, its output suggests that it is a promising tool to assist in the operational management of an MPA.

Keywords: Models, Nutrients, Diatoms, Dinoflagellates, South-Central Mediterranean

Introduction
One of the most frequent and impacting vectors of changes in the environmental status of coastal areas is the input of dissolved nutrients, from both point and diffused sources.The simultaneous occurrence of high nutrient loads, high water temperatures and low hydrodynamic flushing of water bodies may lead to dystrophic and anoxic events, with cascade effects on the entire marine ecosystem. Understanding and predicting the mechanisms leading to such events is therefore of fundamental importance for a proper management of the marine environment within marine areas of high conservation value, such as MPAs. The operational monitoring of the relevant water parameters is frequently thwarted by prohibitive demands on costs and manpower.

Materials and Methods
In this context, we developed an integrated numerical platform that is able to provide, operationally, an evaluation of the Current Environmental Status (CES) of the Dwejra MPA on the island of Gozo (Maltese Islands, lon=14° 11'17"; lat=36°03'14"). This system is based on a coupled 2D hydrodynamic and ecosystem model and constitutes a pilot case of a Decision Support System (DSS) formulated to support the governance of an MPA's coastal waters, capable of forecasting different water quality scenarios arising under different nutrient loads. In particular, an ecological model (BFM - Vichi et al. 2007) and a shallow water finite element hydrodynamic model (SHYFEM – Umgiesser et al., 2004) have been coupled to each other (Cucco et al., 2012) and applied to reproduce the main hydrodynamic and biogeochemical processes affecting the water quality features within the Dwejra MPA in Gozo. Both hydrodynamic and biogeochemical flux models run operationally to predict, on a daily basis, the changes in both hydrodynamic and biogeochemical variables. The hydrodynamic and biogeochemical model domain covers the coastal waters of the Malta archipelago in their entirety (up to a distance of 20 km from the coast) by means of an unstructured grid, with a spatial resolution varying between a few km for offshore areas to a few hundred meters for the more coastal areas around the Dwejra site. Boundary conditions for the hydrodynamic module were provided by the ROSARIO sub-regional oceanographic prediction system (ROSARIO, 2006), whereas boundary conditions for the biogeochemical module were downloaded from MyOcean Web data services (MyOcean, 2012). Responses of ammonium, diatoms, dinoflagellates, carnivorous and omnivorous zooplankton to varying input of nitrates to the aquatic system in question were monitored. About 110 boathouses, frequented by approximately 220 persons annually, mainly during the spring and summer periods, are located around the periphery of the same lagoon. The nutrient loads produced by the boathouses were estimated by means of the so-called "*equivalent population*" procedure. This method is based on an estimation of the nutrients concentration of the sewages generated by anthropogenic activities. Considering the boathouse agglomerate as a 'camping' activity, for which 1 EI corresponds to 2 physical persons frequenting the area, an equivalent population of about 110 EI was adopted to represent the current scenario. Adopting the same table of conversion from EI to nutrients loads adopted in Italy, the wastewaters produced daily by each EI is characterized by a BOD_5 at 20° C equal to 60g of oxygen (Art.74 of Law 152/06 of the Italian Ministry of the Environment). A set of 2 simulation scenarios have been carried out for the 1st July-1st September period (when boathouse occupation levels are highest). Such an exercise involved varying the value of EI in the area, to represent a corresponding increase in the number of boathouses in the area, from the current number of 110 boathouses to 160, in order to explore the water quality consequences of a more permissive environmental policy in future.

Results and Discussion
According to the output of the developed numerical platform, a scenario where nutrient (nitrate and phosphate) input to the coastal area is increased (as a result of the increase in boathouses in the area) is also characterized by a corresponding increase in ammonium levels, which increase by approximately 30%, and in dinoflagellate populations, whose annual blooming at this time of year in the Mediterranean (e.g. Daly Yahia-Kefi et al., 2005) is further accentuated. Diatom populations, already depressed at this time of year in the Mediterranean (e.g. Daly Yahia-Kefi et al., 2005), do not exhibit any significant increases in their abundances in the EI160 scenario, as do both omnivorous and carnivorous zooplankton classes. The fact that no cascade effect of the surge in nutrients up different trophic levels within the pelagic food web at Dwejra was observed might be due to the intense hydrodynamic flushing and advection that the Dwejra area is generally subjected to, which in turn results in low nutrient residence times within the lagoon. Such observations are further confirmed through the results of a third simulation (assuming an EI value of 210), run over the 1st June-30th September period.

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MIXING VOLUME: A HYDRODYNAMICS INDICATOR FOR ECOLOGICAL STUDIES

A. Fiandrino [1]*, V. Ouisse [1], F. Dumas [2], S. Le Noc [3], F. Lagarde [1] and N. Malet [4]
[1] Ifremer - LER LR - Annie.Fiandrino@ifremer.fr
[2] Ifremer DYNECO/PHYSED
[3] UMR 5119 ECOSYM Université deMontpellier
[4] Ifremer LER-PAC

Abstract
The cleaning capacity of Mediterranean lagoons depends largely on hydrodynamics. We propose for such semi-enclosed ecosystems a hydrodynamics indicator, i.e., the mixing volume. This indicator allows discriminating between areas where the lagoon water is well-mixed with the inflowing sea water, and confined areas. An application of this indicator is presented for the Bages-Sigean lagoon and its use for biogeochemical budget modelling for studies of eutrophication phenomena will also be discussed.

Keywords: Restoration, Eutrophication, Lagoons, North-Western Mediterranean

Mediterranean coastal lagoons are semi-enclosed ecosystems subject to intensive anthropogenic inputs and its cleaning capacity depends on three main hydrodynamic factors: flushing potential of tide, meteorological forcing and freshwater runoff. The efficiency of physical cleaning processes is commonly approached with residence time. This hydrodynamics indicator is not sufficient for addressing ecological questions that need a spatio-temporal indicator to distinguish between areas where the lagoon water is well-mixed with the inflowing sea water, and confined areas. We propose a hydrodynamics indicator the mixing volume that can be estimated using hydrodynamics modelling and based on the renewal time concept defined for well-mixed tank (Figure 1).

Fig. 1. Cartography of renewal time into the Bages-Sigean lagoon calculated using the numerical hydrodynamics MARS-3D model.

An example of calculation of the mixing volume is shown for the Bages-Sigean lagoon (Western Mediterranean French coast) using the numerical hydrodynamic MARS-3D model [1].
Preliminary results show how this indicator varies during the year responding to the seasonally changing environmental conditions. It appears that the mixing volume, depending on wind and tide induced water body circulation, exhibits a low seasonal variability (Figure 2). In the Bages-Sigean lagoon water body circulation is strongly constrained by the complex lagoon topography (Figure 1).

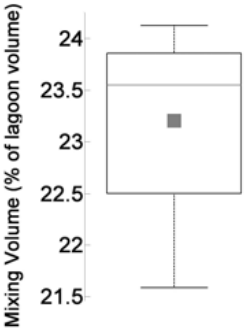

Fig. 2. Variability of the "Mixing Volume" indicator under different environmental conditions expressed as a percentage of the whole lagoon volume (i.e. 65 Mm3).

We will finally present the use of this mixing volume to improve how hydrodynamics processes can be taken into account in spatially not explicit budget models (LOICZ-like model) that are applied on coastal lagoon ecosystem to study eutrophication phenomena.

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RESPONSE OF THE PELAGIC ECOSYSTEMS TO THE DEEP CONVECTION IN THE NORTHWESTERN MEDITERRANEAN SEA

Fayçal Kessouri [1]*, Caroline Ulses [1] and Claude Estournel [1]
[1] Laboratoire d'Aérologie, Observatoire Midi Pyrénées - Faycal.Kessouri@aero.obs-mip.fr

Abstract
The north western mediterranean deep convection redistributes organic and inorganic matters all over the water column; the consequent spreading of the deep and intermediate waters induces important modifications of the biogeochemical budgets also far from the NWM region. The large and intense bloom of the NWM that follows winter mixing represents the most important process of the basin itself probably at the origin of large carbon export to the deep layers and high biodiversity of the region. The presentation focuses on the modeling of an annual cycle also documented by observations at different periods.

Keywords: Models, Water convection, Blooms, Nutrients, North-Western Mediterranean

Similarly to most of the temperate regions of the global ocean, but conversely to the rest of the basin, the North Western Mediterranean is characterized by a bloom-like trophic regime.
The general objective is to understand the sensitivity of the North Western Mediterranean biogeochemical behaviors to the alterations/modifications of the environmental forcing [1,2]. The first step is to assess the coupled modeling performances in relation with the CASCADE and the DeWex experiments of the MERMEX-MISTRALS program to represent the most important processes of the basin in terms of primary and secondary productions and export toward the deep layers. A modified version of the high resolution 3D model ECO3M-S [3] was coupled to the hydrodynamic SYMPHONIE model [4]. The model configuration had a 1 km horizontal resolution, and uses 40 vertical sigma levels. . Two data sets of atmospheric and oceanic forcing at different resolution have been used. Different options for the initialization and boundary conditions of the biogeochemical model have also been tested. A simulation running from January 2011 to December 2011 was analysed. Comparisons were performed with the available data set including nutrients, dissolved and particulate organic matter from the CASCADE experiment in March 2011 during mixed to weakly stratified conditions and the MOOSE experiment in May 2011. Sea surface chlorophyll concentrations were also compared with the 4 km resolution Modis satellite images .

The results illustrate :
- the spatial and temporal evolution of convection and how the associated physical structures affect the ecosystem (planktonic groups..),
- the quantification of the N/P ratio, its evolution along the seasonal cycle and its impact on the zooplankton and phytoplankton groups,
- the spatial evolution of the nutriclines and of the bacterial distribution,
- and finally, the history of the planktonic ecosystem during the key periods for the North Western Mediterranean including the winter mixing, the bloom development and the complete establishment of the stratification.

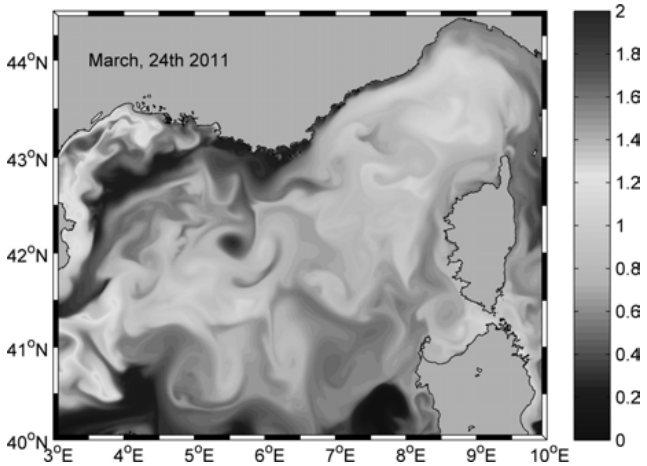

Fig. 1. Chlorophyll a concentration (in µg/l) during the spring bloom in the north western mediterranean sea from the SYMPHONIE/ECO3M high resolution model

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RECOMMENDED METHODOLOGY AND CONSIDERATIONS FOR ACCEPTANCE OF THE CALIBRATION AND VALIDATION OF A HYDRODYNAMIC MODEL

Sergiu Dov Rosen [1]*
[1] Israel Oceanographic & Limnological Research - IOLR - rosen@ocean.org.il

Abstract
This paper present a concise set of model calibration and validation criteria, based on a number of extensive numerical coastal hydrodynamics and water quality model studies, for which the author served as specifyier of the modeling conditions, data provider, supervisor and reviewer.

Keywords: Models, Coastal models, South-Eastern Mediterranean

Purpose
Marine and coastal developments are nowadays based on a-priori ecological modeling using numerical models of the hydrodynamic transport integrated with bio-geo-chemical numerical models. The reliability of the model outcomes depend not only on the ability of the numerical tools to simulate the various hydrodynamic and ecological processes, but to a high degree, also on performing a proper calibration and validation of the models. Below we present a concise set of criteria required to obtain reliable outcomes from hydrodynamic models of the coastal zone. They were derived based on extended experience of the author in providing data and specifications suited to the modeling goals, supervision and results review of extensive numerical modelling studies, using leading edge software packages by renown commercial bodies. The outcomes are summarized in the following lines and are suitable to be applied for similar modelling investigations.

System Performance Criteria
Model calibration should be performed generally in accordance with the criteria agreed. The overall model performance for obtaining an acceptable calibration and validation of the model should be based on a number of **system performance criteria** (an assessment of whether or not the results obtained via the calibration and validation process of the model are satisfactory for a reliable assessment). The main purpose is to ensure that controlling factors and processes for the simulations are satisfactorily represented by the model. It is noted that the system performance criteria are considered the most important elements for the acceptance of the calibration and validation of the hydrodynamic modeling.

System Performance Criteria consist of:

1. Checking the calibrated model's ability to represent the general and observed current patterns in the study region – comparison of simulated and measured snapshots of the currents for various flow situations (both directions alongshore currents, on-offshore currents, calm conditions, stormy conditions).
2. When relevant - check the calibrated model's ability to represent the general and observed flow patterns in the study region – comparison of simulated stratification pattern with observed vertical profiles (flow, temperature, salinity) represented in the model.
3. When relevant - check the calibrated model's ability to properly simulate the transport of pollutants – comparison of measured and simulated concentration distribution (nitrogen, phosphorous, TSS).
4. When relevant - check the calibrated model's ability to reproduce observed variability in water quality (Chlorophyll, nutrients, dissolved oxygen) in selected zones of the study region – comparison of simulated and measured ranges in dedicated zones.
5. When relevant - check the calibrated model's ability to obtain expected residence times in selected zones of the study region – comparison against previous studies.

Supporting Performance Criteria
It is understood that specification of criteria for hydrodynamic and water quality calibration, without provision of a detailed data set for the modelling (input data as well as calibration data), may result in unrealistic model performance, hence the outcomes must be evaluated against the system performance criteria as specified above. However, as a supporting instrument, also quantitative performance criteria for certain hydrodynamic and water quality selected parameters should be used in the assessment. The quantitative performance criteria outlined below constitute the required performance for stations/zones where sufficient data for both the measured parameters and the underlying controlling input data (such as wind, solar radiation, fluxes and concentrations at model boundaries, pollution loading etc.) exist.

Hydrodynamic parameters:

a. Sea levels (RMS error between measured and simulated levels, corrected for datum differences) within 15% of the monthly tide range, defined by the values of the monthly averages of the daily measured tide lows and tide highs, provided the trends are similar. Timing of highs and lows accurate to the hourly time.

b. Current speeds (average deviation between measured and simulated speeds) within 20% of the monthly average current speed. Current speeds below 1cm/s will not be included in the computation.

c. The current directions differences between the measured and simulated main monthly currents should be confined within a ± 10 deg range. The main directional sectors to be identified from current roses, and the main directions to be calculated as the mean direction in each directional sector weighted with respect to the speed (both for measured and simulated data). This criterion will apply to locations with pronounced and reasonably easily identifiable main current directions.

d. Current speed and direction vertical profile distribution within the criteria under **b** and **c**, provided also that measured and modeled currents profiles have in general similar trends.

e. Timing of values accurate to the hour, months are defined by Gregorian calendar.

f. The above sea level and current criteria are applied to the model calibration period as well as the model validation period.

The cal/val process must be presented in a detailed report including reasoning and main results, prior to cal/val acceptance of the model. Proper details for Initial Conditions and for Boundary Conditions, including for wind, currents (including wave induced currents where relevant), sea levels, etc.

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ATLANTIC INFLOW CONTROLS FISH RECRUITMENT AT THE WESTERN MEDITERRANEAN

J. Ruiz [1]*, D. Macias [1], M. M Rincon [1], A. Pascual [2], I. Catalán [2] and G. Navarro [1]
[1] Instituto de Ciencias Marinas de Andalucia (CSIC) - javier.ruiz@icman.csic.es
[2] Instituto Mediterraneo de Estudios Avanzados (CSIC)

Abstract
The eastward current at the Strait of Gibraltar (the Atlantic Jet) fertilizes the southwestern Mediterranean and it is the responsible for the comparatively high fish landing of this region. However, we demonstrate in this communication that the high kinetic energy of this current negatively impacts the recruitment of anchovy owing to the advection and dispersion of larvae and post-larvae. The inhibitory effect of kinetic energy on anchovy landings is not a transient but a persistent state. Only an exceptional combination of events can release anchovy recruitment from this inhibition to create landing outbreaks. We disentangle here what are these events and their high sensitivity to climatic fluctuations.

Keywords: Fisheries, Alboran Sea, Mesoscale phenomena, Recruitment

A comparative analysis of historical anchovy (*E. encrasicolus*) fisheries record [1] and data from remote sensors [2] indicates that anchovy recruitment in the Alborán Sea is extremely sensitive to the Atlantic Jet (AJ) flowing eastward from the Strait of Gibraltar. During the 17 years analyzed, anchovy recruitment was largely unconnected to the spawning stock biomass in the area. However, conditions where the AJ had a strongly weakening were able to create years of massive landings.

One of such rare events occurred at the year 2001 when the AJ, and its associated western anticyclone gyre, almost vanished during autumn and winter. This persistent absence created exceptional conditions for recruitment because of diminished advection and dispersion of early stages thus creating an exceptional year for catches. This pattern of enhanced recruitment during weak AJ is coherent with in situ observations on the effect the AJ has on ichthyoplankton distribution in the northwestern Alborán.

AJ incursions to the north are accompanied by a substitution of neritic ichthyoplankton (such as anchovy) by oceanic ones in the shelf [3]. These results show the high sensitivity of Western-Mediterranean fish to the Mediterranean-Atlantic balance of water masses and, therefore, to the climate changes that control them.

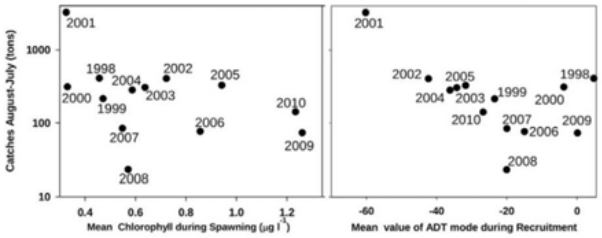

Fig. 1. Recruitment versus chlorophyll and a tracer of AJ-WAG strength in the Alborán Sea.

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Session

Sub-mesoscale variability

Modérateur : **Nadia Mkhinini**

OBSERVATIONS OF SUBMESOSCALE COHERENT VORTICES OF LEVANTINE INTERMEDIATE WATER: FORMATION AND ROLE IN THE CIRCULATION OF THE WESTERN MEDITERRANEAN SEA

A. Bosse [1]*, P. Testor [1], L. Mortier [2], L. Beguery [3], K. Bernardet [3], L. Prieur [4], V. Taillandier [4] and F. D'Ortenzio [4]
[1] CNRS-Université Pierre et Marie Curie, LOCEAN/IPSL, Paris, France - bosse@locean-ipsl.upmc.fr
[2] ENSTA-ParisTech, Palaiseau, France
[3] CNRS-DT INSU, La Seyne sur Mer, France
[4] CNRS-Université Pierre et Marie Curie, LOV, Villefranche-sur-mer, France

Abstract
Repeated observations made by gliders in the Ligurian Sea have revealed the presence of anomalously warm and saline sub-thermocline eddies. They are likely formed along the shelf slope off West-Saridinia during upwelling events generated by northerly winds, have a life time much greater than two months and are expected to participate both in the spreading of the Levantine Intermediate Water in the whole basin and in the preconditioning of deep convection in the Gulf of Lion.

Keywords: Intermediate waters, North-Western Mediterranean, Mesoscale phenomena, Turbulence, Upwelling

Since 2010, sustained observations of the circulation and water properties of North-Western Mediterranean Sea have been carried out in the framework of MOOSE [1]. As an important part of this integrated ocean observing system, gliders [2] are regularly deployed in the Western and Eastern parts of this basin and revealed, in particular, outstanding warm core eddies in the Ligurian Sea.

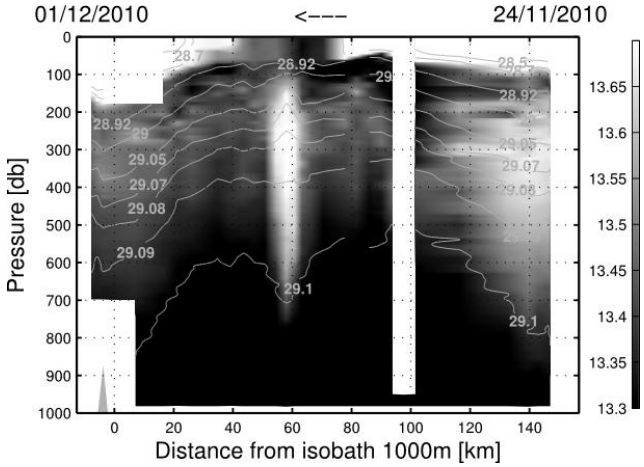

Fig. 1. Temperature section [°C] and density contours [kg/m^3] across the Ligurian Sea revealing the presence of a warm core subsurface eddy.

These eddies are characterized by a low-stratified core located at about 400m depth. Their cores are composed of Levantine Intermediate Water (LIW) and are much warmer (+0,3°C) and more saline (+0,1psu) than the surroundings. They have a radius of about 5km, which is order of the internal deformation radius (~5-15km). The lenticular shape of the isopycnal deformation associated with these eddies below the thermocline is a typical feature of sub-thermocline Submesoscale Coherent Vortices [3]. Geostrophic velocities computed from the glider section with a reference given by the depth-averaged velocity estimates from the gliders navigation lead to velocity maximum within the eddies of about 5-10cm/s, which corresponds to a Rossby numbers of 0,1-0,2. Nevertheless, the small radius of these SCVs regarding the internal deformation radius suggests an importance of the centrifugal force in the cyclostrophic balance and thus higher relative vorticity than estimated.

In order to track back their formation area, we analysed the LIW characteristics over the whole Western Mediterranean by taking all available Argo and CTD profiles performed during the last few years [4]. The data show the LIW Vein flowing northward at intermediate depth along the Sardinian coast and its slow erosion in terms of T/S characteristics while flowing to the North. Due to dynamical barriers, the waters composing their cores should have similar characteristics (or slightly less pronounced) while tracing back to their formation area. So, they are most likely formed along the shelf-slope West of Sardinia at around 41°N. The observations of the LIW SCVs are separated of about 250km from their hypothetical zone of formation. If we therefore assume them to be advected at about 5cm/s (mean currents are not very strong at depth), they should have spent at least two months to travel North to the place where they were observed.

Sea Surface Temperature images of the West coast of Sardinia often exhibits cross-shore positive temperature gradient, sign of an upwelling caused by strong northerly wind events. From a CTD and a glider section realized during two different upwelling events, we were able to observe an uplift of the isopycnals at depth as observed in upper part of the LIW SCVs. The baroclinicity of the flow is enhanced during such upwelling events and the LIW Vein takes the form of an undercurrent isolated from the surface. Dynamical processes likely implicating the interaction of the flow with the topography (change in slope steepness, corner-shaped isobaths at around 41°N [5]) and the wind forcing should then be at play to destabilize the flow and eventually detach the eddies.

These particular kind of SCVs transporting LIW should have strong implications for the physics of the basin. They likely play an active role into the spreading of the LIW (like the Sardinian Eddies formed at the south-west corner of Sardinia [6]) and this is especially important to set the stratification of the Northern basin before the winter. This is critical for the deep convection phenomenon, since their low-stratified core furthermore locally precondition the water column and favour the winter vertical mixing.

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PROBING COASTAL DYNAMICS BY HF RADAR OFF PROVENCE COASTS (FRANCE) AND APPLICATIONS

P. Forget [1]*, Y. Barbin [1], L. Bellomo [1], P. Fraunié [1], K. Guihou [1], C. Quentin [1], J. Marmain [1], A. Molcard [1], Y. Ourmières [1] and B. Zakardjian [1]

[1] Mediterrenan Institute of Oceanology - philippe.forget@univ-tln.fr

Abstract

An HF radar system has been deployed along the Provencal coasts for probing the surface circulation in this region which is characterized by a large scale flow (Northern Current) and by a broad range of other scales of variability induced by meteorological and tidal forcing. The presentation is an overview of the radar network, of the surface current mapping facility offered by the system, of recent observation results and of an application in assimilation of radar data.

Keywords: Coastal processes, North-Western Mediterranean, Circulation, Remote sensing

An HF radar system has been implemented for 3 years in the region of Toulon-Hyeres (France) with the objective of probing the surface current variability with large spatial coverage (50 km), at relevant time and space resolutions (1 hour-5 km) and during a significant period of time (several years).

The mapping of surface current by radar primarily addresses the variability of the Northern Current (NC), flowing in the North Western Mediterranean, and the meso/submesoscale activity in the region. This remote sensing activity is performed in conjunction with high resolution modeling, measurements at sea and the collection of other remote sensing data (SST, altimetry).

An operational perspective is also targeted in the frame of the emerging Mediterranean Ocean Observing System on Environment (MOOSE, INSU-CNRS). A first step was reached recently by radar derived current maps provided in real time on a web interface.

The radar has been single-site during the first 1.5 years and then dual-site up to now. The network uses monostatic and bistatic radar units.

This presentation presents the radar system and emphasizes on its relevance to meet the scientific objectives and also to satisfy a large variety of users.

Recent results are shown concerning the NC variability over 3 years, showing in particular the bathymetric guiding effect (figure); the main periods of variability as revealed by spectral analysis; signatures of remarkable features like meandering and frontal events; an overview of recent results on data assimilation of radar currents to optimize wind and open boundary forcing of a regional NEMO-based model (Glazur64).

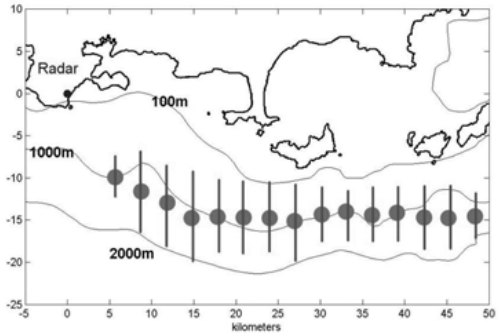

Fig. 1. Radar derived mean position of the Northern Current over 28 months (red points) and corresponding rms bars in the Toulon-Hyeres region.

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MESOSCALE AND SUB-MESOSCALE VARIABILITY ALONG THE COASTS OF THE SOUTHEASTERN TYRRHENIAN SEA

Anna Maria Fragliasso [1]*, Giannetta Fusco [1] and Giorgio Budillon [1]
[1] Università degli Studi di Napoli 'Parthenope' - anna.fragliasso@uniparthenope.it

Abstract

The dynamical aspects of the Southeastern Tyrrhenian Sea were studied using data provided by moored Acoustic Doppler Current Profilers (ADCPs) located along the southern coasts of Italy. The observations highlighted the variability of the long-shore currents and showed the presence of a surface jet north of the Strait of Messina due to the atmospheric forcing. In order to study the dynamical variability, we used the wavelet analysis and identified the presence of inertial oscillations and internal waves, linked to the tidal regime of the area.

Keywords: Mesoscale phenomena, Tyrrhenian Sea

The Southeastern Tyrrhenian Sea is characterized by a dynamics strongly connected to the presence of a complex bathymetry and influenced by several narrows, such as, the Strait of Messina that connects the Ionian and the Tyrrhenian Seas. The analysis of ADCPs data acquired from February to September 2008 between Sicily and Campania (fig.1) showed a typically barotropic behavior with changes in direction and intensity mainly due to the basin scale circulation [1].

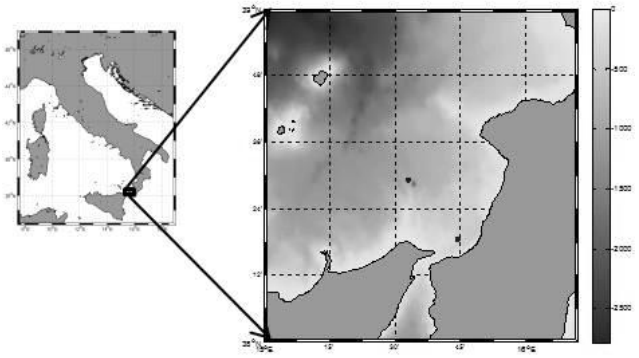

Fig. 1. Moorings Positions.

Moreover, our results showed that under particular atmospheric conditions, the presence of a strong coastal current is established in the surface layer, highlighting the existence in the mixed layer of a strong surface jet flowing towards NE north of the Strait (fig.1) from mid-May to mid-June, characterized by maxima speed values of about 30 cm/s on both zonal and meridional components of the current (fig.2a-2b).
Wind data provided by the European Centre for Medium-Range Weather Forecasts (ECMWF) showed that during the same period the wind was mainly directed towards NW. According with Ekman's theory, we observed a clockwise rotation in direction and a decrease inmagnitude of the currents with the depth (fig. 2a-2b).
This direct relationship between surface currents and the wind stress was assessed by means of the Cross-Wavelet (XWT) and the Wavelet Coherence (WTC) analysis, highlighting a strong in-phase correlation on both zonal and meridional components during the observed jet. It is well known that the Ionian and the Tyrrhenian Seas, at the sill of the Strait of Messina, show an opposite configuration of tidal regimes, that seems to be responsible for the development of internal waves trains propagating from the sill northward and southward of the Strait [2].Our tidal analysis on the U and V components of currents, acquired by two ADCPs north of the strait (fig.1), has confirmed previous results [3], highlighting the prevalence of semi-diurnal component in the whole area. The wavelet analysis of residual currents, showed the presence of several harmonics, such as those related to the inertial motion with an oscillation period of about 17 hours or internal waves with a period shorter than 20 hours. These waves, with a sub-inertial oscillation frequency, are a particular type of waves guessed and observed at straits similar to that of Messina. Here, the tide generates waves trains propagating towards north and south and are typically caused by the sudden depth increase just out of the sill of the strait. These waves oscillate with a frequency lower than the tide that generated them and propagate over long distances. Our observations and analyses show the presence of mesoscale structures and phenomena of particular interest, such as internal waves and inertial motion, highlighting the importance of the Southeastern Tyrrhenian Sea dynamics and the need to broaden the knowledge of this area.

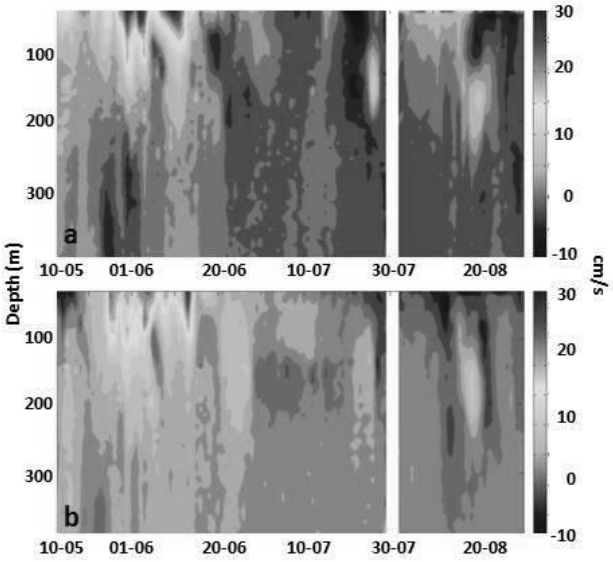

Fig. 2. Temporal evolution of zonal (a) and meridional (b) components of current North of the Strait of Messina.

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BLACK SEA ANCHOVY *(ENGRAULIS ENCRASICOLUS PONTICUS)* TRANSPORT PATHWAYS

Ceren Guraslan [1]*, Bettina Fach [1] and Temel Oguz [1]
[1] IMS-METU - ceren@ims.metu.edu.tr

Abstract
Overwintering migration of Black Sea anchovy from the northwestern shelf to the southeast coast of the Black Sea is investigated using a Lagrangian particle-tracking model. By releasing drifters into surface currents calculated from satellite data, transport pathways of anchovy were simulated during different years and seasons. Simulations included different types of swimming behavior. Dominant pathways for anchovy to migration towards the southeast are suggested as direct transport from the Crimea south, transport along the Eastern Gyre following the Rim Current and transport across the Eastern Gyre.

Keywords: Black Sea, Migration, Models

Introduction
Anchovy migration in the Black Sea is not well understood and contrasting theories on overwintering migration exist. One theory is that anchovy are doing extensive overwintering migration from the spawning ground at the northwestern shelf to the southeastern coast of the Black Sea by beginning of October [1] or early autumn [2], while others suggests that anchovy spawning grounds are located in the southern region [3] and hence only local anchovy of the southern Black Sea migrate to this overwintering ground. Also it is know that anchovy migration is driven by ambient temperature criteria [1]. The present work focuses on elucidating which migration routes are feasible for anchovy to complete successful migration to the overwintering grounds depending on the interannual variability of ocean currents and sea surface temperature distribution.

Methods
Surface circulation fields were calculated from AVISO (Archivinig, Validation and Interpretation of Satellite Oceanographic data) sea surface height anomaly data. A Lagrangian particle-tracking model was used. Sea surface temperature optimal was obtained from AVHRR (Advanced Very High Resolution Radiometer) temperature product for the Black Sea. A total of 1026 drifters were launched along the northwestern shelf at different times during autumn of different years (2001-2003) that span a variety of environmental conditions in the Black Sea. To account for behavior, directional swimming with differential swimming speeds and directions (i.e. SE, ESE, SSE) were added on top of advection to test how many drifters arrive successfully to overwintering rounds and in what amount of time. Temperature thresholds of 13.5^{o}, 15^{o} and 17^{o}C were tested as the maximum allowable temperature for them to start active migration.

Results
Sea surface temperature varies greatly between years and is known to influence anchovy migration. Using 17^{o}C as threshold below which anchovy migration starts defines areas from which anchovy may start migration. Choosing lower temperature thresholds allowed no migration in the years of interest during fall. Directional swimming towards ESE at 1-2.5 body length per second is the most successful swimming behavior.

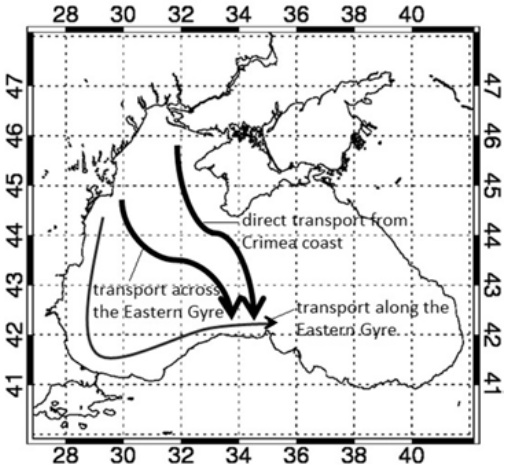

Fig. 1. Conceptual figure of anchovy pathways.

Three different pathways identified for anchovy migration (Fig.1): 1) direct transport from Crimea to the Turkish coast midway between the Eastern and Western Gyre, 2) transport along the eastern and then the southern edge of the Eastern Gyre following the Rim Current, and 3) transport through the Eastern Gyre. Moreover, anchovy located near the Danube plume, Kali-Akra and Constantsa regions of the NWS, prefer transport pathways 1, 2, and 3, respectively. Furthermore, the Danube and Sevastopol eddies and the cyclonic quasi-stable inner cell, as well as the Sinop and Kizilirmak eddies enhance anchovy transport.

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EDDY TRACKING AND QUANTIFICATION IN THE EASTERN MEDITERRANEAN SEA: DATA AND MODELS

N. Mkhinini [1]*, K. Béranger [1], A. Stegner [2], T. Arsouze [1], A. Santi Coimbra De Oliveira [1] and I. Taupier-Letage [3]
[1] ENSTA-ParisTech - nadia.mkhinini@ensta-paristech.fr
[2] LMD
[3] MIO

Abstract
The aim of this study is to detect and quantify the eddies along the Lybio-Egyptian (LE) coast. We analyse the results of a regional ocean model adapted for the Mediterranean region. We extract characteristics of the LE eddies (size, intensity, trajectory, lifetime ...) using a tracking algorithm. These statistics are compared with drifter or altimetry data.

Keywords: Circulation models, Salinity, Mesoscale phenomena, Levantine Basin, Libyan Sea

Introduction - The circulation in the eastern Mediterranean is characterized by a high mesoscale activity. In particular, anticyclonic eddies are flowing along the Lybio-Egyptian coasts, mainly eastwards [1] but sometimes westwards [2]. In this study, we use a high resolution simulation to study the circulation in this area, and we apply an eddy tracking algorithm to identify the mesoscale eddy trajectories.

Tools - The eddy-resolving model is MED36, a 1/36 degree resolution configuration with 75 vertical levels, based on the NEMO system in a regional configuration of the Mediterranean Sea. This model is close to the MED12 model [3] with both higher horizontal and vertical resolutions. MED36 is forced by the atmospheric forcing ARPERA, which is obtained by performing a dynamical downscaling of ECMWF products above the Mediterranean Sea over the period 1998 to 2011 [4]. Then a tracking code [5] is used at 30 m depth to detect the core of the eddies and their trajectories. This code is based exclusively on the geometry of the velocity vectors.

Eddies tracking - An example of the preliminary results is shown in Figure 1. The core of eddies detected by the algorithm from the velocity fields are represented by elliptical close contours with a star for the center. Then to identify the trajectories of those eddies, daily analyses are made during the EGYPT-EGITTO compaign [4] in 2005-2006. Big structures as the Ierapetra eddy south-east of Crete are easily detected, but smaller or less recurrent eddies are more difficult to detect. Several parameters of the algorithm have to be modified to increase the accuracy of the algorithm. Some coastal eddies located in the Ionian Basin are flowing westwards. Large Libyo-Egyptian eddies are relatively permanent features while smaller eddies are flowing eastwards. The same tracking algorithm has been applied to the AVISO geostrophic currents and the model results were compared with it. The agreement is good between the two sets of data and the observed trajectories from EGITTO-EGYPT are well reproduced.

Conclusion - These analyses shows that in the Levantine basin, the model is able to reproduce a realistic circulation with the presence of both Ierapetra Eddy and Libyan eddies. Nevertheless the algorithm must be improved to better highlight and clarify the modelled eddy dynamics along the Libyan coast.

Acknowledgments - Modeling work was supported by Mercator Ocean. Computations were made at IDRIS from the CNRS (project i010227). Atmospheric forcing was made available by CNRM.

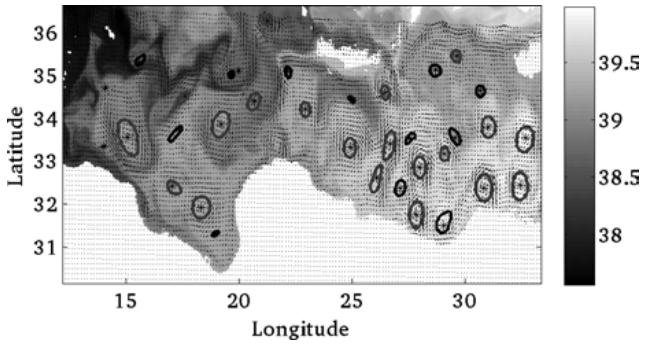

Fig. 1. Snapshot in November 2006 in MED36v75 simulation. Salinity (grey) and currents (vectors, $m.s^{-1}$) at 30 m depth. Eddies detected by the tracking algorithm are indicated with a star for the center and for their diameters with a black elliptical close contours for cyclones and grey close contours for anticyclones.

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THE WINTER-SPRING TYRRHENIAN SEA SURFACE CIRCULATION

Ernesto Napolitano [1]* and Roberto Iacono [1]
[1] ENEA - ernesto.napolitano@enea.it

Abstract
Altimeter data and numerical results indicate that, from late winter to mid spring, a well-defined surface circulation is present in the eastern part of the Tyrrhenian Sea, made of a stream of Atlantic water that meanders around several cyclone-anticyclone couples, while progressing cyclonically along the Italian coasts. It is suggested that this circulation pattern may result from basin scale instability of the Atlantic stream.

Keywords: Circulation, Tyrrhenian Sea

A detailed understanding of the circulation structure in the central and eastern parts of the Tyrrhenian Sea (TYS) is still lacking. The area appears characterized by complex dynamics (see, e.g. [1]), but in the recent reconstruction of the spring 2004 circulation by Vetrano *et al.* [2] it was found occupied by large cyclonic and anticyclonic structures, also present in typical spring altimeter data. These structures could therefore be robust features of spring dynamics around which the flow and the transport organize. To gain further insight, we have analyzed the long time series of altimeter data now available (SALTO-DUACS data provided by AVISO; http://www.aviso.oceanobs.com/duacs/). Here we present results from this analysis, which confirm and extend the picture sketched in [2]. Our main finding is that in winter-spring a consistent mean flow can be individuated in the eastern TYS, formed by a stream of Atlantic water (AW) that meanders around several anticyclonic structures located along the Italian coast, having cyclonic companions offshore. The signatures of these vortices clearly appear in the maps of Sea Level Anomaly (SLA) and of Absolute Dynamic Topography (ADT). As an example, we show in the left panel of Figure 1 the March ADT map over the eastern TYS (average over 1993-2010), with a geostrophic reconstruction of the circulation superposed. The coastal anticyclonic cells (to the north of Sicily, off the Calabria coast, off Naples, and off Rome) are clearly seen in this map, as well as their cyclonic companions offshore.

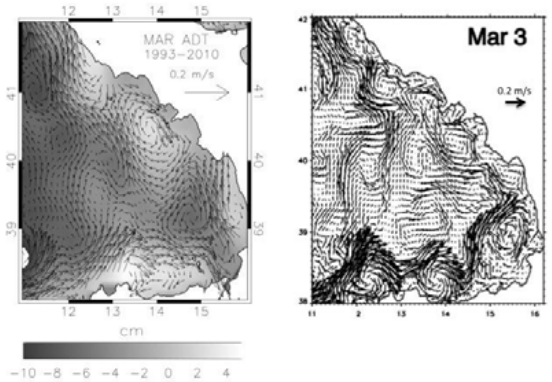

Fig. 1. Circulation in the eastern TYS. Left: average March ADT with geostrophic circulation superposed. Right: surface flow from an operationa model (March 3, 2009)

The signatures of these structures are seen from mid winter to mid spring, and become stronger and better defined towards the end of the winter, when the cyclonic wind forcing weakens. Analysis of the energy exchanges indicates that in this period eddies extract energy from the mean flow, suggesting the presence of a basin scale instability of the AW stream. Support to this picture also comes from the outputs of a high-resolution operational model of the TYS circulation (see [3]). The right panel in Figure 1 shows the surface flow (10 m of depth) of March 3, 2009, displaying strong meanders in which anticyclones (cyclones) are nested near shore (offshore) (the genesis and evolution of this structure is illustrated in Figure 6 of [3]).

An idealized experiment with the Princeton Ocean Model was also performed. The model has realistic bathymetry, but no surface forcing, and is initialized with zero velocity and typical winter stratification, with no horizontal gradients. Net barotropic transports are prescribed at the open boundaries (+ 0.7 Sv at the Sardinia Channel, - 0.7 Sv at the Corsica Channel, and 0 Sv at the Sicily Strait), together with realistic temperature and salinity sections. By day 150 (Figure 2) several robust vortices have formed, anticyclonic near shore, and cyclonic on the offshore side of the stream, in most of the places in which the altimeter anomalies are located. Thus, even in absence of surface forcing, baroclinic adjustment to the boundary conditions and to the bathymetry is capable of producing a circulation pattern similar to that observed in the eastern TYS.

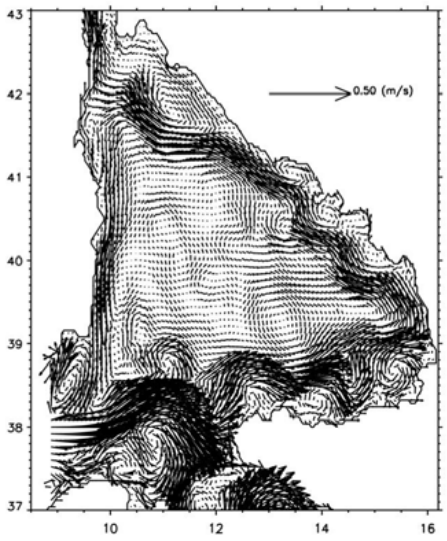

Fig. 2. Idealized POM experiment (details in the text). Surface flow at day 150.

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IS THE SOUTHERN ADRIATIC PIT CHARACTERIZED BY A CYCLIC ALTERNATION OF SLOW MIXING AND ABRUPT RENEWAL OF BOTTOM WATER?

S. Querin [1]*, M. Bensi [1], C. Solidoro [1], V. Cardin [1], D. B. Giaiotti [2], S. Bacer [3] and V. Malacic [4]
[1] OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), Sgonico (TS), ITALY - squerin@ogs.trieste.it
[2] ARPA FVG - CRMA (Regional Center for Environmental Modeling), Palmanova (UD), ITALY
[3] University of Trieste - Dept. of Physics, Trieste, ITALY
[4] National Institute of Biology, Marine Biology Station, Piran, SLO

Abstract
The dynamics of the bottom layer of the southern Adriatic Sea are investigated merging experimental data and numerical simulations. The observed continuous temperature and salinity increase, interrupted by the sudden intrusion of very dense water masses, is hypothesized to be one cycle of a general "saw-tooth" pattern: alternation of long-lasting linear increase (mixing phase) and sudden decrease (dense water intrusion phase) of temperature and salinity. Model results corroborate this theory reproducing the observed oceanographic features and giving a basin-scale view of the investigated process.

Keywords: South Adriatic Sea, Deep waters, Models

This study aims at exploring and understanding the dynamics of the bottom layer (below 1000 m) of the southern Adriatic Sea (SAS) merging direct measurements and numerical simulations. The SAS has been constantly monitored since November 2006 by means of the E2M3A deep mooring located in its central part (Lat. 41°32'N, Lon. 18°05'E, Fig. 1), and by several oceanographic cruises [1].

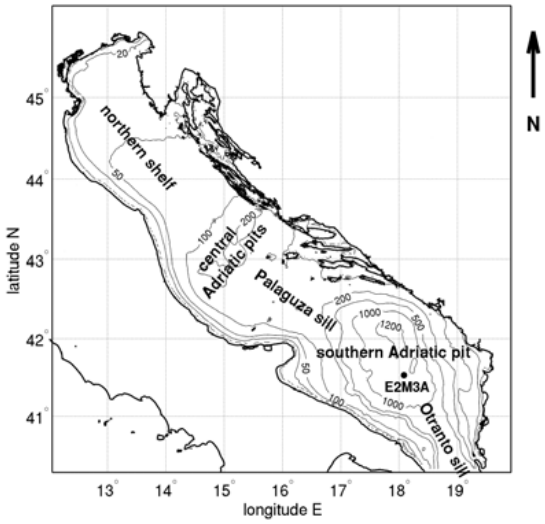

Fig. 1. Coastal and bathymetric map of the Adriatic Sea

Experimental time series running from November 2006 until March 2012 show that the bottom layer (~1200 m) was characterized by a continuous temperature (T) and salinity (S) increase (linear trend of ~0.05°C/y and ~0.004 psu/y, respectively), with a resulting density decrease. The positive trend was interrupted only in March 2012 by the intrusion of a very dense water vein (Northern Adriatic Dense Water, NADW), which was generated by an exceptional Bora event on the northern/central shelf. This sudden dense water intrusion modified abruptly the system, dropping both T and S.
In this study we demonstrate that the long-lasting (~5 years) "linear" increase is caused mainly by local mixing processes (i.e., mesoscale and sub-mesoscale turbulence). Moreover, we hypothesize a "saw-tooth" modulation of two main alternating phases: the long-lasting linear increase (mixing phase) and the sudden decrease of T and S (NADW intrusion phase). Under this assumption, the ventilation of the bottom layer of the SAS depends on the "return period" of exceptionally cold and dry winters.

We use a numerical model of the Adriatic Sea in order to have a basin-scale view of the observed oceanographic features and to corroborate the proposed interpretation of the experimental data. Numerical simulations are carried out customizing the MITgcm (Massachusetts Institute of Technology general circulation model), a three-dimensional, finite volume, general circulation model, with horizontal resolution of 1/32° (~3.4×2.4 km) and 60 unequally spaced levels [2]. Numerical results reproduce properly the spatial and temporal thermohaline variability in the SAS, as well as its main mesoscale features. When seeking an explanation for the long-lasting "linear" phase (T and S increase, density decrease) in the bottom layer, we can exclude possible thermal and chemical contributions from external sources (e.g., submerged volcanoes) because the model reproduces the bottom dynamics without considering any kind of external source. Moreover, the thermohaline trend can neither be ascribed to the open-ocean deep convection in the SAS, because deep convection is very limited in time and never reached depths greater than 1000 m. Conversely, the bottom of the SAS is a system surrounded by shallower sills (Palaguza (180 m) and Otranto (800 m) on the northern and southern side, respectively) and it is characterized by an almost permanent cyclonic circulation. Local mesoscale and sub-mesoscale turbulent processes, highlighted by model results, tend to slowly homogenize the deepest water masses there.

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HIGH-RESOLUTION SURVEY IN BOTH SPACE AND TIME OF THE GIBRALTAR STRAIT: THE HYDROCHANGES GIBRALTAR INTERNATIONAL CAMPAIGN (3-8 JULY 2012)

I. Taupier-Letage [1]*, G. Rougier [1], J. Garcia Lafuente [2], S. Sammartino [2], J. Soto Navaro [2], C. Bachelier [1], J. Chioua [3], B. El Moumni [4], A. Lalilti [4], D. Malengros [1], C. Naranjo Rosa [2] and A. Orbi [3]
[1] MIO UMR CNRS 7294 Aix Marseille Université IRD USTV - isabelle.taupier-letage@univ-amu.fr
[2] University of Malaga, Spain
[3] INRH, Maroc
[4] Faculté Polyvalente de Larache, Maroc

Abstract
The 2012 yearly maintenance of the HydroChanges moorings operated at Gibraltar jointly by Morocco (Faculté Polyvalente de Larache /FPL) and France (Mediterranean Institute of Oceanography /MIO/Aix-Marseille University/CNRS/IRD/USTV) had to be organized with a French research vessel. This was the opportunity to carry a hydrological campaign involving French, Moroccan and Spanish teams, focusing on high resolution, both in space and time. Seven transects across the strait yield an unprecedented detailed insight of the hydrological situation.

Keywords: Circulation, Hydrology, Alboran Sea, Gibraltar Strait, Water transport

Introduction

The time series recorded by moored instruments in the Strait of Gibraltar have shown the importance of the variability, from tidal to interannual scales, and the complexity of the hydrological situation (identification of the water masses exiting the Mediterranean, respective distribution in the cross-section…) [1, 2, 3].

The 4-day hydrological survey HydroChanges on board the R/V Tethys II (INSU/CNRS) was designed to address the issue of the very high spatial and temporal variability in the Gibraltar Strait. For the first time transects across the strait of Gibraltar have been performed with CTD casts spaced every ~1 mile, and /or with a Moving Vessel Profiler (MVP), a towed free-falling CTD down to ~500m that enables a ~800m-spacing interval, whenever possible occupying the same transects as GIBEX (Fig. 1). A total of 306 MVP profiles have been acquired along transects R1, R2, R3, R4, R7 and R7'. CTD profiles were interleaved when depth too great for MVP: 26 CTD casts have been recorded on transects R2, R5 and R7'. Transect R1 has been performed twice within ~6hours, and R2 3 times (1 with 11 CTD casts and 2 with MVP) within ~12 hours in order to capture different tidal situations. Thermosalinometer and ADCP data were recorded underway.

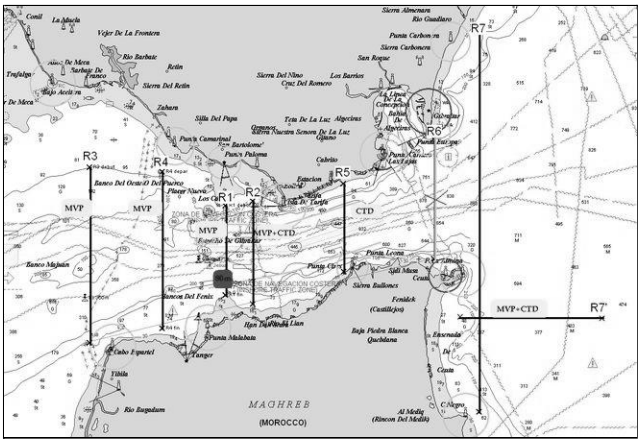

Fig. 1. Map of the sampling during the HydroChanges Gibraltar campaign in July 2012.

Results

The data processing is still underway at the time of writing. Nevertheless it is possible to see from now on the quality of the information about the waters stratification in the strait (Fig.2). The results of the CTD and MVP profiles will detailed, and this 5-day situation (a snapshot), will be analyzed in conjunction with the time series recorded on moorings.

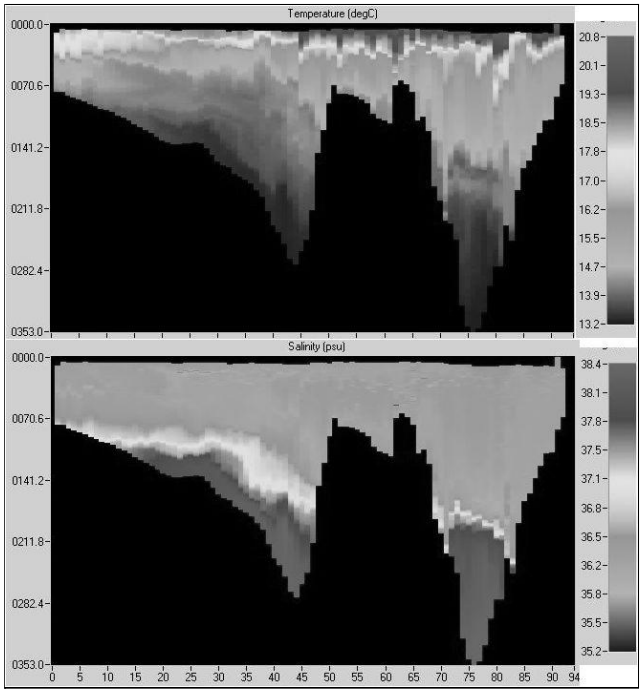

Fig. 2. MVP series of 94 CTD profiles across the R3 transect (from North (left) to South (right)).

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SUBMESOSCALE EDDIES AT THE NARROW BLACK SEA SHELF

A. Zatsepin [1]*, V. Kremenetskiy [1], A. Korzh [1], A. Ostrovskii [1], D. Elkin [1] and D. Soloviev [2]
[1] Shirshov Institute of Oceanology RAS - zatsepin@ocean.ru
[2] Marine Hydrophysical Institute

Abstract
Investigation of submesoscale eddies having horizontal dimensions of 1-10 km at the narrow shelf of the north-eastern Black Sea was carried out in 2007-2013. *In situ* hydrophysical data were complemented by the remote sensing. Generation mechanisms of the submesoscale shelf eddies were studied by using laboratory models.

Keywords: Coastal processes, Black Sea

In the report we present some results of recent investigation of the fluid dynamics variability over the narrow north-eastern Black Sea shelf. It was revealed that short-term (1-100 hours) and submesoscale (1-10 km) variability of shelf currents depends on the coast orography and bottom topography and is strongly effected by fluid dynamics over continental slope and deep part of the sea.

The regular *in situ* observations were carried out and the satellite remote sensing data were analyzed for the north-eastern Black Sea (Gelendzhik region) during 2007-2013 as follows: the cross-shelf CTD sections; the towed ADCP surveys with submesoscale resolution; the bottom mounted ADCP measurements at selected sites; the moored profiler Aqualog surveys of vertical thermohaline structure and current velocity; the NOAA, MODIS-AQUA and MODIS-TERRA and MERIS-Envisat satellite imagery (sea surface temperature, chlorophyll "a", water leaving radiance. It was found that characteristic feature of the sea current variability is an intermittency of its along-shore and cross-shore components accompanied by rather intensive water exchange between the shelf zone and the open sea [1].

In general, the observed variability was associated with formation and alongshore transfer of the submesoscale eddies having diameter in the range of 1-10 km. These eddies were ageostrophic and non-stationary in nature and their life-time normally did not exceed several days. The main energy source for the submesoscale eddy generation was due to the open sea circulation – mesoscale and basin scale currents over the continental slope and deep part of the sea. On the base of observations two main physical generation mechanisms for the submesoscale eddies were suggested. The first one was the shear instability of the alongshore current. The second was associated with the alongshore current detachment from the shoreline at the cape which resulted in periodical formation of eddies behind the cape and their separation from the coast.

Both mechanisms were studied by means of laboratory modeling. Several experiments were conducted in the cylindrical tank on top of rotating platform filled by homogeneous fluid (distilled water) [2]. To study the first generation mechanism, the cases of cyclonic and anticyclonic shear between a core of alongshore current and a coast were reproduced in the rotating fluid. It has been shown that in the presence of a current with cyclonic shear, chain of eddies were formed in wide range of non-dimensional shear. In case of a current with the anticyclonic shear, chain of eddies was observed only at rather small values of shear and by contrast, the current had chaotic turbulent structure at large non-dimensional shear. An asymmetry in the conditions of the eddy-like structure formation in the alongshore current with cyclonic and anticyclonic shear was explained by simple physical model.

An investigation of the second mechanism indicated that the periodic eddy formation behind the cape and separation of eddies from the coast occurs only in the case of decelerating cyclonic alongshore current in rotating fluid (Fig. 1).

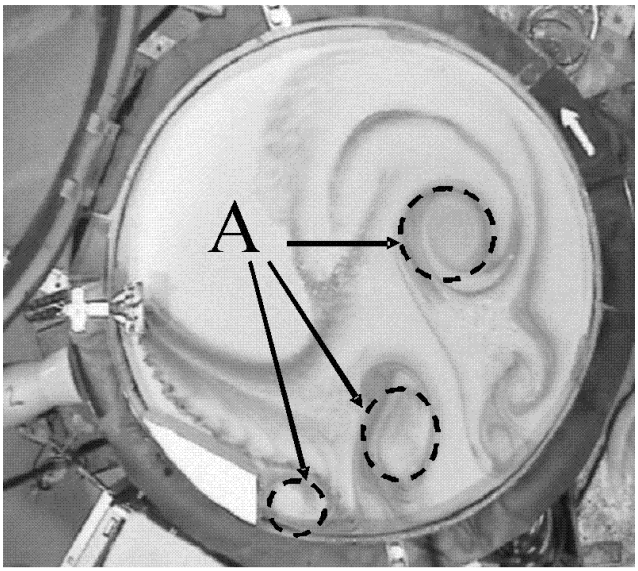

Fig. 1. Periodic formation of anticyclonic eddies (A, dotted circles) behined a cape in rotating fluid in the case of decelerating cyclonic alongshore current (top view).

An explanation for the physical nature of this effect was suggesteded. The dependences of eddy basic parameters (diameter, orbital and translational velocity, etc.) on time and other external parameters of the experiment were establised.

Results of the laboratory experiments were used to interprett the observations of the submesoscale eddies at the narrow shelf of the north-eastern Black Sea.

Acknowledgements. The study was supported by the EC CP PERSEUS, Program 23 of the Russian Academy of Sciences, and Russian Foundation for Basic Research, grants 11-05-00830, 11-05-00804.

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Session

Thermohaline cells and biochemical status - 1

Modérateur : **Samuel Somot**

SURFACE CIRCULATIONS IN THE SICILY CHANNEL INFERRED FROM A NEURAL CLASSIFICATION APPLIED TO A 50-YEAR NUMERICAL EXPERIMENT

M. Jouini [1], K. Béranger [1]*, T. Arsouze [1], S. Thiria [2], J. Beuvier [3], S. Somot [4] and M. Crépon [2]
[1] ENSTA-ParisTech - karine.beranger@ensta-paristech.fr
[2] LOCEAN
[3] Mercator
[4] CNRM

Abstract
As the surface circulation in the Sicily channel is highly variable, we have applied a neural clustering method on 30-m depth currents of a 50-year high resolution model to identify the different important circulation regimes. We have then showed that a part of the classes therefore obtained correspond to different seasonal modes and some others are the signature of an inter-annual variability.

Keywords: Water transport, Sicily Channel, Circulation models

Introduction - The circulation in the Sicily Channel (SC) can be described as a two-layer exchange of inflowing Atlantic Water (AW) and outflowing of dense eastern Mediterranean waters discharging in the Tyrrhenian Sea. At the SC entrance, due to topographic effect, the Algerian Current splits into three branches, one entering into the Tyrrhenian Sea while the two others pass through the SC and enter into the Eastern Mediterranean. These later branches are the Atlantic Tunisian Current (ATC), and the Atlantic Ionian Stream (AIS) (see [1] for a review). The variability of the SC surface circulation is therefore investigated using a 50-year simulation of a high resolution model of the whole Mediterranean Sea. To separate large and mesoscale variability, we first investigate the different important regimes by clustering 30-m depth currents into groups having close statistical properties. For each regime, we tried then to study its mesoscale activity.

Tools - The eddy-resolving MED12 model [2] was forced by daily atmospheric fields during the 1958-2011 period. Then we used a neuronal network classifier, the Self Organizing Algorithm (SOM) [3], which is an unsupervised classification method made of a competitive neural network structured in two layers. The first layer represents the input layer, which receives the data, L hereinafter, and made of the u and v velocities components at 30 m depth during 50 years taken on a SC subgrid. The second one is a 2D-classes grid composed of typical circulations, with a topological ordering and resuming at best the input data L. The objective of SOM is hence to summarize the information contained in one multivariate study set L of all daily situations by producing a small number of reference vectors ***rv***s statistically representative of the surface circulation. Each neuron represents a subset of L that gathers data having common statistical characteristics (not usually linear) and is associated to one ***rv***s.

Results - Once SOM is applied on L, we obtained a 5x6 SOM map providing 30 ***rv***s reference vectors corresponding to 30 typical circulations.The large number of classes allowed taking into account the complexity of the dataset and let to analyze the circulation regimes and their associated mesoscale variability. This high number of circulation regimes is difficult to interpret in term of physical processes. To counteract this difficulty, this large number was aggregated into a smaller number by using an Hierarchical Ascendant Classification method (HAC)[4]. The 30 situations were reduced to 7 typical circulation regimes . The inspection of the 7 typical circulation classes showed a strong seasonal signature. For example, classes 5 and 3 mainly occur in winter and present an enhancement of the ATC while classes 6 and 2 mainly occur in summer and characterize an enhancement of the AIS. Classes 4 and 1 are occurring during short time periods only. The atypical regime 7 seems to be associated with a change of the general circulation of the Mediterranean Sea. The regime variability inside each class reflects its mesoscale variability.

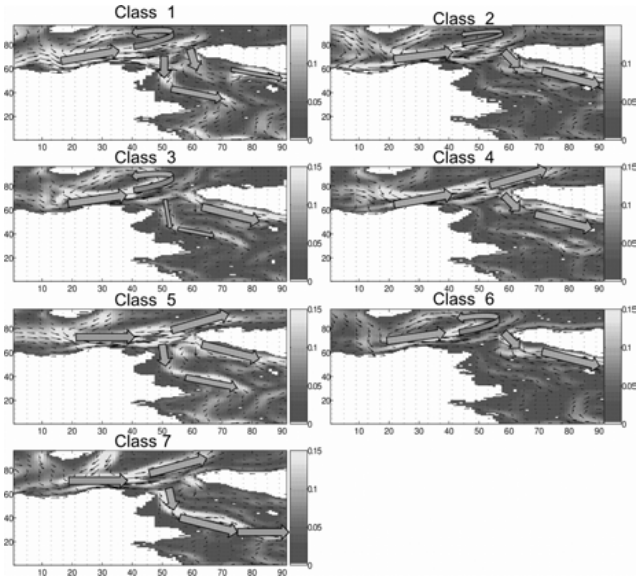

Fig. 1. The 7th typical circulation regimes.For each class,the color bar correspond to the current intensities and black arrows represent the current directions.

Conclusion – The classification method allows new analyses of the Sicily Channel circulation at the seasonal and interannual scales. The role of mesoscale features in reproducing typical circulation patterns could also be highlighted and quantified.

Acknowledgments - Modeling work was supported by Mercator Ocean. Computations were made at IDRIS from the CNRS (project i010227). Atmospheric forcing was made available by CNRM.

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DENSE WATER BOTTOM CURRENTS IN THE SOUTHERN ADRIATIC SEA IN SPRING 2012

J. Chiggiato [1]*, K. Schroeder [1], A. Bergamasco [1], M. Borghini [1], F. Grilli [1], L. Langone [1], M. Marini [1], S. Miserocchi [1], P. Falco [2] and A. Russo [3]
[1] CNR-ISMAR - jacopo.chiggiato@ismar.cnr.it
[2] DISAM - UNIPARTHENOPE
[3] DISVA-UNIVPM

Abstract
Following the formation of very dense water in the northern Adriatic shelf during the severe cold spell in February 2012, a rapid-response cruise was organized by CNR-ISMAR to sample the flow and fate of the dense water in the Southern Adriatic Sea. In addition to the measurements carried out during the surveys, five moorings continuously monitored the bottom layer temperature, salinity and currents in selected sites in the southern Adriatic Sea. Data collected allowed to carry out a description of the veins of bottom density currents, both in time and space.

Keywords: South Adriatic Sea, Currents

In February 2012, the European region experienced a 2-weeks severe cold spell. This cold spell was triggered by a large Siberian high causing blocking of the Atlantic flow, forced northward, and retrogression of westward flow of dry and cold air masses from eastern Russia along the southern flank of the anticyclone all the way to Europe. This situation caused temperature as low as -40 °C in north-eastern Europe and –10° to –20°C in central Europe, with significant snowfall in southern Europe associated to deep lows in the Mediterranean Sea. The Northern Adriatic Sea was heavily impacted by this cold spell, with large decrease of surface temperature and the onset of severe north-easterly Bora wind, blowing almost continuously and intermittently reinforced by cyclogenesis in the western Mediterranean. A significant heat loss took place in the basin with surface water temperatures as low as 3-6 °C. The Lagoon of Venice partially froze. The impact of this extremely cold outbreak, the severe cold and dry Bora flow and the very limited discharge of the Po river in the preceding autumn, caused therefore the formation of extremely dense shelf water, with potential density anomaly as high as 30.5 kg/m^3 [1]. After few weeks, the dense shelf water reached the Southern Adriatic, where it sunk through successive cascading events. Rapid-response cruises were organized by CNR-ISMAR and the Southern Adriatic was extensively sampled by the R/V Minerva Uno (leg1, 23 March – 2 April 2012) and R/V Urania (leg2, 14-20 April 2012) with CTD-rosettes equipped with additional sensors for fluorescence, dissolved oxygen, LADCP as well as ship-borne ADCP and XBTs. In addition to the 3D snapshot carried out during the surveys, five moorings continuously measured temperature, salinity, currents and downward particle fluxes by means of SBEs, ADCPs and automatic sediment traps, respectively. CTD data sampled the veins in both legs, with dense water flowing on the shelf of the southern Adriatic as cold as 10.5 °C and sampled maximum density of 29.7 kg/m^3, relatively high in salinity (due to the unusually low discharge of rivers in the generation area) and rich in oxygen. Conversely, the bottom layer sampled by moorings and CTD casts off the shelf, few tens of meters thick, showed temperature seldom lower than 13 °C, yet significant velocities (above 50 cm/s several times). This is suggestive of significant mixing during cascading. Data collected allowed to carry out a description of the veins, both in time and space (Figure 1). The time series analysis showed significant differences in the behavior of the dense water flow at the mooring locations.

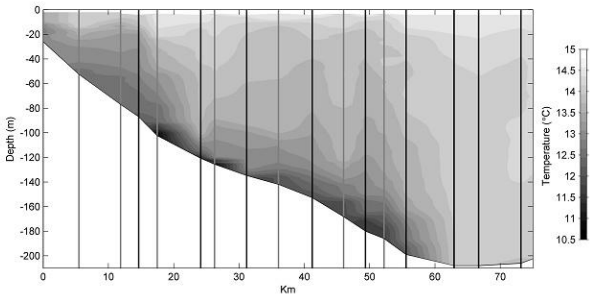

Fig. 1. Figure 1: vertical transect of in-situ temperature from CTD and XBT showing the vein of dense water flowing southward along the shelf in the Southern Adriatic Sea.

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FLUCTUATIONS IN THE ADRIATIC: THE BIOS MECHANISM AT WORK IN THE LAST 130 YEARS

G. Civitarese [1]*, M. Batistic [2], M. Bensi [1], M. Gacic [1], R. Garic [2] and V. Kovacevic [1]
[1] OGS - gcivitarese@ogs.trieste.it
[2] Institute for Marine and Coastal Research, University of Dubrovnik, Dubrovnik, Croatia

Abstract
In 1953, Buljan published the first detailed study on the salinity variability in the Adriatic Sea ("Fluctuations of salinity in the Adriatic"). Analyzing several oceanographic campaigns from 1875 to 1949, he hypothesized a mechanism called "Adriatic Ingression" at the base of the salinity oscillations in the Adriatic Sea. Here, the effects associated with the Adriatic ingressions are more appropriately explained by the recently discovered Bimodal Oscillating System (BiOS) mechanism, connecting the change of salinity with the circulation in the Ionian Sea. Our analysis is corroborated by the physical, biogeochemical and biological observations carried out in the past 130 years.

Keywords: Ionian Sea, Otranto Strait, South Adriatic Sea, Alien species, Salinity

The term "Adriatic Ingression" (AI), according to the original formulation, denotes the fluctuations of salinity in the southern and middle Adriatic (hereafter called Adriatic Sea, AS) due to the intensification of the flux of intermediate waters from the Ionian Sea through the Strait of Otranto. The term was first coined by Buljan [1], after an extended analysis of the results obtained by early oceanographic investigations in the Adriatic carried out in the first half of the 20th century. Together with the salinity increase, the AI implies a parallel increase of nutrients, since the Levantine Intermediate Water (LIW) is both the saltiest and the nutrients richest water mass in the Ionian as well as in the Eastern Mediterranean. Then, the AI mechanism impacts the thermohaline properties and the biogeochemistry of the AS. In addition, also the biology is affected by the increased availability of nutrients for the primary production during the ingression periods.

Recently, Civitarese et al. [2] have associated the periodical variation of salinity in the AS, in the period 1986-2012, with the upper layer circulation of the Northern Ionian Gyre (NIG), that in turn depends on, and influences the thermohaline properties of the Adriatic Dense Water (AdDW) produced in the AS. This mechanism was called Adriatic-Ionian Bimodal Oscillating System (BiOS) [3]. According to the sense of circulation of the NIG, the pathways of the Atlantic Water (AW) and of the water of Levantine/Aegean origin change on decadal scale, consequently changing the thermohaline properties of the water advected into the Adriatic through the Strait of Otranto.

Civitarese et al. [2] have shown that the change of salinity in the AS was accompanied by the change of the biogeochemical properties, and that nutrients variations were out of phase with the change of salinity. This is clearly in contrast with the AI view, where the variability of the LIW flux at the Strait of Otranto is responsible for the increase of both salinity and nutrients. On the other hand, in the BiOS perspective, the exchange at the Strait of Otranto is implicity considered stationary [4].

Results emerging from the literature of the 19th and 20th centuries and the available experimental data, suggest that the reported Adriatic ingressions can be considered as the past manifestation of the BiOS mechanism. Two results are worth mentioning: (i) the salinity variations in AS and Ionian Sea recorded from 1950 till now are mostly in phase (Fig. 1), in agreement with the advective impact of the Ionian circulation on the AS as expected in the BiOS mechanism; (ii) a number of biological recordings of alien organisms of the Western Mediterranean or Atlantic origin during the phases of minimum salinity in tha AS also suggests again the advection of those waters through the Strait of Otranto, a phenomenon not considered in the AI mechanism.

In conclusion, several signs confirm that the BiOS mechanism was already working in the past century, affecting the decadal variability of salinity, biogeochemical and biological properties of the Adriatic Sea. In his fundamental paper [1], Buljan stressed that in the AS "the ingressions leave a marked impression on both the quantitative and qualitative composition of populations". Although referring to a mechanism here revised, i.e. the AI, Buljan's words still hold their validity after more than fifty years, and should be guidelines for future research.

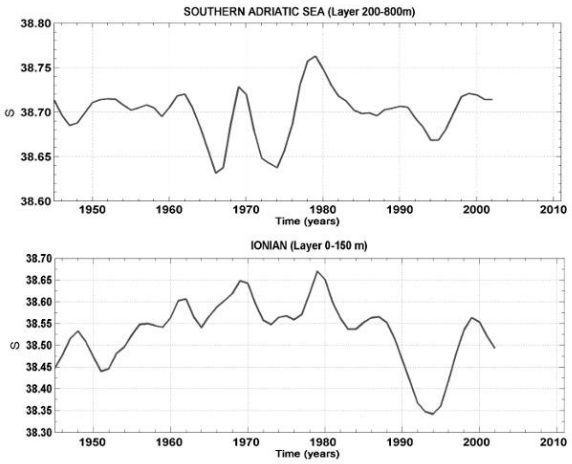

Fig. 1. Comparison between the salinity time series of the Adriatic and Ionian Seas.

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USING OCEAN COLOUR SATELLITE AND BIOGEOCHEMICAL PROFILING FLOATS TO EXPLAIN BIOGEOGRAPHICAL REPARTITION OF THE MEDITERRANEAN SEA.

F. D'Ortenzio [1]*, S. Augusti [2], G. Civitarese [3], H. Claustre [1], C. Duarte [2], C. Fontana [1], M. Gacic [3], H. Lavigne [1], P. Le Traon [4], T. S. Moore [2], L. Mortier [5], P. Poulain [3], L. Prieur [1], M. Ribera D'Alcalà [6] and V. Taillandier [1]
[1] Laboratoire Oceanographie de Villefranche - dortenzio@obs-vlfr.fr
[2] IMEDEA
[3] OGS
[4] IFREMER
[5] LOCEAN
[6] SZN

Abstract
A recent developed network of biogeochemical profiling floats in the Mediterranean Sea is used to confirm the biogeographical repartition of the basin obtained using phenological criteria and remote sensing data. Preliminary results are presented in the context of the relationship between the phytoplankton phenology, the circulation features of the basin and the biogeographical repartition of the basin; additionally, sensors calibration and coherence with ocean colour observations are also discussed.

Keywords: Biogeography, Ocean colours, Levantine Basin, North-Western Mediterranean, Ionian Sea

Satellite ocean colour observations of surface chlorophyll concentrations confirmed that several phytoplankton phenological regimes exist in the Mediterranean Sea [3]. The spatial distribution of these phenological regimes resulted in a biogeographical repartition of the basin, where each bioregion displays statistically similar seasonal cycles. Ocean colour observations are, however, limited to the ocean surface, calling into question the relevance of the proposed Mediterranean biogeography. The biogeography is dependent on the circulation features and its temporal variability, as shown for e.g. Ionian Sea [2]. Therefore, only by combining satellite observations with a significant consistent number of vertical in situ profiles could we shed light on the mechanisms inducing the existing phenological differences.Profiling floats (which are at the basis of the international Argo program, [6]) appear as a promising technology to obtain continuous and satellite-like (in terms of quantity of data) observations of open ocean biogeochemistry. In particular, a new generation of profiling floats equipped with biogeochemical sensors has recently emerged, demonstrating the capability of this technology for biogeochemical ocean studies [1,4,7]. In this work, we present data obtained with a recently developed network of biogeochemical profiling floats operating in the Mediterranean Sea. Floats are based on the Provor platform and are equipped with a complete suite of biogeochemical sensors (Chlorophyll and CDOM fluorescence, backscattering, three wavelengths irradiance, PAR, nitrate and oxygen, [5]). They were developed in the framework of French project NAOS (PIs P.Y. LeTraon and F. D'Ortenzio, www.naos-equipex.fr), although Mediterranean deployments and data analysis are organized on the basis of an international collaboration. We present here the results in the context of the relationship between the phytoplankton phenology, the circulation features of the basin and of the biogeographical repartition of the basin; additionally, sensors calibration and coherence with ocean colour observations are also discussed.

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CLIMATE OF THE MEDITERRANEAN SEA

Paola Malanotte-Rizzoli [1]*
[1] Massachusetts Institute of Technology - rizzoli@mit.edu

Abstract
A Report written by a number of Mediterranean scientists acting as members of a newly formed Pan-Med group under the auspices of IOC/UNESCO and of CIESM was published in their respective web sites in September 2012. The major motivation for this Report was a call for a Pan-Mediterranean initiative bringing together the western and eastern oceanographic communities for the evolution and strengthening of a broad, interdisciplinary collaboration focused on the unique features of the Mediterranean Sea.

Keywords: Global change, North-Eastern Mediterranean

Paola Malanotte-Rizzoli Massachusetts Institute of Technology A Report written by a number of Mediterranean scientists acting as members of a newly formed Pan-Med Group under the auspices of IOC/UNESCO (Intergovernmental Oceanographic Commission/United Nations Educational, Scientific and Cultural Organization) and of CIESM (The Mediterranean Science Commission) was published in their respective web sites in September 2012.The Report in its turn stemmed from a workshop held in Rome in November 2011, on the occasion of the 25th anniversary of the POEM (Physical Oceanography of the Eastern Mediterranean) Programme. The objectives of the workshop were however rather more ambitious that having simply a memorial. First, the workshop was meant to provide a synopsis of the state-of-the-art of research and present knowledge of the Mediterranean Sea physical/chemical/biological properties. Secondly, it wanted to offer the opportunity to scientists working in different regions of the sea, both in the Western and Eastern basins, to meet and share ideas, and hence foster pan-Mediterranean collaborations. The importance of the Mediterranean Sea for the world ocean has long been recognized. First, the Mediterranean Sea has a profound impact on the Atlantic Ocean circulation. The Mediterranean salty water tongue exiting from the Gibraltar strait at intermediate depths and spreading throughout the Atlantic interior has been evidenced in the literature since long. Even more importantly, the Mediterranean sea is a laboratory basin for the investigation of processes of global importance, being much more amenable to observational surveys because of its location in mid-latitude and its dimensions. Both the western and eastern basins in fact possess closed thermohaline circulations. A unique upper layer open thermohaline cell, analogous to the global conveyor belt, connects the eastern to the western basin and, successively, to the north Atlantic through the Gibraltar strait. In it, the Atlantic water entering via Gibraltar in the surface layer, after travelling to the easternmost Levantine basin, is transformed into one of the saltiest water masses through air-sea heat and moisture fluxes. This is the salty water which, crossing the entire basin in the opposite direction below the surface Atlantic water, finally exits from the Gibraltar strait at mid-depths. The western and eastern basins are in turn endowed with deep/intermediate convection cells analogous to the polar Atlantic deep convection cells or to the intermediate mode water ones. Deep and intermediate water masses are formed in different areas of the basin. These convection cells are readily accessible to direct observational surveys and mooring arrays. Both wide and narrow shelves are present separated from the deep interiors by steep continental slopes. Cross-shelf fluxes of physical as well as biogeochemical parameters are crucial in determining the properties of the shallow versus deep local ecosystems and their trophic levels (chains). Most importantly, the Mediterranean Sea is a basin of contrasting ecosystems, from its strongly oligotrophic deep interiors to the fully eutrophic northern Adriatic, which is characterized by recurrent, anomalous algal blooms and related anoxia or hypoxia events. For reasons that may be linked to geographical locations and national scientific policies, the western and eastern basins have, in the past, been mostly investigated independently from each other. Recent international collaborative programs such as the Gibraltar Experiment, the Western Mediterranean Circulation Experiment (WMCE), the Programme de Recherche Internationale en Méditerranée Occidentale (PRIMO) and POEM itself, all have investigated separately the western and eastern basin or subbasins of them. Only in the last two decades the European research projects have addressed scientific issues related to the entire Mediterranean Sea, such as MATER, SESAME, PERSEUS etc. The major motivation for the Report was therefore a call for a Pan-Mediterranean initiative bringing together the western and eastern oceanographers and for the further evolution and strengthening of a broader, interdisciplinary collaboration to create a full integrated Mediterranean community of physical, chemical, biological oceanographers and of climate scientists.

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AFTER DEEP WATER FORMATION: SINKING AND SPREADING OR REORGANISING PHASE, INCLUDING UPWELLING?

Jordi Salat [1]*, Mikhail Emelianov [1], Eugenio Fraile [2] and Mikel Latasa [2]
[1] Institut de Ciències del Mar (CSIC) - salat@icm.csic.es
[2] Instituto Español de Oceanografía

Abstract
Oceanographic data obtained by mid spring at open sea in the central part of the NW Mediterranean reveal evidences that almost two months after the open sea Deep Water Formation (DWF) process, there are still energetic mechanisms reorganising the water mass structure. Among those, clear indications of a relevant upwelling below the thermocline, that would contribute to maintain the early spring open sea phytoplankton bloom

Keywords: Circulation, Blooms, Deep sea basins, North-Western Mediterranean, Upwelling

Traditional description of the DWF cycle in the Western Mediterranean involves a final phase of sinking and spreading of the newly formed deep water. At the same time, the upper level is progressively recovering its stratification. Both mechanisms are well known. While the first has been obviously observed in the deep layers, the latter has been identified as the main driver for the typical phytoplankton blooms, especially in those areas where deep water formation was previoulsy active. These descriptions assume that on slacking the thermohaline DWF forcing, exerted by strong, dry and cold winds, the sea recovers its typical circulation patterns. Then, vertical motions are almost negligible and horizontal current intensity is decaying with depth, at least in the upper and intermediate layers. Spring phytoplankton blooms developing during this stage can stand for a couple of months, often depending on the intensity of the former DWF process and the, not so scarce, early spring storms [1]. However, to our knowledge, nothing has been reported about possible upwelling of intermediate waters into the upper layer as a mechanism contributing to sustain and perhaps extend the period of blooming.

Within the framework of the "Famoso" project (Fate of the Northwestern Mediterranean Open sea Spring bloom) two cruises were carried out in the NW Mediterranean, in March and early May 2009 respectively. Winter 2009 was considered to be "normal" to "cold" in terms of DWF [2]. At the beginning of the March cruise DWF was still active and, at the end of the cruise the phytoplankton bloom was clearly growing. In early May, several patches of high chlorophyll were still present in the vicinity of the formerly active DWF areas. A closed box around one of these chlorophyll patches was surveyed with the on-board ADCP and a SeaSoar towed system covering the upper 400 meters of the water column. The box was almost closed, from late 29 April to 2nd May, and the flow across the boundaries was estimated in two layers above and below the 29.0 isopycnal. Surprisingly, the results show that in the upper 400 m outflow was much higher than inflow (Figs 1 and 2). One can easily assume that the missing flow through the opening at the N corner of the box should compensate the output on its western side, since it falls under the path of the well know slope current. However, even with this assumption the outflow still remained much higher than inflow. Since the shape chlorophyll distribution at surface evidences that the SE corner of the box was almost at the centre of a cyclonic eddy, another part of the uncompensated flow could be explained if the eddy were moving towards the SW during the survey. However such situation would compensate not more than an additional 20%. Thus the remaining ~50% could only be explained assuming an additonal inflow from below 400 m. Although most of this flow left the box below the 29.0 σ_t surface, part of which would reach the upper layer above that isopycnal (~60-100 m) within the photic zone. In addition to this surprising result, during the cruise there were additional evidences (not shown) for relatively strong currents at depths below 400 m as well as the presence of LIW at less than 200 m depth in several stations. The region thus, at early May, was still involved in a reorganising phase after DWF.

Summarising, the results show evidences that the last phase of the DWF would not only include sinking and spreading of the newly formed DW but also other energetic processes leading to the reorganisation of the dynamic structures, including upwelling pulses that would contribute to maintain the spring phytoplaknton bloom in NW Mediterranean open sea.

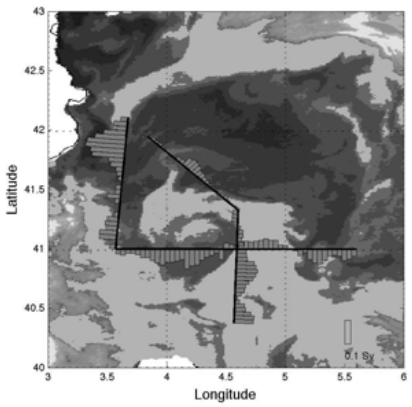

Fig. 1. Surface chlorophyll image from Modis Aqua (2/05/2009) and transport across the boundary estimated through ADCP and SeaSoar data through the Box Inverse method (upper layer above the 29.0 isopycnal)

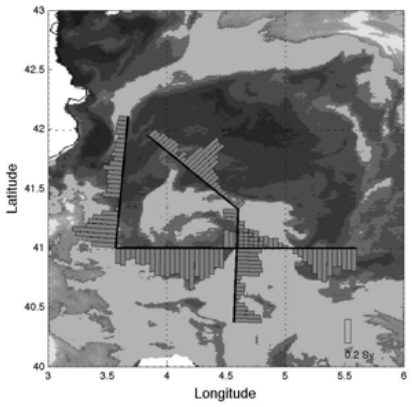

Fig. 2. Idem Fig. 1 with transport between 29.0 isopycnal and 400 m depth.

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MODEL EVALUATION AND UNDERSTANDING OF THE INTERANNUAL VARIABILITY (1980-2012) OF THE NORTH-WESTERN MEDITERRANEAN OPEN-SEA DEEP CONVECTION

S. Somot [1]*, L. Houpert [2], X. Durrieu de Madron [2], P. Testor [3], M. Herrmann [4] and F. Sevault [1]
[1] Météo-France, CNRM-GAME - samuel.somot@meteo.fr
[2] CEFREM, Univ. Perpignan
[3] UPMC, IPSL-LOCEAN
[4] IRD, LEGOS

Abstract
Recent intensive observation field campaigns and reanalysis of past observations allow an intensive evaluation of the North-Western Mediterranean open-sea deep convection process in the fully-coupled CNRM regional climate system model. Both case study for specific Winter (e.g. 2011-2012) and interannual variability are well reproduced. Using the model, a comprehensive description of the interannual variability of the process is proposed as well as a first analysis of the main driving factors.

Keywords: Deep waters, Water convection, Open sea, Models, North-Western Mediterranean

Introduction
The North-Western Mediterranean Sea is known as one of the only place in the world where open-sea deep convection occurs (often down to more than 2000m) with the formation of the Western Mediterranean Deep Water (WMDW). At the event scale, the WMDW formation is characterized by different phases (preconditioning, strong mixing, restratification and spreading), intense air-sea interaction and strong meso-scale activity but, on a longer time scale, it also shows a large interannual variability with impact on the regional biogeochemistry. Simulating and understanding the temporal variability of this open-sea deep convection is thus a challenging task for the ocean and climate modelling community.

Modeling approach
In order to achieve such a goal, we developed a Mediterranean Regional Climate System Model (RCSM) that includes high-resolution representation of the regional atmosphere (ALADIN, 50km), land surface (ISBA, 50km), rivers (TRIP, 50km) and ocean (NEMOMED8, 10km). All the components are interactively coupled daily without any constraint at the air-land-river-sea interfaces and a simulation over the period 1979-2012 has been performed using the atmosphere ERA-Interim reanalysis and the ocean NEMOVAR1° reanalysis as 4D lateral-boundary conditions. Spectral nudging technique is applied in the atmosphere to better constrain the large-scale atmospheric circulation.

Winter 2011-2012 case study
We first evaluate the ability of the model to simulate one of the most recent and best observed WMDW formation events: Winter 2011-2012. Time series of air-sea flux, surface water characteristics, mixed layer depth dynamics, convective surface, water mass characteristics and deep water formation rate are analyzed and compared to in-situ observations (Durrieu de Madron et al. 2013) of the programs MOOSE, HyMeX and MERMEX. The model is able to match well the available observations (see for example the mixed layer depth chronology in Fig. 1) despite a slight underestimation of the newly-formed deep water density (29.12 maximum value instead of 29.13 kg/m^3) and of the estimated deep water formation rate (0.44 Sv instead of 1.1 Sv).

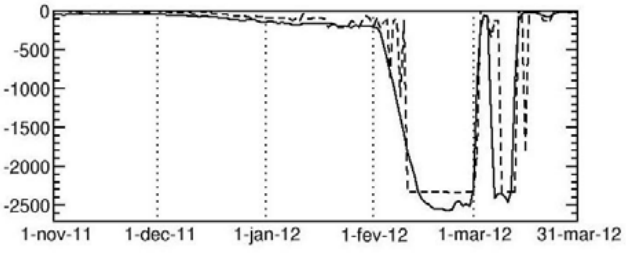

Fig. 1. Daily mixed layer depth time series (1st Nov. 2011 – 31st March 2012, in meter) in the center of the convective area (near 42°N-5°E) for the observations (dashed line) and for the model (full line).

Understanding the interannual variability
The model shows a very good ability to reproduce the observed past chronology of the mixed layer depth in the Gulf of Lions with 75% of the years showing maximum mixed layer depth higher than 1500m. In addition, the model shows about 50% of the years with a deep water formation rate higher than 0.1 Sv (for waters > 29.10 kg/m^3) with three years above 1 Sv (1981, 1999, 2005). The 1980-2012 interannual variability of this open-sea deep convection is then analyzed comparing the relative role of the water column preconditioning before Winter and of the Winter (DJFM) accumulated buoyancy loss in driving the annual maximum depth of the mixed layer and the deep water formation rate. The variability of the intensity of the deep convection is strongly related to the buoyancy loss but it is also correlated to the preconditioning of the water column (see Fig. 2). As an illustration, a Winter buoyancy loss less than 0.6 m^2/s^2 leads to negligible annual deep water formation rate whereas November stratification index higher than 0.9 m^2/s^2 are likely to prevent intense deep convection.

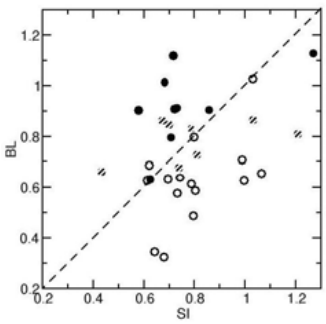

Fig. 2. Scatter-plot (1 circle per year) of the preconditioning stratification index (SI in m2/s2) versus the cumulative Winter buoyancy loss (BL in m2/s2), white/dashed/plain circles show deep water formation rate respectively <0.1 Sv / [0.1-0.4] Sv / >0.4 S.

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FACTORS FAVORING LARGE ORGANIC PRODUCTION IN THE NORTHERN ADRIATIC: TOWARDS THE NORTHERN ADRIATIC ECOLOGICAL MODEL

Romina Kraus [1], Nastjenjka Supic [1]* and Robert Precali [1]
[1] Rudjer Boskovic Institute - supic@cim.irb.hr

Abstract
The high interannual variability in the primary production of the northern Adriatic possibly reflects on the secondary production of the entire Adriatic. Although phytoplankton blooms are usually high in summer, the winter phytoplankton blooms are of special interest as in that period of low stratification especially large amounts of organic matter can be produced. Applied PCA analyses show that interannual variability in the winter production is primarily related to circulation, while the one in the spring/summer production is an immediate response to the Po River discharge. In addition, forcings from the previous period, up to a year, play a significant role in interannual changes of bioproduction.

Keywords: Circulation, Organic matter, Monitoring, Models, North Adriatic Sea

Introduction
The northern Adriatic (NA) is held to be one of the most productive regions of the Mediterranean Sea. However, its productivity is high only when influenced by the Po River, whose impact on the region significantly varies on seasonal and annual scales (Fig. 1). If waters of the Po River do not reside in it, the NA is oligotrophic like the rest of open Adriatic areas. Long-term changes in the NA organic production are therefore highly pronounced, and, most likely reflect on the secondary production of the entire Adriatic region or even wider.
An ecological model could explain and eventually predict long-term changes in the organic production of the region. In order to prepare grounds for it, we have tried to distinguish the main factors responsible for large organic production of the NA, throughout empirical analysis of long-term measurements in the region.
Although phytoplankton blooms are very high in summer, we have mainly focused to the winter ones [1]. When, in conditions of low stratification the nutrient rich Po River waters spread across the NA, they can fill volumely large spaces and induce exceptionally large organic production in general (as observed in 2004). Such events could probably result in an exceptional increase in the secondary Adriatic production.

Data and methods
Oceanographic data were collected monthly to seasonally in the 1990-2000 interval at six stations at a section in the NA (Figure 1). PCA and simple linear correlations were used to investigate relations between phytoplankton blooms and surface geostrophic currents relative to 30 dbar between the stations, Po River discharge rates, and atmospheric fluxes.

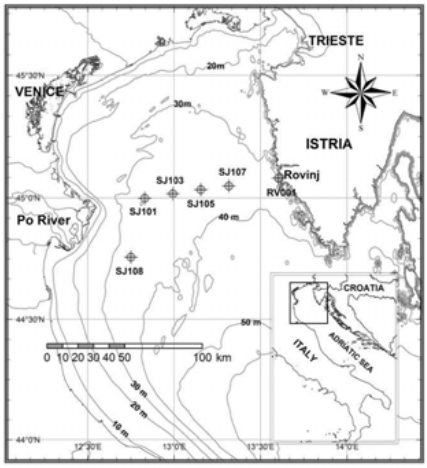

Fig. 1. The northern Adriatic with map of sampling stations.

Results and discussion
Long-term changes in phytoplankton abundances at the section between the Po River delta and Rovinj in winter (Jan and Feb) significantly depend on the circulation patterns, while in spring/summer (May-Jul) a direct Po River influence could be attributed (Table 1). However, discharge in the previous period, up to 45 days earlier, reflected possibly on winter blooms (Table 1).
High Po River discharge rates in the preceding summer along with intense evaporation and low Po River rates in the preceding autumn favoured large winter (Feb) blooms at st. SJ108, SJ101 and SJ107 (not shown). On the contrary, intense blooms in summer (Jul) at the same three stations were favoured concomittantly by high Po River rates in previous summer, autumn and winter, by heavy rain in the preceding autumn, and by enhanced insolation in the previous spring.

Tab. 1. Correlation coefficients between the first (F1) or second (F2) mode of interannual changes in phytoplankton abundance at 6 stations of Figure 1 in a chosen month (I to XII; abundances were normalized before performing PCA) and first two modes of geostrophic current distribution across the Po section at the sampling time (C1 and C2), Po discharge rates on the same day (Po), as well as cumulative values of Po discharge rates in period preceding the sampling, up to 1 (Po-1), 5 (Po-5), 10 (Po-10), 30 (Po-30) or 45 (Po-45) days. Correlations significant at 95% CL are bolded.

Month		C1	C2	Po	Po-1	Po-5	Po-10	Po-30	Po-45
I	F1	**0,66**	0,05	0,08	0,03	0,02	0,04	0,12	**0,76**
	F2	0,43	**0,63**	0,17	0,06	0,12	0,04	0,25	**0,61**
II	F1	**0,65**	0,21	0,18	0,16	0,16	0,11	0,09	0,02
	F2	0,32	0,36	0,00	0,00	0,05	0,30	0,24	**0,59**
III	F1	0,27	0,17	0,07	0,02	0,02	0,17	0,24	0,31
	F2	0,40	0,13	0,39	0,45	0,54	0,25	0,32	0,38
IV	F1	0,54	0,47	0,17	0,23	0,08	0,19	0,55	0,59
	F2	0,38	0,53	0,56	0,52	0,33	0,29	0,40	0,28
V	F1	0,04	0,08	**0,67**	0,57	0,42	0,38	0,37	0,25
	F2	0,11	0,09	0,07	0,17	0,03	0,08	0,33	0,27
VI	F1	0,15	0,00	0,51	**0,61**	**0,55**	**0,75**	0,06	0,21
	F2	0,33	0,46	0,00	0,12	0,00	0,39	0,41	0,23
VII	F1	0,21	0,40	**0,76**	**0,72**	**0,75**	0,34	0,05	0,24
	F2	0,15	0,46	0,41	0,44	0,41	0,73	0,10	0,20
VIII	F1	0,04	0,21	0,33	0,23	0,26	0,22	0,05	0,00
	F2	0,25	0,42	0,04	0,05	0,00	0,30	0,18	0,24
IX	F1	**0,62**	0,37	0,41	0,42	0,44	0,20	0,12	0,39
	F2	0,14	0,32	0,38	0,26	0,17	0,15	0,00	0,00
X	F1	0,00	0,30	0,43	0,46	**0,72**	**0,63**	0,00	0,23
	F2	0,26	0,54	0,36	0,38	0,24	0,00	0,14	0,24
XI	F1	0,34	0,48	0,12	0,14	0,06	0,16	0,22	0,16
	F2	**0,75**	0,29	0,50	0,51	0,56	0,30	0,48	0,27
XII	F1	0,04	0,00	0,30	0,27	0,33	0,68	0,24	0,42
	F2	0,41	0,12	0,61	0,58	0,61	0,62	0,58	0,58

Conclusion
The obtained results, showed that oceanographic forcing at the time of sampling and in previous periods, are important for the understanding of the long-term variability of the NA organic production, and can be used to forecast such events. In addition, they can be used for development of the NA ecological model.

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AN INTERNAL MECHANISM ALTERNATIVELY DRIVES THE PRECONDITIONING OF BOTH THE ADRIATIC AND AEGEAN SEAS AS DENSE WATER FORMATION SITES IN THE EASTERN MEDITERRANEAN

Dimitris Velaoras [1]*, George Krokos [1] and Alexander Theocharis [1]
[1] Hellenic Center for Marine Research Institute of Oceanography - dvelaoras@hcmr.gr

Abstract
Dense water produced in the Aegean Sea during the late 2000's supports the existence of a rather permanent thermohaline pump mechanism that regulates the production of dense/deep waters in the Adriatic and Aegean Seas. The mechanism disturbs the Eastern Mediterranean (EMed) upper thermohaline cell modifying their hydrological structure which alternatively preconditions each Dense Water Formation (DWF) source. The role of this internal mechanism seems to prevail over the long-term atmospheric influence in DWF events.

Keywords: Aegean Sea, Levantine Basin, Circulation, Deep waters

The Adriatic and the Aegean Seas are the two dense/deep water producing sources in the EMed. It has been shown [1] that during the 1960 - 2000 period these two areas presented alternating competitive cycles of DWF which were followed by periods of less intense activity. The mechanism responsible for the alternation of dense water production is based on their antagonistic functioning in controlling the EMed deep thermohaline cell at almost decadal time intervals. The massive outflow of dense water through the deepest layers of these two marginal seas during their active phases is balanced by increased inflow from the upper layers. Thus, a thermohaline pump is created that advects upper layer available water masses towards the active areas through their straits and gradually disturbs the upper thermohaline cell of the EMed finally modifying the main water mass pathways. This disturbance is portrayed in two different modes: Following the activation of the Adriatic Sea, the Atlantic – Ionian Stream (AIS) is deflected towards the North Ionian with limited eastward flow resulting in the recirculation of the Levantine Intermediate Water (LIW) in the Levantine. Therefore salinity gradually increases in the eastern part of the EMed which leads through preconditioning to DWF in the Aegean Sea. Respectively, the activation of the Aegean Sea re-establishes the AIS eastward flow and consequently restores the LIW westward return flow. The mechanism modifies the thermohaline structure of the water column, alternatively preconditioning each source area.

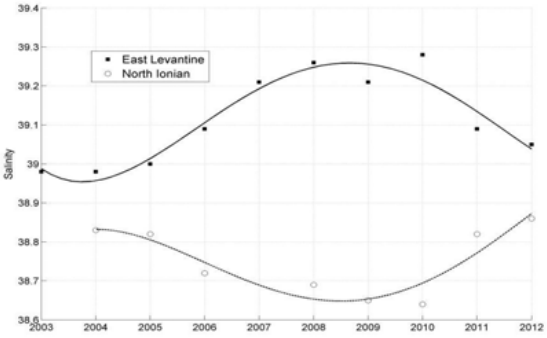

Fig. 1. Yearly mean integrated salinity values for the first 300m in the N. Ionian and E. Levantine Seas (2003-12). Polynomial curves have been added for clarity

Recent field studies [2] have provided solid indication of dense water formation taking place in the Aegean Sea a few years after the 2006 AIS deflection towards the North Ionian [3]. Dense water outflow has been monitored in the Western Cretan Straits during 2007, 2008 and 2009 characterized by high temperature and salinity values and with potential densities occasionally reaching up to 29.21 kg/m3.
Using ARGO and Glider data from the MyOcean project's data pool [4], yearly mean integrated salinity values in the first 300m were produced for the eastern Levantine basin (east of 31ºE) and the North Ionian Sea (north of 37ºN) for the available data period 2003-12. The results (figure 1), show a clear anti-correlated behavior between them with an apparent almost decadal signal. Following the 2006 AIS deflection upper thermocline salinities in the North Ionian decrease, while the eastern Levantine salinities are enhanced. In order to estimate the contribution of the atmosphere we examined the net heat flux derived from the ERA Interim reanalysis dataset [5]. Results presented in figure 2, show that the recent activation of the Aegean is not characterized by any significant thermal interaction with the atmosphere. The same conclusion can be reached by examining the E-P budget (not shown). The role of the air-sea interactions should nonetheless not be underestimated since severe winter atmospheric events can modulate the intensity of the DWF, as in the case of the Eastern Mediterranean Transient.

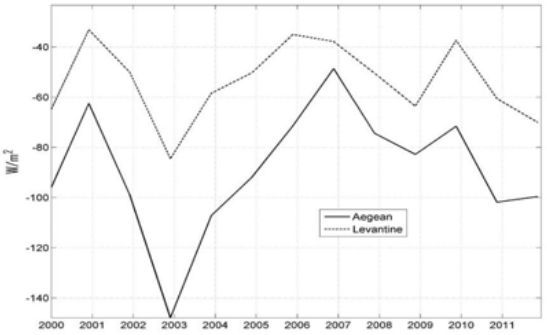

Fig. 2. Winter net heat budget (December to March) in the Aegean and Levantine Seas (2000-12)

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ESTIMATION OF RESIDENCE TIMES AND MIXING RATES IN THE HELLENIC SEAS

V. Zervakis [1]*, E. Tragou [1], S. Leontiou [1], P. Poulain [2], R. Gerin [2], S. Kioroglou [1] and S. Sofianos [3]
[1] Department of Marine Sciences, University of the Aegean, Greece - zervakis@marine.aegean.gr
[2] National Institute of Oceanography and Experimental Geophysics (OGS), Italy
[3] Dept of Physics, National Kapodistrian University of Athens

Abstract
In the framework of the European Marine Strategy Framework Directive, the mixing characteristics and residence times of the Hellenic seas are reviewed and analyzed. To that purpose, analysis of Lagrangian observations is used, as well as other methods, wherever applicable. The method of Optimum Multiparametric Analysis is also used and compared to Lagrangian and hydrographic estimates, to assess mixing of water masses and age of deep waters. The above methods compare quite well in the intermediate and deeper waters. Both Lagrangian analysis and a variety of other methods, including velocity shear measurements, buoyancy budgets, density overturn analysis and specially planned Lagrangian experiments are also employed in an assessment of horizontal and vertical mixing in the Hellenic Seas.

Keywords: Surface waters, Turbulence, Circulation, Currents, Aegean Sea

In the framework of the Greek response to the European Marine Strategy Framework Directive (EMSFD), a review of mixing assessments and water residence times is attempted for the parts of the Mediterranean surrounding Greece, hereby referred to as the Hellenic Seas. For the purposes of the EMSFD, the seas surrounding Greece were divided into four major sub-basins, i.e. the North, Central and South Aegean, the NW Levantine and NE Ionian Seas. In each of these basins, estimation of mixing rates and residence times was based on the availability of surface drifter (in the surface layer) and ARGO float tracks (in deep waters), as well as other methods, whenever applicable. Regarding residence times, surface estimates were obtained through drifter tracks provided by the MedSVP project (http://nettuno.ogs.trieste.it/sire/medsvp/) and by the data set of the University of Athens. The residence times for each of the above sub-basins were estimated by averaging the times over which the drifters remained within the sub-basin, normalized by the ratio of zonal or meridional extent of the basin to zonal or meridional extent of each drifter track, to account for limited drifter lifetimes.

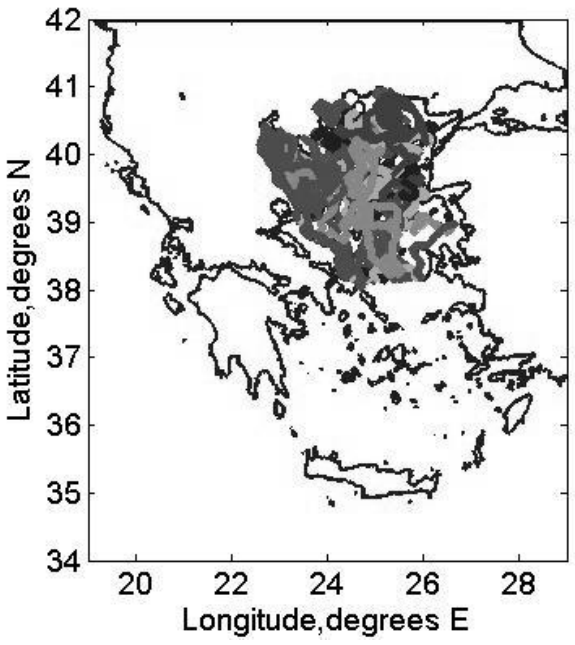

Fig. 1. Spaghetti diagram of the drifter tracks used for the estimation of mixing and residence times in the North Aegean sub-basin

The same method was applied on a much smaller data set of ARGO floats for the deeper layers.
The method of Optimum Multiparametric Analysis (Karstensen and Tomczak, 1998; Leontiou, 2010) has been exploited for the estimation of residence times in intermediate and deep waters. The surface residence times based on drifter tracks in the surface layer naturally increased with basin size, ranging from 20 days in the Central Aegean to 150 days in the Northwestern Levantine. In the deeper layers of the Aegean the ARGO float tracks, whenever available, provided estimates comparable to the OMP method results. In the Ionian and Levantine Seas, residence time increased with distance from the Cretan Straits, ranging from 1 year to 30 years, based on the OMP method. ARGO float estimates should provide significantly smaller numbers, as the OMP method inherently incorporates the mixing taking place within a whole basin. The description of mixing processes in each sub-basin was also assessed via a range of methods. Horizontal mixing was addressed via the surface drifter and ARGO float observations, by estimating the eddy diffusivities through calculating Lagrangian decorrelation scales. Again, these estimates were applied over the whole sub-basins reported above, thus the considered mixing processes include all sub-basin scale circulation. Our results vary from 350 m^2s^{-1} in the North Aegean to more than 3000 m^2s^{-1} in the Levantine for the surface layer, and from 80 m^2 s^{-1} in the South Aegean to 140 m^2 s^{-1} in the Levantine Sea for the deep layers. A review on vertical mixing estimates provides values ranging from 10^{-5} to 10^{-3} m^2s^{-1}, based on a spectrum of methods ranging from direct shear measurements via microstructure profilers (Gregg et al., 2012), to buoyancy budget estimations (Zervakis et al., 2003), to mixing assessment observed through Lagrangian experiments (Zervakis et al., to be submitted) as well as obtained via analysis of density overturns (Kioroglou et al., manuscript under revision).

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Session

Thermohaline cells and biochemical status - 2

Modérateur : **Chiara Santinelli**

SENSIBILITY ANALYSIS OF THE WESTERN MEDITERRANEAN TRANSITION INFERRED BY FOUR COMPANION SIMULATIONS

T. Arsouze [1]*, J. Beuvier [2], K. Béranger [1], S. Somot [3], C. Lebeaupin Brossier [3], R. Bourdallé-Badie [2], F. Sevault [3] and Y. Drillet [2]

[1] ENSTA-ParisTech - thomas.arsouze@ensta-paristech.fr
[2] Mercator Ocean
[3] CNRM

Abstract

Four companion eddy-resolving simulations, obtained by running the NEMO code in regional Mediterranean configurations differing only by the horizontal or the vertical resolution grid, are compared during the 1998-2011 period with a focus on the Western Mediterranean Transition event in 2004-2006. The increase of the model resolution highlights the models skills in simulating such processes as the water mass formation and spreading towards the southern boundaries of the basin.

Keywords: Circulation models, Water convection, Mesoscale phenomena, Gulf of Lyon, Algerian Basin

Introduction - The Western Mediterranean Transition (WMT) is a strong event [1] occurring during the winter 2004-2005 in the Western Mediterranean resulting in the formation of a large amount of Western Mediterranean Deep Water (WMDW). The newly formed WMDW then invaded the whole Western Mediterranean in a relatively short period of time. Our modeling study compares four companion eddy-resolving simulations obtained by running the NEMO code in regional Mediterranean configurations differing only by the horizontal or the vertical resolution grid. The first configuration MED12v50, considered as our reference, is well described in [2] and refers to a 1/12° ORCA grid with 50 vertical levels. The second configuration MED12v75 refers to a 1/12° ORCA grid with 75 vertical levels. The third and the fourth configurations refer to a 1/36° ORCA grid with 50 and 75 vertical levels, MED36v50 and MED36v75 respectively. All the simulations used MEDATLAS climatology [3] in October 1998 as an initial condition and were forced from 1998 to 2011 by the ARPERA atmospheric fields, at about 50km resolution [4].

Results - The first study of the reference simulation MED12v50 has shown the role of deep mesoscale cyclones in transporting a large amount of new WMDW in the southwestern Mediterranean, in agreement with altimetry data [5]. The companion simulations are compared to the reference simulation on the 2004-2006 period and the differences are quantified in terms of horizontal patterns and WMDW formation rate, mesoscale eddy characteristics and drift, and bottom spreading towards the Channel of Sardinia and the Strait of Gibraltar.

The increase in the horizontal resolution consequences an increase of the formation rate for density higher than 29.11 $kg.m^{-3}$ (Table 1) in particular in 2006. The increase in the vertical resolution consequences an increase of the formation rate, more pronounced for density higher than 29.12 $kg.m^{-3}$ (Table 1). The horizontal resolution increase consequences a decrease in the diameter of deep cyclones transporting WMDW southwards by 20km (80 km against 100 km in the reference run) , while the vertical resolution increase consequences an increase of the deep cyclone southern drift velocity with higher bottom speed, in better agreement with the satellite data [5] and observations of [1].

Conclusion - The MED36v75 model shows a realistic formation rate and characteristic time for southward spreading in the basin, although the newly formed WMDW caracteristics are a little too cold and less salty than when compared to the observations of [1], partly due to the influence of the modeled shelf waters coming from the Cap Creus. In both MED36 simulations, as for 2005, the winter 2006 shows intense deep convection and WMDW formation, contributing to the fast spreading southward observed.

Acknowledgments - Modeling work was supported by Mercator Ocean. Computations were made at IDRIS from the CNRS (project i010227).

Tab. 1. Formation rates in Sverdrups (1 Sv = $10^6 m^3.s^{-1}$) according to [1] for the two years in mean, and for the four companion simulations, for density higher than 29.11 $kg.m^{-3}$ and 29.12 $kg.m^{-3}$.

Criteria ($kg.m^{-3}$)	>29.11	>29.11	>29.12	>29.12
year	2005	2006	2005	2006
[1] in mean	2.4 Sv	2.4 Sv		
MED12v50 [2]	3.1 Sv	0.4 Sv	1.3 Sv	0.2 Sv
MED12v75	3.5 Sv	0.4 Sv	2.1 Sv	0.1 Sv
MED36v50	3.1 Sv	1.9 Sv	1.2 Sv	0.6 Sv
MED36v75	3.7 Sv	2.1 Sv	2.6 Sv	1.1 Sv

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EVOLUTION OF THE DISSOLVED OXYGEN IN THE CENTRAL PART OF THE NW MEDITERRANEAN SEA: NEW RESULTS ABOUT THE WATER MASS PROPERTIES CHANGE OVER THE LAST 20 YEARS

Laurent Coppola [1]*, Dominique Lefevre [2], Louis Prieur [1] and Vincent Taillandier [1]
[1] Laboratoire Océanographique de Villefranche CNRS UPMC - coppola@obs-vlfr.fr
[2] Institut Méditerranéen d'Océanologie Université Aix-Marseille CNRS, France

Abstract
Recent studies evidenced that intermediate and deep water masses properties in the western Mediterranean Sea are affected by the propagation of the EMT signal and the deep convection events. The long oceanic time series operated at the DYFAMED site (Ligurian Sea) since 1993 recorded recent and rapid change of the water mass properties. We present here new results from the dissolved oxygen, more sensitive to the dynamic processes, to detect deep convection process and intrusion of new water mass that occurred over the last 20 years in the Ligurian Sea and affecting the biogeochemical budget.

Keywords: Oxygen, Time series, Ligurian Sea

Recent studies evidenced that climatic changes does not only occur at centenary and millenary scales, but may also occur at much shorter time scales. This is particularly important for the Mediterranean Sea, where the spatial and temporal scales are one order of magnitude smaller than in the global ocean. Since the late 80s a rapid and extended change of the deep water formation cell in the eastern basin has been observed (Eastern Mediterranean Transient event). More recently, modifications of the deep and intermediate water masses properties have been also observed in the western basin suggesting a propagation of the EMT event (so called the Western Mediterranean Transient) and more intense local deep convection events with a probable impact on marine ecosystems. This change shows the importance for a continuous monitoring of the Mediterranean circulation in strategic area to estimate the impact of the water circulation on biogeochemistry cycles. The DYFAMED time series (Ligurian Sea) represents one of the longest oceanic time series in the Mediterranean Sea where water mass changes have been already observed [1]. To detect hydrodynamic change, T and S parameters are currently used. Here we propose to use the dissolved oxygen concentrationsand more sensitive to the physical processes and which has been acquired at the DYFAMED site since 1993 (EUROSITES, PERSEUS and MOOSE since 2010). These new results allow us to observe the variability of the deep convection events, the water mass ventilation and the intrusion of new water mass that occurred in the Ligurian Sea over the last 20 years and affecting the biogeochemical budget. For example, since 1993, the dissolved oxygen concentrations showed the lowest values in the Levantine Intermediate Water at the DYFAMED site (from 170 to 190 umol/kg) with a strong variability due to mixing process. In the deeper waters (~2,000m depth) O2 concentrations showed less variability (from 200 to 215 umol/kg) with the maximum could be related to the deep convection processes that appeared some winters in the Ligurian Sea.

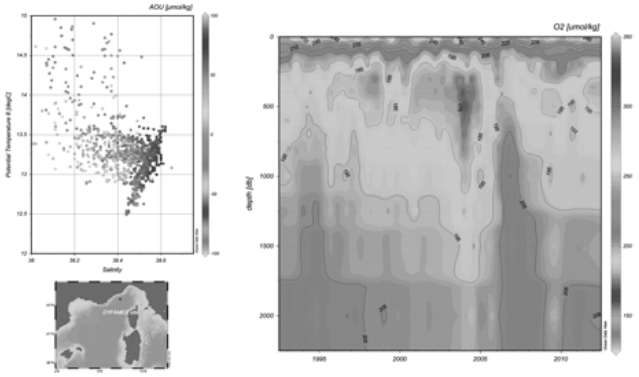

Fig. 1. Time series of the dissolved oxygen concentrations measured at the DYFAMED site. Data have been acquired from bottles sampling and Winkler method.

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SEASONAL VARIATIONS OF ORGANIC MATTER AND NUTRIENTS IN THE NORTHEAST MEDITERRANEAN (MERSIN BAY)

Emine Erdogan [1]*, Süleyman Tugrul [2] and Özden Bastürk [1]
[1] Mersin University, Faculty of Fisheries - emineerdogan@mersin.edu.tr
[2] Middle East Technical University, Institue of Marine Sciences, Erdemli 33731, Mersin, Turkey

Abstract
In the present study,4 field studies,in the April 2010 – February 2011 period,were conducted in the eastern region of Mersin Bay extending from Mersin city up to Seyhan River delta.In the river-fed coastal waters, nitrate values were high (1.1 -9.2 µM);the low phosphate(0.06-0.16 µM)values result in higher N/P ratios (35-50) in nearshore waters.Surface total phosphorus, chlorophyll-a and particulate organic matter displayed similar spatial distributions, decreasing 5-10 times in the offshore waters, exhibiting seasonal variations. POM values were as high as 10.9-88.4 µM for POC, 1.5-8.3 µM for PON and 0.05-0.27 µM for PP in the polluted shallow zone, with the POC/PON: 7.1-10.6 and PON/PP: 18-35 ratios.These ratios generally ranged between 7 and 10 as the concentrations decreased markedly in the oligotrophic offshore waters of the bay.

Keywords: Eutrophication, Nutrients, Particulates, Mersin Bay

Shelf waters of NE Mediterranean (Cilician basin) have been polluted by discharges of the major rivers (Seyhan, Ceyhan) and domestic wastewaters of the big cities in the region. Therefore, eutrophication phenomena have increased in the Mersin bay shallow waters fed by polluted river and domestic water discharges. On the other hand, open surface waters of the Eastern Mediterranean is a typical example for the oligotrophic seas [1-2]. This study aims to assess inpacts of land based inputs on the distributions of eutrophication- related biochemical parameters in the bay, covering the affected coastal zoen and offshore waters (Fig. 1). Four field surveys were conducted by R/V BILIM during the April, 2010-February, 2011 (funded TUBITAK within 107G066 project). Conventional methods were followed in the measurements of chemical parameters. Concentrations of dissolved inorganic nutrients, POM, biomass, CHL-a were expectedly high in the nearshore waters of the bay fed by nitrate-rich rivers (with high N/P) and domestic wastewater discharges. Impacts of land-based inputs weaken markedly in the offshore waters due to limited water exchanges between the shallow inner bay and deeper (>50 m) offshore (Fig. 1). Typical surface distributions of nitrate and CHL-a (algal biomass indicator) in the bay show the highly impacted water body in the nearshore zone. In spring-autumn period, surface nutrient values were consistently low in the central and outer bay waters (0.02-0.05 µM for PO_4 and 0.05- 0.67 for NO_3) with relatively low N/P molar ratios (8-15) which increased up to 35-50 in the nearshore waters fed by river discharges.

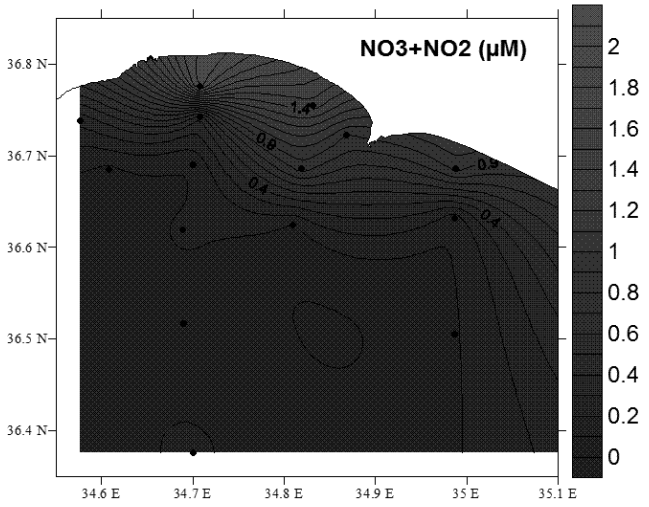

Fig. 1. Surficial distribution of nitrate in the bay in April 2010.

Surface water N/P ratios appears to decrease in spring-autumn period due to decreasing nitrate values of the surface waters. Surface CHL-a concentrations, as low as 0.05-0.15 µg/L in offshore waters displaying oligotrophic properties, increased steadily to 2.7 µg/L level in the river-fed nearshore waters. Apparent increase in the POM conetrations coastal waters with low C/N ratios indicate that the enhanced eutrophication dominates the POM pool in the inner shelf compared to the POM of regenerative origin in the open sea during spring-autumn period. Particulate P and PO4 constituted merely 10-35 % and 8-25 % of TP pool in the nearshore; the rest by DOP which dominate in the TP pool in the euphotic zone of the open sea.

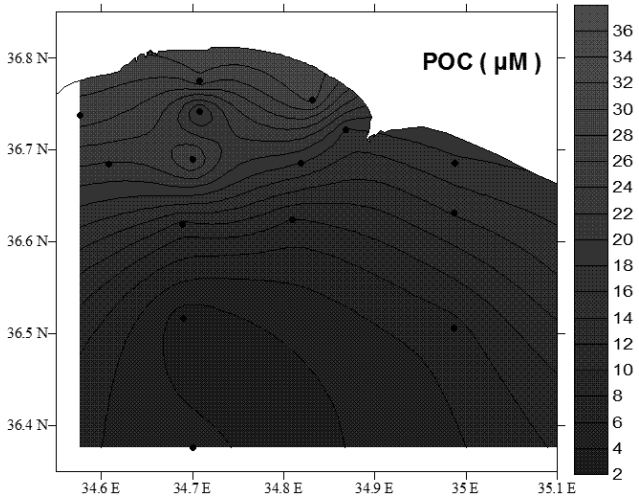

Fig. 2. Surficial distribution of POC in the bay in April 2010.

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VARIABILITY OF NUTRIENT CONCENTRATION PROFILES IN RELATION TO SEASONAL PHYSICAL AND BIOGEOCHEMICAL PROCESSES: DATA FROM THE DYFAMED STATION (LIGURIAN SEA)

Orens Pasqueron de Fommervault [1]*, Christophe Migon [1], Fabrizio D'Ortenzio [1] and Laurent Coppola [1]
[1] Université Pierre et Marie Curie, CNRS, UMR 7093 Laboratoire d'Océanographie de Villefranche - orens.de-fommervault@obs-vlfr.fr

Abstract
Nutrient (nitrate, phosphate and silicate) concentrations profiles were continuously measured at the DYFAMED time-series station (Ligurian Sea) between 1991 and 2011, and underwent quality control. Concentration profiles showed seasonal patterns in relation to physical and biogeochemical processes (winter convection, spring bloom, and summer stratification). The interannual variability of nutrient concentrations was examined, which permitted to figure composite years of nutrient concentrations from surface to 200m depth. Nitrate to phosphate ratios permitted to assess the seasonal variability of chemical limitation in this region.

Keywords: Time series, Nutrients, Ligurian Sea

The knowledge of physical and biogeochemical processes that control the availability of nutrients is a key point for the understanding of the chemical limitation of primary production. However, time-series data on nutrient dynamics are still scarse in the Mediterranean Sea. From 1991 to 2011, nutrient concentrations were measured at the time-series DYFAMED site (central Ligurian Sea, 28 nautical miles from the continental French coast, 2350m deep, 43°25'N, 7°52E), now in the framework of the French Service d'Observation MOOSE (Mediterranean Ocean Observing System on Environment). After quality control on the whole data set, outliers and aberrant values were removed. Remaining data permitted to evidence clear patterns in relation to seasonal physical and biogeochemical processes: Winter convection homogenises nutrient concentrations along the water column, resulting in rectilinear profiles. The convection process yields the fuelling of nutrients to the photic layer, which triggers the subsequent phytoplankton bloom, in spring. Then, nutrients are progressively consumed by biota, while the stratification of the water column increases. The depletion of surface waters characterises the oligotrophic season, resulting in typical surface-depleted profiles. Such reproducible patterns permitted to draw composite years of nutrient concentrations, e.g. nitrate concentrations (Fig. 1).

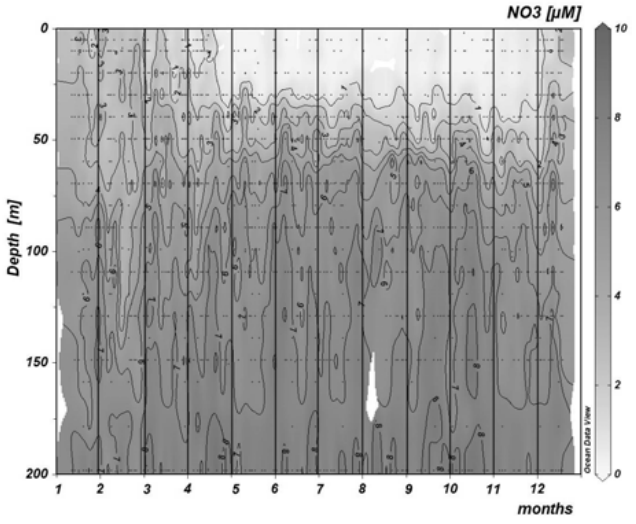

Fig. 1. Seasonal plot of nitrate concentration in the 0-200m layer for a composite year (1991-2011), after quality control at the DYFAMED site.

Ultimately, this data set permitted to assess the seasonal variability of nitrate to phosphate ratios, which evidences the seasonal variability of the chemical limitation of primary production: a shift from nitrate (spring) to phosphate (summer and fall) is characteristic of the north-western Mediterranean [1] (Fig. 2).

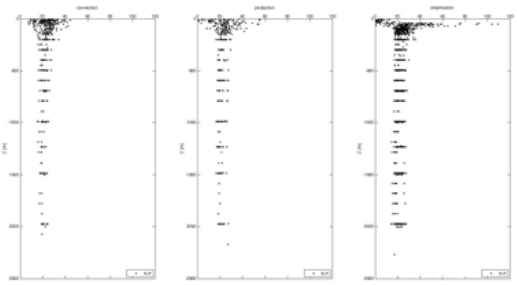

Fig. 2. N:P ratio for the 0-2500m layer at the DYFAMED site. Data are gathered according seasonal patterns: Left, middle and right graphs represent the convective, productive, and stratified periods, respectively. The seasonal variation is clearly marked in the surface layer. Below 500m depth, the ratio is around 21-22, and much less variable. Note that low values calculated at the surface during the stratified period are due to very questionable estimates of the N:P ratio when nitrate and phosphate concentrations are low.

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IMPACT OF P VS SAHARAN DUST/AEROSOL ADDITIONS ON THE MICROBIAL FOOD WEB OF THE EASTERN MEDITERRANEAN SEA - A MESOCOSM APPROACH

Paraskevi Pitta [1]*, T. Frede Thingstad [2] and Barak Herut [3]
[1] Institute of Oceanography, Hellenic Centre for Marine Research, Heraklion, Crete, Greece - vpitta@hcmr.gr
[2] Department of Biology, University of Bergen, Bergen, Norway
[3] Israel Oceanographic & Limnological Research, National Institute of Oceanography, Haifa, Israel

Abstract
Atmospheric aerosols have been found to supply not only phosphorus but also macro- and micro-nutrients (N, Fe and other) to the Mediterranean. The impact of P alone and Saharan dust/aerosol additions on the microbial food web of the oligotrophic Eastern Mediterranean Sea was studied by means of two mesocosm experiments carried out at the new mesocosm facility of the Hellenic Centre for Marine Research in Crete, Greece, during September 2009 and May 2012, respectively. During both experiments, a wide range of chemical and biological rate and state variables was measured. The results of the two kinds of addition are discussed in terms of their effects on the phytoplankton and bacterial component of the food web.

Keywords: Atmospheric input, Phosphorus, Food webs, Cretan Sea, North-Eastern Mediterranean

The Eastern Mediterranean Sea (EMS) receives high dust fluxes, with maximal inputs, especially from the adjacent Sahara desert, during the spring and early summer periods. Since Saharan dust has been shown to contain bioavailable phosphorus (P) but also macro- and micro-nutrients (N, Fe and other trace metals) [1], dust deposition events could stimulate the biological activity at the Low Nutrient Low Chlorophyll EMS. During the past years, many efforts have been carried out to understand the effect(s) of P-addition on the entire pelagic food web of the P-limited EMS, through a Lagrangian [2] as well as a mesocosm study [3]. However, this kind of ecosystem-level approach has not been used in the case of dust/aerosol in the Eastern Mediterranean.

The impact of Saharan dust and mixed aerosols on the microbial food web of the oligotrophic Cretan Sea was studied during a mesocosm experiment in May 2012 (ATMOMED project), at the new mesocosm facility of the Hellenic Centre for Marine Research in Crete, Greece (http://mesoaqua.eu/cretacosmos). Saharan dust (1.6 mg l^{-1}) and mixed aerosols (1 mg l^{-1}), collected in Crete and elsewhere, were each added to 3 mesocosms of 3 m^3, while 3 more mesocosms were used as control (no addition). A wide range of biological state (abundance and biomass of all biota from viruses to mesozooplankton, bacterial, microplankton and mesozooplankton community composition) and rate (primary, bacterial, viral and mesozooplankton production, bacterial respiration, phosphorus uptake, N2 fixation, photosynthetic efficiency, microzooplankton grazing) variables were measured during 9 days of experiment.

The results of primary production and phytoplankton biomass (mainly *Synechococcus*) indicated a net response of the autotrophic community to both Saharan dust and mixed aerosol additions between days 1 and 4. The response of the heterotrophic bacterial community to both dust and mixed aerosol treatments was also clear but faster than the one of the phytoplankton and lasted only from day 0 to day 2. This would suggest that Saharan dust and mixed aerosol stimulated the auto- and hetero-trophic sides in different time scales and probably triggered interactions between them.

The above-mentioned biological parameters were related to the temporal distributions of numerous chemical species, such as inorganic and organic nutrients, total proteins, total mono- and poly-saccharides and their molecular composition profiles, in order to highlight the production and degradation dynamics of organic matter.

The results of this experiment are compared to the ones of a previous mesocosm experiment with addition of P alone that took place at the same facility, in September 2009 (Nutritunnel project).

The impact of dust and aerosol additions on the microbial food web was spectacularly more significant than the one of addition of P alone and it was evident in the case of both bacteria and phytoplankton whereas only bacteria were found to benefit when P was added to the pelagic ecosystem of the Eastern Mediterranean. This differential response is not unexpected given that atmospheric inputs contain P and N and also that phytoplankton has been found to be N&P co-limited in the area, at least during the warm period [2,3].

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TROPHIC STATE OF THE NORTHERN ADRIATIC

Robert Precali [1]* and Tamara Djakovac [1]
[1] Rudjer Boskovic Institute Center for Marine Research - precali@cim.irb.hr

Abstract
The annual mean trophic index and efficiency coefficient were used to address the trophic state of the northern Adriatic in the last forty years. Differences in the efficiency of nutrients use between the western (more eutrophied) and eastern (more oligotrophic) part were identified at the beginning of the investigated period. Later, after the ban of polyphosphates in detergents (mid-eighties) the NA ecosystem showed similar patterns in the whole area.

Keywords: Eutrophication, North Adriatic Sea

Introduction
The trophic state of the northern Adriatic (NA) is mainly under the influence of the Po River (70 % of the inflow), one of the largest Mediterranean rivers. The trophic index (TRIX) and the Efficiency coefficient (EFCO) are widely used to address the trophic state of an area [1]. As the NA undergoes changes in the nutrients availability and the ecosystem responds to that *stimulus* [2], it is important to understand if the trophic state of the area shows same patterns.

Methods
Water samples for nutrients (ammonium, nitrite, nitrate and total phosphorous) and chlorophyll *a* concentration measurements were collected on a monthly scale from 1972-2011 at five oceanographic depths at stations SJ107 (13 Nm off Rovinj) and SJ108 (13 Nm SE off Po River mouth; Fig. 1). Parameters were determined by standard oceanographic methods described in previous authors' publications.

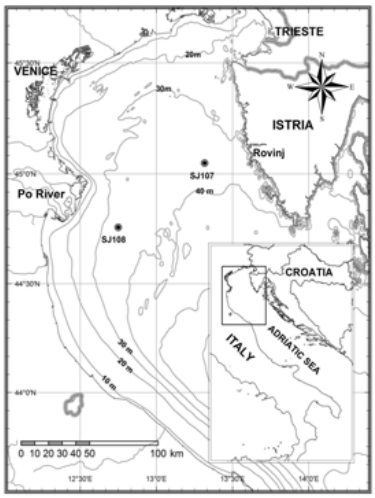

Fig. 1. Northern Adriatic map and station locations.

To understand the changes of the trophic state of NA two indexes (TRIX and EFCO) were calculated as originally stated by Giovanardi and Vollenweider [1]. Data for the surface layer (depth<11 m) were only considered. Cumulative anomaly of those two indexes was calculated summing cumulatively their differences from the average value for the whole investigated period.

Results and discussion
Stations SJ107 and SJ108 (Fig.1) are situated at the opposite ends of the trophic gradient in the NA [1]. The overall mean TRIX at the western station SJ108 is 3.92 and 2.97 at eastern SJ107, indicating that the western one is mesotrophic while the eastern oligotrophic. These differences are maintained through the whole period (Fig. 2). The overall mean EFCO differed at the beginning of the investigated period showing a more efficient use of the available nutrients up to the mid-eighties in the mesotrophic western part. Later, after the ban of polyphosphates in detergents in the eighties no difference between the two stations in nutrient use was detected (Fig. 2).

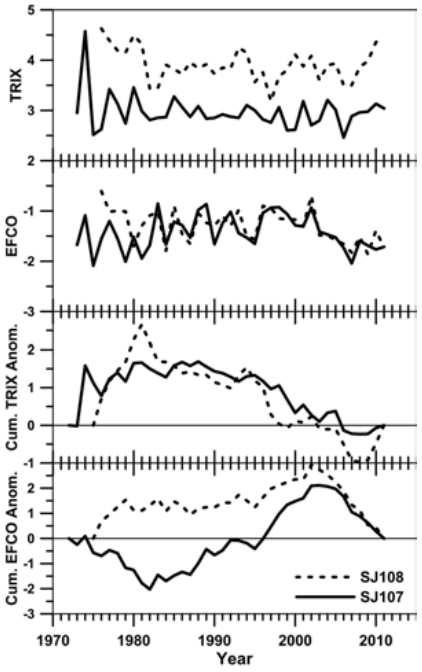

Fig. 2. Mean annual trophic index (TRIX) and Efficiency coefficient (EFCO), Cumulative TRIX and EFCO Anomaly at stations SJ107 and SJ108 for the period 1972-2011 in the surface layer (depth<11 m).

Cumulative TRIX and EFCO anomaly are more difficult to understand because this type of data presentation is a good indicator of systematic behaviour rather than trend. After the eighties they (Fig. 2) show similar patterns on both stations, indicating that the trophic state of the NA after the ban of polyphosphates in detergents and with that lowering the phosphorus pressure, is in the whole controlled by the same processes (nutrient availability – Po River input, forcing from southern basin - intrusions, general circulation - open or closed etc…).

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INFLUENCE OF MESOSCALE ACTIVITY ON DOC DYNAMICS: THE TYRRHENIAN SEA CASE

Chiara Santinelli [1]*, Ernesto Napolitano [2], Roberto Iacono [2] and Maurizio Ribera D'Alcalà [3]
[1] Biophysics Institute, CNR - chiara.santinelli@pi.ibf.cnr.it
[2] ENEA, C.R. Casaccia, Roma, Italy
[3] Stazione Zoologica Anton Dohrn, Napoli, Italy

Abstract
Vertical distributions of Dissolved Organic Carbon (DOC) were studied along a section in the southern Tyrrhenian Sea sampled in seven cruises from 2006 through 2011. DOC showed the highest concentrations in the surface layer (0-150 m) with an interesting variability strongly influenced by mesoscale circulation features. Persistent anticyclonic eddies appear to provide a favorable environment for DOC accumulation.

Keywords: Circulation models, Mesoscale phenomena, Carbon, Organic matter, Tyrrhenian Sea

Dissolved Organic Carbon (DOC) represents the largest reservoir of organic carbon on the Earth and plays a key role in the global carbon cycle. Almost all biological processes occurring in the oceans concur to determine its concentration which is also affected by external inputs (e.g., atmosphere, rivers, sediments). Physical processes (water masses circulation, winter convection), on the other hand, redistribute DOC in the Mediterranean Sea and in the Oceans. DOC data were collected along a selected section, starting off the Gulf of Naples and reaching a central location in the eastern Tyrrhenian Sea (39.5°N, 13.5°E), during seven cruises (2006-2011 conducted in different seasons) in the framework of the Italian Project "VECTOR". Altimeter data and maps of surface velocity from an operational model of the Tyrrhenian Sea circulation [1] were studied for the same periods, in order to figure out if the variability in surface DOC distribution could be mainly explained by mesoscale activity. DOC distribution showed a decoupling between the surface layer (0-150 m), where the highest concentrations (57-80 µM) were observed throughout the year, and the intermediate and deep waters, where DOC ranged between 33 and 49 µM. This feature can be explained by the basin's seasonal cycle which, to some extent, may be characterized as permanently stratified. In this basin late winter mixing seems to rarely exceed 120-150 m. This is consistent with the low nutrients concentrations observed in this area even in winter [2], and supports the idea of a basin with a subtropical-like behavior. Surface DOC distribution showed different patterns during the various cruises, without a clear seasonal cycle. DOC vertical distribution superposed to isopycnals is shown for three periods representative of the different patterns (Fig.1). In April 2007 DOC showed high concentration (69-78 µM) down to 100 m in the middle of the section, in August 2010 two maxima (60-73 µM) were observed towards the edges of the section. Low concentrations (53-60 µM) were found in January 2009 above the pycnocline. The structure of the isopycnals suggests the occurrence of an anticyclonic circulation in both April 2007 and August 2010 (even if in this month the high stratification masks this feature in the upper 100 m). No such feature is present in January 2009.

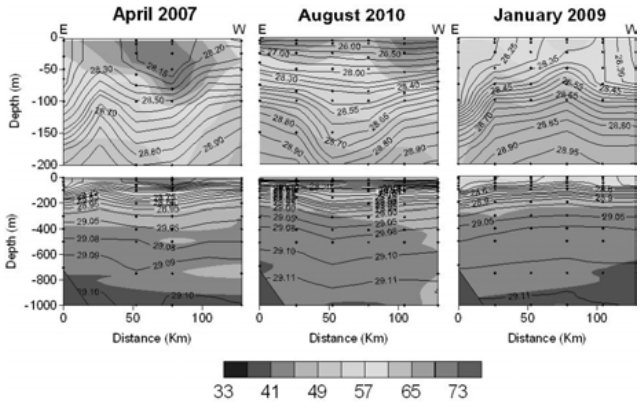

Fig. 1. DOC (µM) vertical distribution along a section in the southern Tyrrhenian Sea. Black lines are isopycnes. CTD data were kindly provided by DiSAm, "Parthenope" University, Napoli and CNR-ISMAR, La Spezia.

To get further information on the horizontal structure of the circulation in the area and to confirm possible effects on the DOC distribution, maps of average Absolute Dynamic Topography from AVISO, with geostrophic circulations superposed, are shown for the same periods (Fig. 2). In April 2007 the section cuts the edge of a strong anticyclonic eddy, that is perfectly centered on the section in August 2010. In January 2009 no such structure is visible and the area is occupied by a coherent northwestward current. These data confirm that mesoscale structures play a major role in shaping DOC distribution in the surface layer of the Tyrrhenian sea as already reported for other areas in the Mediterranean Sea [3] and in the subtropical NE Atlantic Ocean [4]. The presence of a persistent anticyclonic structure may provide favorable conditions for the establishment of high DOC concentrations. However our repeated surveys suggest that the DOC maximum is located on the edge of the structure and not in its core. All the above asks for an in depth analysis of the mechanisms by which mesoscale activity affects DOC accumulation and redistribution in the Thyrrhenian Sea.

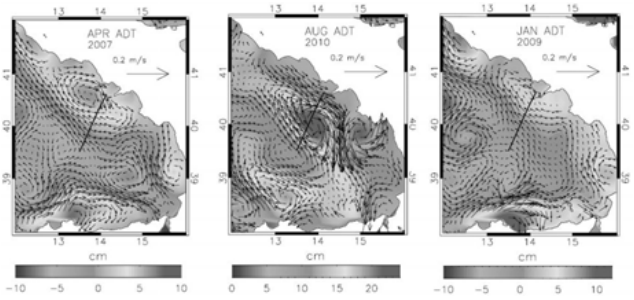

Fig. 2. Maps of average Absolute Dynamic Topography from AVISO for April 2007, August 2010, and January 2009, with geostrophic circulations superposed The section is indicated with a black line.

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DISSOLVED ORGANIC CARBON DYNAMICS IN THE MEDITERRANEAN SEA

Chiara Santinelli [1]*
[1] Biophysics Institute, CNR - chiara.santinelli@pi.ibf.cnr.it

Abstract
Dissolved Organic Carbon (DOC) data collected in the Mediterranean Sea during 15 cruises (1999-2011) allow to study the basin-scale DOC distribution and to estimate DOC stocks and fluxes at the straits. This study will also report new information about the metabolic state of the basin.

Keywords: Carbon, Geochemical cycles, Organic matter, South-Central Mediterranean, North-Western Mediterranean

To date the contribution of the Mediterranean Sea (MS) to the global carbon cycle is still under debate. This basin shows some peculiar characteristics that make it a good model to assess Dissolved Organic Carbon (DOC) dynamics. It is characterized by (1) unique thermohaline circulation including deep water formation; (2) short ventilation rates and residence times for deep waters (20-126 years); (4) Deep water temperatures ~10°C higher than in deep oceans; (5) enhanced respiration rates (6) high DOC mineralization rates and (7) different patterns of stratifications in areas located within close proximity.
The main goal of this work is to give a snapshot of the basin-scale DOC distribution, its fluxes at the straits and external inputs. This is the first attempt to combine stocks, fluxes and mineralization rates by merging data and information regarding the whole basin. The increased number of DOC data has facilitated a large progress in the knowledge of DOM spatial distribution and dynamics on a basin-scale.
The vertical distribution and concentration of DOC in the Med Sea are similar to those observed in the oceans. DOC ranges between 31 and 128 µM, values higher than 128 µM have been observed in coastal areas impacted by river input (e.g. the Gulf of Lions and northern Adriatic Sea). DOC vertical profiles show the highest concentrations in the mixed layer, with a gradual decrease to reach a minimum of 40-48 µM between 200 and 500 m, in the core of the Levantine Intermediate Water (LIW). Below 500 m DOC shows almost constant values (34-43 µM) with a slight increase close to the bottom. Figure 1 shows surface (5 m) contour plot of temperature and DOC from the data collected during 15 cruises (1999-2011).

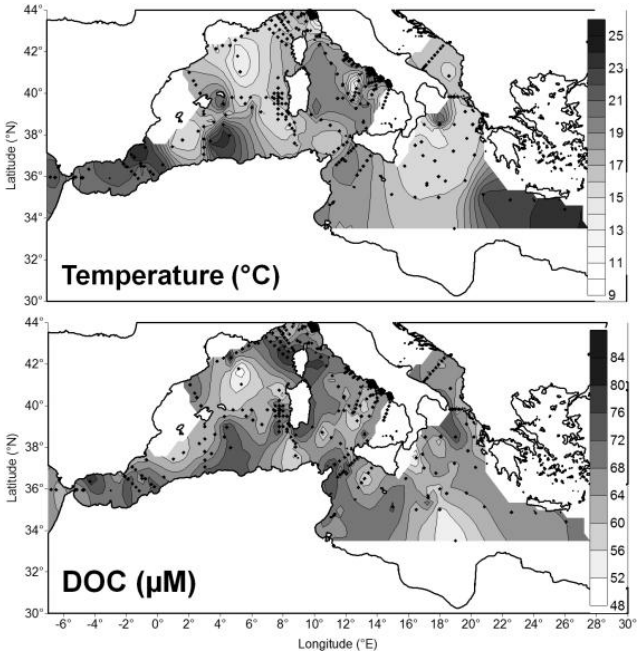

Fig. 1. Surface (5 m) contour plot of temperature and DOC from the data collected during 15 cruises (1999-2011).

There is an interesting correspondence between the two distributions, with the lowest DOC concentration in correspondence of the coldest areas, that are the areas where the water column is completely mixed due to winter convection or to the occurrence of cyclonic eddies. DOC shows high values in the warmer areas, that is in the mixed layer of high stratified waters, and in the core of anticyclonic eddies (Fig. 1). In the intermediate and deep water physical processes (water masses circulation, winter mixing and deep water formation) play a key role in shaping DOC distribution [1].
DOC plays an important role in carbon export down to meso- and bathy-pelagic layers by deep-water formation. The amount of DOC exported by deep-water formation is $0.85\text{-}1.19\cdot10^{12}$ g C year^{-1} in the Adriatic Sea and $0.54\text{-}18.24\cdot10^{12}$ g C year^{-1} in the Gulf of Lions [1]. By the same process, the LIW formation may carry $8.3\text{-}12.5\cdot10^{12}$ C year^{-1} from the surface to intermediate layer.
The large data set available allows for a re-assessment of DOC stocks in the different depth-layers of two sub-basins [2]. Total Mediterranean DOC stock is $1692\cdot10^{12}$ g C ($660\cdot10^{12}$ g C in the West Med and $1032\cdot10^{12}$ g C in the East Med). Net inputs supply a high fraction of DOC to the Mediterranean Sea each year (1% of total stock). On the basin scale, primary production is $178\cdot10^{12}$ g C y^{-1} [3]. Estimated PER is 38% [4], so $68\cdot10^{12}$ g C y^{-1} are released as DOC by phytoplankton and $12.9\text{-}18.5\cdot10^{12}$ g C y^{-1} are supplied by external inputs. In order to give information on the metabolic state of the basin three assumptions were made (i) a steady state, (ii) a BGE of 50% and (ii) the average value of BCD estimated for the Ligurian, Tyrrhenian and Ionian Sea [5, 6, 7] could be representative for BCD in the whole basin. Based on these assumptions, we can roughly estimate that BCD is $81\cdot10^{12}$ g C y^{-1} in the upper 100 m and $61\cdot10^{12}$ g C y^{-1} between 100 m and the bottom. In this scenario about $55\text{-}61\cdot10^{12}$ g C y^{-1} are still missing to satisfy bacterial carbon demand, confirming the importance of other mechanisms of DOC production and/or DOC inputs to the Mediterranean Sea.

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INFLUENCE OF DEEP WATER FORMATION ON THE NUTRIENT STOICHIOMETRY OF THE NORTHWESTERN MEDITERRANEAN SEA

T. Severin [1]*, P. Conan [1], X. Durrieu de Madron [2], J. Ghiglione [1], J. Caparros [1], L. Oriol [1] and M. Pujo-Pay [1]
[1] LOMIC, UMR 7621CNRS-UPMC, Banyuls/Mer, France - tatiana.severin@obs-banyuls.fr
[2] CNRS-CEFREM, université de Perpignan, Perpignan, France

Abstract
The stoichiometry of the northwestern Mediterranean Sea depends largely on the formation of dense water during winter. Observations collected in the center of the MEDOC area [1], in March 2011, allowed to follow the evolution of N:P ratios at the end of the convection period and at the beginning of the restratification. While the convection episode led to homogeneous nutrients concentration with deep N:P value of 22 over the entire water column, the stratification allowed the mineralization of fresh organic matter exported during the convection. These processes could be partly responsible to enhance the known phosphate depletion of the Northwestern Mediterranean sea.

Keywords: North-Western Mediterranean, Water convection, Nutrients, Phosphorus, Chlorophyll-A

The winter convection is an important process for the northwestern basin of the Mediterranean Sea. While sinking dense water entrains dissolved and particulate organic matter to the deep layer, upward motions transport nutrients to the surface layer. This refueling is a key factor for the ensuing spring bloom [2], and a significant evolution of the stoichiometry of the nutrients is expected during the transitional period between the unstratified and stratified conditions. The CASCADE cruise succeeded in sampling a late convection episode during the winter 2011, and followed the rapid restratification of the water column.

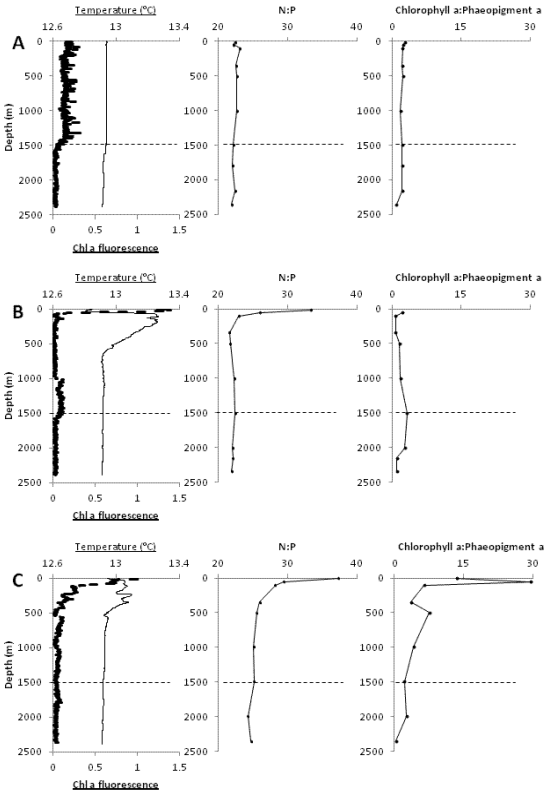

Fig. 1. Profiles of potential temperature (bold line), chlorophyll a concentration (thin line), DIN-DIP ratio (noted N:P), and chlorophyll a : phaeopigments a ratio at the station 42°00N 4°40E, during the convection event (A), 5 days after (B) and 12 days after (C). The dashed line is the mixed layer depth of 1500m.

The convection event produced a mixed layer of 1500m depth (Fig. 1A). It followed a bottom-reaching convection event that occurred a couple of weeks earlier. A N:P ratio of 22, similar to the few known values for the deep layer in the northwestern basin [3], was observed on the entire water column. Chlorophyll a was also detected throughout the mixed layer. The chlorophyll a to phaeopigments ratio indicated that the phytoplanktonic community was still healthy despite its advection well below the euphotic depth.

Five days later, the water column restratified due to the rapid advection of Levantine Intermediate Water over the convection area (Fig. 1B) that isolated the newly formed deep water from the surface layer. The nutrient load in the surface layer supported a phytoplankton development (1.95 µgChl.L^{-1}), which rapidly consumed the nutrient and led to a relative phosphate depletion (high N:P ratio). The newly-formed deep water and the older bottom waters preserved their biogeochemical properties.

Then, a short wind event destabilized the first 500m of the water column (Fig. 1C), but was enabled to induce a new convective event. Twelve days after the convection event, the N:P ratio increased on the whole water column i.e. from surface to the bottom. Considering the steadiness of nitrate and decrease of phosphate concentrations, we hypothesized that mineralization of fresh organic matter by bacteria occurred within a redfieldian N:P ratio. Phosphate consumed by this mineralization process rapidly led to its limitation.

Following this hypothesis, the northwestern Mediterranean convective region is possibly an area where surface and deep N:P ratio are significantly altered at the end of the mixing period due to mineralization of fresh organic matter present in the winter deep mixed layer. Hence, this process possibly contributes to the reinforcement of the existing Mediterranean phosphate depletion.

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PHYSICOCHEMICAL INTERACTIONS BETWEEN THE ADRIATIC AND THE IONIAN SEAS

Ekaterini Souvermezoglou [1]* and Evangelia Krasakopoulou [1]
[1] Hellenic Centre for Marine Research Institute of Oceanography - katerinasouv@hcmr.gr

Abstract
The ability of the Adriatic in renewing the deep waters of the Eastern Mediterranean is investigated in relation to the properties of the LIW entering from the Ionian Sea. This study is based on oxygen and nutrient data collected in the Otranto strait and the surrounding area between 1987 and 2000.

Keywords: Oxygen, Nutrients, Intermediate waters, Otranto Strait

The Adriatic Sea is a semi-enclosed basin shallow in the north and deep in the south. It communicates with the Ionian Sea thought the Strait of Otranto, a 70 km wide and 800 m deep channel. The general circulation in the Adriatic basin is cyclonic [1] consisting from a rather weak current along the eastern coast (the Eastern Adriatic Current - EAC) and a fast mainly coastal current along the western coast (the West Adriatic current - WAC).

The Ionian Sea is a deep (up to 4000m) and wide basin which receives salty and warm waters from the easternmost part of the Mediterranean and fresher and relatively colder water from the western Mediterranean. The EAC bring Levantine Intermediate Water (LIW) and Ionian Surface Water (ISW) into the Adriatic [2]. Adriatic is prone to strong winter outbreaks of cold dry northerly winds which induce extended heat losses and evaporation, that drive to deep water formation events. During cold winters and restricted fresh water input, the densest water in the whole of the Mediterranean, the North Adriatic Dense Water (NAdDW) is formed over the shallow northern shelf of the Adriatic [3]. In addition, in the Southern Adriatic Pit, the Adriatic Deep Water (ADW) is produced through open ocean deep convection [4].

The capacity of the Adriatic Sea to form dense water depends to:
- the incorporation of saline intermediate waters
- the intensity of the winters.

During the Eastern Mediterranean Transient (EMT) the salinity of the intermediate layers (200-700 m) entering in the Adriatic Sea became reduced by the upwelling of the deep waters in the Eastern Mediterranean, due to the massive dense water supply from the Cretan Sea [5]. The reduction of salt content in combination with milder winters limited the capacity of the Adriatic Sea to form dense water [6].

The systematic study of the nutrient and oxygen regime from 1987 in the Otranto strait in the frame of national and international research programs permitted to follow the temporal evolution of oxygen and nutrients in the Strait of Otranto (Fig. 1 & 2) and the surrounding area [7] and [8].

Our observations show that the ability of the Adriatic in renewing the deep waters of the Eastern Mediterranean is closely linked to the properties of the LIW entering from the Ionian Sea. The modulation of the LIW characteristics entering in the Adriatic Sea due to the reversal of the North Ionian Gyre (NIG) from anticyclonic during the period of 1987-1995, to cyclonic during the period of 1996-2005 [9] is also examined.

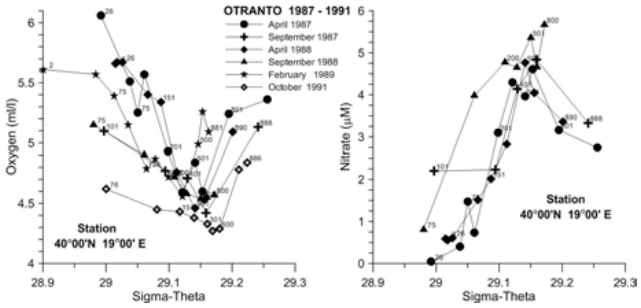

Fig. 1. Dissolved oxygen and nitrate plotted against sigma-theta in the station 40^{o} 00'N 19^{o} 00' E in Otranto strait for the period 1987-1991.

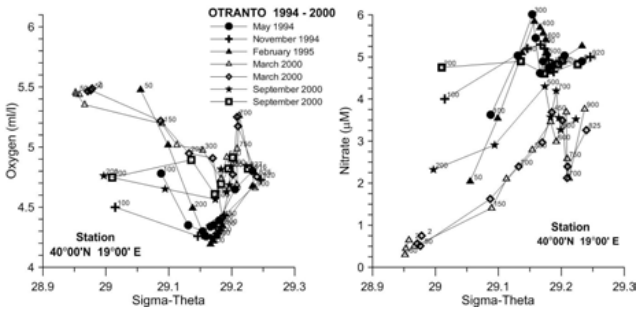

Fig. 2. Dissolved oxygen and nitrate plotted against sigma-theta in the station 40^{o} 00'N 19^{o} 00' E in Otranto strait for the period 1994-2000.

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Session

Variability on climatic scales - 1

Modérateur : **Sergiu Dov Rosen**

SENSITIVITY OF THE MEDITERRANEAN SEA LEVEL AND THERMOHALINE CIRCULATION TO BOUNDARY FORCINGS IN AN ENSEMBLE OF 21ST CENTURY CLIMATE CHANGE SCENARIOS

F. Adloff [1]*, S. Somot [1], F. Sevault [1], M. Déqué [1], M. Herrmann [2], C. Dubois [1], R. Aznar [3], E. Padorno [3], E. Alvarez-Fanjul [3], G. Jorda [4] and D. Gomis [4]
[1] CNRM-GAME / Météo France, Toulouse, France - fanny.adloff@meteo.fr
[2] IRD, LEGOS, Toulouse, France
[3] Puertos del Estado, Madrid, Spain
[4] IMEDEA, UIB, Palma de Mallorca, Spain

Abstract
We performed 21st century climate change scenario simulations with a Mediterranean regional ocean model in order to assess the sensitivity of changing Mediterranean water masses to boundary forcings. Our study aims to quantify the uncertainty linked to the choice of boundary conditions such as the Atlantic hydrography at the western margin, the river runoffs or the surface fluxes. We particularly focus on changes in mean sea level and thermohaline circulation. Results show that the near-Atlantic hydrographic changes have the strongest influence on the evolution of the Mediterranean water masses.

Keywords: Circulation models, Sea level, Deep waters, Stratification, Gibraltar Strait

The Mediterranean climate is expected to become warmer and drier during the 21st century [1]. This typical response and the associated changes may vary, depending on the chosen scenario. However, the regional ocean model behaviour could also be sensitive to the choice of the boundary conditions such as Atlantic hydrography, runoffs and air-sea fluxes.

To assess and quantify the sensitivity of the Mediterranean Sea to boundary forcings, a set of numerical experiments was carried out with the regional ocean model NEMOMED8 set up for the Mediterranean Sea. The model is forced by air-sea fluxes derived from the regional climate model ARPEGE-Climate on a 50-km stretched grid. Freshwater inputs from the rivers and the Black Sea are prescribed. At the Atlantic boundary, temperature and salinity are relaxed towards values derived from a global model.

Historical simulations representing the climate for the period 1961-2000 were run to obtain a reference state. From this baseline, various sensitivity experiments were performed for the period 2001-2100, following IPCC-A2 scenario. In these simulations, the three main boundary forcings (river runoff, near-Atlantic water hydrography and air-sea fluxes) were alternatively changed to better identify the role of each forcing in the way the ocean responds to climate change.

Our numerical experiments suggest that the choice of the boundary forcings substantially impacts the response of the Mediterranean Sea to an IPCC-A2 scenario. The range of mean SSS anomalies (2070-2099 vs. 1961-1990) spreads between 0.6 and 0.9 psu depending on the boundary conditions applied. The near-Atlantic surface water evolution, which is very uncertain in global ocean scenario simulations, has the strongest influence on the evolution of the Mediterranean water masses and dense water formation. Significant differences of the future thermosteric mean sea level trends are thus simulated, with a range of increase between 40 and 60 cm. This uncertainty is mainly driven by Atlantic boundary conditions. We also analyse the changes in the Mediterranean thermohaline circulation (MTHC). Finally, we address the question of the influence of the initial MTHC state on the ocean climate projections.

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WESTERN MEDITERRANEAN DEEP WATER ANOMALY: PREVIOUS TRENDS, TEMPORAL EVOLUTION AND SPREADING AFTER 2005

Rosa Balbín [1]*, Jose Luis López-Jurado [1], Alberto Aparicio-González [1] and Mª Del Mar Flexas [2]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Baleares - rosa.balbin@ba.ieo.es
[2] Jet Propulsion Laboratory, California Institute of Technology,

Abstract
With the help of IBAMar data base new deep water (DW) formed in the Western Mediterranean (WM) after winter 2005 is tracked all along the Spanish Mediterranean coast since it was formed to nowadays. After winter 2005 an abrupt uplift of isopycnals of the order of hundreds of meters was observed in the DW formation areas. No clear trend of isopycnals is observed since then. Using MEDAR, CORA and MATER databases, isopycnal trends during the previous decades will be analyzed in the same area, trying to understand the processes that induce the new DW formation.

Keywords: Deep waters, North-Western Mediterranean

1. Introduction After winter 2005 an abrupt change was observed in the Western Mediterranean Deep Water (WMDW), with the apparition of a complex thermohaline structure due to the contribution of different water masses, that could be observed from the north of the WM to the Argelian sub-basin [1]. It has been denoted as the Western Mediterranean Transition (WMT), to distinguishing it from the Eastern Mediterranean Transient (EMT), and is described in [2] and references therein. Different hypothesis have been proposed to explain the new properties of the WMDW: a progressive increase of salinity and heat in the intermediate levels due to EMT advection, a progressive increase of salinity and heat of the Atlantic Water (AW) entering through Gibraltar, or an extreme winter forcing. Long term trends on the increase of salinity and temperature have been observed in the DW in the eastern and westerm sub-basins during the second half of 20th century but there are no clear results in the intermediate and surface waters that participate in their formation [3]. Those studies have been done on isobaric surfaces and it is necessary to do the same analysis on isopycnals [4] to better understand the impact of salinity and temperature tendencies of intermediate and surface waters on the new WMDW formation.

2. Data and Methodology IBAMar 2.0 is a new data base created from the oceanographic data obtained during the development of different oceanographic projects by the Balearic Center of Spanish Institute of Oceanography (IEO) and conducted from 1974 and ongoing in the Western Mediterranean basin (Balearic Sea and Algerian Basin) [5]. The main goal of this data base is to establish a climatology for the most significant variables to study the existence of decadal cycles or long term trends, trying to better understand the behaviour of the hydrographic conditions of the Spanish Mediterranean coast, at both seasonal and interannual time scale and long term. Using IBAMar database it is possible to characterize the temporal evolution of the thermohaline anomaly since 2005 to nowadays. With the help of MEDAR [6], CORA [7] and MATER [8] it is possible to study the thermohaline characteristics of the WMDW before 2005. Using all databases together, figure 1 shows potential temperature and salinity versus pressure and time from 1972 to the end of 2012 for stations between 40.0 ºN and 42.5 ºN, 3.5 ºE and 7.0 ºE, area that corresponds to DW formation in the WM. Data was interpolated over a regular grid every 100 days and 10 dbar. Interpolated isopycnals are also shown. Similar plots can be done for selected areas along the Spanish Mediterranean coast down to the Alboran sea to characterize the spreading of the anomaly along the west of the WM sub-basin.

3. Discussion After winter 2005 an abrupt uplift of isopycnals of the order of hundreds of meters was observed in the DW formation areas. This uplift seems to be faster than previous observed events, and remains on time since nowadays. No clear trend of isopycnals is observed since then. With the help of IBAMar data base it is expected to characterize the isopycnals behavior along the Spanish Mediterranean since 2000. Using the MEDAR, CORA and MATER data bases it should be possible to analyze the isopycnal trends during the previous decades in the DW formation area to help to understand the processes that induce the new DW formation.

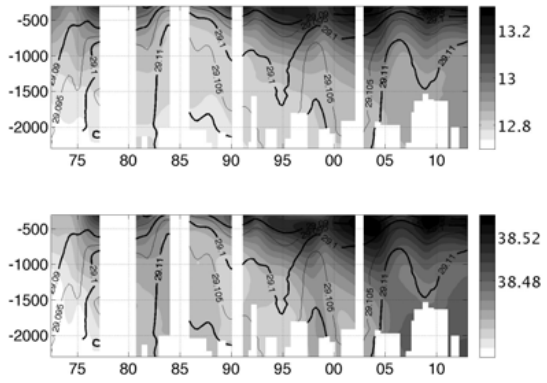

Fig. 1. Potential temperature (top) and salinity (bottom) at the north WM. Black curves are isopycnals.

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GLIDER OBSERVED SUB-SEASONAL VARIABILITY IN WATER MASS TRANSPORT IN THE IBIZA CHANNEL, A KEY 'CHOKE' POINT THE WESTERN MEDITERRANEAN CIRCULATION

E. Heslop [1]*, S. Ruiz [1], J. Allen [2], J. López-Jurado [3] and J. Tintoré [4]
[1] IMEDEA (CSIC-UIB) - eheslop@imedea.uib-csic.es
[2] University of Portsmouth, UK
[3] IEO-COB, Palma de Mallorca, Spain
[4] SOCIB, Palma de Mallorca, Spain

Abstract
Autonomous underwater gliders provide accurate, high-resolution datasets that can unlock hidden variability in ocean processes at critical control points, as demonstrated for a 'choke' point between two ocean sub-basins in the Western Mediterranean Sea. This high-resolution observation skill is important for characterizing sub-mesoscale and sub-seasonal variability in order to detect future climatic change, improve our constraint of models and understand ecosystem response to physical process.

Keywords: Mesoscale phenomena, Circulation, Coastal processes, North-Western Mediterranean

It is becoming increasingly important to understand sub-mesoscale and sub-seasonal variability in our ocean circulation system: in order to place historical observations in context, to detect future climatic change and to improve our modeling and forecast capability. The in-situ monitoring of this variability at inter-basin 'choke' points, narrow channels and straits that exert a controlling influence on the exchanges of watermass such as Drake Passage in the Southern Ocean and the Fram Straits in the North Atlantic, is particularly important [1]. The Ibiza Channel in the Western Mediterranean is one such 'choke' point in the basin-scale thermohaline circulation of the Western Mediterranean Sea, where an important north/south exchange of watermasses is known to affect local ecosystems of economic importance, e.g. the spawning grounds of Atlantic bluefin tuna [2]. From January 2011, within the framework of SOCIB activities [3] and now also within the framework of PERSEUS (an EU funded project), autonomous underwater gliders have been deployed on a regular basis across a standard transect at this narrow 'choke' point and have proved particularly effective at capturing the signature of a high sub-seasonal variability (days-weeks) in the inter-basin exchange of watermasses [4], a variability that had previously only been observed at a seasonal level through ships surveys or at a coarse resolution with moorings [5]. Combining the data from these recent glider missions (now from 2011-2012) with a historical timeseries of ships CTD surveys (1996 – 2012) from the IBAMar database [6], enables us to define a new more detailed seasonal cycle of transports. This, in conjunction with the glider data, clearly demonstrates the contribution of sub-seasonal variability to the seasonal pattern of transports (Figure 1), indicating that mesoscale processes are as important as the seasonal cycle in governing the North/South exchange at this Mediterranean 'choke point'. The links between this observed high variability, atmospheric forcing and mesoscale indicators are investigated to determine the key dynamic processes governing this sub-basin exchange and resolve the links between basin-scale and mesoscale processes.

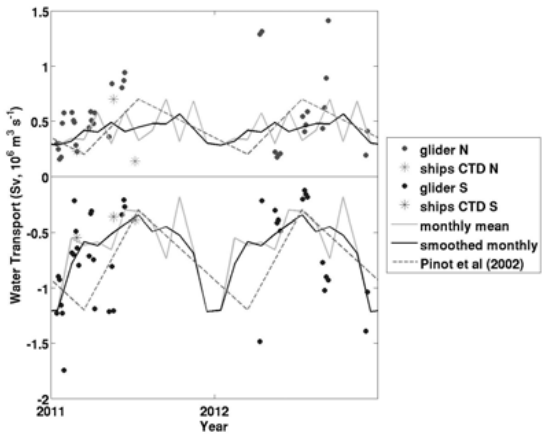

Fig. 1. Geostrophic transports of water mass volumes, both north (positive values) and south (negative values), per transect of Ibiza Channel; glider transects (dots) and CTD transects (stars). The new seasonal cycle (black line) is shown, with the mean monthly values (grey line) and an earlier [5] simple seasonal signal (dashed line). The high sub-seasonal variability in transports captured by the repeated glider transects is clearly visible.

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OCEAN COLOUR AND OTHER OPTICAL SATELLITE DATA VERSUS IN-SITU DATA

Mira Morovic [1]*, Branka Grbec [1], Žarko Kovac [1] and Živana Nincevic Gladan [1]
[1] Institute of Oceanography and Fisheries - morovic@izor.hr

Abstract
Different optical data are available at JRC database, covering partly the same time period. The idea of this paper was to extract monthly mean data from the geoportal from different satellites for the same location in the open middle Adriatic Sea and compare them with each other and with the in-situ optically weighted monthly chlorophyll pigments. The correlation coefficients were calculated between various optical data retrieved from the satellites like Chlorophyll data from SeaWiFS, MODIS and MERIS diffuse attenuation coefficient, absorption coefficient, particulate backscattering coefficient and euphotic zone depth with the monthly in-situ chlorophyll and Secchi disk transparency.

Keywords: Remote sensing, North-Central Mediterranean

The data series of the Institute of Oceanography (Split, Croatia) especially in the Middle Adriatic has long tradition of almost monthly oceanographic measurements. Among these data we used transparency and in-situ chlorophyll from the station located at 43N; 16.33E for the period 1997-2007 (Fig 1).

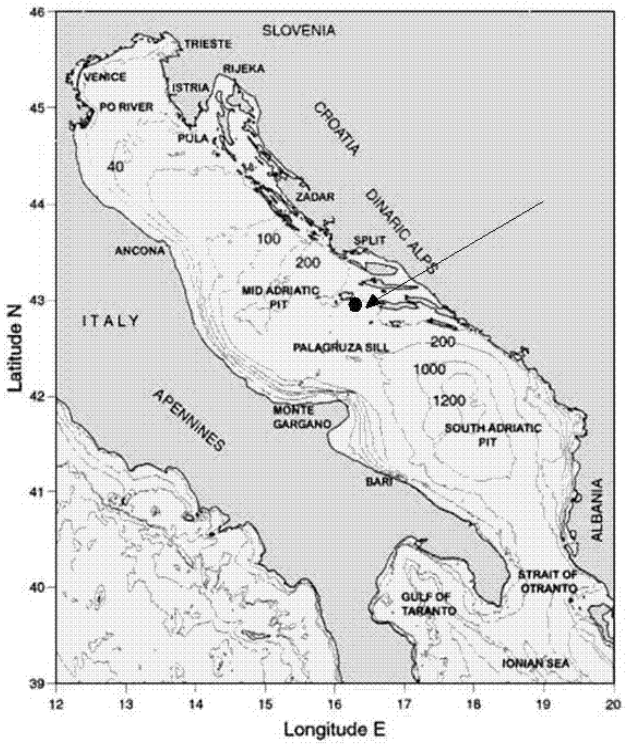

Fig. 1. Investigated location.

From the same point all the available satellite optical data were retrieved form www.jrc.it geoportal.
Recent comparison of in-situ to satellite colour data from the same area at the monthly scale has shown rather high differences, especially in summer when satellites often show higher values (1). In some earlier analysis high seasonal differences were also found (2). Daily pixel values also show in some periods large differences relative to the same day and location in-situ data (3). The question is how to handle these differences, if we wish to complement one data type with the other?
Besides anylsing the annual course of the differences, the correlation analysis was performed to see to what extent the data from different sources, the satellite and the in-situ, correspond and also to what additional parameters, retrieved from the satellites, are they best related.
In spite of the differences, high correlation coefficients were obtained between in-situ optically weighted chlorophyll (OPW) with chlorophyll values from satellite sensor MODIS and somewhat less with the data from MERIS (Table 1).
Also high correlation was obtained between OPW and diffuse attenuation coefficient Kd490 (MODIS). The correlation coefficients, although significant, are lowest with the Secchi disk depth, which is understandable due to their dependence not only on water properties.
Euphotic zone depth is highly correlated to absorption coefficient and both euphotic zone depth and absorption coefficients are highly correlated (0.96) to MERIS Kd490, while correlation of these with particulate backscattering coefficient is somewhat lower (0.7).
The correlation coefficients between the chlorophyll satellite data from the three satellites are very high while correlations among Kd490 from the three satellite sources are little lower.
Although the analysis of long-term series of both in-situ and satellite data often lead to similar and comprehensive results, the differences in data require particular attention in order to take the advantage of frequent optical satellite data measurements.

Tab. 1. Correlation coefficients between diffuse attenuation coefficient Kd_{490}, Chlorophyll pigments from different sensors (MERIS, MODIS and SW-SeaWiFS), transparency (SD), optical data from MERIS: euphotic zone depth (Z_{eu}), absorption coefficient at 443 nm (a_{443}), particulate backscattering coefficient at 443 nm (bb_{443}) and optically weighted in-situ chlorophyll pigments (OPW). N-data number, p-significance level <0.01 for all unmarked coefficients, and p<0.045 for coefficient marked with *. Only the significant correlation coefficients are shown.

	K_{490} (m-1)		(m)	Chl (mg dm-3)				(m)	(m-1)	
	SW	MODIS	SD	MERIS	SW	MODIS	OPW	Zeu	a_{443}	bb_{443}
K_{490} MERIS	0.78 N=30	0.85 N=85	-0.42 N=74	0.98 N=113	0.85 N=30	0.85 N=85	0.63 N=46	-0.98 N=109	0.92 N=113	0.68 N=113
K_{490} SW		0.88 N=27	-0.38 N=54	0.80 N=30	0.97 N=86	0.86 N=27		-0.78 N=30	0.82 N=30	0.55 N=30
K_{490} MODIS			-0.47 N=57	0.87 N=85	0.90 N=27	0.97 N=85	0.81 N=40	-0.82 N=85	0.89 N=85	0.41 N=85
SD				-0.46 N=74	-0.37 N=54	-0.48 N=57		0.43 N=74	-0.44 N=74	-0.32 N=74
Chl MERIS					0.87 N=30	0.89 N=85	0.65 N=46	-0.96 N=109	0.96 N=113	0.70 N=113
Chl SW						0.90 N=27		-0.86 N=30	0.88 N=30	0.64 N=30
Chl MODIS							0.80 N=40	-0.81 N=85	0.90 N=85	0.50 N=85
Chl OPW								-0.59 N=46	0.66 N=46	0.30* N=46
Zeu									-0.91 N=109	-0.69 N=109
a_{443}										0.57 N=113

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VALIDATION OF CLIMATOLOGICAL MAPS IN THE ADRIATIC SEA

E. Partescano [1]*, M. Lipizer [1], A. Crise [1], A. Giorgetti [1] and A. Rabitti [2]
[1] Ist. Naz. Oceanografia e Geofis. Sperimentale-OGS - epartescano@ogs.trieste.it
[2] NIOZ, Royal Netherlands Institute for Sea Research, Texel, NL

Abstract

The interpolation error and the uncertainty degree associated to the updated climatology of oceanographic properties of the whole Adriatic Sea, based on campaigns from a large temporal range (about a century), have been estimated in order to provide information on the reliability of the products obtained and on the stability of the climatological fields. The updated climatologies have been produced using the Variational Inverse Method (VIM) and a resolution by Finite Element Method; error and uncertainty maps associated to each climatological field approximation have been obtained by calculating the error associated to data interpolation and by comparing climatology with measured data. The uncertainty associated to the climatology provides an estimate of the importance of mesoscale processes in the Adriatic Sea.

Keywords: Mesoscale phenomena, Global change, North Adriatic Sea, Central Adriatic Sea, South Adriatic Sea

Climatological maps provide valuable information for different purposes such as optimization of regional and subregional numerical prediction models, validation of new datasets and as baseline information to identify possible modifications in the marine environment related to global climate changes. However, the climatology *per se* provides only an estimate of average fields without explicitly showing the intrinsic dynamics connected to the short and long term variability (from submesoscale to decadal) that *insitu* data do contain. In this study we provide updated climatologies of temperature and salinity for the Adriatic Sea produced using the Variational Inverse Method (VIM) [1]. We applied successfully different quality assessment procedures of VIM field approximation (cross-validation, SST comparison with satellite data, real *vs* synthetic T-S profiles) with good results. There is yet a strong discrepancy in some areas between the interpolation error associated to the method (used as a measure of the reliability of field approximation) and the uncertainty degree calculated from the average difference between the spatial distributions obtained using the VIM and the original data acquired *in situ* (a measure of the persistence of the climatological fields). Error field (Fig. 1) and uncertainty maps (Fig. 2) of winter surface salinity are reported as an example. The comparison shows that in the North Adriatic Sea, near the Po River outflow, the interpolation error is low due mostly to the good spatial data coverage and, accordingly, the reliability of the field reconstruction is high. On the other hand, in the same area the uncertainty is high, with large deviations from the climatology (differences > 20%) which indicate intrinsic high temporal variability due to the mesoscale processes, that is properly reflected in the dataset used. In comparison with earlier climatologies [2], [3], [4], the climatology presented in this paper covers the whole Adriatic Sea, includes data spanning over a century (1900 – 2009) and provides estimates of the interpolation error and the uncertainty associated to the climatology.

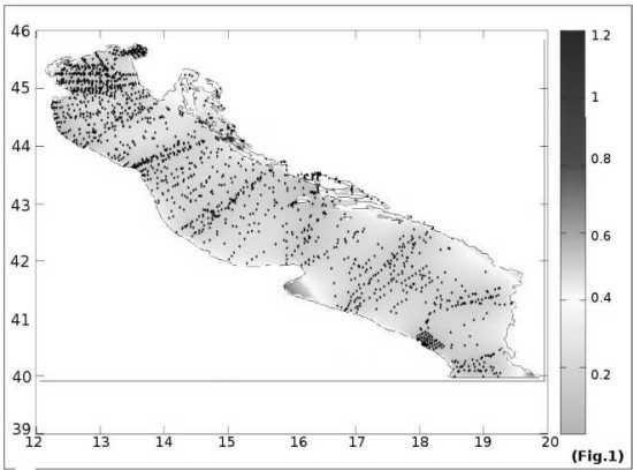

Fig. 1. Interpolation error field map of winter surface salinity (in salinity units)

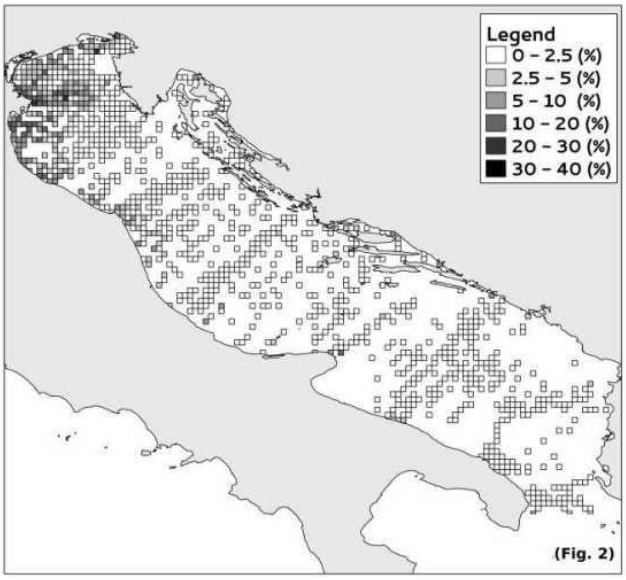

Fig. 2. Uncertainty map of winter surface salinity (units are average difference from the climatology, expressed in percentage).

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LONG-TERM CHARACTERISTICS OF SEA LEVEL, WAVE, WIND AND CURRENT AT CENTRAL MEDITERRANEAN COAST OF ISRAEL FROM 20 YEARS OF DATA AT GLOSS STATION HADERA

Sergiu Dov Rosen [1]*, Lazar Raskin [1] and Barak Galanti [1]
[1] Israel Oceanographic & Limnological Research - IOLR - rosen@ocean.org.il

Abstract
We present the long term main meteo-marine characteristics at the central Mediterranean coast of Israel, based on monitored wind, sea level, wave and current data during April 1992 to March 2012 at IOLR's GLOSS station 80 Hadera, 2.1 km offshore.

Keywords: Currents, Sea level, Waves, Wind, South-Eastern Mediterranean

The long-term main meteo-marine characteristics at the central Mediterranean coast of Israel, were determined based on wind, sea level, wave and current data gathered during April 1992 to March 2012 at IOLR's GLOSS station 80 Hadera, about 2.1 km offshore the Hadera coast.
The data were analyzed in hydrographic years (from April of first year to March of following year), to ensure events independence occurring in winter season, versus normal splitting at calendary year start on 1st of January. Thus, each year was characterized by contiguous winter and summer seasons.
It was found that the sea level rose on the average about 6mm/year, about twice the global sea level rise average. By comparing yearly changes in the monthly averaged values of the wind speed, significant wave height and current speed, the fluctuations of these parameters on monthly to yearly scales were investigated. An example of the outcome is presented in Figure 1 showing the monthly averaged sea level change during the monitored period.

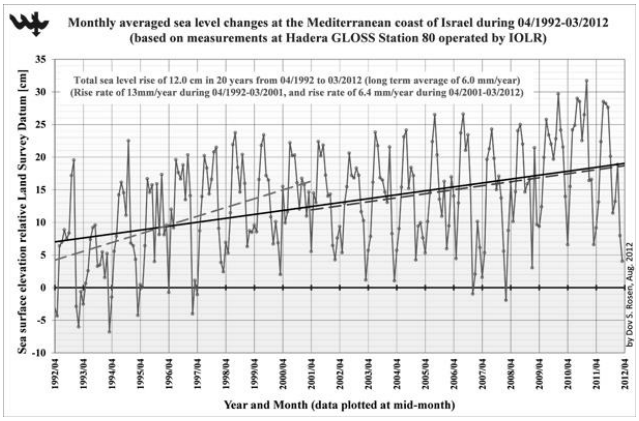

Fig. 1. Sea Level change at Hadera, Israel during 04/1992 -03/2012

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THE ROLE OF TELECONNECTION PATTERNS ON CLIMATE VARIABILITY IN THE AEGEAN SEA, EASTERN MEDITERRANEAN

Alexandra Spyropoulou [1]*, Effie Kostopoulou [2] and George Tsirtsis [1]
[1] Aegean University, Department of Marine Sciences - spyropoulou@marine.aegean.gr
[2] University of the Aegean, Department of Geography, University Hill, Mytilene 81100, Greece

Abstract
The aim of this study is to investigate the possible role of the most representative atmospheric oceanic modes on climate variability of Aegean Sea. The North Atlantic Oscillation-NAO, the East Atlantic/West Russian Pattern-EA/WR, and the Scandinavian Pattern-SCAN indices from the NOAA Climate Prediction Centre were taken into account along with NCEP-Reanalysis data.

Keywords: Temperature, Aegean Sea, Time series

1. Introduction
Several regional studies have revealed negative trends in precipitation over the Mediterranean during the past decades (New *et al*. 2001), while air temperature has shown an increasing trend especially during summers. Especially, the eastern Mediterranean region is characterized by cooler and drier conditions during the positive phase of NAO, while the negative phase is related to anomalously warm and wet conditions (Xoplaki *et al*. 2000). Moreover, during the negative (positive) phase of EAWR wetter (drier) than normal weather conditions prevail over a large part of the Mediterranean region. Although many studies have been carried out for the Mediterranean, only few have emphasized on the Eastern Aegean Sea, where trends in both precipitation and air temperature have been identified locally during the last decades (Spyropoulou *et al.* 2013).

The aim of the present work is to analyze the climate trends in the Aegean region from 1950 to 2008 and to link possible background variations of the meteorological fields with the dominant atmospheric modes expressing the most prominent patterns of atmospheric circulation variability in the Northern Hemisphere.

2. Data and Methodology
The time series for the atmospheric modes NAO, EA/WR, EA and SCAN were obtained on a monthly basis from the NOAA Climate Prediction Center (CPC, http://www.cpc.ncep.noaa.gov/data//eledoc//nao.html) for the period 1950-2008. Similarly, the NCEP-Reanalysis data (air temperature at 2m) were extracted for a window-area extending from 44.76°N to 31.42°S and from 13.12°W to 35.62° E on a monthly basis. In order to exclude seasonality, anomalies were calculated for both the Reanalysis data and the teleconnection indices on a monthly basis. To determine the relative influence of the various modes on climate variability, the time series of temperature were analyzed statistically. Linear correlations were calculated between the monthly, yearly and seasonally means and the ocean modes series. The relationship between monthly temperature means and the large-scale atmospheric circulation indices was investigated using Canonical Correlation Analysis (CCA), after extracting the empirical orthogonal functions (EOFs) for temperature. The latter was performed in order to more clearly reveal signals in both time and space.

3. Results
The leading EOF of temperature pattern accounts for 52%, the second for 15.9% and third for 12% of the total variance. CCA revealed 3 statistically significant pairs of canonical variables, therefore 4 physically relevant pairs of patterns that describe the responses of monthly temperature in the Eastern Mediterranean seems that it is connected with the considered Ocean Modes. The first pair of canonical variables has a correlation coefficient of 50%, showing a relatively strong negative effect of EAWR and NAO on air temperature, with CCA coefficients of -0,80 and -0,50, respectively.

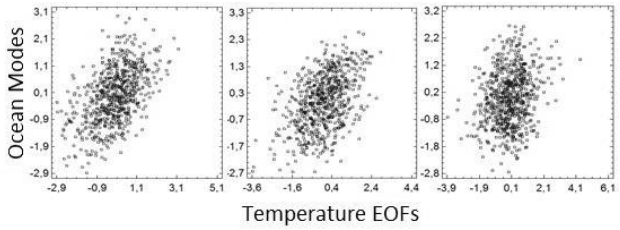

Fig. 1. Fig1. Canonical Correlations Between air temperature in Eastern Mediterranean and Ocean Modes

The second pair has also shown a high correlation coefficient (46%), however EA was the ocean mode with the higher contribution, being positive and with a coefficient of 0.96. The third pair although it was also found statistical significant, had a low correlation coefficient of 22%. In conclusion, the observed trends of warming of air temperature over the Aegean region, Eastern Mediterranean during the last decades seem to be related with three Ocean Modes (EA, EAWR, NAO), showing the effect of teleconnection on climate variability over Eastern Mediterranean

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Session

Variability on climatic scales - 2

Modérateur : **Katrin Schroeder**

EXTREME WINTER 2012 IN THE ADRIATIC: AN EXAMPLE OF CLIMATIC IMPACT ON THE BIOS RHYTHM

M. Gacic [1]*, G. Civitarese [1], P. Poulain [1], M. Menna [1], M. Bensi [1], V. Cardin [1], L. Ursella [1], S. Cosoli [1], G. Notarstefano [1] and V. Kovacevic [1]

[1] Ist. Naz. di Oceanografia e di Geofisica Sperim. - mgacic@inogs.it

Abstract

The North Ionian circulation is subject to decadal reversals of direction of rotation. From the altimetric data and surface geostrophic currents a "premature" inversion of the North Ionian circulation from cyclonic to anticyclonic was documented in the second half of the year 2012. This can be caused by the very cold and dense Adriatic Dense Water (density anomaly > 29.25 kg/m^3) formed during the severe winter in the Adriatic in 2012, representing an example of climatic impact on the BiOS rhythm.

Keywords: Circulation, Ionian Sea, Deep waters

The Ionian circulation is characterized by the presence of the North Ionian Gyre (NIG) which reverses its direction of rotation on a decadal scale. These circulation variations were explained in terms of the internal mechanism denoted as Bimodal Oscillating System (BiOS) associated with the feedback between the Adriatic and Ionian [1]. The mechanism has a Mediterranean basin-wide importance since it determines thermohaline properties of the Levantine, Adriatic and even the western Mediterranean [2]. Altimetric data and meridional components of the surface geostrophic currents along the eastern and western Ionian flanks, which show clearly decadal inversions of the NIG (Fig. 1), also reveal that seasonal variations are relatively weak resulting rarely in reversals at the intra-annual scale. A sudden decrease of the northward geostrophic flow (along the west coast) and the concomitant increase of the southward flow (along the east coast) is evident in the year 2012 as a sign of the weakening/reversal of the preceding year (cyclonic) circulation.

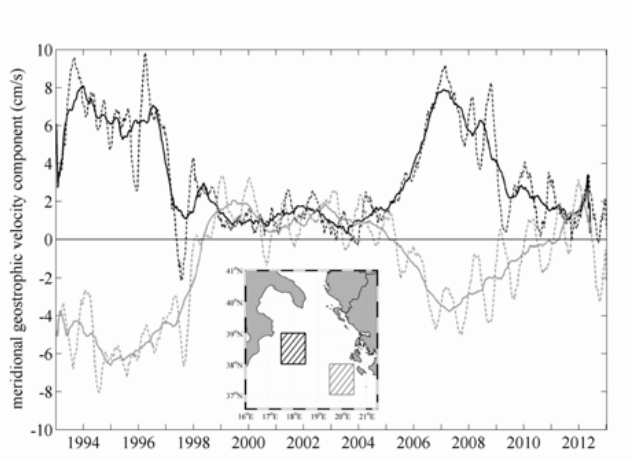

Fig. 1. Time-series of the spatially averaged meridional geostrophic surface velocity components (area of averaging shown in the insert). Continuous lines represent thirteen-month moving average while the dashed lines are monthly time series.

We hypothesized that this "premature" circulation inversion was due to the inflow of the very dense water formed during the winter 2012. In order to evidence differences in the thermohaline properties of the AdDW spreading in the Ionian, we collected all available hydrographic data for the two years, i.e. 2011, considered "normal" winter and 2012, an extremely cold one. More specifically, we used T-S profiles from both Argo floats and oceanographic campaigns and grouped them together for each year separately, implicitly neglecting the seasonal signal which is a rather realistic assumption for the layer below the seasonal pycnocline. The data show the first occurrence of the dense AdDW in the Ionian having density anomalies over 29.24 kg/m^3 in July 2012. Consequently, the horizontal density distribution reveals the presence of the denser water along the Ionian flanks with respect to the centre of the basin. This fact explains the sea level being lower along the boundaries than in the center and thus the occurrence of the anticyclonic surface geostrophic circulation. The opposite pattern was evident in 2011 when the density gradient reversed with the density maximum in the centre of the basin. The reversed density gradient is associated with the surface cyclonic flow. The linear relationship between the altimetric data and the isopycnal depths was sought from the calculations of the linear regression between the sea surface absolute topography and the depths of the 29.00 and 29.18 kg/m^3 isopycnals. The dispersion diagram (Fig. 2) between the two variables suggests a linear relationship for the 29.00 isopycnal (being at a depth of about 200 m). This confirms the impact of density changes in shaping the Ionian circulation. For the 29.18 kg/m^3 isopycnal (depth around 1200 m) the linear relationship is not statistically significant which is probably due to the very weak vertical density stratification in deeper portion of the water column.

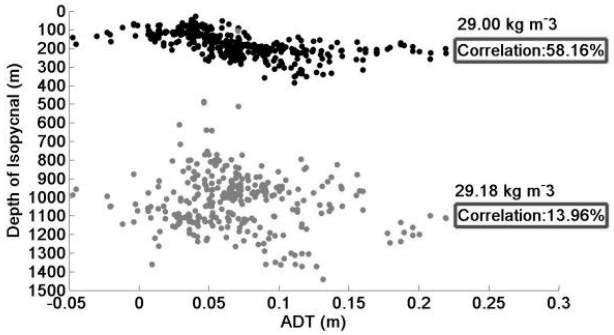

Fig. 2. Dispersion diagram of the depth of 29.0 and 29.18 kg/m^3 ispycnals versus absolute sea-level height.

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THE CASE FOR A SEA-SURFACE-HEIGHT CONTROL BARRAGE ON THE STRAIT OF GIBRALTAR

Jim Gower [1]*
[1] Institute of Ocean Sciences - jim.gower@dfo-mpo.gc.ca

Abstract
Global sea level rise is now seen as one of the most significant impacts of long term climate change. A dam on the Strait of Gibraltar would provide long-term protection for the entire Mediterranean and Black Seas against every conceivable future global sea level rise for the next few millennia. The dam would be designed to cause a height difference between its two sides of only a few metres, and would therefore have a limited impact on shipping, requiring lock gates at the dam and on the Suez canal. This paper discusses arguments for and against a dam, including long-term effects connected to Mediterranean salinity. The dam would be a major project, requiring international agreements and resources. It will probably not be built soon, but it would be useful to start discussions now to quantify costs, benefits and impacts.

Keywords: Global change, Salinity, Water transport, Messinian, Gibraltar Strait

Introduction
The word "dam" suggests a wall of concrete holding back water many metres deep. Although we use the word here, discussion is of a sea-level-rise barrage as in the title, designed to cause a relatively minor sea level difference between its two sides. A dam at Gibraltar allows a Mediterranean Sea level to be chosen and maintained. Choosing a level that is 30 to 40 cm below the present average would probably be best for a coastal city like Venice, returning their sea level to the average for the last century. However, this might not suit everyone in the Mediterranean. Also, a 35 cm drop in Mediterranean Sea level implies a 3 mm rise in the global average level (Mediterranean and Black Seas together represent about 0.8 % of global ocean area). This might be hard for non-Mediterranean nations to accept. Perhaps they would also object to the 0.8% extra rise rate they would experience if Mediterranean countries decide to defend themselves by building a Gibraltar dam. This would seem a less reasonable objection, since any prevention of coastal flooding must cause some increase in global sea level. If world opinion allows Mediterranean countries to defend themselves with a dam, but not to lower the level of the Mediterranean below its level at the time the dam is built, then there is a major incentive to build the dam soon.

Dam history
A Gibraltar dam was most famously proposed for the much more radical German Atlantropa project of the 1930s (see for example Cathcart 2006, and references therein), designed to lower Mediterranean Sea level by 200m, provide new land, and allow power generation from the resulting inflow at the Strait. Proponents did not explain how the world would cope with the resulting 2 metre global sea level rise, and I have not seen this discussed in historical descriptions of the proposal. More recently, Johnson (1997) urged constructing of a dam across the Strait of Gibraltar to prevent what the author saw as a coming ice age induced by the building of the Aswan Dam on the Nile. However, the claimed effects of Mediterranean salt water outflow appeared exaggerated (Rahmstorf, 1998).

Oceanographic implications
The Strait of Gibraltar is 340 m deep and 13 km wide. Damming it would be a major project. The dam would not need to withstand a large head of water pressure, though as global sea level rises, the head would increase in future centuries. Lock gates would be needed for shipping and would also be needed on the Suez Canal, where presently there are none. The amount of power generated at Gibraltar could still be significant, since the flow of water needed to stabilize the depth of the Mediterranean is large. The water deficit is due to the excess of evaporation over the combination of precipitation and river flow. Since only fresh water is removed, the main effect of replacing the 1200 km^3/year deficit with salty (37 psu) Atlantic water will be that Mediterranean average sea water salinity will increase at an initial rate of about 0.012 psu per year (Mediterranean total volume is 3,700,000 km^3), or 1 psu every 80 years. Without control measures, Mediterranean salinity would eventually get very high, with an equivalent smaller reduction in global ocean salinities. We need to understand and quantify the long term effects of this salinity rise. If a 5 psu rise in Mediterranean salinity is acceptable, then we have 400 years before this value is reached, and time to plan responses. High salinity has significant effects on fish at present levels, with major harm by about 50psu. These effects need to be quantified.

Cost of the dam
This would be a major project, costing tens of billions of Euros. Johnson (1997) shows a map of the dam site, and estimates that it would require about 1.4 cubic km of rock material. This is about 4 billion tons, less than half of annual world coal production, for example, so the Gibraltar dam is not beyond imagination. The project could use local rock, transported and dumped by ship. The resulting loose rock structure might be slightly permeable at first, but could easily be filled with finer material and will tend to solidify by marine fouling. A rail link between Spain and Morocco has been proposed (http://en.wikipedia.org/wiki/Strait_of_Gibraltar_crossing). Local tectonic activity is a severe problem for a deep tunnel, and would also be a concern for the dam, but the dam would make a surface rail and road link possible, which could be a major positive factor. The dam would cross the Azores-Gibraltar Transform Fault, which moves at about 4 mm per year. This would be a severe problem for a solid concrete dam, but less significant for a loose rock structure.

Conclusion
The proposed Gibraltar dam can maintain the Mediterranean and Black Seas at their present level for many centuries, during which time global sea levels are expected to rise by several metres. Such a rise is expected to have huge impacts on all other coasts. The project is going to cause increasing Mediterranean salinity, though this can be limited by remedial action. This would be a major project, but the benefits in terms of coastal protection are very large. Discussions should start now on feasibility and impacts.

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CLIMATE CHANGE IMPACTS ON SEA SURFACE TEMPERATURE IN THE EASTERN MEDITERRANEAN, LEVANTINE BASIN

Y. Samuel-Rhoads [1], G. Zodiatis [1], D. Hayes [1]*, G. Konnaris [1] and G. Georgiou [1]
[1] Oceanography Centre University of Cyprus - dhayes@ucy.ac.cy

Abstract
Increases in SSTs have been recorded to occur in the Mediterranean at about twice the rate as that of the global oceans. Here we analyze and compare satellite remote sensing SST data with in-situ data from 1996 to 2012 in the Levantine. Further, SST profiles from oceanographic cruises and gliders were processed to study the variability at the surface layer (0-10m). These data were collected during several CYBO research cruises that the Oceanography Centre has conducted, as well as during missions of the gliders owned and operated by the OC. We show that the Levantine has undergone SST increases, and that satellite and in-situ SST data are correlated. The driving mechanisms of these changes need to be investigated, in order to understand the future trends and impacts of climate change in the region.

Keywords: Temperature, Remote sensing, Surface waters, Levantine Basin

Several studies have reported regional temperature increases in the Mediterranean Sea for each of its two basins [1-5]. Changes occurring in the eastern and western basins are frequently out of phase as a consequence of different processes that affect the climate of the two [6-7]. Overall, SSTs across the Mediterranean as a whole have been rising about twice as much as those of the global oceans [8-9]. The objective of this work is to investigate the increase in SST due to climatic changes in the Eastern Mediterranean Levantine basin from 1996 until 2012, with the use of satellite remote sensing data as well as with in-situ data.

Analyses of annual mean satellite sea surface temperature (SST) data indicate that over the last years a general warming has occurred over the Levantine Basin, and occurred at an average rate of approximately 0.065°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 satellite SST anomalies, with positive anomalies dominating most of the Levantine during the years 1999, 2001, 2002, 2003, and 2008. The highest sea surface temperatures appear in 1999, 2003, and 2008. An area southeastern of Cyprus is seen during some years to be warming up much more strongly than the rest of the Levantine Basin. Empirical Orthogonal Function (EOF) analysis was performed on the annual and seasonal satellite SST data to examine their spatial and temporal patterns of variability. 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 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. Analyses of annual and summer in-situ SST data reveal similar increases in temperatures to the ones recorded by satellites in the region. The average rate of increase of SSTs is 0.53°C, which is approximately three times higher than the recorded 0.18°C rate of increase of global SSTs [10]. During the year 2010, the highest temperatures were recorded up to date, which were much higher than the recorded ones from summer of 2003 (mean values for the summer of 2010 for T=29.57°C). Analyses of monthly in-situ SST data collected during glider expeditions from 2009 until 2012, and calculated for the top 10 meters of the water column, reveal the monthly variability in temperatures in the Levantine basin. However, the time series in some cases does not represent well the entire region of interest, as the gliders may have been in an area with a local effect, which is then affecting the regional averages. Further examination, processing and analysis of these data is needed.

The present study has shown that an increase in the Levantine Basin sea surface temperatures (SSTs) has taken place from 1996 to 2012. The SST variability is characterized by a broad, basin-wide warming (mode 1) occurring at both seasonal and interannual time scales, and a weaker dipole pattern that fluctuates at similar time scales (mode 2). Further, satellite SST data are correlated with in-situ CTD SST data, especially during the summer months. The warming in the Levantine, which is revealed by the satellite SST data, as well as by the recorded increases in in-situ SSTs, occurred at both seasonal and interannual time scales. The fact that in 2010 the highest temperatures have been recorded so far, which were even higher than the record values of 2003, indicates that the increasing trend is expected to continue. 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.

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IS THE MEDITERRANEAN SEA LEVEL RISING AGAIN?

Mirko Orlic [1]* and Miroslava Pasaric [2]
[1] Faculty of Science, University of Zagreb, Croatia - orlic@irb.hr
[2] Faculty of Science, University of Zagreb, Croatia

Abstract
Sea-level data collected in a wider Mediterranean area since 1920s are analyzed with the aim of separating changing trends from decadal-scale and interannual variability. During the second half of the twentieth century the trends were close to zero in the West Mediterranean and the Adriatic, and they resembled the global trends in the Atlantic off Gibraltar and the Black Sea. There are some indications that over the last twenty or so years the rate of sea-level rise considerably increased in the Black Sea and thus surpassed the Atlantic rate, while it became similar to the Atlantic rate in the West Mediterranean and the Adriatic.

Keywords: Sea level, North-Western Mediterranean, Central Adriatic Sea, Black Sea

It is well known that a pronounced sea-level deceleration was observed at the Adriatic and West Mediterranean tide-gauge stations in 1960s and 1970s [1, 2]. Subsequently and until the end of the twentieth century, mean sea level was almost stagnant in the area. There are now some indications that the quiet interval is over and that the Mediterranean sea level is beginning to accelerate. Although rather preliminary, the indications deserve to be presented to the Mediterranean research community.

In the analysis we use annual mean values recorded at sixteen tide-gauge stations in the Mediterranean and Black Sea region and the Iberian coast of the Atlantic, taken from the Permanent Service for Mean Sea Level database [3]. The stations are chosen such that the correlation coefficient between buddy stations exceeds a threshold value, in order to eliminate records with some anomalies due either to the measurement problems or the local tectonic activity. We construct time series of regional sea level (for the Atlantic, West Mediterranean, Adriatic and Black Seas) by averaging tide-gauge data over each basin, in order to obtain signals that are coherent over wider areas and to minimize local effects; prior to the averaging, zero level at each station was set to long-term mean value, the mean being calculated over interval with simultaneous data from all stations within a basin. Gaps not longer than one year were linearly interpolated within the time series. The regional sea-level time series eventually obtained cover the interval from 1928 to 2008. They are subjected to interannual and decadal-scale variability that has to be minimized in order to determine the trends. Interannual variability is eliminated by smoothing all the time series with a 5-year moving average. As for the decadal-scale variability, it is reduced by fitting a third-degree polynomial to the time series.

The result of the analysis is depicted in Figure 1. It is obvious that the decadal-scale variability was most pronounced and was characterized by the shortest periods in the Black Sea, while it had smaller amplitudes and was shifted towards the longer periods in the other regions. Of more interest for the present study is the longer-term variability, illustrated by the cubic fits. It shows a different behavior in the Atlantic as compared to the Mediterranean and, to a lesser extent, the Black Sea. In the Atlantic the sea level was rising and was slightly accelerating throughout the interval considered, whereas in the remaining regions the sea-level rise slowed down in the second half of the twentieth century. The deceleration was most obvious in the West Mediterranean and the Adriatic, where the sea-level rise almost tapered off, and there was a slight deceleration in the Black Sea, where, however, the rise remained similar to that in the Atlantic. Over the last twenty or so years the rate of sea-level rise considerably increased in the Black Sea and thus surpassed the Atlantic rate, while it became similar to the Atlantic rate in the West Mediterranean and the Adriatic. It should be stressed that this last finding may be strongly influenced by sensitivity of cubic fits to decadal-scale variability at the edges of time series, and that therefore the finding should be regarded as preliminary until confirmed by some independent methods.

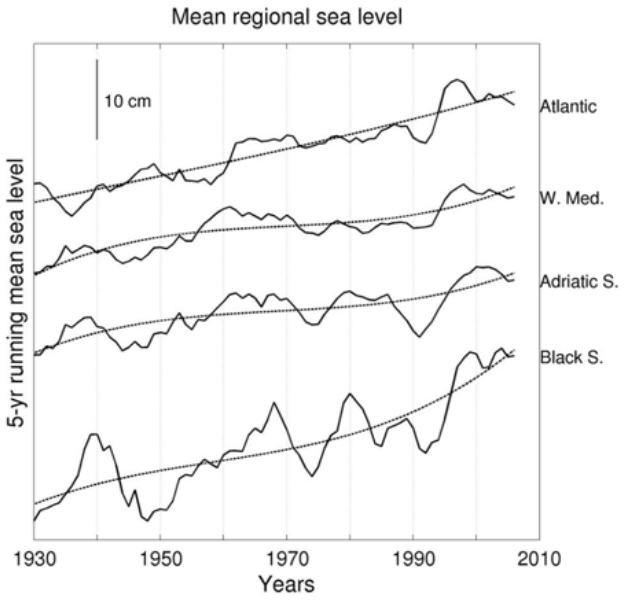

Fig. 1. Time series of sea level registered by tide gauges in the Atlantic close to Gibraltar and in the West Mediterranean, Adriatic and Black Seas and smoothed by a 5-year moving average (full lines). Cubic fits are superimposed to the time series (dashed lines).

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IS GLOBAL WARMING RESPONSIBLE FOR MASS MORTALITIES IN THE UPPER LAYER OF THE MEDITERRANEAN SEA?

I. Rivetti [1]*, S. Fraschetti [1], P. Lionello [1], E. Zambianchi [2] and F. Boero [1]
[1] DiSTeBA, Università del Salento, CoNISMa, 73100 Lecce, Italy - irene.rivetti@unisalento.it
[2] Dipartimento di Scienze per l'Ambiente, Università "Parthenope", CoNISMa, 80143 Napoli, Italy

Abstract
The thermal structure of the shallow water column over the past 65 years is reconstructed from a large dataset of temperature profiles at basin scale. Data do not support a consistent signal of climate change for the upper layer of the Mediterranean Sea, but identify areas more exposed to thermal anomalies than others. Areas subjected to mass mortalities correspond to positive thermal anomalies, suggesting a causal link between higher temperatures and mass mortalities. Methodological concerns in deriving conclusions on climate change require systematic assessment of thermal anomalies in the future. <\/div>

Keywords: Global change, Mortality, Temperature, Vertical profile, Mediterranean Ridge

Introduction The Mediterranean Sea is changing, but both the magnitude of change and the identification of areas more exposed to thermal anomalies are idiosyncratic [1, 2]. The increasing mass mortalities of temperate sessile invertebrates suggest their vulnerability to rises in seawater temperature [3]. We combined and compared the thermal structure of the uppermost part of the water column both at regional scale and at the smaller scale of mortality events, using all the high vertical resolution data (bottles, CTDs, XBTs, MBTs) available for the basin over the period 1945-2011 [4].

Methods
The thermal structure of the uppermost part of the water column has been assessed by using two approaches: first at the spatial scale of Mediterranean regions and at the temporal scale of seasons; second at the spatial and temporal scale of mortality events. For the first approach Mediterranean sub-basins were combined into five regions and the seasonal temperature anomalies at 10, 30, 50, and 100 m depth were estimated in four 15-year-long periods. For the second approach, in those areas where mass mortalities were observed average temperature profiles in the periods 1945-1982 and 1992-2011 in the months when mass mortalities were reported at least once have been considered together with the temperature profiles in the months when mass mortalities occurred. This analysis was been made for the Ligurian Sea, the Provence Coast, the Western and Eastern Tyrrhenian and the Balearic and Columbretes Islands.

Results and discussion
The available data for the upper layer of the whole Mediterranean Sea, at regional scale and at the temporal scale of season, do not show a coherent signal at basin scale. Temperature increased in the Western and in the Central Mediterranean, but not in all other areas. The Eastern Mediterranean shows larger positive and negative temperature anomalies (Fig. 1).

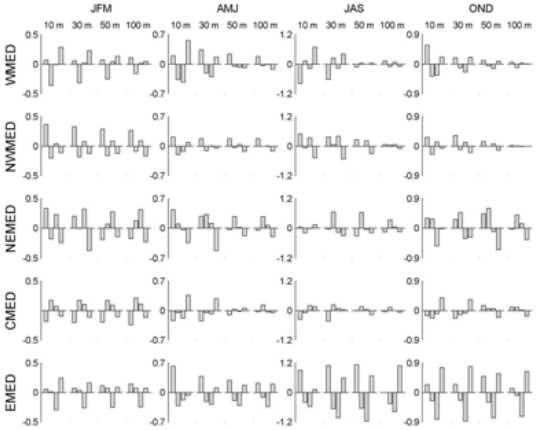

Fig. 1. Temperature anomaly for depth and seasons for the periods 1945-1959, 1960-1974, 1975-1989, 1990-2011 in the five Mediterranean regions.

At locations where at least a mortality event was recorded, mean temperature profiles document a systematic warming since the early 1990s. Here, changes of mean monthly temperature caused a rise of the upper limit of interannual temperature fluctuations, sharply associated with mass mortalities (Fig. 2).

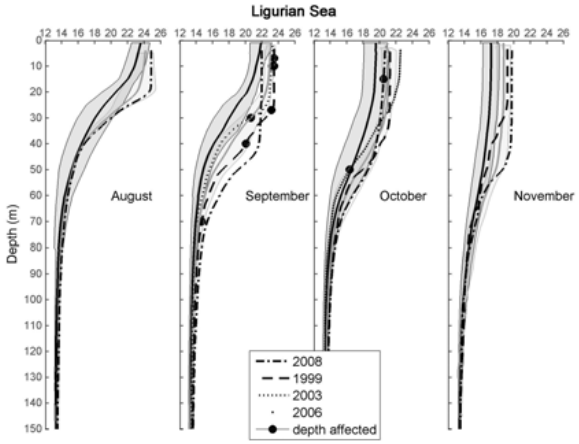

Fig. 2. Monthly average temperature profiles for the periods 1945-1982 (black lines) and 1992-2011 (grey lines) and average temperature profiles for the years and months in which mass mortalities occurred, in the Ligurian Sea. <\/div>

Though biota represent a reliable proxy for ecological responses to global change, since mass mortalities occurred especially in areas with no clear signals of climate warming at regional scale (see the N-W Mediterranean), caution in interpreting changes only in terms of thermal anomalies is needed. The lack of systematic assessment of thermal anomalies can be partly responsible for our contrasting results. Implementing monitoring programs to understand the magnitude of this phenomenon, together with specific conservation actions, should be the core of future management strategies for the whole Mediterranean Sea.

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LONG-TERM VARIABILITY OF THE EXCHANGES BETWEEN THE TYRRHENIAN SEA AND THE LIGURIAN SEA THROUGH THE CORSICA CHANNEL

K. Schroeder [1]*, M. Borghini [1], S. Sparnocchia [1], G. Gasparini [1], A. Vetrano [1] and J. Chiggiato [1]
[1] CNR ISMAR, Venice, La Spezia, Trieste, Italy - katrin.schroeder@ismar.cnr.it

Abstract
The aim of this study is to investigate the interannual signal of the time series (1985-2012) of temperature and water transport through the Corsica Channel, connecting the Tyrrhenian Sea with the Ligurian Sea. The variability from the annual to the interannual scale is explored and an investigation of the possible forcing mechanisms determining the long-term variability of transports is carried out, trying to correlate transports through the channel with large scale atmospheric modes as well as other atmospheric forcings. There is a striking similarity between the annual cycles of transport and temperature with high winter transports associated to a larger portion of purer LIW in the outflow through the Corsica Channel.

Keywords: Ligurian Sea, Circulation, Water transport, Time series

The north-western Mediterranean Sea is a region of dense water formation (DWF). It is characterized by a cyclonic circulation, which is fed by the Western Corsican Current (WCC), flowing northeastward on the western side of the island of Corsica, and the Eastern Corsican Current (ECC), flowing northward on the eastern side of Corsica. The ECC is forced to cross the narrow Corsica Channel (430 m depth), making this location ideal for the monitoring of a choke point of the Western Mediterranean circulation (Figure 1).

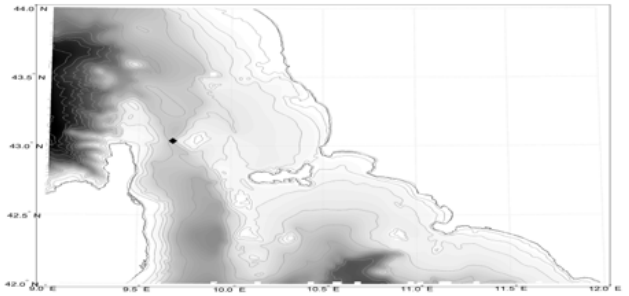

Fig. 1. Location of the mooring in the Corsica Channel. The site is part of the CIESM HYDROCHANGES Programme.

The 27-years long time series of current velocities and thermohaline properties within the water flowing through the Corsica Channel provides now a unique chance to evaluate the temporal variability, at different scales, of the exchanges between the Tyrrhenian and the Ligurian Sea. Given the extension of this time series, the focus is on periods ≥ 1 year, including the annual cycle, keeping in mind that there are also important sub-annual periodicities, as reported e.g. by Astraldi and Gasparini (1992).
Since early research efforts in the region, it is known that a two-layer shear flow crosses the Channel, where the upper layer is occupied by Atlantic Water (AW) and the lower layer by Levantine Intermediate Water (LIW) (Astraldi and Gasparini, 1992). Air–sea fluxes and steric differences between the two basins, also related to DWF events in the NW-Mediterranean, are possible candidates to explain the variability of the exchanges at the interannual scale. According to Astraldi and Gasparini (1992), a link can be established between the winter increase of currents inside the channel and the cooling of the Ligurian Sea. Other parameters are found to have a correlation with the interannual variability of transports, such as the North-Atlantic Oscillation (Vignudelli et al., 1999), the sea level pressure, net heat loss and wind speed in the Ligurian Sea.
The integrated transport over the whole water column ranges between -0.5 Sv (i.e. southward) and 2.3 Sv (Fig. 2a). The flow shows a clear annual cycle, directed northward and intensified in winter, as it has been already discussed by, e.g., Astraldi and Gasparini (1992), who estimated that the winter transport is about 60% of the annual transport. This behaviour is even more evident considering the integrated transports for each individual season, as shown by the bar plots in Figure 2b. Winter transports are always very strong, compared to the other seasons, while in summer there are a few cases of current inversions. Considering only the winter transports, a strong interannual variability is evident as well, with increased throughflow during the mid-80s, the mid-90s and mid-2000s.

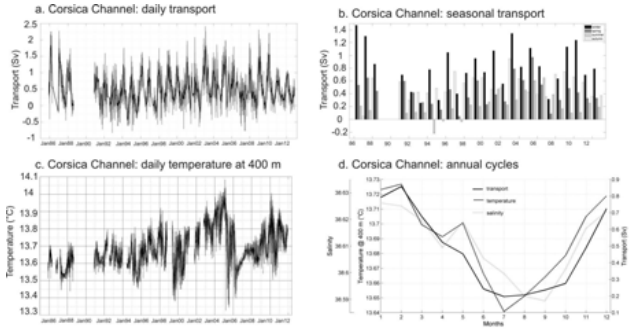

Fig. 2. A. Daily time series of the integrated transport throught the Corsica Channel; b. seasonal transport; c. daily time series of the temperature at 400 m depth; d. annual cycles of integrated transport, temperature at 400 m and salinity at 400 m.

Also the temperature time series has a clear annual cycle (Fig. 2c). The data at 400 m are proxy of the hydrological variability of the LIW (Schroeder et al., 2013). The maximum temperature was recorded in early 2005 (more than 14° C): compared to the mid 1980s, when the average was 13.6 °C, up to 2005 there has been an increase of +0.4°C. It is interesting to note that within one year (2005–2006) the highest and lowest values of the 1985–2012 time series were observed. There is a striking similarity between the annual cycles of transport, temperature and salinity (Fig. 2d). Maxima are in January-February, and minima in summer. High transports thus seem to be associated to a larger portion of purer LIW in the outflow through the Corsica Channel. Being the LIW core (i.e. the T and S maximum) in the Tyrrhenian Sea located at 500-600 m, and the sill depth at Corsica only 430 m, according to the Bernoulli principle (see its application to the Mediterranean Outflow at Gibraltar, by Stommel et al., 1973), the higher the flow, the deeper the level of "aspiration". This means that in winter the strong transport is able to "aspire" water more close to the LIW core (i.e. warmer and saltier) than in summer, when the transport is reduced, and thus also the "aspiration" depth: a behaviour that has been found also by Astraldi and Gasparini (1992), analyzing the 1985-1988 time series.

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SEASONALITY IN INTERANNUAL VARIABILITY OF MEDITERRANEAN SEA SURFACE TEMPERATURE AND ITS LINKS TO REGIONAL ATMOSPHERIC DYNAMICS

Igor Zveryaev [1]* and Klaus P. Koltermann [2]
[1] Shirshov Institute of Oceanology, RAS - igorz@sail.msk.ru
[2] Faculty of Geography, Moscow State University

Abstract
Sea surface temperature (SST) data from the NOAA OI SST V2 High Resolution dataset for 1982-2011 are used to investigate intraseasonal and interannual variability of Mediterranean SST, their relationships and links to regional atmospheric dynamics during winter and summer seasons.

Keywords: Temperature, Surface waters, North-Western Mediterranean, South-Eastern Mediterranean

Sea surface temperature (SST) data from the NOAA OI SST V2 High Resolution dataset (Reynolds et al., 2007) for 1982-2011 are used to investigate intraseasonal and interannual variability of Mediterranean SST, their relationships and links to regional atmospheric dynamics during winter and summer seasons.

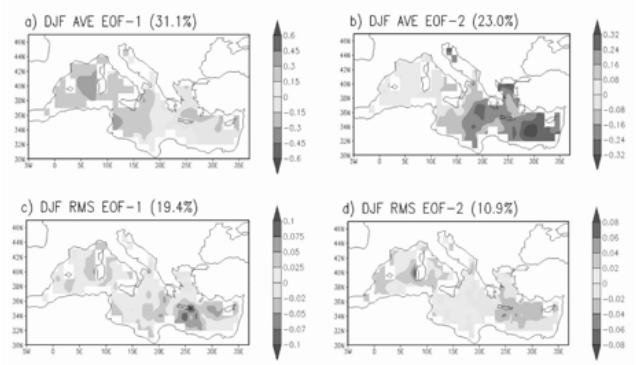

Fig. 1. Spatial patterns of the EOF-1 (a, c) and EOF-2 (b, d) of the winter (December-February) seasonal mean SST (a, b) and its intraseasonal STDs (c, d).

An empirical orthogonal functions (EOF) analysis has revealed that both in winter and summer the leading EOFs of the seasonal mean SSTs and the intensities of their intraseasonal fluctuations (expressed by standard deviations (STD) of the daily SST data) are characterized by the principally different spatial patterns. For example, in winter EOF-1 of SST is characterized by east-west dipole with the largest variability in the western Mediterranean Sea (Figure 1). Wintertime EOF-1 of intraseasonal STD, however, is characterized by the monopole pattern with the largest variability in the eastern Mediterranean Sea. Note, the EOF-1 of winter evaporation is characterized by monopole pattern (Zveryaev and Hannachi, 2012). Interannual variability of the leading principal components was also different for SSTs and intraseasonal STDs. Therefore, present analysis did not reveal significant links between interannual variability of Mediterranean SST and that of the intensity of intraseasonal fluctuations of SST.

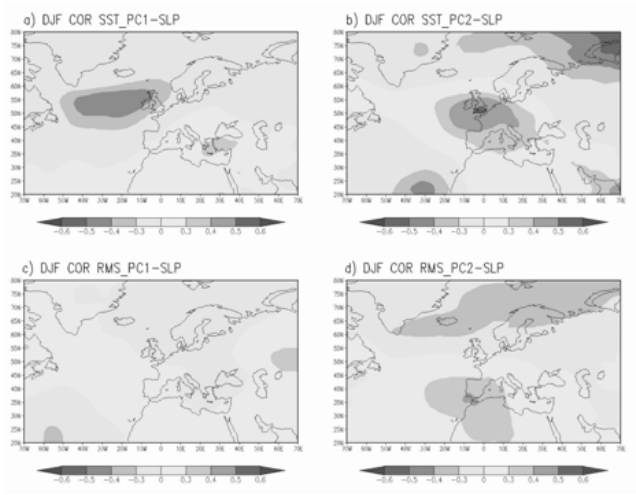

Fig. 2. Correlations between principal components (PC) of the EOF-1 (a, c) and EOF-2 (b, d) of the winter seasonal mean SST (a, b) and its STDs (c, d) and respective sea level pressure fields.

Analysis of the links to the regional atmospheric dynamics has revealed quite different patterns of correlations between leading principal components (PCs) and sea level pressure fields obtained for seasonal mean SSTs and intraseasonal STDs. In particular, it was found that during winter EOF-1 and EOF-2 of seasonal mean SST are associated respectively with the East Atlantic and the East Atlantic/West Russia teleconnections (Barnston and Livezey, 1987). Wintertime EOF-2 of intraseasonal STDs is linked to the North Atlantic Oscillation. Overall, results of the present study suggest that interannual variability of Mediaterranean SST is not associated with variations in the intensity of its intraseasonal fluctuations, and that they are driven by the different modes of regional atmospheric dynamics.

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Session

Ventilation transients

Modérateur : **Manuel Bensi**

EFFECTS OF 2012 WINTER CONVECTION ON THE DEEP LAYER OF THE SOUTHERN ADRIATIC SEA

M. Bensi [1]*, V. Cardin [1], A. Rubino [2], G. Notarstefano [1] and P. M. Poulain [1]
[1] OGS, Oceanography Section, Trieste, Italy - mbensi@ogs.trieste.it
[2] University Cà Foscari, Venice, Italy

Abstract
Winter convection occurred during 2012 in the Northern Adriatic produced an exceptionally dense water, which caused abrupt thermohaline changes in the bottom layer of the Southern Adriatic after its arrival as a bottom-arrested current. We investigate this phenomenon merging data from a fixed point observatory and from drifting profiling Argo floats.

Keywords: South Adriatic Sea, Deep waters, Circulation experiments, Deep sea processes

An unusually harsh and long-lasting (~20 days) episode of Bora wind, which occurred from 24 Jan to 14 Feb 2012 in the Adriatic Sea, was responsible for a large production of very dense water (σ_θ > 30 kg m^{-3}) in the northern basin, where maximum depth does not exceed 250m. Here, we merge Temperature (T), Salinity (S), and current time-series collected at the E2M3A deep-ocean observatory of the Southern Adriatic (41°32' N, 18° 05' E) with CTD (Conductivity-Temperature-Depth) profiles obtained from freely drifting Argo profiling floats to analyse the drastic thermohaline changes which occurred in the deep layer (>1000m depth) of the Southern Adriatic Pit (SAP) after the arrival of the dense water formed on the northern shelf. The signal of that water mass arrived in the Jabuka Pit (middle Adriatic) by the end of February 2012, and its effect was clearly evident in the bottom layer (Fig. 1).

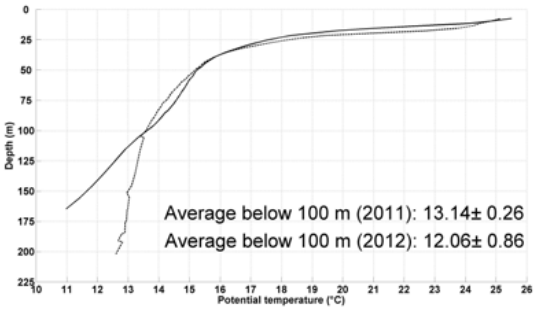

Fig. 1. Average pot. temperature profiles obtained from float data in July-August 2011 (dashed line) and 2012 (solid line) in the Jabuka Pit (middle Adriatic).

Afterwards, its arrival in the SAP interrupted the positive T and S bottom trends observed during the last 5 years, which were quantified by ~0.05°C y^{-1} and ~0.004 y^{-1}, respectively (Fig. 2).

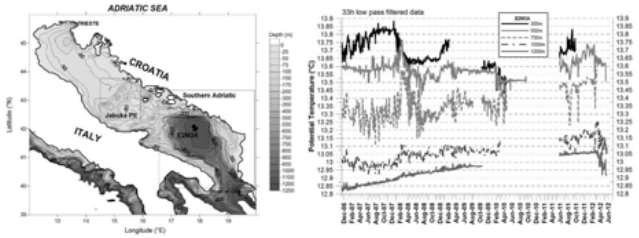

Fig. 2. Map of the Adriatic Sea (left panel) and temperature time series (right panel) at the fixed point observatory E2M3A from 2006 to 2012.

Previous studies report that, presumably, these trends were associated to the combined effect of local mesoscale eddies, large scale circulation changes, and dense water formation processes ([1], [2], [3]). The descent of dense waters of Northern Adriatic origin (NAdDW) caused an abrupt bottom T and S decrease (~0.15 °C and ~0.015, respectively). The corresponding density increase was ~ 0.02 kg m^{-3}. Our data confirm that the deepest part of the SAP undergoes intense modifications only when harsh winter conditions are able to produce a high volume of NAdDW with different properties from those of the previous years. Moreover, they show that the exceptionally dense waters produced on the northern shelf arrived in the central, deepest part of the SAP as a series of individual pulses not earlier than 10 March 2012, while a stronger and prolonged signal that significantly modified the deep water stratification arrived after 10 April 2012. CTD float profiles collected in the Strait of Otranto, which connects the Adriatic Sea with the Ionian Sea, reveal that the Adriatic outflow in July 2012 was characterized by relatively cold and dense water (θ ~13.08°C, S~38.71, and σ_θ~29.25 kg m^{-3}). This fact clearly indicates that the harsh winter conditions, responsible for an exceptional production of very dense water in the Northern Adriatic, caused also strong modifications in the thermohaline properties of the Adriatic outflow with respect to those observed in the previous years ($\Delta\theta$~ -0.2°C, ΔS~ 0.01, $\Delta\sigma_\theta$~ +0.02-0.03 kg m^{-3}).

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INTERANNUAL CHANGES IN THE THERMOHALINE STRUCTURE OF THE SOUTH EASTERN MEDITERRANEAN

Isaac Gertman [1]*, Ron Goldman [1], Tal Ozer [1] and George Zodiatis [2]
[1] Israel Oceanographic & Limnological Research - isaac@ocean.org.il
[2] Oceanography Center University of Cyprus

Abstract
CTD data shows long term increase of the Levantine Surface Water salinity (0.01 per year) and temperature (0.1ºC/year) during the last 33 years. Fluctuations of salinity and temperature in the Atlantic Water and Levantine Intermediate Water do not show substantial long term tendencies.

Keywords: Levantine Basin, Stratification, Salinity, Temperature

The South Eastern Mediterranean (SEM) is the region with the highest temperature and salinity values in the upper layer. The so called Levantine Surface Water (LSW) originates from Atlantic Water (AW) whose properties change through evaporation and heating in the course of their eastward propagation. During summer the LSW is bounded from below by overturning halocline and stabilizing seasonal thermocline. The later prevents vertical mixing of LSW with the less transformed (cold and less saline) AW. During winter, the overturning halocline sinks as a result of winter cooling. However, AW signal (minimum salinity) is not typically destroyed. Levantine Intermediate Water (LIW) formation occurs when LSW cools down and sinks along isopycnals into intermediate depths. This usually occurs as LSW reaches Rhodes Gyre regions (Lascaratos et al., 1999). Nevertheless, some indications of intermediate water formation were observed on continental shelves of Israel and Turkey (Oszoy et al., 1989). When sufficiently saline LSW propagates further to the Aegean it can cool down to reach densities of Eastern Mediterranean Deep Water (EMDW) and cause intensive deep water formation, as occurred during the Eastern Mediterranean Transient (EMT) (Roether et al., 2007; Gertman et al., 2006). In this study we estimated interannual variability of thermohaline structure in the region where LSW circulates and accumulates before it propagates further to LIW and EMDW formation regions

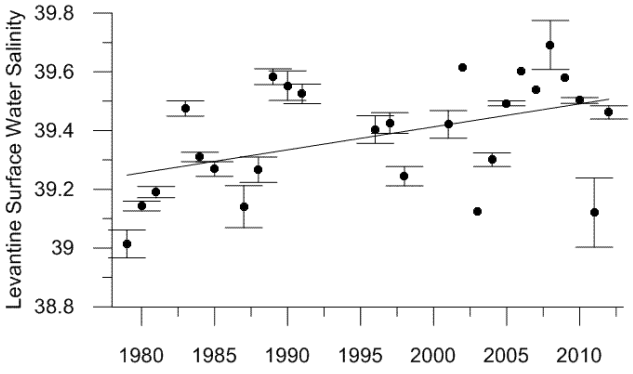

Fig. 1. Long term changes in LSW salinity. Confidence interval (Emery & Thmoson, 2001) is shown when number of observations is more than 3.

Thermohaline structure was obtained by analysis of CTD profiles from a regional cast database containing data from the SESAME project cast DB along with recent observations made by IOLR and OCUCY. For the analysis we used only CTD profiles in the SEM which are at least 50 km away from the coast. This was done in order to eliminate influence of coastal upwelling. To characterize the thermohaline structure variability we derived the following parameters from the vertical profiles of potential temperature, salinity and density: depth of the seasonal mixed layer and its temperature and salinity (LSW parameters); thickness of minimal salinity layer, location of salinity minimum as well as water temperature and salinity of the minimum (AW parameters); thickness of intermediate maximal salinity layer, location of salinity maximum as well as water temperature and salinity of the maximum (LIW parameters). In order to increase the robustness of the estimated parameters, all CTD profiles were smoothed initially by low pass median filter (effective to eliminate spikes) and then by running average filter to finalize the smoothing. The depth of the seasonal mixed layer was defined as the size of the upper layer where total increase in potential density was less than 0.08 kg/m^3. The same depth was used as the upper boundary of AW layer. The low AW boundary was defined as the depth of isopycnal surface 28.5 kg/m^3. The low boundary of the LIW layer was defined as the depth of isopycnal surface 29 kg/m3.

Thickness of LSW during summer fluctuates between 10 m and 50 m and between 20 m and 350 m during winter. Time series of summer and winter salinity show long term increase of the LSW salinity with a rate of about 0.01 per year (Fig. 1). In the summer salinity time series, two periods of salinity increase can be observed: from 1978 (39.10) to 1991 (39.55) and from 1996 (39.4) to 2008 (39.7). The first period preceded the EMT. It is not yet clear whether the second increase in salinity will cause another EMT, however data observed during 2010-2012 shows some decrease of the LSW salinity. The winter salinities of LSW show the similar behavior. Summer and winter temperature series shows a long term tendency of the LSW warming with the rate of about 0.1°C/year (Fig.2). Fluctuations of salinity and temperature in the AW and LIW does not show substantial long term tendencies.

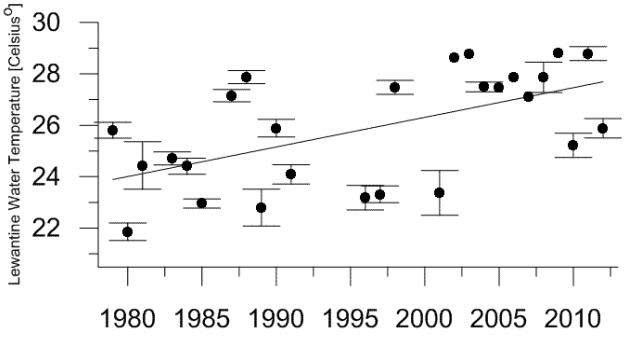

Fig. 2. Long term changes in LSW temperature.

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CHANGES IN LEVANTINE INTERMEDIATE WATER PROPERTIES OBSERVED IN THE EASTERN LEVANTINE: 1995-2012

D. Hayes [1]*, G. Zodiatis [1], G. Georgiou [1], E. Mauri [2], P. Poulain [2], R. Gerin [2], G. Notarstefano [2] and P. Testor [3]
[1] Oceanography Center, University of Cyprus - dhayes@ucy.ac.cy
[2] OGS, Trieste, Italy
[3] LOCEAN-IPSL/CNRS, Universite Pierre et Marie Curie, Paris, France

Abstract
Hydrographic data have been collected for 17 years in the northeastern Levantine by the Cyprus Basin Oceanography (CYBO) initiative of the Oceanography Center, University of Cyprus. Twenty-three cruises have covered the region extensively, and have shown significant changes in the salinity of the Levantine Intermediate Water (LIW: 250 m depth) from values of around 39.1 to 39.3 since 2007. Profiling float data since 2003 and glider data since 2009 show agreement. LIW temperature shows a very small change at the same time from all three platforms.

Keywords: Intermediate waters, Levantine Basin

LIW is primarily formed in February and March in the cyclonic Rhodes Gyre [1]. It is signified by a sub-surface maximum in salinity, around 250 m. During and after buoyancy driven convection, LIW spreads laterally around the Levantine basin, eventually finding its way into the Western Mediterranean, and to the Atlantic Ocean. Salinity and temperature values at the time of formation are reported to be 38.95-39.1 and 15-16 deg C [2]. In this paper, the properties of LIW from 1995 to present is examined.

Since 1995, the CYBO program has carried out 23 hydrographic cruises of up to ninety stations to 1000 m over 9 days (Fig. 1). For the last 10 years or so, profiling Argo floats have been deployed in earnest in the Mediterranean Sea [3]. While coverage is not the same every year, a significant portion of the region is covered in any given year. The last three years gliders have been used: over 4000 profiles have been collected, most to 1000 m (Fig. 1). The salinity and temperature at the depths of the LIW have been extracted from floats and gliders for the Eastern Levantine each year in order to be compared to the CYBO data.

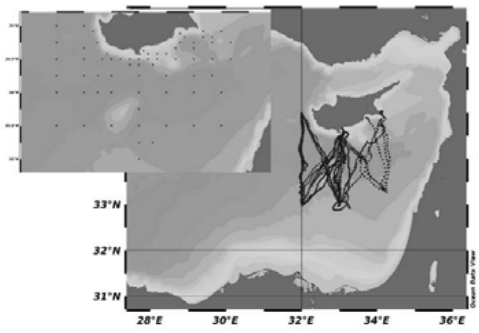

Fig. 1. Location map of standard Cyprus Oceanography hydrographic stations (zoom) and Cyprus glider fleet missions (2009-2012).

Results from CYBO show a significant increase in LIW salinity and temperature from 39.0 to 39.15 and 15.4 to 16.0 deg, around 2009 (Fig. 2).The glider data (connected symbols) also show higher salinity and temperature in recent years, in agreement with CYBO. Maps of salinity at 200 m (Fig. 2) from floats also indicate a sudden change in LIW salinity around 2009, with the years before and after not exhibiting large-scale changes.These results could indicate a change is taking place on the fresh water budget of the Mediterranean. Besides the slow changes over the last century because of the damming of major rivers, it could be that different sites for LIW formation are favored in recent years. The geographic extent outside the eastern Levantine is not yet known, nor is the mechanism for this change. Further analysis of the in situ data, as well as model re-analyses will shed light on the mechanisms at work.

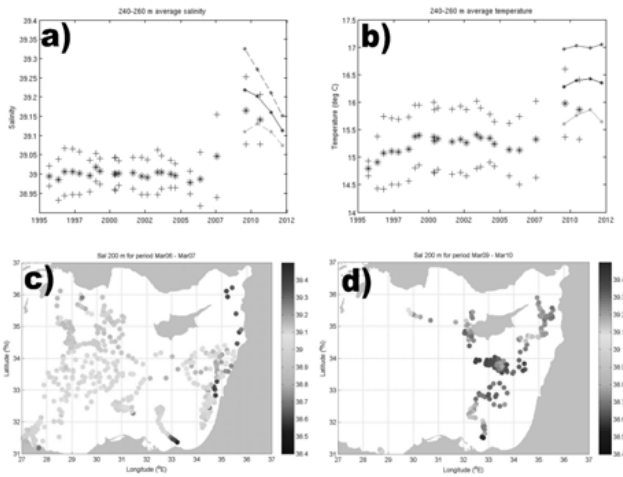

Fig. 2. Time series of salinity (a) and temperature (b) at 250 m depth from cruises and from glider missions (lines) with +/- standard deviation. Profiling float values of salinity at 200 m for March 2006-2007 (c) and March 2009-2010 (d).

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OBSERVATIONS OF DENSE WATER FORMATION AND DEEP WATERS CHANGES IN THE NORTHWESTERN MEDITERRANEAN OVER THE RECENT PERIOD (2007-2012) FROM IN-SITU MEASUREMENTS.

Loïc Houpert [1]*, Xavier Durrieu de Madron [1] and Pierre Testor [2]
[1] CEFREM,CNRS-Université de Perpignan, Perpignan, France - loic.houpert@univ-perp.fr
[2] LOCEAN, CNRS-IRD-Université Pierre Marie Curie-MNHN, Paris, France

Abstract
We present here new in-situ observations collected since 2007 in the Gulf of Lions that enable to characterize the variability of the different phase of the deep water formation and the subsequent thermohaline changes.

Keywords: North-Western Mediterranean, Air-sea interactions, Deep waters, Deep sea processes, Water convection

Open-ocean deep convection is a key process that transfers the heat and salt contents from the surface to the deep ocean. In the Northwestern Mediterranean Sea, this leads to the formation of the Western Mediterranean Deep Water (WMDW) which underwent in 2005 an abrupt increase in its thermohaline properties, and an important modification in the deep stratification (known as the Western Mediterranean Transition, WMT [1]).

A mooring line was setup since 2007 in the Gulf of Lions (42°N-4.6°E) to monitor the deep convection process. This observation system is composed by 20 temperature sensors, 10 salinity sensors and 5 current meters between 150m depth and the bottom (2330m depth). Theses recent measurements reveal the temporal evolution of the physical processes interfering in the phases of deep convection (deepening of the mixed layer depth, violent vertical mixing and restratification [2]).

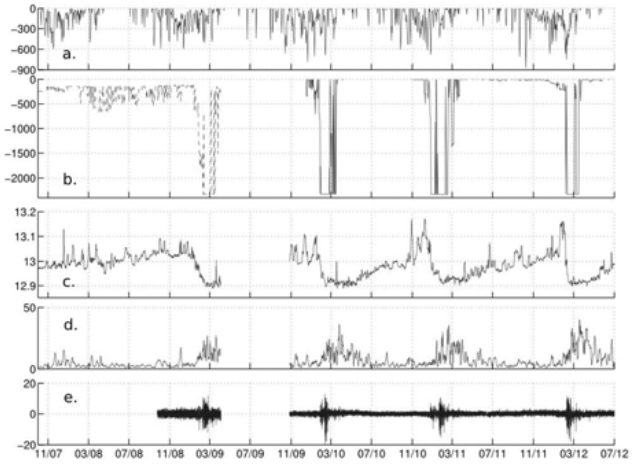

Fig. 1. (a) Daily net heat fluxes (W.m-2) from ERA-Interim reanalysis, (b) daily MLD (m) calculated with a 0.08°C criterion and a 10m depth reference level (continuous line from November 2009 to July 2012) and with a 0.05°C criterion with a 150m depth reference level (dashed line from October 2007 to April 2009), (c) daily θ (°C) at 750m depth, (d) daily horizontal speed (cm.s-1) at 1000m depth, (e) bi-hourly vertical current (cm.s-1) at 1000m depth

Some remarkable features point out from the analysis of four deep convection events observed between 2009 and 2012. The time for the mixed layer deepening is comprised between 1 and 2 months, while the violent vertical mixing is in the range of 7-10 days. Due to the strong heat losses, the mixed layer can reach the bottom (Fig 1.) and its temperature may undergo a 0.02°C decrease.
Strong currents were also recorded during the different events of deep ocean convection: high frequencies vertical velocities exceeded 10 cm.s-1 during the violent vertical mixing phase and strong mesoscale horizontal currents reached 40cm.s-1 during the restratification phase (Fig. 1). Horizontal currents were strongly barotropic during each deployment. The first EOF dominate the variability, containing 85% to 95% of the variance, while the second mode contains 5% to 10%.
Dense shelf water cascading also contributed to deep water formation during winter 2012 [3]. Each of these five deep water formation events modified the deep stratification by producing a new deep water. The thermohaline changes of the bottom water between 2007 and 2012 corresponds to a potential density (σ) increase of 0.015 kg.m-3 in 4 years, linked to a salinity (S) increase of 0.03 and a potential temperature (θ) increase of 0.03°C (Fig. 2). These stepwise increases in bottom water characteristics are marked by postivie jumps in θ , S and σ, and correspond to the mixed layer reaching the bottom in February. We interpret the 0.02°C decrease in temperature after each jump, already seen in [4], as the effect of the persistent net heat losses after that the MLD reached the bottom (Fig. 1). A remarkable signal corresponding to a strong decrease in θ and S can be seen in March 2012, indicating the arrival of dense shelf water to the mooring location [3].

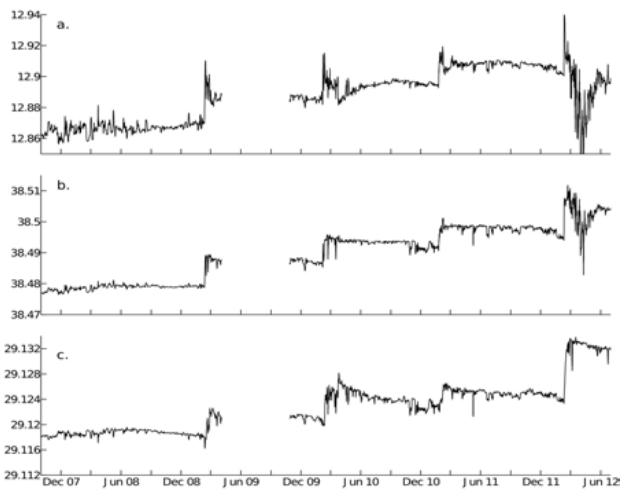

Fig. 2. (a) Potential temperature (°C), (b) salinity and (c) potential density anomaly (kg.m-3) from the mooring line at 2300m depth.

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A COMBINED NUMERICAL AND ANALYTICAL MODEL STUDY OF DENSE WATER FORMATION IN THE NORTH AEGEAN SEA DURING THE YEAR 1987

Ettore Salusti [1]* and D. Gasbarra [2]
[1] ISAC-CNR - ettore.salusti@gmail.com
[2] Univ. of Rome "La Sapienza"

Abstract
We investigate the role of year 1987 in a kind of preconditioning the EMT, being the first of a series of increasingly cold winters affecting the Aegean Sea. Due to the scarceness of direct in situ observations in this sea during 1987, we implement satellite and in situ data with numerical simulations from Protheus, a coupled ocean-atmosphere model. We use just such numerical temperature and salinity data to simulate lacking observations in some transects to infer dense water formation sites, evolution and mixing during this pre-EMT year. We so obtain a detailed description of North Aegean dynamics but that around Cyclades plateau looks a more complex situation.

Keywords: Deep sea processes, Models, Aegean Sea

The numerical simulation of transects and heuristic T/S diagrams Information from the simulated Protheus transects is synthesized in some heuristic hydrologic maps of monthly data, that allow one to infer some dynamics of the dense waters [Fig 1]. Unfortunately no Lagrangian version of the Protheus model data has been available. For the PROTHEUS data, the densest Northern Aegean Sea (NAS) water appears during January over the shelf of transect M15. From the deep M15 densities, no dense water cascade is evident, so we assume that such densest M15 water flows geostrophically over the NAS slopes. Its effect is evident over the O1 sill , at ~ 200 m depth, where σ decreases of ~ 0.1 in February and ~ 0.2 in March. In the following months the O1 sill dense water increases slightly its temperature, perhaps due to a mild mixing with the fresher and colder O3 waters. No evident effect of such dense surface M15 water appears on the O3 nor M15 deep data, that anyway are ~ 0.5 denser than the sill waters. We therefore assume that M15 flows as a density current into the sill, while probably the fresher and colder O3 water diffuses over the NAS bottom.

In these NAS density evolutions two important effects can be seen. First the time delay between surface dense water formation and bottom waterdensity increase (about two months) can be explained by considering the dense water evolution over a slope with its mild alongflow deepening due to bottom friction. Considering the distance along isobaths from the M15 shelf and the O1 sill as ~ 200 Km and a water velocity of ~ 4 cm/s, one indeed has a time delay of 57 days. The second important physical effect concerns again the sill deepest point (O1 at 200m depth): the dense water over the sill bottom is increasingly mixed with the dense M15 (and O3) shelf January waters while no relation with the Turkish shelf dense water (O1, 30 m) is evident. All this supports the idea that Turkish dense water (O1, 30m) has no important effect in the NAS dynamics but most probably flows around Limnos into the central Chios Basin.

The most important question about the thermodynamics of the central basin concerns the origin of the dense water near the Cycladic Plateau, where in January, February and March σ ~ 29.25, then ~29.36 in June to finally reach 29.5 in August . We examine hydrologic data of the possible sources, i.e. the O1 sill and shelf, the NE O7 shelf and deep points, the Z5 transect shelf or the northward flow of salty water along the Turkish shelf during January, February and March.

In these deep layers, salinities for both NE O7 (~ 500 m deep) and Z5 (at ~ 250 m depth) increase during January, February and March. At the deep O7 point near the Cyclades it looks reasonable that such NE O7 deep water during March is mixed with new salty water. This could come from the O1 sill (at a distance of ~ 180 Km from the NE O7 deep point, with model velocity u ~ 2 cm/s), or from the Limnos/Gokçeada shelf (~ 320 Km from the NE O7 deep point, with u ~ 3 cm/s), or to dense water formed over the same NE O7 Turkish shelf at a distance of ~ 160 Km (about 50 m deep , with u ~ 3 cm/s). It could also have been influenced by a violent storm.

In the following 3 months, S of this deep NE O7 water increased to ~ 38.2 and T decreased giving a density of about 29.35, most probably due to the mixing with O1 and salty waters. So in August a very dense water (σ ~ 29.48) was there found. In synthesis, a general increase of the water salinities and densities was evident, but no clear effect of the Z 5 transect on NE O7 can be found.

A similar effect holds in the other point of interest, the Z5 sill water. Its σ increased to ~ 29.2 in March, from 29.1 in January, while its salinity increases from 39.72 in January to 38.84 in March. In April, May and June its densities remained constant but S and T both show a mild decrease, with a large σ ~ 29.40.

Fig. 1. Map of selected transects to simulate hydrologic data unfortunately not measured.

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CHANGES IN VENTILATION IN A VIEW OF TRANSIENT TRACERS TIME SERIES AND A CONSTRAINED TRANSIT TIME DISTRIBUTION MODEL

Tim Stoeven [1]*, Toste Tanhua [1], Anke Schneider [1] and Wolfgang Roether [2]
[1] Helmholtz Centre For Ocean Research Kiel - GEOMAR - tstoeven@geomar.de
[2] Institute of Environmental Physics, University of Bremen, Germany

Abstract
Measurements of transient tracer in the Mediterranean Sea cover the time frame between pre Eastern Mediterranean Transient (EMT) state in 1987, the EMT during the 1990's and post EMT progress as well as the Western Mediterranean Transit (WMT) up until 2011. The transient tracers can be used to determine the tracer age and mean age of water masses, i.e. the Transit Time Distribution, and thus provide a significant insight into the temporal variability of the ventilation processes in the Mediterranean Sea.

Keywords: North-Central Mediterranean, South-Central Mediterranean, Circulation, Time series, Models

The time series of transient tracer surveys includes several expeditions in the Western and Eastern Mediterranean Sea (WMed, EMed) between 1987 and 2011: Meteor 5/6 in 1987, Meteor 31/1 in 1995, Urania MAI2 and Poseidon 234 in 1997, Aegaeo M4WF in 1988, Urania MAI7 in 1999, Meteor 44/4 in 1999, Meteor 51/2 in 2001 and Meteor 84/3 in 2011 (Fig. 1). Transient tracers can be used for water mass analysis in terms of tracer age calculations and mean age modeling. The data sets consist of different combinations of CFC's, Helium isotopes, Tritium and SF_6 whereat the extent of the tracer data and sampling area are relatively similar. Changes in the composition of transient tracers resulting from changes in ventilation have a direct impact on the different ages, rates of age growth and age shifts. This provides a versatile and powerful tool to describe ventilation and transport processes in the ocean. According to this age applications the classical approach of tracer ages like the $^3He/^3H$-age [1] and the Inverse Gaussian - Transit Time Distribution (IG-TTD) [2] were used for the analysis of the time series. The ventilation of the Mediterranean Sea has direct implications for several biogeochemical processes, such as storage of anthropogenic carbon, oxygen and nutrient distribution, and transport of labile dissolved organic matter to the deep interior waters.

The comparison of apparent tracer ages and mean ages over the period of 25 years shows changes in circulation (like the EMT [3,4,5] and WMT [6]) as well as shortcomings of the different methods and to use them as such. Furthermore, the relation between the SF_6 ages in 2011 and the CFC-12 ages in 1997 of the same oceanic region give additional insights to changes in circulation. This approach is based on the almost identical atmospheric increase functions of both tracers with a time shift of 14 years [7]. In a steady-state system the tracer age of SF_6 in 2011 should match the tracer age of CFC-12 in 1997. In most tracer age shifts this was not the case. Increased ages for the eastern basin can be found below ~1500 m in 2011 and younger waters at depth in the western basin, respectively.

The comprehensive data set of the latest Meteor cruise M84/3 in 2011 consisting of CFC-12, SF_6, Helium isotopes and Tritium indicates that the EMed returns into the pre EMT state with the Adriatic Sea as major deep water source. Young water masses with higher tracer concentrations intrude the deep water layer in the Ionian Sea. Nevertheless, the Cretan Sea Outflow Water (CSOW) is still present in the bottom layer of the Levantine Sea shown by younger mean ages beneath the Tracer Minimum Zone (TMZ) in the intermediate layer. The WMT between 2005/06 leads to a complete renewal of the deep and bottom layer in the Western Basin by tracer rich water masses. Parts of the newly formed deep water spill over the shallow sill between Sicily and Sardinia intruding the old water masse of the Tyrrhenian Sea along the continental slope of Italy. Furthermore, the data set allows in addition to the standard investigation of ventilation processes to constrain the Inverse Gaussian (IG) - TTD model with either one (1IG) or two (2IG) main water masses, or transit time distributions. The obtained parameters like D/G-ratios ratios (the ratio of diffusion over advection) and alpha (the relative contribution of one water mass in a 2IG model) in the EMed give an insight into the advective/dispersive behavior of the water masses. Based on a constrained TTD model the mean age can be determined considering the particular water mass properties. The used tracer couples to constrain the 1IG-TTD were CFC-12 / SF_6 and Tritium / SF_6. However, not all data points were constrainable by those two couples and there were also small but distinctive differences in mean ages of the constraints. Therefore, the 2IG-TTD was applied to the tracer data which provides possible solutions describing one mean age by three transient tracers. Building on these results the anthropogenic carbon (C_{ant}) column inventory might be better estimated compared to the results of the standard TTD model. A further examination of the practical use and the improvement of the 2IG model within field data will be part of future work.

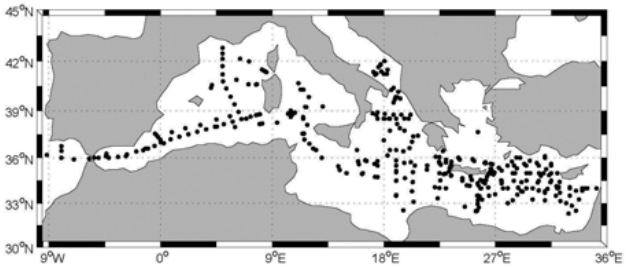

Fig. 1. Sampled stations of all nine cruises between 1987 and 2011.

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COMITÉ 3

Biogéochimie marine

Président : Axel Romaña

Rapports des modérateurs

Acidification

Patrizia Ziveri, UAB, Spain

Résumé

The introduction covered the concept of ocean acidification and the unique characteristics of Mediterranean acidification and biological impacts. It was followed by communications covering diverse topics related to the chemistry, past carbonate chemistry dynamics, biological impacts and modelling. Several presentations contributed to the on-going European project (MedSeA-project.eu) focusing on acidification in the Basin.

During the debate many important issues were discussed:

1. Data on seawater carbonate chemistry are still few, particularly in the southern Mediterranean and there is a need of long-term time-series stations for monitoring ocean acidification and other biogeochemical and physical parameters. The MedSeA project, among others, is collecting many new carbonate chemistry and biological data related to elevated CO2 conditions.

2. Ocean acidification training activities for scientists and laboratories starting to work on this research field was promoted. There is a need of method standardization for both chemistry (pH, AT, DIC, pCO2) and experimental biological work testing the impacts of acidification. It is particularly important to have long term monitoring time-series on the seawater carbonate chemistry and target biogeochemical processes, because only with a long record it is possible to identify trends in seawater pH and relative impacts. During the presentation new data were presented from the DYFAMED site (North Western Mediterranean) and the LTER-C1 (North Adriatic Sea). Time series stations should be established, especially in the eastern and southern Mediterranean and the Black Sea. They should follow the same standard operational protocols for measuring the basic carbonate system parameters

3. The negative impacts of acidification could be much more relevant in coastal ecosystems, where marine life is concentrated and biogeochemical processes are more active. However, changes in pH in these areas are difficult to study due to the multitude of physical and biological drivers, including watershed processes, nutrient inputs, and changes in ecosystem structure and metabolism. The next challenge for the ocean acidification research is to focus on these environments, using a multidisciplinary approach; chemical, physical and biological aspects should be well investigated and integrated.

4. Different kinds of impacts by acidification could exert themselves in the near future. Not only chemical and biological impacts were discussed, but also the importance of socio-economic aspects arose; collectively these highlight a transversal way that integrates the main decision making components in a holistic approach.

5. The last point discussed was the potential effects of acidification on metal and contaminant speciation. The MedSeA project only partly covers this topic, which also bears on the biota and on human health itself. This is an important issue that is just at its infancy. In the Mediterranean some initial work has been performed in MedSeA project mesocosm experiments. It would be also interesting to understand the effect of acidification on dust input and elemental availability.

6. An international ocean acidification coordination was launched recently. It provides important information about research status and OA collaborators (OA-ICC web site: www.iaea.org/ocean-acidification News Stream: news-oceanacidification-icc.org).

7. A dedicated information outlet on Mediterranean Sea acidification, climate and environmental changes is available at http://medseaclimatechange.wordpress.com.

Bioaccumulation, methodology

Bourhane Belabed, Univ.d'Annaba, Algérie

Résumé

La protection de la Méditerranée s?était fixé plusieurs objectifs, dont un était la création d?un programme de surveillance de la pollution marine. Depuis, le programme MEDPOL s?est développé, et remodelé plusieurs fois. Les États membres du bassin méditerranéens se sont engagés à fournir des données sur la qualité des eaux côtières. Les travaux réalisés restent insuffisants pour estimer l?état des écosystèmes marins. De plus, la situation est rendue complexe par une forte urbanisation, une explosion démographique et surtout des usines le long du littoral. Ces zones présentent des habitats riches et variés, un réservoir de biodiversité, et des espaces de développement d?activités : portuaires, industrielles, urbaines et touristiques et jouent un rôle nourricier pour de nombreuses espèces de poissons. Face aux risques environnementaux générées par l?introduction de substances chimiques dans le milieu marin il est urgent de mettre en place des outils pertinents- notamment des bio indicateurs quantitatifs- afin d?évaluer les perturbations des écosystèmes.

Les participants de la session 82 ont proposé de suivre, à l?échelle internationale, les concentrations de contaminants dans les organismes vivants en vue de surveiller le milieu. Les stratégies de surveillances présentées sont diverses ; l?utilisation de mollusques, et surtout de poissons- mulet et thon- dans les programmes de surveillance, ont rencontré le plus de succès.

La douzaine de travaux présentés lors de cette session ont montré que les métaux lourds et certaines substances radio-nucléiques entrainent des modifications du comportement et des perturbations du métabolisme et des réponses génétiques, pouvant avoir des répercussions à toutes les échelles trophiques, affectant ainsi le fonctionnement des écosystèmes. Lors du débat les participants ont pu conclure:

- qu'il n?existe pas de bio-indicateur universel. L'utilisation d?indicateur biologique répond à une problématique appliquée;

- à l'intérêt d'indicateurs basés sur l?individu comme les indices de croissance et de condition.

- que la création d?un réseau de suivi de la contamination littorale était donc un objectif socio- économique vital pour la région considérée.

Chemical fluxes - 1

N/A

Résumé

Modérateur absent

Chemical fluxes - 2

Christian Tamburini, MIO, Université Aix-Marseille, France

Résumé

In this session, 12 speakers presented their results in front of a large audience (the room was full). The short introduction presentation provided a brief overview of the different presentations focused on: (i) eutrophisation in the Black Sea leading toward anoxic conditions in the water column (three talks: A. Alkan, S. Trugul and A. Alkan); (ii) benthic nutrient fluxes in Adriatic and Aegean Seas and geochemical characteristics in recent deep sediments under influence of open sea convection in the Gulf of Lion (three talks: F. Spagnoli, C. Dumas and M. Stabholz,); (iii) the silica budget at the scale of the Mediterranean Basin (one talk: M. Krom); (iv) production of dissolved organic matter (DOM) in culture experiment and in coastal zone and its degradation (three talks: E. Sanchez-Perez, B. Charriere and C. Tamburini).

While the panel of presentations was relatively large, the discussion was rich, active, well distributed through the different presentations and crossing the many themes.

Coastal lagoons status

Michèle Forestier, Univ. Genève, Suisse

Résumé

Durant cette session, 4 auteurs ont présenté leurs résultats, après une courte introduction de la modératrice sur les lagunes côtières: (i) H. Chalghmi, Suivi de la réponse des biomarqueurs de métabolisation de phase I et II dans le Lac de Tunis (Tunisie); (ii) D. Munaron, Assessment of chemical contamination of french coastal lagoons using passive sampling techniques; (iii) U. Sunlu, Distribution of Some Heavy Metals in Surface Sediments From The Homa Lagoon (Izmir Bay, Turkey). (iV) M. Forestier, Historical trace metal contamination assessment of Orikum Lagoon, Albania, based on dated recent sediments record.

Ces présentations ont contribué à la mise en lumière de différentes méthodes d'évaluation des systèmes lagunaires selon diverses approches (biologique, géologique et chimique). La discussion fut riche et pertinente, rappelant les difficultés que les auteurs ont pu rencontrer à travers l'étude de tels systèmes dynamiques complexes.

Ecosystem modelling

J. Tronczynski, Ifremer, France

Résumé

Absence de résumé

Estuaries status

Ana-Marija Cindric, Ruder Boskovic Institute, Zagreb, Croatia

Résumé

The session ?Estuaries status? hosted in total eight presentations covering specific, but quite different topics: the intrusion of seawater into the surrounding aquifer, lithogenic and biogenic particle fluxes, distribution of water masses and nutrients, distribution and behavior of metal contaminants, application of specific techniques for the speciation of trace elements, the intrusion of alien species and their use as possible bio-indicator of pollution. The use of radon and radium isotopes for estimating submarine groundwater discharge (SGD) and the study of anchialine caves were presented as particular environments with freshwater and seawater mixing.

All these systems present environments in which freshwater and seawater are mixed, causing dramatic changes in physical, chemical and biological properties. Significant differences in hydrology as well as chemical properties between estuaries in the south and in the north of the Mediterranean were clearly exemplified by the Mafragh estuary with periodic offshore bar causing closure of the estuary?s mouth and the permanently highly stratified Krka River estuary. Contrary to these mostly ?pristine? estuaries, untreated discharges to Dil Creek estuary increase the level of inorganic and organic contaminants. Particularity of estuary hydrodynamics is presented by the Alexander River estuary where partial salinization of the adjacent aquifer takes place. Populated, industrialized and touristic regions are prone to threaten the sensitive estuary ecosystems.

Biological responses as well as chemical changes of contaminants occurring within estuarine salinity gradient affected by the anthropogenic pressure were identified as topics of primary research interest. Identification of the specific physico-chemical processes, increase of the sampling frequency as well as number of samples and sites, was highly recommended in order to better understand and to predict the behavior of contaminants. Finally, modeling of contaminants transport and behavior across the salinity gradients was pointed as one of the tasks which would help in predicting their negative effects.

Fouling, status and novelties

Christine Bressy, University of Toulon, France

Résumé

This session focused on (i) the fouling communities which could colonize any substrata immersed in the Mediterranean Sea and (i) antifouling strategies.

The moderator outlined that surfaces immersed in seawater are subjected to biofouling, i.e. the settlement of undesired marine micro- and macroorganisms. This leads to negative economic consequences on marine structures such as vessels, offshore platforms, sensors and fishnets in aquaculture. Ocean-going vessels have been plagued by the deleterious effects of biofouling for centuries. In addition to marine 'bio' risks from non-invasive species transfers, biofouling reduces vessel speed due to a reduction in hydrodynamics and maneuverability, causing increased fuel, gas emissions and maintenance costs.

The design of more environmentally-friendly coatings and the use of non-toxic active molecules extracted from sponges, macroalgae and metabolites of macroalgae as promising antifouling strategies were discussed. Taxa of micro- and macro-organisms which colonize surfaces immersed in Mediterranean Sea were reported and the microbial processes were shown to be spatially and temporally variable.

It was concluded that developing antifouling surfaces presents a major challenge due to the environmental impact on the marine environment. New environmental concerns related to antifouling strategies have been highlighted for marine renewable energy resources including tidal marine turbines, wave energy and ocean thermal energy converters where fouling could degrade performances over time.

Marine litter

François Galgani, France

Résumé

11 presentations/posters were planned for this first session on Marine litter in a CIESM meeting. The presentations covered all fields on the topic, including (i) the processes of degradation of polymers at sea , (ii) assessments of marine litter on beaches, sea floor and deep sea floor from various regions of the Mediterranean sea, (iii) the evaluation of densities of microplastics on beaches and at sea , (iv) methodological developments , including monitoring protocols and new methods, (v) monitoring within the Marine Strategy

Framework Directive and finally (vi) social awareness, reporting about the impact of marine litter, in order to support the reduction of the litte at sea.

The session was followed by more than 50 attendants. It was very active, with a dense and open discussion on the different aspects of the issue, demonstrating the importance of this new topic, especially in CIESM related seas. The presentations and discussion enabled to identify the scientific questions to be

addressed in the future and the specific issues in both the Mediterranean and black seas. Typically, a consistent evaluation of densities , a better understanding of harm and degradation pathways, the importance of circulation in driving the transport of litter and the transborder transportation within the CIESM areas, the occurence of trophic transfer or not, will facilitate the investigations on processes and help to understand why the Mediterranean and Black seas are the most affected basins in the world.

Overall, the session provided a basis for the networking of scientists

from both the Mediterranean and Black seas, the support of further research,

the harmonisation of common projects and the implementation of monitoring.

Mercury in the Mediterranean

Donata Canu, Italy

Résumé

Seven presentations were given in this session, addressing different aspects, such as the state of mercury contamination in its different forms, in different substrates, including biota, at different sites such as local hotspots located in Turkey, Tunisia, Croatia, Italy, Slovenia, and sampling stations in the Adriatic and in the Mediterranean basins. Mercury budgets, isotopes tracking and dynamic model results were also presented.

The open discussion touched general and specific aspects of the biogeochemistry of mercury, highlighting knowledge gaps and open scientific questions. It emerged that -in general- the information regarding transformation rates and processes is still highly uncertain and -in particular those involved in methylation- need to be better evaluated in order to improve the general understanding of the global mercury cycle. Examples of open issues were cited, such as the observed increasing mercury concentration in open sea fishes and un-correlation between mercury concentration in sediment and in the corresponding biota.

More information is needed regarding the environmental variables influencing mercury transformations and speciation, and their synergistic effects, also including the role of the microbial community. The identification of new methylation potential of various microbial taxa could also benefit of recent advances in genomics. It was generally agreed that the integrative analysis of mercury transport and transformation processes should be improved, also considering biogeochemical and physical oceanographic processes, such as DOC complexation or the and dawn-ward transport of mercury during the dense water formation and spreading in the North Adriatic.

The same integration should be viewed as a medium-long term goal of mercury modeling, improving current mercury modelling performances with a full coupling with physical and biogeochemical models. The modeling approaches should be developed and used in parallel with measurements to investigate the effects of changes in given parameters, forcing and inputs, and to evaluate the effects of future natural and anthropogenic changes in environmental variables.

Methods and technics - chemical and toxicological monitoring

David Sánchez Quiles, IMEDEA, Esporles, Spain

Résumé

The Mediterranean Sea is under intense pressure because of the anthropogenic impacts caused by population growth, which inevitable leads to the introduction of organic and inorganic chemicals in the marine environment. In that context, some studies presented during this session focused on human activities proper, such are the dredging of polluted coastal sediments, the effects of a common insecticide as permethrin over the acetylcholinesterase activity in Chelon labrosus, or the use of sunscreens in touristic beaches of the Mediterranean. The other communications, indicated or suggested specific organisms (i.e. protists, ragworms, Paracentrotus lividus, and Pinna nobilis among others) for the monitoring of specific contaminants or for signaling contamination in a given area (i.e. near Rovinj, Croatia).

While monitoring and biomonitoring programs are powerful tools to know the level of pollution in the Mediterranean, there is an urgent need to improve the analytical processes and analytical techniques in order to obtain results of high quality. In that sense, the importance of the Proficiency Test for trace elements, the problematics of an inappropriate pre-treatment of the samples and the need of increase the number of laboratories participating in these tests were highlighted.

Oxygen depletion

Nadira Ait-Ameur, Algérie

Résumé

This session dealt with the problem of oxygen depletion in Mediterranean sea at two scales- the coastal area and the open sea. The Mediterranean Sea is very sensitive to anthropogenic pressure and to Climate change and warming. The dissolved O2 in sea water is important for the viability of the ecosystems. The anthropogenic and river input in the coastal area could lead to eutrophication and hypoxia. In the open sea, the surface warming could induce a stratification which could lead to a decrease in the ventilation of intermediate and deep water, and so deoxygenating.

The coastal areas studied included a presentation on the Black sea (A. Capet), were it is shown, using a biogeochemical model, that climatic stressors intensify the response of hypoxia to nutrient discharge, and affect the seasonal dynamics of hypoxia. For the North Adriatic Sea (T. Djakovac), marked hypoxia has been often observed in bottom layers during autumn. This feature seems to be related to the circulation in the area and not exclusively to eutrophic pressure. In the southwesternMediterranean Sea (Algerian coast, N. Ait-Ameur), the anthropogenic input in phosporus (enrichment from domestic waters and fresh water input) reduces the N/P ratio but the amount in dissolved O2 seems to be above the critical limit of eutrophication. In the bay of Algiers, where the air-sea CO2 exchange is mainly controlled by the fresh water input, the circulation may ventilate the waters.

For the open sea, the time series (D. Lefevre) collected since 2008 at the ANTARES fixed moored site has shown a decrease of 2.5 µM O2 during three years of observation. This depletion is associated to hydrological and biological events at the basin scale. The ensuing debate concerned mainly the lack or paucity of accurate data for dissolved O2 in sea water. The need for time series in open sea in the eastern and southernwestern sectors of the Mediterranean Sea is critical.

The importance of using sensitive and accurate sensors for O2 and the need for calibration with standardized protocols and to intercalibrate the method and protocols were stressed. The problem of O2 depletion in intermediate and deep water in open sea remains. Observation and the implementation of long-term monitoring sites appear necessary to understand this phenomenon. Comparing both basins in terms of the processes affecting the O2 content of intermediate and deep waters, and investigating the impact of climate forcing are also needed. Another question, still open, was raised: the possible link between the downward trend of O2 in the intermediate waters of the Western basin and the EMT (Eastern Mediterranean Transient, deep change in the flow of water in the Eastern basin).

Transitional habitats - biological and chemical process

N/A

Résumé

Modérateur absent

Session

Acidification

Modérateur : **Patrizia Ziveri**

EFFECTS OF OCEAN ACIDIFICATION ON THE PRECIOUS MEDITERRANEAN RED CORAL (CORALLIUM RUBRUM)

L. Bramanti [1]*, J. Movilla [2], E. Calvo [2], A. Gori [2], C. Dominguez-Carrió [2], J. Grinyó [2], A. Lopez-Sanz [2], A. Martinez-Quintana [2], C. Pelejero [3], S. Rossi [4] and P. Ziveri [4]

[1] UPMC LECOB Observatoire Océanologique Banyuls sur Mer - philebo@gmail.com

[2] ICM CSIC, Barcelona

[3] ICREA, Barcelona

[4] ICTA-UAB, Barcelona

Abstract

Corallium rubrum is an octocoral endemic to the Mediterranean Sea. Slow growing and long living, it has been harvested since ancient times determining overexploitation due to the high economic value of axial skeleton. Moreover the Mg rich calcite skeleton make it vulnerable to ocean acidification. To understand the effects of elevated pCO_2, colonies of *C. rubrum* were maintained for 314 days in aquarium tanks at 2 pH levels (8,16 and 7,84). Buoyant weight, biochemical balance (protein, carbohydrates and lipids) and spicules morphology were measured. Buoyant weight increment was significantly different between controls and acidified treatment. Aberrant spicule shapes were observed only in acidified treatments. Total organic matter was higher in acidified treatments while no difference was found in carbohydrates, lipids and proteins contents

Keywords: Global change, Conservation, Mediterranean Ridge, Cnidaria, Ph

Introduction: Mediterranean Sea is is considered one of the world's most sensitive regions to Ocean Acidification (OA) [1]. OA is a threat for calcifying organisms and can also have regional socio-economic effects related with the reduction in the harvest of high commercial interest species [2]. Red coral, *Corallium rubrum* is a long-lived, slow-growing gorgonian endemic to the Mediterranean Sea, where it dwells between 10 and 600 m depth. The high economic value of the skeleton used for jewelry, determined overexploitation [3]. The axial skeleton and the sclerites, coated with living tissue, are both composed of Mg-rich calcite [4] which solubility is greater than that of aragonite or calcite [5], moreover the seawater saturation state with respect to carbonate minerals decreases with increasing latitude [6]. Thus *C. rubrum* is expected to be highly susceptible to OA. We evaluated the effects of OA on $CaCO_3$ deposition, sclerites morphology and biochemical balance.

Methods. 48 colonies of *C. rubrum* (from 40 m depth) were distributed among 6 aquaria, further subdivided into 2 treatments (3 replicates): control (~8.10) and low pH (~7.81), simulating, respectively, seawater in equilibrium with ~380 and ~800 ppm CO_2 (current and projected levels for year 2100). Seawater pH was adjusted by bubbling CO_2 and monitored by glass electrodes connected to a pH controller. Additionally, total alkalinity was analyzed by potentiometric titration and pH using spectrophotometry. Buoyant weight, sclerites morphology, organic matter (OM) content and biochemical balance were measured quarterly during 314 days (Time 0 to Time 3). At the end of the experiment, specific microdensity and porosity were estimated on 6 colonies (1 from each aquarium). Sclerites (photographed at SEM) were categorized in 3 morphological types (I, II and aberrant) and the ratio area/perimeter, width/height and circularity were calculated and analysied by PERMANOVA. OM content was determined as the difference between dry and ash weight. Total carbohydrates, protein and lipid content were quantified colorimetrically and results analysed by ANOVA.

Results and discussion. No significant differences were observed, neither in microdensity nor on porosity, indicating that the structural material composition of skeleton was not affected by treatment. Calcification rates in low pH treatment was significantly lower (59%) with respect to control, confirming the expected detrimental effect on skeletal formation. Sclerites morphology was significantly different at Time 3, and aberrant shapes were detected only in low pH treatments. According to [7] the main function of sclerites is the mechanical protection, although [4] suggested a role in $CaCO_3$ temporary stocks. Therefore, in the long term, OA should affect *C. rubrum* compromising the $CaCO_3$ stocking capacity and skeleton biomechanical properties. OM content was significantly higher in the low pH treatment with stable values through time while changed in control treatments from T0 to T3. According to [8] metabolism is affected under low pH conditions and the energetic cost of calcification is higher. Therefore we hypothesize that *C. rubrum* respond to low pH by increasing the formation of OM, consequently decreasing calcification rates. Total protein, carbohydrate and lipid content were not different between treatments but the Coefficient of Variation (CV) was lower in low pH treatments indicating a more dimmed seasonal trend, probably due to endogenous processes or dormancy activated to save energy. A decrease in calcification rate together with a metabolic depression could have negative rebounds on the economy of the jewellery industry linked to this species leading to a price deflation. Furthermore some populations may suffer local extirpation due to the combined effects of climate and athropogenic threats. Projections of population structure under OA scenarios based on our results can be used to give advices for management and conservation [9] to preserve *C.rubrum* with the associated biodiersity and the economy linked to its exploitation.

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CARBONATE SYSTEM AND ACIDIFICATION IN THE MEDITERRANEAN SEA: VARIABILITY, IMPACTS OF PHYSICAL AND BIOLOGICAL PROCESSES AND VALUATION OF CARBON SEQUESTRATION

G. Cossarini [1]*, D. Melaku Canu [1], A. Ghermandi [2], P. A. Nunes [3], C. Solidoro [1] and P. Lazzari [1]
[1] OGS - Ist. Naz. di Oceanografia e di Geofisica Sp. - gcossarini@ogs.trieste.it
[2] University of Haifa
[3] Marine Economics Research Program, CIESM; WAVES - Word Bank

Abstract
We evaluated the biogeochemical impact of planktonic related processes on the space-time distribution carbonate system variables (e.g. alkalinity, pH, air-sea CO2 fluxes) in the Mediterranean Sea and related economic implications by using a validated 3D coupled transport-biogeochemical model (OPATM-BFM). Simulations provided a reconstruction of the state and variability of contemporary carbonate system and an assessment of the relative impacts of the biogeochemical processes on the carbonate system dynamic and on the sea-air CO2 fluxes. Basing on these data a microeconomic valuation of the economic impacts of changes in marine carbon sequestration was then performed.

Keywords: Air-sea interactions, Economic valuation, Ecosystem services, Geochemical cycles, North-Western Mediterranean

The Mediterranean Sea shows alkalinity and dissolved inorganic carbon concentrations much higher than those observed in the Atlantic Ocean at the same latitude and strong spatial gradients [1]. Estimating the scale of variability of carbonate system and the processes involved may help in understanding the amplitude of the acidification processes due to atmospheric carbon sequestration and its possible evolution. In this work we use a validated biogeochemical model in order to estimate the scale of spatial-temporal variability of the carbonate system properties and to estimate the impact of physical and biological processes involved. The physical-biogeochemical model OPATM-BFM [2] has been coupled with the OCMIP2 carbonate system model and initial condition and boundaries conditions have been estimated from existing dataset. The reference simulation covers the contemporary conditions (1998-2005) forced by ECMWF fields and an atmospheric pCO2 ranging from 360 to 380 ppm. Results of the simulation show that a spatial gradient from the Gibaltrar strait to the marginal seas (Aegean and Adriatic seas) of DIC and Alkalinity is a permanent structure along the water column (Fig. 1) although it is less marked in the intermediate and deep layers. Vertical profiles are generally characterized by lower values at surface, a sharp increase between surface and 200 meters and almost stationary values below 500 meters. At surface, alkalinity dynamics are driven by the terrestrial input, mainly located in the eastern marginal seas and the basin wide surface circulation, dominated by the intrusion toward east of the surface atlantic water and the two thermoaline cells of the western and eastern sub-basin.

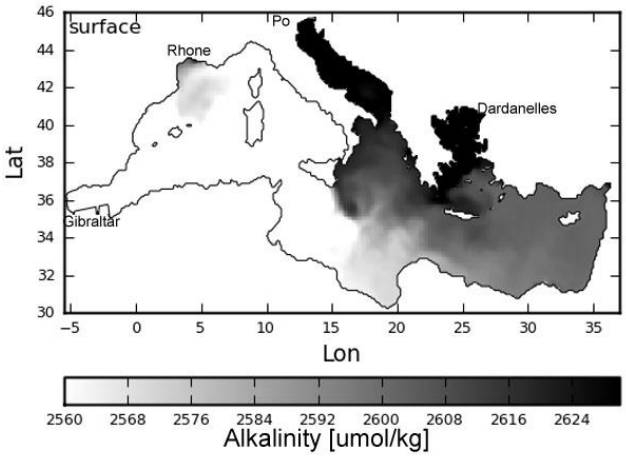

Fig. 1. Alkalinity distribution in the surface layer of the Mediterannean Sea.

The results show that primary producers affect the carbonate system by fixing CO2 into organic carbon that eventually sinks under the mixed layer as particulate organic matter. Organic carbon is then respired within the deep layers, contributing to carbon oversaturation especially in the western Mediterranean sub-regions. The carbon pumps combined with the inverse estuarine Mediterranean circulation results in a net carbon export toward the Atlantic sea of about 45TgC per year. This net carbon loss is compensated by the sinking of atmospheric CO2 through the water-air exchange (20TgC per year) and by the input from rivers (25TgC per year). Further, primary production processes, such as nutrient uptake, alter the alkalinity at surface and consequently the carbonate system equilibrium by increasing the solubility of CO2 and the sinking of atmospheric CO2. Results of the numerical simulation show that the most productive areas such as mixing and coastal areas (i.e. the Gulf of Lion, the Adriatic Sea and the Alboran Sea) present the highest seasonal variations of alkalinity (up to more than 20 mmol/kg) and the highest rate of atmospheric CO2 sequestration. Additional simulations were then run aiming at evaluating the impacts of the biogeochemical processes on CO2 sequestration.

Monetizing the loss of the environmental service, in this specific case under sea acidification scenarios, can be performed applying different economic theories and valuation methodologies. Notwithstanding the ample variability, the assessment literature can be grouped into two large streams: "partial equilibrium" and "general equilibrium" methodologies. Both are widely applied in the area of climate-change economics. Partial equilibrium analysis is based upon appropriate microeconomic-econometric valuation techniques, including market-based economic valuation tools (e.g., market price, direct-costing analysis) as well as non-market valuation tools (such as contingent valuation method, travel cost method, meta-analysis and value transfer). Its main characteristic is to quantify a damage without considering the potential feedback and rebound that this damage can trigger onto the macroeconomic context. The micro-economic element of the study relies on the use of market-based, unitary values for carbon, which are multiplied by the carbon flux estimates resulting from the biogeochemical model to obtain a spatially explicit estimate of the yearly flow of values. In other terms, the air-sea CO_2 exchanges are regarded as additional, spatially distributed, sources (or sinks) of CO_2 for the atmosphere, which therefore translate into a social cost (or benefit). In order to value the carbon sequestration services in the Mediterranean Sea in monetary terms and reflect the uncertainties in the damages caused by different degrees of climate change, we consider in this study a range of estimates of the Social Costs of Carbon, and a set of simulation scenarios aimed at varying the biogeochemical properties of the Mediterranean Sea system, in order to take into account the socio-economic and the natural variability, also in response to future climate changes impacts.

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PHOTOTROPHIC AND HETEROTROPHIC BENTHIC COMMUNITIES IN A SHALLOW CO_2-DOMINATED HYDROTHERMAL VENT (PANAREA ISLAND, TYRRHENIAN SEA)

A. Franzo [1]*, T. Cibic [1], S. Beaubien [2], S. Graziani [2], P. Del Negro [1] and C. De Vittor [1]
[1] Oceanography Section OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) - afranzo@ogs.trieste.it
[2] Department of Earth Sciences, University of Rome La Sapienza

Abstract
To assess the ability of communities to adapt following prolonged exposure to locally elevated CO_2 and temperature levels, phototrophic and heterotrophic benthic communities were analysed at the natural seepage site of Panarea Island. Preliminary results highlight that microalgal proliferation seems to be stimulated by gas emissions and warm temperatures as shown by the elevated abundances and the high primary production rate. In contrast, the low densities of meiofauna suggest that this community could be less tolerant to higher CO_2 concentration and temperature.

Keywords: Tyrrhenian Sea, Diatoms, Hydrothermal vents, Copepoda

Introduction
Carbon capture and storage (CCS) is considered as a valid option to 'permanently' store carbon dioxide (CO_2) from large anthropogenic point sources, providing a short-term approach for mitigating potential global climate change due to anthropogenic CO_2 emissions. Nevertheless, several concerns exist regarding the long term safety of sub-seabed CO_2 storage, including the potential impact of CO_2 leakage on the biota. In marine environments the potential leakage could cause local high concentrations of CO_2 and consequently a pH decrease, with possible significant impact on marine organisms. Although laboratory experiments can be performed [1], the study of natural analogue systems likely provides a more complete (and realistic) understanding of the potential hazard associated to CO_2 leakage from CCS. In the framework of the "Sub-seabed CO_2 Storage: Impact of Marine Ecosystems" (ECO2) project (EU project FP7 n. 265847), OGS and the University of Rome "La Sapienza" performed two field campaigns near the island of Panarea (Aeolian Islands, Italy) in June and October 2012. The site is characterised by natural, thermo-magmatic CO_2 leakage from the seafloor at water depths ranging from 5 to 30 m. Early surveys showed that the system is relatively stable in both gas chemistry (i.e. 98% CO_2, 1.7% H_2S plus other trace gases) and flux rates (7-9 x 10^6 L/d) [2]. Although from most release points only gas leaks, various points also release water of different origin, ranging from geothermal to seawater end-members that are mixed to variable degrees [3]. On the bases of these peculiarities, Panarea represents an exceptional location to study natural processes and impacts related to shallow seabed CO_2 leakage. Both structural and functional parameters have been considered and integrated following a holistic approach directed to the study of the overall benthic ecosystem functioning.

Materials and Methods
During both campaigns, sediments were sampled at two points at a shallow site to the NE of Panarea Island: one characterised by the emission of hot water from the coarse sand and one, located 1 m away, where sediments were characterised by *in situ* temperatures (St. Hot-Cold). Two benthic chamber experiments were performed at both points to measure the flux of dissolved CO_2, heat and the main carbonate system parameters from the sediments to the overlying water. Temperature and pCO_2 were measured *in continuum* using a probe while the water for the other parameters was sampled thrice (once every 10 minutes). Sediment samples were collected for the analyses of abiotic parameters (sediment grain-size, Total Organic Carbon, Biopolymeric Carbon) and benthic communities (microphytobenthos and meiofauna). Along with the biological and chemical structural characterisation during both campaigns, in October 2012 some preliminary estimates of functional parameters, i.e. Primary Production and Prokaryotic C Production (PCP), were also carried out at this site.

Results
During the benthic chamber experiments the hot part of St. HC was characterised by a gradual increase of both temperature and CO_2 concentration while the cold counterpart did not show any evident variation for these parameters. The microphytobenthic assemblage in the hot gas/fluid emission site was more abundant particularly in June 2012, when the densities were two orders of magnitude higher than in the cold sediments nearby. Pennate diatoms belonging to the family Naviculaceae dominated the microalgal community in both periods. The species *Navicula* cfr. *cancellata* alone exceeded 30% of the total abundance, whereas in the nearby cold site its density was negligible. Primary production rates which strongly depend upon the microphytobenthic abundances were six times higher in the hot site (42.88 ± 5.75 mg C m^{-2} h^{-1}) than in the cold one (7.16 ± 0.13 mg C m^{-2} h^{-1}). During both campaigns, meiofaunal abundances in the cold part of St. HC were higher than those within the sediments exposed to high temperatures, characterised by the almost absence of organisms. From a qualitative point of view, the community of the cold part of St. HC was dominated by Copepoda, followed by Nematoda and Ostracoda. In October 2012, lipids were the dominant fraction of the biopolymeric carbon pool, followed by proteins while carbohydrates were negligible. Both lipid and protein contents were 2-fold higher in hot sediments than in cold ones.

Discussion
Preliminary results highlight that benthic communities at different trophic levels could respond differently to gas emission and warm temperatures. The elevated abundances of microalgae inhabiting the hot sediments suggest that higher CO_2 concentration and temperatures could exert a stimulatory effect on this community which seems also active as shown by the elevated primary production rates. The organic enrichment observed in the sediments, particularly in terms of proteins and lipids, could be ascribable to the proliferation of microalgae. On the contrary the meiofaunal contribution was an unimportant source of carbon due to extremely low densities. These organisms in fact showed a limited tolerance to increased CO_2 concentration and temperatures. The integration of these results with others, particularly those related to benthic prokaryotes, is expected to shed more light on the benthic ecosystem functioning in this natural analogue system.

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SOME EVIDENCES OF ACIDIFICATION IN THE MEDITERRANEAN SEA

Paul Geri [1]*, Franck Touratier [1] and Catherine Goyet [1]
[1] Institut de Modélisation et Analyse en Géo-Environnement et Santé (IMAGES) University of Perpignan, Laboratoire IMAGES EA 4218 52, Avenue Paul Alduy. F-66860 Perpignan cedex, France - paul.geri@univ-perp.fr

Abstract
The Mediterranean Sea is one of the most impacted ecosystems by anthropogenic pressure. Several published papers have shown that all Mediterranean waters (from surface to the bottom) are already contaminated by significant concentrations of anthropogenic CO2. The accumulation of anthropogenic CO2 contributes for a large percentage of the pH decrease in seawater (phenomenon of acidification). However, since anthropogenic CO2 cannot be measured at sea, this property is estimated using various models. Since uncertainties still exist on the concentration of anthropogenic CO2, it is difficult to precisely estimate the level of acidification. In the present poster, another approach is proposed to assess the level of acidification. It consists in the reconstruction of times-series using data from the 2002 Medar/Medalas and Dyfamed databases.

Keywords: Surface waters, Ph, Ligurian Sea

The ocean acidification is under interest by the scientific community for his effects on our environment. This study presents an approach to asses the level of acidification in the Mediterranean Sea. Results highligth the importance of the phenomenom is this sea.

pH evolution
The ocean acidification is under interest by the scientific community for his effects on our environment. According to several studies around the world, acidification of seawater has increased since the beginning of the industrial era. For instance, pH measured at the times-series stations during several decades, and located in the Pacific Ocean (station HOT) and in the Atlantic Ocean (station BATS) indicate significant pH decreases of -0.0019 ± 0.0002 yr-1 (Dore et al., 2009) and -0.0017 ± 0.001 yr-1 (Bates, 2007), respectively.

Medar/Medalas database (82-92)
For the present study, we focus on pH data within the surface layer (0-10m) located in the area close to the Mediterranean Dyfamed site. Figure 1 shows the map (using the Ocean Data View software) with the localization of the measurement spots. Figure 2 draws the corresponding pH according to the period of time (from 1982 to 1992), with the linear regression on this period.

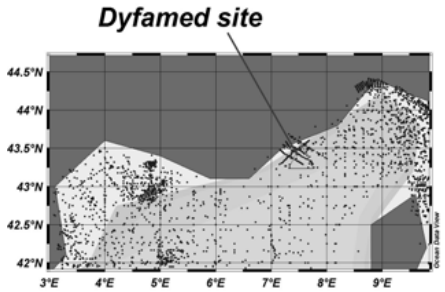

Fig. 1. Localizations of the data sites used in the estimation
The figure presents pH measurements in the surface water around the Ligurian Sea. The Linear regression shows a decrease of 0.009 pH unit per year (6599 points considered).

Dyfamed database (95-2011)
The Dyfamed site is located in the North Mediterranean Sea (see Figure 1). The location is part of the previous map to allow us to compare or complete the observations. A study made using the Dyfamed database (Yao, submitted to Ocean Acidification) to rebuild pH time-series from 1995 to 2011 has underlined an average decrease of -0.003 pH units.yr-1. The evolution is calculated from total dissolved inorganic carbon, total alkalinity, temperature, salinity and some incomplete pH data. The results are indeed more accurate than the previous one thanks to the precision of the values.

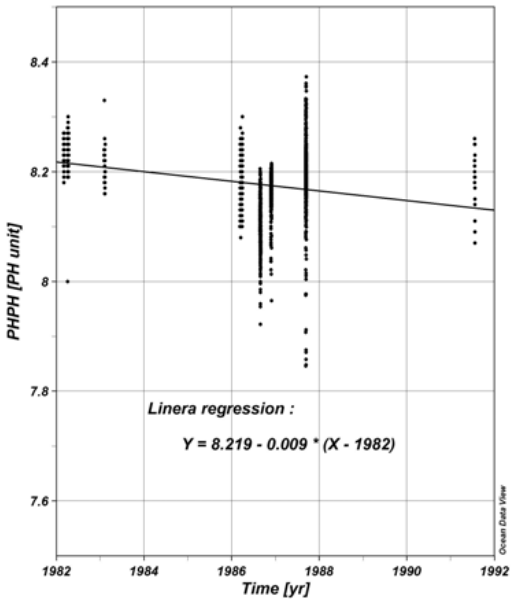

Fig. 2. Medar/Medalas pH data and linear regression from 1982 to 1992

Conclusion
Observations between Medar/Medalas and Dyfamed databases present an important difference, from -0.009yr-1 to -0.003 yr-1. These results show that this decrease is much higher than those observed in other oceanic region. It clearly strengthens the need to develop projects to study the impact of acidification in the Mediterranean Sea.

Acknowledgment
The research leading to these results has received funding from the European Commu-nity's Seventh Framework program under grant agreement 265103 (Project Med-SeA).

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THE EFFECT OF OCEAN ACIDIFICATION ON BACTERIAL AND VIRAL COMMUNITIES: A MICROCOSM APPROACH

A. Giannakourou [1]*, E. Strogyloudi [1], A. Konstadinopoulou [1], P. Pitta [2], A. Tsiola [2], C. Zeri [1], A. Gogou [1], E. Pitta [1], K. Parinos [1], L. Giannoudi [1] and E. Krasakopoulou [1]

[1] Hellenic Centre for Marine Research , 46,7 km Athens Sounio Ave P.O. Box 712, 19013, Anavyssos Attiki, Greece - agiannak@hcmr.gr

[2] Hellenic Centre for Marine Research, Former American Base of Gournes P.O. Box 2214, 71003 Heraklion, Crete, Greece

Abstract

Microbial processes can be affected either directly or indirectly through changes in seawater pH. The results presented here are part of the MedSea project -Mediterranean Sea Acidification in a changing climate-obtained through laboratory microcosm experiments. The main aim was to describe the effect of acidification on bacterial and virus communities as well as on microbial metabolism. Natural bacterial populations exhibited increased production under more acidic conditions and changes on the reaction velocity of extracellular enzymes could affect the processing of organic matter in the sea.

Keywords: Bacteria, Enzymes, Organic matter, Aegean Sea

Bacterial communities play an important role in organic matter cycling and the carbon balance in the future ocean [1]. The oceanic uptake of CO_2 emissions leads to an alteration of seawater carbonate chemistry, manifested as a drop in seawater pH. This process, called "ocean acidification" have direct and indirect effects on the growth and physiological processes of a range of marine organisms [2]. Little is known about the response of marine microbes to increasing pCO2 [3].

The effect of lowered seawater pH was investigated during a microcosm experiment, on bacterial and viral communities as well as on microbial metabolism in natural bacterioplankton communities. Our study included a laboratory 10-day incubation experiment, with natural 0.8μm filtered seawater, under past -8.13, present-day -8.04 and predicted for the year 2100-7.83 pH conditions.

Bacterial production was remarkably enhanced after the start of the experiment (up to 342 $ngCl^{-1}h^{-1}$) under the more acidic conditions.

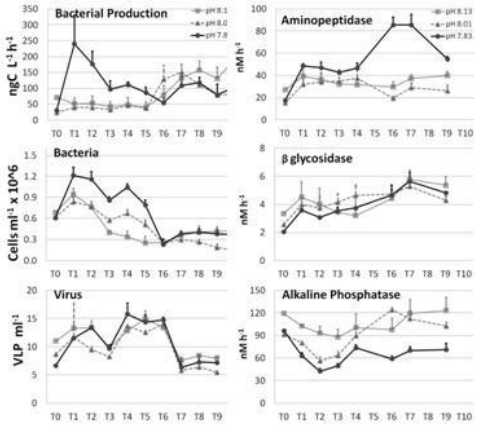

Fig. 1. Changes in bacterial production, bacterial / virus abundance, and enzymatic activities during the experimental period. Error bars correspond to standard deviation.

Values were progressively decreased similar or lower, compared to the past and present-day pH treatments. The same trend was observed for bacterial abundance that reached quickly high values (up to $1.34x10^6$ cells ml^{-1}) under the acidified conditions. Viral abundance was not significantly different among treatments (varied from $6.67x10^6$ - $1.88x10^7$virus ml^{-1}) (Fig.1) In agreement with bacterial production data, increased dissolved organic carbon (DOC) concentration was observed in low pH microcosms, possibly due to increased exudation of photosynthetic cyanobacteria. Dissolved monosaccharide (MCHO) concentration decreased with time in experimental bottles, showing no influence from the different pH concentration. On the contrary dissolved polysaccharide (PCHO) rose as the pH value lowered, with two peaks on day 1 and 4, acting also as precursors for the abiotic formation of transparent exopolymer particles (TEP), rich in acidic polysaccharides. TEP-C formation peaked on days 3-4 (Fig.2).

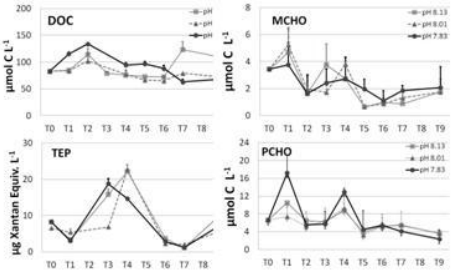

Fig. 2. Dissolved organic carbon (DOC) , monosaccharide (MCHO), polysaccharide (PCHO) concentration and Transparent Exopolymer Particles (TEP) during the experimental period. Error bars correspond to standard deviation.

β-glycosidase specialised in the degradation of polysaccharides showed no significant variation in activity among different pH's and an increasing trend towards the end of the experiment. For alkaline phosphatase lowered activity was recorded in acidified environments, translated to a potential inhibition of phosphate turnover whereas leucine aminopeptidase (protease) activity which degrades polypeptides was enhanced under lower pH conditions (Fig.1).

The ongoing pH decline has the potential to cause changes at the bottom of the food web and consequent shifts in plankton community composition and food web functioning. The impact of ocean acidification on the reaction velocity of extracellular enzymes could affect the processing of organic matter. An increase in bacterial concentration could increase the transfer of carbon between bacteria and protists, alter the community composition of microbial top predators and give an advantage to the heterotrophic food web.

Acknowledgements This work was supported by FP7 Program MedSea 'Mediterranean Sea Acidification in a changing climate'.

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PHYSICAL AND BIOLOGICAL INFLUENCES ON THE VARIABILITY OF PH AND CARBONATE SYSTEM IN THE GULF OF TRIESTE (NORTHERN ADRIATIC SEA)

G. Ingrosso [1]*, M. Giani [1], M. Celussi [1], T. Cibic [1], C. Comici [1], P. Del Negro [1], C. De Vittor [1], C. Fabbro [1], A. Karuza [1] and M. Kralj [1]

[1] Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste, Italy - gingrosso@inogs.it

Abstract

A 2 years surveys showed that the variations of pH and of the carbonates system in a coastal area of the northern Adriatic sea resulted mainly affected by the seasonal thermal cycle, by the inputs of carbonates from riverine waters of karstic origin and from degradation processes taking place below the main pycnocline in the warm season. The CO_2 air – sea exchanges showed that the gulf was a sink during cold months and a source during the warm period.

Keywords: Ph, Carbon, North Adriatic Sea, Coastal processes

The effects of acidification, caused by the uptake of anthropogenic CO_2 from atmosphere, can be additional to those produced by natural biological processes such as respiration and organic matter degradation [1]. The Gulf of Trieste, which lies in the northernmost part of the Adriatic (Fig. 1), is a region of freshwater influence under the inflow of the eastern Adriatic Current. Seasonal variations of the carbonate system and of the seawater biogeochemistry, were investigated in the framework of MEDSEA (Mediterranean Sea Acidification in a changing climate) FP7 Project, for 2 years along a transect (Z1-Z4 stations) from the Isonzo River mouth to the centre of the Gulf, on a 2-months sampling frequency, and monthly at coastal site (C1-LTER site, Fig.1).

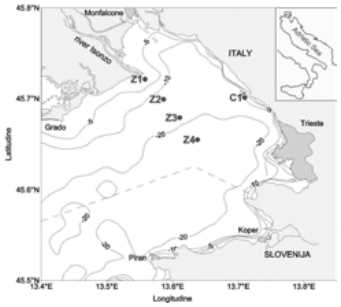

Fig. 1. Sampling sites in the gulf of Trieste (Northern Adriatic Sea).

Total alkalinity (A_T) was measured by open cell potentiometric titration [2]. The titration has been carried out in a cell thermostated at 25 °C. Dissolved Inorganic Carbon (DIC) and the partial pressure of CO_2 (pCO_2) have been calculated by CO2SYS program [3]. Certified reference materials (CRM Batch 107 supplied by University of California, San Diego USA) for DIC were used to check the accuracy of the results. pH ($pH_{T)}$ was measured by m-cresol violet colorimetric method iby a double beam spectrophotometer with cell thermostated at 25 °C [4]. Prokaryotic Carbon Production (PCP) was measured by the incorporation of ^{3}H-Leucine [5]. Seawater temperature ranged from 2.88 to 26.98 °C whereas the salinity variations were comprised between 27.04 and 38.50. The A_T varied from 2663 to 2933 µmol kg^{-1} and was inversely correlated with salinity ($p<0.0001$) due to the inputs of local rivers with karstic watersheds. The contribute of riverine inputs to the increase of A_T and DIC resulted particularly evident in surface waters. The annual pH_T variations ranged from 7.878 to 8.259. Strong seasonal variations of pCO_2 occurred in the water column due to the thermal effect, to primary productivity and to the degradative processes. The thermal effect was predominant, the biological drawdown of CO_2 occurred mainly from March to July and was more relevant in the waters above the pycnocline. From August to September in the oxygen depleted bottom waters, the remineralization processes prevailed increasing the pCO_2 and nutrients and, notwithstanding the lowering of pH, the waters remained always oversaturated in carbonates with respect to the more soluble biogenic carbonate form (i.e. aragonite). The seasonal thermal effect resulted the main driver of variations in the carbonates system, whereas the not-thermal effects prevailed in the bottom water during late summer where the respiration processes consume O_2, regenerate nutrients and increase CO_2. The air-sea CO_2 exchanges showed a marked sink during the winter dense water formation which can act as a physical pump transporting the CO_2 towards the southern Adriatic sea and the Eastern Mediterranean Deep Waters. The winter CO_2 atmosphere-seawater invasion determined an increase of dissolved inorganic carbon (DIC) which gradually decreased with warming (Fig. 2). The strong seasonal thermal increase (ΔT up to 22.4 °C) shifted the carbonate equilibria towards the dissociate species with the effect of lowering the pH. On this process superimposed the CO_2 produced by degradation processes, particularly evident in bottom water during late summer-autumn. This resulted supported by a negative linear correlation ($p<0.001$) between pH_T in situ and secondary carbon production (PCP). The PCP maxima occurred in late summer whereas the pH_T minima were temporally delayed. The seasonal changes of this shallow semi-enclosed sub-basin showed a strong temporal and spatial dynamics of the carbonate system due to the complex coupling of circulation patterns, heat exchanges, riverine inputs and biological processes.

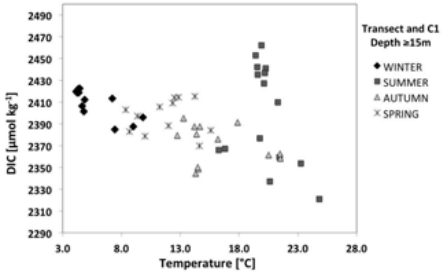

Fig. 2. Variations of dissolved inorganic carbon (DIC) as a function of seawater temperature.

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TOWARD THE ASSESSMENT OF MEDITERRANEAN SEA CARBONATE SYSTEM CLIMATOLOGIES

Tomas Lovato [1]*, Marcello Vichi [1], William J. McKiver [1] and Patrizia Ziveri [2]
[1] CMCC - Centro Euro-Mediterraneo sui Cambiamenti Climatici, I-40127 Bologna - tomas.lovato@cmcc.it
[2] Institute of Environmental Science and Technology, Universitat Autònoma de Barcelona, E-01893 Barcelona

Abstract
A monthly climatological dataset is proposed to model the seawater carbonate system in the Mediterranean Sea. We exploit gridded objective analysis of hydrochemical parameters and literature-based empirical relationships to estimate total alkalinity and total dissolved inorganic carbon. The comparison of the reconstructed fields with the experimental data of two oceanographic cruises highlighted the consistency of the total alkalinity field, while the estimate of total carbon was more uncertain.

Keywords: Carbon, Pelagic, South-Central Mediterranean

The Mediterranean Sea is characterized by high values of alkalinity [1], which are likely to contrast the impacts of anthropogenic acidification on the carbonate system. Nevertheless, the scarcity of long-term basin-scale observations and the lack of knowledge of the response of Mediterranean key species have increased concern on the vulnerability of this system to acidification. The EU FP7 project MedSeA (www.medsea-project.eu) has been conceived to investigate this vulnerability by combining new observations of the carbonate system and numerical models that will allow analyses of acidification at the basin scale.

The historical observations of the carbonate system are sufficient to describe the east-west distribution for total alkalinity (TA) and total dissolved inorganic carbon (TC), and to provide the first estimates of the concentration of anthropogenic CO_2 [2]. The available experimental datasets are however confined to very short time windows and are not evenly distributed across the basin. These limitations become a critical issue when dealing with numerical models, as they require spatially continuous data for initialization and validation.

As a mandatory first step to the modelling of the carbonate system in the Mediterranean Sea, a monthly climatology has been developed. The reconstruction of TA and TC fields was achieved through the application of empirically estimated relationships available in the literature [see 1,2,3], which make use of temperature, salinity and dissolved oxygen as input data. The backbone of the carbonate system data climatology is composed of the objectively analysed monthly climatologies of ocean hydrochemical parameters from the SeaDataNet project (www.seadatanet.org). These gridded products cover the period 1985-2007, with a horizontal resolution of 1/8 of degree and 33 vertical levels.

A comparison with the experimental data collected in the METEOR51 (October-November 2001) and METEOR82 (April 2011) trans-Mediterranean cruises was carried out to assess the skills of the reconstructed carbonate system fields. Data were extracted from the corresponding monthly fields by interpolating the values at the same depth of each sample for the nearest grid point to the considered sampling station. Only data below a threshold depth of 400 m were used, according to literature findings on the reliability of the empirical relationships [1,2].

The Mean Absolute Error (MAE) and the standard deviation of absolute errors (SD) were computed for each reconstructed field and the two oceanographic cruises. The following relationships lead to the smallest differences with the experimental data: $TA=76.631*S - 369.51$ [3] and $TC=3915.55 + 4.30*\theta - 0.33*AOU - 43.54*S$ [2]. In particular, a good agreement was obtained with the METEOR51 data (TA: MAE=6.01, SD=4.30 µmol/kg; TC: MAE=18.85, SD=6.02 µmol/kg), while the statistics indicated larger differences for the METEOR82 cruise (TA: MAE= 13.55, SD=8.09 µmol/kg; TC: MAE= 44.83, SD=57.07 µmol/kg).

The reconstructed TA (Fig.1) compared well with the data thus indicating the robustness of the adopted formulation. Conversely, the empirical relation used to estimate the TC (not shown) was in a better agreement with the METEOR51 cruise rather than METEOR82. This was clearly related to the use of the data from the first cruise to estimate the coefficients of the multiple linear regression. Nonetheless, the large discrepancy in the MAE of the TC can also be attributed to the accumulation of anthropogenic CO_2 within the Mediterranean Sea, as the two cruises were made ten years apart. Further non-parametric statistics were also applied to extend the skill assessment and provide a broad picture of the differences within the different sub-basins.

This preliminary analysis of the reconstructed carbonate system monthly climatology showed that the TA can be reliably derived from the salinity data and it can be used to initialize predictive biogeochemical models, while the determination of the TC from other hydrochemical parameters is affected by larger uncertainties.

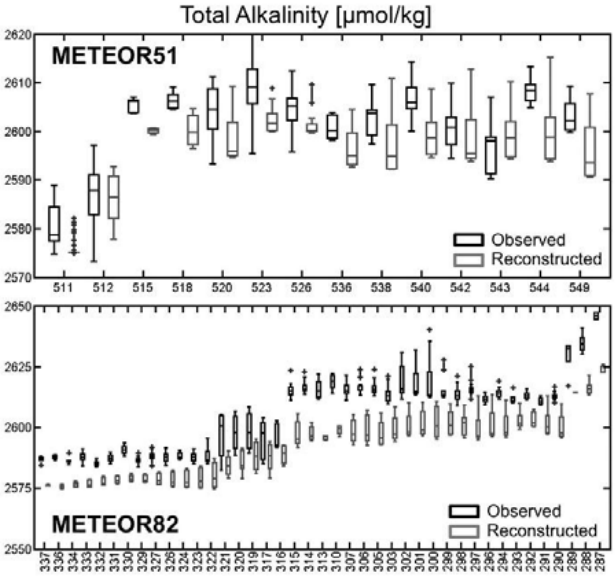

Fig. 1. Comparison of the total alkalinity (µmol/kg) between the experimental data of the METEOR51 (top) and METEOR82 (bottom) cruises and the reconstructed fields for the months of October and April, respectively. Data for each sampling location (east-west going from left to right) is described by means of box-whiskers and outliers are indicated by the cross symbol.

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AIR – SEA CO_2 FLUXES IN THE ADRIATIC SEA: TWO SEASONAL SNAPSHOTS IN FEBRUARY AND OCTOBER 2008

Carolina Cantoni [1], Stefania Sparnocchia [1] and Anna Luchetta [1]*
[1] CNR - Istituto di Scienze Marine Italy - anna.luchetta@ts.ismar.cnr.it

Abstract
We present the air-sea CO_2 fluxes in the Adriatic Sea calculated from shipboard pH_T and alkalinity measurements, under two contrasting seasonal conditions. During February 2008 the whole basin was undersaturated with respect to the atmosphere and acted as a CO_2 sink, with higher fluxes on the Northern Adriatic shelf, where dense water formation was occurring. In October 2008, under late summer stratified conditions, the North Adriatic was still a CO_2 sink, with weaker fluxes, while the central South Adriatic was acting as a weak CO_2 source.

Keywords: North Adriatic Sea, Air-sea interactions, Carbon, South Adriatic Sea

Inorganic carbon cycle and air - sea CO_2 exchange in the Mediterranean basin have received, in the past, little attention by the oceanographic community. In the last years some studies have started to fill this gap [1, 2, 3, 4] and they put in evidence that the signal of anthropogenic CO_2 has already reached the interior of the basin. The Mediterranean is hence emerging as one of the basins more impacted by acidification process and where a faster carbonate ion concentration decrease is likely expected in response to anthropogenic CO_2 invasion.

Within this framework, all authors underpin the potential role of the dense waters formed in the Adriatic sea (NAdDW and ADW) as preferred pathways for transferring atmospheric CO_2 into Mediterranean deep layers, but the air-sea CO_2 fluxes available are limited to two fixed stations in the northernmost part (the Gulf of Trieste) [5,6].

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 Italian VECTOR projects and presents the first air-sea CO_2 fluxes data (FCO_2), at sub-basin scale, both for North and the South Adriatic sea.

The fluxes were calculated from the sea – air gradient of fCO_2 across the sea – air interface ($DfCO_2 = fCO_{2SW} - fCO_{2atm}$) according to Wanninkhof, (1992); fluxes towards the sea are denoted with a negative sign.

Sea surface fCO_2 values have been calculated from experimental determinations of pH_T (SD ± 0.002) and total alkalinity (SD ± 2 µmol/kg) using the CO2SYS program; the accuracy of both parameters was assessed by measurements of certified reference materials. Wind field at 10 m and mean sea level pressure were derived from the atmospheric model COSMO-I7 (courtesy of ARPA – SIMC Emilia Romagna). Atmospheric fCO_2 values were calculated from XCO_2 concentrations measured during the February 2008 cruise, SST and SSS from cruise CTD data and pressure derived from model.

During the winter season, cooling and evaporation trigged mixing leading to dense water formation over the northern shelf (sigma-t > 29.3 kg m^{-3}), and deep convection in the Southern Adriatic (SA). Under these conditions all the Northern Adriatic shelf (NAs) was strongly undersaturated in CO_2 (avg $DfCO_2$ = -92 µatm). During the cruise bad weather conditions prevailed and average daily wind speeds recorded were up to 10.3 ms^{-1}. Air-sea CO_2 fluxes reached values up – 23 mmol m^{-2} d^{-1}, in the middle of the basin, off the Po delta (Fig 1) with an average value of -8.3 mmol m^{-2} d^{-1} over the whole shelf (depth< 80 m).

In this period the convection reached 700 – 800 meter depth in the SA allowing mixing and outcropping of older LIW water masses enriched in CO_2; nevertheless the area remained undersaturated with respect to the overlying marine air (avg $DfCO_2$ = -33.9). The lower undersaturation and the absence of strong wind events sustained lower CO_2 fluxes (avg FCO_2 = -1.9 mmol m^{-2} d^{-1}) and during February 2008 the SA acted as a moderate CO_2 sink.

In October 2008 the water column presented a marked thermal stratification with production processes prevailing in the upper water column. The effect of biological CO_2 drawdown in the NAs prevailed over the fCO_2 increase determined by the SST increase and the whole area remained undersaturated with respect to the overlying marine air (avg $DfCO_2$ = - 50 µatm). As already observed in February, also in October the NAs acted as a CO_2 sink, but the lower wind speeds (< 3.97 ms^{-1}) resulted in weak CO_2 fluxes (avg. FCO_2 = -1.34 mmol m^{-2} d^{-1}).

In the central part of the SA, the temperature driven fCO_2 increase was only partially compensated by biological CO_2 drawdown and the area resulted slightly oversaturated (avg $DfCO_2$ = 8.0 µatm), on the contrary to the more productive western shallower area ($DfCO_2$ = -27.1 µatm). Air-sea CO_2 fluxes were low in the central part of the basin (FCO_2 = 0.31 mmol m^{-2} d^{-1}) and directed to the atmosphere while the more coastal area, also in fall, acted as a weak CO_2 sink (FCO_2 = -1.6 mmol m^{-2} d^{-1}).

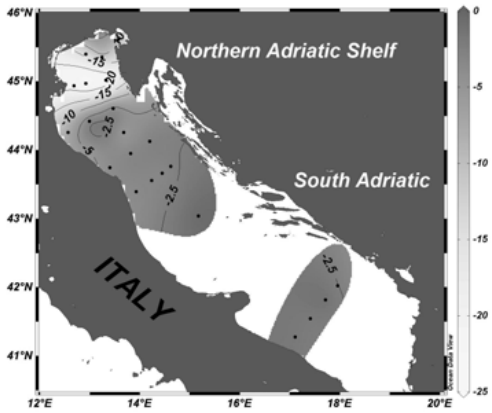

Fig. 1. Spatial distribution of air-sea CO_2 fluxes [m mol CO_2 m^{-2} d^{-1}] in the Adriatic Sea during 16-27 February 2008.

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IMPACT OF OCEAN ACIDIFICATION ON PELAGIC FOOD WEB IN A COASTAL AREA OF EASTERN MEDITERRANEAN SEA

S. Zervoudaki [1]*, H. Orek [2], G. Assimakopoulou [1], E. Krasakopoulou [1], C. Frangoulis [1], S. Isari [1], A. Zenginer Yilmaz [2] and B. Fach [2]

[1] Hellenic Center for Marine Research, Institute of Oceanography - tanya@hcmr.gr

[2] Middle East Technical University, Institute of Marine Science, Erdemli, Mersin 33731, Turkey

Abstract

The main aims of this study were to quantify the response of a marine planktonic system to increasing CO_2 levels as well as to identify the potential changes of key biological processes (e.g. primary production, secondary production, copepod grazing) to ocean acidification. In order to address these overall goals, experiments were carried out in small volume enclosures (200 l) during April 2012 in a Mediterranean coastal station. Two different CO_2 levels were tested: (1) present pCO_2 (380 µatm) and (2) future pCO_2 (750 µatm). The obtained results showed that the different functional groups of plankton and biological processes presented diverse response to increased CO_2.

Keywords: Food webs, Plankton, Biomass, Global change, Aegean Sea

Rising atmospheric carbon dioxide (CO_2) is causing global warming and ocean acidification (e.g. [1]), which are increasingly recognized as important drivers of change in biological systems ([2]). During this study we quantified the effects of increased CO_2 on the stock and composition of several functional groups of plankton, attempting to investigate the impact of OA on planktonic food web processes in a coastal area of the Eastern Mediterranean Sea.

For this purpose, four small volume (200 L) enclosures were used, filled with filtered (through 200 µm to exclude grazers) sea water collected from a station in Saronikos Gulf (Greece) during April 2012 (period of maximum copepod abundance). Targeted pCO_2 levels in the mesocosms were: 1) present pCO_2 (380 µatm) and (2) future pCO_2 (750 µatm) and were regulated via CO_2 injections controlled automatically by a continuous pH-stat system (IKS, Karlsbad, Germany). The measured chemical and biological parameters were nutrients, C_T and pH (pH_T, expressed on the total hydrogen ion concentration scale), DOC, bacteria, viruses, picoplankton, Chlorophyll a (<2.0 µm and >2.0 µm), phytoplankton pigments, nanoflagellates and ciliates, whereas the measured biological processes were phytoplankton production (<2.0 µm and >2.0 µm), copepod feeding and copepod fecal pellet production.

The results showed that nutrients and DOC exhibited similar variation in both treatments. Also, the abundances of bacteria and virusespresented similar trend regardless of pCO_2 levels. Chlorophyll *a* and PP didn't reveal any significant difference between treatments, and the observed values were similar to those recorded in oligotrophic ecosystems. However, phytoplankton pigments differentiated considerably in both pCO_2 levels. Copepod feeding rates and fecal pellet production were lower in the future pCO_2 conditions compared to the current environmental state (Fig.1). Our findings revealed that the different functional groups of plankton and biological processes presented diverse response to increased CO_2 that might have impact on the structure of the pelagic food web of the Mediterranean Sea.

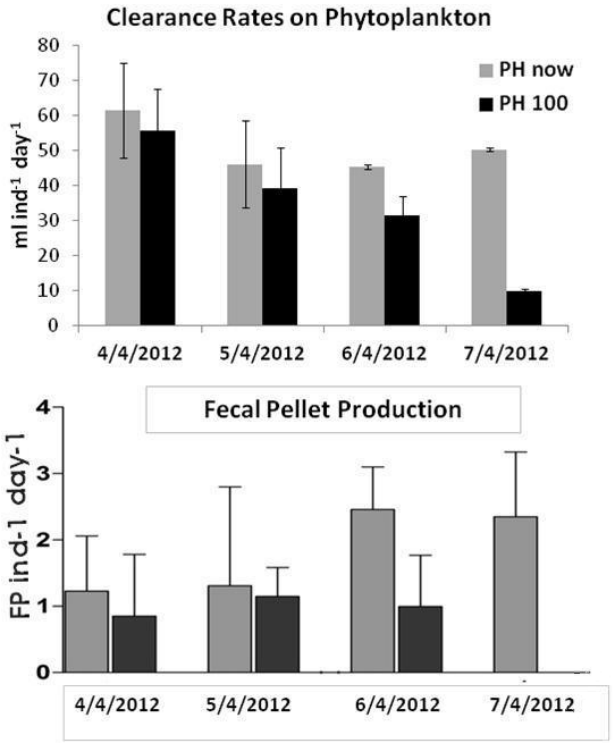

Fig. 1. Clearance rate on phytoplankton and fecal pellet production of *Acartia clausi* in both treatments (pH_{now} and pH_{100}).

Acknowledgment This study was supported by the Joint Research and Technology Programmes 2010 – 2011 Turkey-Greece, MedSeA project (FP7-ENV-2010-265103) and CROA LS8 1893 ("Supporting Postdoctoral Researchers Action" & "Education and Lifelong Learning Program").

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PALAEO-CARBONATE CHEMISTRY OF THE MEDITERRANEAN SEA

Gianluca Marino [1], Patrizia Ziveri [1]* and MedSea Project Members - [2]
[1] Universitat Autònoma de Barcelona (UAB) Institute of Environmental Science and Technology (ICTA) - patrizia.ziveri@uab.cat
[2] -

Abstract
The dynamics of marine carbonate chemistry and biocalcification in the Mediterranean Sea are to date poorly understood, mainly due to a dearth of observational data of sufficient length and spatial coverage to document the biogechemical response(s) of the basin to the ongoing rise in atmospheric CO_2 concentrations. To fill this gap in our understanding we use a paleoceanographic approach. We present a suite of new micropaleontological and geochemical results portraying the variability of the carbonate system parameters and the attendant response of the main planktonic calcifying organisms across key intervals of the recent palaeoceanographic history of the Mediterranean Sea, such as the last interglacial period (~125,000 years ago), the last glacial-interglacial transition (19,000 to 8,000 years ago), and the last millennium.

Keywords: Ocean history, Carbon, North-Western Mediterranean, South-Central Mediterranean, South-Eastern Mediterranean

The Mediterranean Sea is a semi-enclosed marginal sea connected via the Strait of Gibraltar to the Atlantic Ocean, with which it exchanges water and chemical properties, such as, nutrients and carbon [1]. Multiple sites of intermediate to deep convection and a vigorous basin-wide thermohaline circulation [2] result in a relatively short residence time of the waters in the basin. These features collectively account for the observed invasion throughout the water column of the so-called "anthropogenic carbon" [3], i.e., the excess carbon injected into the atmosphere by fossil fuel burning, cement production, and deforestation since the beginning of the industrial era. High alkalinity levels and a prominent $CaCO_3$ supersaturation are observed throughout the basin with the former partly balanced by carbonate sedimentation [4]. However, the response of the carbonate chemistry changes and their impacts on biocalcification during the rapid rise of atmospheric CO_2 concentrations of the last several decades remains elusive, mostly because only few time-series are available (e.g., DYFAMED) and their spatial and temporal coverage are insufficient to provide a conclusive picture. As part of the EU-funded project MedSeA (Mediterranean Sea acidification under changing climate) we have generated several geochemical (e.g., boron isotope-pH proxy) and micropaleontological (e.g., planktonic foraminiferal shell weight and coccolith mass) time-series to reconstruct carbonate chemistry and biocalcification changes across the Mediterranean Sea (Figure 1) during key intervals of the Late Pleistocene featuring different magnitude of atmospheric CO_2 and climate forcing. A pertinent feature of our results is the marked decrease of both foraminiferal shell weight and coccolith mass at different locations of the Mediterranean Sea during intervals of increasing atmospheric CO_2 concentrations, such as the last deglaciation. This alludes to considerable changes in biocalcification also in an "supersaturated" basin like the Mediterranean Sea. These results will be further discussed in the contexts of similar "proxy records" from open ocean settings to provide a first order assessment of the main factors controlling the variability of the Mediterranean Sea carbonate chemistry and biocalcification on decadal to millennial timescales.

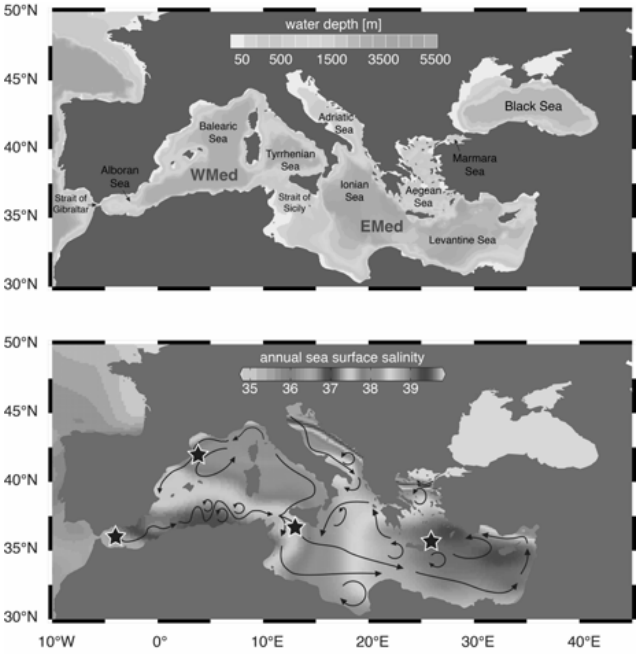

Fig. 1. time-series to reconstruct carbonate chemistry and biocalcification changes across the Mediterranean Sea

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RESEARCH TURNS TO ACIDIFICATION AND WARMING IN THE MEDITERRANEAN SEA: THE MEDSEA PROJECT

Patrizia Ziveri [1]* and MedSeA Project Members - [2]
[1] Universitata Autonoma Barcelona - patrizia.ziveri@uab.cat
[2] -

Abstract

The *Mediterranean Sea Acidification in a changing climate* (MedSeA), a project funded by the European Commission (EC) under the 7th Framework Programme, is assessing uncertainties, risks and thresholds related to Mediterranean acidification and warming at organism, ecosystem and economic scales. A main goal is to identify where the impacts of acidification on Mediterranean waters will be more severe, taking into account the complete chain of causes and effects, from ocean chemistry through marine biology to socio-economic costs. As a practical outcome, it proposing policy measures for adaptation and mitigation that may geographically vary and at the same time requiring coordination between regions or countries.

Keywords: Carbon, Temperature, South-Central Mediterranean, North-Western Mediterranean, South-Eastern Mediterranean

Although the general impact of acidification on water chemistry is globally well understood, fine-scale regional models are needed to resolve the complexity of the physical and ecological interactions of small and complex basins, such as the Mediterranean Sea. The Mediterranean Sea is considered a small-scale ocean with high environmental variability and steep physicochemical gradients within a relatively restricted region. Its circulation is characterized by zonal gradients of physicochemical variables, with salinity, temperature, stratification and alkalinity all increasing towards the east. The generally low-nutrient (from oligotrophic to ultraoligotrophic) waters offshore stand in contrast to many near-shore regions, often containing coral and seagrass ecosystems, which are affected by human-induced eutrophication. Thus acidification is an additional anthropogenic pressure on Mediterranean Sea ecosystems, already suffering from overfishing, increasing sea surface temperatures, and alien species invasions. To properly project how key biogeochemical and ecosystem processes will change, it is fundamental to adequately represent the general circulation of the Mediterranean basin, i.e., both the fine-scale processes that control it (e.g. eddies and deep convection), and the highly variable atmospheric forcing. With their relatively short residence times, Mediterranean Sea deep waters are likely to lag changes in surface waters by a few decades at most. Changes in deep-water formation sites, such as characterized by the dramatic shift with the Eastern Mediterranean Transient, are likely to coincide with changes in the hot spots where much of anthropogenic CO_2 is taken up from the atmosphere and transferred into the deep sea (where it is stored for longer periods). The efficiency of carbon uptake and export from the surface waters to the basin interior depends on the relatively rapid time scales for surface-to-deep water exchange and the Mediterranean general circulation. Thus the combined effect of Mediterranean seawater acidification (absorbing anthropogenic CO_2 per unit area), with low tropospheric warming on Mediterranean biogeochemistry, ecosystems, and the ecosystem services they support, through direct impacts on its highly adapted calcareous and non-calcareous organisms, may be large.

The EC MedSeA project (medsea-prject.eu) is assessing the chemical, climatic, ecological, biological, and economical changes of the Mediterranean Sea driven by increases in CO_2 and other greenhouse gases (ocean acidification (OA) and ocean warming). Our findings suggest that the degree of OA and warming expected over the next 100 years may have major consequences for the biodiversity and biogeochemistry of endemic and keystone species of Mediterranean coastal ecosystems, such as coralline algae. Other habitats such as sea grass meadows are expected to suffer from elevated seawater temperature and invasion by non-indigenous algae species, which benefit from increased pCO_2 and elevated temperature. A central goal is to provide science-based projections of Mediterranean acidification under the influence of climate change as well as associated economic impacts. Projections will be based on new observations of chemical conditions as well as new observational and experimental data on the responses of key organisms and ecosystems to OA and warming, which will be fed into existing ocean models that have been improved to account for the Mediterranean ´s fine-scale features. These scientific advances will allow us to provide the best advice to policymakers who must develop regional strategies for adaptation and mitigation. A MedSeA strategy is to focus on a selected set of key ecosystem and socio-economic variables that are likely to be affected by both acidification and warming, studying the combination of both effects through ship-based observations, laboratory and mesocosm experiments, physical-biogeochemical-ecosystem modeling, and economical analyses. It aims to provide best estimates of future changes, and related uncertainties, in Mediterranean Sea pH, $CaCO_3$ saturation states, and other biogeochemical-ecosystem variables. In addition, it assesses the changes in habitat suitability of relevant ecological and economically-important species.

Here we are presenting an overview of the project and of selected important scientific achievements. Initial project results confirmed that the concentration of anthropogenic carbon extrapolated from Mediterranean field measurements is high and penetrating the deep sea. It is clear that due to the complexity and high variability of the basin, this process will have different regional impacts. This is anticipated to occur in regions where future model projections of sea surface temperature indicate a mean increase of winter and summer temperature of up to 2-4 degrees by the year 2050 if anthropogenic emissions remain unchanged. In terms of impacts on Mediterranean marine species and ecosystems, the extensive work using Mediterranean CO_2 vents as natural acidification laboratories showed consistently a decrease in benthic species biodiversity. Ocean warming and/or acidification impact *Posidonia oceanica*, coralligenous reef, *Corallium rubrium*, and vermetids. Experimental work is also showing that there is a strong influence of temperature on jellyfish.

Finally to convey acquired scientific knowledge to a wider audience of policy-makers, decision-makers, marine managers and other stakeholders, we are developing the formation of the Mediterranean Reference User Group (MRUG). We will suggest policy measures for adaptation and mitigation that will vary from one Mediterranean area to another. As a result, project managers and stakeholders in the different Mediterranean areas will have, for the first time, a set of up-to-date vulnerability maps upon which future action plans can be designed.

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Publication list at: http://medsea-project.eu/publications/

Session

Bioaccumulation, methodology

Modérateur : **Bourhane Eddine Belabed**

NEW RESULTS CONCERNING ACCUMULATION RATE OF METALS IN ALGAE *CYSTOSEIRA BARBATA* AND IN ALGINATE

D. P. Balaban [1]*, G. Stanciu [1], M. Canuta [2], D. Sava [1], V. Badea [1] and M. Grigorian [1]
[1] Ovidius University of Constanta, Romania - dpbalaban@yahoo.com
[2] Sanitary Veterinary and Food Safety Laboratory, Constanta, Romania

Abstract
New results concerning Cu, Zn, Cd, Pb accumulation rate in algae and alginate extracted from algae *Cystoseira barbata* collected in March 2012 from Mangalia, located in the southern part of the Romanian Black Sea coast, are reported. The patterns of heavy metal accumulations rates of contaminated algae and alginate extracted from contaminated algae, in increments, were for algae Zn < Cd < Cu < Pb and for alginate Pb < Cd < Cu < Zn.

Keywords: Algae, Black Sea, Metals

Introduction
The ecosystem of the Romanian Black Sea coast has been damaged as a result of metal contamination. Marine algae are frequently used as biological indicator of heavy metal pollution [1]. The results of heavy metal accumulation in algae of the Romanian Black Sea coast are reported [2]. Brown algae are known to have high concentration of alginate, which is extracted and largely exploited in various domains. Evaluation of metal accumulation rate in alginates isolated from contaminated algae is highly important, considering the diversified usage of alginates in food industry and medicine. No studies have been carried out in Romania concerning heavy metal accumulation in alginate extracted from contaminated algae, correlated with contamination rate of algae with metals.

The aim of this study was to determine the accumulations rates of Cu, Cd, Zn, and Pb in algae *Cystoseira barbata* and in the alginate extracted from the contaminated algae.

Materials and methods
Samples of algae *Cystoseira barbata* have been collected in March 2012 from Mangalia Gulf, located in the southern part of the Romanian coast. The accumulations rates of Cu, Cd, Zn, and Pb in algae *Cystoseira barbata* were realized by means of contamination procedure of algae with metals. Batch contamination experiments of algae were carried out using the following materials: fresh biomass, contaminated sea water with heavy metal ions such as Cu (I), Cd (II), Zn (II), Pb (II) (60mg/L for each metal). Alginates were extracted from contaminated algae by a specific method [3]. The algae and alginate have been carefully prepared (washed, dried) and subjected to dissolution with nitric acid and hydrogen peroxide in a Digesdhal device. Metal concentrations were determined by atomic absorption spectrophotometer (GBC Avanta). The accumulation rate of heavy metals in fresh algae was calculated considering the initial concentration of this metals in algae (uncontaminated). Analyses were made three times in the same conditions and the mean values were reported.

Results and discussion
Results obtained in this experiment are shown in Table 1.

Tab. 1. The metal concentration and accumulation rates in algae and alginate

Cu	Zn	Cd	Pb
The mean metal concentration in uncontaminated[a] and contaminated[b] algae (mg/Kg dry wt)			
5.72 ± 0.38[a]	26.00 ± 2.05[a]	0.95 ± 0.07[a]	7.73 ± 1.49[a]
365.00 ± 24.38[b]	107.25 ± 8.45[b]	185.50 ± 13.74[b]	1206 ±233.00[b]
The mean metal concentration in uncontaminated[a] and contaminated[b] alginate (mg/Kg dry wt)			
2.35 ± 0.16[a]	4.52 ± 0.36[a]	0.19 ± 0.01[a]	1.44 ± 0.28[a]
6.84 ± 0.46[b]	6.82 ± 0.54[b]	1.22 ± 0.09[b]	7.61 ± 1.47[b]
The mean accumulation rates of contaminated algae[a] and contaminated alginate[b] (%)			
19.96[a]	4.51[a]	10.25[a]	66.50[a]
0.45[b]	1.02[b]	0.21[b]	0.19[b]

In a study of Chirila et al (2006) the heavy metals concentrations in the algae *Cystoseira barbata* collected from Romanian coast of the Black Sea were higher than the concentrations obtained for uncontaminated algae of our study (2012) [4]. *Cystoseira barbata* is a biological indicator of heavy metal pollution and our results obtained for the uncontaminated algae suggests that pollution rate on the Romanian Black Sea coast decreased at the end of the period 2006 – 2012. Zn and Pb concentrations were higher than Cd and Cu in uncontaminated algae probably because of sulphur water springs existing in the Mangalia gulf coastal area. Concentrations of metals were higher in contaminated algae and alginate than concentrations found in uncontaminated algae and alginate. On the other hand, Pb accumulation rate was higher in algae and lower in alginate and Zn accumulation rate was lower in algae and higher in alginate. The lead is a toxic metal for human body and our results showed that the accumulation rate of Pb in alginate extracted from contaminated algae was lower than contaminated algae (0.19 versus 66.5). This fact is very important for human health.

Conclusions
Accumulation rates of the heavy metals in algae and alginate increases as follows: for algae Zn < Cd < Cu < Pb and for alginate Pb < Cd < Cu < Zn. It is very important for human health that accumulation rate of Pb in alginate extracted for contaminated algae to be lower versus contaminated algae. There is no evidence in current literature to confirm or invalidate the results obtained through this experiment, regarding accumulation rate of metals in alginate extracted from contaminated algae.

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ETUDE DE LA CONTAMINATION PAR LES MÉTAUX LOURDS DE LA ZONE INDUSTRIALO-PORTUAIRE DU GOLFE DE ANNABA, À L'AIDE DE BIO-INDICATEURS

Bourhane Eddine Belabed [1]*, Abderafik Meddour [1], Tahar Tata [1] and Lotfi Aleya [2]
[1] Université Badji Mokhtar Annaba - Algérie - bourhanebelabedmarine@yahoo.fr
[2] CNRS 6249-Université de Franche-Comté Place Leclerc

Abstract
Les teneurs en fer, cuivre, zinc, chrome, nickel, plomb, cadmium et mercure ont été déterminées par SSA dans les sédiments, les moules et les poissons. La pollution montre un degré de contamination inquiétant; résultat de l'activité portuaire et à l'exposition directe aux effluents d'origine anthropique. Ils ont aussi permis de valider l'utilisation de deux organismes, un mollusque (*Perna perna*) et un poisson (*Mugil cephalus*) pour un biomonitorage.

Keywords: Pollution, Algerian Sea, Metals

Introduction
Ce travail s'intéresse à une pollution chimique par les métaux lourds, ces métaux sont présent naturellement et au dessus d'un certain seuil ils deviennent toxiques **[1].** Les éléments retenus dans cette étude sont au nombre de 8 métaux (Fe Cu, Zn, Ni, Cr, Pb, Cd et Hg). Certains sont essentiels à la vie comme le cuivre et le zinc et d'autres toxiques comme le plomb, le cadmium et le mercure. Ces éléments sont des produits d'usages domestiques, urbains, industriels et agricoles, ces métaux on les retrouve aux niveaux des eaux les sédiments et les organismes vivants drainés par les eaux ou par voie atmosphérique. Ces derniers sont bio accumules et bio amplifies, dans la chaîne alimentaire et par conséquent à certains seuils ils deviennent dangereux. La présente étude se propose de déterminer le degré de contamination par les huit éléments traces au niveau des principales matrices du complexe industrialo–portuaire de Annaba à savoir les moules (Perna perna), les poissons (le mulet Mugil cephalus) et les sédiments. Cette zone est exposée à divers polluants de différentes origines.

II. Matériel et Méthodes : II.1 Présentation de la zone d'étude : Le golfe d'Annaba est limité à l'Est par le cap Rosa (8° 15'E et 36° 58'N) et à l'ouest par le cap de garde (7° 47'E et 36° 58'N) . Six stations ont été choisies, dont six pour les sédiments et les moules et deux pour ceux des poissons.

II.2 Stations de prélèvement : Station ST1 « Sidi Salem » : à proximité de l'embouchure de l'oued Seybouse et de l'ensemble des rejets industriels et urbains de toute la plaine de la ville d'Annaba. Station « ST2 » la petite Darse. Station « ST3 » la grande Darse. Station « ST4 » 3ème bassin. Port de pêche Station ST5 « Lever de l'aurore » se trouve du côté ouest du port. Station ST6 «La kyenne» en dehors de la zone urbanisée. L'échantillonnage du sédiment a été effectué au cours d'une seule campagne de prélèvement par site durant l'année 2011 ; des moules d'une campagne mars, avril 2011 ; pour les poissons 'une campagne en période printanière de l'année 2012. Le calcul de l'indice de contamination selon l'agence du bassin du Rhône(1990) : a établit trois classes de pollution en fonction de l'indice de contamination Ic, qui est le rapport entre la valeur considérée comme normale **[2]** et celle observée dans le sédiment , Ic< 3 sédiment de référence 3 <Ic<10 sédiment pollué Ic> 10 sédiment à risque.

II.3 Préparation et analyse des échantillons : La minéralisation est effectuée selon les méthodes : **[3]-** sédiments, **[4]-** moules, et **[5]-** poissons. Les teneurs des ETM sont déterminées par spectrophotométrie d'absorption atomique à flamme de type PERKIN-ELMER Analyst 100 ; Pour le mercure selon la méthode IAEA/UNEP (1984). Les analyses statistiques ont été effectuées à l'aide du logicie STATISTICA.

III. Résultats et discussion :
Tab. 1. Teneurs en métaux (enmg.kg^{-1} de poids sec) chez le poisson au niveau de deux stations (St1et St2) et les moules au niveau des 6stations de la zone industrialo–portuaire de Annaba.

Métaux	Fe	Cu	Zn	Ni	Cr	Pb	Cd	Hg
ST1	2.29	2.32	3.42	1.14	2.66	8.45	4.38	0.50
ST2	3.60	7.84	11.84	1.82	4.22	20.45	7	19
ST3	3.06	4.30	6.70	0.93	2.73	15.22	4.16	12
ST4	1.45	3.07	3.86	0.82	1.62	11.81	2.83	5.50
ST5	0.87	3.46	1.02	0.99	9.22	7.95	2.50	0.005
ST6	0.65	0.00	2.15	0.37	2	0.45	0.00	0.00

Tab. 2. Indice de contamination métallique (IC) des sédiments prélevés au niveau de la zone industrialo- portuaire durant l'année 2011.

Stations	ST 1	ST2	ST3	ST4	ST5	ST6
Fer	93.2± 1.30 M 46. ± 9.52 P	113.20±4.24M 56± 6.16 P	65±4.12M	42.2±1.30M	45.5±0.50M	37.2±0.44M
Cuivre	3.10±0.2M 7.55± 0.45P	4.72±0.06M 10±0.95P	3.33±0.03M	1.68±0.14M	1.79±0.16M	0.50±0.07M
Zinc	35.90±0.54M 114.7±30.6P	48±2M 128.3±41.7P	42.10±1.2M	15.80±0.83M	18.40±0.42M	13.1±0.74M
Chrome	2.24±0.08M 0.79±O.01P	2.80±0.13M 0.90±0.02P	2.67±0.21M	1.85±0.11M	2.43±0.02M	0.71±0.02M
Nickel	1.12±0.02M 0.36±0.01P	1.71±0.02M 0.68±0.03P	1.35±0.02M	0.90±0.02M	0.94±0.04M	0.34±0.03M
Plomb	1.68±0.14M 1.19±0.01P	2.67±0.25M 1.99±0.63P	2.09±0.114M	1.79±0.167M	1.68±0.14M	0.03±0.002M
Cadmium	0.51±0.11M 0.040±0.001P	0.90±0.01M 0.08±0.010P	0.79±0.02M	0.22±0.02M	0.25±0.01M	Traces M
Mercure	0.16±0.03M 0.02±0.001P	0.20±0.06M 0.15±0.01P	0.17±0.01M	0.01±0.001M	0.02±0.001M	Traces M

Dans les sédiments on observe un degré de contamination inquiétant. On note à cet effet des indices de contamination élevés, en plomb 20.45-7.95, en mercure 19-5.50,en zinc 11.84-3.42, en chrome 9.22-4.22, en cuivre 7.84-3.07, en cadmium 7-4.16, en fer 3.60-3.06, résultat probable de l'importance activité au niveau de port ; et à l'exposition directe aux effluents d'origine anthropique, classant les sédiments de ces stations de sédiments pollués par le zinc, le chrome, le cuivre ; le cadmium et le fer et de sédiment à risque par le plomb au niveau des stations 1,2, 3,4 et 5 et pour le mercure au niveau des stations 2, 3 et 4 .Les teneurs en métaux relevées dans la chair de moules , on observe une contamination dominée le plus souvent par les métaux toxiques tels que le plomb (1.67–2.68) mg.kg^{-1}, le mercure (0.16–0.20) mg.kg^{-1}, le cadmium (0.25-0.90) mg.kg^{-1} et le chrome (2.24–2.80) mg.kg^{-1} · comparées aux médianes Françaises. Quant aux teneurs relevées dans les muscles de poissons ; on note des teneurs élevées ;notamment par le plomb (1.19-1.99) mg.kg^{-1}, le mercure (0.02–0.15) mg.kg^{-1}, le cadmium (0.040-0.08) mg.kg^{-1} et le chrome (0.79-0.90) mg.kg^{-1}.Quant aux basses teneurs relevées dans la station 6, elles s'expliqueraient par l'éloignement de toute activité.

IV. Conclusion : Les résultats obtenus font état d'une contamination métallique. La consommation des moules et des poissons peuplant, l'intérieur du port et l'embouchure est dangereuse notamment pour le plomb. Ces résultats ont aussi permis d'identifier les principales sources de pollution, et de valider l'utilisation de deux organismes marins, un bivalve Perna perna et un poisson Mugil cephalus pour un biomonitorage.

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HEAVY METALS BIOACCUMULATION IN TWO SPECIES OF MOLLUSCS IN N.EVOIKOS GULF-GREECE

Leila Bordbar [1]* and Manos Dassenakis [1]
[1] University of Athens, Department of Chemistry, Laboratory of Environmental Chemistry, - leila.bordbar@gmail.com

Abstract
Two different species of Molluscs (*Monodonta turbinata* and *Patella caerulea*) from seven stations around the smelting plant in the bay of Larymna (N.Euvoikos Gulf-Greece) were sampled seasonally from Autumn 2009 to Autumn 2010. Iron, Mn, Zn and Cu were determined in the soft tissues of organisms using Atomic Absorption Spectrometry (AAS). The highest concentration of Fe, Mn in both species were detected at the station near the smelting plant .All metals measured in *M. turbinata* were higher in spring 2010, while in *P. caerulea* the highest Fe and Mn concentrations were measured during the cold period of the year (winter 2010). Higher mean levels of Cu (six fold) and Mn (two fold) were measured in soft tissues *M. turbinata* than in *P. caerulea.*

Keywords: Bio-accumulation, Metals, Mollusca, Monitoring, Aegean Sea

Introduction: aquatic environments are highly impacted by human activities, either by its use for resources exploitation, transportation, recreational proposes or as dumping .The heavy metal pollution of the marine environment has long been recognized as a serious environmental concern (2) The bay of Larymna in the N. Evoikos Gulf (Central-Greece), receiving huge a mount of waste from the most important ferronickel smelting plant in the country (3) since 1963. The by-product of smelting plant is deposited in Gulf includes iron oxides, silicon dioxide as well as Fe, Al, Mn, Cr, Ni and Co (5). The Hellenic Centre for Marine Research (HCMR) has been charged for monitoring the impact of dumping slag in N. Evoikos gulf, since 1983 (4). The aim of the present study is to select the most appropriate sentinel species naturally growing in the area to use for the monitoring of the metal pollution in the coastal environment.

Material and Methods: two different mollusc species (*Monodonta turbinata* and *Patella coerulea*) from seven stations around the smelting plant and two stations from the other side of Gulf as a reference area have been collected .(120 individuals from each species per each station) figure1.

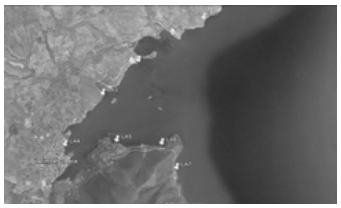

Fig. 1. The location of stations around the smelting plant.

Ten individuals from *P. caerulea* and 15 from *M. turbinata* were pooled; freeze dried. One gram of sample was digested with 6 ml of concentrated HNO_3 (65%) (Merck, Germany) and 2 ml of concentrated H_2O_2 (30%) (Merck,Germany) in microwave digestion system and diluted to 20 ml with Milli-Q water (blank digest was carried out in the same way).Four heavy metals" i.e." Fe, Mn, Cu and Zn measured by Atomic absorption spectrometry AA20. The accuracy of our measurements were verified by analysis of certified reference materials.(Ulva (CRM NO 279)) and IAEA (NIST 2976). More than 90% recovery for all metals were obtained.

Results and discussion: the box plot distribution of Fe and Mn in *P. coerulea* and M. *turbinata* were presented in table 1. It is detected that Fe and Mn were in their highest concentration in the station near the smelting plant (LA4) in the both species, suggesting the direct water discharging from the smelting plant in the Gulf and the metal dust around the smelting plant cause the high concentration of mentioned metals as form of dissolved and particulate in water samples (1). Zn & Cu, metals not directly related to slag (5).The highest concentration of Cu was detected in LA5, in *M. turbinata*, while in *P. coerulea* the highest concentration was found in LA6.both stations are near to an aquaculture farm and the high concentration of this metal would probably due to the antifouling used in fish farm. LA5 station is located near village of Larymna and Zn concentration is significantly high in this station. Zn and Cu are known to be related to direct anthropogenic inputs such as sewages, aquaculture and agriculture activities. (3), therefore the high concentration of this metal could be attributed to vicinity of this station to the rural area . For all metals the highest concentration in *M. turbinata* were determined in Spring 2010, while in *P.caerulea* the highest Fe and Mn were measured in Winter 2010, and Zn and Cu were marked in Autumn 2010.Comparision of metal concentration in the two species showed Significantly higher level of almost all measured metals in M. *turbinata* expect for Fe in *P. caerulea* which was two times more than *M. turbinata.*

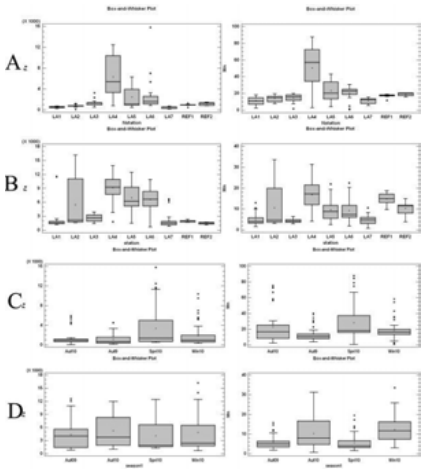

Fig. 2. Fe and Mn (µg/g dw) box-plot distribution of *P. coerulea* (B&C) and *M. turbinata* (A&D).

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FUKUSHIMA RADIOACTIVITY IN TUNA: IMPLICATIONS FOR PUBLIC HEALTH AND TRACING MIGRATIONS

N. Fisher [1]*, Z. Baumann [1], D. J Madigan [1], K. Beaugelin-Seiller [2], T. G Hinton [2] and J. Garnier-LaPlace [2]
[1] Stony Brook University, Stony Brook, NY USA - nicholas.fisher@stonybrook.edu
[2] 2. IRSN, Centre de Cadarache, St. Paul lez Durance Cedex, France

Abstract
Bluefin tuna accumulated ^{134}Cs and ^{137}Cs released from the Fukushima nuclear power plant in Japan and transported these isotopes to the eastern Pacific. Radiation doses to the tuna and to human seafood consumers are below doses from natural radiation background, but these isotopes can be used to trace migratory routes and timing in large pelagic animals.

Keywords: Fishes, Radionuclides, Pollution, North-Central Mediterranean

The damage to the Fukushima Da-ichi nuclear power plant in Japan in March 2011 resulted in a the largest accidental release of radioactivity to the oceans in history. The principal radionuclides released into the Pacific were ^{131}I, ^{134}Cs, and ^{137}Cs, but others were also found in biota and marine sediments. Nearly all the short-lived ^{131}I decayed away within a few months, but ^{134}Cs ($t_{1/2}$ = 2 y) and ^{137}Cs ($t_{1/2}$ = 30 y) are detectable in water and biota in coastal regions near Japan. We used gamma spectrometry to analyze biota in Japanese waters in June 2011, 2.5 months after the date of maximal release of radioactivity. We found that zooplankton were contaminated with equal quantities of ^{134}Cs and ^{137}Cs (~15 Bq kg^{-1} each), as well as ^{110m}Ag (~8 Bq kg^{-1}). Small myctophid fish were found to have both Cs isotopes (~10 Bq kg^{-1} each) but no Ag [1]. In August of 2011, we also collected Pacific bluefin tuna from waters off California; this species spawns in the western Pacific and migrates eastward to California, often at the age of 1-2 years.

All 15 bluefin tuna that were new arrivals to California in August 2011 were found to have both Cs isotopes in their muscle, resulting in concentrations that were over ten times the amount of radioactivity from anthropogenic radionuclides prior to the accident [2]. Yellowfin tuna, a residential species, also collected off California had no ^{134}Cs and only "background" ^{137}Cs (from nuclear weapons testing in the 1960s), indicating that the radioactivity in the bluefin tuna off California was accumulated in waters off Japan and transported via migration to the eastern Pacific. The radioactivity in bluefin tuna caught off California that derived from Fukushima was only about 3% above the radioactivity from the naturally occurring ^{40}K.

Using a simple model, we calculated that the radioactivity from ^{134}Cs and ^{137}Cs in these tuna prior to their departure from Japanese waters was about 15 times higher than at the time of capture in California waters [2], matching independent measurements of tuna radioactivity near Japan. The decrease during the migration across the Pacific was attributable to excretion of the Cs, which has an efflux rate constant from marine teleosts of ~2% d^{-1}. We also evaluated the radiation risks to human consumers of the contaminated bluefin tuna in Japan and in the USA. Japanese eat more seafood, on average, than Americans (57 vs. 24 kg y^{-1}). The total estimated annual dose from consumption of these fish in August 2011 from $^{134+137}$Cs would be 0.9 µSv in the US and 33 µSv in Japan in April 2011 [3]. By comparison, the annual dose to tuna eaters from the naturally occurring ^{40}K and ^{210}Po in the same fish would be 570 µSv in the US and 1340 µSv in Japan (Table 1) [3]. Doses from ^{210}Po to the tuna exceed doses from radiocesium by 2-3 orders of magnitude [3].

The radioactivity from the Fukushima reactor to human consumers of Cs-contaminated tuna would thus be well below the natural radiation background to which we are all exposed, and estimated additional cancers from tuna consumption would be ~2 per 10 million people, although this estimate is highly uncertain. Other species of fish in Japanese coastal waters have also been reported to be contaminated with ^{134}Cs and ^{137}Cs, particularly benthic species [4]. As with the tuna, consumption of most other contaminated species would not exceed human safety limits, although some greenlings are extremely contaminated (7400 times the Japanese legal limit for Cs), and although banned, fishermen who ignore regulations and eat them would exceed human safety limits. In 2012, 50 additional bluefin tuna off California had $^{134+137}$Cs concentrations < half the levels found in 2011 [5], reflecting the dilution of the radioactive wastes in the Pacific. By studying the ^{134}Cs:^{137}Cs ratios in the fish, it is possible to discern the timing of migration of these fish and to assess the fraction of total fish in the eastern Pacific that are recent migrants [2, 5]. Such information is vital for proper management of this imperiled fishery. One positive outcome of this accident is that the application of radioactive tracers for evaluating migration routes and timing could be extended to understanding dynamics of other migrating animals, including other fish, turtles, birds, and mammals.

Tab. 1. Radioactivity in biota (Bq kg^{-1} dry wt) and radiation doses to tuna and humans

	Zooplankton	Bluefin tuna-US	Bluefin tuna-Japan	Dose to tuna (nGy h^{-1})	Dose to human tuna eaters (µSv y^{-1})
$^{134+137}$Cs	33	155	10	0.5-1.7	0.9: US; 33 Japan
^{40}K, ^{210}Po	199	347	347	600	570: US; 1340: Japan

This study highlights the possibility of using point sources of contamination, not restricted to radioactivity, to trace migration patterns of animals in any body of water, including the Mediterranean. The Mediterranean and Black Seas have numerous point sources of chemical contaminants whose background concentrations in uncontaminated seawater are negligible; bioavailable contaminants can be used to trace the movement of animals in these waters, as exemplified by tuna transporting Cs. Thus, any future radioactive releases from nuclear installations or accidents could be used to better understand animal migrations in these waters. And, importantly, detectability of contaminants in seafood does not necessarily imply significant risk for consumers.

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RECENT ADVANCES IN THE BIOMONITORING OF TRACE ELEMENTS USING POSIDONIA OCEANICA (L.) DELILE

Sylvie Gobert [1]* and Jonathan Richir [1]
[1] Université de Liège - sylvie.gobert@ulg.ac.be

Abstract
One of the most studied bioindicator in the Mediterranean is the seagrass *Posidonia oceanica*. Trace element (TE) monitoring surveys using that species have however mostly focussed on a few elements (e.g. Pb, Cd), while numerous others, efficiently bioconcentrated by the plant and potentially toxic, have been barely or not studied (e.g. Ag, V, Bi). Furthermore, although *P. oceanica* bioaccumulation behaviour relies on synergistic effects between the sampling environment and its ecophysiology, this aspect has been mostly underestimated until now. This study presents recent advances in the biomonitoring of TEs using *P. oceanica* and insists on the necessity of developing consensual monitoring protocols in order to improve its use as bioindicator.

Keywords: Trace elements, Bio-indicators, Ecotoxicology, North-Western Mediterranean

Coastal ecosystems are submitted to numerous anthropogenic pressures: among them, the chemical pollution by traces elements (TEs). Biomonitoring surveys using the marine magnoliophyte *Posidonia oceanica* (L.) Delile, endemic to the Mediterranean, have mainly focussed on contaminations by Cr, Ni, Cu, Zn, Cd, Pb and Fe. However, other TEs like As, V, Ag, Be, Al, Mn, Co, Se, Mo, Sn, Sb and Bi, categorized as elements of "environmental emerging concern", have been subject to nearly no ecotoxicological survey with that species. As the worldwide evolution of our technologies and of our lifestyle increases the extraction and production of most of the listed TEs, their environmental monitoring remains a topical subject. Furthermore, little is known about TE kinetics within *P. oceanica* meadows. The respective importance of the plant ecophysiology and its sampling environment henceforth needs further investigations in order to properly use this bioindicator in intercomparative monitoring surveys. We firstly monitored TE mean annual levels in *P. oceanica* shoots sampled during 3 years (2008-2010) in front of the oceanographic station STARESO (Calvi Bay, Northwestern Corsica, France). Results showed that *P. oceanica* shoots bioaccumulated TEs of emerging concern to levels ranging from 0.001 (e.g. Bi) to 100 (e.g. Mn) $\mu g.g_{DW}^{-1}$ of shoot [1]. A spatial monitoring survey (April 2007) along the French Mediterranean littoral further pointed out that many of these TEs effectively threatened its chemical integrity: the observed spatial variability of *P. oceanica* shoot TE levels (in $\mu g.g_{DW}^{-1}$ of shoot) could be linked to specific anthropic activities like agriculture (Mo: up to 27 ± 14), mining (Sb: up to 0.70 ± 0.13), storage and refinement of oil products (V: up to 23 ± 7), or the presence of major urban centres (Bi: up to 0.049 ± 0.004). Their monitoring, along with the one of TEs classically studied in that species, turned out to be essential [2]. A complementary small-scale study (May 2010) of TEs contents in *P. oceanica* shoots sampled along a radial located at the back of the Ajaccio Bay (western Corsica) further demonstrated that the spatial variation of their TE contents (e.g. Bi, in $\mu g.g_{DW}^{-1}$ of shoot) could vary as much at the scale of 1 km (from 0.009 ± 0.004 to 0.061 ± 0.012) than at the scale of the French Mediterranean littoral (from 0.004 ± 0.000 to 0.049 ± 0.004; Richir, 2012). The election of a representative monitoring site to characterize the global health status of a wider area (e.g. a Bay) is thus a very important step when planning a monitoring survey based on benthic (and rooted) organisms. We also studied the physiological mechanisms of accumulation, storage and excretion of a mix of 15 TEs by *P. oceanica* though the *in situ* contamination of seagrass bed portions (June 2009). Realistic low TE concentrations within the experimental setup (from 0.018 ± 0.004 $\mu g.L^{-1}$ for Ag to 16 ± 8 $\mu g.L^{-1}$ for Zn, as measured with DGTs) were similar to pollution levels recorded in contaminated coastal areas of the Mediterranean. Plant compartments responded differently to TE exposures: adult senescent leaves assimilated TEs less rapidly than young intermediate actively growing ones. Mean contamination factors were3.0 ± 1.7 for *P. oceanica* intermediate leaves (min. = 1.2 for Fe; max. = 7.4 for Bi) and 2.0 ± 0.9 for adult leaves (min. = 0.95 for Cd; max. = 3.7 for Bi), at the levels of contamination tested. TEs, once accumulated, could be redistributed between plant compartments, notably towards rhizomes buried in sediments. Rhizomes could therefore play the role of storage organs, in particular for essential nutrients such as Cu or Zn, and thereafter supply plant demands during the moment of maximum leaf growth [3]. TE levels and kinetics in *P. oceanica* beds will thus evolve seasonally and spatially according to the synergistic effect of both environmental bioavailable TE levels and the plant ecophysiology. However no general sampling rule and/or protocol prevails nowadays when using that species in biomonitoring surveys, contrary to other species (e.g. *M. galloprovincialis*). In the light of our observations, we strongly recommend developing consensual monitoring protocols in order to improve the use of *P. oceanica* as bioindicator of TE pollution, although we are conscious of the difficulty of such a task.

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PECULIARITIES OF MACRO- AND MICROELEMENTS ACCUMULATION IN *CYSTOSEIRA* SPP. IN THE COASTAL WATERS OF SOUTH-WESTERN CRIMEA (THE BLACK SEA)

Alexandra Kravtsova [1]*
[1] Institute of Biology of the Southern Seas - alexkravtsova@yandex.ru

Abstract
The peculiarities of 26 macro- and microelements accumulation in the thalli of brown algae *Cystoseira* from the coastal waters of south-western Crimea (the Black Sea) were studied using instrumental neutron activation analysis (INAA). The possibility of using brown algae *Cystoseira* as a biomonitor of coastal waters pollution was shown.

Keywords: Black Sea, Algae, Bio-indicators, Trace elements

Macroalgae can accumulate trace elements in concentrations that are orders of magnitude greater than their content within the environment. This ability allows them to indicate the level of coastal waters pollution [1]. Although features of macro- and microelements accumulation by Black Sea macroalgae (Chlorophyta, Rhodophyta and Ochrophyta) have been described by a number of authors [2], the data about relationship between concentrated elements and plant age, morphostructural elements of the thalli and seasons are scarce. Therefore it is difficult to give a science-based recommendation for their use as biomonitors of the coastal waters pollution. The aim of our work was to study features of accumulation of macro- and microelements by brown macroalgae *Cystoseira barbata* C. Ag. and *Cystoseira crinita* (Desf.) Bory from the coastal waters of south-western Crimea (Sevastopol region) and relate their concentrations with the seasons, ages and different parts of the thalli. The study was carried out at five aquatic sites in Sevastopol area with different degree of anthropogenic pollution. The plants of *Cystoseira* species were sampled at the depths of 0,5–1,5 m during spring and summer seasons in 2012. The concentrations of 26 macro- and microelements (Na, Mg, Al, Cl, K, Ca, Sc, V, Mn, Fe, Co, Ni, Zn, As, Br, Rb, Sr, Sb, I, Cs, Ba, Sm, Nd, Ag, Au and U) were determined by means of INAA, which is widely used in current ecological studies [3]. INAAwas performed in the radioanalytical laboratory at the fast pulsed reactor IBR-2 of the Frank Laboratory of Neutron Physics, JINR (Russia). Average concentrations of macro- and microelements in the thalli of *Cystoseira barbata* and *C. crinita* widelydiffer and are dependent on ecological conditions. The results showed a tendency to increase concentrations towards more polluted waters. The highest concentrations of trace elements were found in young plants less than one year old at all stations, regardless of their degree of pollution (figure 1).

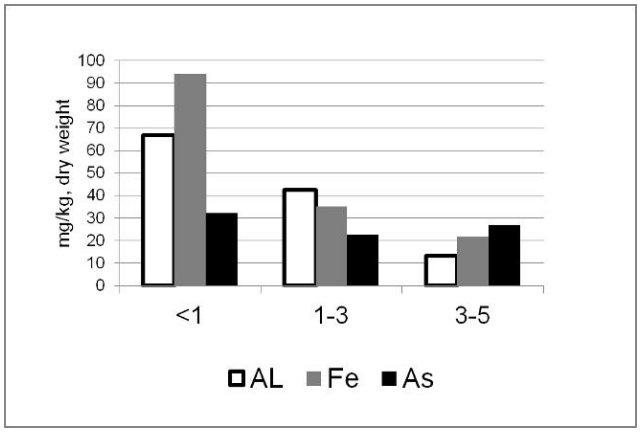

Fig. 1. Average concentrations of Al, Fe and As (mg/kg) in *Cystoseira* spp. stems at various ages in summer season 2012 (Sevastopol region).

The content of trace elements in the stems and branches of the thalli from the same station differed by a factor of 1,5-7. In the spring, the greatest concentration of elements in stems was higher than in the summer; the reverse was observed for the branches (figure 2). In the summer season the epiphytic macroalgae are an additional source of elemental sorption from the aquatic environment resulting in raised concentrations in the branches of *Cystoseira barbata* and *C. crinita.*

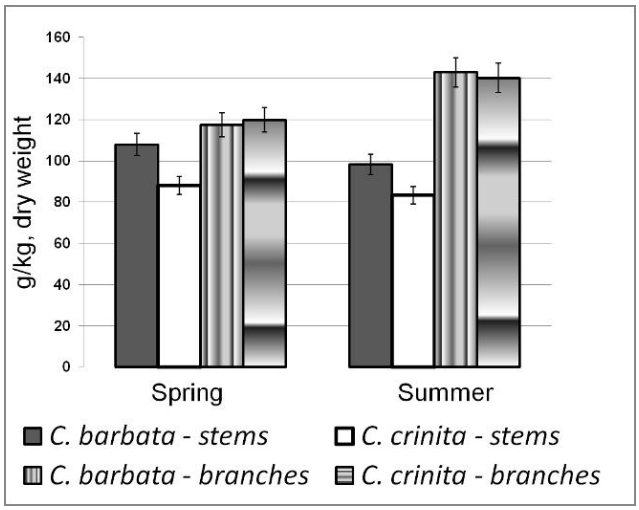

Fig. 2. Total concentration of elements (g/kg, dry weight) in *Cystoseira barbata* and *Cystoseira crinita* thalli in spring and summer season 2012 (Sevastopol region).

Taking into account a wide range of variation in concentrations of elements in *Cystoseira* species thalli and their relationship with ecological factors, structure and the age of the thalli, it was recommended to use stems and branches of the same age for biomonitoring purposes that were sampled in the same season. The stems of 2-3 year old plants of *Cystoseira barbata* and *C. crinita*, sampled in the summer season, could be the biomonitors of water pollution in the Sevastopol coastal zone. Acknowledgements. This research has received funding from the EC (FP7/2007-2013) under Grant Agreement No. 287844 for the project CoCoNet ("Towards Coast to Coast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential").

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ASSESING HEAVY METALS IN THE MARINE BIVALVE *PINNA NOBILIS* IN THE BALEARIC ISLANDS (WESTERN MEDITERRANEAN)

M. Morató [1]*, S. Deudero [1], M. Vázquez-Luis [1], C. Guitart [2] and J. Campillo [2]
[1] Centro Oceanográfico de Baleares-IEO - merce.morato@ba.ieo.es
[2] Centro Oceanográfico de Murcia-IEO

Abstract
Heavy metals (Cd, Cu, Hg, Pb and Zn) concentration were determined in the marine bivalve *Pinna nobilis* along the Balearic Islands, comparing a protected area with two sites with strong anthropogenic influence. Analyses of Cabrera and Mallorca indicated that heavy metal concentration were generally higher in the most of samples, specially in Santa Maria bay (Cabrera, MPA), and Magaluf (Mallorca, with strong anthropogenic influence). *Pinna nobilis* appears to efficiently bioaccumulate heavy metals exhibiting large differences in a range of anthropic scenarios. The results on *P. nobilis* metal accumulation show that the concentrations decrease according to order: Zn > Cu >Pb> Cd > Hg.

Keywords: Balearic Islands, Bivalves, Metals, Bio-accumulation

Introduction
Heavy metals in marine biota have natural and anthropogenic origin, and are regarded as serious pollutants of the aquatic environment because of their toxicity, persistence, low biodegradability and their tendency to concentrate in aquatic organisms [1]. Many benthic organisms accumulate trace metals to the levels reflecting those in the environment, and the molluscs in particular may therefore be sensitive biomonitors of metal inputs. *Pinna nobilis*L., 1758 is a fan mussel endemic to the Mediterranean Sea and is consideredthe biggest bivalve mollusc of this area [2]. It is commonly found within the seagrass meadows, especially those of *Posidonia oceanica* [3], and the species is a long-lived filtering bivalve. There are numerous studies on heavy metals in the Mediterranean Sea, especially in sediment [4], seagrass meadows [1] and benthic invertebrate species [11], but there are few studies on large filter feeders like *P.nobilis*.

Materials and methods
The study area is the Balearic Islands coast, includes two islands, Mallorca (Andratx and Magaluf) and Cabrera (Santa Maria bay) included within a zone of integral protection. Fourteen *P. nobilis* samples were taken in October 2011 with scuba diving. Concentrations of Cd, Cu, Pb and Zn were determined by atomic absorption spectrometry (AAS), and Hg was determined by an Advanced Mercury Analyzer AMA 254. For comparison of total metals at the sampling sites, the metal pollution index (MPI) was applied ([8]; [9]; [1]): $MPI= (Cf_1 \times Cf_2 \ldots Cf_n)^{1/n}$; where the Cf_n is the metal concentration *n* in the sample.

Results and discussion
Metal concentrations in soft tissues of *P. nobilis* samples (dry weight) range from 1.21 to 33.1 mg/Kg for Cd, from 4.1 to 319.2 for Cu, from 0.247 to 1.158 mg/Kg for Hg, from 0.58 to 39 mg/Kg for Pb and from 1244 to 4529 mg/Kg for Zn (Table 1).

Tab. 1. Mean SD (min-max) mg/Kg dry weight and metal pollution index (MPI) by site. (n= number of samples)

sites	1.Andratx (n= 4)	2.Magaluf (n= 4)	3.Santa Maria bay (n= 6)
Metals			
Cd	1.613± 0.606 (1.21-2.5)	8.918 ± 3.002 (5.82-13.03)	26.435 ± 6.966 (15.03-33.1)
Cu	6.05 ± 2.204 (4.1-9.2)	197.85± 88.084 (127,1-319,2)	57.25 ± 30.405 (20.9-96.5)
Hg	0.297± 0.044 (0.25-0.35)	0.795 ± 0.22 (0.56-1.09)	0.957 ± 0.133 (0.82-1.16)
Pb	0.895 ± 0.21 (0.58-1)	20 ± 6.272 (12-27)	22.67 ± 5.164 (15-29)
Zn	4034.25± 358.71 (3670-4529)	1763± 607.879 (1244-2631)	2708.33±347.757 (2364-3224)
MPI	6.22 ± 0.528	34.446 ± 11.55	38.171 ± 8.2

All examined metals had maximal concentration in Santa Maria bay in Cabrera, excepte for Cu at Magaluf, and Zn in Andratx. The obtained concentrations are comparable with those reported for Pinnidae elsewhere ([4]; [5]; [6]; [7]). We compared the concentrations of all heavy metals by metal pollution index (MPI), and the MPI reaches the maximal value for site 3 (Santa Maria bay) linked to the highest concentrations of three metals (Cd, Pb and Zn).

Conclusions
Elevated metal concentrations can cause a severe reduction or elimination of intolerant species, thereby having a significant effect on the diversity and trophic structure of the biological community [10]. In view of the range of concentrations that can be found in the soft tissues of bivalves species, the magnitude of metals in the *P. nobilis* can be considered high. The species shows a high bio-accumulation capacity, thus further analysis are needed to assess their tolerance ranges to metal pollution and monitoring data indicate that the bioacumulation potential is sufficient to be of concern.

Acknowledgement
This work was supported by research Project (024/2010), "Organismo Autónomo de Parques Nacionales, Ministerio de Medio Ambiente y Medio Rural y Marino".

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TRACE METAL CONCENTRATIONS IN THE DATE MUSSELS, *LITHOPHAGA LITHOPHAGA* (L., 1758) FROM IZMIR BAY (EASTERN AEGEAN SEA)

Meral Özsüer [1] and Ugur Sunlu [1]*
[1] Ege University, Faculty of Fisheries - ugur.sunlu@ege.edu.tr

Abstract
This study determined zinc (Zn), cadmium (Cd), lead (Pb) and copper (Cu) in the bivalve *Lithophaga lithophaga* from Izmir Bay (Aegean Sea) in 2011 seasonally. All values were measured by voltammetry. Mean values of trace metals for all seasons were 49.07 µg Zn g^{-1}, 0.34 µg Cd g^{-1}, 1.69 µg Pb g^{-1} and 12.65 µg Cu g^{-1} as wet weight.

Keywords: Trace elements, Bio-accumulation, Izmir Bay, Bivalves

Introduction
Aquatic organisms are in a fragile equilibrium with the aquatic environment which they inhabit and they can biologically represent its level of pollution The aim of the study was to determine the concentrations of Zn, Cd, Pb and Cu accumulated in *L. lithophaga* in the middle part of Izmir Bay.

Materials and Methods
Izmir Bay is a part of the eastern coast of the Aegean Sea. Yassica Ada is an island located at the middle part of the bay (Fig. 1).

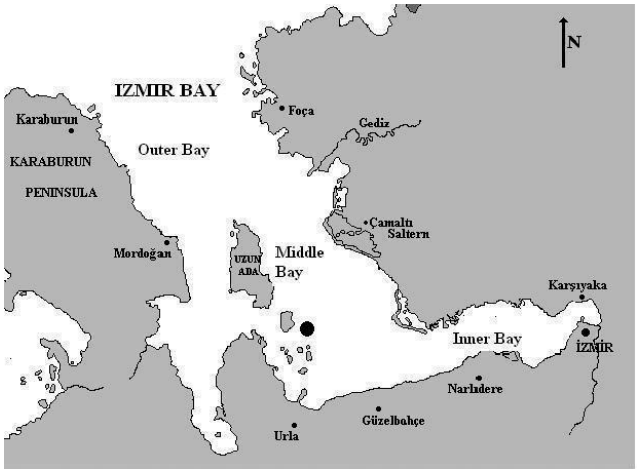

Fig. 1. Izmir Bay and the sampling area (*).

A bivalve of the Mytilidae family, *L. lithophaga* is an endolithic species inhabiting limestone rocks.The species has been protected by the Bern Convention and Barcelona Convention – Genoa Protocol. Only consuming by local fishermen they are not commercially exploited and there aren't any legal restrictions on harvesting and collecting them in Turkey.
Individuals of *L. lithophaga* were collected by SCUBA diving from the coastal area of the Isle of Yassica Ada between August 2010 and May 2011 in a seasonal study. The metal contents of individuals were extracted according to international standard methodology[1] Trace metal concentrations were measured using a hanging drop electrode voltammetric analyzer. Inter-calibration homogenate samples (IAEA-142/TM) for mussel, from the IAEA, Monaco Laboratory were used as a quality control for the analytical methodology. Detection limits for 5 g wet weight (ww) were 0.001 ppm for Cd and Pb and 0.02 ppm for Zn and Cu.

Results and Discussion
Voltammetric analyses of extracted forms of *L. lithophaga* are presented as mean values in Table 1. Our results showed that the pattern of trace metal occurrences in the mussel was Zn>Cu>Pb>Cd. Only one study [2] could be found in the literature concerned about the same species as in our study. Keeping in the mind that trace metal levels and their bioavailibity in water are affected by numerous variables (both anthropogenic and natural); differences in concentrations might be expected. Dissimilar results of the two studies also could stem from different device and methods of the measurement. The table further shows the permissible upper limits of metals in edible bivalves, as published in the Turkish Food Codex [3], European Regulations EC1881 [4] and the world Health Organization [5].

References	∑ Zn	∑ Cd	∑ Pb	∑ Cu
This work	49.07	0.34	1.69	12.65
Deudero *et. al.* 2007(dw)	341.90	2.21	9.20	18.40
WHO	50.0	0.2	2.0	20.0
EC	-	1.0	1.5	-
Turkish Food Codex	50.0	1.0	1.5	20.0

Fig. 2. Results of another study and legally permissible amounts of trace metals as well as mean concentrations measured in the present study (ppm ww).

The results from our study for Pb are not below the established EC or Turkish Food Codex guidelines and level for Cd is not below the WHO guideline. High Zn concentration is just below the guidelines, suggests a need for further monitoring of seafood species from this immediate area that are harvested for human consumption.

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THE MEDITERRANEAN MUSSEL WATCH, TEN YEARS AFTER: SUCCESS AND END

Hervé Thébault [1]*
[1] Institut de Radioprotection et de Sûreté Nucléaire Antenne de Radioécologie Marine - herve.thebault@ifremer.fr

Abstract
A regional monitoring program - the CIESM Mediterranean Mussel Watch (MMW) - has been running for 10 years, using the mussel *Mytilus galloprovincialis* as unique bio-indicator specie. The network consists of some 20 marine environmental laboratories from 18 different Mediterranean and Black Sea countries. As of today, more than 100 sites have been sampled to produce the first distribution map of ^{137}Cs in coastal waters at the Mediterranean basin scale. Despite repeated efforts to set up more permanent monitoring on this basis, the second phase of the program did not found the necessary institutional and financial support which brought the project to its end.

Keywords: Monitoring, Bio-indicators, Radionuclides, Mediterranean Ridge

Introduction
Coastal management requires complete information on baseline levels of contaminants for any impact assessment, especially for semi-enclosed Mediterranean and Black Seas with very long water residence time. Although included in the Barcelona Convention protocol, radioactivity monitoring was not implemented in the MEDPOL program. Then, as part of its observation and monitoring programs, the CIESM launched in 2002 a regional "Mediterranean Mussel Watch (MMW)" to record levels and trends of radioactivity in the environment. In addition to some existing monitoring activities at the national levels, the objective of the MMW was to promote the common production of large and reliable datasets, on a long term basis, throughout the network of Mediterranean marine research institutes. This was achieved during the course of a dedicated workshop resulting in a consensual agreement on monitoring strategy, procedures and methods [1].

Methodology and implementation
The Mediterranean mussel *Mytilus galloprovincialis* was selected as unique bio-indicator specie, widespread in the region and capable of accumulating many contaminants including radionuclides. In sectors where natural populations are rare, samples were obtained from transplanted mussels, a technique initiated in France and successfully extended to the entire Mediterranean Sea [2]. Trace level measurements of radionuclides are performed by direct gamma spectrometry as a routine technique. Intercalibration of all participating analytical laboratories was achieved with the making of a specific reference material, AIEA-437 [3]. Some 20 marine environment laboratories from 18 Mediterranean countries have been involved in the MMW and more than a 100 sites have been sampled so far. The database of radionuclides measurements comprises some 500 original values. Results have been discussed among participants within dedicated round-tables during the course of CIESM congresses from 2004 to 2010.

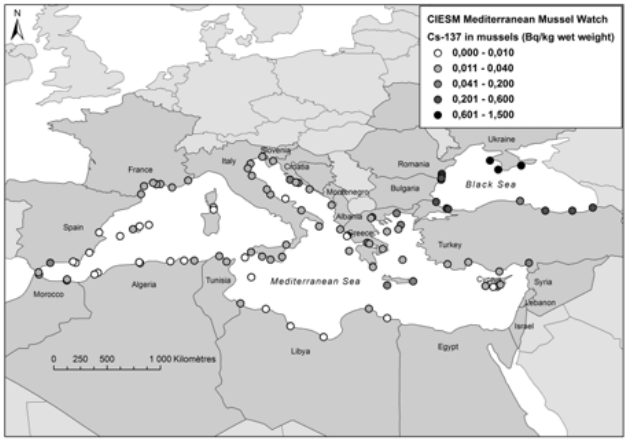

Fig. 1. Distribution of ^{137}Cs concentrations in mussels collected in 2004-2009.

Results and conclusion
Among artificial radionuclides, ^{137}Cs is the main element regularly detected in mussel tissues. By 2009, the MMW network has been able to produce the first comprehensive distribution map of ^{137}Cs at the regional level (Fig. 1). This artificial radionuclide, mostly originated from global fallout of former nuclear weapons tests, is now detected at very low level in all Mediterranean coastal waters [4]. The mean value is 0,085 Bq.kg^{-1} wet weight, which is three orders of magnitude below the compliance level for human consumption of seafood products. However, in the Black Sea and North Aegean Sea, ^{137}Cs activity in mussels is still remarkably higher than in the Western basin (max value of 1,5 Bq.kg^{-1} w.w.), showing the remaining impact of Chernobyl accident. The MMW was quite successful in its implementation phase and brought much interest from monitoring activity of other regional seas (i.e. ROPME in the Gulf). In European countries of the Mediterranean basin, this program is also considered as a good basis for the mandatory radionuclides monitoring provided for by the European Marine Strategy Framework Directive. The second phase of the program was planned to set up more permanent monitoring and to extend the network activity to emerging contaminants [5]. However, despite repeated efforts from the coordination team and many participants, the program did not found the necessary institutional and financial support to go beyond the initial involvement of CIESM. This action was not considered with high priority for the Mediterranean marine environment, possibly due to the low level of artificial radionuclides.

Aknowledgements
The author, as coordinator of the program on behalf of CIESM, deeply thanks all participants for their scientific involvement and personal enthusiasm over the last ten years. The group is grateful to the CIESM staff, to MEDPOL program, to IAEA for technical support and to the team of Ifremer-coordinated EC projects Mytilos/Mytimed/Mytior for ship opportunity and efficient logistic support.

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ETUDE PRÉLIMINAIRE DES MÉTAUX TRACES AU NIVEAU DE *CYMODOCEA NODOSA* À PROXIMITÉ DU PORT DE PLAISANCE EL KANTAOUI

Rym Zakhama-Sraieb [1]*, Yassine R. Sghaier [1], Ahmed Ben Hmida [1] and Faouzia Charfi [1]
[1] Unité de Recherche de Bio-écologie et Systématique Evolutive - zakhamarym@yahoo.fr

Abstract
Les herbiers de Magnoliphytes sont reconnus comme un outil efficace pour l'étude de l'environnement côtier car ils sont très répandue dans le bassin méditerranéen, sont fixés sur le fond et ils sont sensibles à la pollution. Dans la présente étude, on a analysé la concentration de cinq éléments traces (Cd, Zn, Pb, Cu et Ni) au niveau des différentes parties de *Cymodocea nodosa*. C'est au niveau des stations à proximité du port et du point de rejet d'eau usé de Hammam Sousse que l'on enregistre les concentrations les plus élevés en éléments traces. Par ailleurs, la comparaison des teneurs des différentes parties de la plante en métaux traces montre que c'est au niveau des feuilles de la *C. nodosa* que la concentration est la plus élevé en particulier pour le Cd, le Pb et le Cu.

Keywords: Metals, Phanerogams, Tunisian Plateau

Introduction
Cymodocea nodosa est une phanérogame marine abondante au niveau des faibles profondeurs des côtes tunisiennes (Sghaier *et al*., 2011) où elle constitue des herbiers denses durant les saisons estivales et printanières; par ailleurs, les angiospermes ont un pouvoir accumulateur des polluants dans leurs tissus. Pour toutes ces raisons, *C. nodosa* semble une candidate intéressante pour l'étude des métaux traces au niveau des zones côtières Tunisiennes. La présente étude s'intègre dans le projet de recherche MAPMED (Management of Port Area in the Mediterranean Basin). Ce projet vise a développer des indicateurs rapides et simples à identifier de la qualité des eaux côtières autours des ports touristiques en Méditerranée.

Matériels & méthodes
L'échantillonnage a été effectué par plongée sous-marine en mars 2012, au niveau de 4 stations aux alentours du port touristique d'El Kantaoui entre 2 et 3m de profondeur (Fig. 1). La densité des faisceaux a été estimé *in situ* en utilisant un cadre de 20cm de coté avec 10 réplicas. Trois échantillons de 15 faisceaux de *C. nodosa* chacun ont été collectés pour l'analyse des métaux traces. Les faisceaux sont séparés en différents compartiments (feuilles, pétioles et rhizomes). Après séchage, les échantillons de *C. nodosa* ont été calcinés à 450°C, digérés avec l'eau régale dans un système fermé ensuite analysés par la méthode de spectrométrie d'émission atomique ICP.

Fig. 1. Localisation des stations d'étude

Résultats
La densité des faisceaux (Fig. 2) montre un gradient croissant des stations à proximité de l'émissaire d'eau traité de Hammam Sousse (C1 et C2) vers les stations les plus éloignées (C3 et C4) avec une différence significative. Les échantillons de *C. nodosa* collectés au niveau des quatre stations contiennent des traces des 5 métaux étudiés et ce dans les différents compartiments (Feuilles, Pétioles et Rhizomes).
C'est au niveau des stations à proximité du port et du point de rejet d'eau usé de Hammam Sousse que l'on enregistre les concentrations les plus élevés en éléments traces en particulier pour le Cadmium, le Cuivre et le Plomb (Fig. 2). Par ailleurs, la comparaison des teneurs des différentes parties de la plante en métaux traces montre que c'est au niveau des feuilles de la *C. nodosa* que la concentration est la plus élevé en particulier pour le Cadmium, le Plomb et le Cuivre.

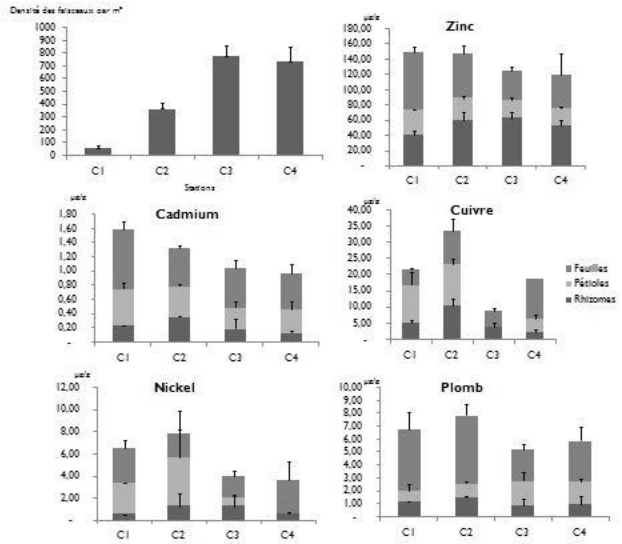

Fig. 2. Variation spatiale de la densité de *Cymodocea nodosa* et de la concentration en métaux traces dans les différentes parties de la plante

Discussion et Conclusion
Les métaux lourds analysés dans cette étude (Cd, Ni, Pb, Cu et Zn) ont été sélectionnés car ils représentent des métaux traces les plus communs dans les communautés côtières (Roberts et al., 2008). Tous ces métaux ont été détectés avec des concentrations plus ou moins importantes au niveau des échantillons de *C. nodosa* collectés dans les herbiers étudiés. Les concentrations trouvées sont comparables avec ceux enregistrées dans d'autres pays de la Méditerranée (Llagostera et al., 2011). Ces résultats préliminaires montrent que la *C. nodosa* peut être utilisé dans les études d'impact et le monitoring des aires portuaires touristiques. Pour une meilleure conservation de la plante, les feuilles peuvent être le seul tissu prélevé pour les analyses de métaux traces.

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Session

Chemical fluxes - 1

Modérateur : **Olivier Montreuil**

PERSISTENT ORGANIC POLLUTANTS (POPS) IN OPEN SEA SURFACE WATERS AND ATMOSPHERE ACROSS THE MEDITERRANEAN AND IN THE BLACK SEA

Javier Castro Jiménez [1]*, Berrojalbiz Naiara [1] and Jordi Dachs [1]
[1] IDAEA-CSIC Department of Environmental Chemistry - javier.castro-jimenez@idaea.csic.es

Abstract
The most complete and comprehensive assessment of base line atmospheric and water concentrations and derived atmospheric deposition fluxes of PCDD/Fs, PCBs, PAHs and OCPs across the Mediterranean Sea open waters and in the South-West Black Sea is presented in this work. The main findings from this extensive investigation based on samples collected during two West-East oceanographic cruises in the Mediterranean Sea will be presented. Key processes controlling the air-water exchange of the studied POPs, spatial variability and potential sources will be also discussed.

Keywords: Atmospheric input, Air-sea interactions, Open sea, Black Sea, Pollution

The Mediterranean and Black Seas are two semi-enclosed marine environments under an intense anthropogenic pressure, which have resulted into different degrees of chemical contamination of their waters as well as the overlying atmosphere, among other compartments. One of the many contaminant classes occurring in these two environments are organic chemicals, in particular persistent organic pollutants (POPs) and related compounds. In this work we present a synthesis of various investigations reporting on baseline atmospheric and water concentrations of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCBs) and selected organochorine pesticides (OCPs) in all Mediterranean Sea basins and in the South-West Black sea. Air-water exchange and atmospheric deposition of the studied POPs, their spatial variability across the Mediterranean as well as potential sources will be also discussed. The presented data set was produced from the analysis of a large number of atmospheric (gas and aerosol phases) and water (dissolved and particulate phases) samples collected across the Mediterranean Sea and in the SW Black Sea during two sampling cruises undertaken on June 2006 and May 2007. In both campaigns, Barcelona was the initial and final port, with Istanbul and Alexandria being the intermediate stops, respectively (Figure 1). Air samples were taken by using high volume samplers. Particulate phase collection was performed by quartz fiber filter (QFFs) whereas gas phase trapping was achieved by polyurethane foams (PUFs). Seawater was pumped on board and low/high sampling systems were used achieving the retention of the particulate water phase by glass fiber filters (GFFs) or QFFs and the dissolved water phase by XAD columns. [1-5]. One of the main findings was that the Mediterranean Sea open waters may act both as sink or source for most of the studied contaminants, depending on the regions and the specific chemical. The total atmospheric loading of organic contaminants (PAHs + OCPs + PCBs + PCDD/Fs) to open Mediterranean sea waters is estimated to varied from 2100 to 4360 tons each year.

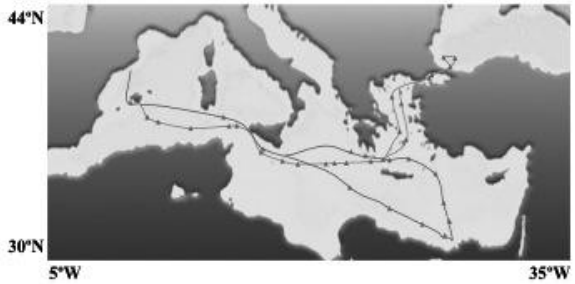

Fig. 1. Oceanographic campaigns performed across the Mediterranean Sea and SW Black Sea in 2006 and 2007 on board of the R/V García del Cid (CSIC)

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ATMOSPHERIC LEVELS OF ORGANOPHOSPHATE ESTER (OPE) FLAME RETARDANTS ACROSS THE OPEN MEDITERRANEAN AND IN THE BLACK SEA

Javier Castro Jiménez [1]*, Berrojalbiz Naiara [1] and Jordi Dachs [1]
[1] IDAEA-CSIC Department of Environmental Chemistry - javier.castro-jimenez@idaea.csic.es

Abstract
First measurements of organophosphate esters (OPE) flame retardants in the atmospheric aerosol over the Mediterranean open waters and in the South-West Black Sea are presented in this work. sum5OPE atmospheric concentrations across the open Mediterranean Sea ranged from 60 to 700 pg m-3, whereas levels in the atmosphere over the SW Black sea varied from 150 to 400 pg m^{-3}.

Keywords: Air-sea interactions, Atmospheric input, Open sea, Black Sea

Organophosphate esters (OPEs) are a group of organophosphorus flame retardants which are currently used in many industrial applications as substitutes of polybrominated diphenylethers(PBDEs) due to their recent ban [1]. Recent investigations pointed to the global occurrence of OPEs in the atmosphere of marine environments, even in remote regions of the world [2]. However, no data have been reported on the presence of OPEs over the open Mediterranean Sea and in the Black Sea to date. This work fills this gap providing with the first data on atmospheric levels of OPEs in these two semi-enclosed marine environments. Atmospheric aerosols across the Mediterranean Sea and in the SW Black Sea were collected during two sampling cruises performed on June 2006 and May 2007 on board of the oceanographic vessel R/V García del Cid (CSIC). In both campaigns, Barcelona was the initial and final port, with Istanbul and Alexandria being the intermediate stops, respectively. The samples were analyzed for tris-(dichloroisopropyl)phosphate (TDCP), triphenyl phosphate (TPhP), 2-ethylhexyl diphenyl phosphate (EHDPP), tris(2-ethylhexyl)phosphate (TEHP) and trycresyl phosphate (TCrP). sum5OPE atmospheric concentrations across the open Mediterranean Sea ranged from 60 to 700 pg m^{-3}, whereas levels in the atmosphere over the SW Black sea varied from 150 to 400 pg m^{-3}. This levels are comparable with measurements undertaken in the atmosphere over the North Sea waters in 2010 (sum8OPE ranging from 110 to 1400 pgm^{-3})[3]. Atmospheric dry deposition fluxes are under calculation and will allow to estimate the main atmospheric loading pathway of OPE to Mediterranean and Black sea waters.

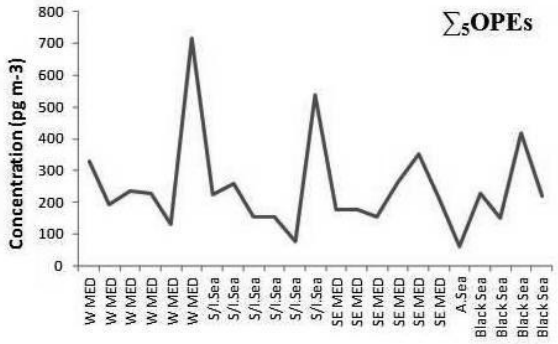

Fig. 1. Spatial variability of OPEs across the studied marine basins

The highest ∑OPE level was found in a sample collected in the Western Mediterranean, while the lowest in a sample collected in the Aegean Sea. ∑OPE atmospheric concentrations showed a high within-basin spatial variability.

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FLUORESCENT DISSOLVED ORGANIC MATTER IN COASTAL WATERS FROM THE NORTH-WESTERN MEDITERRANEAN SEA UNDER THE INFLUENCE OF RHÔNE RIVER INPUTS

Nicolas Ferretto [1]*, Marc Tedetti [2], Stéphane Mounier [2] and Madeleine Goutx [1]
[1] MIO - nicolas.ferretto@univ-amu.fr
[2] PROTEE

Abstract
The characteristics of FDOM from waters sampled in the Rhone River and at different distance from the river mouth in Marseille Bay were contrasted. In the Rhone River, the terrigenous material was the most abundant with elevated protein-like material contribution. In marine waters, the biological activity significantly contributed to the FDOM pool. The Rhone River impacted sporadically the coastal water with an increase of humic-like material in FDOM. This signature was coupled to an increase of protein-like material due to the biological activity when simultaneous nutrient input occurred.

Keywords: Coastal waters, Estuaries, Geochemistry, River input, North-Western Mediterranean

The Rhone River is the major source of freshwater and terrigenous material to the Mediterranean Sea (*1, 2*). Generally, the plume of the Rhone River moves toward the west due to the North Current, but under particular meteorological conditions, it may reach the Bay of Marseilles (*3*). The objective of this work is to characterize and to assess the seasonal variation of fluorescent DOM (FDOM) in the Rhone River and in marine coastal waters potentially under the influence of freshwater inputs. Three stations were sampled bi-monthly from February 2011 to January 2012: one in the Rhone River and two stations in the Bay of Marseilles (Fig.1). Two PARAFAC analyses were performed, one on the Rhone water and another on the marine water dataset. In freshwaters, the PARAFAC analysis validated a model at three components, two humics and one protein. In marine water, a model at three components including one humic and two proteins was validated. In the Rhône River, humic-like material dominated, while protein-like fluorophores were the most abundant in the marine waters. These fluorophores displayed a seasonal pattern. The humic-like fluorophores in the Rhone River were more abundant in winter. This would be due to the higher inputs of terrigenous material from higher plants and soil to the river in relation to rain events. The tryptophan followed an opposite pattern with higher concentrations during the summer compared to the winter that most probably related to the phytoplankton activity (*4*).In marine waters, both humic-like and protein-like materials exhibited the highest concentration values during the summer and weaker values during the winter due both to the plankton activity (*4*) and to the freshening events that occurred mostly during the warmest seasons. The influence of Rhône River in marine waters was evidenced by the decrease in salinity and changes in the marine FDOM composition. At Couronne, the Rhone plume intrusion increased the humic acids proportion whereas the nutrient-rich intrusions increased the amount of proteins. At Sofcom, the plume effect on FDOM composition was limited because of its location in the south Bay,far from the Rhone river mouth.

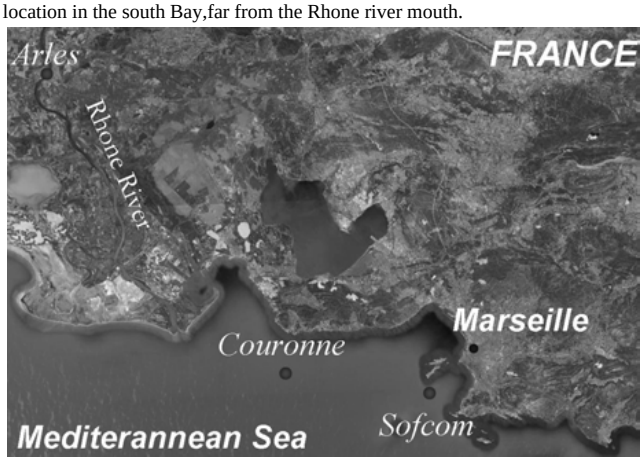

Fig. 1. Map of the Marseille Bay

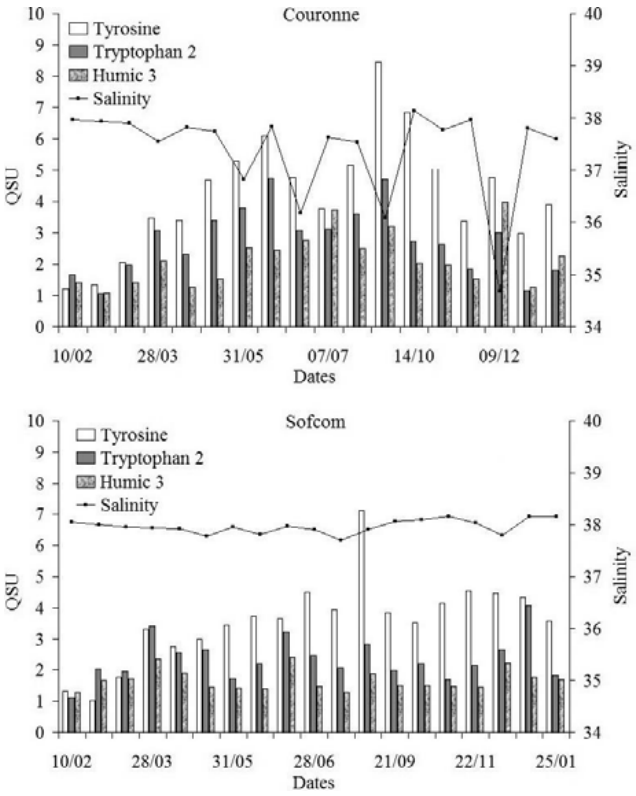

Fig. 2. Fluorophore abundance and salinity during the sample period

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IMPACT OF SAHARAN DUST AND POLLUTED AEROSOL ON BIOGEOCHEMICAL PROCESSES IN THE EAST MEDITERRANEAN SEA, PRELIMINARY RESULTS OF A MESOCOSM EXPERIMENT (MAY 2012)

B. Herut [1]*, P. Pitta [2], N. Mihalopoulos [3], T. Tsagaraki [3], E. Rahav [1], I. Berman-Frank [4], S. Psarra [2], A. Giannakourou [5], A. Tsiola [3] and Z. Shi [6]

[1] Israel Oceanographic and Limnological Research - barak@ocean.org.il

[2] Institute of Oceanography, Hellenic Centre for Marine Research, Heraklion, Crete, Greece

[3] Department of Chemistry, University of Crete, Heraklion, Crete, Greece

[4] Mina and Everard Goodman Faculty of Life Sciences, Bar-Ilan University, Ramat Gan, Israel

[5] Institute of Oceanography, Hellenic Centre for Marine Research, Anavyssos, Athens, Greece

[6] School of Geography, University of Birmingham, UK

Abstract

Recent nutrient budgets for the Eastern Mediterranean Sea (EMS) indicate a significant role of Mediterranean aerosols as a net supplier of macro- and micro- nutrients to the Low Nutrient Low Chlorophyll EMS. A mesocosm experimental study was performed in Crete during May 2012 examining the overall response of the oligotrophic EMS (Cretan Sea) to two different types of aerosol additions, "pure" Saharan dust (1.6 mg/L) and mixed (polluted and desert origin) aerosols (1 mg/L). Generally, the additions triggered an increase in several of the performed rate (primary production, bacterial production, phosphate turnover time, N_2-fixation) and state measurements, showing relatively larger impacts by the mixed aerosols.

Keywords: Air-sea interactions, Cretan Sea, Aerosols, Atmospheric input, North-Eastern Mediterranean

Significant quantities of leachable nutrients from dry atmospheric inputs become potentially bioavailable and may influence bacterial production and abundance, primary production rates, chlorophyll *a* (or other phytopigments), diversity of pico and nanophytoplankton communities, and may also affect diazotrophs and nitrogen (N_2) fixation rates [1 ,2]. To date, these influences were assessed by on-board, dust enrichment, microcosm experiments, while no previous mesocosm experiment has been performed in the EMS. A mesocosm experiment in the Western Mediterranean examined the addition (~0.8 mg/L) of a dust analog (treated Saharan soil) to surface seawater (Corsica, www.obs-vlfr.fr/LOV/DUNE). Here we present preliminary results of a mesocosm experimental study performed in Crete in May 2012 examining the overall response of the oligotrophic EMS (Cretan Sea), during a transitional spring season, to two different types of aerosol additions, "pure" Saharan dust (1.6 mg/L) and mixed aerosol (1 mg/L) containing a natural mixture of desert dust and polluted aerosols. The second treatment represents an aerosol with more leachable nutrients and metals, and somewhat higher N/P ratios. The two treatments, run in triplicates (3 m^3 each), were compared to control runs. Preliminary measurements show an average addition of approximately 2-3 and 65-75 nM dissolved inorganic phosphorous (DIP) and dissolved inorganic nitrogen (DIN), respectively, representing 30% of the ambient concentrations. Converting the estimated nutrient addition to potential carbon production (or chlorophyll *a* increase) reveals values similar to the observed changes. The additions triggered an increase in several of the performed rate and state (Table 1). Considering similar aerosol/dust particle concentrations, larger biological impacts were observed in the polluted aerosols treatment (Figure 1).

Tab. 1. Response to dust/aerosol additions to East Mediterranean seawater, statistical comparison (ANOVA and Fischer's test) between the different mesocosm treatments (control, Saharan dust and aerosol). S - statistically significant ($P < 0.05$) difference from the control; NS - not statistically significant.Response to dust/aerosol additions to East Mediterranean seawater, statistical comparison (ANOVA and Fischer's test) between the different mesocosm treatments (control, Saharan dust and aerosol). S - statistically significant ($P < 0.05$) difference from the control; NS - not statistically significant.

Parameter	Saharan dust	Aerosol
Chlorophyll *a*	S	S
Synechococcus abundance	S	S
Bacterial abundance	S	S
Primary productivity	S	S
Bacterial productivity	S	S
N_2 fixation	S	NS
Alkaline phosphatase activity	NS	NS
P turnover time	NS	NS
Photosynthetic efficiency (Fv/Fm)	NS	NS

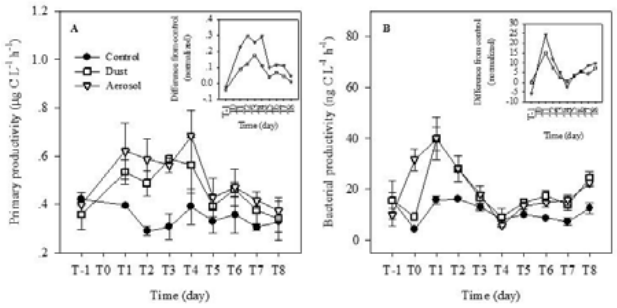

Fig. 1. Primary and bacterial production in the different treatments as a function of time (total of 8 days). Inserts – differences between the dust/aerosol additions and control, normalized to the addition of 1 mg particles/L. Rates of bacterial production were determined by incorporation of tritium-labelled leucine using the procedure of [3] and primary production was measured, using the ^{14}C incorporation method of [4].

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ACCURACY OF ANNUAL AND MONTHLY LUMPED WATER BALANCE MODELS FOR THE ASSESSMENT OF RIVER DISCHARGE IN THE MEDITERRANEAN AND BLACK SEAS DRAINAGE BASINS

Wolfgang Ludwig [1] and Olivier Montreuil [1]*
[1] CEFREM, UPVD-CNRS - olivier.montreuil@univ-perp.fr

Abstract
Accuracy of 16 annual and monthly water balance models (WBM) for modelling annual river discharge were assessed on an extended discharge series data set for Mediterranean and Black Sea rivers. Results indicate a better accuracy of some monthly models to reproduce inter-annual mean, variability and trends. Using gauged discharge filled with monthly WBM and extrapolating to the whole drainage basins, freshwater discharge to the Mediterranean Sea (excluding the Nile) significantly decreased in 1960-2009 (-22%, $p<0.05$), while decrease was not significant for the Black Sea.

Keywords: North-Western Mediterranean, Hydrology, Black Sea, South-Eastern Mediterranean, River input

Materials and Methods: A previous data set of discharge series [1] in Mediterranean and Black Sea rivers was extended through data mining from national and international water agencies. This new data set includes 467 monthly or annual series within the 1960-2009 period for downstream stations and sub-catchments greater than 1000 km². If possible, gaps in time series were completed using linear regression with neighboring stations ($r^2 > 0.80$). The corresponding rainfall and potential evapotranspiration time series were extracted from the CRU TS 3.10 climatologies. For water discharge modeling, we tested the accuracy of 16 monthly and annual WBM: 3 free-parameter annual WBM, 6 one-parameter annual WBM and 8 monthly multiparameters WBM. Parameters were calibrated by maximizing an objective function (Favg) which is the average of Nash-Sutcliffe model efficiency coefficient (NS), the NS of logarithmically transformed flow, the Pearson correlation coefficient and the bias score. The magnitude of discharge trends was estimated using the slope of the Kendall-Theil robust line. We used the Kolmogorov-Smirnov test (KS) to compare the equality of observed and modeled trend distributions. The Pearson correlation coefficient and the mean absolute error were used to test the similarity of trend patterns. For extrapolation of the water budgets to the entire 1960–2009 period, we combined observed and modeled discharge values in order to fill the data gaps in the observed time series. We extrapolated to the whole drainage basins using ratio between discharge modeled with free-parameter annual WBM in and outside gauged catchments.

Results: For the Mediterranean Sea drainage basin, the mean coverage of the whole basin by gauged catchments is only about 20% (excluding the Nile). Taking account spatial variation in precipitation depth, this coverage increases to 36% for total precipitation. Using the 3 free-parameter annual WBM, gauged discharge account for about 50% of the total freshwater discharge. For the Black Sea, the mean coverage by gauged catchments is better and reaches 73% of the whole drainage area, 77% of total rainfall and 85% of the total freshwater discharge. Model calibration of WBM for discharge series >10 years allow to increase the spatial coverage with 26% for the Mediterranean Sea and 81% for the Black Sea. This coverage represents 43% of precipitation and about 55% of freshwater discharge for the Mediterranean Sea and, respectively, 84% and 91% for the Black Sea. WBM performances are highly dependent on the model type. The lowest Favg scores are observed for the three free-parameter WBM, with only 1 to 7% of the discharge series having Favg > 0.60. For one-parameter WBM, these percentages increase to 13-20%. The WBM performing best are multi-parameters monthly models. Here, Favg > 0.6 could be reached for 51 to 54% of the discharge series with the models GR2M [2], ABCD [3] and ZH3 [4]. Using observed discharge series filled with these three monthly WBMs and extrapolating discharge to the whole Mediterranean (excluding the Nile) and Black Sea drainage basins, we computed an interannual mean of freshwater discharge of 365-367 $km^3.yr^{-1}$ and 351-355 $km^3.yr^{-1}$ for the 1960-2009 period. Correlations between observed and modeled absolute trends are significant ($p < 0.05$) for all WBM. Best Pearson correlation coefficient reaches 0.75 for two monthly WBM: ZH3 and GR2M. Lowest mean absolute error was about 1.4 $mm.yr^{-1}$ for 3 monthly WBM: GR2M, ZH3 and ABCD. The hypothesis of the KS test for similar distributions was rejected for all WBM. All WBM slightly overestimate the occurrence of weak negative trends (74-87% for modeled discharge and 60% for observed discharge) but underestimate occurrence of strongest negative trends. Looking the cumulative trends at downstream gauging stations, observed and modeled value for the Mediterranean Sea are very closed with respectively -38 km^3 and -34 to -36 km^3 for GR2M, ABCD and ZH3. For the Black Sea, the cumulative trends is <-1 km^3 for observed discharge but between -34 and -36 km^3 for this three models. This difference is mostly explained by the difference between observed and modeled trend for the Donau. Using gauged discharge filled with monthly WBM and extrapolated to whole drainage basin, a 22-23% decrease in river discharge was calculated for the Mediterranean drainage basin ($p<0.05$, excluding the Nile) while no significant trend was detected for the Black Sea drainage basin.

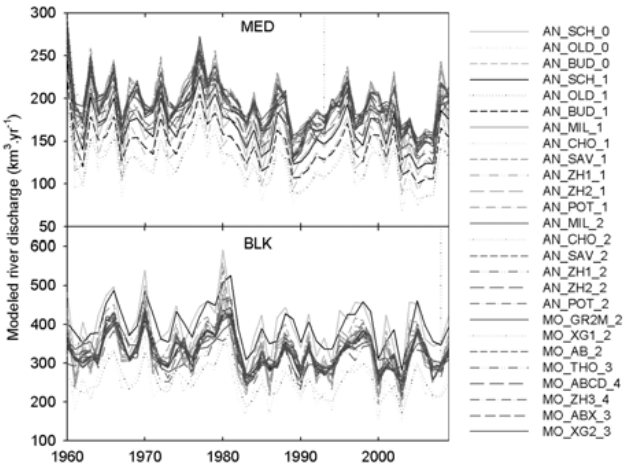

Fig. 1. Modeled annual river water discharge from 1960 to 2009 for 26% and 81% of the whole Mediterranean (MED) and Black Sea (BLK) drainage basins. AN: Annual water balance, MO: Monthly water balance. The last number specifies the count of calibrated parameters.

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DISSOLVED ORGANIC MATTER DYNAMICS IN THE GULF OF NAPLES DURING SUMMER 2012

A. Paluselli [1]*, E. Zambianchi [2], M. Gonnelli [1], S. Vestri [1] and C. Santinelli [1]
[1] CNR- Istituto di Biofisica, Pisa, Italy - andrea.paluselli@hotmail.it
[2] DiSAm, Università "Parthenope" & CoNISMa, Napoli, Italy

Abstract
The data collected in the Gulf of Naples in summer 2012 indicates that dissolved organic matter distribution is strongly affected by the complex pattern of circulation typical of the Gulf. Interestingly, freely dissolved extracellular enzymatic activity showed different values of Vmax depending on DOC concentrations. Mineralization experiment indicated a 10 µM DOC removal in two months in the stations characterized by the highest DOC concentrations. These data suggest that the surface water masses circulating in gulf of Naples show different biogeochemical properties.

Keywords: Gulf of Napoli, Organic matter, Enzymes, Coastal waters, Coastal processes

The Gulf of Naples is a semi-enclosed bay, strongly affected by anthropogenic pressures. It is characterized by a marked spatial and temporal variability in hydrodynamic processes, that make it a natural laboratory to investigate the interaction between physical and biogeochemical processes [1].
The main goal of this study is the biogeochemical characterization of different water masses in the Gulf of Naples during summer 2012. Surface distribution of dissolved organic carbon (DOC) and chromophoric dissolved organic matter (CDOM) were combined with the information coming from mineralization experiments and determination of freely dissolved microbial extracellular enzymatic activity (leucine aminopeptidase and β-glucosidase), in order to gain information about the biogeochemical properties of this area.
DOC and CDOM data were collected in 64 stations during July/August 2012 during the GELaTo (Gulfofnaples Eulerian/LAgrangian TOsca) 2012 experiment, carried out in the framework of the MED TOSCA project. Mineralization experiments and microbial extracellular enzymatic activity measurements were carried out in 7 stations, representative of the different water masses circulating in the Gulf.
DOC showed a surface distribution consistent with the occurrence of different water masses as indicated by salinity and temperature distributions (Fig. 1). The lowest DOC concentration (50-60 µM) was observed in the southern side of Bocca Grande, in the water mass incoming from the Tyrrhenian Sea and characterized by the highest salinity. Surprisingly the highest DOC values (85-90 µM) were not found in proximity to the Sarno river mouth, but in front of Naples city and in the northeastern part of the Gulf. High DOC values (75-80 µM) were also found in the northern side of Bocca Grande in correspondence with the salinity minimum. In the southern part of the Gulf, near the coast and in front of the Sarno river, DOC showed concentrations of 70-75 µM (Fig. 1).
Information on CDOM pool were obtained through absorption spectra and fluorescence excitation-emission matrix (EEMs) associated with parallel factorial (PARAFAC) analysis. Four fluorophore groups were identified and their emission/excitation spectra suggested the occurrence of protein-like, humic-like, fulvic-like compounds and of a fourth group with spectral properties similar to phenols. The distributions of CDOM was consistent with the temperature and salinity distributions, suggesting the occurrence of different fluorophores and/or different CDOM concentrations in the different water masses. In particular, the incoming water from the Tyrrhenian Sea was characterized by very low values of absorption and fluorescence, while the highest values were found close to the coast, in front of the Sarno river mouth and the Naples city, especially for humic and fulvic-like. This pattern is clearly due to terrestrial input.
Extracellular enzymatic activities can give indirect information about the substrates that are readily transformed and metabolized. Vmax of β-glucosidase (0.72-2.87 nM h-1) and leucine aminopeptidase (1.15-5 nM h^{-1}) were in agreement with the total enzymatic activity reported for the Mediterranean Sea [2], but surprisingly they showed a contrasting pattern. Vmax of β-glucosidase was maximum in the southern part of the Gulf in correspondence with the lowest DOC values and it progressively decreased until a minimum in front of Naples, where the highest DOC concentration were observed. In contrast, the Vmax of leucine aminopeptidase showed the highest value in front of Naples.
Mineralization experiments suggested the occurrence of variable concentrations of labile DOC. In the samples collected in the northern stations (characterized by high DOC concentrations), 10 µM of DOC were removed in two months, while in the stations with DOC concentrations of 65 µM 2-4 µM were removed during the same period.

These data suggest that the surface water masses circulating in Gulf of Naples show different biogeochemical properties (DOC, CDOM, enzimatic activity, mineralization experiments) and that CDOM is a very good tracers of fresh water.

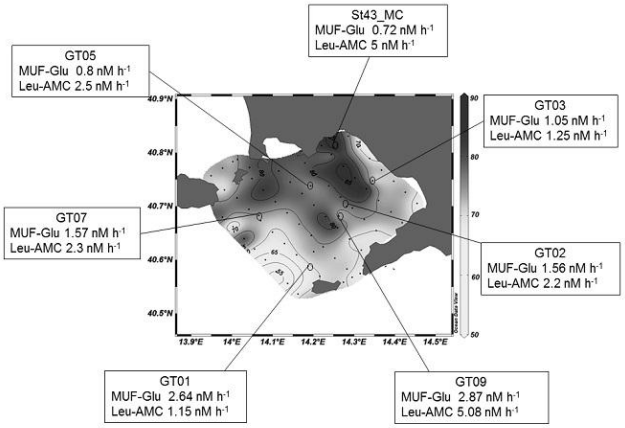

Fig. 1. Surface distribution of DOC in the Gulf of Naples. The Vmax of leucine aminopeptidase and β-glucosidase is reported for the seven stations investigated.

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DISSOLVED ORGANIC MATTER DYNAMICS IN A COSTAL AREA OF THE TYRRHENIAN SEA STRONGLY IMPACTED BY RIVER INPUTS

Simona Retelletti Brogi [1]*, Margherita Gonnelli [1], Rosario Lavezza [1] and Chiara Santinelli [1]
[1] Biophysics Institute, CNR, Pisa - simona.rb86@gmail.com

Abstract
This study report the first Dissolved Organic Carbon (DOC) and Cromoforic Dissolved Organic Matter (CDOM) data for a large coastal area of the southern Tyrrhenian Sea strongly impacted by river inputs. The input of both DOC and CDOM is well visible at the mouth of all rivers and it is correlated to the river discharge. CDOM optical properties show the occurrence of humic-like, fulvic-like and protein-like fluorophores in the riverine plumes. This work was supported by the Italian Project RITMARE.

Keywords: Geochemical cycles, Coastal processes, Bacteria, Tyrrhenian Sea, Organic matter

Dissolved organic matter (DOM) is the main reservoir of reactive carbon on the Earth and represents the main source of energy for heterotrophic prokaryotes. The fraction that absorbs light (UV and visible) is defined chromophoric DOM (CDOM) and affects the penetration and diffusion of the UV and visible light in the water, in particular in the costal environment. In coastal areas, riverine DOM undergoes to different physical-chemical (dilution, photodegradation, flocculation [1]) and biological (consumption and transformation by microbes [2]) processes.

The main goal of this work is to study DOM dynamics in a large coastal area of the Tyrrhenian Sea (from the Gulf of Salerno to the Tevere river) strongly impacted by river inputs, with particular regards to the physical and biological processes affecting riverine DOM at the river mouth.

More than 600 samples were collected for DOC analysis in October-November 2010. CTD data were kindly provided by CNR-ISAC. Information about CDOM pool were obtained on 260 selected samples, through absorption spectra and fluorescence Excitation Emission Matrix (EEM) combined with parallel factorial analysis (PARAFAC). EEM showed the occurrence of 4 different components with spectral characteristics similar to proteins, humic and fulvic acids [3].

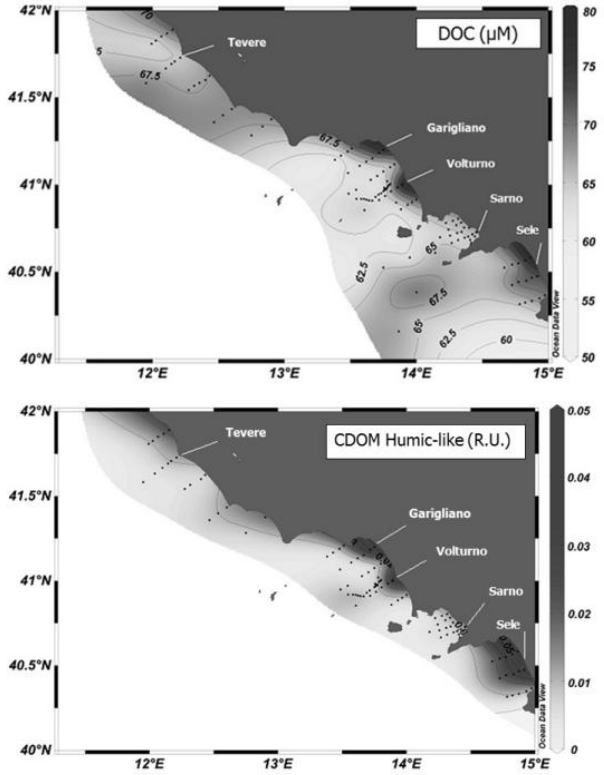

Fig. 1. Surface map of DOC and humic-like component of CDOM, individuated by EEM combined with parallel factorial analysis (PARAFAC).

The input of DOM was well visible at the mouth of all the rivers and was correlated to river discharge. DOC (73-89 µM) and CDOM (both humic and protein-like component) showed their maximum in the river plume (salinity minimum) and decreasing values going far from the coast (Fig. 1). The four groups of fluorophores showed a similar distribution confirming that rivers are an important source of CDOM in coastal areas.

The good linear correlation between DOC and salinity allowed a rough estimate of the DOC concentration in the rivers. This estimate indicates that the carbon input due to these rivers is about 50.000 ton C yr^{-1}, and represents the 21% of the whole riverine carbon input in the Western Mediterranean Sea [4, 5, 6].

In the samples collected in the riverine plume, microbial mineralization experiment showed a 6-7 µM DOC decreases in 2 months, suggesting removal rates of 3 µM $month^{-1}$. A decreasing gradient in DOC removal rate was observed going from the costal to the open sea. CDOM, in particular the fulvic-like component, showed an increase in all the mineralized samples. This suggests that microbes can be a source of CDOM in both coastal areas and open sea water, in agreement with previous studies [7].

Our data indicates that: (1) DOC and CDOM distribution are clearly affected by river input; (2) minor rivers are important in the western Mediterranean Sea carbon budget and (3) CDOM could be released by heterotrophic prokaryotes during mineralization.

This work stress the necessity of intensifying the studies in coastal areas impacted by river inputs and improving experiments with estuary microbial communities to better understand the role of heterotrophic prokaryotes in DOM transformation.

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ATMOSPHERIC DEPOSITION OF DISSOLVED NITROGEN AND PHOSPHORUS IN THE NORTH WESTERN MEDITERRANEAN

K. Violaki [1]*, P. Nikolaou [1], M. Loÿe-Pilot [2], F. Bourrin [3], N. Delsaut [3] and N. Mihalopoulos [1]
[1] University of Crete - kviolaki@chemistry.uoc.gr
[2] CERES-ERTI, Ecole Normale Supérieure, Paris, France
[3] University of Perpignan, France

Abstract
In this study the speciation, the sources and the biogeochemical significance of soluble atmospheric P and N over the North-Western Mediterranean is investigated. Our results show that the annual average atmospheric deposition of TDN and DIN are estimated at 62.9 and 51.9 mmol m^{-2} y^{-1} respectively, while the average percentage contribution of DON to TDN was 25%. The annual average atmospheric deposition of DIP was calculated to 0.6 mmol m^{-2} y^{-1}, while the average TDP was 2.9 mmol m^{-2} y^{-1}.

Keywords: Atmospheric input, North-Western Mediterranean, Nutrients

The Mediterranean Sea (MS) has any of the most oligotrophic surface waters in the world, but displays a great heterogeneity, especially in the Western Basin [1]. The average annual productivity in the Mediterranean Sea is typical of oligotrophic waters, ranging from 80–90 g C m^{-2} y^{-1} estimated by the classical methods [2] to 130-140 g C m^{-2} y^{-1} given by satellite images [1]. Previous studies have shown that atmospheric inputs are an important source of nutrients (N and P) to the MS [3,4], even in productive zones such as the NW Mediterranean [5]. Atmospheric dissolved inorganic nitrogen (DIN) input to the Western Mediterranean is of the same order of magnitude as riverine input [6]. During the last decades, special attention has been drawn to the inorganic forms of nitrogen and phosphorus and particularly to the inorganic forms of nitrogen (NO_3^- & NH_4^+).
This study aims to investigate the sources, forms and the biogeochemical significance of soluble atmospheric P & N over the North Western Mediterranean Sea. Bulk deposition samples (n=84) have been collected at Cape Bear (Perpignan, France) during a seven year period (2005-2011)and analyzed for P and N speciation. The dissolved inorganic nitrogen (DIN) was measured by ionic chromatography. The dissolved organic nitrogen (DON) was determined by subtracting DIN from the total dissolved nitrogen (TDN), measured as NO_3^- after persulfate oxidation. Details about the methodology can be found elsewhere [7]. Total dissolved phosphorus (TDP) was measured on the acidified samples following by persulfate digestion method. Dissolved organically bound phosphates (DOP) were determined by subtracting TDIP from TDP. Details about the analytical protocol can be found elsewhere [8]. Our results show that the annual average TDN and DIN atmospheric deposition fluxes are 62.9 and 51.9 mmol m^{-2} y^{-1}, respectively, while the average percentage contribution of DON to TDN is 18%. The dominance of inorganic nitrogen species in Total nitrogen pool N is presented in Fig.1.

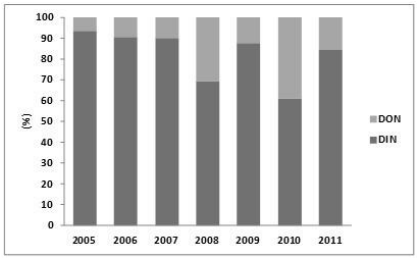

Fig. 1. The percentage contribution of nitrogen species to TN during the years 2005-2011.

The annual average atmospheric deposition of DIP is 0.6 mmol m^{-2} y^{-1}, while the average TDP is 2.9 mmol m^{-2} y^{-1}. The average DIN/DIP ratio in atmospheric deposition samples is calculated at 86, which is in agreement with previous study (Markaki et al., 2010). Almost equal contribution of organic and inorganic forms of total phosphorus has been observed as depicted in Fig.2.

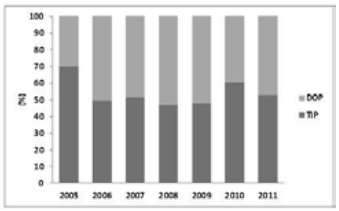

Fig. 2. The percentage contribution of phosphorus species to TDP during the years 2005-2011.

A source apportionment analysis is performed from the chemical speciation for the major ions. The results will be presented and the factors controlling the P & N concentration levels in deposition samples over the North Western Mediterranean will be thoroughly examined.

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Session

Chemical fluxes - 2

Modérateur : **Christian Tamburini**

THE WINTER NUTRIENT PROFILE OF OXIC/ANOXIC INTERFACE LAYER IN THE SOUTHEASTERN BLACK SEA WATER COLUMN

Ali Alkan [1]*, Dilek Fidan [2] and Serkan Serdar [2]
[1] Karadeniz Technical University Maçka Vocational School - alialkan@gmail.com
[2] Central Fisheries Research Institute

Abstract
Water column winter nutrient profiles were evaluated of 250 m especially oxic/anoxic interface layer in Southeastern Black Sea. Although nutrient concentrations according to the depth are difference, density profiles are similar. Silicate concentrations were increased depending on depth while maximum phosphate concentration observed with the boundary of the 16,2 density. Ammonium concentrations increased depending on depth below 16.2 density layer. Minimum temperature of the CIL were measured at 100 meter depth of TY, OM and OF statiton while were measured at 75 meter of AA and SB stations. Nitrite maximas were usually observed bottom boundary of oxic layer except for AA station. Nitrate maximas were showed differences on stations according to depth and concentration. Chlorophyll-a maxima, usually at a depth of 30 m and 13.8 sigma-t.

Keywords: Nutrients, Black Sea, Anoxic basin, Redox, Oxygen

Introduction
The Black Sea is the world's largest anoxic water body and H2S gas available below oxic layer which is initial depth depending on the region [1-4]. The Black Sea, due to their characteristic hydrochemical structure, is used as a natural laboratory for studies of actual processes in oxic / anoxic intermediate layer. Winter mixing leads to formation of a cold intermediate layer oxygen-enriched at a depth of approximately 60-100m[3]. Also the Black Sea is serious threat of climate change and intensive anthropogenic pollutants. Various changes were observed in the natural ecosystem of the Black Sea as a results of changes in the composition of nutrients (increase in nitrate, decrease in Si), entry of alien species (mneiopsis, beroa), due to international shipping etc. For this reason, temporal variation of the processes that occur in the Black Sea's the chemical system and the redox boundary is actual and important issues [3]. This study was conducted at least affected areas from two factors are important for the Black Sea hydrodynamic.

Material Method
This study was carried out in February of 2012 in selected 5 stations to represent the Southeastern Black Sea. Stations were 10 nautical miles from the shore (Fig1).

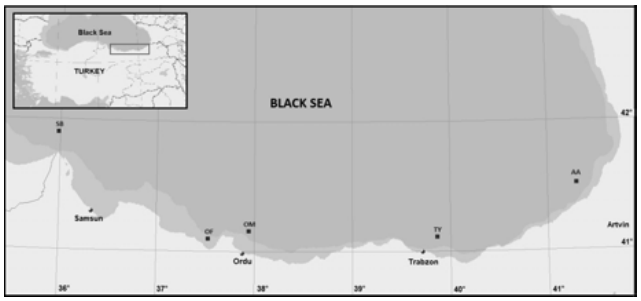

Fig. 1. Map of sampling area

Physicochemical parameters (Temperature, salinity, conductivity, pH, DO, ORP, chlorophyl-a, transmission) of the water column were measured with Sea Bird SBE 25 CTD profiler.Sampling was made at intervals of 5 meters in oxic/anoxic interface layer. DO were measured by winkler method and H2S was measured by titration. Nutrient analyses made with the Seal CFA.

Results and Discussion
SST were measured 8,61-9,69°C at stations. Minimum temperatures were different depths of the cold intermediate layers at the stations and the lowest temperature was measured as 7,23°C in the CIL. Average nutrient concentrations were determined for nitrate, nitrite, phosphate and silicate as 0.48 µM, 0.07 µM, 0.02 µM, 4.16 µM and 0.11 µM, respectively in the first 50-meter oxic layer. Maximum nutrient concentrations were measured for nitrate as 5,54 µM, for nitrite as 0,25 µM, for phosphate as 6,87 µM, for silicate as 161 µM and for ammonium as 22 µM in the water columns. Si concentrations increased depending on depth and phosphate maximas were observed at 16.2 density layer. It was found that hydrogene sulphide starting depth was under 150 meter. Average H2S was determined as 0.18±0.09 mg/L at 175 m, 0.60±0.06 mg/L at 200 m, 0.92±0.18 mg/L at 225 m and 1.52±0.05 mg/L at 250 m. Dissolved oxygen values started to decrease rapidly after 50 meters and drops close to zero at 160-200 meter depth related to stations in this study. It was found that ORP values were started to decrease rapidly after 150-160 m depths all stations. Maximum chl-a concentrations were differ from each stations and chl-a maximas were found about 30 m depth at all stations. Except OM station, nitrite maxima usually was determined at 15.6 sigma-t density layer (Fig 2)

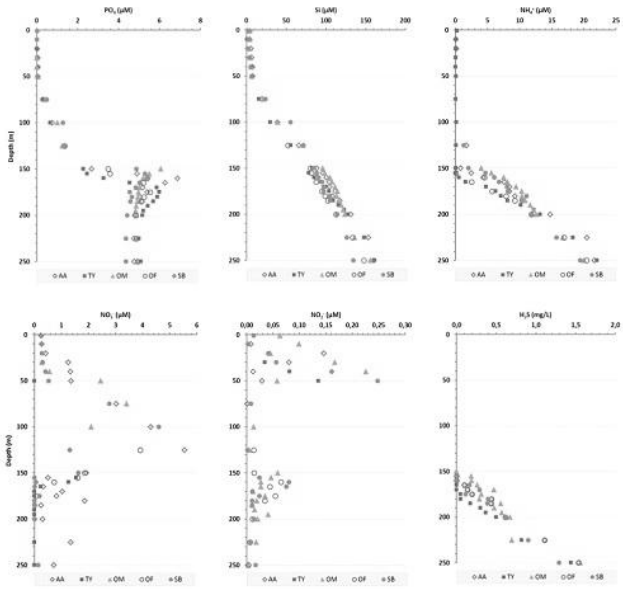

Fig. 2. Nutrient concentrations of Black Sea water column

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DOM EXTRACELLULAR RELEASE BY *E. HUXLEYI*

B. Charrière [1]*, C. Santinelli [2], M. Gonnelli [2], S. Vestri [2], F. Vaultier [1], J. Rontani [1], M. Vaitilingom [1], A. Barani [1] and R. Sempéré [1]

[1] MIO, UM 110, Aix Marseille Universite - bruno.charriere@univ-amu.fr
[2] CNR-IBF, Pisa, Italy

Abstract

The role of phytoplanktonic DOM release is poorly understood. In the framework of a CNR-CNRS cooperation project, strictly linked to MERMEX, we studied the release of extracellular dissolved organic matter (DOM) by viable phytoplankton in a culture of *E. huxleyi* during four months. DOM was mainly released after 41 days even if the highest increase in both DOC and CDOM was observed after 4 months. The fluorescence increased with CDOM content but its relative composition remained constant along the experiment. The DOM release by *E. huxleyi* can be mineralized with high mineralization rates by *heterotrophic bacteria iso*lated from Mediterranean coastal seawater

Keywords: Geochemistry, North-Western Mediterranean, Diatoms

Results Phytoplankton plays a key role in DOM production and release in oceanic water, since it is the most important group capable of producing organic molecules starting from CO_2 and inorganic nutrients. Primary production sets an upper limit to DOM production. It is not clear what is the most important mechanism of DOM release through the food web, however phytoplankton seems to be the main producer of labile DOM, that is the DOM that can be used by heterotrophic prokaryotes on a temporal scale of hours-days. Literature data show that the amount and molecular characteristics of organic molecules released by phytoplankton depends on the specie, growth phase as well as the health of the population [1]. Here we report the results of a 5 month experiment focused on the study of dissolved organic matter released by a 2 liter culture of a non-axenic strain of *E. huxleyi* (Strain CS 57 from CISRO culture collection) . Dissolved organic carbon (DOC), absorption spectra and fluorescence excitation emission matrix (EEM) of CDOM as well as phytoplankton cells (measured by flow cytometry) were measured during time course experiment. This algae is an interesting model since it is cosmopolitan and a major contributor to primary production in the open oceans. The results (Fig. 1) showed an exponential growth of *E. huxleyi* in the first 8 days, while DOC concentration showed just small variations, with a slight increase (30 µM) at day 8. In the following 8 days E. Huxley declined and DOC was characterized by a second pick of 284 µM at day 14s, when the number of cells was at its lowest (at the end of the decline phase). Surprisingly, after the decline, the population started to growth again and entered in stationary phase in which DOC showed a 133 µM increase until the 41 day. EEM showed the occurrence of three groups of fluorophores with characteristics similar to proteins (λex = 280 nm, λem= 350 nm), Fulvic (λex=310 nm, λem=435) and humic (λex=270, 360, λem=480 nm) acid. Surprisingly, after 4 months all the parameters showed an impressive increase. We found that the number of *E. huxleyi* cells was 3-times higher than after 41 days, whereas DOC concentration reached 1031 µM and both absorption and fluorescence increased 3.5 times in the same period.

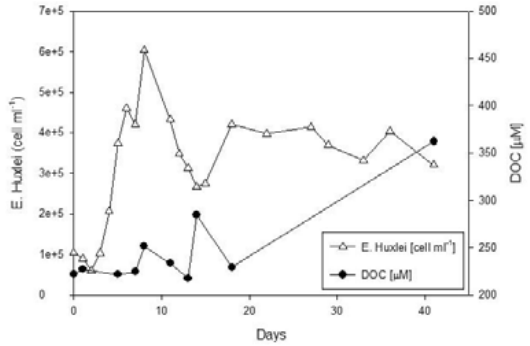

Fig. 1. Cell abundance (by flow cytometry) and DOC content during the growth of *E. huxlei*.

Such dynamic was not observed in previous studies because the experiments were generally stopped after 15-22 days [1, 2]. In order to test the lability of DOM released during the various stages of cell growth, the exudates collected after 14 days (285 µM DOC) and 4 months (1030 µM DOC) were inoculated with coastal seawater from Pisa (filtered at 0.8 µM) and DOC was measured monthly for the following three months, in order to study its removal rates. This second experiment showed an exponential decrease of DOC concentrations with the total removal of 22 and 117 µM in the exudates collected after 15 days and 4 months, respectively indicating the DOM released by *E. huxleyi* is labile and its removal rates are markedly higher for the molecules released in the old culture (4 month), when the highest DOC concentration were observed.

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GEOCHEMICAL CHARACTERISTICS IN RECENT DEEP SEDIMENTS FROM THE GULF OF LION : TRACE METALS, ORGANIC MATTER, REDOX CONDITIONS AND GRAIN-SIZE DISTRIBUTION

C. Dumas [1]*, D. Aubert [1], R. Buscail [2], C. Sotin [1], C. Menniti [1], X. Durrieu de Madron [2] and W. Ludwig [1]
[1] Univ. Perpignan Via Domitia, CEntre de Formation et de Recherche sur les Environnements Méditerranéens, UMR 5110, F-66860, Perpignan, France - chloe.dumas@univ-perp.fr
[2] CNRS, CEntre de Formation et de Recherche sur les Environnements Méditerranéens, UMR 5110, F-66860, Perpignan, France

Abstract
Few studies dealing with geochemical properties of the sediment have been done in the abyssal plain. This work aims at assessing the role of physico-chemical conditions and diagenetic processes on trace metals enrichment, and especially on anthropogenic inputs. It is based on samples taken during the CASCADE campaign in the Gulf of Lion (March 2011).

Keywords: Trace elements, Organic matter, Deep sea sediments, Gulf of Lyon, North-Western Mediterranean

Most studies on the geochemical properties of the sedimentation in the western Mediterranean Sea have been performed in slope and margin environments of the Gulf of Lion ([1], [2], [3]). On the contrary few have been done in the abyssal plain ([4], [5]) where sedimentation rates have been modeled and where enrichment of contaminants has been evidenced ([6]).

Geochemical characterization of the deep deposits is of importance in the global study of benthic processes and their modifications through anthropogenic inputs. Discrimination between natural and anthropogenic origins is rather complicated here due to diagenetic transformations that happen in deep sediment and that can cause misinterpretation in trace metals accumulations.

The aim of this work is to assess the role of physico-chemical conditions during the sedimentation and early diagenesis processes in the control of trace metal accumulation in deep environments of the Gulf of Lion.
During the CASCADE cruise (1-31 March 2011) sediment cores were collected using a multi-tube corer at three stations located between 1957 and 2657m in the northwestern mediterranean basin (Fig.1).

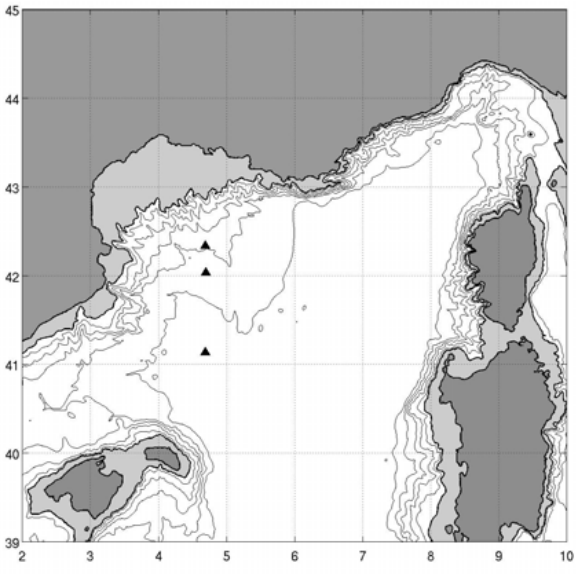

Fig. 1. Location of CASCADE sediment core sampling in the Gulf of Lion

Physico-chemical conditions such as redox potential, pH, porosity and grain-size distribution were considered in order to evaluate changes in relation with environmental and hydrodynamic factors. The first indication for diagenetic processes is given by the thickness of the oxidised mud layer. We find that in these deep-sea deposits the redox discontinuity is located below 25 cm depth. Oxidised layers are hence important and correspond to low sedimentation rates, i.e. a long residence time at the sediment-water interface (SWI). This is supported by the vertical distribution of Mn in the cores which follows a positive gradient from the deepest layers to the surface.
Porosity profiles in sediment cores show a regularly decreasing trend. Grain-size distribution allows to define the sedimentological facies and is hence an important parameter in the interpretation of geochemical data.
The role of carbonates and organic matter is especially important with respect to the enrichment and complexation of metallic elements in sediment. Organic carbon (OC), total nitrogen (TN), C/N ratios, have been measured in order to determine the organic matter origin, abundance and distribution with burial depth. Trace metal concentrations are of the same order of magnitude in each core, with a mean of 42 µg/g of Ni, 33 µg/g of Cu, 76 µg/g of Zn and 26 µg/g of Pb.
The south core (M01) is a classic example where values (OC, trace metals concentrations) are high at the top of the core and then decrease with depth. Nevertheless this core exhibits the highest concentrations of Cu, Zn and Ni (with 230, 160 and 106 µg/g respectively) in a single peak at 2 cm depth.
The north core (M08) shows high values of OC and C/N at 6 cm depth, which is likely the signature of a terrestrial imprint. Trace metals, and Mn concentrations in particular indicate the burial of a redox front at 15cm depth which implies a late turbidite deposition.
The central core (SC2400) shows a classic profile except for a peak in OC at 3cm depth that is characterized by high concentrations of trace metals (Mn, Ni, Cu, Zn).

All these results allow us to draw a first cartography of this abyssal environment in terms of sedimentological properties.

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AN UPDATED SILICA BUDGET FOR THE EASTERN MEDITERRANEAN

Michael Krom [1]*, Kent Fanning [2] and Nurit Kress [3]
[1] Charney School of Marine Haifa University - M.D.Krom@leeds.ac.uk
[2] College of Marine Science, University of South Florida
[3] Israel Oceanographic & Limnological Research, National Institute of Oceanography

Abstract
An updated silica budget for the Eastern Mediterranean Sea (EMS) including both silicate and particulate biogenic silica (BSi) showed a net outflow of 27 x 10^9 molesSi/yr. This deficit suggests that the terms in the budget are still as not well defined. The major term in the budget is the exchange at the Straits of Sicily with 137 x 10^9 molesSi/yr flowing into the EMS and 258 x 10^9 molesSi/yr flowing out. Other important terms are the riverine input (34 x 10^9 molesSi/yr) and diagenetic supply of silicate from underlying sediment (54 x 10^9 molesSi/yr). Dust is a minor input (5 x 10^9 molesSi/yr). New focused measurements needed to close the budget should include improved riverine flux, better measurements of diagenetic weathering of clays in the water column and sediment, sediment burial flux and coastal recycling processes.

Keywords: Nutrients, South-Eastern Mediterranean

Nutrient budgets have been used extensively to understand biogeochemical cycling processes in the Eastern Mediterranean[1-2].The most recent silica budget for the EMS [3] found that the net flux of silica out of the basin was far higher (157-250 x 10^9 molesSi/yr) than the best estimates available for the inputs from rivers and other sources. Here we present an improved updated budget that takes into account fluxes of biogenic silica (BSi) which is likely to dissolve in the highly unsaturated waters of the EMS. The silicate flux through the Straits of Sicily was calculated using water flow rates determined in 1997 [4] . Measured silicate from the MTPII-MATER database was used. Crombet et al., [5] found 0.25 µmoles/l of BSi concentration in the upper (inflowing) water column with no BSi in the outflowing water in July 2009 when primary productivity was at a minimum. Here we assumed that dissolved silicate measured in November surface waters (mean value = 3 µmoles/l) was representative of the winter bloom conditions (6 months) and will be taken up as BSi and that total average BSi concentration of 1 µmoles/l during summer stratified conditions The calculated flux of silicate from diagenetic processes in the sediment was 54 x 10^9 MolesSi/yr [6]. We assume that this silicate is all formed from in-situ clay diagenesis since there is no evidence of dissolution of BSi derived silica in the uppermost layers[7]. The estimated average riverine flux between 1963 and 1998 was 23 x 10^9 molesSi/yr [8] but they underestimate the global flux of silica to the ocean because it does not include BSi [9]. We therefore used the global average of 50% for BSi to modify our riverine flux. Finally we determined the atmospheric flux as 5.2 x 10^9 molesSi/yr.

Tab 1 : of calculated fluxes of silicate and BSi into and out of the EMS

Input to the Eastern Mediterranean	**Flux (10^9 Mol/yr)**	**Comment**
Straits of Sicily – dissolved silicate	121	<100m in summer & <200m in winter [4]
Straits of Sicily – BSi	16	See text above for BSi concentrations converted to flux using Astraldi et al., [4] water flow rates.
Riverine input – dissolved silicate	23	Ludwig et al., [8]
Riverine input – BSi	11.5	Assumed value from Conley [9]
Sediment pore water flux	54	Jones [6] assumed to be all fluxing Si is diagenetic based on [7]
Atmospheric input – BSi	5.2	Krom unpublished data
Total input	**203.7**	
Output from the eastern Mediterranean		
Straits of Sicily – dissolved silicate	258	>100m in summer & >200m in winter.[4]
Sediment burial flux	0	Assumes all BSi dissolves
Net export flux	**-27.3**	

With the inclusion of BSi in this budget and maximising all possible external inflow terms, the net deficit of silica, 27.3 x 10^9 MolesSi/yr is much reduced compared to previous estimates of 157-250 MolesSi/yr. We conclude that dissolution of external biogenic silica and diagenetic clay weathering is an important source of silicate to the basin. Another potentially important process not included in this budget is silica cycling processes in coastal areas. To further improve the budget it is necessary to better quantify the annual BSi in the surface inflowing waters at the Straits of Sicily and contribution from rivers and from the sediments both offshore and in coastal regions. References:

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SEDIMENTARY POLYCYCLIC AROMATIC HYDROCARBONS IN THE EASTERN MEDITERRANEAN SEA (IONIAN, AEGEAN AND LEVANTINE BASINS):OCCURENCE, SOURCES AND TRANSPORT PATHWAYS

Constantine Parinos [1]*, Alexandra Gogou [1], Ioanna Bouloubassi [2] and Ioannis Hatzianestis [1]
[1] HCMR, Institute of Oceanography, Anavyssos, Attiki, Greece - ksparinos@hcmr.gr
[2] LOCEAN-IPSL, CNRS Université P. et M. Curie, Paris, France

Abstract
Polycyclic aromatic hydrocarbons (PAHs) were investigated in surficial sediments collected from 46 stations in the open Eastern Mediterranean Sea (Aegean, Ionian and NW Levantine basins), in order to assess their distribution, sources and transport pathways. Total PAH concentrations were generally low ranging from 8.76 to 184 ng g^{-1}. Their molecular profiles reveal contributions from both pyrolytic and petrogenic sources, with their relative importance displaying significant regional variability. PAH concentrations are significantly correlated with the total organic carbon (TOC) content of sediments, which indicates that the latter exerts an important control on their transport and ultimate accumulation in sediments. Strong sub-basin variability of water masses also impact the regional patterns of sedimentary PAH accumulation.

Keywords: Pah, Sediments, Pollution, North-Eastern Mediterranean

Polycyclic aromatic hydrocarbons (PAHs) are widespread components in marine systems in which they enter through both atmospheric and aquatic pathways. Therein association with sinking particles is considered as the major mechanism of their downward transport through the water column and subsequent accumulation in sediments. Mostly originating from various anthropogenic activities, PAHs are included in lists of priority pollutants (EU-EEA, US-EPA) since certain homologues are highly carcinogenic/mutagenic to both aquatic and sediment dueling organisms. The Eastern Mediterranean Sea (EMS) is a region under intense anthropogenic pressure resulting in pollutant discharges [1]. Although PAH burden of surficial sediments in the EMS has been thoroughly studied in coastal sites, much less attention has been given to open sea and deep basin settings [2, 3].

In this study, surficial sediments from the open EMS including Aegean, Ionian and NW Levantine basins were analyzed for fourteen PAH compounds (parent and alkyl substituted), in order to assess their distribution, major sources and transport pathways. Samples were collected from 46 stations during various oceanographic cruises between 1998-2012 and PAHs were analyzed by GC-MS [2, 3].

Total PAH concentrations (Figure 1) were generally low ranging from 8.76 to 184 ng g^{-1} comparable to those reported in relatively unpolluted open sea and coastal marine areas. Within the Aegean Sea, higher concentrations were recorded in the northern part (max. 184 ng g^{-1}, aver. 91.1 ng g^{-1}) which likely reflects anthropogenic inputs from major rivers outflowing in the area. The lower concentrations recorded in South Aegean Sea (max. 147 ng g^{-1}, aver. 49.9 ng g^{-1}) are related to the absence of fluvial inputs and the oligotrophic character of the area, which results in lower accumulation of sedimentary organic matter and associated pollutants. In the deep basins of the Ionian Sea and NW Levantine Sea, PAH concentrations averaged 50.4 ng g^{-1} showing an increasing westward trend with maximum concentrations (153 ng g^{-1})found in the central Ionian Sea. TOC contents presented a similar spatial trend.

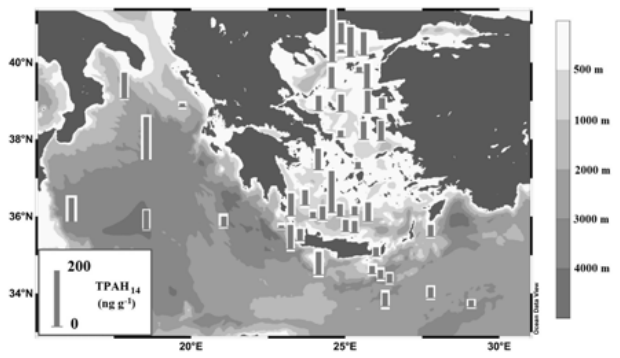

Fig. 1. Concentrations of sedimentary PAHs across the open Eastern Mediterranean Sea

The molecular profile of low- and high- MW PAHs reflects an admixture of both unburned fossil sources and combustion/pyrolysis of fossil fuels. The composition of PAH mixtures displayed significant variability which reflects regional differences in the relative importance of sources. PAH concentrations correlated significantly with the TOC content of sediments, indicating that organic carbon exerts an important control on their transport, fate and ultimate accumulation in the study area, while strong sub-basin variability of water masses also impact their regional characteristics. Our results imply a transport of more soluble, light petrogenic PAHs from the central Aegean Sea towards the EMS through the western Cretan-Antikythera straits canyons, the latter acting as a sink of organic carbon and associated PAHs.

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VARIABILITÉ SAISONNIERE DE LA MATIÈRE ORGANIQUE DISSOUTE COLORÉE EN ZONE MEDITERRANÉENNE CÔTIÈRE

Elvia D. Sanchez-Perez [1]*, Pascal Conan [1], Celia Marrasé [2] and Mireille Pujo-Pay [1]
[1] UPMC Université Paris 06, UMR 7621, INSU-CNRS, Laboratoire d'Océanographie Microbienne, Observatoire Océanologique, F-66651 Banyuls/mer, France - denisse.sanchez@obs-banyuls.fr
[2] Institut de Ciéncies del Mar, CMIMA-CSIC, Barcelona, Spain

Abstract
Un suivi multiparamétrique de 8 mois sur une station côtière (golfe du Lion, Méditerranée Nord occidentale) permet de décrire la variabilité saisonnière de la matière organique dissoute colorée (CDOM) et de préciser son origine et son devenir. Au cours du cycle saisonnier, la concentration de la CDOM permet de montrer l'importance dominante des apports continentaux par rapport à la production autochtone de matière, même lors du développement d'efflorescences phytoplanctoniques et de montrer l'importance relative de l'exportation vis à vis des consommations par le compartiment bactérien.

Keywords: Organic matter, Gulf of Lyon, North-Western Mediterranean, Nutrients, Phytoplankton

La matière organique dissoute colorée (CDOM) joue un rôle clé dans la régulation de la pénétration de la lumière dans l'océan, en absorbant les ondes électromagnétiques à forte énergie du spectre (visible et rayonnement ultraviolet). D'un côté, cela protège les organismes aquatiques d'une photo-dégradation potentielle, mais d'un autre côté, cette énergie n'est plus disponible pour la photosynthèse (1, 2). Outre des apports continentaux, les principales sources de CDOM en milieu marin sont différents processus physiques et biologiques tels que le photo-blanchiment, la photo-humification, ou la bio-génération, qui agissent autant comme des puits que comme des sources de CDOM. L'objectif de la présenteétude est d'apporter **des informations quant à l'origine et à la dynamique de la CDOM** dans les écosystèmes marins côtiers méditerranéens. La CDOM est dosée par fluorescence de l'échantillon d'eau de mer filtré sur 0.2µm et quantifiée à l'aide d'une gamme d'étalonnage de quinine. L'interprétation est faite en utilisant les valeurs de couples émission/excitation (EM/EX) caractéristiques: 370/460 et 370/450 caractérisent deux types de substances humiques d'origine terrestre et 370/500 caractérise plutôt des substances d'origine marine (3). Cela permet d'avoir des informations sur la composition et l'origine de la CDOM sur la base de fluorophores dominants.

La zone d'étude (station "SOLA" 42°29'300 N – 03°08'700 E) est caractérisée par un cycle saisonnier bien marqué avec le développement d'un bloom phytoplanctonique printanier (avril) qui consomme rapidement les sels nutritifs introduits au cours de l'hiver. Au cours du suivi, les températures sont minimales à la fin de l'hiver (11°C) puis augmentent pour atteindre un maximum (23 °C) en début septembre (Figure 1a). La salinité (proche de 38) est marquée par des épisodes de légère dessalure (mai, juillet août et octobre) traduisant l'influence d'apports continentaux pendant les périodes de précipitations intenses et/ou de crues des rivières locales ou du Rhône. Les concentrations en sels nutritifs sont variables, avec des valeurs minimales en été (limite de détection des méthodes classiques) qui atteignent respectivement 1.06 µM et 0.06 µM en nitrate et en phosphate (Figure 1b). La diminution des sels nutritifs est concomitante à l'apparition d'un bloom printanier prononcé (1.8 µgCHL.L^{-1}; Figure 1c).

Les variations saisonnières et à méso échelles décrites précédemment, sont également bien observées dans le compartiment organique dissous. Les concentrations en carbone organique dissous (DOC) sont marquées par 2 maxima, l'un en fin de printemps en relation avec la fin du bloom printanier et l'autre en fin d'été, suite à l'accumulation de DOC dans les couches superficielles comme déjà discutées pour l'azote (4). Ce processus d'accumulation est accentué par les apports continentaux et par les processus de photo-dégradation.

Au cours du suivi, quelque soit le couple EM/EX considéré, les concentrations en CDOM sont faibles en hiver (<0.2 QSU en février et septembre) et maximales au printemps (<1.4 QSU en avril) au moment des maxima mesurés DOC (Figure 1d). La valeur maximale (1.8 QSU) est mesurée pour le couple 370/500 en mai, c'est-à-dire après le bloom printanier lorsque les nutriments sont faibles et la colonne d'eau stable et stratifiée. Un second maximum en CDOM (1.4 QSU) est mesuré en novembre, de nouveau après le pic de chlorophylle, mais sans augmentation significative du DOC cette fois-ci. D'une façon générale la station SOLA en surface est plutôt influencée par des substances humiques d'origine terrestre. Cela indique notamment le rôle important et dominants des sources continentales allochtones en zone côtière quelques soit le débit des fleuves. Seules 8 (3/03 ; 10/05 ; 25/06 ; 02/07 ; 16/07 ; 29/08 ; 03/09 ; et 22/10) des 23 dates échantillonnées sont caractérisées par une CDOM d'origine plutôt marine, démontrant qu'à l'échelle annuelle, la MOD autochtone est rapidement exportée soit vers la profondeur soit vers les zones plus au large (rôle de source de matière des zones côtières).

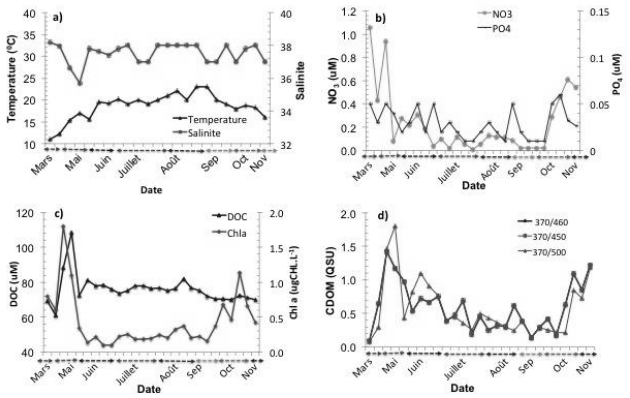

Fig. 1. Suivi à la station SOLA de a) Salinité et Température (°C) et des concentrations en b) nitrate (NO_3) et phosphate (PO_4) en µM, c) en chlorophylle *a* (Chla en µgCHL.L^{-1}) et en carbone organique dissous (DOC, µM), et d) en CDOM (QSU) selon les 3 couples EM/EX (307/460, 370/450 et 370/500).

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BENTHIC NUTRIENT FLUXES IN CENTRAL AND SOUTHERN ADRIATIC AND IONIAN SEAS

Federico Spagnoli [1]*, Gabriella Bartholini [2], Bruno Capaccioni [2] and Patrizia Giordano [3]
[1] ISMAR-CNR, Ancona, Italy - f.spagnoli@ismar.cnr.it
[2] University of Bologna, Italy
[3] ISMAR-CNR, Bologna, Italy

Abstract
Pore waters were collected and benthic fluxes were calculated at the sediment water interface in 7 stations in Adriatic and Ionian sea to asses the importance of different hydrodynamic and morphological features on early diagenetic processes. Benthic fluxes reflect regional differences due to different quality and quantity of organic matter inputs.

Keywords: Geochemical cycles, Ionian Sea

Establishing the magnitude of benthic fluxes is important for understanding geochemical budgets and for determining the role of early diagenetic processes in sediments. It is known that the burial of organic carbon (OC) in marine sediments is one of the major long-term sinks of reduced carbon on Earth ([1]; [2]) and the long-term sink of particulate OC in marine sediments contribute to moderate atmospheric CO_2 levels on geological time scales [3]. For this reason several efforts have been made to understand early diagenetic zonation and evaluate the associated benthic fluxes. The objectives of the present study are to document the features controlling the early diagenetic processes in areas of different sedimentation in the central Mediterranean Sea (Adriatic and Ionian seas) and to quantify the related reaction rates and fluxes. The study has been carried out in 7 stations characterized by different bathymetry, hydrological setting and trophic conditions. Northern stations, located in the central and southern Adriatic depressions, are characterized by shallow depths, higher sedimentation rates and higher organic matter inputs. Southern stations, located in the Northern and Central Ionian Sea, are characterized by increasing depths, different provenances of terrigenous sediments, lower productivity, lower sedimentation rates and organic matter inputs. In each stations sediment cores were collected to extract pore waters and to calculate diffusive benthic fluxes. Benthic diffusive fluxes highlighted regional differences between the Adriatic and Ionian basins reflecting the early diagenesis processes recorded in the Adriatic and Ionian pore water profiles. Higher inputs of reactive organic matter promote a northern-southern and shallow-deep trend in Adriatic sediments. These sediments are characterized by lowering of remineralization processes in accord with bathymetry, dissolved oxygen fluxes (Fig. 1) into the sediments and Dissolved inorganic Carbon (DIC) fluxes outside the sediments (Fig. 2). Ammonium and nitrate fluxes are complicated by the nitrification/denitrification processes occurring in the oxic zone. In the Ionian basin the remineralization processes takes place mainly by means of oxic reactions-the depth of oxygen penetration is higherthen a lower oxygen uptake and intense NH_4 production occur (Fig. 1, 2), the denitrification processes reach greater depths and produce lower organic matter degradation product. This means that the inputs of reactive organic matter in this area are lower for the lower productivity of this basin, for the greater water column depth and for the higher distance from fluvial inputs. However, an inverse DIC flux occur, Adriatic sediments are a net source of DIC while Ionian sediments show negative fluxes (sink of DIC) suggesting a possible precipitation of carbonate.

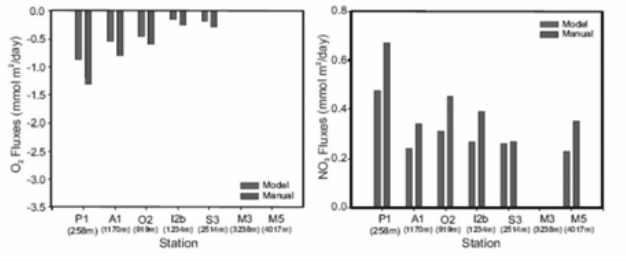

Fig. 1. Oxygen and nitrate fluxes at sediment water interface calculated by Fick's law (black line) and by model (grey line).

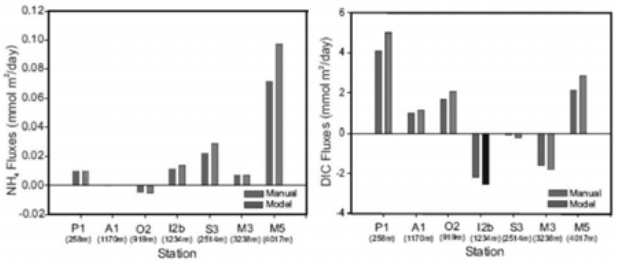

Fig. 2. Ammonium and DIC fluxes at sediment water interface calculated by Fick's law (black line) and by model (gray line).

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IMPACT OF OPEN-OCEAN CONVECTION ON PARTICLE FLUXES AND SEDIMENT DYNAMICS IN THE DEEP MARGIN OF THE GULF OF LIONS

M. Stabholz [1]*, X. Durrieu De Madron [1], M. Canals [2], A. Khripounoff [3], I. Taupier-Letage [4], P. Testor [5], S. Heussner [1], P. Kerhervé [1], N. Delsaut [1], L. Houpert [1] and G. Lastras [2]

[1] CEFREM, CNRS, Université de Perpignan Via Domitia, UMR 5110, 52 avenue Paul Alduy, 66860 Perpignan, France. - marion.stabholz@univ-perp.fr

[2] GRC Geociències Marines, Departament d'Estratigrafia, Paleontologia i Geociències Marines, Universitat de Barcelona, C/Martí i Franqués, s/n, 08028 Barcelona, Spain.

[3] IFREMER, Département EEP/LEP, Centre de Bretagne BP70, 29280 Plouzané Cedex, France.

[4] Aix-Marseille Université, Université du Sud Toulon-Var, CNRS/INSU, IRD, MIO, UMR 6117, UM 110, 83507 La Seyne sur Mer, France.

[5] LOCEAN, CNRS, IRD, Université Pierre et Marie Curie, MNHN, UMR 7159, 4 place Jussieu, 75252 Paris, France.

Abstract

The deep outer margin Gulf of Lions and the adjacent deep basin, in the western Mediterranean Sea, are regularly impacted by open-ocean convection, a major hydrodynamic process responsible for the ventilation of the deep waters. The impact of open-ocean convection on the flux and transport of particulate matter remains uncertain. We present results of 5 mooring lines deployed in the deepest part of the continental margin and the deep basin between September 2007 and April 2009. Our results on temperature, salinity, currents, and near-bottom fluxes suggest that the winter 2008-09 open-ocean deep convection event resulted in significant remobilization of bottom sediment with a subsequent alteration of the seabed likely impacting the functioning of the deep-sea ecosystem.

Keywords: Particle flux, Deep sea sediments, Water convection, Organic matter, North-Western Mediterranean

Introduction

Albeit the deep-sea is the largest ecosystem on Earth, not much is known about how it is affected by changes in environmental conditions controlling the cycling of biogeochemical compounds, the distribution of deep-sea habitats or the functioning of ecosystems. Dense water convection represents, among physical processes influencing circulation in the deep-sea, one of the few linking the surface ocean to the deep ocean and, ultimately, to the seabed. The Gulf of Lions and the adjacent basin, in the western Mediterranean Sea, are regularly impacted by open-ocean deep convection responsible for the ventilation of the deep water in the western Mediterranean Basin. However, the impact of open-ocean convection on the flux and transport of particulate matter remains poorly understood.

Material and method

The variability of water mass properties (i.e., temperature and salinity), currents, and particle fluxes were monitored between September 2007 and April 2009 at five instrumented mooring lines deployed between 2050 and 2350-m depth in the deepest continental margin and adjacent basin of the Gulf of Lions. Four of the lines followed a NW–SE transect, while the fifth one was located on a sediment wave field to the west.

Results

The results of the main, central line SC2350 ("LION") located at 42°02.50 N, 4°410E, at 2350-m depth, show that open-ocean convection reached midwater depth (≈ 1000-m depth) during winter 2007–2008, and reached the seabed (≈ 2350-m depth) during winter 2008–2009. Horizontal currents were unusually strong with speeds up to 39cm.s^{-1} during winter 2008–2009. The measurements at all 5 different locations indicate that mid-depth and near-bottom currents and particle fluxes gave relatively consistent values of similar magnitude across the study area except during winter 2008–2009, when near-bottom fluxes abruptly increased by one to two orders of magnitude. Particulate organic carbon contents, which generally vary between 3 and 5 %, were abnormally low (≤1 %) during winter 2008–2009 and approached those observed in surface sediments (≈ 0.6 %). Turbidity profiles made in the region demonstrated the existence of a bottom nepheloid layer, several hundred meters thick, and related to the resuspension of bottom sediments.

Conclusions

The major outcomes of this study are:

1. Particle fluxes at the different sites between 2050 and 2350-m depth present temporal variations in the 101–104 mg.m^{-2}.d $^{-1}$ range. Near-bottom TMF and POC content show coherent temporal variations with a clear signal of late winter–early spring maxima. The interannual variability was largely dominated by large fluxes in February–March 2009, which relates to deep OOC. This variability confirms similar patterns previously reported in the Gulf of Lions and in the Ligurian Sea for winters with deep OOC. The discrepancy between the fluxes at mid-depth and near the bottom, and the low POC content close to that of the sediment, observed for the highest fluxes in winter 2008–2009 highlight the role of sediment resuspension by strong currents taking place during the deep OOC.
2. Near-bottom fluxes are believed to vary according to the deep-water formation intensity from (1) moderate TMF (< 1000 mg.m^{-2}.d $^{-1}$) from a dominant biological source resulting from the surface production export during the winters of shallow OOC; (2) large TMF (up to 10 000 mg.m^{-2}.d $^{-1}$) from a dominant sedimentary source due to the remobilization of surface sediment of the deep basin during winters with deep OOC and shallow DSWC; and (3) extreme TMF (> 10 000 mg.m^{-2}.d $^{-1}$) from a dominant sedimentary source due to the remobilization of surface sediments from the shelf and slope and mainly from the deep basin during winters with deep OOC and deep DSWC.
3. The observations suggest that the recurrence of deep OOC in the area has a long-term effect on seabed morphology (i.e., by prevention of particle sedimentation) and thus should be considered as a major driving force for deep sedimentary dynamics.
4. Open-ocean deep convection has to be considered, together with dense shelf water cascading, as a major driving force for benthic ecosystems as it occasionally fuels them with labile POC from the surface layer and/or disrupts the benthic habitats by reworking superficial sediment. A better understanding of the composition of the particulate flux (i.e., biogenic and lithogenic contents), and its associated elements (including contaminants) generated by deep OOC events is now required to better assess the impact of such events on benthic ecosystems.

These observations support the view that open-ocean deep convection events in the deep margin of the Gulf of Lions can cause significant remobilization of sediments in the deep outer margin and the basin, with a subsequent alteration of the seabed likely impacting the functioning of the deep-sea ecosystem.

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PROKARYOTIC DEGRADATION OF NATURAL DISSOLVED ORGANIC MATTER IN THE DEEP-SEA WATERS OF NW MEDITERRANEAN SEA DURING CONTRASTED HYDROLOGICAL CONDITIONS

M. Boutrif [1], C. Panagiotopoulos [1], R. Sempéré [1], D. Repeta [2], M. Garel [1], B. Charriere [1], D. Nerini [1] and C. Tamburini [1]*
[1] Mediterranean Institute of Oceanography (MIO) - christian.tamburini@univ-amu.fr
[2] Woods Hole Oceanographic Institution

Abstract
Dissolved organic carbon (DOC) is divided into three reservoirs of different reactivities (labile, semi-labile and non-reactive). The contribution of the semi-labile DOC to the global prokaryotic production has been assessed in very few previous studies. Interestingly enough some experiments show rapid utilization of semi-reactive DOC by prokaryotes, while other experiments show almost no utilization at all (1,2). However, all these studies did not take into account the role of hydrostatic pressure for the degradation of organic matter (3). In this study, we investigate the degradation of HMW-DOM incubated with deep-sea water samples (2000 m-depth, NW Mediterranean Sea) collected under *in situ* pressure conditions with their own prokaryotic assemblages during stratified water conditions (summer) and mixed water conditions (winter).

Keywords: Deep sea processes, Bacteria, Carbon, Geochemical cycles, Ligurian Sea

In the framework of MERMEX (Marine Ecosystems Response in the Mediterranean Experiment, Chantier MISTRALS), we attempt to better understand the role of prokaryotes into the degradation of dissolved organic matter in the deep-sea Mediterranean waters (4). Deep-sea water samples, recovered under *in situ* pressure conditions, were enriched with natural occurring organic matter [high molecular weight dissolved organic matter or HMW-DOM (corresponding to the organic matter > 1000 Da)], and incubated for 10 days under atmospheric (ATM) and *in situ* hydrostatic pressure (HP) conditions. Total organic carbon (TOC), dissolved sugars (DCHO), and bacterial abundance were monitored overtime. Using these parameters we estimated TOC and DCHO decay rates (k) as well as prokaryotic growth rates (μ). Our results indicated that during HP incubations TOC and DCHO exhibited the highest degradation rates ($k_{HP\ TOC}$ = 0.82 d^{-1}; $k_{HP\ DCHO}$ = 0.98 d^{-1}) compared to the ATM conditions were no degradation was observed ($k_{ATM\ TOC}$= 0.007 d^{-1}, $k_{ATM\ DCHO}$= 0.002 d^{-1}). Similarly prokaryotic growth rate was higher in HP than in ATM conditions (μ_{HP} = 0.47 d^{-1} *vs* μ_{ATM} = 0.39 d^{-1}). These results suggest that deep-sea prokaryotic communities are autochthonous to the deep-sea realm and therefore more adapted to degrade HMW-DOC under *in situ* hydrostatic pressure conditions. An opposite trend was observed for the HP incubations from mixed deep water masses (MWM). HP incubation measurements displayed the lowest TOC degradation and prokaryotic growth rates ($k_{HP\ TOC}$=0.031 d^{-1}; $k_{HP\ DCHO}$=0.35 d^{-1}; μ_{HP} = 0.25 d^{-1}) compared to the ATM conditions ($k_{ATM\ TOC}$=0.62 d^{-1}; ($k_{ATM\ DCHO}$=0.60 d^{-1}; μ_{ATM} = 0.46 d^{-1}). These results imply the presence of allochthonous prokaryotic cells in deep-sea samples after a winter water mass convection. Apparently, these prokaryotic communities are more adapted at atmospheric pressure conditions, pointing to a surface origin. This study demonstrates that remineralization rates of semi-labile DOC in deep NW Med. Sea are controlled by the prokaryotic communities, which are influenced by the hydrological conditions of the water column.

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NUTRIENT EXHANGES BETWEEN THE MARMARA AND BLACK SEAS TROUGH THE BOSPORUS STRAIT

Suleyman Tugrul [1]*, Ahsen Yuksek [1], Husne Altiok [1] and Erdogan Okus [1]
[1] I.U. Institute of Marine Sciences and Management - tugrul@ims.metu.edu.tr

Abstract
Chemical datacollected systematically by the METU-IMS and IU-IMSM groups between 1987-2010 were compiled to assess temporal changes in the concentrations and fluxes of nutrients (DIN, PO4; TP) and total organic carbon (TOC) exchanged between the adjacent seas of Marmara and Black Sea via the two-layer flow regimes in the Bosporus. Chemicals exported by the Black Sea outflow (0-30 m depth) increased in winter due to changes in both the concentrations and volume fluxes; but no long term trend was seen in this period. The majority of the Black Sea input accumulates in the Marmara lower layer waters entering the Black Sea.

Keywords: Nutrients, Bosphorus Strait

The less saline Black Sea surface waters (S~17) polluted by the major rivers exports nutrients to the Sea of Marmara. The first estimates of the nutrient exchanges between these adjacent seas were carried out in the 1990's [1]. The study evaluates data sets collected seasonally/monthly by the two groups at the Bosporus exits since 1987. The Black Sea inflow is nearly two-fold the more saline Marmara waters (S~38) flowing into the Black Sea annually [1]; the surface N, P fluxes increase in winter-spring periods (Figüre 1). The Marmara lower layer waters flowing into the Black Sea are enriched in nitrate and phosphate concentrations (NO_3: 8-12 µM and PO_4: 0.7-1.2 µM phosphate; N/P: 8-10). No significant long-term trend has been seen in the exchange fluxes during the last two decades. However, the nitrate outflux (6.6 $x10^8$ moles/year) from the Black Sea was about 4- 6 times the summer and autumn outfluxes. Seasonal variations were less pronounced in the TN, (1.2$x10^9$ moles/year), TP (0.24 $x10^7$ mole/year) and TOC (~2.5$x10^{11}$ tons/year). Phosphate constituted about 30% of the Black Sea TP outflux whilst the nitrate outflux was about 10% of the TN export. However, the nutrient exports from the Marmara basin to the Black Sea have been introduced in the forms of nitrate and phosphate ions. Therefore, the Black Sea DIN and DIP exports to the Marmara are much less the inputs from the Marmara lower layer. The Black TOC outflux was about 5 times that of the Marmara export via the Bosporus underflow. However, the Marmara TP export the Black Sea slightly exceeded the TP input from Black Sea via the Bosphorus surface flow, indicating that the TN (biochemically labile) and TP export to the Marmara is nearly compensated by the Bosporus underflow in the forms of phosphate and nitrate with molar ratios of about 8-10.

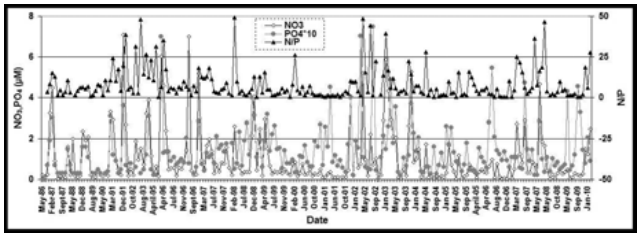

Fig. 1. Variations of nitrate, phosphate and N/P ratio in the Black Sea outflow between 1986-2010

Acknowledgements: This study was supported by TUBITAK, Istanbul Menicipality and EC-FP6 (SESAME).

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THE ANTHROPOGENIC EUTROPHICATION OF THE BLACK SEA: QUANTITATIVE REGULARITIES AND MECHANISMS

Oleg Yunev [1]*
[1] Institute of Biology of the Southern Seas - yunev@mail.ru

Abstract
The work investigates the main aspects of the Black Sea eutrophication that have never been addressed before. Among the aspects addressed are: 1) the quantitative analysis of the eutrophication made on annual primary production which was calculated for the pre-eutrophication period (1960s) and the period of intensive eutrophication (late 1980s - early 1990s) for all regions; 2) eutrophication mechanisms in the shallow and deep parts of the sea; 3) the main effect of eutrophication on marine ecosystems, namely its impact on the redistribution of incoming organic matter in the pelagic food web.

Keywords: Eutrophication, Black Sea

Materials
This study is based on data mainly pooled from 2 databases created within the framework of the NATO TU Black Sea and MEDAR/MEDATLAS II Projects at the end of the 1990s and beginning of the 2000s [1, 2]. These databases include principal oceanographic data from almost all Black Sea riparian countries. The data are generally on a basin-wide scale and cover the period of most dramatic changes for the Black Sea ecosystem, starting from the "little impact" state in the 1960s [3, 4, 5, 6].

Results
The work shows that in the pre-eutrophication period (1960s) the annual primary production (APP), the factor which is commonly used to evaluate the rate of organic matter income into marine ecosystems, was below 65 g C m^{-2} yr^{-1} in most parts of the Black Sea including its deep regions. We are the first one to show that this low level of APP in the deep regions in that period were determined by the deep nitrates maximum localization and the presence of the highly-stratified zone of upper half of pycnocline which separates the nitrates from a photosynthetic layer and, thus prevents their penetration into a photosynthetic layer. It was shown that in the shelf regions affected by the Danube River nutrient loads, intensive eutrophication resulted in significantly increased levels of APP, up to 250-350 g C m^{-2} yr^{-1}, having reached the eutrophic level. The rest of the regions and the Black Sea on average became mesotrophic with APP of approximately 145 g C m^{-2} yr^{-1} in the late 1980s - early 1990s. It was also shown that the second half of the 1990s - early 2000s was characterized by oligotrophication of all regions of the Black Sea caused by the decreasing rate of input of organic matter into the ecosystem. Moreover, we are the first one to use the international oceanographic databases to comprehensively analyze the long-term changes in related to eutrophication hydrobiological, hydrochemical and hydrooptical parameters in the shallow and deep regions of the Black Sea [3, 4, 5, 6] and to demonstrate that in both regions the eutrophication developed in two phases (from the beginning of the 1970s to the mid of the 1980s and from the mid of the 1980s to the beginning of the 1990s), which differed from each other changes in functionally related eutrophication characteristics (Fig. 1).

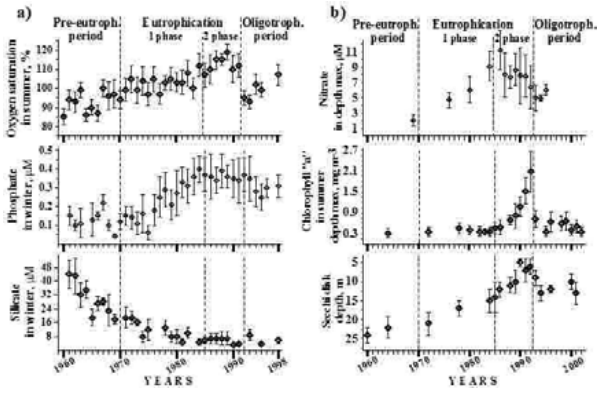

Fig. 1. Long-term changes of eutrophication characteristics in the surface layer of the shelf (a) and in the depth maxima in the open part (b) of the Black Sea.

We further analyzed the role of various natural and anthropogenic factors in the bi-phasic nature of eutrophication of the Black Sea. Finally, the work demonstrated that the eutrophication resulted in significant reduction in the efficiency of transformation of phytoplankton production in the food web in the pelagic zone and in the dominance of a jellyfish-headed trophic chain, that, despite of the high levels of primary production, determined the low energy level of the present Black Sea ecosystem.

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Session

Coastal lagoons status

Modérateur : **Michèle Forestier**

SUIVI DE LA REPONSE DES BIOMARQUEURS DE METABOLISATION DE PHASE I ET II DANS LE LAC DE TUNIS (TUNISIE)

Houssem Chalghmi [1]*, Ines Zrafi [1], Jean Paul Bourdineaud [2] and Dalila Saidane-Mosbahi [1]
[1] Université de Monastir, Laboratoire d'Analyse, Traitement et Valorisation des polluants de l'environnement et des produits, Faculté de Pharmacie de Monastir, Rue Avicenne, 5000 Monastir, Tunisie - houssem.chalghmi@yahoo.fr
[2] Université de Bordeaux, CNRS UMR EPOC 5805, Station Marine d'Arcachon, Place du Dr Peyneau, 33120 Arcachon, France.

Abstract
L'objectif de ce travail est d'évaluer la qualité du lac de Tunis en utilisant des biomarqueurs biochimiques chez la palourde *Ruditapes decussatus*. Les résultats ont montré une augmentation des activités benzo(a)pyrène hydroxylase et glutathion-S-transférase chez les palourdes collectés dans trois sites du lac. Cette augmentation est due à la présence de différentes sources de pollution aux alentours des sites d'étude.

Keywords: Bivalves, Lagoons, Monitoring, Gulf of Tunis

Introduction
Pour la surveillance de la qualité de l'environnement, deux approches biologiques complémentaires sont utilisées de nos jours : la première est basée sur les communautés ou populations. Il s'agit notamment des indices biocénotiques, qui de par la présence ou l'absence de telle ou telle espèce, nous renseignent sur l'état de santé d'un milieu, mais malheureusement à postériori. La seconde approche est plus prédictive sur l'état de santé du milieu, elle se situe au niveau de l'individu et concerne l'utilisation de biomarqueurs [1]. Cette étude a pour but d'utiliser et de suivre mensuellement deux biomarqueurs biochimiques pour évaluer la qualité d'un milieu lagunaire (lac de Tunis).

Matériel et méthodes
Les palourdes *Ruditapes decussatus* ont été récoltées chaque mois dans le lac de Tunis durant la période allant de Novembre 2008 jusqu'à Mai 2009 à partir de trois zones : Z1 (une zone recevant les effluents de plusieurs industries), Z2 (proche du canal de navigation) et Z3 (se localise au voisinage d'un port commerciale qui est le port de Radés). Les palourdes témoins sont des palourdes destinées à la consommation. Les glandes digestives de 18 palourdes/site ont été prélevées et récupérées en pools de trois individus. Dans ce travail on s'est intéressé à deux marqueurs biochimiques qui sont l'activité benzo(a)pyrène hydroxylase (BPH) qui est un biomarqueur de métabolisation des contaminants organiques de phase I et l'activité glutathion-S-transférase (GST), biomarqueur de métabolisation des xénobiotiques organiques de phase II. L'activité BPH a été mesurée selon la méthode fluorométrique décrite par de [2]. L'activité GST a été déterminée selon la méthode de [3].

Résultats et discussion

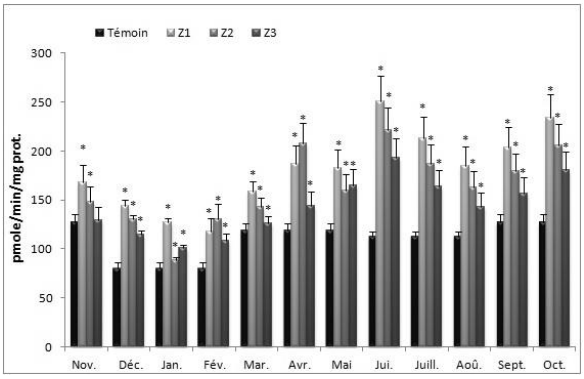

Fig. 1. Variation mensuelle de l'activité Benzo(a)pyrène hydroxylase chez la palourde *Ruditapes decussatus*

Les résultats de l'activité BPH sont présentés dans le fig. 1. L'analyse comparative entre les mois montre que l'activité BPH chez les palourdes provenant des trois sites (Z1, Z2 et Z3) est faible durant les mois de décembre, janvier et février par rapport aux autres mois. L'activité BPH la plus élevée a été enregistrée durant les mois de juin et octobre. On peut souligner que le système CYP chez les bivalves est sujet à des variations saisonnières importantes, ce qui ne facilite pas l'utilisation de ses composants en tant que biomarqueurs pour des études *in situ* [4]. L'analyse comparative entre les sites montre que l'activité BPH chez les palourdes collectées dans Z1, Z2 et Z3 est plus importante par rapport à celle des palourdes témoins. Ces résultats montrent que les sites d'étude choisis sont contaminés par les xénobiotiques. Les résultats de l'activité GST sont rapportés dans la figure 2. L'analyse de cette figure montre que l'activité glutathion-S transférase (GST) a subi une fluctuation temporelle. Comparés aux palourdes témoins les trois sites d'études présentent une activité GST élevée. Ces résultats plaident en faveur d'une contamination des sites d'étude.

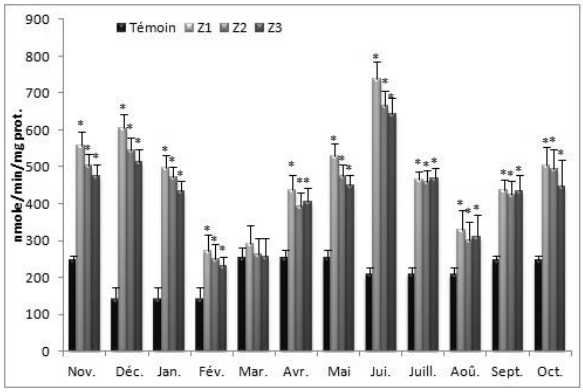

Fig. 2. Variation mensuelle de l'activité glutathion-S-transférase chez la palourde *Ruditapes decussatus*

Conclusion
Les biomarqueurs biochimiques utilisés dans ce travail ont montré la présence d'une contamination dans le lac de Tunis.

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HISTORICAL TRACE METAL CONTAMINATION ASSESSMENT OF ORIKUM LAGOON, ALBANIA, BASED ON DATED RECENT SEDIMENTS RECORD

Michèle Forestier [1]*, Neil D Graham [1] and Jean-Luc Loizeau [1]
[1] Institut F.-A. Forel, Université de Genève - forestm7@etu.unige.ch

Abstract
In the present research we reconstructed the time evolution of the metal contamination of Orikum Lagoon on the Albanian coast of the Adriatic Sea. The lagoon is directly connected to the sea on one side and agricultural fields on the other. The lagoon is exposed to several potential contaminant sources. Two dated sedimentary cores allowed for assessing the contamination history of the lagoon in the last century. Metal contents increased by a factor 2 to 4 in the last fifty years, with concentrations of Cr and Ni that could impact the benthic biota.

Keywords: Geochemistry, Lagoons, Sediments, Trace elements, South Adriatic Sea

Sedimentary records are archives of the environmental evolution of a water body and of its watershed. They are especially valuable in region with poor knowledge of environmental contaminations. The present study focused on the Orikum lagoon, a small coastal water body with an area of approximately 1 km2 and a maximum depth of 2.5m (Peja et al. 1996). It is located on the southern end of the gulf of Vlorë on the Albanian Adriatic coast (figure 1). The lagoon is connected to the sea by an artificial channel on its northern margin, and is supplied with freshwater from the south. The lagoon has been potentially contaminated by several sources, including agricultural effluents, municipal and military wastes, or uncontrolled domestic dumping.

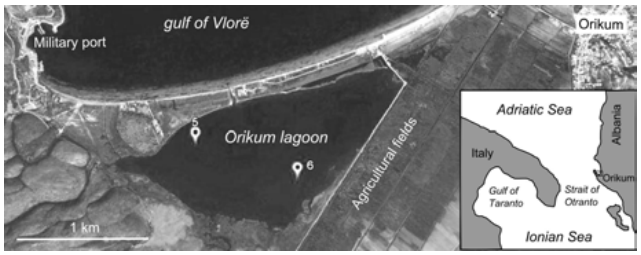

Fig. 1. Location of the sediment cores (#5 and #6) retrieved in the Orikum Lagoon (base image from Google Earth). Inset: situation of the lagoon on the Albanian Adriatic coast

To reconstruct the contamination history of the lagoon, two sediment cores were retrieved, one located on the northern side (#5, figure 1), in the deepest part of the lagoon, whereas the second was collected on the southern side (#6), closed to the freshwater inputs. Dating based on ^{137}Cs and ^{210}Pb methods showed that the sediment were deposited during the last century. Profiles of ^{137}Cs activity, sand, calcite, and metal contents, of the sediment core #6 are presented on figure 2.

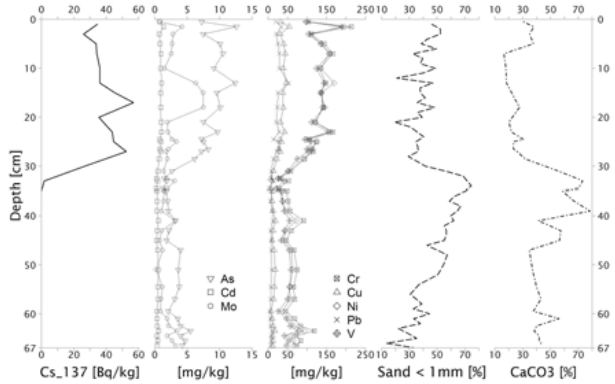

Fig. 2. Depth profiles of ^{137}Cs activity, selected metal concentrations, sand and calcium carbonate percentage in core #6.

The ^{137}Cs activity profile didn't show peaks that could be attributed to Chernobyl (1986) or atmospheric nuclear weapon tests (1964). However no activity has been recorded below 33 cm, indicating that the upper sediment section (0-33 cm) was deposited after the first atmospheric fallouts in 1954-1955, and the lower sediment section was deposited before this date. The profile of sand percentage correlated with the profile of carbonates, indicating that the main source of carbonate probably comes from shell fragments. ICP-MS analysis results showed that the metallic concentrations between 32 and 67 cm corresponded to natural background levels found in the continental crust (Wedephol, 1995), except for As and Cd that were 2 to 4 times more concentrated than natural levels. A significant increase in metal concentrations was observed after 30 cm depth. Concentrations of trace metals ranged in the intervals 1.2-12.6 mg/kg (As), 0.2-1.4 mg/kg (Cd), 27-213.2 mg/kg (Cr), 5.4-53.7 mg/kg (Cu), 1-4 mg/kg (Mo), 36.3-195.0 mg/kg (Ni), 3.1-33.6 mg/kg (Pb) and 20.9-188.7 mg/kg (V). Mean values in the upper section were 2 to 3 times (Cr, Cd and Ni) and 3 to 4 times (Cu, As, Pb and V) more concentrated than in the lower core section. These results showed clearly the beginning of the sediment contamination, corresponding to the mid of the 20th century. The maximum surface values of Cr et Ni (213.2 and 195.0 mg/kg) are above their respective values of Probable Effect Concentration (MacDonald et al, 2000) of 111 mg/kg for Cr et 48,6 mg/kg for Ni. Therefore metal concentrations recorded at the sediment surface may cause adverse effects on benthic organisms.

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ASSESSMENT OF CHEMICAL CONTAMINATION OF FRENCH COASTAL LAGOONS USING PASSIVE SAMPLING TECHNIQUES

D. Munaron [1]*, M. Hubert [1], N. Tapie [2], H. Budzinski [2], J. Guyomarch [3], B. Andral [4] and J. Gonzalez [5]
[1] IFREMER Laboratoire "Environnement et Ressources du Languedoc-Roussillon", Avenue Jean Monnet, BP 171, 34203 SETE Cedex - dominique.munaron@ifremer.fr
[2] Université de Bordeaux 1, EPOC, UMR 5805, 351 cours de la Libération, 33405 TALENCE Cedex
[3] CEDRE Service Recherche & Développement, 715 rue Alain Colas, CS 41836, 29218 BREST Cedex
[4] IFREMER LER-PAC, CS 20330 Zone Portuaire de Brégaillon, 83507 LA SEYNE/MER Cedex.
[5] IFREMER BE CS 20330 Zone Portuaire de Brégaillon, 83507 LA SEYNE/MER Cedex.

Abstract
Since 2008, projects supported by french government agencies were dedicated to improve the assessment of chemical contamination of water bodies defined by the Water Framework Directive (2000/60/CE)(Munaron et al, 2012 [1]). Among these studies, the aim of PEPSLAG was to investigate the utility of passive samplers for sampling contaminants present at trace levels in coastal lagoons environments, and to realize a first assessment of the contamination on the French Mediterranean coastal lagoons.

Keywords: Pollution, Coastal waters, Pesticides, Metals, North-Western Mediterranean

The aim of PEPSLAG was to investigate the utility of passive samplers for sampling contaminants present at trace levels in coastal lagoons environments, and to realize a first assessment of the contamination on the French Mediterranean coastal lagoons. 23 transitional lagoons water-bodies were investigated along the French Mediterranean coast, using three passive samplers (DGT, POCIS and SBSE). Passive samplers were exposed in water during one (DGT) or three/four weeks (POCIS), between june and july 2010. A water sample was collected for SBSE extraction at each sample point.

141 contaminants from various chemical families (trace metals, pesticides, pharmaceuticals, alkylphenols, PAHs, PCBs…) were investigated and their concentrations compared to Environmental Quality Standard (EQS) defined until now.

Various analytical methods were used to quantify these contaminants: atomic absorption for metals in DGT, on-line extraction of SBSE and analysis of organochlorinated pesticides, PAHs and PCBs by GC-MS, off-line extraction of others organic contaminants sequestred in POCIS and analysis by HPLC-MS-MS (ESi+ and ESi -) or GC-MS... Several methods developted were previoulsly published (Roy et al, 2005 [2]; Togola and Budzinski, 2007 [3]; Tapie et al, 2011 [4]).

With passive sampling techniques used, concentrations of many dissolved contaminants were detected during analysis and measured.

The study showed the operational assets of these systems, as low quantification limits required by the WFD reached and ensure measurement of metals and organic contaminants at trace levels, which are generally difficult to quantify with classical methods, especially in marine waters. In this study, many usual contaminants that have an EQS did not overstep it except some insecticides and trace metals. In spite of this, many water bodies have been considered in a bad chemical quality according to WFD. These passive samplers represent a sensitive and promising tool for use in marine and coastal monitoring under the EU WFD and the future EU Marine Strategy Framework Directive. Indeed, information is needed about marine contamination and passive samplers could clearly help to better characterize the real exposure of marine organisms to complex mixtures of contaminants present at low concentrations.

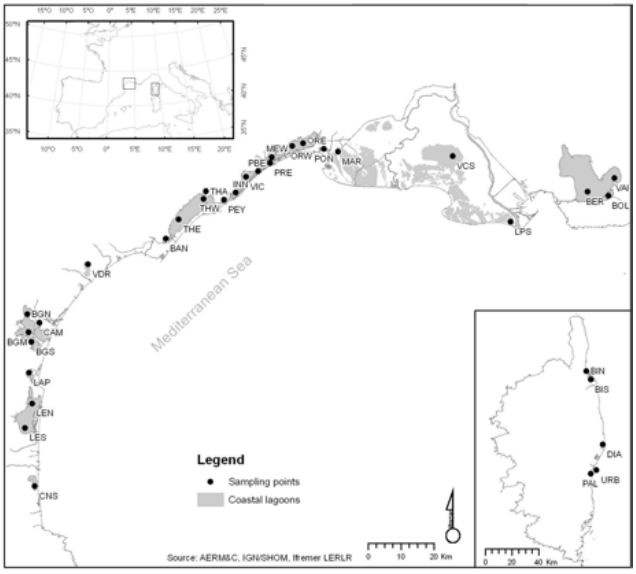

Fig. 1. French mediterranean lagoons sampled during the PEPSLAG project

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DISTRIBUTION OF SOME HEAVY METALS IN SURFACE SEDIMENTS FROM THE HOMA LAGOON (IZMIR BAY, TURKEY).

Elif Çagri Tas [1] and Ugur Sunlu [1]*
[1] Ege University, Fac. of Fisheries, 35100, Bornova- Izmir TURKEY - ugur.sunlu@ege.edu.tr

Abstract
Homa Lagoon is one of the commercially important fishing areas in Izmir Bay (Aegean Sea, Turkey) which is under the influence of heavy metal pollution due to the urbanization, industrial and agricultural activities.The purpose of this study was to determine the levels of some heavy metals such as Cd, Cu, Pb, Zn, Cr, Fe in surface sediment. The sediment samples were collected from 10 stations during autumn 2012. Mean concentrations of heavy metals in sediments are 0.65 ppm for Cd, 18.10 ppm for Cu, 16 ppm for Pb, 68.8 ppm for Zn, 156.6 ppm for Cr and 23900 ppm (d.w.) for Fe in Homa fisheries lagoon. Sediments which was taken from Homa Lagoon were most toxic for Cr due to exceedance of the LEL and SEL values.

Keywords: Sediments, Metals, Pollution, Izmir Bay, Aegean Sea

Introduction
Marine sediments are considered a sink for metals in aquatic environments, especially in estuarine and coastal waters. Generally, sediments contain three or five times higher concentrations of heavy metals than sea water samples. Consequently, sediments usually provide useful information for environmental and geochemical research about marine pollution. The study area, Homa Lagoon is located middle part of the Izmir Bay (Aegean Sea, Turkey) (Fig.1.). It's the only active coastal lagoon located in the Gediz Delta where agricultural drainage water, industrial and domestic wastewater are transported by Gediz River. The Homa Lagoon has approximately 1824 ha of surface area and a depth varies between 0.5-1.0 m. It is added to The Ramsar Convention and preserved by Ministry of Environment in 1998. The main aims of this study are to investigate the present status and distribution of heavy metal concentrations (Cd, Cu, Pb, Zn, Cr, Fe) in the sediments of the Homa Lagoon and compare these sediment results with other study in the same area done previously.

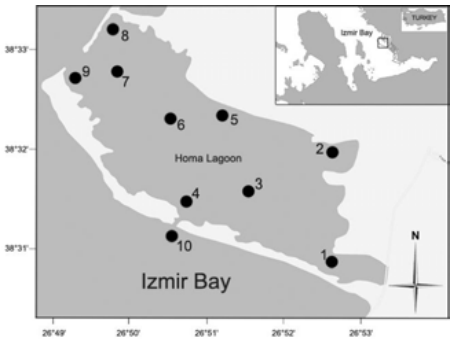

Fig. 1. The locations of sampling stations.

Materials and Methods
This study was carried out 10 stations of the Homa Lagoon. The sediment samples were collected using Van-Veen grap for heavy metals in autumn 2012. Two stages of preparation, consisting of drying and screening, were performed on the sediment samples [1]. The heavy metal analysis in all sub samples was performed using the 4 acid digestion and ultra trace ICP-MS method by the ACME Analy. Lab. Ltd. (Vancouver, Canada). Reference materials (STD DS9 and STD OREAS45EA) were used as a control for analytical methods.

Results and Discussion
The ranges of Cd, Cu, Pb, Zn, Cr and Fe contents of the surface sediments from the Homa Lagoon are 0.5-0.8, 9-24, 6-30, 38-88, 92-220 and 16500-28300 ppm d.w., respectively. Metal concentrations in sediments of this study were compared to other studies performed in Homa Lagoon and Gediz River. As a result of the evaluation between 1990 and 2012, the heavy metal concentrations in sediments of Homa Lagoon were generally similar, except Cr (Tab.1.). Metal distributions show that Cu (24 ppm), Zn (88 ppm) and Fe (28300 ppm) concentrations in sediments of Station 5 were higher than those from the other stations. Sediments from Homa Lagoon were most toxic for Cr due to according to the LEL (26 ppm) and SEL (110 ppm) values [8]. According to the results, high Cr values confirm that the pollution is caused by untreated waste water of espcecially leather industry. The concentrations of Cr were generally higher in the Gediz that the other contaminated rivers worldwide due to the leather tanning plants, which use large quantities of Cr in the tanning procedure [3] (Tab.1.). Sediment characterization was sandy mud in the Homa Lagoon. The percentage of sandy-clay varied between 2%-34%, the percentage of silt-clay 3%-43% and the percentage of silt-sand 34%-93% in the sampling period. The sediment organic carbon content varied from 1.22% to 4.2% with an average of 2.6% throughout the Homa Lagoon [7]. The organic matter is a major factor controlling the distrubition of Hg, Pb, Cr, Cu, Zn, Ni and Fe in the Gediz River [3]. The order of heavy metal concentrations were: Fe>Cr>Zn>Pb>Cu>Cd. In conclusion, the study area Homa Lagoon located in the Gediz Delta is under the effects of Gediz River which is transported industrial and domestic wastewater, agricultural drainage water (Tab.1.).

Tab. 1. Metal levels of sediments from Gediz River and Homa Lagoon (ppm).

Locations	Cd	Cu	Pb	Zn	Cr	Fe	References
Gediz River	-	108-152	105-140	140-180	170-220	26000-28500	2
Gediz River	-	15-148	38-198	314-196	59-494	10629-72387	3
Homa Lagoon	1.6-2.7	14.2-18.5	28.2-38.2	23.8-41.6	-	-	4
Homa Lagoon	0.03-0.43	17.2-41	6.5-19.1	-	33.4-84.9	-	5
Homa Lagoon	0.001-1.16	4.03-51.3	5.27-19.1	13.1-95.5	19-90	9270-28700	6
Homa Lagoon	0.06-0.19	10.3-25.8	2.43-17.2	46.2-91.9	84-129	17054-30234	7
Homa Lagoon	0.5-0.8	9-24	6-30	38-88	92-220	16500-28300	**This Study**

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Session

Ecosystem modelling

Modérateur : **Jacek Tronczynski**

MODELING OF PCB TROPHIC TRANSFER IN THE GULF OF LIONS; MARS3D/ECO3M COUPLED MODEL APPLICATION

E. Alekseenko [1]*, B. Thouvenin [1], C. Tixier [2], J. Tronczynski [2], M. Baklouti [3], V. Loizeau [4], P. Garreau [1], R. Verney [1], F. Carlotti [3], B. Espinasse [3] and B. Queguiner [3]

[1] IFREMER, DYNECO/PHYSED, B.P. 70, 29280, Plouzane, France - lena.alekseenko@gmail.com

[2] IFREMER, RBE/BE/LBCO, B.P. 21105, 44311 Nantes, France

[3] Univercity of Aix-Marseille, Univercity of South Toulon-Var, CNRS/INSU, IRD, MIO, UMR 110

[4] IFREMER, RBE/BE/LBCO, B.P. 70, 29280, Plouzane, France

Abstract

This work aims at assessing the role of plankton in the transfer of PCBs to higher trophic levels in the Gulf of Lions by coupling biogeochemical and hydrodynamical processes and taking into account the physico-chemical properties of PCBs (PCB153 and PCB28). Plankton plays indeed a key role in biogeochemical cycles of PCBs in aquatic environments. Phytoplankton and bacteria sorb persistent organic contaminants by diffusive processes of the planktonic cells and the surrounding waters. On the other hand, for zooplankton, which feeds on them, two contamination pathways must be considered: diffusive transfer and ingestion of contaminated food.

Keywords: Adsorption, Bio-accumulation, Plankton, Pollution, Gulf of Lyon

The environmental occurrence of persistent organic pollutants (POPs), such as polychlorinated biphenyls (PCBs), is a matter of concern for ecosystems. PCBs are mainly characterized by their persistence, long-range transport in the atmosphere and the ocean, bioaccumulation, and toxicity. Thus, understanding and quantifying the dynamics of PCBs are important to assess their environmental impact and final fate. The ocean is considered to be the one of the global PCBs reservoirs. The Mediterranean Sea and the Gulf of Lions are unique marine environments subject to important anthropogenic pressures due to riverine and atmospheric inputs of PCBs.

Plankton plays a key role in the biogeochemical cycles of PCBs in aquatic environments. Since phytoplankton and bacteria are only exposed to the contaminants via water, it seems probable that the bioaccumulation is governed by sorption between the cells and the surrounding water [1,2]. On the other hand, for zooplankton feeding on them, two contamination pathways must be considered: diffusive exchanges and ingestion of contaminated food [1]. There is little information on the transfer of PCBs to zooplankton actually occurring in the field. However such information is crucial to make reliable predictions about PCB transfer to the higher trophic levels.

In the coastal area as Gulf of Lions, the process of PCBs bioaccumulation along the trophic web is ruled by interactions between compounds physico-chemical properties, organisms biological properties and also by hydrodynamical and biogeochemical processes. This work aims at a better understanding of such processes combination in the Gulf of Lions. We developed a coupled three-dimensional model for the assessment of PCB dispersion in space and time and of its transfer to zooplankton via biogeochemical processes. Specifically, the MARS3D hydrodynamical model [3] taking into account the PCB transport was coupled with a biogeochemical model Eco3M [4,5]. The case of two PCBs congeners was studied: PCB153 and PCB28.

Transport of various PCB species were simulated during one year: total dissolved, freely dissolved, particulate, biosorbed on plankton, assimilated by zooplankton. PCB budgets and fluxes into the Gulf of Lions between various species were governed by different processes, such as: adsorption/desorption, bacteria and plankton mortality, zooplankton excretion, grazing, mineralization, volatilization and biodegradation.

In the first step, the simulated PCBs distributions within particulate matter and plankton were compared with several in-situ measurements performed in the Gulf of Lions (COSTAS and Merlumed campaigns) for two size classes of plankton X ($60\mu m<X<200\mu m$ and $200\mu m<X<500\mu m$). The model reproduces quite well the orders of magnitudes. Although the model can not be fully validated for PCBs in terms of transfers in the trophic chain, its application on an annual period can highlight the impact of dominating forcings and the importance of processes necessary to explore in future research. Processes influencing PCB transfer were thereby analysed: (i) physical and chemical processes, such as riverine and atmospheric inflow, volatilization, sorption and resuspension and (ii) biogeochemical processes, namely grazing, mortality, mineralization and excretion. The Rhone River input appears to play a major role in the PCB contamination of the planktonic trophic chain of the Gulf of Lions. The contamination propagation from east to west, from the coast to the sea, from the surface to the bottom and its transfer from water and particules to bacteria and plankton is displayed according to seasonal events. The riverine PCB adsorbed to particulate matter desorbs into the water phase and, then contaminate the lower trophic levels (phytoplankton and bacteria) by sorption process. The higher trophic levels (zooplankton) are contaminated by PCBs mostly by grazing (feeding on the contaminated lower trophic levels) and slightly by sorption.

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BIOKINETICS OF RADIOCESIUM IN PRAWN (*PALAEMON ADSPERSUS*): SEA WATER AND FOOD EXPOSURES

N. Sezer [1], Ö. Kiliç [1], M. Belivermis [1]*, S. Topçuoglu [1] and Y. Çotuk [1]
[1] Istanbul University - belmurat@istanbul.edu.tr

Abstract

In the present study, the biokinetics of cesium was investigated in prawn (*Palaemon adspersus*). Prawns were contaminated either from sea water or food exposures under laboratory conditions by using ^{134}CsCl. CF (Concentration Factor) of ^{134}Cs in whole body of prawn was found to be ~15 at steady state. The biological half-lifes were found to be 85.5 and 79.2 days for sea water and food pathways.

Keywords: Biokinetics, Radionuclides, Crustacea, Marmara Sea, Bio-accumulation

INTRODUCTION

Cesium was accumulated in soft tissues of living things. Also cesium is carried to human through the food chain [1]. The aims of this study are: to investigate CF of ^{134}Cs, to determine radiotracer distribution among edible and inedible parts, to examine the uptake and differences the depuration kinetics following sea water and food exposures.

MATERIALS AND METHODS

Approximately 140 samples of prawn (*Palaemon adspersus*) were collected from Marmara Sea coast. Uptake kinetics was followed in 30 l closed circuit spiked sea water (salinity: 24.6‰, temp: 16 ± 1 °C). Activity of ^{134}Cs was arranged to 2582Bq/l. During the experiment, spiked sea water was renewed every other day and animals were fed with *Isochrysis galbana* during 30 minutes in uncontaminated sea water. At the end of the exposure period, 45 prawns were transferred to another aquarium which has running uncontaminated sea water. For the food experiment, 70 mussels were exposed to ^{134}Cs by sea water pathway during 18 days [2] then the prawns were fed with radiolabelled mussels (*Mytilus galloprovincialis*) during 3 hours (pulse-chase feeding method) [3]. Loss experiment was carried out following the feeding.

RESULTS AND DISCUSSION

Uptake experiment continued 27 days and during this period accumulation of Cs was followed in prawns. CF value was found to be~15 at end of the uptake period. CF was found to be 19 and 21 in edible and inedible parts, respectively. After a 27 days exposure, the prawns were maintained for 38 days in uncontaminated sea water to follow depuration kinetics. Biological half-life was found to be 85.5 and 79.2 days following the sea water and food exposure, respectively. Biological half-life of cesium found to be 85.5 days for the slow component which found to be longer for mussel (47 days) [2]and winkle (75 days) in some investigations [4]. On the other hand, under Chernobyl field conditions $Cs_{Tb1/2}$ was determined to be 63 days [5]. CF_{Cs} values found to be lower than previous studies carried out in Turkey which are mussel (*Mytilus galloprovincialis*) and clam (*Ruditapes philippinarum*) respectively [2, 6].

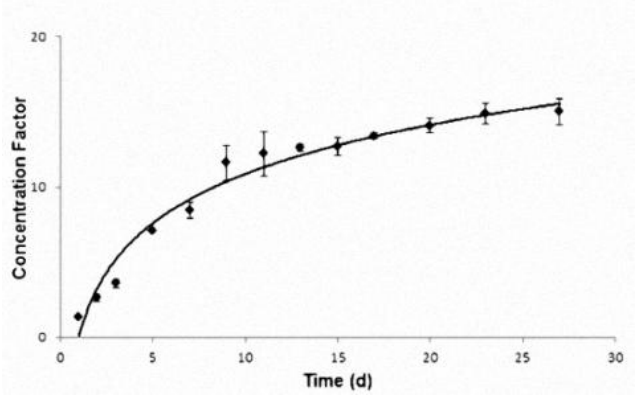

Fig. 1. Uptake kinetics of ^{134}Cs

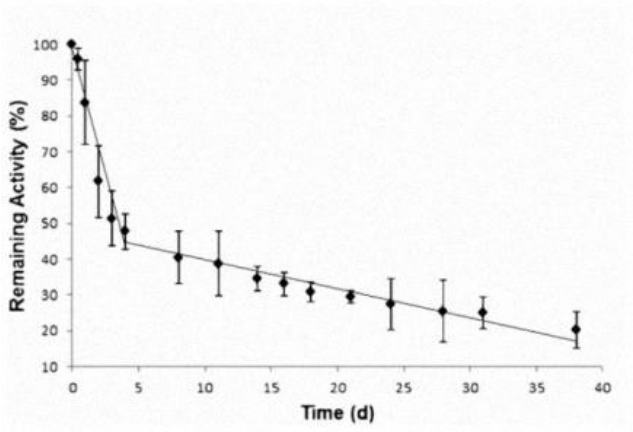

Fig. 2. Depuration kinetics of ^{134}Cs in prawn following dissolved radiotracer

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MODELLING THE COUPLING OF BIOGEOCHEMICAL PROCESSES WITH AIR-WATER EXCHANGE AND ITS INFLUENCE ON POP CONCENTRATION IN PHYTOPLANKTON

Jordi Dachs [1]* and Naiara Berrojalbiz [1]
[1] Department of Environmental Chemistry IDAEA-CSIC - jordi.dachs@idaea.csic.es

Abstract
Atmospheric deposition, and particularly diffusive air-water exchange, is the main entrance and driver of the concentrations of many persistent organic pollutants (POPs) in the surface waters of open oceans and Lakes. Once in the water, partitioning processes influence the transport pathways, degradation processes, residence times and the final fate of the compounds. In fact, the occurrence and impact of pollutants in the aquatic environment are the result of the interplay of numerous trophic and physical drivers. The main objective of this estudy is to clarify the interactions of atmospheric inputs of POPs and the biogeochemical processes occurring in the surface ocean mixed layer emphasizing the implications of the biological pump and degradation in such processes.

Keywords: Pollution, Pcb, Models, Atmospheric input, South-Central Mediterranean

Atmospheric deposition, and particularly diffusive air-water exchange, is the main entrance and driver of the concentrations of many persistent organic pollutants (POPs) in the surface waters of open oceans and Lakes. Once in the water, partitioning processes influence the transport pathways, degradation processes, residence times and the final fate of the compounds. In fact, the occurrence and impact of pollutants in the aquatic environment are the result of the interplay of numerous trophic and physical drivers. Nevertheless, there are still major gaps in our knowledge regarding to the relative importance of each of the factors controlling the occurrence of those pollutants in marine waters. The main objective of this estudy is to clarify the interactions of atmospheric inputs of POPs and the biogeochemical processes occurring in the surface marine mixed layer emphasizing the implications of the biological pump and degradation in such processes. An air-water-phytoplankton coupled model to calculate air-water, water-plankton and settling fluxes have been developed modifying the approach developed by the group previously. In addition, we have included the degradation in surface waters in the model. Field measurements of air (C_G), seawater (C_W) and plankton (C_P) POP concentrations have been used in the validation of the model. All samples were obtained on board of RV-Garcia del Cid research vessel during two Mediterranean sampling cruises on June 2006 and May 2007. Both transects from Barcelona to Istanbul and from Barcelona to Alexandria respectively allowed the sampling of many different Mediterranean regions including Marmara Sea and Black Sea. The used sampling strategy has allowed the simultaneous collection of atmospheric and aquatic matrices to enable the parametrization of atmosphere-ocean-plankton interactions. All samples were analyzed for PCBs, PAHs, HCHs and HCB covering a wide range of physical-chemical properties. Concentrations of the more hydrophobic PCBs in phytoplankton decreased at those locations with higher biomass, following the equation:

Log Cp = -b Log Biomass + constant [1]

Conversely, ligther PAHs, which undergo degradation in surface waters, followed the same trend, with lower concentrations in phytoplankton at higher biomass. These results are important because show that the concentrations of a wide range of organic pollutants in the water column depend on the trophic status of the sea, and not on other variables such as distance to coast. The extend of the dependence of concentrations on trophic status, measured as biomass, is given by the term *b* of equation [1]. When *b* is ploted versus the octanol-water partition coefficient (K_{OW}), then HCB, PCBs and high mollecular weight PAH fall in a line (Figure 1), showing a higher value of b, thus major dependence of the concentrations of organic pollutants in phytoplankton with biomass. Conversely, for HCH and low MW PAHs, such as phenanthrene and methylphenanthrene, which are subject to microbial degradation in the water column, the concentrations in phytoplankton decrease to greater extend (higher b) for the les hydrophobic compounds (Figure 1). These trends can be explained using the developed air-water-phytoplankton model and are the result of the relative contribution of the biological pump, the degradative pump, and the dilution effect operating in the surface water column of the Mediterranean Sea. This is the first time that it is shown that concentrations of organic pollutants in open sea phytoplankton depend on the trophic status rather than distance to sources.

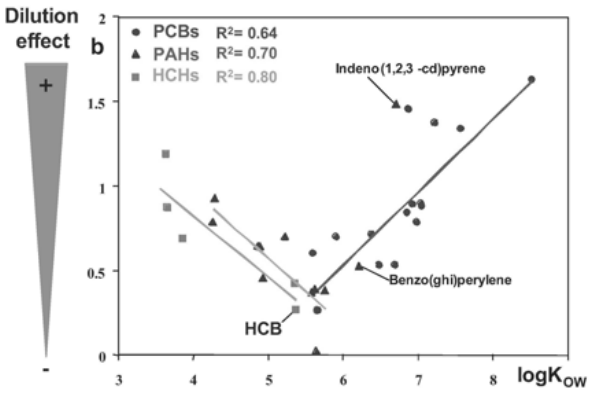

Fig. 1. The concentrations of most PCBs, HCH and PAHs in phytoplankton were higher when lower concentrations of phytoplankton biomass (B) occurred in the water column (following equation 1). However, the intensity of the response varies upon the chemical and their physical chemical properties (K_{OW}).Chemicals with higher values of b (see Equation 1), mean that their concentrations in phytoplankton show a greater dependence on biomass. The high b values for chemicals with low K_{OW} are due to degradaton in the water column, conversely, the high b values at high K_{OW} are due to the biological pump.

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DISSOLVED VS PARTICULATE ORGANIC CARBON EXPORT ESTIMATION USING A 3D PHYSICAL-BIOGEOCHEMICAL COUPLED MODEL OVER THE MEDITERRANEAN SEA

A. Guyennon [1]*, F. Diaz [1], M. Baklouti [1], J. C. Dutay [2] and T. Moutin [1]
[1] Aix-Marseille Université , Université du Sud Toulon-Var, CNRS/INSU, UMR 6535, IRD, Institut Méditerranéen d'Océanologie MIO, UM 110, 13288, Marseille, Cedex 09, France - arnaud.guyennon@univ-amu.fr
[2] Laboratoire des Sciences du Climat et de l'Environnement, UMR CEA-CNRS, CEA Saclay, F-91191 Gif-sur-Yvette, France

Abstract
A three dimensional (3D) ocean biogeochemistry model is used to describe the carbon (C), nitrogen (N) and phosphorus (P) cycles in the Mediterranean Sea in order to estimate the carbon export to the deeper layer (deep water circulation). Combining a high-resolution version of the physical model NEMO and a biogeochemical model with flexible stoichiometry (Eco3M), we investigate the contribution of particulate and dissolved organic matter to the total carbon export.

Keywords: Models, Carbon, North-Western Mediterranean

Introduction
The export of organic carbon into deep waters can be divided into two processes: the sink of large particles and the accumulation followed by vertical transport of dissolved organic carbon. While particulate export is usually considered as the main mechanism in the world ocean ([1]), the dissolved organic carbon export may represent the most part of the total organic carbon export in specific areas like the NW Mediterranean Sea ([2]) characterized by Low P Low Chlorophyll (LPLC) conditions [3].
A 3D physical-biogeochemical model has been developed on an off-line approach in order to investigate dissolved versus particulate organic carbon export to the deep layers of the Mediterranean Sea.

Model
Daily physical parameters are produced by a high-resolution model of the Mediterreanean Sea, NEMO-MED12. This model is a Mediterranean version of the NEMO numerical ocean model here used over the whole Mediterranean basin on a 1/12° horizontal resolution grid with a 50 levels vertical resolution. An exhaustive description of the ocean model can be found in [4].
The atmospheric forcings are derived from ECMWF on a ~50 km grid using the dynamic downscaling tool ARPERA. Ocean physical forcing are available from 1958 to 2010 and they provide realistic representation of deep water formations and extreme events.
The pelagic ecosystem model (figure 1) is a multi-nutrient multi plankton functional types (PFTs) model with a flexible stoichiometry working with 34 variables. It has been implemented in the Eco3M numerical platform [5]. It includes six plankton types (3 phytoplanktons, 2 zooplanktons and bacteria) and represents the cycles of C, N and P. Organisms are also represented through cellular abundances [6]. A constant sinking velocity is applied to the particulate organic matter compartment corresponding to large dead organisms and fecal pellets. Most processes are described with mechanistic formulations (photosynthesis, photoacclimation, exudation,…) and biogeochemical processes including nutrients assimilation and growth are governed by variable intracellular quotas.
In the western boundary of the domain, a nudging to climatic field derived from MEDATLAS for nutrients and in situ measurements for chlorophyll is applied on a buffer zone from 11°W to 6°W.
Rivers inputs are derived from the Ludwig's study [7] and the model includes inputs of dissolved organic carbon, total nitrogen and total phosphorus representing 32 rivers, coastal discharge and the Black Sea.

Results
We obtained a first twenty-year hindcast from 1990 to 2010 validated using in situ biogeochemical parameters and multi-satellite surface chlorophyll measurements. The mean annual total organic carbon export to the deep layer was estimated for the whole Mediterranean Sea and at basin scale, together with the ratio between dissolved and particulate carbon export.

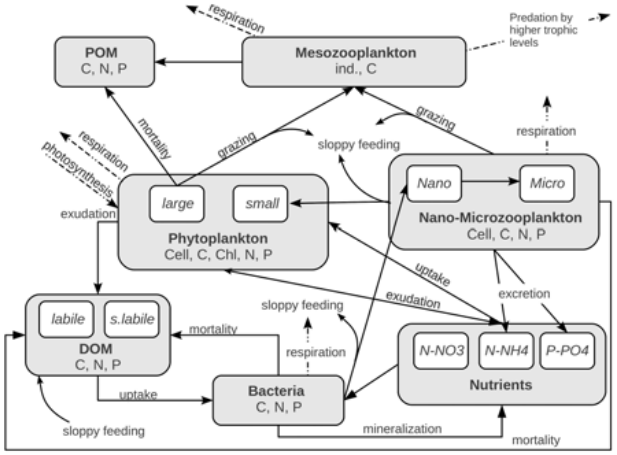

Fig. 1. Schematic representation of the biogeochemical model ([8])

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IMPACT OF INTERANNUAL VARIABILITY AND CLIMATE CHANGE ON NORTHWESTERN MEDITERRANEAN PELAGIC PLANKTONIC ECOSYSTEMS.

M. Herrmann [1]*, C. Estournel [2], F. Diaz [3], P. Marsaleix [2] and C. Ulses [2]
[1] LEGOS, Toulouse - marine.herrmann@ird.fr
[2] LA, Toulouse
[3] MIO, Marseille

Abstract
The Northwestern Mediterranean Sea (NWMS) is biologically one of the most productive areas of the Mediterranean Sea. The functioning of the NWMS pelagic planktonic ecosystem is strongly influenced by hydrodynamics, in particular deep convection that shows a strong interannual variability and that could be strongly impacted by climate change. We investigated the response of the NWMS pelagic planktonic ecosystem and associated carbon cycle to the interannual variability of oceanic and atmospheric circulations and to climate change. For that we developed and used a dedicated tridimensional coupled physical-biogeochemical model.

Keywords: North-Western Mediterranean, Models, Water convection, Phytoplankton, Carbon

Deep convection is one of the major processes of the NWMS circulation. Winter atmospheric events associated to cold winds (Mistral and Tramontane), high evaporation rates and strong buoyancy losses are at the origin of surface dense water formation. This induces vertical mixing that brings nutrients initially present in the deep layers up to the surface, resulting in spring phytoplanktonic blooms when the water column restratifies. Deep convection shows a strong interannual variability [1] and could severely weaken as a consequence of climate change [2]. Our objective is to understand how this variability and long-term evolution could impact the functionning of the NWMS pelagic planktonic ecoystem and associated carbon cycle. For that, we developed a coupled physical-biological regional model and performed two groups of simulations under respectively the present and future (end of the XXIth century) climate conditions.

Numerical tools and design

The 3D primitive equation ocean model SYMPHONIE [3] is used at 3 km resolution to compute the evolution of the NWMS planktonic pelagic ecosystem due to the hydrodynamics. The biogeochemical model is a multi-nutrient and multi-plankton functional types model that simulates the dynamics of several biogeochemical decoupled cycles of biogenic elements (carbon, nitrogen, phosphorus and silicon) and of non-redfieldian plankton groups. The model structure used in this study is the same as the one used by [4] and [5], with 6 main groups and 33 state variables.

The coupled model was forced by atmospheric and large-scale oceanic fields coming from a basin-scale Mediterranean simulation over the period 1960-2011 under the IPCC A2 scenario assumptions [2]. Due to numerical cost, we could not perform a 140 year simulation with our model. We therefore selected two groups of 7 years for the present (1970-2000) and future (2070-2100) periods and performed the corresponding coupled physical-biogeochemical simulations. [6] presented the results of the simulations concerning the hydrodynamics.

Results

First, our coupled model reproduces correctly and quantitatively the seasonal evolution of the NWMS pelagic planktonic ecosystem in terms of biogeochemical components and processes. It however overestimates the contribution of nanophytoplankton to the total phytoplanktonic biomass and primary production. Our model confirms that the control of phytoplanktonic development and bacteria growth by the phosphorus availability is a marked specificity of the NWMS.

Second, our results show that the seasonal evolution and annual carbon balance of this ecosystem show generally a weak interannual variability, though the strong interannual variability of winter deep convection induces a strong variability of the nutrients availability. The net metabolism and deep carbon export show larger variabilities related respectively to the variability of the euphotic layer temperature and the deep convection intensity. The NWMS however seems to be systematically a sink for the organic and dissolved inorganic carbon.

Finally, our results suggest that the evolution of oceanic and atmospheric circulations during the XXIst century does not significantly influence the functioning of the NWMS pelagic planktonic ecosystem and associated carbon cycle at a first order. However differences mainly induced by the deep convection weakening and the surface layer warming are obtained at a second order. The spring bloom occurs one month earlier. Resulting from the decrease in allochtonous nutrients availability, the bottom up control of phytoplankton development and bacteria growth by the nitrogen and more particularly phosphorus availability strengthens, the microbial loop intensifies and the contribution of regenerated primary production increases.

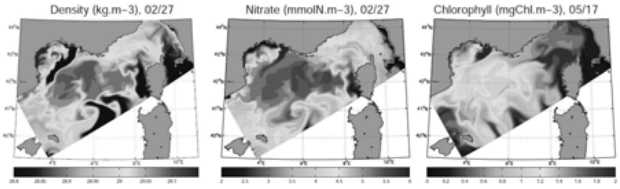

Fig. 1. Surface density (left) and nitrate concentration (middle) on end of February and surface chlorophyll concentration (right) on mid-May for one of the present period year.

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CONTAMINANTS BIOACCUMULATION AND BIOMAGNIFICATION IN A SHORT TROPHIC SYSTEM: PHYTOPLANKTON, ZOOPLANKTON, ANCHOVY, SARDINE (COSTAS)

Jacek Tronczynski [1]*, François Carlotti [2], Nathalie Bodin [3] and Oilivier Radakovitch [4]
[1] IFREMER - Jacek.Tronczynski@ifremer.fr
[2] University of Aix-Marseille, University of South Toulon-Var, CNRS/INSU, IRD, MIO, UM 110, 13288 Marseille, France
[3] IRD Centre de Recherche Halieutique Méditerranéenne et Tropicale (CRH)
[4] 4CEREGE, UMR (6635), CNRS-Univ Aix-Marseille-IRD-Collège de France

Abstract
The main scientific goal of COSTAS project is to bring useful knowledge to the understanding of the conditions, which favor the accumulation and transfer of organic and metallic contaminants at the primary trophic levels (autotrophes and hetetrophes), and then within the food web of small pelagic fish (anchovy and sardine) in the Gulf of Lion, Western Mediterranean.

Keywords: Plankton, Bio-accumulation, Trace elements, Pcb, Gulf of Lyon

In the integral scheme of biogeochemical cycles of contaminants in marine ecosystems, the assimilation of anthropic compounds and elements at primary trophic levels, in plankton, is not yet well known [1,2]. However, planktonic populations play a key role in the trophic food webs in marine ecosystems by the mobilizing and transfer of organic matter towards higher trophic levels [3,4]. Thus our study focuses on the whole food web, including water column/ phytoplankton/ zooplankton/ and small pelagic fish.

The main groups of compounds and trace elements were considered: persistent organic contaminants (polychlorobiphenyls PCBs and polybrominated diphenyl ethers PBDEs), mercury (Hg) and methylmercury (CH_3Hg), other trace metals (Pb, Cd, Co, Cu, Ag, Zn), natural radioelements (^{210}Pb, ^{210}Po) and stable lead isotopes (^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb). The presented approach embraces the ecological and biogeochemical dimensions of the food web. It is also based on the simultaneous use of chemical "tracers" (organic and metallic contaminants) and biological "tracers" (stable isotopes of δ13C and of δ15N and fatty acids).

The presented results show also the mechanisms of the bioaccumulation of toxic substances in the tissues of small pelagic fish (tissue distributions, excretion, metabolization), as well as the influence of ontogenic factors (growth, reproduction, migration) [5]. Finally, the modeling allow us the spatial and dynamic interpretation of data [6], as well as at the first attempt to integrate the biogeochemical, ecological, and physical behavior of contaminants in their transfer at primary trophic levels, including also development and application of the dynamic energy budget model (DEB) of anchovy in the Gulf of Lion [7,8].

The research work was carried out within COSTAS project and calls for competence in marine biology, ecology, biogeochemistry and physics employed together in the scientific tasks of data acquisition during oceanographic cruises, laboratory analysis, and coupled modeling.

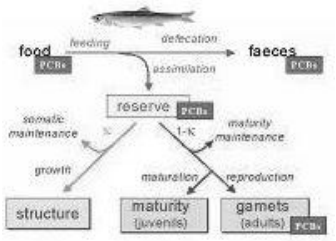

Fig. 1. Conceptual diagram: Dynamic Energy Budget DEB model comprises a good knowledge of physiology of fish controlling vital functions (such as reproduction and growth) and fate of contaminants in fish [9].

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ORGANOCHLORINATED (PCBS) AND ORGANOBROMINATED (PBDES) CONTAMINANTS IN EUROPEAN ANCHOVY (*ENGRAULIS ENCRASICOLUS)* FROM THE NORTH-WESTERN MEDITERRANEAN SEA

C. Munschy [1], V. Loizeau [2], H. Pethybridge [2], C. Tixier [1], J. Tronczynski [1]*, N. Bodin [3], F. Le Loch [4] and M. Harmelin-Vivien [5]
[1] IFREMER - Biogeochemistry and Ecotoxicology Unit, Laboratory of Biogeochemistry of Organic Contaminants (BE/LBCO), Nantes, France - jtronczy@ifremer.fr
[2] IFREMER - BE/LBCO, Brest, France
[3] IRD - UMR 212 EME, Victoria, Seychelles
[4] IRD - UMR 212 EME, Sète, France
[5] Institut Méditerranéen d'Océanologie, Aix-Marseille Université, UM 110, Station Marine d'Endoume, Marseille, France

Abstract
Polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) were investigated in European anchovy (*Engraulis encrasicolus)* collected in the Gulf of Lions. The contaminants were determined in different organs and tissues of male and female adult fish sampled during the spawning and resting seasons. The influence of sex, age and reproduction on contaminant concentrations was evaluated.

Keywords: Bio-accumulation, Gulf of Lyon, Fishes, Pcb

Small pelagic fish, such as European anchovy (*Engraulis encrasicolus*), stand at intermediate levels in food webs and play an essential role in North-Western Mediterranean ecosystems [1]. Understanding their contamination by persistent toxic contaminants is therefore of importance. The contamination of selected organochlorinated (polychlorinated biphenyls - PCBs) and organobrominated (polybrominated diphenyl ethers -PBDEs) contaminants was investigated in European anchovy collected in the Gulf of Lions (North-Western Mediterranean Sea). The spatial distribution of contamination was assessed at different locations throughout the Gulf of Lions, from the mouth of the Rhône River in the Eastern part of the Gulf, to Port Vendres in the South-Western part. Male and female adult fish of homogeneous size were sampled during the spawning and resting seasons (i.e., July 2010 and March 2011, respectively). Contaminant determination was done on pooled individuals of similar size and sex, and replicate pools were analysed when available. Extensive determination of contaminants in different organs and tissues (muscle, liver, gonad, viscera and carcass) allowed to calculate the whole body's contamination levels and to assess the effects of anchovy's reproductive activity on the distribution and levels of organic chemicals. Fish contamination was examined together with total lipid content. Lipid classes (triacylglycerols, sterols and phospholipids) as well as carbon and nitrogen stable isotopes were also determined in selected tissues in individual anchovies. Finally, contaminants, lipids and stable isotopes were assessed in anchovy main diet (small zooplankton), and BMF and TMF were evaluated. No significant differences in anchovies' contamination levels were observed throughout the Gulf of Lions, revealing a fairly homogeneous population within the study area and no local influence of contaminant inputs on fish contamination. During the spawning season, females exhibited lower contamination levels than males, while no statistically significant difference was found during the resting season. CB-153 (predominant PCB congener) concentrations ranged from 4.1 ng g-1 wet weight (ww) to 9.3 ng g-1 ww in females and males respectively during the reproductive season; they ranged from 9.6 ng g-1 ww to 12.2 ng g-1 ww during the resting season. BDE-47 (predominant PBDE congener) concentrations were 40- to 60-fold lower than those of CB-153. The lower PCB and PBDE levels measured in females during the spawning season could result from a decontamination process that occurred during spawning [2]. Moreover, a modelling approach based on the Dynamic Energy Budget (DEB) theory revealed age differences between fish of given sex and length between the two seasons [3]; this could also explain the differences observed in anchovies' contamination.

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Session

Estuaries status

Modérateur : **Ana Cindric**

DISTRIBUTION OF TRACE METALS IN THE STRATIFED KRKA RIVER ESTUARY (CROATIA)

A. M. Cindric [1]*, C. Garnier [2], B. Oursel [2], D. H. Dang [2], N. Cukrov [1], I. Pižeta [1] and D. Omanovic [1]
[1] Ruder Boškovic Institute, Center for Marine and Environ. Research, POB 180, Zagreb, Croatia - ablatar@irb.hr
[2] Université du Sud Toulon-Var, PROTEE, EA 3819, 83957 La Garde, France

Abstract
Distribution of trace metal(oid)s (Zn, Cd, Pb, Cu, Ni, Co and As) along vertically stratified Krka river estuary was studied. The concentrations of trace metals are maintained at low levels across the estuary during winter, because of low input of trace metals by the Krka River and the lack of permanent diffusive sources. Localized anthropogenic influence was identified in the harbor of Šibenik town and in the two nautical marinas. However, due to the intensive nautical traffic during summer periods, a significant increase of metal concentrations (especially of Cu and Zn) in upper brackish layer was evidenced as a consequence of release of metals from the antifouling paints.

Keywords: Trace elements, Estuaries, Vertical profile, Electrochemistry, Central Adriatic Sea

Introduction
Karstic river Krka is situated on the East coast of the Adriatic Sea (Croatia) and is partly located within the National park Krka. Numerous lakes formed by tufa barriers rendered concentration of trace metals in water at very low levels [1]. The Krka river is forming 22 km long estuary which is, due to the low tidal range and sheltered geography, permanently vertically stratified. The three separate layers in a vertical profile exist along the estuary and could be easily spotted: upper brackish layer, freshwater – seawater interface (FSI) with high salinity gradient and bottom seawater layer. Halocline is mostly formed between 1.5 and 2.5 m from the surface with the gradient of more than 20 salinity units within 1 m. Strong salinity gradient is controlled by hydrological conditions (river flow) and weather (precipitation, wind). First measurements of trace metals in a vertical profile of estuary conducted 20 years ago [2] showed their very low levels and the absence of anthropogenic pressure. An increase of nautical tourism and the harbor activities in the last decade refer to the possible anthropogenic influence [3]. Thus, the objectives of this study were to indentify major sources of trace metal inputs to the estuary, as well as to estimate and quantify their influence and distribution in both, horizontal and vertical directions.

Sampling and measurements
Water samples were collect along the estuary transect at total 14 sites in summer 2011 and in winter 2012. Additional freshwater sample was collected in the Krka river, while seawater end-member sample was taken at position far from the estuary. At each estuary sampling site, samples were taken at three depths covering the whole salinity range (upper brackish layer with variable salinity, intermediate layer with salinity ~20 and bottom seawater layer with salinity >37). In order to identify the main sources of trace metals in the Šibenik bay, a high resolution sampling of surface layer at 40 sites was conducted in summer 2012 (Fig. 1).

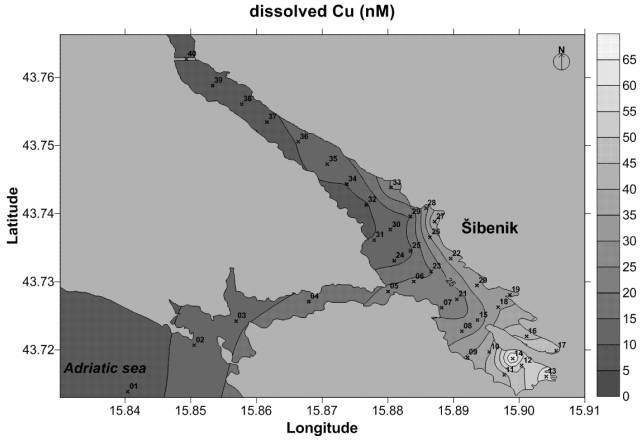

Fig. 1. Locations of sampling sites in the Šibenik bay and diss. Cu distribution

All samples along the vertical profile were sampled by using horizontal water sampler, while surface samples in the Šibenik bay were taken by grab sampling using homemade "swing sampler" (1 L FEP bottle mounted at the end of the long stick). Trace metal concentrations were determined by standard addition method on fully automated auto-sampler. Differential pulse anodic stripping voltammetry (DPASV) was used for measurement of Zn, Cd, Pb and Cu, while adsorptive cathodic stripping voltammetry (DPAdCSV), with Nioxime as a ligand, was used for analysis of Ni and Co. Hydride Generation Atomic Fluorescence Spectroscopy was used for As analysis.

Results and discussion
A non-conservative behavior of metals with salinity was observed because of low content of particulate matter and additional sources of metals within the estuary. Regarding the trace metal distribution along the estuary transect, a significant increase of metals concentration, especially Cu, was found in brackish layer in the summer period (Table 1). Change in concentrations is related to the increase of nautical traffic in touristic period, primarily because of metals leached from the antifouling paints [3]. Due to a progressive enrichment by metals scavenged from the more polluted brackish layer there is an upstream increase in bottom seawater layer. Highest concentrations of all metals were found in the Šibenik bay. Detailed mapping (Fig 1.) has demonstrated that concentrations are highest in nautical marina (Cu diss. ~ 70 nM) and in the Šibenik harbor (Cu diss. ~ 49 nM). Comparing to average concentration of Cd in the bay (0.07 nM), increased concentrations (0.19 nM) were found in part of the harbor where transshipment phosphate ores is located. Zn is significantly correlated to Cu because of the same sources. Difference between unfiltered and filtered metal concentrations (Cu/Zn) is low, indicating that they are mostly added to the ecosystem in a dissolved form and thus are potentially bioavailable/toxic for microorganisms. Taking into account a previous speciation study conducted in this estuary [4], toxic levels of free Cu could be expected in areas of the highest copper concentrations. A survey on a global scale and a study of metal speciation in the coastal zone is needed in order to estimate a potential toxic effect on sensitive organisms such as planktons.

Tab. 1. Ranges of dissolved Cu concentrations (in nM)

Layer	Summer	Winter
Brackish	**1.36** ± 0.46 – **27.6** ± 1.16	**1.76** ± 0.14 – **7.29** ± 0.37
FSI	**3.79** ± 0.36 – **16.01** ± 0.29	**3.07** ± 6.17 – **6.17** ± 0.15
Seawater	**2.57** ± 0.35 – **9.25** ± 0.27	**2.98** ± 0.19 – **5.90** ± 0.20

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ESTIMATION OF SUBMARINE GROUNDWATER DISCHARGES USING RADON AND RADIUM ISOTOPES IN THE MAR MENOR LAGOON (SPAIN) AND THE PORT-MIOU CALANQUE (FRANCE).

S. Cockenpot [1]*, O. Radakovitch [1], P. Baudron [2], B. Arfib [1], F. Lopez-Castejon [3], A. Mayer [4], J. Gilabert [5], J. Garcia Arostegui [6], C. Leduc [2] and C. Claude [1]

[1] CEREGE UMR7330, Aix-Marseille Université - cockenpot@cerege.fr

[2] G-EAU-UMR183 IRD, Montpellier, France

[3] Dept Chem. & Environ. Engineering. Tech. Univ. of Cartagena, Cartagena, Spain

[4] LHA-EMMAH-UMR 1114. Univ.Avignon et des Pays de Vaucluse. Avignon, France

[5] Dept Chem. & Environ. Engineering. Tech. Univ. of Cartagena, Cartagena, Spain

[6] IGME (Instituto Geológico y Minero de España), Murcia, Spain

Abstract

Submarine Groundwater Discharge (SGD) may represent important inputs of water and associated elements to the coastal zone. We evaluated such SGD fluxes on two contrasting environment: the Mar Menor lagoon (Cartagena, Spain) and the Port-Miou karstic springs (Marseille, France). In both cases we used radon and radium mass balances to quantify and/or locate SGD. In the Mar Menor we combined radon and radium surveys with an hydrodynamic modeling of the lagoon.

Keywords: Radionuclides, Lagoons, North-Western Mediterranean, Coastal systems

Coastal areas are vulnerable environments undergoing increasing anthropogenic pressures. Various processes can affect them, and one particularly important is the degradation of water quality in the continent or in the ocean. In this context, the groundwater discharge into the coastal zone has received increased attention in the last years as it is now recognized that this process may represent an important pathway for the delivery of nutrients, and metals to the ocean. SGD have been evidenced as submarine springs (karstic springs) or diffuse seepage across the seafloor. SGD could be freshwater (Submarine Freshwater Groundwater Discharge, SFGD) or recirculated saline groundwater (RSGD), i.e. seawater intrusion into coastal porous sediments, mixed with continental freshwater discharged back to the sea. SGD fluxes are less affected by surface drought than rivers and can occur all the year, in contrast to Mediterranean temporary rivers. Furthermore, because groundwaters can have higher concentrations of dissolved chemicals (nutrients, metals) than most terrestrial surface waters, SGD can make a disproportionately large contribution to the flux of dissolved constituents from continent to ocean. In the Mediterranean Sea, SGD was not studied at the global scale, whereas an estimate from UNESCO (2004) indicates that the karstic areas bordering 65% of the coastline could contribute for 75% of the total freshwater runoff mostly through SGD. However, recent papers underlined the occurrence of SGD in Spain, France or Italy and revealed the different influences they could have on coastal fluxes of elements ([1], [2], [3], [4]).

In the two studied areas we used radon and radium isotopes as tracers of SGD. These elements are enriched in groundwater compared to coastal waters and the estimation of their budget in a coastal area allows locating and quantifying SGD.

^{222}Rn was analysed with a RAD-7 system on 250 mL bottles (groundwater and river water) or in continuous by surface water pumping on-board of small vessel along the coast. 15 L of water were collected for radium isotopes, preconcentrated on Mn-fiber. And analysed using a RaDeCC system designed by Moore and Arnold [5].

In Mar Menor (Spain), we used an approach combining radon (^{222}Rn) and radium (^{223}Ra, ^{224}Ra) surveys together with an hydrodynamic modeling of the lagoon. This allowed to decipher the radionuclide signal issued from surface water, atypically highly enriched in radionuclides and nutrients, than those issued of SGD. Radionuclides mass balances provide SGD fluxes of water of 26-58 (^{222}Rn), 10-20 (^{224}Ra) and 18 m^3/s (^{223}Ra). The budget evidences that sea-level variation is likely to be an important process for this SGD by adding recirculated seawater from the sediment to the water column, while fresh groundwater discharge from the aquifer is about 1% of total SGD. This corresponds to a fresh groundwater input of 0.2 m^3/s that is similar to river flux (0.33 m^3/s) and clearly lower than inter and outer water fluxes exchanged with the Mediterrenean Sea.

The Port-Miou karstic submarine spring (France) is typical of brackish groundwater discharging through karst conduits, and it was investigate in order to validate the mass balance model approach. Combining ^{222}Rn, ^{223}Ra and ^{224}Ra mass balances with water and salt budgets, we obtained a SGD value of 3.6 m^3/s, consistent with the discharge estimated by an hydraulical approach based on pressure sensors. This validation allows the use of ^{222}Rn as a tracer for other important karstic areas in the Mediterranean Sea (Croatia, Greece, ….) where discharges data are not available.

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TWO ANCHIALINE CAVES FROM THE CROATIAN ADRIATIC COAST

N. Cukrov [1]*, R. E. Bishop [2], V. Cuculic [1], C. Garnier [3], B. Jalžic [4], Ž. Kwokal [1] and V. Žic [5]
[1] Ruder Boškovic Institute, Division for Marine and Environmental Research, Bijenicka 54, 10000 Zagreb, Croatia - ncukrov@irb.hr
[2] Penn State University, 120 Ridge View Drive, Dunmore, PA
[3] Laboratorie PROTEE, Université Du Sud Toulon Var, BP 20132, 83957 La Garde, France
[4] Croatian Natural History Museum, Demetrova 1, 10000 Zagreb, Croatia
[5] Central Water Management Laboratory, Hrvatske vode, Uvala Škar b.b., p.p. 40, 22 001 Šibenik, Croatia

Abstract
A preliminary study of distribution of total trace metal concentrations (Hg, Cd, Pb, Cu, Zn, Ni, Co), nutrients (nitrate, nitrite, ammonium, phosphate & silica) and physico-chemical parameters (water temperature, salinity, conc. of dissolved oxygen - DO), dissolved inorganic/organic carbon (DIC, DOC) in water columns of two anchialine caves (Bjejajka and Živa voda) from eastern Adriatic coast (Croatia) has been performed.

Keywords: Trace elements, Anoxia, Central Adriatic Sea, Organic matter, Nutrients

Introduction
The anchialine environment was defined at the 1984 International Congress of Marine Cave Biology, Bermuda [1] as containing bodies of haline waters, usually with a restricted exposure to open air, and always with more or less extensive subterranean connections to the sea, which show noticeable marine as well as terrestrial influences. Last year, during the 2nd International Symposium on "Anchialine Ecosystems", Croatia, a new definition was proposed: "A type of subterranean estuary containing at least seasonally stratified water body, that may or may not be in direct contact with the atmosphere, and is capable of supporting a characteristic biota" /www.anchialine.com/. Recently, these unique aquatic environments of the Croatian Adriatic coast became the target of interdisciplinary research [1, 2, 3].

Study area & methodology
The anchialine caves presented here are located on the Adriatic islands, and are exposed to a minimal anthropogenic influence. Bjejajka anchialine cave is located on the Island Mljet [1, 2, 3], while Živa voda cave is situated on the the Island of Hvar [1, 4]. Cave waters were sampled by a scuba diver in September 2012. Four samples were taken from each cave (two above and two below the halocline). Differential pulse anodic strippingvoltammetry (DPASV) was used for measurement of Zn, Cd, Pb and Cu, while adsorptive cathodic stripping voltammetry (DPAdCSV), with Nioxime as a ligand, was used for analysis of Ni and Co.Mercury concentrations were analysed by CV-AAS.

Fig. 1. Locations of anchialine cave Bjejajka and Živa voda

Results
Values of total trace metal concentrations, nutrients and physico-chemical parameters (water temperature, salinity & dissolved oxygen), dissolved inorganic /organic carbon (DIC, DOC) are presented in Table 1. Although Živa voda cave is three times deeper than Bjejajka cave, the salinity distributions were similar. Dissolved oxygen concentrations were significantly lower in Bjejaka cave, and hypoxic conditions were registered around the halocline. The nutrient results show that the external nitrogen and phosphorus loading is higher for the Bjejajka Cave. Interesting though, the caves share high similarity with respect to N/P ratio, which is close to the Redfield ratio in deep waters, but substantially higher at the surface. The differences in silica (and inorganic carbon) concentrations between the caves is, as already suggested [3], most likely a result of the compositional differences between the rocks/soils that surround these systems. Mercury and cadmium concentrations were significantly higher in samples taken below the halocline in Bjejajka, and are comparable to those reported earlier [2]. In Bjejajka cave higher copper and zinc concentrations were found, relative to Živa voda cave, while the concentrations of lead, nickel and cobalt were comparable in both caves. Concentrations of DIC and DOC were considerably higher in Bjejaka cave, only DOC amounts were slightly lower than was reported earlier [2]

Tab. 1. Physico-chemical parameters (water temperature, salinity, conc. of dissolved oxygen – DO), nutrients (nitrate, nitrite, ammonium, phosphate & silica), total trace metal concentrations (Hg, Cd, Pb, Cu, Zn, Ni, Co),) and dissolved inorganic/organic carbon (DIC, DOC) in water columns of two anchialine caves (Bjejajka and Živa voda).

	Bjejajka cave				Živa voda cave			
Depth (m)	0.1	2.2	5.7	11	0.1	2.2	6.4	32.5
Salinity	3.63	11.3	28.2	35.8	7.9	12.7	32.6	38
DO (mg/L)	5.4	2.37	0.96	2.53	9.05	6.32	6.37	6.67
Temperature (°C)	14.8	14.8	15.2	15.6	14.7	15.3	16.7	17.8
nitrate (µM)	193	57	7	5	100	12	3	3
nitrite (µM)	1.22	0.05	0.08	<0.02	0.18	<0.02	<0.02	<0.02
ammonium (µM)	2.2	1.6	0.7	<0.4	2.6	1.6	0.4	0.9
phosphate (µM)	0.97	0.51	0.13	0.27	0.36	0.22	0.15	0.26
silica (µM)	79	79	65	31	54	44	8	13
Hg (ng/L)	1.80	2.60	290	198	0.8	2.7	5.8	4.9
Cd (ng/L)	23.5	37.9	206	147	17.2	32.1	16.7	22.8
Pb (ng/L)	31.1	18.1	206	63.3	91.8	36.5	14.4	104
Cu (ng/L)	1127	908	1137	373	563	215	234	450
Zn (ng/L)	1546	1059	1532	706	1092	528	267	854
Ni (ng/L)	460	532	519	259	311	379	261	510
Co (ng/L)	23.3	24.1	18.8	10.3	20.2	13.1	8.1	167
DIC (mgC/L)	137	140	87.2	43.9	52.6	59.5	33.4	32.9
DOC (mgC/L)	3.99	3.12	1.23	0.46	0.96	0.54	0.55	0.48

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TOXIC METALS IN TUBES AND TISSUE OF ALIEN SPECIES *FICOPOMATUS ENIGMATICUS* (FAUVEL, 1923) FROM THE KRKA RIVER ESTUARY, CROATIA

Marijana Cukrov [1], Dario Omanovic [2] and Neven Cukrov [2]*
[1] Croatian Biospeleological Society, Demetrova 1, 10000 Zagreb, Croatia
[2] Ruder Boškovic Institute, Division for Marine and Environmental Research, Bijenicka - ncukrov@irb.hr

Abstract
Alien species *Ficopomatus enigmaticus* (Fauvel, 1923) (Annelida, Polychaeta) was registered in the Krka River Estuary for the first time seven years ago. Since *F. enigmaticus* inhabits many polluted areas around the world, it is potential candidate which could be used as a pollution bio-indicator. Thus, the levels of accumulated toxic metals in tubes and in soft tissue of this specieswere monitored at different locations along the estuary.

Keywords: Annelida, Central Adriatic Sea, Alien species, Metals, Estuaries

Introduction
Serpulid species *Ficopomatus enigmaticus* (Fauvel, 1923) builds calcareous tubes on any hard substrate with distinctive collar-like rings at irregular distances. It has been found worldwide inhabiting coastal brackish waters, lagoons, estuaries and anchialine ecosystems of warm temperate areas of both hemispheres. This tubeworm is an efficient suspension-feeder, very tolerant and physiologically well adapted to temperature and salinity variations, eutrophic conditions and low dissolved oxygen content.

Study area and methodology
F. enigmaticus was recently registered at Krka River Estuary [1] and adjacent anchialine caves [2, 3]. Situated in the karst region, the Krka River Estuary is 22 km long with the gradually increasing depth from 2 m to 42 m. It is a typical example of a permanently stratified estuary. Villages Skradin, Raslina and Bilice are located in the upper part of estuary, while Zaton village and the town of Šibenik are located in the lower part of the Estuary.
Around the shores of the Estuary, *F. enigmaticus* occurs as a single tube or in large dense fouling aggregates, mostly on artificial substrates. It exists at depths up to 3 m, but the largest settlements are up to 0.5 m [1]. For analyses on metal contents, *F. enigmaticus* samples were taken by scuba diver at 10 locations along the estuary in two seasons (spring and summer). Carbonate tubes and soft tissues were digested using concentrated nitric acid on a hot plate, and analysed separately by HR-ICP/MS. Mercury concentrations were analysed by CV-AAS.

Results
Concentrations of toxic metals in tubes of *F. enigmaticus* are presented in Table 1. The highest concentrations of Hg, Cu, Zn, Cr, Ni and Co were found in local nautical port Vrnaža situated in the lower part of estuary, while the highest concentration of Pb and As were found in port of Šibenik town.

Tab. 1. Toxic metals in tubes of *F. enigmaticus* from sampling points (K1-K10) in the Krka River Estuary. Capital letters A & J means month of sampling (A-April and J-June).

	Hg (ng/g)	Cd (µg/g)	Pb (µg/g)	Cu (µg/g)	Zn (µg/g)	Cr (µg/g)	Ni (µg/g)	Co (µg/g)	As (µg/g)	Ag (µg/g)
KR-1/A	< 5	0.09	6.84	5.89	11.9	< 0.5	5.70	1.20	0.20	0.03
KR-2/A	6	0.16	3.57	10.1	21.9	< 0.5	4.90	0.50	< 0.1	0.08
KR-3/A	21	0.27	4.43	27.2	28.7	0.70	5.90	0.70	< 0.1	0.01
KR-4/A	< 5	0.22	4.38	39.9	71.9	1.10	5.70	0.60	1.50	0.01
KR-5/A	< 5	0.22	3.67	11.8	15.7	0.50	5.90	0.60	0.30	0.00
KR-7/A	7	0.16	17.6	7.57	49.8	< 0.5	4.90	0.70	0.50	0.07
KR-10/A	< 5	0.04	6.06	4.84	11.0	< 0.5	5.40	1.20	1.00	0.02
KR-7/J	22	0.17	89.6	10.3	54.8	< 0.5	5.50	1.10	1.90	0.07
KR-9/J	64	0.11	19.5	55.2	69.9	2.70	7.40	1.60	1.20	0.04
KR-10/J	11	0.07	7.95	5.64	13.9	< 0.5	5.70	1.40	< 0.1	0.02

Regarding the temporal variation, the highest difference at the particular sampling site was found for Pb (four times difference), while at the same site concentration of Hg was three times higher. The highest concentrations of Cd and Ag were found around nautical ports of Zaton village. In general, concentrations of all metals varied on both spatial and temporal scale at least one order of magnitude, reflecting probably variations in a localized anthropogenic pressure at sampling sites. The largest concentration ranges were found for Ag and Pb, following that of Hg, Cu and As. It is interesting to note that for Pb, Hg, As at some sampling points (Table 1) a quite high differences in metal concentrations between samples for two sampling events were observed, while for Cd, Cu, Cr, Ni, Co, Ag concentrations remained at the same level. Fairly good correlations between Cd – Co and Cu – Zn concentrations in tubes of *F. enigmaticus* were found. Concentrations of toxic metals in soft tissue of *F. enigmaticus* are presented in Table 2. Generally, the highest concentrations of metals in tissue were found at locations with likely anthropogenic influence (nautical and city ports). Very high concentrations of Cr and Ni, found at sampling site at nautical pontoon near Skradin village (upper part of the estuary), are probably related to settlements formed on chrome/nickel plated iron surface. Variations of concentrations in soft tissue are smaller comparing to tubes, with the exception of Cr, which varied more than seventy times. Variations in Pb concentrations reflect its levels in water column along the Krka River estuary. Statistically significant correlations were found between Cu-Zn and Co-Pb concentrations in soft tissue of *F. enigmaticus*. Analyses performed in tubes and in soft tissues of *F. enigmaticus* indicated that they respond on the level of toxic metals in the water column, however a more detailed survey should be undertaken in order to define all relevant parameters which have influence on the content of accumulated metals during period of exposure/monitoring.

Tab. 2. Toxic metals in soft tissue of *F. enigmaticus* from sampling points (K1-K10) in the Krka River Estuary. All samples were taken in June.

	Cd (µg/g)	Pb (µg/g)	Cu (µg/g)	Zn (µg/g)	Cr (µg/g)	Ni (µg/g)	Co (µg/g)
KR-1	1.80	1.62	9.78	46.60	1.03	2.18	0.39
KR-4	0.70	1.61	14.00	62.70	1.68	1.72	0.53
KR-6	0.43	0.39	3.73	33.60	20.70	10.30	0.40
KR-7	1.40	2.28	16.00	80.70	0.34	2.06	0.29
KR-8	0.54	3.49	26.70	87.90	0.90	1.32	0.25
KR-9	1.01	5.48	11.40	74.30	0.27	1.24	0.18
KR-10	1.09	1.78	12.10	47.80	0.30	1.47	0.35

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LITHOGENIC AND BIOGENIC FLUX CHANGES IN DIL CREEK ESTUARINE (THE MARMARA SEA)

H. A. Ergul [1]*, A. Küçük [1], G. Çelebi [1], M. Terzi [1] and S. Aksan [1]
[1] Kocaeli University Department of Biology - halim.ergul@kocaeli.edu.tr

Abstract
This study represents first lithogenic and biogenic particle flux in sediment trap sediments from Dil Creek estuarine in the Izmit Bay (the Marmara Sea). In sediment samples, vertical flux of TOM, C_{org}, $CaCO_3$, BSi and Lithogenic contents were determined between Aug. 2008 and May 2010. Lithogenic matter was dominant component during the sampling period that represents terrigenic input. BSi concentrations in trapped sediment were mainly driven by siliceous organisms. Contrary to common belief, $CaCO_3$ mainly originated from mineralogical sources. TOM and C_{org} concentrations are generally higher than other Mediterranean coasts. It is assumed that elevated TOM and C_{org} levels in Dil Creek estuarine are sourced from untreated discharges.

Keywords: Sediments, Marmara Sea, Particle flux

Introduction: Scientific attention for organic matter (TOM), organic carbon (C_{org}), biogenic silica (BSi) and carbonate ($CaCO_3$) cycle is increasing since recent decades. Studies have shown that marine silica cycle is dominated by phytoplankton and mainly diatomaceous organisms contribute to trophic transfer of organic carbon besides marine biogenic silica [1] and carbonates. Although some studies have been done in Mediterranean Sea coastal ecosystems [2], [3] there was no study related with biogenic components of marine sediment from the Marmara Sea in turn Dil Creek which inflow to the Izmit Bay. The Izmit Bay receives considerable amount domestic and industrial discharges. Dil Creek, is known as the most polluted river of Turkey (Fig 1). Dil Creek carries 200 big factories industrial and more than one million inhabitants (untreated) domestic discharges to the Izmit Bay beside agricultural runoff from its catchment area. Thus, this study represents first lithogenic and biogenic particulate flux results from Dil Creek estuarine in the Izmit Bay.

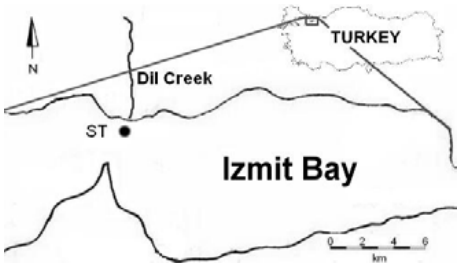

Fig. 1. Sampling station (ST) in the Izmit Bay inshore.

Methods: Sediment trap was deployed Dil Creek estuarine in the Izmit Bay at 15 m depth (Fig. 1) with average 20 days intervals between Aug. 2008 and May 2010. TOM were determined after combustion in 550 ^{o}C, C_{org} were measured using non-dispersive infrared analyzer, 0.5 N HCl were used for $CaCO_3$ determination and wet alkaline digestion method were used for BSi analysis. Also some oceanographic parameters (i.e. Chl-a, Temperature) were determined. All the resuls were statistically tested and Principal Component Analysis (PCA) were used for source identification.

Results: Vertical flux of lithogenic and biogenic material in sediment samples is presented in Fig. 2. Lithogenic matter was generally dominant component that represents terrigenic input. However, correlations between BSi and Chl-*a* (not presented here) (i.e. r=0.5, p<0.01) reveal that BSi in trapped sediment were mainly driven by siliceous organisms (i.e. phytoplankton) in marine water. There were no correlations between $CaCO_3$ and BSi and between $CaCO_3$ and Chl-*a* (p>0.05). Contrary to common belief, PCA results (not presented here) reveals that $CaCO_3$ mainly not related with the lithogenic contents in the bay. Already, It is reported that substantial carbonate mine (i.e. limestone and dolomite) present in the Izmit Bay coasts [4]. Thus it is assumed $CaCO_3$ flux originated from mineralogical sources and inflow to the Izmit Bay via Dil Creek.

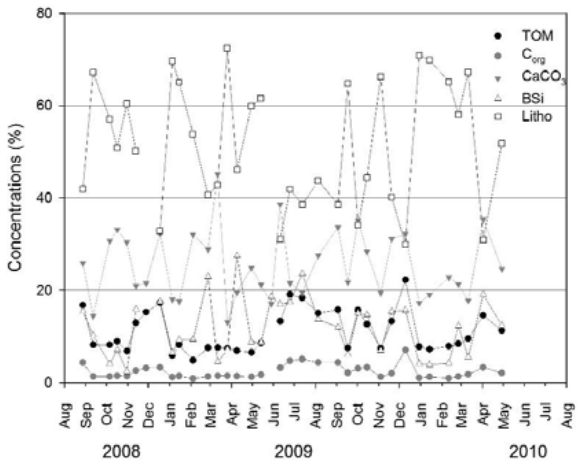

Fig. 2. Lithogenic and biogenic matter concentrations in trap sediments.

Significant correlations were determined between C_{org} and TOM (i.e. r=0.94, p<0.001) and between C_{org} and BSi (i.e. r=0.52, p<0.01). These results indicate that organic material in sediment are strongly related with the biogenic component and Dil Creek is the main source. Data comparison indicates that, except some polluted bays [5], TOM and C_{org} are generally higher than other Mediterranean coastal ecosystem. As is known industrial and domestic effluents discharged to the Dil Creek substantially untreated. Thus, it is assumed that elevated levels of TOM and C_{org} in Dil Creek estuarine are sourced from untreated discharges.

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THE MAFRAGH ESTUARY. AN ATYPICAL AND PRISTINE MEDITERRANEAN ESTUARINE SYSTEM

Meriem Khelifi-Touhami [1]*, Meriem Khelifi-Touhami [1] and Makhlouf Ounissi [1]
[1] Département des Sciences de la Mer - meriem_khelifi@yahoo.fr

Abstract
The Mafragh estuary represents a particular Mediterranean wetland area rising northeast Algeria by its diversity of habitats and hydrological functioning. It is a semidiurnal microtidal estuarine system including two river estuaries with their marshlands and three dams. The catchment weakly populated, is exploited for agriculture from the middle estuary to the upper river parts. Distribution of water masses and nutrients has been investigated from 2005 to 2012 at four stations in the lower estuary. The Mafragh appears as an atypical estuary with a hydrologic cycle comprising river, estuarine core and lagoonal phases. The duration of each phase varies with the river input and the extent of dry season. A part from, the low SiO4 levels (Si:N and Si:P ratios are however balanced), the Mafragh may be considered as a rare pristine estuary.

Keywords: Hydrology, Algerian Sea, Nutrients, Salinity

The Mafragh estuary (Fig.1) water flow at the mouth is strongly variable (0 $m^3 s^{-1}$ in dry years and up to 2000 $m^3 s^{-1}$). The estuary mouth might be closed from its tidal connection under extended period of dry years [1]. In dry season, the salt wedge extends up to 20km inland. Following periods of high rainfall and freshwater run-off, the volume of the estuary system (3-4 Millions m^3) was entirely discharged into the sea and the salt wedge was then retreat to the coast in a few days. In winter and in the beginning of spring, tributary rivers discharge high flows to the sea, retreating then the salt wedge up to the sea. From the middle spring to the end of autumn, the estuary was dominated by tidal advection.

Fig. 1. Map of the Mafrag estuarine system. Bold line: limit of the catchment. W: limit of the salt wedge; ?: dam; ¡: position of the studied stations, 2005-2012.

The estuary expands then in a very stratified system, with two layers in which the saltwater layer occupies over 80% of the water column (Fig. 2). Water masses stability remains up to 10 months and very few mixing occurs at the halocline layer thickness (50-150 cm). Surface salinity varied between 0.10-20 and the deep saltwater salinity fluctuated between 28-36. Levels of nitrate in surface water were always 2-3 times higher than those of the bottom. Mean surface levels in all inorganic nutrients were comparable for the studied stations: 11-16 µM for nitrate, 6-10 µM for ammonium, 1-2 µM for phosphate and 50-70 for silicates. Waters were rich in dissolved organic nitrogen (26 µM), indicating then the existence of strong biological activity. This activity is also expressed by the abundance of particulate organic carbon (250 µM).

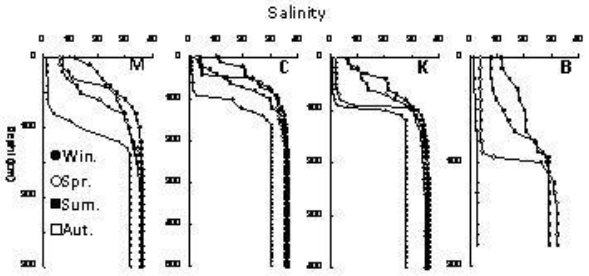

Fig. 2. Seasonal typical profiles of salinity in four stations of the Mafragh estuarine system. M: Mouth; C: confluence; K: Eastern Kebir; B: Bounamoussa.

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APPLICATION OF DGT TECHNIQUE IN SPECIATION OF TRACE METALS IN A STRATIFIED ESTUARY

D. Omanovic [1]*, A. Cindric [1], C. Garnier [2], B. Oursel [2], P. Salaün [3], N. Cukrov [1] and I. Pižeta [1]
[1] Ruder Boškovic Institute, Dept. for Marine and Environ. Research, Bijenicka 54, 10000 Zagreb, Croatia - omanovic@irb.hr
[2] Laboratoire PROTEE, Université du Sud Toulon Var, BP 20132, 83957 La Garde, France
[3] Department of Earth and Ocean Sci., Univ. of Liverpool, Brownlow St., Liverpool, L69 3GP, UK

Abstract
An evaluation of Diffusive Gradients in Thin films (DGT) technique for speciation of trace metal(oid)s in relation to their bioavailability was performed in the stratified Krka river estuary (Croatia). Chelex-100 based DGT probes with both open and restrictive pores were used for speciation of Zn, Cd, Pb, Cu, Ni and Co, while iron-hydroxide resin was used for As speciation. The percentage of DGT-labile concentrations varied from >90% for Cd, down to ~20% for Cu. The difference between open- and restrictive-pores was unexpectedly small. An increase of total dissolved and DGT-labile As concentrations was observed with increase of salinity.

Keywords: Brackish water, Coastal waters, Trace elements, Organic matter, Central Adriatic Sea

Introduction
Bioavailability (and toxicity) of trace metals in natural waters depends primarily on the concentration of their reactive species. The speciation of inorganic metal complexes is well known, however the characterization of the interaction between metals and organic matter is still a challenging task, whether due to methodological or analytical limitations. Environmental Quality Standards (EQS) are still mostly based on total dissolved concentrations although it is well recognized that metal speciation should be taken into account for quality criteria. Simple and easy to use speciation methodology is prerequisite for such implementation on a wider scale. The DGT technique is one of the most promising techniques, because it provides a time-weighted average concentration of labile metal (i.e. potentially bioavailable/toxic) obtained directly in the water column (*in-situ*).
In this work, the DGT technique was used for trace metal speciation in the Krka River estuary (Croatia). The estuary is highly stratified with salinity gradient of more than 20 units within only 1 m depth range. Although considered as an unpolluted oligotrophic estuary, it is subjected to periodic anthropogenic pressure in summer seasons due to intensive nautical traffic which makes this site highly interesting to study metal speciation.

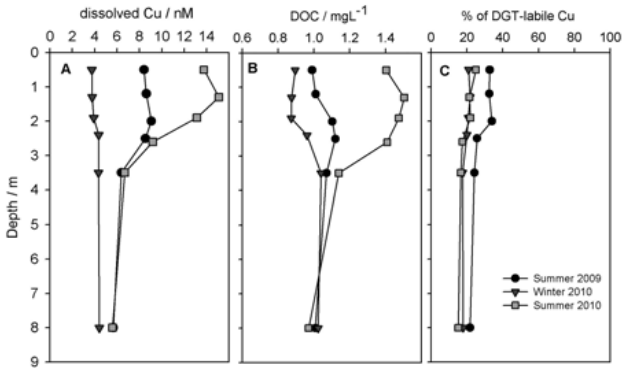

Fig. 1. Dissolved Cu, DOC and percentage of DGT-labile Cu at a "clean" site

Methodology
Several surveys were undertaken between 2008 and 2012 (winter and summer periods). Two contrasting sites were selected, one located in a "clean" area and the other one in a 'polluted" one. DGT devices for metals (open and restrictive pores) and arsenic (iron-hydroxide) were deployed at six depths for ~5 days during 5 separate campaigns. Accumulated metal(loid)s were, analyzed by HR-ICP/MS. Discrete samples were collected once or twice a day at each depth to make up composite samples in which dissolved and total metal concentrations (Zn, Cd, Pb, Cu, Ni, Co, As) were analyzed by voltammetry. Dissolved organic carbon (DOC) was measured as well.

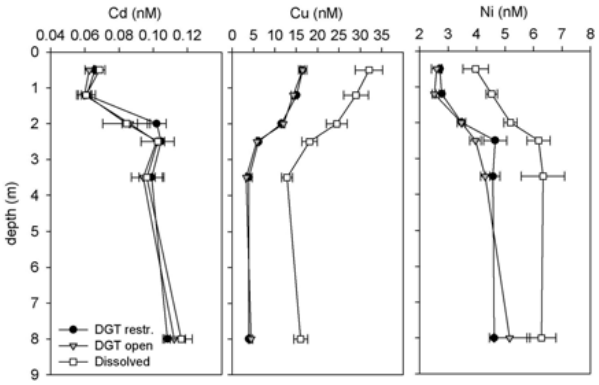

Fig. 2. DGT-labile and diss. Cd, Cu and Ni at "polluted" site (July, 2009)

Results
A typical seasonal variation of vertical concentration profiles of dissolved copper is presented in Fig. 1A. An increase of copper in the upper layer was observed in summer times as a consequence of copper release from anti-fouling paints. However, the extent of this increase is also dependent on the Krka river flow (dilution factor). Although of different origin and behavior, similar vertical concentration profiles were obtained for Cu and DOC (Fig. 1A,B), which in turn resulted in an analogous vertical profiles of DGT-labile copper (Fig. 1C). Vertical distribution of DGT labile metals displayed the same trends with depth as the one observed for total dissolved metals (Fig. 2). The percentage of DGT-labile metal was >90% for Cd, ~60% for Ni, ~50% for Pb and >20% for Cu but varied due to the different affinity of metals to dissolved organic matter (DOM), as well as different metal/DOM ratios [1] (Fig. 2). Surprisingly, DGT-labile metal concentrations measured using restrictive pore devices were almost the same or only slightly lower (<10 %) than those obtained using open pore probes (Fig. 2). In addition, a performance of DGT devices for measurement of Mn, Mo, V and U in estuary conditions was also examined. Voltammetricaly-labile (reactive) concentrations of Cu determined at natural pH were similar to those found by DGT technique, despite different characteristic timescale regarding the lability criteria of the two techniques [2]. The same increasing trends of both, DGT-labile and total dissolved concentrations of arsenic with salinity were observed in estuary water column. The absolute difference between these two concentration profiles suggests that As is to some extent organically complexed.

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THE EXTENT AND DYNAMIC OF AQUIFER SALINIZATION NEXT TO AN ESTUARINE RIVER

Y. Shalem [1]*, Y. Weinstein [1], E. Levi [2], B. Herut [3], M. Goldman [2] and Y. Yechieli [4]
[1] Bar-Ilan University - yehudashalem@gmail.com
[2] Geophysical Institute of Israel and University of Haifa, Israel
[3] Israel Oceanographic and Limnological Research, Haifa and University of Haifa, ISRAEL
[4] Geological Survey of Israel

Abstract
We studied the relations between the estuarine Alexander River (eastern Mediterranean) and the adjacent aquifer. In this river, salinity and stratification are controlled by the sandbar at the river mouth. Highest salinities (27, 4 km from the sea) were observed following storm events, when the sand bar was breached, while during the dry season salinities dropped (<15) and stratification weakened. Electrical resistivity surveys (ERT and TDEM) and observations in shallow boreholes reveal that seawater intrusion is limited to the close proximity of the river. However, while at 300 m from the sea high salinities were restricted to several meters, at 1,800 m from the sea salinization reaches 100 m from the river. At both sites, salinization is limited to the superficial aquifer (<10 m), while the underlying aquifer retains its fresh water.

Keywords: Coastal processes, Levantine Basin, Estuaries, Salinity, River input

Introduction
Surface water-groundwater interaction, in particular seawater intrusion, occurs both along the coastline and along estuarine rivers. Seawater intrusion and its impact on coastal aquifer was widely investigated [1]. However, seawater intrusion via estuarine rivers was hardly studied in the field. The riverbed of the Alexander River (eastern Mediterranean, Israel) is partly below sea level, therefore it is permanently subjected to seawater encroachment, which reaches 4-5 km upstream. The estuarine part of the river cuts through a Quaternary granular aquifer, which is the main aquifer along the Mediterranean coast of Israel. The lithological sequence varies along the river due to temporal and spatial variability in sedimentatary environments.

Results and Discussion
The river mouth is usually blocked by a sandbar. Due to sandbar dynamics, major sea encroachments occur as short events (few days), mostly during or shortly after flood events (2-3 times a year), when high discharge flows and high sea conditions combine to breach the bar. Shortly after flood cessation (a few days), seawater intrudes through the entire length of the estuarine river. In such events, salinity may reach 27 at a distance of 4 km upstream. Shortly after the flood (<week), the sandbar is re-built, and seawater is no longer entering the river. Consequently, salinity of the bottom layer starts decreasing, usually within two weeks after the flood. Dry season salinities remain relatively high, with surface layer salinity ranging between 2-8 and bottom layer salinity usually does not exceed 15 and 7 (500 and 3900 m from the coastline, respectively). The applicability of the electrical resistivity method to the characterization of the salinity field was studied at the sea-aquifer system [2] but was never tested in the saline river-aquifer systems. We studied the extent of aquifer salinization along the estuarine part of the Alexander River, using both the electrical resistivity ERT and TDEM methods and salinity profiles in shallow boreholes. It was found that aquifer salinization is pretty limited but variable along the river. At 1,800 m from the sea, high salinities (<12) were observed in boreholes up to 45 m from the river and the ERT transect further extends the high salinity zone (low resistivity values) up to 100 (Fig. 1). On the other hand, at 300 m from the sea, high salinities were limited to a few m from the river. Both methods agree that salinization is limited to the superficial aquifer, and that the regional aquifer, at depths greater than 15 m (both sites), retained its fresh water (high resisitivity, Fig. 1). The variability in the extent of aquifer salinization is explained by differences in the aquifer-river hydraulic gradients (significantly lower at the eastern site), though it could also be related to heterogeneity in the near-river conductivities due to sediment variability. In other studies, salinization was observed to much larger distances from the river (e.g. 500 m) [3]. This is probably due to different hydrogeological settings and should be further studied.

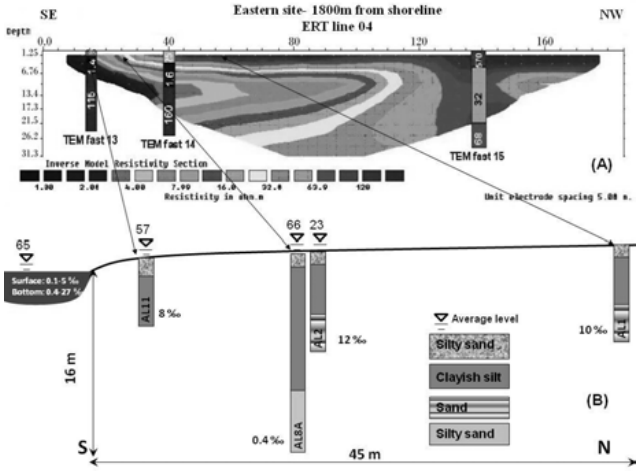

Fig. 1. (A) Integrated ERT-TDEM transect north of the river, 1,800 m from the sea; (B) borehole lithology, salinities (during drilling) and average water level at the same site. Black area (on the left side) in the ERT profile represents low resistivity, which is interpreted as high salinity water, while dark area (from right end to below) is of low salinity water. The gray area (in between) is of mixed water. Arrows indicate the boreholes location on the ERT line.

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Session

Fouling, status and novelties

Modérateur : **Christine Bressy**

ANTIFOULING ACTIVITY OF NATURAL ACTIVE COMPOUNDS THROUGH BIOASSAYS AND FIELD IMMERSION TESTS

C. Anton [1], M. Camps [1], R. Davy [2], S. Couteau [1], B. Tanguy [1], L. Horatius [1], G. Culioli [1], J. Briand [1], Y. Blache [1], F. Quiniou [2], C. Compere [2] and C. Bressy [1]*

[1] Laboratoire MAPIEM (E.A. 4323), Université de Sud Toulon, Var, France - christine.bressy@univ-tln.fr

[2] IFREMER, Centre de Brest, France

Abstract

A growing concern for environmental issues is observed in the development of marine paints and coatings. This study is part of ECOPAINT PACA project and is focused on the comparison of the activity of several natural compounds to those of commercial biocides on the adhesion of marine bacteria and macroorganisms. *In vitro* and *in situ* tests were carried out on the selected compounds and on coatings containing them.

Keywords: Fouling, North-Western Mediterranean, Bacteria

Introduction

Any object immersed in seawater will rapidly attract the attention of marine fouling, causing severe problems on dynamic or static structures such as vessels, platforms, buoys or fishnets. Antifouling coatings generally comprise biocides or active compounds which could inhibit the settlement of marine micro- and macro-organisms [1]. In the past decade, the antifouling paint industry has been totally disrupted with the ban of tributyltin oxide or tributyltin-based compounds by the International Maritime Organization. The ECOPAINT PACA project aims at developing innovative antifouling paint technologies with long-time efficiency and limiting toxic products. In accordance with the European Biocidal Products Directive, the selected active compounds have to inhibit the adhesion of target marine organisms on immersed structures without toxicity and to exhibit no ecotoxicity against non-target organisms.

Materials & methods

3 wt. % of commercial active compounds [SeaNine^{TM} 211N (SN), Preventol® A4S (Dichlofluanid), copper oxide (Cu_2O), copper sulfate ($CuSO_4$), and bis(tri-*n*-butyltin)-oxide (TBTO)] were dispersed separately in a polymer matrix (Metamare^{TM} B175). Eleganediol previously extracted from the brown alga *Bifurcaria bifurcata* [2] and two commercial natural compounds (e.g. farnesol and capsaïcin) were used. TBTO was used as a toxic reference. Panels coated with paints together with a reference panel coated with the matrix only were immersed in duplicates. The immersion was performed for 6 months in Toulon bay. Macrofouling development was followed every month and a score, called N factor, was given. The N factor depends on the intensity and the type of species settled on the surface. An anti-adhesion test was performed for assessing the EC_{50} of each substance on three pioneer marine bacteria [3]. Two *Pseudoalteromonas* spp. and one *Polaribacter* sp. were used. The ecotoxicity of each substance was also assayed on five species (i.e. *Phaedactylum tricornutum, Acartia tonsa, Crassostrea gigas, Paracentrotus lividus, Psetta maxima).*

Results & discussions

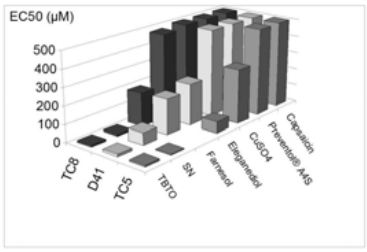

Fig. 1. Adhesion response (EC_{50}) for the three bacterial strains with all the assayed compounds.

Figure 1 shows the ability of each substance to inhibit the adhesion of three marine bacterial strains. TBTO was found unsurprisingly to be the most efficient compound against all the strains but SN exhibited also a high activity. Natural compounds such as eleganediol displayed interesting results with quite good anti-adhesion activities against two of the three strains associated with no toxic effects. Preventol® A4S showed no activity as it is classified as a fungicide. Figure 2 shows that four coatings exhibit a good antifouling activity over 6 months of immersion. Coatings containing SN, Cu_2O and Preventol® A4S were efficient against macrofouling. Farnesol, eleganediol and capsaicin did not show any effective enhancement of the antifouling activity of the coating. Finally, a correlation was established between the N/N_{ref} ratio and the adhesion response (EC_{50}) from bioassays. Ecotoxicity tests showed that TBTO, SN and $CuSO_4$ are highly toxic towards phytoplankton, crustacea, bivalve molluscs, echinoderms and fish juveniles. Eleganediol and Preventol® A4S exhibited moderate toxicity whereas capsaicin was not toxic towards all species. Therefore, promising results were shown for Preventol® A4S-based coatings considering its activity/ecotoxicity ratio.

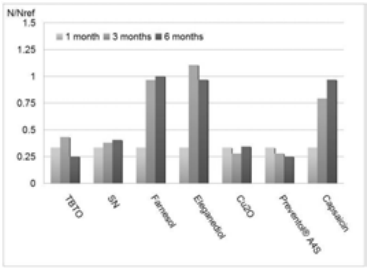

Fig. 2. *In situ* activity of coated panels through the assessment of the N factor (*Adapted from the French standard NFT-34-552 (September 1996)).* N = antifouling efficiency of the active compound-based coatings. N_{ref} = antifouling efficiency of the polymer matrix-based reference coating.

Conclusion

This study highlighted the difficulties encountered to found and to assess the antifouling efficiency of new eco-friendly antifoulants. To replace TBTO or copper-based compounds in antifouling coatings, the active compounds have to inhibit the adhesion of foulers on immersed structures without toxicity and to exhibit no ecotoxicity on non-target marine organisms.

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SPATIO-TEMPORAL VARIATION OF THE MARINE BIOFILM COMMUNITIES COLONIZING ANTIFOULING COATINGS IN THE MEDITERRANEAN SEA *VS* THE ATLANTIC OCEAN

F. Urvois [1], K. Réhel [2], G. Gregori [3], A. Bouchez [4], C. Garnier [5], A. Barani [6], B. Le Berre [4], C. Le Poupon [5], C. Bressy [1] and J. Briand [1]*

[1] MAPIEM - Univ. Sud Toulon Var - briand@univ-tln.fr
[2] LBCM-EA 3883, Université de Bretagne Sud
[3] UMR 7294 MIO- Aix-Marseille University
[4] INRA-UMR CARRTEL-RITOXE, Thonon-Les-Bains
[5] PROTEE-EA 3819, Toulon University
[6] PRECYM UMR 7294 MIO- Aix-Marseille University

Abstract

Biofouling is a natural process of colonization of submerged surfaces, involving a wide range of organisms, from bacteria to invertebrates. This study aims to assess the spatio-temporal variation of microbial communities that colonize different antifouling coatings for ship hull in two contrasted immersion sites.

Keywords: Fouling, North-Western Mediterranean, Bacteria, Coastal waters, Diatoms

Introduction

When immersed in sea water, any substrate would be rapidly colonized by micro and then macroorganisms. This complex natural process called biofouling induces economic and ecological prejudices, especially talking about ship hulls or aquaculture nets. Antifouling (AF) coatings are required to prevent the coloniation of ship hulls. Increasing attention is paid to biofilms that develop on coatings [eg 1], firstly because their presence directly increases frictional resistance and consequently fuel consumption, and secondly, because biofilms have been shown to influence the secondary settlement of invertebrate larvae and/or algal spores [2]. Biocidal coatings include several biocides without clear idea of the effect of each one. Previous studies in the Toulon bay with commercial AF paints showed that specific effects could be observed on biofilm communities for each coating [3]. In this study, we intend to characterize the specific effect of three commercial biocides on biofilm communities.

Material & methods

The commercial biocides (Copper pyrithione, Zinc pyrithione and Zineb®) were dispersed separately in one polymer matrix (Neocryl B725®). Panels coated with the polymer matrix alone together with a Poly(vinyl chloride) (PVC) reference surface were also immersed in triplicates as negative controls. The immersions were performed for one month at each season, in two temperate French coastal sites, Toulon bay (North-Western Mediterranean Sea) and Lorient bay (Atlantic Ocean). Water quality (temperature, salinity, oxygen, pH, dissolved organic/inorganic carbon, dissolved trace metals) was monitored during the immersion periods. Microbial communities were analysed using complementary tools: PCR-DGGE, pyrosequencing and flow cytometry (FCM) for prokaryotes, pico- and nano-eukaryotes, inverted microscopy for microphytobentic populations.

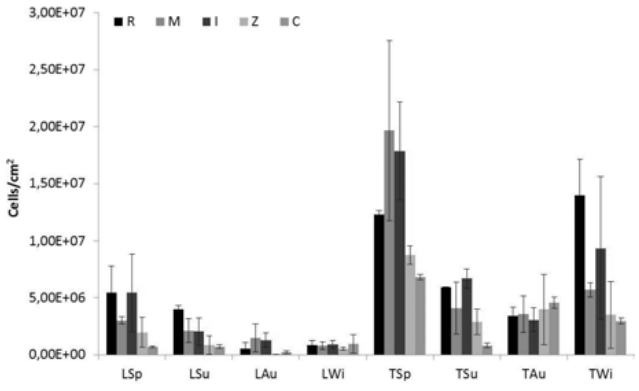

Fig. 1. Seasonal variations of the density of bacteria on the five coatings (R=PVC, M=B725, I=Zineb, C=CuPyr, Z=ZnPyr) assessed using flow cytometry (L=Lorient, T=Toulon / Sp=spring, Su=summer, Au=autumn, Wi=winter)

Results & discussion

FCM shows that copper pyrithione was the most efficient biocide whatever the location. Bacterial density was divided until 8 times compared to R, although no effect was also be observed in one case at each location (Fig.1). On the contrary, I displayed no significant difference in terms of abundance compared to R. Higher densities were observed at Toulon without a clear seasonal effect whereas the latter was clear at Lorient with the highest densities in spring. Similar clustering was obtained using DGGE analysis at both locations (Fig.2): Season was preponderant but coatings also impact clearly the prokaryotic communities. M (closely related to I) did not show a significant effect compared to R in terms of bacterial abundance (Fig.1) but clearly in terms of structure of bacterial communities (Fig.2). C and Z also displayed closed communities whatever the season and the location although densities appeared different in most cases. The current analysis of the whole data will allow us to get a general vue and to precise the effect of each parameter (biocide, season, geographical location) on biofilm communities on AF coatings.

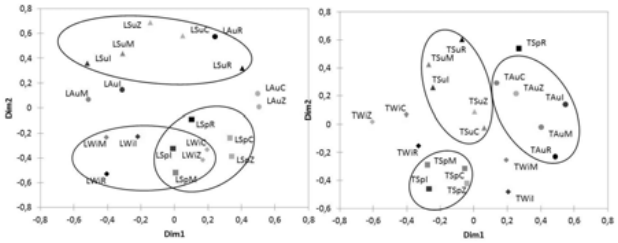

Fig. 2. MDS graph showing Jaccard similarity index of bacterial diversity of the five coatings analysed by 16S rDNA DGGE

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FRC/SPC HYBRID ANTIFOULING COATINGS: A NEW CONCEPT OF ENVIRONMENTALLY FRIENDLY ANTIFOULING TECHNOLOGY.

Marlène Lejars [1]*, André Margaillan [1] and Christine Bressy [1]
[1] Université de Toulon, MAPIEM, EA 4323 - marlene.lejars@univ-tln.fr

Abstract
Environmentally friendly FRC/SPC hybrid antifouling coatings were developed with the aim of improving the antifouling efficiency of FRCs during idle periods and at low ship speed and reducing the impact of biocides into the marine environment. Well-defined graft copolymers based on hydrolyzable *tert*-butyldimethylsilyl methacrylate (SPC-type) and hydrophobic poly(dimethylsiloxane) methacrylate (FRC-type) were synthesized by the RAFT process. The polymers exhibited a low surface energy similar to FRCs and erosion properties like SPCs. They were used as binders in the formulation of FRC/SPC hybrid antifouling coatings containing no biocides (or low amounts). The coatings were immersed in the Toulon bay (France), and good antifouling properties were observed after several months of immersion, combined with a fouling release behavior.

Keywords: North-Western Mediterranean, Fouling

Any surface immersed in seawater is rapidly colonized by fouling organisms. This colonization has serious impacts on ship navigation (e.g. increased roughness, increased fuel consumption) and is responsible for the transfer of invasive species from an eco-system to another. Two main antifouling coatings can be applied on ship hulls to limit fouling colonization:
- Self-Polishing Coatings (SPC) [1]: These coatings release toxic biocides into the marine environment by controlled erosion of the surface.
- Fouling Release Coatings (FRC) [2]: These coatings based on a poly (dimethylsiloxane) (PDMS) matrix, without biocides, limit the fouling adhesion strength owing to their low surface energy, resulting in the easy removal of fouling organisms at ship speed higher than 10 knots.
The aim of our work is the development of an environmentally friendly FRC/SPC hybrid coating, without biocides, with both the hydrophobic properties of PDMS and a controlled erosion of the coating. Thus, the antifouling efficiency of FRCs during idle periods and at low speed could be improved and the impact of biocides into the marine environment reduced.

Tri-alkylsilyl methacrylate monomers can be used for the synthesis of binders for SPCs. Indeed, they can be hydrolyzed in seawater which influences the hydrophilic character of the synthesized polymers and consequently its erosion upon time. Hybrid FRC/SPC polymer binders, based on *tert*-butyldimethylsilyl methacrylate (TBDMSiMA, SPC-type) and PDMS methacrylate (FRC-type) have been synthesized by the RAFT process (Radical Addition-Fragmentation chain Transfer) (Figure 1).This controlled polymerization process enables the synthesis of well-defined graft copolymers (diblock, blocky, gradient) with controlled molecular weights (M_n = 20,000 and 50,000 g.mol^{-1}) and narrow distributions (PDI < 1.2).[3]

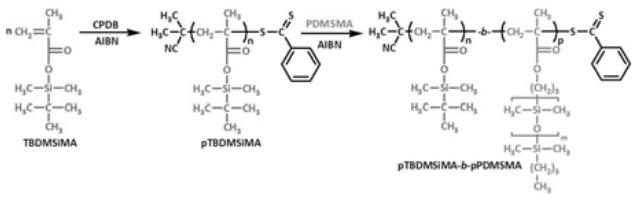

Fig. 1. Synthesis of pTBDMSiMA-*b*-pPDMSMA diblock graft copolymers by the RAFT process in the presence of 2-cyanoprop-2-yl dithiobenzoate (CPDB) as chain transfer agent, azobisisobutyronitrile (AIBN) as initiator, at 70°C, in xylene.

The PDMS side chains distribution and length (1,000 or 5,000 g.mol^{-1}) were shown to be significant parameters influencing the thermal behavior of the copolymers, their low surface energy and their erosion properties in artificial seawater. The graft copolymers exhibited surface energies as low as 21 mJ.m^{-2}, similar to commercial FRCs. They were used as binders for the formulation of antifouling coatings with no biocides (or low amounts). The coatings were applied on PVC panels and immersed in the Mediterranean sea (Toulon bay). Coatings showed good antifouling properties after 7 months of static immersion, combined with fouling release properties (Figure 2). Indeed, coatings containing 20wt.% of Cu_2O + 2wt.% of Seanine 211 were free from fouling organisms, like the commercial SPC reference which contains higher amounts of biocides. Coatings without biocides were colonised by only 15% of spirorbus and 10% of bryozoans compared with the PVC panel without coating which was fully covered by spirorbus, barnacles, bryozoans, ascidies, tubeworms, etc. Moreover, it showed good fouling release properties when slightly washed with a wet sponge on the top of the panel.

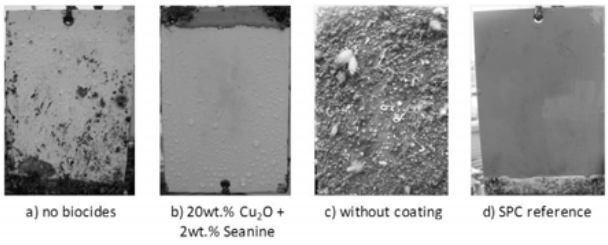

Fig. 2. Pictures of panels coated a) with a FRC/SPC hybrid coating containing no biocides, b) with a FRC/SPC hybrid coating containing 20wt.% of Cu_2O and 2wt.% of Seanine 211, c) panel without coating and d) panel coated with a commercial SPC reference, after 7 months of static immersion in the Toulon bay. Fouling organisms were easy removed using a wet sponge at the top of the panel a).

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INTERACTIONS BETWEEN MACRO-ALGAE AND ASSOCIATED BACTERIA: BIOFILM CONTROL BY SURFACE SECONDARY METABOLITES IN THE MEDITERRANEAN BROWN SEAWEED *TAONIA ATOMARIA*

A. Othmani [1]*, M. Molmeret [1], Y. Blache [1], J. F. Briand [1] and G. Culioli [1]
[1] Université du Sud Toulon-Var, ISITV Laboratoire MAPIEM - ahlem.othmani@univ-tln.fr

Abstract
Marine biofouling concerns all submerged surfaces. However, some marine organisms, namely macroalgae, such as the Mediterranean brown species *Taonia atomaria*, appeared to be relatively free from macro-colonizers. The production of secondary metabolites at the surface of this alga could be strongly linked to its antifouling defence capability.

Keywords: Algae, Bacteria, North-Western Mediterranean

Introdcution
In the marine environment, biofouling can be observed on all immersed surfaces including natural substrata. However, some marine organisms, such as macroalgae, appeared to be relatively free of epibionts. Many studies have shown that various algal taxa release substances with inhibitory effects to colonizers [1, 2, 3]. In order to understand the defence strategies of marine organisms against foulers, the analysis of the surface metabolome and the study of its involvement in the regulation of bacterial biofilm were undertaken in the case of the Mediterranean Phaeophyta *Taonia atomaria*, which appeared to be somewhat colonized.

Materials and methods
Specimens of *T. atomaria* were collected on the French Mediterranean coast (Carqueiranne, Var). In a first step, the total and the surface chemical composition of this alga were characterized. A specific extraction protocol of surface compounds was developped using the dipping technique in organic solvents [4]. This included the choice of organic solvents and exposure time, which were selected in order to preserve the integrity of the algal surface. The resulting surface extracts were analyzed by chromatographic techniques (GC-MS and LC-DAD/ELSD/MS^n) and the identification of their major compounds was achieved by comparison of these data with those of the pure metabolites isolated from the whole-cell extracts and characterized by spectral techniques (MS, 1D & 2D NMR). The next step was to isolate bacterial strains associated onto the surface of *T. atomaria*. Two methods were used: (i) sonication of rinsed thalli in artificial sea water and (ii) scraping with cotton swab. These strains were inoculated on VNSS agar meduim. The main objective, following the identification of surface secondary metabolites and the isolation of bacterial strains, was to understand the chemical mediation between this alga and associated biofilms by the assessment of the deterrent effects of those metabolites against some associated bacterial strains and several marine strains isolated from artificial substrata (Reference bacteria).

Results and Discussion
Spectral analyses allowed the characterization of several phytoconstituants of this alga as sesquiterpenes and fatty acids. Some of them were identified as new compounds. After the development of a specific extraction protocol of surface-associated metabolites. MeOH and mixture of CH_2Cl_2/MeOH seemed to be the suitable solvent systems for the extraction of surface metabolome. The corresponding surface extracts showed the occurrence of a major compound after GC-MS analysis, which was identified as (1) by comparison of its spectral data with those of the resulting pure substances obtained from the whole-thallus extract. Cell lysis was assessed by staining the treated algal pieces with a solution of DAPI (60 µM). Using an epifluorescence microscope, damaged cells were counted and the appropriate time exposure without disrupting cells was determined (less than 30s). The anti-adhesion effectiveness of selected surface compounds was tested against ten marine bacterial strains including five out of 33 cultivable bacterial strains isolated from the surface of *T. atomaria*, and five reference strains isolated from artificial surfaces. The obtained results showed that commercial biocides (TBTO and Zineb®) and other compounds from the whole-extract of *T. atomaria* exhibited a similar effect on all bacterial strains. Interestingly, the main surface metabolite (1) showed no effect against surface-associated bacteria while it seemed to inhibit significantly the settlement of reference strains. Further experimentations are in progress to test the effectiveness of these surface-associated metabolites against a large panel of fouling colonizers (spores of macro-algae, larvae of invertebrates,...) and to explore if chemical cues from associated bacterial strains are implicated in the biofilm regulation?

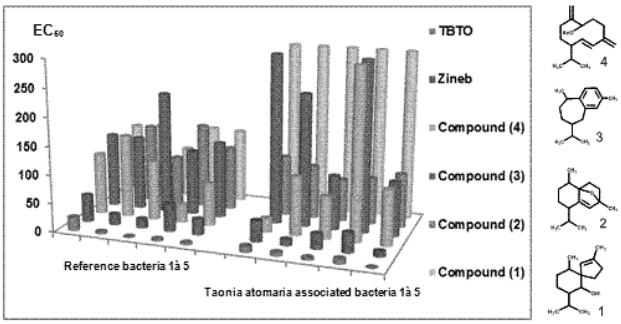

Fig. 1. Anti-adhesion activity (EC_{50}) of commercial biocides and compounds isolated from *Taonia atomaria* against several marine bacterial strains.

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ANTIFOULING ACTIVITY OF THE MARINE SPONGE *CRAMBE CRAMBE*

S. Morgana [1], E. Perino [1]*, M. Faimali [2], V. Piazza [2] and R. Pronzato [1]
[1] Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, Università di Genova, Corso Europa 26, 16132, Genova, Italia - ericaperino@yahoo.it
[2] CNR—Istituto di Scienze Marine ISMAR Sezione Tecnologie Marine, Via de Marini, 6, 16149 Genova,Italia.

Abstract
Crambe crambe (Porifera - Poecilosclerida) is known to possess an array of highly bioactive metabolites strongly bioactive in general bioassays. Crude extracts from *Crambe crambe* (Schimdt, 1862) collected in Paraggi Bay (Ligurian Sea) have been investigated for their antifouling activities using larvae of the barnacle *Amphibalanus amphitrite*.

Keywords: Fouling, Ligurian Sea

Introduction

Many marine sponges, as well as other benthic organisms, are relatively free of settlement by fouling organisms (1) due to the production of biogenic compounds that possess many chemical defense agents.
The common encrusting sponge *Crambe crambe* (Schmidt, 1862) is widely distributed in the Mediterranean Sea and this species is known to possess an array of potentially active metabolites with lots of activities, including antifouling properties (2).
The present study investigated the antifouling activity of a series of crude extracts from the sponge *Crambe crambe* against *Amphibalanus amphitrite*, one of the main constituents of sea biofouling.

Materials and Methods

Six specimens of *C. crambe* was collected by SCUBA diving at Paraggi Bay (44°18'38.81"N 9°12'47.48"E), Ligurian Sea. After collection the samples were rinsed with filtered sea water and debrids and surface microflora was removed. The clean material was freeze and then freeze-dried. The dry material was pulverize and then extracted three times at room temperature with MeOH. The extract was then concentrated under vacuum.
The antifouling activities was detected in CNR-ISMAR's laboratory where the crude extracts were tested with cypris larvae of *A. amphitrite* in the settlement inhibition bioassay and with nauplii of *A. amphitrite* in the mortality bioassay. Settlement inhibition (EC50) at 72h and mortality (LC50) values at 48h were calculated using Trimmed Spearman–Karber analysis. The extracts were tested in three replicates at 10, 5, 2.5, 1 and 0.1 µg of extract per ml.
The Therapeutic Ratio (TR) is defined as LC50/EC50. It was calculated in order to estimate whether settlement inhibition is due to a toxic or non-toxic mechanism (3).

Results

The results of settlement inhibition and mortality bioassays summarized in Table 1.

Tab. 1. EC50 (cyp) and LC50 (cyp) derived from settlement inhibition test with cypris larvae after 72h and LC50(nauplii) from mortality test with nauplii of *A. amphitrite* (with 95% confidence limits).
The values are express in µg/ml.

Sample	EC50 (cyp)	LC50 (nauplii)	LC50 (cyp)
1	0.67(0.31-1.47)	1.33(1.20-1.48)	>10
2	1.71(1.41-2.06)	1.11(1-1.23)	>10
3	2.53(2.31-2.77)	0.92(0.79-1.06)	>10
4	1.64(1.47-1.84)	1.50(1.35-1.68)	>10
5	1.73(1.54-1.94)	1.33(1.19-1.49)	>10
6	0.70(0.63-0.78)	1.10(0.98-1.23)	>10

In table 2 it is reported the TR values. High TR values indicates low toxicity of the tested compounds.

Tab. 2. TRn values

Sample	TR (nauplii)
1	1.98
2	0.65
3	0.36
4	0.91
5	0.77
6	1.57

Conclusions

Complying with the guidelines of the U.S. Navy Program that require an EC50 <25 µg/ml for a compound to be considered a promising natural antifoulant products (NAPs), all the samples evaluated in this study meet this requirement. Settlement inhibition levels of the tested extracts are similar to some of the most significant ones found in literature for natural products (3). Looking at TR, compounds with TR>15 could be considered as non toxic antifouling: the results suggest that settlement inhibition of all the texted samples can be associated to a toxic mechanism. This study confirms that Crambe crambe is a highly successful Mediterranean sponges in chemical defence (4) and it points out the well performing antisettlement activity against barnacle, which is due to a toxic mechanism. Ecotoxicological characterization with non-target organisms will be needed in the future to assess the potential environmental impact and to validate the passage to the second stage of screening as a potential biocide of natural origin.

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FOULING ON THE LARGEST WRECK OF THE GULF OF GENOA

G. Relini [1]*, L. Lanteri [1], V. Tonoli [1], R. Bertolotto [2] and P. Moretto [2]
[1] University of Genoa Dipartimento di Scienze dell'Ambiente, della Terra e della Vita (DISTAV) - biolmar@unige.it
[2] ARPAL –Agenzia Regionale Protezione Ambiente Ligure, Genova

Abstract
The development of macrofouling settled on the VLCC Haven wreck was followed after sinking from 13 years to 18 years in relation to oil removal operations. The main components of the fouling assemblage are algae, serpulids, bryozoans , sponges, madreporians, hydroids, molluscs. The bivalve *Neopycnodonte cochlear* (Poli, 1795) and the jewel sea anemone *Corynactis viridis* Allman, 1846 are the dominant species of fouling after 18 years.

Keywords: Artificial reefs, Fouling, Ligurian Sea

On April 11th 1991 the VLCC Haven, carrying 144,000 tons of "heavy Iranian crude oil", exploded off the Genoa oil terminal. In the first explosion the ship lost the deck, the burning wreck broke into two parts: the main part (220 m of length) sank to a depth of 75-78 meters, 1,5 nm off the coast of Arenzano. The amount of burned petroleum hydrocarbons was estimated in the range 95,500-103,500 tons while 3,000 tons remained trapped inside the wreck. The paint of the hull was also burned.

Many years later, in 1999 money was made available to carry out a study and, mainly, for restoration work. Moreover, it was decided to remove liquid oil residues still contained inside the wreck and to monitor the environment before, during and after the removal operations. The study of fouling was considered a valid tool, along with others, to assess the potential impact of reclamation activities on the marine environment.

To our knowledge, there are no studies on fouling of shipwrecks in the Mediterranean sea except for photos and films produced by scuba divers, but identification of organisms is lacking.

The macrofouling of the NW Mediterranean basin is quite well known [1] and some data also deal with colonization of offshore structures [2]. The main aim of this paper is to describe the macrofouling monitored on the largest wreck in the Mediterranean Sea during the 18-year period from 1991 to 2009.

The study of Haven fouling was performed on the main part of the wreck sunk at 75-78 m depth off the coast of Arenzano (Lat. 44°16'24''N, Long. 008° 41'23'' E) by scuba divers expert in marine biology and ecology. A first survey, visual and photographic, was carried out in December 1991 but only many years later it was decided to organize and support a detailed programme of investigation on the fouling of the wreck from February 2004 to November 2009. Two complementary methods were used: scraping of the benthos settled on the wreck and photographic monitoring. Five stations were chosen at about 39 m depth on the main deck and the funnel. The samples were collected on a vertical surface of 310 cm^2 in three replicates per station. Before scraping all sampled areas were photographed by a Nikon with 28 mm lens on a surface of 310 cm^2.

Biomass was assessed by wet weight of entire samples than transformed in g/dm^2; the main difficulty was the separation of ferrous and burned material scraped with biological material. Organisms are identified at the lowest possible taxonomic level. Six surveys were carried out three before (on 12-13/02/2004; 01/04/2004; 9-17/11/2004), one during (15-19/05/2008) and two after (17-27/11/2008; 19-24/11/2009) reclamations activities. In the present paper only organisms present in the samples of five stations are described. Fish and megabenthos observed by scuba divers are not taken into consideration.

In December 1991, eight months after the Haven sinking, some organisms were settled on the wreck in spite of the presence of burnt materials on the surface. About 25% of the surface was settled, the main foulers were serpulids *Serpula concharum* (Lagerhans 1880), *Pomatoceros triqueter* (Linnaeus 1758), *Spirobranchus polytrema* (Philippi 1844) and the bivalve *Neopycnodonte cochlear*.

During the six surveys (February 2004-November 2009) in total 217 taxa were identified, 161 at species level in the five sampled stations. The most numerous taxon is Annelida (N=50) followed by Algae (N=47) and Mollusca (N=27), this ranking occurred in almost all surveys. Among cirripedes only *Verruca spengleri* Darwin, 1854 was found in a single sample. The number of taxa increased from February 2004 (N=42) to May 2008 (N=126) then decreased to 102 in November 2008 and 83 in November 2009 (Table 1).

Tab. 1. Number of taxa monitored during the six surveys.

	Survey							
	1	2	3	4	5	6	*Total Number*	
Taxa	Feb-04	Apr-04	Nov-04	May-08	Nov-08	Nov-09	*Taxa*	*Species*
ANNELIDA	11	12	12	28	30	24	*50*	*43*
ALGAE	2	2	2	29	19	20	*47*	*45*
MOLLUSCA	7	8	4	22	17	12	*27*	*18*
BRYOZOA	6	6	8	15	9	8	*24*	*15*
PORIFERA	3	4	3	9	9	8	*21*	*13*
CRUSTACEA	3	3	4	10	8	5	*18*	*13*
CNIDARIA	8	7	5	8	7	5	*15*	*11*
ECHINODERMATA	0	1	2	2	2	0	*5*	*2*
PROTOZOA	1	2	1	2	1	1	*4*	*1*
PYCNOGONIDA	1	1	2	0	0	0	*2*	*0*
TUNICATA	0	1	1	0	0	0	*2*	*0*
SIPUNCULIDA	0	1	1	1	0	0	*1*	*0*
PLATYHELMINTHES	0	1	0	0	0	0	*1*	*0*
Tot.	42	49	45	126	102	83	*217*	*161*

The higher reduction occurred for molluscs, algae and bryozoans. The main components of the fouling assemblage are algae, serpulids, bryozoans , sponges, madreporians, hydroids, molluscs. *N. cochlear* and the jewel sea anemone *Corynactis viridi*s are the dominant species of the final community in 2009. Their role changed from the first survey (13 years after sinking) to the sixth, carried out five years later (18 years after sinking).

The biomass (wet weight - g/dm^2) of fouling increased with time from the first survey to the last two: there is a huge difference between the first two samplings (an average of about 30.6 g/dm^2) and the final two with an average of 168.0 g/dm^2. The value of the 6th survey is a little lower than that of 5th survey. This trend is confirmed in almost all stations. The highest values generally were in relation to the amount of the oyster *N. cochlear*.

The highest number of taxa occurred during the 4th survey where a large number of shells of the oyster *N. cochlear* were found empty and no more individuals settled in the following years, probably because of competition with sponges and *C. viridis*. These taxa not only take up a lot of space but can produce antifouling substances (antibiotic/allelopatic competition) and so be the main cause of reduction of the fouling community. An additional cause could be the increased silting in the last year due to beach nourishment along the nearby coast. There is no evidence that the restoration (cleaning) operation of the wreck carried out in May-June 2008 has influenced the fouling community of the wreck.

The Haven wreck is of great interest for scuba diver tourism and behaves as an artifical reef, like that described by Hiscock et al. [3].

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Session

Marine litter

Modérateur : **Francois Galgani**

PROJECT TO RAISE SOCIETY AWARENESS TO THE IMPACT OF MARINE DEBRIS ON THE SEABED: PILOT PLAN IN THE MEDITERRANEAN SEA

M. Demestre [1]*, E. Vallejo [1], M. Masó [1], S. De Juan [1], R. Sáez [1], A. Muntadas [1], A. Gárcia-De-Vinuesa [1], P. Sánchez [1], P. Martín [1] and J. Fortuño [1]
[1] Institut de Ciencies del Mar - CSIC - montse@icm.csic.es

Abstract
This Pilot Plan was designed with the aim to report the impact of marine litter and to heave public awareness of the necessity to protect marine ecosystems. The project consisted on a socio-scientific work developed by students who analysed the marine debris collected from bottoms off Palamós coast (NW Mediterranean). It aimed to raise awareness of the importance of management actions to favour drastic reduction of the litter dumped at sea.

Keywords: Plastics, North-Western Mediterranean, Continental shelf

AIM AND OBJECTIVES
The Pilot Plan was the outreach objective of the scientific Project "Evaluation of the state of benthic communities subjected to impact of trawling and marine debris as a tool for the ecosystem management", COMSOM (CTM2008-04617/MAR) (http://comsom.cmima.csic.es). The final aim of the Pilot Plan was to alert the society about the necessity to protect marine ecosystems from the accumulation of bottom marine debris and about the urgent need to eliminate this source of impact on the seabed. The Pilot Plan was designed to be an education tool aiming to change the attitudes of the society, that need to be involved if the problem of recycling the marine debris is to be solved. The project was a pioneer experience that coordinated both social and scientific work and, most importantly, it simultaneously involved different stakeholders: fishermen, students, managers, disseminators and scientists.

WORKING PLAN
A spatiotemporal work plan was designed in the Palamós fishing grounds (fig. 1), to collect the benthic marine debris obtained during a week:
• at each season of the year, and
• at 5 different depths: <50m, 50-100m, 100-200m, 200-400m and 400-900m

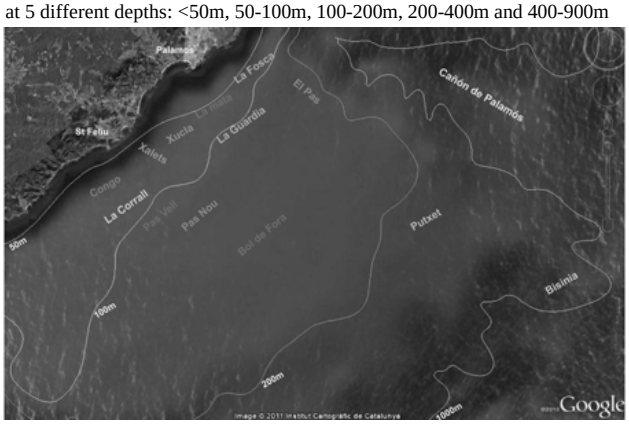

Fig. 1. Palamós fishing grounds where the benthic marine debris was collected

Therefore, 4 outreach activities, each with 5 samples of benthic debris, were developed. The fishermen were responsible to "fish" the benthic debris with 5 fishing boats, 1 trammel net (<50m) and 4 trawlers (50-900m), during the proposed plan. The students were the "scientists" that worked during each of the four activities with the debris "fished", and followed a research protocol, sampling, process of samples, analysis of data, discussion of results and conclusions, always supervised by the scientific team from ICM-CSIC. The work of communicating with the society and contacting with schools was conducted by the Museum of the Fishing of Palamós, and the recycling was done by the Environment Area of the city hall of Palamós.

ACHIEVEMENTS AND STATEMENT
The participation of 191 students from three schools during the four activities was the greatest achievement of the Pilot Plan. At the end of the experience each School presented their results and discussion in a joint meeting (Fig. 2).

Fig. 2. Images during the activities of the schools: a) sampling of debris at the vessels; b) presentation of the Pilot Plan to the students; c) preparing samples; d) separation and classification of the debris; e) weighing plastics; f) identification of colonizing organisms; g) analyzing data; h) closing meeting, presentation of results by students

The students' work provided basic information to convincingly inform the society of the need to advance towards a correct management for the recycling of marine debris. The main conclusion presented by the students were: i) plastics are the most abundant marine litter accounting to 63% of the total litter, being bags the most abundant typology (29%), ii) the abundance of marine litter diminishes with depth, being plastics and general litter most abundant at depths between 50-100 m, iii) there is no clear seasonal pattern in litter collection, and iv) the majority of the plastics had a great level of degradation and were colonized by organisms that evidenced a long permanence on the seabed. In addition, two high school research works were developed with those data. The major conclusion that students deduced from the Pilot Plan was that the presence of litter, particularly plastics, on the seabed could modify the natural benthic ecosystem equilibrium. The statements presented by the students were in accordance with published scientific papers ([1], [2], [3]).

Acknowledgements. Thanks to Gloria Ñaco and colleagues of the Museu de la Pesca de Palamós for their help on the dissemination works. We are grateful to skippers and crew of the vessels used for the sampling, and the Fishermen's Association of Palamós port. We acknowledge the enthusiastic participation of the IES Puig Cargol, Vedruna and Palamós.

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PROTOCOL FOR LITTER DATA COLLECTION DURING THE MEDITS TRAWL SURVEYS

F. Fiorentino [1], E. Lefkaditou [2], A. Jadaud [3], P. Carbonara [4], G. Lembo [4] and F. Galgani [5]*
[1] IAMC - Coastal Marine, Mazara del Vallo (TP), Italy
[2] HCMR Institute of Marine Biological Resources & Inland Waters, Anavyssos, Greece
[3] IFREMER, Sète Cedex, France
[4] COISPA Tecnologia & Ricerca, Stazione Sperimentale per lo Studio delle Risorse del Mare, Bari, Italia
[5] IFREMER LER/PAC, Bastia, France - Francois.Galgani@ifremer.fr

Abstract
This protocol aims to the standardization of the data collection procedure for litter deposited on the sea floor that is collected mainly during the International Bottom Trawl Surveys in the Mediterranean (MEDITS). Thirty four different typologies were identified including 9 main categories related to litter material and 25 sub-categories related to source and main litter findings. Information on litter composition is recorded in terms of total weight and number and weight by litter categories, in a specific form to be integrated with haul information. This procedure will enable the estimation of total and by categories litter abundance per km^2, by depth and geographic area, aiming to future recommendation depending on litter sources.

Keywords: Trawl surveys, Monitoring, North-Central Mediterranean, North-Eastern Mediterranean, North-Western Mediterranean

The manufactured litter lost or deliberately discarded into the sea is variable and represents a growing threat to marine ecosystems, fisheries and public safety [1]. The availability of Litter Monitoring Data and harmonized monitoring methodologies are considered of prime importance to assess marine litter spatio-temporal abundance, to identify its origin and achieve an equal level of Good Environmental Status (GES) across all European Seas through the implementation of Marine Strategy Framework Directive (MSFD) concerning Descriptor 10 : «Properties and quantities of marine litter do not cause harm to the coastal and marine environment». The MSFD GES Technical Subgroup on Marine Litter, established following to the Commission Decision 2010/477/EU, proposed the inclusion of litter monitoring during the coordinated MEDITS trawl surveys, which are conducted for demersal fish stock assessments on the continental shelf and upper slope in 20 Geographical Sub-Areas (GSA), as the best option to gather information on the amount and composition of litter on the Mediterranean Sea bottom [2]. The protocol prepared by the MEDITS Working Group for Litter is mainly based on the IFREMER protocol for the observation of macro-litter during Fisheries Surveys [3] but also on the suggestions of Marine Litter Technical Recommendations for the Implementation of MSFD Requirement [2], CEFAS protocol for benthic litter recording [2], as well as the results of a relevant study in the Tyrrhenian Sea [4]. The proposed procedure concerns observations of macro-litter collected from the sea floor by fishing gears (trawl nets, drags, hand lines, e.t.c.) used during fisheries surveys, but not those of floating litter or non-fisheries surveys.

Definition of marine litter:
In the framework of the MSFD for the GES of the sea, marine litter consists of items that have been deliberately discarded, unintentionally lost, or transported by winds and rivers, into the sea and on beaches. It mainly consists of plastics, wood, metals, glass, rubber, clothing and paper. Land-based sources account for up to 80% of marine litter – these include tourism, sewage and illegal or poorly managed landfills. The main sea-based sources are shipping and fishing [5].

Procedure to collect litter data:
On board the vessel, the litter collected is weighted as total and split into the categories and sub-categories shown in Table 1. It is mandatory to record or estimate total weight, regardless the categories and subcategories, as well as number of items for each main category: It is facultative to register weight by categories and number of items by sub-category. Qualitative and quantitative data on the litter must be reported in a specific form on litter and be connected to data regarding the general characteristics of the haul (haul code, date, geographic coordinates, depth zone, e.t.c.) and the gear performance, allowing the estimation of the trawled surface for each haul and standardized indices of total and by categories litter abundance per km^2. A photograph of total litter separated from fish catch, labelled with main haul data, is recommended as it might be used to future analysis of litter composition by Image Analysis Tools. Organisms attached on litter might be also noted.

Tab. 1. Litter typology and codes

Main Categories	Sub-categories
L1 Plastic	L1a. Bags
	L1b. Bottles
	L1c. Food wrappers
	L1d. Sheets (table covers, e.t.c.)
	L1e. Hard plastic objects (crates, containers, tubes, lids, e.t.c.)
	L1f. Fishing nets
	L1g. Fishing lines
	L1h. Other fishing related (pots, floats, e.t.c)
	L1i. Ropes/strapping bands
L2 Rubber	L2a. Tyres
	L2b. Other (gloves, boots/shoes, oilskins e.t.c.)
L3 Metal	L3a. Beverage cans
	L3b. Other food cans/wrappers
	L3c. Middle size containers (of paint, oil, chemicals)
	L3d. Large metallic objects (barrels, pieces of machinery, electric appliances
	L3e. Cables
	L3f. Fishing related (hooks, spears, e.t.c.)
L4 Glass / Ceramic	L4a. Bottles
	L4b. Pieces of glass
	L4c. Ceramic jars
	L4d. Large objects (specify)
L5 Cloth (textil)/ natural fibres	L4a. Clothing (clothes, shoes)
	L4b. Large pieces (carpets, mattresses, e.t.c)
	L4c. Natural ropes
	L4d. Sanitaries (diapers, cotton buds, e.t.c.)
L6 Wood processed (palettes, crates, e.t.c.)	
L7 Paper and cardboard	
L8 Other (specify)	
L9 Unspecified	

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WAVEGLIDING FOR MARINE LITTER

Francois Galgani [1]*, Gilles Hervé [1] and Ryan Carlon [2]
[1] IFREMER - francois.galgani@ifremer.fr
[2] Liquid Robotics, Sunnyvale, CA 94089, USA

Abstract

A video-camera was mounted on a Wave Glider, an unmanned autonomous marine robot using wave energy for propulsion, to observe and count marine litter. A gopro2 type camera was fixed on the submersed winged ballast of the glider and programmed for 10.5 hours videos during a 24 hours survey. The system enabled to count floating debris in the subsurface layer (0-4.5 m), providing consistent data along a distance of 17.75 km. Densities were found at 40.5 items/km2. The system may be used for monitoring surface debris and large passive organisms from plankton such as jellyfishes.

Keywords: Surface waters, Pollution, North-Western Mediterranean, Monitoring

The Wave Glider is the first autonomous marine robot to use only wave energy for propulsion (http://liquidr.com/index.html). Because of its energy independence, its long persistence and its cost-effective operation, the Wave Glider platform is able to collect and transmit data over distances of thousands of miles across wide geographic areas and specific areas of interest and operation, with a strong potential to replace ships, satellites or buoys when considering surface of the sea. Many applications have been recently described including (i) the Tracking of ocean salinity, temperature, primary production and ocean CO2, (2) the continuous acoustic monitoring of fish, micro nekton populations and tagged mammals or sharks, (3) the Monitoring of Hurricanes and earthquakes, and (iv) the environmental monitoring of oil fields or radioactivity (review in http://liquidr.com/resources/downloads.html).

To date, the use of video has not been tested for regular and distance surveys. Here we report a first application of video-camera to monitor surface/subsurface marine litter at sea. After tests of various camera/positions, a HD Gopro2 Long-Play camera, with 13 hours of autonomy in Full HD, 1080p, 30 images per second, mounted in resistant tube (60cm length) was fixed on ballast (Figure 1a), front side and sea surface oriented with a 45° angle to enable observation in the 0-4.5 meters subsurface layer. After tests, the system was launched at sea for a 24 hours transect offshore south of Toulon (starting position at 43.05980 N / 5.96595 E), along 2 regular routes of 7.40 + 2.5 nautical miles (13,70 + 4,05 km), enabling line transect evaluation (figure 1b). The video was programmed for 45min per hour to avoid warming, at day light, with 10.5 hours of videos on 24h used for analysis. Many approaches have been used for the evaluation of floating marine litter, including ferry boxes, trawling, aerial surveys and direct counting (review in Galgani et al., 2012). The use of subsurface video has been restricted because of sea movements and cavitation at speeds above 5-6 knots. Moreover, evaluation of surface covered is difficult and results are given as items per m or km observations. In our study, we demonstrated that what may be a problem and restrict the use of video imaging becomes an advantage. A speed never above 1.5 Knots and the immersion of the camera at 4,5 meters, provided consistent and stable images along straights routes. The orientation of the camera (45°) and the angle of the video lens (90°) enabled counts along a transect of 12.7m width at the surface.

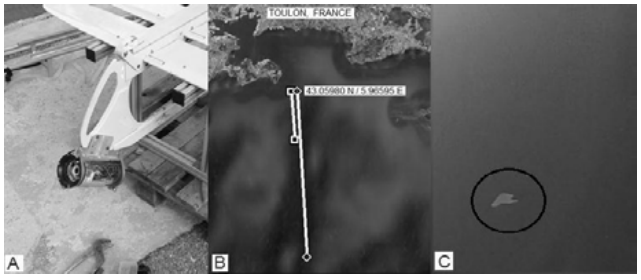

Fig. 1. Video camera system for marine litter quantification. (1) video system on Wave Glider's ballast, (2) map of sampling routes (13.70 + 4.05 km), and (3) Sample of litter observed during transects.

Video analysis revealed the possible counts of marine litter (figure 1c). 9 litter (100% Plastic) were observed giving a density of 40.5 items/ km2, above known densities in the basin (Aliani et al., 2003), indicating a possible underestimation of classical approaches. Optimisation is still necessary, including the evaluation of best capes in relation to the sun orientation and/or the use programmed cameras with large memories which will allow regular shots during more than 20 days surveys. One *Cestus veneris* and two *Pelagia noctiluca* were also observed indicating the possible observation and quantification of large passive organisms from plankton. Finally, we think a rotating camera system (Pelletier et al., 2012), as developed for necto-benthic species, may also be used as a controlled Fish Aggregating Devices (FAD) for evaluation of fish populations at selected and chosen areas.

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METHODOLOGICAL APPROACHES TO ASSESS MARINE LITTER IN THE MSFD INITIAL ASSESSMENTS OF MEDITERRANEAN AND BLACK SEA EU COUNTRIES

D. Gonzalez [1]*, G. Hanke [1], M. Pantazi [2], C. Vassilopoulou Vassiliki [2], S. Laroche [3], B. Andral [3], F. Galgani [3], D. Vasile [4] and G. Oaie [4]

[1] JRC - EC - daniel.gonzalez@jrc.ec.europa.eu

[2] HCMR

[3] IFREMER

[4] GeoEcoMar

Abstract

This study presents the main findings from the review of the methodological approaches used by EU countries to assess Marine Litter in the Mediterranean and Black Seas, according to the Marine Strategy Framework Directive requirements (MSFD). The analysis provided information on main methodologies and gaps identified in the Initial Assessment (IA) draft reports for articles 8, 9 and 10 of the MSFD. Outcomes suggest that there is still an important need to harmonize methodologies and to establish coherent monitoring programs, and underline the general lack of data and knowledge constraining the assessment of the current status of Marine Litter.

Keywords: Pollution, Monitoring, Black Sea, North-Eastern Mediterranean, North-Western Mediterranean

The aim of the research project PERSEUS (Policy-orientated marine Environmental Research for the Southern European Seas) is to assess the impact of pressures on marine ecosystems in the Mediterranean and Black Seas in order to design a research governance framework based on solid scientific knowledge. One focal point of the project is to identify, develop and promote tools and methods to ensure consistency in the assessment of marine environmental status across EU and non-EU countries, in accordance with the Marine Strategy Framework Directive (MSFD, 2008/56/EC). Information included in this study refers to the MSFD Descriptor 10, "Properties and quantities of marine litter do not cause harm to the coastal and marine environment". Criteria and indicators for the achievement of Good Environmental Status are defined by Commission Decision 2010/477/EU (Tab 1). Within PERSEUS, the analysis of methodological approaches has been based on information compiled in the review of the available Initial Assessment (IAs) draft reports (MSFD - Articles 8, 9 and 10), including the following Mediterranean and Black Seas EU countries: Cyprus, France, Greece, Romania and Spain.

Tab. 1. Criteria and indicators for Descriptor 10 (Commission Decision 2010/477/EU)

Criteria	Indicators
10.1. Characteristics of litter in the marine and coastal environment	**10.1.1.** Trends in the amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source.
	10.1.2. Trends in the amount of litter in the water column (including floating at the surface) and deposited on the seafloor, including analysis of its composition, spatial distribution and, where possible, source
	10.1.3. Trends in the amount, distribution and, where possible, composition of micro-particles (in particular micro- plastics)
10.2. Impacts of litter on marine life	**10.2.1.** Trends in the amount and composition of litter ingested by marine animals (e.g. stomach analysis)

Figure 1 and 2 include relevant findings from the analysis: main methodologies used in the IA and main gaps mentioned by EU countries in their reports. Marine litter was not considered in the IA by Cyprus and Romania, due to lack of pertinent data and knowledge, while the other three countries adopted a qualitative approach. In the overall analysis, references to methodological elements were limited. Only Spain and France included international methodological frameworks in their approaches. Both cited the use of methodologies recommended by the MSFD Good Environmental Status Technical Subgroup on Marine Litter and OSPAR. Furthermore, France included also other valuable methodological sources such as scientific programs, monitoring programs and reports at different geographical scales (Figure 1). The analysis showed that, in general, there is an important lack of data and knowledge for all countries. Regarding specific information for Criterion 10.1 (Tab 1), although data was almost inexistent for Romania, its document referred that characteristics of marine litter (amount, sources and the composition) should be included. Greece based the assessment on Criterion 10.1, but no information at indicator level was provided. For indicator 10.1.1, Spain reported that no adequate information was available. France referred to an OSPAR protocol and to MED-POL recommendations, but sampling methodologies needed further development. For indicator 10.1.2, Spain reported partial lack of information. Only bottom litter in the shelf area was characterized (trawling surveys). France mentioned that protocols were under development for the water column. For the seafloor, France included trawling surveys and diving observations. Regarding indicator 10.1.3, Spain asserted lack of knowledge, while France highlighted that inter-calibration and harmonized protocols were necessary. France reported that methodologies were under development for sandy beaches and already available for surface sampling. Criterion 10.2 (Tab1) was only considered by France and Spain. For indicator 10.2.1, Spain stated a lack of information to assess litter impacts: only scarce data on fish stomach content (from trawling surveys); and marine birds stomach content and plastic entanglements. In France, data were available on turtle stomach content, however, the data collection network needed improvement.

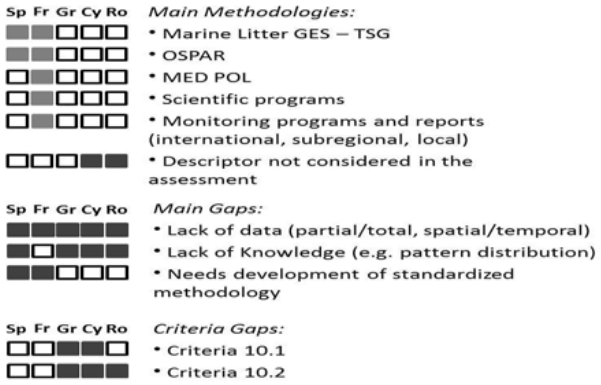

Fig. 1. Main methodologies and gaps reported in Descriptor 10 (Marine Litter): Spain (Sp), France (Fr), Greece (Gr), Cyprus (Cy) and Romania (Ro).

In conclusion, the implementation of the MSFD Descriptor 10 will require further development of harmonized methodologies and support to the establishment of appropriate and coherent monitoring programs at EU level. Due to the cross-border nature of the marine litter problem, the methodologies should also be harmonized with the neighbouring Regional Sea Conventions. In particular this is important within the Southern European Seas as they constitute marine areas in which the majority of bordering countries are not in the EU.

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OBSERVATIONS DES MICROPLASTIQUES SUR LES COTES FRANCAISES DE MEDITERRANEE OCCIDENTALE

Maryvonne Henry [1]* and François Galgani [2]
[1] Ifremer Zone portuaire de Brégaillon CS 20330 83 507 La Seyne-sur-Mer Cedex - maryvonne.henry@ifremer.fr
[2] Ifremer Z.I Furiani Immeuble Agostini 20600 Bastia

Abstract
Une campagne de prélèvements de microplastiques en surface a été opérée dans les masses d'eau littorales méditerranéennes françaises, de la frontière espagnole à la frontière italienne et sur le pourtour de la Corse. Les microplastiques sont présents dans tous les échantillons récoltés, avec des concentrations variant de 20 à 5 656 particules à l'hectare.

Keywords: Plastics, Pollution, Surface waters, North-Western Mediterranean

Introduction Le plastique n'est pas biodégradable et à ce titre a été longtemps considéré comme un matériau inerte. Sous l'action combinée des forces mécaniques, des UV et de la température, il se fragmente en particules de plus en plus fines, les microparticules (Thompson, 2009). En se fractionnant, le plastique développe une surface de contact considérable avec le milieu environnant qui permet l'adsorption sur ces particules, de contaminants organiques hydrophobes tels que PCB, hydrocarbures et pesticides et leur transport en mer. Afin de définir les modalités scientifiques et techniques d'une surveillance des micro-particules dans le contexte de la Directive Cadre Stratégie pour le Milieu Marin, 30 prélèvements ont été réalisés sur trente masses d'eau littorales méditerranéennes de la frontière espagnole à la frontière italienne et sur le pourtour de la Corse en mars et avril 2012 à bord du N/O l'Europe (IFREMER). Ces prélèvements ont été effectués dans le cadre d'un programme de surveillance de la qualité des eaux méditerranéennes françaises afin d'étudier la densité des microplastiques en surface, leur distribution en mer, leur composition et leur évolution dans le temps.

Méthode Les 30 prélèvements sont réalisés dans chaque masse d'eau côtière avec un filet « Manta » de 90 cm d'ouverture, 15 cm de hauteur et une maille de 0,3 mm. La durée de chaque chalutage est de 20 min pour une vitesse moyenne de 2 nœuds, permettant un échantillon composite sur une distance parcourue d'environ 1 mille, ce qui correspond à une surface d'environ 1000 m2. Les microplastiques sont collectés, séparés par taille supérieure ou inférieure à 5mm, comptés et pesés (poids sec).
Le nombre de microplastiques (< 5mm) et de particules plastiques (> 5 mm) et leur poids est rapporté à la surface échantillonnée et exprimé en nombre et poids par hectare.

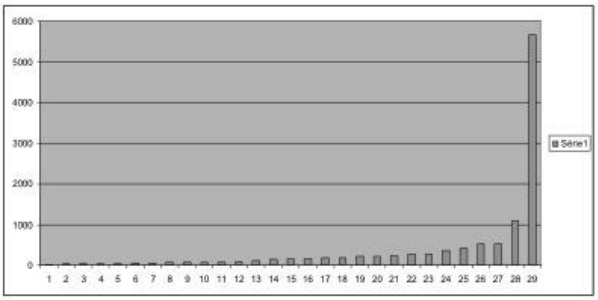

Fig. 1. Nombre de particules (<5mm) à l'hectare sur chaque masse d'eau échantillonnée

Résultats et discussion Les microplastiques sont observés dans tous les prélèvements, confirmant une présence généralisée. Le nombre de microplastiques (de taille inférieure à 5mm) est en moyenne de 393 par hectare (minimum 20 ; maximum 5 656). Un total de 1 454 particules a été compté dans les 29 échantillons pour un poids sec total de 0.749 g, soit un poids moyen par particule de 0.515 mg. Le poids moyen à l'hectare des microplastiques est égal à 0.204g (minimum 0.003g ; maximum 3.168g). La variabilité est identique à celle observée pour l'expression en nombre. Pour les particules plastiques supérieures à 5mm, leur nombre moyen est de 38 par hectare, avec également une grande variabilité (minimum 0 ; maximum 366). Le poids moyen à l'hectare des particules plastiques supérieures à 5mm est égal à 0.197g (minimum 0 g ; maximum 3.216 g) et à 0.089g.

Si les prélèvements effectués sur la majorité des masses d'eau génèrent des valeurs largement inférieures à 1000 microplastiques à l'hectare, ls deux zones de Figari Bruzzi (5656 particules ha) et Saint Tropez (1103 particules /ha) présentent des valeur élevées. L'analyse retro active de courants pendant la période de prélèvement (www.Previmer.org) permet d 'expliquer les niveaux dans ces zones par l'existence d'un courant de surface d'Est en Ouest dans les bouches de Bonifacio qui remonte sur la zone Figari Bruzzi, ainsi que la formation d'un gyre au large de Saint Tropez.

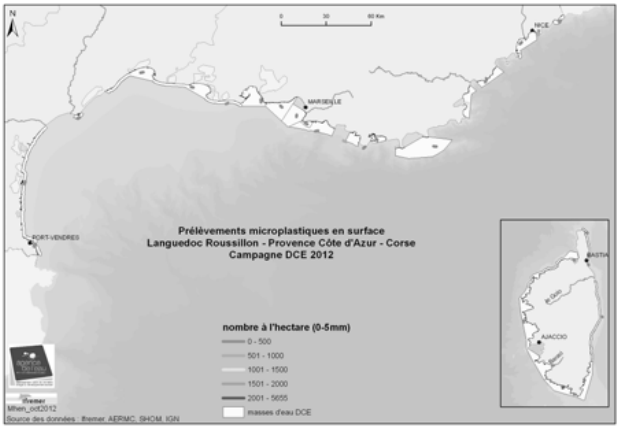

Fig. 2. Distribution du nombre de microplastiques (<5mm)

Les premiers résultats de cette campagne confirment que les microplastiques sont présents dans tous les échantillons récoltés, confortant les résultats des campagnes précédemment effectuées en Méditerranée (Collignon et al., 2011) . Les quantités sont cependant significativement inférieures en raison d'un échantillonnage en dehors de la période estivale et sur une emprise spatiale plus large. L'ensemble des travaux permet de disposer des bases scientifiques et techniques en vue d'une intégration dans les programmes de surveillance dès 2014.

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OCCURRENCE OF BENTHIC MARINE LITTER IN THE EASTERN MEDITERRANEAN: A PRELIMINARY ASSESSMENT.

C. Ioakeimidis [1]*, C. Zeri [1], H. Kaberi [1], N. Streftaris [1], K. Antoniadis [2], E. Papathanassiou [1] and G. Papatheodorou [3]
[1] Hellenic Centre for Marine Research (HCMR), Institute of Oceanography, 19013 Anavissos, Greece - cioakeim@hcmr.gr
[2] Department of Fisheries and Marine Research, Marine Environmental Division, 1416 Nicosia, Cyprus
[3] Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras

Abstract
The objective of this study is to investigate the density, distribution and composition of marine litter on the seafloor of selected marine areas in the Eastern Mediterranean basin. This is the first large-scale study related to benthic marine litter in Saronikos Gulf in Greece and Limassol Gulf in Cyprus, whereas in Patraikos Gulf it is one of the few attempts towards the creation of time series datasets (2002, 2003, 2013, 2014).

Keywords: Pollution, Plastics, Aegean Sea, Ionian Islands, Levantine Basin

For centuries, the oceans have been a convenient and cost effective dumping site ([3]). Nowadays, marine litter is one of the most serious, rapidly developing and worsening global environmental problems ([5]). Especially for the Mediterranean Sea, marine litter has been an issue of concern since the early 1970?s ([6]). There are various studies ([4], [1], [2]) related to the assessment of benthic marine litter in the Mediterranean Basin.

In Greece, marine litter was investigated in two semi-enclosed Gulfs, Saronikos Gulf (SR) in the Aegean sea and Patraikos Gulf (PT) in the Ionian sea, while in Cyprus the Limassol Gulf (LM) was selected. Litter items, were collected by professional trawling fisheries during the fishing period; Jan-Mar 2013. Marine litter, from each trawling was stored in separate bags together with their corresponding trawling characteristics. In total, 47 trawl cruises have been sampled (SR:19, PT:24, LM:4). The collected litter items were sorted according to their material type and size following the TSG ML Monitoring Protocol.

A total of 3,238 marine litter items were collected during the twenty-seven trawling cruises (SR:1,664; PT:1,561; LM:13). In Saronikos Gulf the items collected per trawl ranged from 22 items/trawl to 176items/trawl; in Patraikos Gulf from 6 to 202 items/trawl; while in Cyprus the collected items were considerably fewer ranging from 1 to 12 items/trawl. Moreover, two trawl surveys in Limassol Gulf were completely litter free. The total weight of the collected marine litter items reached up to 589 kg (SR:162kg; PT:425kg; LM:2kg). In terms of densities (items/m^2), the mean concentration of marine litter on the seafloor was $11x10^{-4}$ items/m^2 in Saronikos Gulf and $5.9x10^{-4}$ items/m^2 in Patraikos Gulf, while in Limassol Gulf it was $0.3x10^{-4}$ items/m^2. Our preliminary data show that there is a difference among the semi-enclosed gulfs (SR, PT) and the open gulf (LM) with the open gulf giving significantly lower benthic marine litter densities. Plastics consisted the major component of marine litter, significantly higher than the other types of material (SR: 94.8%; PT: 60.0%; LM: 61.5%).

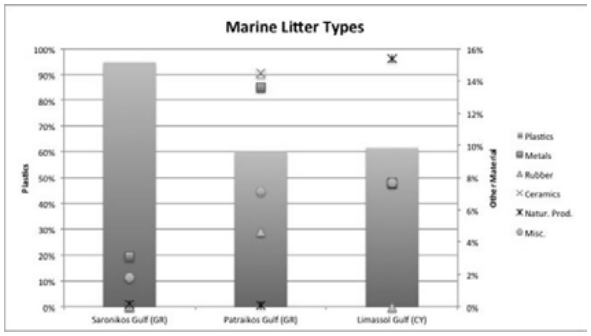

Fig. 1. Different benthic marine litter types

The second most abundant type was metals for SR (3.1%), ceramics for PT, (14.5%) and natural products for LM (15.4%). Regarding the size of the benthic marine litter, six size categories were recorded referring to surface area. The majority of the items belonged to the following three categories: i) <100cm^2, ii) <400cm^2, iii) <2,500cm^2.

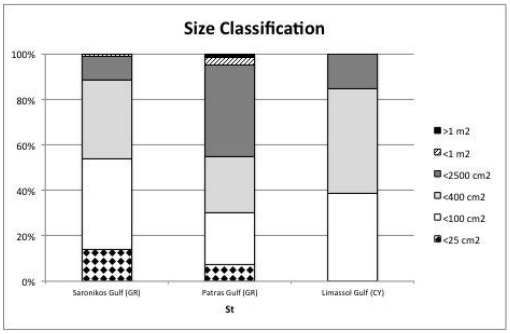

Fig. 2. Different size categories of the recorded marine litter items

Lastly, the recorded marine litter items were separated according to their origin, whether they originated from fishing activities or not. The majority of the items in the three study areas were not related to fishing activities (SR: 87.9%; PT: 90.5%; LM: 100.0%), while the fishing related items were much less (SR: 12.1%; PT: 9.5%; LM: 0.0%).

Aknowledgments This work was supported and funded by PERSEUS FP7 Program.

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LITTER ABUNDANCE, COMPOSITION AND SOURCE ESTIMATION IN 161 BEACHES, BASED ON RECORDINGS FROM A NATIONAL VOLUNTARY CLEAN-UP CAMPAIGN IN GREECE, MEDITERRANEAN

S. Kordella [1]*, S. Kyriakoulakou [1], A. Moirotsou [1], K. Papamichalopoulou [1], G. Papatheodorou [1], M. Geraga [1], N. Roumelioti [2], M. Koukiasa [2], E. Frezouli [2] and T. Makridou [3]

[1] Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Greece - stakord@upatras.gr

[2] Mediterranean S.O.S Network

[3] 16th Secondary School of Patras, Patras, Greece

Abstract

Abundance and composition of beach litter was assessed for 161 beaches in Greece, with the participation of volunteers in 2010, 2011 and 2012. This study showed that plastic is the dominant litter material (43-51%) while plastic lids from water/beverage bottles are the most affluent (8-12%) litter item regarding former use. Recreational activities seem to account for more than 20% of the beach litter load in the Greek coasts.

Keywords: Pollution, South-Eastern Mediterranean, Beach, Coastal management

Introduction

Marine litter is identified as a global environmental issue that poses a threat to marine ecosystems and negatively affects marine-based human activities. In this work we present the results of recordings made by volunteers of beach stranded litter in 161 coasts from all over Greece. The aim of this study is to evaluate the beach litter composition and origination on the Greek coastline, with the participation of volunteers [2], to promote public environmental awareness and to provide a baseline study for the development of future beach litter management plans.

Methods

For the purposes of the present study, data were collected on May 2010, 2011 and 2012 from 161 beaches, with the participation of thousands of volunteers (2010 in 16,495; 2011 in 21,020; 2012 in 17,238) of the "Clean up the Med" nationwide campaign of voluntary beach clean – ups, coordinated by the environmental N.G.O. Mediterranean S.O.S Network. The campaign takes place once a year, each May in Greece, where thousands of volunteers remove manmade debris from local beaches while recording them in a questionnaire, the "Beach Observation Questionnaire" (B.O.Q). With guidance provided by the B.O.Qs, and the research working group, the volunteers counted and classified all items of litter they find in the beaches in terms of former use (e.g. plastic bags, plastic bottles of water, detergents, aluminium beverage containers, fishing lines etc.). All data were statistically processed and re-classified by material in the following 12 categories: plastic, paper, nylon, Styrofoam, fabric, metal, glass, wood, rubber, foam, building materials, leather.

Results and Discussion

According to the acquired data all litter items that were recorded and removed from the surveyed beaches account for 89,652, 83,039 and 27,074 in 65, 53 and 43 Greek beaches in 2010, 2011 and 2012 respectively. Plastic was the dominant litter material (Table 1) in the studied beaches, accounting for 43-51% of the total litter items, in accordance with the global tendencies [1,2,3]. Plastic dominance was followed in all years by paper (14-18%) and metal (12-14%; Table 1) showing the same tendency as in previous studies in Greece [2]. High paper litter abundance compared to global levels probably indicates recent pollution due to its low pervasiveness [1,2].

Tab. 1. Percentages of the top five litter material categories.Other materials include all material categories with low contributions.

Litter Material Categories	2010 (%)	2011 (%)	2012 (%)
Plastic	51	44	43
Paper	14	19	18
Metal	14	14	12
Wood	7	7	6
Glass	6	6	5
Other Materials	9	10	16

Plastic lids from former water/beverage containing bottles (8-12%) appear to be the most abundant litter in the Greek beaches (Table 2). Plastic bottles (6-7%), plastic pieces (5-7%), straws (5-7%), cardboard (6%) and paper pieces (7%) are some of the dominant litter in the majority of the beaches (Table 2).

Consequently, more than 20% of litter found in the studied beaches are related to the consumption of water and beverages near or on the beach, suggesting recreational activities as a major contributor to the beach litter load [2, 3].

Tab. 2. Percentages of the top five former use categories. Other include categories with contribution >5%.

Year	Use	%
2010	Plastic Lids (water/ beverage containing bottles)	12
	Straws	7
	Plastic bottles (water/beverage)	6
	Plastic Bags	5
	Plastic Pieces <50cm	5
	Other (each category participation < 5%)	65
2011	Plastic Lids (water/ beverage containing bottles)	8
	Plastic bottles (water/beverage)	7
	Cardboard	6
	Plastic Bags	5
	Straws	5
	Other (each category participation < 5%)	69
2012	Plastic Lids (water/ beverage containing bottles)	8
	Paper Pieces	7
	Plastic bottles (water/beverage)	7
	Plastic Pieces <50cm	7
	Straws	5
	Other (each category participation < 5%)	66

Former use categories that individually include relatively low amounts of litter (<5%) but when grouped they total significant contributions, suggest that apart from recreation, the studied Greek beaches are also affected by urban/domestic activities, with litter related to domestic use (detergents, sanitary paper etc.) reaching levels of at least 8% and fishery, with related litter items accounting for more than 5%. The present study was made possible with the participation of volunteers of different age groups, whose direct involvement in coastal management issues lead to the promotion of environmental awareness and to the achievement of a large-scale survey.

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MULTIPLE PHASE MICROPLASTIC ASSESSMENT OF THE GREEK MARINE ENVIRONMENT

R. Seary [1]*, C. Acasuso-Rivero [2], A. Miliou [2], R. Standerwick [2], M. Demetriou [2], D. Chuda [2] and I. Siwka [2]
[1] Swansea University, Department of Biosciences - 630994@swansea.ac.uk
[2] Archipelagos, Institute of Marine Conservation, PO Box 42, Samos, Greece.

Abstract
Microplastic pollution is of growing concern worldwide and hence the assessment of its extent in the Greek marine environment is of uppermost importance due to the vast, albeit fragile biodiversity it possesses. In 2009, the first research phase assessed 114 beaches of the Greek islands and mainland producing evidence of microplastic contamination at all sites, leading to further study of an extra 49 sites in 2011. In order to evaluate the impact of this contamination at the lowest level of the trophic chain, the 2012 investigation focused on deposit feeder microplastic ingestion of *Holothuria* spp. from the NE Aegean, finding an average of 4.68 fibres ingested per individual.

Keywords: Plastics, Aegean Sea, Pollution

Introduction
A newly defined threat, microplastic fibres and particles (≤ 5mm), have become a major constituent of debris in the marine environment [1]. The small size of microplastic particles make them easily accessible to many marine biota and, feeding unselectively, filter feeders and deposit feeders ingest these plastic particles in the place of their natural food source, giving them the potential to accumulate throughout the food chain [2]. In order to collectively assess the level of microplastic pollution in the Greek environment, this study investigates microplastic contamination of beach sediments on a wide scale, in addition to quantifying the uptake of microplastics by deposit feeding Holothurians.

Materials and methods
Beach sediments were sampled from the shore line at 3, 25 metre intervals in 114 sites during phase 1 of research in 2009 and in 49 sites during phase 2 in 2011. 50 ml of each sediment sample was mixed with 100ml saturated salt solution and shaken vigorously. Solution was left for 30 minutes to allow microplastic particles to float to the surface, where they are removed with a syringe and processed using Whatman™ GF/F filters and a vacuum filtration apparatus, microplastic fibers were then visually identified. During phase 3 of research (2012), 18 *H.forskali* and 4 *H. tubulosa* individuals were stored in tanks of filtered sea water for 24 hours. The sample containing Holothuria faeces was shaken and left for sedimentation, water was then removed and filtered through Whatman™ GF/F filters, microplastics were then visually identified.

Results
All 114 sites sampled in 2009 were contaminated with microplastic fibres. Overall, in 2009 the most contaminated locations were the Attika peninsula and Ikaria Island, at a mean microplastic level of 20.13 ± 16.03 (SD) and 19.79 ± 10.74 (SD) fibres per 50 ml of sediment, respectively (Fig. 1). All 49 locations sampled in 2011 exhibited microplastic fibre contamination. Sifnos Island displayed the highest microplastic contamination, at 112.08 ± 67.54 (SD) fibres per 50 ml of beach sediment. Locations sampled in both 2009 and 2011, Rhodes and Ikaria, showed an increased mean microplastic level per 50ml of sediment (Fig. 1). 100 % of the Holothurians examined were found to have ingested microplastic fibres, at an average of 4.68 microplastic fibres per individual. One exceptionally high result measured 32 fibres for *H.forskali* individual. As well as confirming that microplastic particles are ingested by deposit feeding organisms at the lower level of the food chain, the results indicate that all Greek beaches are potentially polluted with microplastic fibres, showing a trend of increasing microplastic contamination over time. This provides strong evidence that enhanced efforts to reduce plastic debris in marine ecosystems are an immediate priority, whilst further and more extensive research is also required in order to provide a better understanding of the extent of microplastic fibre contamination at different levels of the food chain, as well as in marine sediment and water.

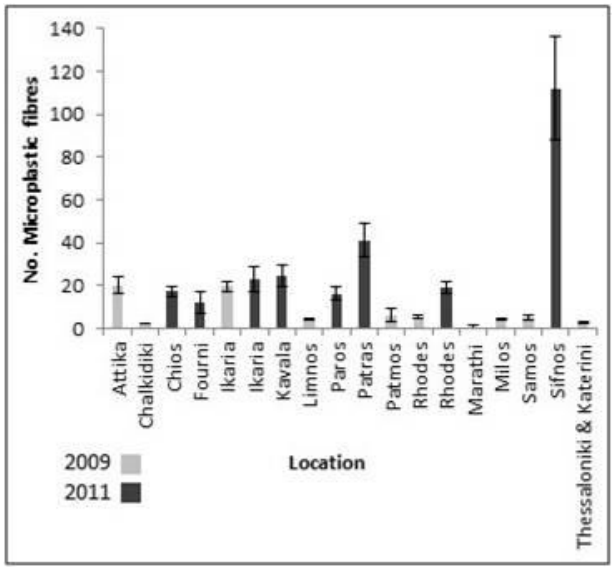

Fig. 1. Mean frequency of microplastic fibres per 50 ml of beach sediment ± standard error (SE) per location sampled in 2009 and 2011.

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DEGRADATION OF BIOPLASTIC IN MARINE ENVIRONMENT

V. Turk [1]*, T. Tinta [1], N. Glavaš [1], O. Bajt [1] and N. Kovac [1]
[1] National Institute of Biology Marine Biology Station Piran - Valentina.Turk@mbss.org

Abstract
Because of their positive characteristics and benefits, bioplastic or biodegradable polymers are considered to be a viable alternative to conventional plastics. The biodegradation of bioplastic in the presence of different microbes was evaluated under diverse conditions in laboratory and marine environment.

Keywords: Plastics, Bacteria, Pollution, North Adriatic Sea

Marine bacteria have been recognized as playing the key role in the mineralization of organic matter including pollutants of man-made origin in marine ecosystems (1). Plastics are one of the major contaminants in the world's oceans (2). The huge production of plastics and their omnipresence/persistence represent many social and economical benefits. At the same time there is a need for assessing the negative, hazardous effects of plastics on the marine environment (3). An alternative way to reduce the environmental impact is to reduce the amount of synthetic plastic, or to replace it with new biodegradable materials on the basis of renewable resources such as polysaccharides, proteins and cellulose nano-fibrils. The general use of such new materials needs additional testing. Abiotic and biotic parameters influence the disintegration of macroplastic into small fragments, and compounds with lower molecular mass microbes tend to degrade only partway.

The biodegradation of polyethylene compounds in the presence of different microbes (bacteria, fungi) has been extensively studied in landfills (4), but there are only a few studies of complete degradation to CO_2. There are some studies performed *in situ* in the marine environment. Photochemical processes, proceeding in the seawater under sunlight, lead to the degradation of many organic compounds. Quite commonly, they are connected to microbial degradation, since photochemical degradation usually transforms large molecules into smaller ones, which are a better substrate for microbial degradation.

In our project, a series of laboratory and *in situ* experiments was set up to follow the changes in the taxonomic structure of the microbial community, the changes in chemical composition and oxygen as well as CO2 concentrations. Three different settings were performed to follow bio fouling and degradation processes of bioplastic material: marine microbial population enclosed in bottle in controlled laboratory conditions, in an aquarium filled with different organisms and *in situ, under* natural conditions in seawater (above the bottom, at 3m depth). The microbial dynamics was followed using microscopic, molecular and radiolabel techniques to determine the succession rates and species composition of microorganisms, and possible differences according to different types/sizes of plastic. The degradation was followed using different chromatographic and spectroscopic techniques (HPLC, GC-MS, FTIR). In order to determine the microbial community composition changes during the degradation process, the bacterial community DNA was extracted and 16S rRNA gene clone libraries were constructed. Experiments, using artificial UV-light sources with the wavelengths characteristic of natural sunlight, were performed first in the laboratory and afterwards under natural conditions.
Our preliminary results show that the degradation process was on the time scale from weeks to months. According to FTIR and elemental analyses, the intense degradation of studied substrate was indicated by decreasing absorption intensities of aliphatic CH_3 and CH_2 stretching (2800-3000 cm^{-1}) and ester C=O stretching (1755 cm^{-1}). The analysis of 16S rRNA gene clone libraries from unfiltered seawater treatment in laboratory experiment showed that most of the clones (app. 33%) are related to *Alphaproteobacteria* (mainly *Rhodobacteraceae*, *Rhodospirillaceae* and *Hyphomonadaceae*), followed by otherwise rare community members *Firmicutes* (*Clostridiaceae*), which represented up to 24% of total bacterial community. *Deltaproetobacteria* represented around 12% and *Gammaproteobacteria* only up to 3%. A large percentage of clones (app. 27%) did not affiliate with any of the sequences deposited in the GeneBank (NCBI). Our first genetic and microscope observations suggests a fast biofouling and importance of complex living communities of bacteria and eukaryotes. Furthermore, these preliminary results suggest a large possible impact of bio-plastic on the ambient bacterial community structure and consequently on the ecosystem functioning. The experiment was conducted within the Eco Innovation project MarineClean (Grant Agreement ECO/10/277396/SI2.601543).

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THE ACCUMULATION OF MARINE LITTER ON THE SEABED OF THE MARMARA SEA

Ahsen Yuksek [1]* and Çolpan P. Beken [2]
[1] Istanbul University Institute of Marine Sciences and Management - ayuksek@istanbul.edu.tr
[2] Environment Institute, Marmara Research Center-TUBITAK

Abstract

Abstract: Distribution of seabed marine litter has been studied in the Sea of Marmara during few demersal biodiversity studies made in the last two decades. The spatial coverage of data was good to make an arial distribution analysis in 2000, hence the accumulation spots were identified and a comparison with earlier findings was made. The major component of litter was found as packing material having plastics in higher percentage. The study has to be evaluated with up-to-date data to assess the trends

Keywords: Biodiversity, Marmara Sea, Pollution

Introduction: It has been accepted that marine litter is a global pollution problem. A number of regional assessments has been made within the UNEP's global inititive including the Mediterranean and the Black Sea. It has also been reserved in the MSFD (2008/56/EC) as one of the descriptors (#10) to define and achieve good environmental status (GES). Considering the importance and current advances in research and monitoring needs of the topic as well as the lack of data and information on the distribution, trends and the impacts on ecosystems, Ministry of Environment of Turkey has started to support a number of studies. In the frames of a national integrated Project (DeKoS), a preliminary assessment on the capacity and extend of the information available around the country for the shore, sea surface and the seabed is being prepared and almost all data sets were gained. The data and information on the sea floor litter distribution is very limited for the Turkish Seas since monitoring activities have not been performed up to now. Only few published studies exist as part of fisheries studies (Topçu et al. 2008, 2010; Bingel et al. 1987). One of the rare data sets –being gathered for DeKoS- of the similar works is presented here for the Sea of Marmara. This study is on the litter accumulation on the seabed as number of items, content and weight of them. A broad comparison of the collected material is presented for two years; 1994 and 2000, and a relationship seen between the solid material ditribution and the biodiversity has been cited. **Material and methods :** The soft bottom substratum was sampled between 20-200 m depth interval at 34 trawl stations. The litter and the biological material caught in 30 min samplings were analyzed according to their types, weight and biomass. **Results :** The results obtained for different periods have shown that about 90-97% of the trowled items is composed of packing material and a small amount of the wastes are related to fishing, sea vehicles and accidents. About 50% of the pollution caused by packing material is plastics and other petroleum derivatives and 30% is cans and other alliminium material. The wastes intensively distributed mainly around Istanbul metropolitan area, coastal shelf between Büyükçekmece-Yenikapi (northern coastal strip), Tuzla shipyards area (southern coastal strip) and Izmit Bay. This is illustrated in Fig.1 and Fig.2, respectively showing the distribution of number of items and the weight of solid wastes in August 2000. In general, 406 kg/m2 solid waste was calculated for unit area which makes 1925 tonnes of litter for the whole seabed. This value is about 16% of the weight of demersal fish caught during the same survey. In 1994, the amount of litter was about 318 tonnes in the same trowling areas showing a ~6 times increase until the year 2000. More reliable trends can be obtained with the analysis of similar data sets after 2000. **Discussion:** The investigations have shown that the species diversity and the biomass of demersal fish was less in areas where quantity of litter was higher. The increasing trend of litter has been causing greater problems for fisheries too. The activities in the river basins as much as in the coastal and marine areas may fairly effect the intense seabed accumulation of marine litter. The problem causing activities in the region are: un-properly managed waste storage sites at the coastal areas and up-stream, intense maritime activities along the Turkish Straits System and lack of enough port reception facilities. The waste collection by fishermen might be encouraged within ongoing fishing activities applying a payment system for the return of wastes. ThIs has to be supported with enough number of waste reception facilities at ports and sea. Nevertheless, the trends and effects of litter at seabed and water column have to be systematically investigated, as being required by the criteria and standards on GES, in order to better understand the present status and the extend of resulting damage.

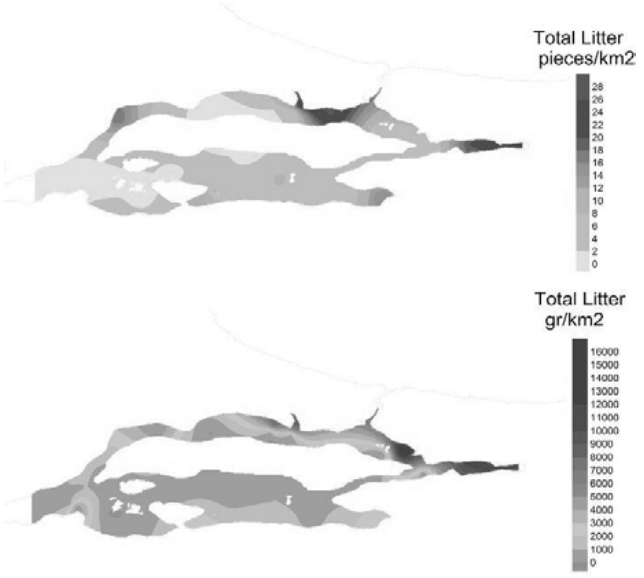

Fig. 1. Distribution of weight (a) and number of items (b) of solid wastes (kg/m2) at the seabed of Marmara Sea in 2000

The activities in the rivers basins as much as in the coastal and marine areas may fairly effect the intense seabed accumulation of marine litter.

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Session

Mercury in the Mediterranean

Modérateur : **Donata Melaku Canu**

EFFECTS OF ABANDONED KALECIK MERCURY MINE ON THE MARINE SEDIMENT (KARABURUN, IZMIR, TURKEY)

Hasan Baha Buyukisik [1]*, Ebru Yesim Okan [1], Ugur Sunlu [1] and Mert Turkdogan [1]
[1] Ege University, Fisheries Faculty, Turkey - h.baha.buyukisik@ege.edu.tr

Abstract
Hg and other heavy metals with some sediment parameters were investigated by statistical methods.14C age determinations were also used for explaining vertical variations in Hg.

Keywords: Mercury, Izmir Bay

Kalecik mercury mine exists in 4 km southeast of Karaburun Peninsula. Apart from Kalecik mercury mine, Karareis and Küçükbahçe mercury mines exist in western part of the peninsula. These mines were abandoned gradually since beginning of 1990s. The aim of this study are to investigate the pathways of Hg accumulation in the sediments and to determine the first contamination date and the changes of sediment properties during the historical times. This study was carried out 8 stations in the NorthEastern part of Karaburun coastal zone (Fig.1). Sediment core samples were taken by gravity core sampler in 20.09.2012 (KB01) and 23.05.2012 (KB02). Subsamples taken were dried at < 60°C and then homogenized.

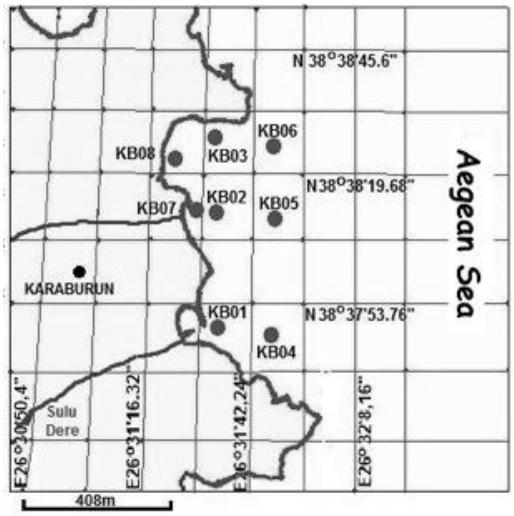

Fig. 1. Sampling stations in coastal area of Karaburun

The heavy metal analysis in all sub samples was performed using the four acid digestion and ultra trace ICP-MS method by ACME Anal. Lab. Ltd. (Vancouver, Canada). Reference materials (STD OREA S45E, STD OREA S24P,…) were used as a control for analytical methods. A contamination factor (Cf) was described the contamination of a given toxic substance in a basin by Hakanson (1980). Contamination factor is ratio of the concentration of the element in samples to preindustrial reference value for the element. The degree of contamination (Cd) in a depocentre is defined as the sum of all contaminants factor various heavy metals (Aksu et al.,1998). The contamination factor calculated from background values determined for the region corresponds to very high contamination level for Hg. Cd, Zr have serious level of contamination, Cu, Pb, Ni, Co, Mn, Fe, Ca, Mg, Ti,Sn, As, Y have medium level of contamination, Sb, Mo, Zn have low-medium level of contamination and Cr have low level of contamination. It was determined that Hg is carried to the sea by increasing rainfall at Holocene maximum and medieval warm period and that it decreased due to decreasing rainfall in small ice ages. In last two thousand years, ca (Fig. 2). 300 significant earth quake occured in Izmir Bay region , so that core samples were not reached to present times. The correlations of metals and Al and their linear relations show that clay minerals are one of the primary carrier phases. 6 factors were distinguished by the factor analysis applied on Al normalized elements. The factor 5 is *Detrital mafic rock* factor. It exposes the unity of Ni,Co and Hg. The mafic rocks surrounding Karaburun are carried to the sea as detrital material by wave erosion and rainfall. OrgC- normalized elements decreasing hyperbolically with orgC emphasizes that a balance with marine organic carbon is established. As a matter of fact the plotting of particulate Hg with dissolved Hg in the water column in the research field shows a hyperbolical decrease. This situation was explained by participating to dissolved phase by colloidal pumping on the surface and by the precipitation of the particulate material at the bottom. (Wen et al.,2008) It was understood at the research field that the particulate Hg input source is the sea water entering the Izmir bay after following the Karaburun shore rather than the river coming from mercury mine. It was emphasized that CDOM, POM and Hg relations has to be examined in detail.

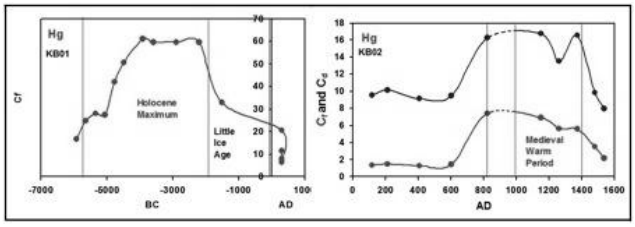

Fig. 2. In Core KB01 change of Hg C_f values in time (in left side), in Core KB02 change of Hg C_f and C_d values in time in (the right side).

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MERCURY AND ITS SPECIES IN THE ADRIATIC SEA

J. Kotnik [1]*, M. Horvat [1], N. Ogrinc [1], V. Fajon [1], D. Žagar [2], D. Cossa [3], F. Sprovieri [4] and N. Pirrone [4]
[1] Jožef Stefan Institute Department of Environmental Sciences - joze.kotnik@ijs.si
[2] Faculty of Civil and Geodetic Engineering, University of Ljubljana
[3] Ifremer, Centre for the Mediterranean Sea
[4] CNR - Institute of Atmospheric Pollution Research, Rende, Italy

Abstract
Mercury and its speciation were studied in surface and deep water of the Adriatic Sea during two oceanographic cruises onboard the research vessel Urania. Several mercury species together with some other water parameters were measured in coastal and open sea deep water profiles. Spatial and seasonal variations of measured Hg species concentrations in different identified water masses were observed. THg concentrations in the water column, as well as in sediments and pore waters, were the highest in the northern, most polluted part of the Adriatic Sea as the consequence of Hg mining in Idrija and the heavy industry of northern Italy. Furthermore, a Hg mass balance for the Adriatic Sea was calculated based on these measurements and literature data.

Keywords: Mercury, Central Adriatic Sea

The Adriatic Sea receives the inflow of heavily polluted rivers and other direct or indirect natural or anthropogenic Hg loads, especially in its northern and central parts. Elevated Hg levels were found on both the western and eastern coast of the N Adriatic. Water concentrations are reflected in THg concentrations in the sediments and pore waters of the area. It is evident that Hg enrichment in coastal N Adriatic waters and sediments is limited to the near shore zone and continental shelf. The spatial distribution of THg in water and sediment strongly depends on the water circulation of the sea, but there are several biological and/or geological factors affecting its speciation. N Adriatic water columns exhibit strong temperature and salinity stratification. The vertical distribution of Hg species reflects well mixed water with low deviations from the average for each location. Some correlations between maximum DGM and RHg peaks and the low oxygen zone were observed, which was not the case at the most polluted locations of the Gulf of Trieste and near Venice. Such an association is more evident in locations in the Central and Southern Adriatic where DGM at the surface is relatively low, reflecting the importance of evasion and photochemical oxidation due to the strong UV radiation and the presence of chlorine and bromine [1] and hydroxyl radicals [2, 3] at the surface. In deeper water layers the DGM distribution shows correlation with the oxygen concentration and indicates the importance of redox processes due to microorganism activity, and another, usually sharp increase towards the bottom. This indicates microorganism production and diffusion from sediment and/or tectonic activity, especially at locations in the S Adriatic Pit, which is tectonically very active. RHg vertical profiles are mostly opposite to those of DGM as Hg(II) is a substrate for DGM production. MeHg profiles are mostly related to Chl-a and oxygen concentrations. This underlines the role of planktonic production and regeneration in the methylation/demethylation processes. The low MeHg concentrations found in shelf edge or coastal sediments and water over the sediment indicate that coastal or shelf sediments are not a significant MeHg source for adjacent open sea waters. At some exceptional deep sea locations the increase of MeHg over the bottom suggest some bottom source (i.e. resuspension or diffusion from sediment), further supported by the estimated diffusive fluxes from sediments ranging from 0.150 to 16.6 pmol m^{-2} day^{-1}. Mass balance calculations showed that deposition and inflow from the Strait of Otranto are the most important sources of Hg, while evaporation and outflow to the Mediterranean are the most important sinks.

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DISSOLVED GASEOUS MERCURY MEASUREMENTS IN SURFACE AND DEEP WATERS IN THE MEDITERRANEAN SEA

Jože Kotnik [1]* and Milena Horvat [1]
[1] Jožef Stefan Institute Department of Environmental Sciences - joze.kotnik@ijs.si

Abstract
Dissolved gaseous mercury (DGM) was studied in surface and deep waters of the Mediterranean Sea for last 12 years during several oceanographic cruises on board the Italian research vessel Urania. The cruises were part of several EU and national research projects (MEDOCEANEOR, MERCYMS, GMOS, etc.), covering regions from Strait of Gibraltar on the west and Levantine Sea on the east as well as Adriatic Sea with the Gulf of Trieste as Mediterranean most northern part. DGM was measured together with some other mercury species (RHg - reactive Hg, THg - total Hg, MeHg - monomethyl Hg and DMeHg - dimethylmercury), and with some water quality parameters in coastal and open sea deep water profiles.

Keywords: Mercury, North-Western Mediterranean

DGM in water profiles was measured manually by purging 0.5 L of sample for 10 min, followed by double gold amalgamation and CV AFS detection (Tekran 2500) [1, 2]. During 2011 cruise, continous method [3, 4] was applied and compared to manual. Hg free ambient air was equilibrated with the seawater in a plexiglass purging bottle with opposite air and water flow. The flow of Hg free ambient air was introduced through a glass frit positioned at the bottom of the bottle. Released DGM was then detected by Lumex RA 915+ AAS detector. The DGM concentration of the water was calculated assuming Henry's law equilibrium between the mercury concentration in the equilibrated air and the water [3, 4]. Special attention was also given to quality control steps by comparing data on board the ship by different laboratories (IJS Slovenia, IVL Sweden, UGOT Sweden, CNR-IIa Italy, IFREMER France) using different analytical protocols on samples collected on board. Dissolved gaseous Hg measured in water is composed of dissolved gaseous elemental Hg (Hg0) and dimetyl Hg (DMeHg), which is present in very small fraction (< 5 %) and is measurable mostly in deep waters [1, 2]. Typically DGM is low at the surface, depeer in oxygen minimum zone it increase to its maximum levels. At most locations DGM sharply increase again in bottom water layer. DGM generally increases with depth, suggesting the presence of a source of volatile Hg in deeper waters. The average DGM concentration was the highest in deep water masses (WMDW and EMDW). Such distribution reflect the importance of evasion and photochemical oxidation/reduction processes due to strong UV radiation and presence of chlorine and bromine [1] and hydroxyl radicals [5, 6] at the surface. In deeper water layers DGM distribution indicate the importance of reduction/oxidation processes due to microorganisms activity, and towards the bottom microorganisms production and diffusion from sediment and/or tectonic activity, which may be the main source of DGM in deep waters where higher concentrations and portions of DGM near the bottom at locations with strong tectonic activity (Alboran Sea, Strait of Sicily, Tyrrhenian Sea, Strait of Otranto) were found. It is well known that emissions from tectonic activity and geological anomalies could represent an important source of mercury. Rajar et al. [7] calculated total natural underwater emission of Hg in the Mediterranean Sea to be 11 to 20 tons y-1 with mean estimate of 15 tons per year. The spatial distribution of DGM in the Mediterranean Sea is generally connected to water circulation in the basin, however there could be several other chemical, biological and/or geological factors affecting the DGM distribution. DGM in bottom and deep waters increase from east toward west. The concentrations of DGM were highest in severely polluted N Adriatic, while S Adriatic waters were within the range reported for the Mediterranean Sea.

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MODELLING THE MERCURY CYCLE IN THE MARANO-GRADO LAGOON. MERCURY BUDGET AND EXPOSURE RISK

D. Melaku Canu [1]*, G. Rosati [1], A. Acquavita [2], G. Mattassi [2] and C. Solidoro [1]
[1] OGS Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - dcanu@inogs.it
[2] ARPA FVG Friuli Venezia-Giulia Regional Environmental Protection Agency

Abstract
Two different models released by US-EPA, SERAFM, a steady state model, and WASP, a dynamic model, have been used to describe major dynamics in the mercury cycle in the Marano-Grado lagoon, (Northern Adriatic Sea, Italy). The lagoon shows high mercury concentration in the water column, sediments and biota due to natural and anthorpogenic sources. The model applications aim at: 1) computing mercury budgets within the lagoon and fluxes between the lagoon and the surrounding systems (watershed, Adriatic Sea, atmosphere); 2) improving the understanding of the importance of different loading sources and transformation processes on methylmercury concentration and bioavailability. Moreover, the models allow to identify major knowledge gaps and suggestions for further modeling development.

Keywords: Lagoons, Mercury, Models, North Adriatic Sea

The Marano-Grado Lagoon (Northern Adriatic Sea, Italy), covers an area of approximately 160 km2. It is one of the most important and best conserved wetland environments in the Mediterranean area, also identified as a Site of Community Importance (SCIs – IT3320037) and it provides important ecosystem services which sustain several economic activities. The lagoon is also a sink for anthropogenic contaminants, and, in particular, for mercury compounds released via natural and anthropogenic sources. Smelting activity at the Idrija mine in western Slovenia has released 39000 tons of mercury over 500 years, and a chlor-alkali plant has released around 186 tons of mercury directly into the lagoon during the 45 years of operation. Elevated Hg concentrations in sediments, ranging from 0.61 to 14.01 µg g-1, have been found related to both historical and more recent anthropogenic activities. Mercury (Hg) is a ubiquitous environmental pollutant of great concern because of the toxicity of its methylated form (MeHg) and bioaccumulative and biomagnifying properties. Mercury occurs in the marine environment in three chemical forms: elemental Hg (Hg(0)); divalent ionic Hg (Hg(II)), present in a variety of both inorganic and organic complexes; and methylated forms that include monomethylmercury (MeHg) and dimethylmercury (DMHg). All these species are linked intricately through the Hg(II) pool [1]. Within the Marano Grado Lagoon, several studies have been developed addressing the state of the mercury contamination in different media, including sediment, water column and biota, ([2, 3, 4] but the implementation of a biogeochemical model could add insight into the mercury fluxes and support the risk management [5]. Data characterising the biogeochemical cycle of mercury in the Marano-Grado Lagoon have been assembled and two models released by US EPA, publicly available, have been implemented to complement the experimental knowledge and to highlight knowledge gaps. A scenario analysis have been performed in order to highlight the relevance of different processes in the mercury fluxes in the lagoon. The two model applications enabled to focus on different aspects of the mercury biogeochemistry. Model parameters have been derived from site specific data, when available, or from parameters related to similar environments, as reported in literature. The Marano Grado lagoon have been represented as a 6 box system, interacting with the surrounding systems (Adriatic Sea, atmosphere, deepest sediments and watershed), following the classification given by [6]. The SERAFM model has been implemented describing the lagoon as indipendent six-box systems at steady state. The model calculates the concentration of the mercury species (HgII, MeHg, Hg0) in the water column, in sediment and in biota, driven by hydrological characteristics, external forcing influence, initial concentration and mercury process parameterization. The SERAFM model calculates also wildlife and human exposure risks related to methylmercury bioaccumulation. The analysis have been made under different scenarios of contamination, decontamination and exchanges with the surrounding systems. The WASP model implementation allows to reproduce the temporal evolution of the mercury in the lagoon. In this application, the Lagoon is represented as a 6 connected box system. Time variable water fluxes between the six boxes and with the Adriatic Sea have been introduced based on hydrodynamic model results. Variable river discharge, and precipitation have also been included as well as mercury and water quality concentration at the boundary systems. The WASP model allows to represent the seasonal evolution of the three from of mercury concentration in the lagoon environment, giving preliminary indications on the temporal and spatial evolution of mercury the mercury species (HgII, MeHg, Hg0) in water (total, particulate, dissolved, Fig. 1) and in sediment. The results have been compared with the available data and used to assess the relative value of different mercury sources on the availability of methylmercury to biota.

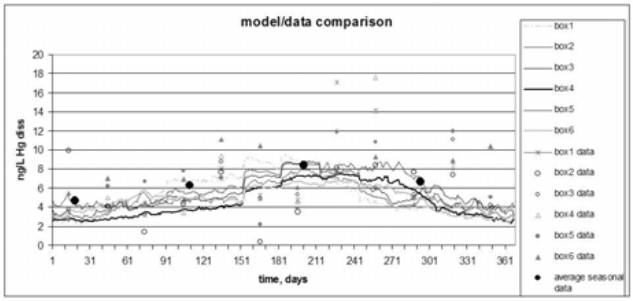

Fig. 1. WASP model predicted concentrations compared with observations and with seasonal averaged data of dissolved mercury.

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HG, AS, CD, AND PB IN DIFFERENT TISSUES OF *MURAENA HELENA* FROM ADRIATIC SEA NEAR DUBROVNIK, CROATIA

D. Đikic [1], D. Franjevic [1], D. Skaramuca [2]*, D. Lasic [3], S. Matic-Skoko [4], P. Tutman [4], A. Mojsovic-Cujic [5], J. Bošnir [3], Z. Franic [6], R. Fuchs [6] and B. Skaramuca [2]

[1] University of Zagreb, Faculty of Science, Division of Biology, Zagreb

[2] University of Dubrovnik - daria.skaramuca@zg.t-com.hr

[3] Institute of Public Health - Dr. Andrija Štampar, Zagreb

[4] Institute of Oceanography and Fisheries, Split

[5] University of Applied Health Studies, Zagreb

[6] Institute of Medical Research, Zagreb

Abstract

This research examines the level of metals in various tissues of wild caught Muraena Helena from Adriatic sea in the year 2010 by the atomic absorption spectrometry (Perkin-Elmer Analyst 600 Zeeman equipped with a THGA-600 graphite furnac). The analysis shows that Hg and As had highest levels in muscle, gills and especially liver while Pb and Cd had highest levels in skin.

Keywords: Bio-accumulation, Fishes, Metals, South Adriatic Sea

Introduction: the trophic level of Moray eels makes them a model organism for the local studies of bioaccumulation or biomagnifications of metals [1].

Material and Methods: morays (N=18) were caught in East Adriatic near Dubrovnik (in 2010). Bioaccumulation of Pb, Cd, As and Hg in various tissues were analyzed by the atomic absorption spectrometry (Perkin-Elmer Analyst 600 Zeeman equipped with THGA-600 graphite furnac) [2].

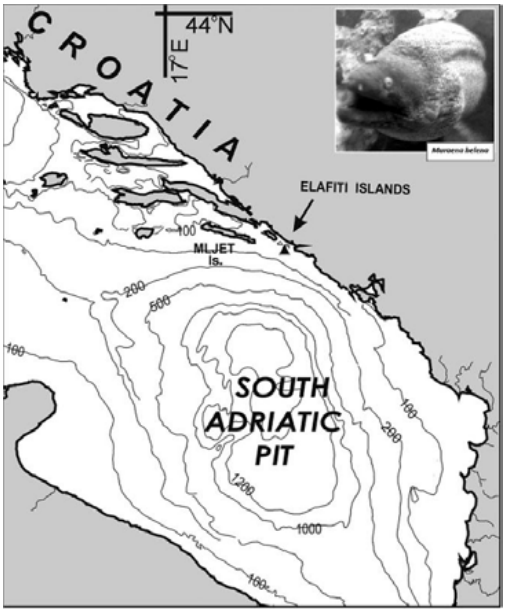

Fig. 1. The sampling location in eastern Adriatic.

Results: all analyzed metals (Table 1) were present in skin, bone, muscle, liver, gills and heart and results were expressed per kg of wet weight (ww). Liver was the tissue with highest and heart with lowest levels of bioaccumulated metals. Hg and As had highest levels in muscle, while Pb was highest in the liver and with Cd had highest levels in skin.

Discussion and Conclusion: in analyzed morays, liver was the organ with highest bioaccumulation potential as similar in other marine fish of similar trophic status and kin eel species. Interestingly, bioaccumulation of As was highest in gills of moray eels although it is known that As accumulation potential in fish muscle tissue is greater than liver [3]. Regardless of the detection and presence of analyzed metals none of them were above allowed safe levels [4]. The levels of detected metals were lower than previously measured in other species from different locations in Adriatic sea.

Tab. 1. Different bioaccumulation of nonessential metals in tissues of Mediterranean spotted moray (N=18).

	ng kg^{-1} ww	mean	median	min	Max
skin	Pb	100,8	70,0	10,0	380,0
	Cd	130,5	10,0	3,0	1560,0
	As	58,8	30,0	10,0	150,0
	Hg	28,9	10,0	3,0	106,0
muscle	Pb	37,3	20,0	10,0	144,0
	Cd	9,9	3,0	2,0	40,0
	As	80,6	35,0	10,0	250,0
	Hg	162,2	115,0	50,0	640,0
bone	Pb	56,4	35,0	10,0	261,0
	Cd	99,6	20,0	3,0	730,0
	As	67,0	40,0	10,0	200,0
	Hg	169,9	70,0	20,0	800,0
gills	Pb	62,3	50,0	10,0	205,0
	Cd	33,0	10,6	4,0	150,0
	As	136,3	20,0	10,0	1540,0
	Hg	82,1	60,0	10,0	235,0
liver	Pb	160,6	83,0	30,0	800,0
	Cd	287,2	180,0	30,0	2060,0
	As	193,1	75,0	10,0	1150,0
	Hg	436,9	390,0	90,0	990,0
heart	Pb	112,9	50,0	30,0	350,0
	Cd	17,9	20,0	7,0	40,0
	As	84,3	60,0	10,0	200,0
	Hg	67,1	60,0	30,0	120,0

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ON THE DISTRIBUTION OF FOUR HEAVY METALS IN THE GULF OF GABES, TUNISIA, USING FOUR MOLLUSK SPECIES

L. Rabaoui [1], R. Balti [2], R. El Zrelli [3], O. K. Ben Hassine [1] and S. Tlig-Zouari [1]*
[1] University of Tunis El Manar - Faculty of Science of Tunis, Tunisia - s.zouaritlig@gmail.com
[2] Ecole Nationale d'Ingénieurs de Sfax, Tunisia
[3] Institut National Agronomique de Tunis, Tunisia

Abstract
The contents of four heavy metals (Mercury, Lead, Cadmium, Chromium) were assessed in four mollusk species (*Gibbula ardens, Patella caerulea, Pinctada radiata* and *Pinna nobilis*), collected from twelve coastal stations in the gulf of Gabes. High concentrations of heavy metals were recorded in the central area of the gulf, nearer to Gabes city; however the low concentrations were found at the gulf edges, which is probably due to the chemical pollution generated from the huge industry of phosphoric acid in Gabes city. The highest heavy metals' concentrations, noted during this study, are comparable to the findings of other authors in other areas, but they are considerably beyond the standards.

Keywords: Pollution, Bio-accumulation, Bio-indicators, Mollusca, Gulf of Gabes

The gulf of Gabes was reported to be highly exposed to pollution through the huge industrial activity based in this area, in particular in Gabes city. In fact, large quantities of phosphogypsum from the phosphoric acid and chemical products industry of Gabes are released into the Gulf of Gabes [1; 2]. Although phosphogypsum is known to contain quantities of heavy metals, only few studies were done before about the distribution of these pollutants in this area. In this work, we assessed the heavy metal pollution in the gulf of Gabes, using four mollusk species: *Gibbula ardens*, *Patella cearula*, *Pinctada radiata*, and *Pinna nobilis*. The contents of four heavy metals (Mercury, Lead, Cadmium, Chromium) were analyzed in the tissues of these species collected from twelve sites (from the north to the south: Chebba, Louata, Sfax, Kerkennah Island, Mahres, Gabes, Zarrat, Elgrine, Djerba Island, Boughrara, Zarzis, and El Biban lagoon), and the level of pollution was compared between the sampling sites. Average concentrations of the four analyzed heavy metals in the four mollusk species are summarized in table 1.

Tab. 1. Minimal and maximal average concentrations of heavy metals recorded with the four mollusk species in the sampling sites of Gabes gulf. CH, Chebba; LO, Louata; SF, Sfax; KI, Kerkennah Island; MA, Mahres; GA, Gabes; ZA, Zarrat; EG, Elgrine; DI, Djerba Island; BG, Boughrara; ZZ, Zarzis; EB, El Biban lagoon.

Species (Tissue)	Heavy Metal	*Minimal* average content µg g-1 (site)	*Maximal* average content µg g-1 (site)
G. ardens (total)	Mercury	0.042±0.018 (EB)	0.181±0.020 (ZZ)
	Lead	0.633±0.107 (CH)	2.543±0.527 (DI)
	Cadmium	0.244±0.067 (CH)	3.005±0.117 (DI)
	Chromium	0.041±0.091 (CH)	1.664±0.246 (DI)
P. caerulea (total)	Mercury	0.031±0.001 (EB)	0.679±0.084 (LO)
	Lead	0.823±0.057 (EB)	2.123±070 (DI)
	Cadmium	0.800±0.028 (EB)	4.300±0.330 (GA)
	Chromium	0.321±0.010 (CH)	2.171±0.139 (GA)
P. radiata (muscle)	Mercury	0.040±0.009 (CH)	0.387±0.012 (MA)
	Lead	0.722±0.075 (EB)	1.848±0.071 (DI)
	Cadmium	0.605±0.025 (EB)	1.065±0.085 (GA)
	Chromium	0.335±0.008 (KI)	1.605±0.286 (GA)
P. radiata (hepatopancreas)	Mercury	0.044±0.007 (EB)	0.420±0.099 (LO)
	Lead	0.860±0.060 (EB)	2.288±0.279 (DI)
	Cadmium	0.732±0.187 (EB)	1.295±0.173 (GA)
	Chromium	0.390±0.021 (CH)	2.066±0.222 (ZZ)
P. nobilis (mantle)	Mercury	0.027±0.002 (EB)	0.312±0.097 (LO)
	Lead	0.691±0.143 (EB)	1.682±0.134 (DI)
	Cadmium	0.666±0.096 (EB)	1.790±0.648 (DI)
	Chromium	0.321±0.029 (EB)	1.627±0.224 (DI)
P. nobilis (gills)	Mercury	0.026±0.005 (CH)	0.399±0.038 (LO)
	Lead	0.654±0.076 (EB)	1.221±0.225 (DI)
	Cadmium	0.374±0.068 (EB)	1.039±0.146 (DI)
	Chromium	0.183±0.063 (EB)	0.870±0.101 (DI)
P. nobilis (muscle)	Mercury	0.041±0.008 (CH)	0.169±0.048 (KI)
	Lead	0.643±0.081 (EB)	1.032±0.166 (DI)
	Cadmium	0.312±0.096 (EB)	0.966±0.1524 (DI)
	Chromium	0.192±0.009 (EB)	0.604±0.077 (DI)
P. nobilis (hepatopancreas)	Mercury	0.033±0.010 (EB)	0.285±0.051 (LO)
	Lead	0.645±0.133 (EB)	1.209±0.200 (DI)
	Cadmium	0.674±0.157 (EB)	1.121±0.090 (CH)
	Chromium	0.386±0.056 (EB)	1.687±0.302 (DI)

The distribution of these pollutants in the gulf of Gabes appeared to follow almost a similar pattern between the four mollusk species. The highest concentrations were found in the area between Gabes and Zarzis sites (central and southern parts of the gulf). The analysis of variance showed highly significant differences between localities of study. The species *P. nobilis* and *P. radiata* were found to accumulate heavy metals less than the two other gastropod species, probably due to their lower trophic level. The hierarchical classification of the sampling localities allowed separating between 6 clusters at a distance of 2.6: cluster 1 consisted of Chebba, Louata, Kerkennah Island, and El Biban lagoon; cluster 2 was formed by Djerba Island; Cluster 3 by Sfax and Mahres; cluster 4 by Gabes and Zarzis; cluster 5 by Zarrat; while cluster 6 was represented by Elgrine and Boughrara (Fig. 1). Heavy metal pollution is certain in the gulf of Gabes and it seems that it has reached a critical level since the highest pollutants' concentrations exceeded the standards fixed as well by the World Health Organization (WHO) as by the Food and Agriculture Organization (FAO). A remediation action is necessarily needed to protect the marine life in the gulf of Gabes.

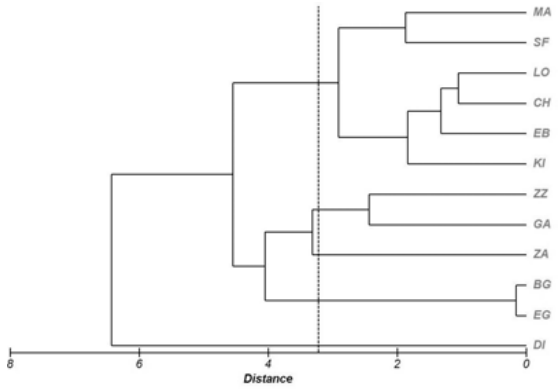

Fig. 1. Hierarchic classification of the sampling sites, done based on Euclidean distance. EB: El Biban lagoon, DI: Djerba Island, CH: Chebba, GA: Gabes, LO: Louata, ZZ: Zarzis, MA: Mahres, KI: Kerkennah Island.

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Session

Methods & technics
Chemical and toxicological monitoring

Modérateur : **David Sánchez Quiles**

COMPARISON OF AMINO ACID ANALYSIS METHODS IN SEAWATER

Hakan Alyuruk [1]* and Aynur Kontas [1]
[1] Dokuz Eylül University Institute of Marine Sciences and Technology - hakan.alyuruk@deu.edu.tr

Abstract
Dissolved organic matter is one of the largest reservoirs for organic carbon in seawater. It contains molecules from simple to complex structures as by-products of metabolism or degradation products. Determination methods of amino acids in seawater were discussed in the present study.

Keywords: Organic matter, Izmir Bay, Analytical methods, Coastal waters

Introduction:
Dissolved organic matter (DOM) is an important component of aquatic biogeochemical cycles. It can be classified as autochthonous (marine origin) and allochthonous (terrestrial origin) according to its source. It is composed of different types of micro- and macro-molecules that are difficult to characterize and separate from each other. Most abundant biomolecules in DOM are amino acids, carbohydrates, lipids, fatty acids, sterols, humic acids, fulvic acids, and lignins. Among other organic molecules, amino acids are descriptive of the origin and transformation rate of DOM [1]. For example, D-amino acids are found in the cell walls of marine bacteria. Therefore, determination of enantiomeric amino acid abundance in seawater gives important information about the origin of DOM [1,2]. Also, enantiomeric amino acid abundance is used in geochronology for estimation of age in fossil samples [1,3]. In the literature, amino acid content found in DOM was fractionated as dissolved free amino acids (DFAA), dissolved combined amino acids (DCAA) and total hydrolyzible amino acids (THAA) [4]. On the other hand, carbon and nitrogen contents in DOM can be measured as bulk quantities; however, amino acid content can only be obtained by advanced analytical techniques such as gas chromatography (GC) and high performance liquid chromatography (HPLC).

Comparison of Methods:
Prior to analysis of amino acids by GC method, high volume seawater sample (about 50 L or more) is filtered from GF/F membrane filters, concentrated via ultrafiltration and diafiltrated to remove salts. Samples can be analyzed without hydrolysis to determine DFAA or it could be subjected to acid hydrolysis to determine THAA. For derivatization, samples are first esterified with 2-propanol and esterified amino acids are acylated with trifluoroacetic anhydride to form trifluoroacetyl-isopropyl esters of amino acids. Then, amino acids in derivatized samples are determined by GC or gas chromatography-mass spectrometer [5-7]. Detectable amino acids by using GC method are alanine, valine, glycine, leucine, isoleucine, proline, serine, threonine, phenylalanine, tyrosine, lysine, asparagine + aspartic acid and glutamine + glutamic acid. Total analysis time for GC method is changed between 80-100 min. On the other hand, HPLC methods can be separated into two categories as simple method and enantiomeric method. In both HPLC methods, concentration step for samples is not required; therefore, just about 100 or 1000 mL of seawater can be directly analyzed after hydrolysis step. In the simple method, amino acids are analyzed via fluorescence detector of HPLC after derivatization with o-phtaldialdehyde (OPA) and mercaptoethanol [4]. Analysis time for this method is about 60 min. Methanol and acetate buffer are used as mobile phases. In the enantiomeric method, derivatization is performed by using OPA and chiral reagents, N-isobutyryl-L or D-cysteine before analysis [4]. Since derivatization reaction is sensitive to reaction time and reactants, an HPLC autosampler is required in this step for reproducibility of the results. Separation of amino acids is achieved by two successive analyses with both chiral reagents on reversed-phase HPLC column. Analysis time per analysis is about 2 hours and it takes about 4 hours in total. In addition to amino acids in L- form listed in GC method, D/L-arginine and D-enantiomers of listed amino acids can be determined.

Conclusion:
HPLC methods are more sensitive and their detection limits are lower than GC methods. Also, D-/L- amino acid speciation can be obtained by using enantiomeric HPLC method. It can be concluded that HPLC methods are much faster and sensitive to apply compared to GC methods for amino acid analysis in seawater. Seasonal variation of DOM in Izmir Bay will be investigated within the PhD thesis of Hakan Alyuruk.

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LESSONS LEARNED FROM PROFICIENCY TESTS ORGANISED BY IAEA/MESL AND UNEP/MAP - MED POL FOR TRACE ELEMENT ANALYSIS IN THE MEDITERRANEAN

Michael Angelidis [1]*, Emilia Vassileva [1] and Sabine Azemard [1]
[1] IAEA Marine Environmental Studies Laboratory - M.Angelidis@iaea.org

Abstract
More accurate analytical results for trace elements in marine samples are generally provided by Mediterranean monitoring laboratories which are regularly participating in Proficiency Tests organised by IAEA/MESL and UNEP/MAP-MED POL. Sample contamination and inappropriate pre-treatment/analytical methods applied also affect the quality of analytical results.

Keywords: Monitoring, Metals, Pollution, Mediterranean Ridge

Marine pollution monitoring is a legal obligation of the Contracting Parties of the Barcelona Convention and much effort has been made to generate marine pollution data through national monitoring programmes implemented in the framework of the MED POL Programme of UNEP/Mediterranean Action Plan. Monitoring data is needed to assess the level and trends of pollution in the Mediterranean in order to decide on action plans, programmes and measures to be established for the protection of the marine environment and for the sustainable development of the coastal zone. It is therefore of primary importance that the generated monitoring data is accurate and representative of the environmental status, i.e. that it is "quality assured". In order to strengthen the data quality assurance of Mediterranean laboratories involved in national marine monitoring programmes, IAEA's Marine Environmental Studies Laboratory (MESL) in collaborating with UNEP/MAP – MED POL, is organising since many years Proficiency Test (PTs) to assess the analytical performance of laboratories through the analysis of a test sample with known reference values for different trace elements. The performance of the participating laboratories is assessed through the evaluation of Z score in accordance with ISO 13528 [1] and the International Harmonised Protocol for the Proficiency Testing of Analytical Chemistry Laboratories [2]. This score effectively express the difference between results reported by participating laboratories and the assigned value for the respective analyte in the PT test sample. The performance is considered acceptable if $|z| \leq 2$, the result is regarded as questionable when $2 < |z| < 3$ and the result is regarded as unsatisfactory if $|z| \geq 3$.

In the last 6 PTs organized by IAEA/MESL since 2005 on the analysis of trace elements in sediment and biota, the participation of the designated Mediterranean laboratories ranged from 53 to 76% (average 61%). Most laboratories did not participated regularly in the PTs, since only 8 out of 44 participating laboratories reported 4 or more times their results in the last 6 PTs. No-participation and low frequency of participation in PTs is a major problem, because it does not allow for a meaningful assessment of the quality of data generated by laboratories. Although no-participation does not necessarily mean that the data of a particular laboratory is "unsatisfactory", it indicates low understanding of the necessary activities to establish and maintain a good level of data Quality Assurance / Quality Control. The laboratories that are regularly participating in PTs have in general better z-scores that those participating less frequently to these exercises (Figure 1).

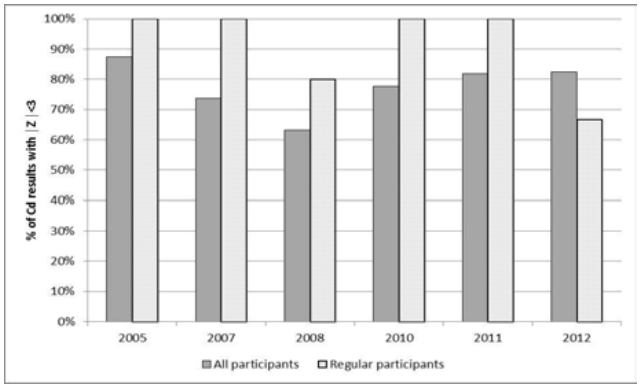

Fig. 1. Percentage of results (Z-score <3) reported for Cd in MED POL PTs: regular participants are laboratories that reported at least 4 times Cd values over 6 PTs

Available PTs results indicate that the number of unacceptable results tend to increase when the concentrations of the element to be detected are low. The measurement results for some elements at low concentrations are seriously biased by sample contamination, as well as when the methods applied for pretreatment and instrumental analyses are not under control (Figure 2). The implementation of principles for good laboratory practice in Mediterranean laboratories is an important point for the further improvement of their measurement capabilities.

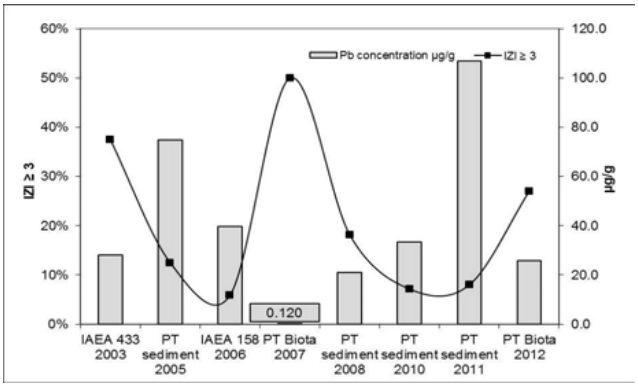

Fig. 2. Comparison between the percentages of unacceptable results ($Z \geq 3$) reported for Pb in PTs and the concentrations of Pb in the sample

Conclusions

Proficiency Tests organized since many years by IAEA/MESL and UNEP/MAP-MED POL indicate that a part of the marine pollution data generated by Mediterranean laboratories in the framework of national monitoring programmes is not quality controlled. Mediterranean monitoring laboratories should improve their data Quality Assurance / Quality Control.

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L'UTILISATION D'UNE APPROCHE MULTIPARAMETRIQUE DANS L'IDENTIFICATION D'UN BIO-INDICATEUR MODELE POUR LA BIO-SURVEILLANCE DE L'ENVIRONNEMENT AQUATIQUE

I. Louiz [1], O. Palluel [2], S. Ait-Aissa [2], M. Ben Attia [3] and O. Ben Hassine [1]*

[1] Unité de Recherche de Biologie intégrative et Écologie évolutive et fonctionnelle des Milieux Aquatiques, Faculté des Sciences de Tunis, Université Tunis-El-Manar, 2092 El Manar, Tunisie - kalthoum.benhassine@gmail.com

[2] Unité d'Écotoxicologie, Institut National de l'Environnement Industriel et des Risques (INERIS), f-60550 Verneuil-en-Halatte, France

[3] Laboratoire de Biosurveillance de l'Environnement, Faculté des Sciences de Bizerte, Université de Carthage, 7021 Zarzouna, Tunisie

Abstract

Des analyses chimiques, des tests *in-vitro*, des examens des anomalies morphologiques et histologiques ainsi que des dosages des biomarqueurs biochimiques ont été réalisés chez des gobies, appartenant à l'espèce *Zosterisessor ophiocephalus*, collectés dans la lagune de Bizerte. Les résultats obtenus ont montré la pertinence de *Z. ophiocephalus* comme espèce bio-indicatrice.

Keywords: Bio-indicators, Fishes, Ecotoxicology, Lagoons, Tunisian Plateau

Introduction: L'environnement aquatique est affecté par différents types de polluants chimiques d'origine anthropique. Toutefois, la complexité des interactions rend les observations in situ plus difficiles à interpréter que les données issues d'expériences contrôlées en laboratoire. L'utilisation d'une approche multiparamétrique, à savoir le poisson gobiidé *Z. ophiocephalus*, est basé sur certaines de ses caractéristiques (mode de vie benthique sédentaire, abondance dans le milieu d'étude) qui lui confèrent un intérêt en écotoxicologie. L'objectif de cette étude est d'évaluer le potentiel de cette espèce comme bio-indicateur modèle pour la biosurveillance de l'environnement aquatique.de biomarqueurs permet de pallier à ce problème. Le choix du modèle biologique,

Matériel et méthodes : Des collectes mensuelles de gobies ont été effectuées d'août 2005 à juillet 2006. Cinq stations de la lagune de Bizerte ont été prospectées (NJ: Njila, MB: Menzel Bourguiba, MR: Maghrawa, MJ: Menzel Jemil et ML: Menzel Abderrahmen). Une station située au niveau de la communication entre la lagune de Ghar El Melh et la mer a été choisie comme station de référence, GH (Fig. 1), en raison de sa salubrité. Les prévalences des malformations vertébrales (Def%) et des altérations histologiques des testicules (Syn%) ont été notées. En outre, le rapport gonado-somatique (RGS), le facteur de condition (IC), le rapport hépato-somatique (RHS) et les biomarqueurs biochimiques, tels que l'activité EROD, la GST, la GSHtot, la teneur en TBARS, ont été déterminées. La présence de composés dioxine mimétiques dans les extraits organiques de sédiments a été évaluée au moyen de tests *in-vitro* et les facteurs d'équivalence toxique (BEQs) ont été estimés. L'ensemble des données obtenues ont été soumises à une analyse multivariée en composantes principales (ACP) afin d'apprécier les relations entre les réponses biologiques et les contaminants chimiques tels que les HAPs que nous avons, nous mêmes, dosés [1] et le DDT, les PCBs et les composés organométalliques CorM dont le dosage a été effectué par d'autres auteurs au cours d'une période très proche de celle de nos prospections [2], [3], [4].

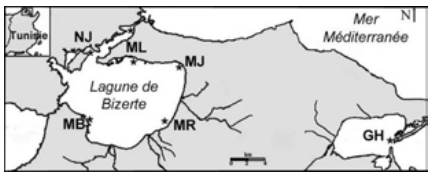

Fig. 1. Localisation des stations d'échantillonnage.

Résultats et discussion: La superposition des stations sur le plan factoriel (F1-F2) a permis une très bonne ségrégation. La composante F2 s'avère être la plus discriminante. Elle sépare, sur son côté négatif, les stations les plus impactées qui sont intimement liées à : (i) une induction des activités GST et GSH, (ii) une prévalence élevée des anomalies vertébrales (Def), (iii) de fortes valeurs des facteurs d'équivalence toxique (BEQs) et (iv) la contamination du sédiment par les PCBs, les HAPs et les CorM. Les stations sont disposées dans l'ordre croissant de perturbation, et ce, en allant de la partie positive à la partie négative de cette composante. Les gobies, provenant de la station (MB), paraissent les plus touchés par les rejets polluants permanents de la zone industrielle (industrie lourde) située à proximité de cette station. En revanche, les gobies capturés au niveau de la station de référence (GH) sont les moins affectés. Ces résultats confirment l'importance de l'utilisation d'une batterie de biomarqueurs pour apprécier l'état de perturbation d'un écosystème aquatique.

Conclusion: Ce travail a montré la pertinence de *Z. ophiocephalus* comme espèce bio-indicatrice et a affirmé l'intérêt de l'utilisation d'une approche multiparamétrique dans un programme de biosurveillance du milieu.

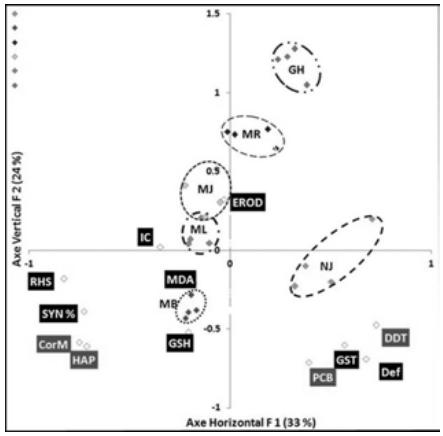

Fig. 2. Représentation graphique des différents échantillons de Z. ophiocephalus sur les deux premiers axes de l'ACP.

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DREDGING OF POLLUTED COASTAL SEDIMENTS: EVALUATION OF THE RISK OF INORGANIC CONTAMINANT REMOBILIZATION

D. H. Dang [1]*, J. Vouge [1], V. Lenoble [1], G. Durrieu [1], D. Francois [2], S. Mounier [1] and C. Garnier [1]
[1] Laboratoire PROTEE, Université de Toulon, BP20132 - dang@univ-tln.fr
[2] LASEM-Toulon, Base Navale de Toulon, BP 61, 83800 Toulon, France

Abstract
The low sedimentation rate and the high water residence time of Toulon bay (NW Mediterranean Sea) associated to numerous anthropogenic inputs have led to a high multi-contamination of its sediments. Lab experiments aiming at simulating resuspension events (e.g. dredging), affecting such sediments (suboxic and anoxic layers), were demonstrated to significantly remobilize inorganic pollutants toward seawater and therefore deteriorate the considered ecosystem.

Keywords: Sediments, Interfaces, Trace elements, North-Western Mediterranean

Introduction
Through the impact of numerous anthropogenic activities, coastal environments are highly contaminated, and mainly the sediments which are the final receptacle of particles. In order to preserve the hydrodynamics features and to maintain harbour and touristic activities, sediment dredging is a frequent practice. Previous studies have proven a high risk of contaminant remobilization from river sediments [1, 2]. Toulon bay (NW Mediterranean Sea), a semi-closed area with a low sedimentation rate (0.2 cm yr^{-1}), is presenting a high sedimentary contamination [3]. This study aims at apprehending the risk of dredging operation upon seawater quality through batch simulations on surface/suboxic and deep/anoxic polluted sediment. Furthermore, the obtained results will allow a better understanding of the processes controlling the contaminant remobilization, mainly governed by the change from anoxic marine sediments to oxic seawater.

Materials and methods
Core sediments, sampled in a site where dredging is intended, was sliced every 2 cm under inert atmosphere. Porewaters and solid fractions were recovered and characterized for their physical-chemical parameters, total concentration of major, minor, trace elements, as well as dissolved/particulate organic matter content and quality (UV and 3D fluorescence). Surface (0-2 cm) and deep (20-22 cm) sediments were stored under inert atmosphere until their mixing with seawater (sampled at the same site, filtered through 0.45 µm filter) at different solid/liquid ratios in Teflon bottles. The mixture was shaken head-over-head at 15 rpm, and exposed at least daily to ambient air to maintain the oxic conditions. Aliquots were collected at 10 contact times, ranging from 5 min to 2 weeks. Physical-chemical parameters (pH, Eh, O_2...) were recorded and different analyses were performed (major, minor, trace elements, dissolved organic/inorganic carbon and organic matter quality).

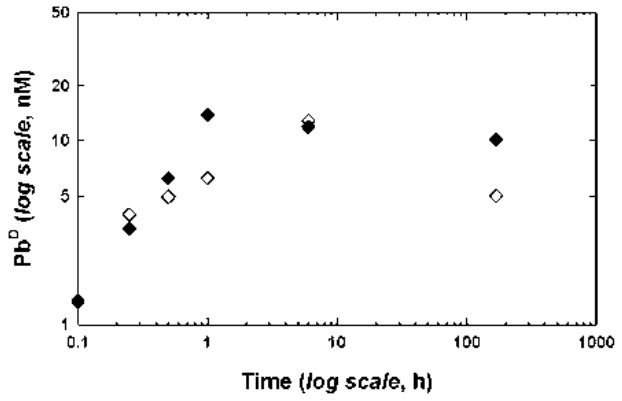

Fig. 1. Pb^D variation as a function of time in dredging simulation of surface sediments at solid/liquid of 0.1 and 1 g L^{-1} (*open and filled diamonds*, respectively).

Results and discussion
The sediments were highly contaminated in inorganic contaminants (0-10 cm: 11 $\mu g_{Hg}\ g^{-1}$, 270 $\mu g_{Cu}\ g^{-1}$, 220 $\mu g_{Pb}\ g^{-1}$, 370 $\mu g_{Zn}\ g^{-1}$...). The batch simulation results showed a continuous acidification of seawater (up to 1 unity of pH over 2 weeks of contact time) whose amplitude was mainly dependent on the solid/liquid ratio but less on the initial redox status of the sediment. A significant increase of active silicate was also demonstrated: signature of bacterial mineralization, while inorganic/organic carbon remained almost stable. Concerning trace elements, As was characterized by a rapid mobilization, right away followed by a readsorption. A similar, but even more pronounced, behaviour was demonstrated for Pb (Fig. 1) and Cd whereas Cu showed an inverse trend. For all cases, the trace element concentrations reached at the maximum of remobilization exceeded the toxicity levels for microorganisms (e.g. plankton). The changes of environmental conditions have then impacted the mobility of the studied contaminants and dredging operation could have a significant impact on the coastal ecosystem.

Conclusion
These labs experiments, simulating sediments resuspension events, demonstrated that such processes could significantly alter the seawater quality. The impacts on the ecosystem of such operations must be deeply surveyed and reconsidered in further Environment Impact Estimation reports.

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CADMIUM ACCUMULATION AND PROTEIN OVEREXPRESSION IN BIVALVES EXPOSED TO CADMIUM CONTAMINATED SEAWATER

Manos Dassenakis [1]*, Olga Chalkiadaki [1] and Nikos Lydakis-Simantiris [2]
[1] University of Athens - edasenak@chem.uoa.gr
[2] Technological Education Institution of Crete

Abstract
Three bivalve species, (*Mytilus galloprovincialis*, *Callista chione* and *Venus verrucosa)* were exposed to Cd concentrations (0.5 - 20 ppm) for 20 days. The tolerance to Cd pollution, the Cd accumulation and the protein over-expression in gills, mantle and the remaining body were measured after 5, 10, 15 and 20 days of exposure and a depuration period of 10 days. The effects of Cd accumulation on the levels of biologically related metals were also examined. The studied species showed different behavior for both Cd accumulation/distribution and protein overexpression in the examined tissues.

Keywords: Cadmium, Bio-accumulation, Bio-indicators, Aegean Sea

It is known that various bivalves accumulate heavy metals from seawater *Mytilus galloprovincialis*, *Callicta chione* and *Venus verrucosa* are common species and seafood in the Mediterranean area. Many studies have been published regarding the behavior of *Mytilus galloprovincialis* in heavy metal polluted environments, whereas only a few studies exist in the literature for the effects of heavy metals on *Callicta chione and Venus verrucosa*. This study aims to cover this gap. To compare these three species and to examine the potential use of these organisms as Cd pollution bioindicators. A significant number of animals of all three species were adapted to laboratory conditions and then exposed to 0.5, 1.0, 2.5 and 20 ppm Cd for 20 days, followed by a 10 days depuration period in fresh seawater. Gills, mantle, and the remaining body were separated from animals collected every 5 days of exposure. The concentration of Cd in all tissue samples was measured by AAS [1], and of metallothionein as described in [2]. Differences regarding the tolerance of the three bivalves to Cd were observed. The survival of *Venus verrucosa* was 15 days at the highest exposure level, while *Callista chione* 10 and *Mytilus galloprovincialis* 5 days. Cd accumulation and distribution in the three tissues was species-dependent and tissue-dependent, (gills appeared to have the highest concentrations of Cd, but the accumulation and the distribution levels varied greatly between the same kind of tissue of different species). Indicatively, Figure 1 presents data on Cd accumulation in *M. galloprovincialis* (a) and *C. chione* (b) gills, where the above mentioned differences are apparent. Depuration of Cd from various tissues of the three organisms occurs slowly and it is species-dependent, since considerable amounts of Cd are still present in the tissues after the depuration period, but different in each bivalve.

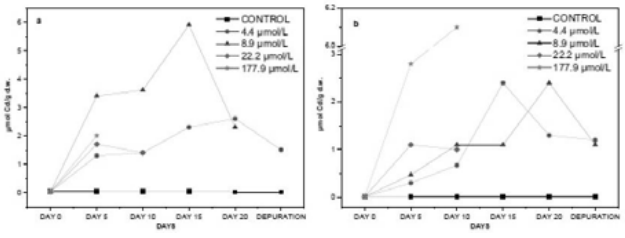

Fig. 1. Cd accumulation in gills of *M. galloprovincialis* (a) and *C. chione* (b) exposed to various contamination levels.

Statistically significant correlations (negative for most of the conditions and tissues under examination), were found between the accumulated Cd and thelevels of the biologically important metals Zn and Fe (especially for M.galloprovincialis). The levels of Cd, Zn and Fe in the tissues of bivalves unexposed to any Cd pollution, were also completely different. A statistically significant positive trend of Cd accumulation in the three tissues of the animals was observed over the exposure period. Significant similarities and differences between the three bivalves in the metallothionein induction and expression were observed. Our research indicate that there are strong interspecies differences in Cd accumulation, elimination and protein overexpression.

Acknowledgements : This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

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ANTHROPOGENIC EFFECTS ON DIGESTIVE GLAND OF *PINNA NOBILIS* USING OXIDATIVE STRESS BIOMARKERS

Antoni Sureda [1], Antonino Natalotto [2] and Salud Deudero [3]*
[1] Grup de Nutrició Comunitària i Estrès Oxidatiu (IUNICS), Departament de Biologia Fonamental i Ciències de la Salut, Universitat de les Illes Balears, 07122 Palma de Mallorca, Spain and CIBER: CB12/03/30038, CIBERobn, Instituto de Salud Carlos III, Sp
[2] Department Animal Biology and Marine Ecology, University of Messina, Viale Stagno D'Alcontres 31, 98166 Messina, Italy
[3] Centro Oceanografico de Baleares Instituto Español de Oceanografia - salud.deudero@ba.ieo.es

Abstract
The fan mussel *Pinna nobilis* L. is the largest endemic bivalve in the Mediterranean Sea under strict protection. The aim was to determine the effects of anthropogenic activity on antioxidant and oxidative stress biomarkers in digestive gland of *P. nobilis*. Antioxidant enzyme activities and protein oxidation were significantly increased in mussels sampled in the impacted area. The anthropogenic activities induced a situation of oxidative stress in *P. nobilis*, resulting in an antioxidant response and in an increased protein oxidation.

Keywords: Ecotoxicology, Bio-accumulation, Bio-indicators, Endemism, Balearic Islands

Aquatic organisms are exposed to anthropogenic contaminants that may strongly affect their performance and survival. The exposure of bivalves to pollutants results in oxidative stress throughout the formation of reactive oxygen species (ROS), which can produce deleterious effects on biomolecules and cell damage [1]. The measurement of the antioxidant response and/or the presence of oxidative damage are potential biomarkers to evidence the effects associated to contaminants and also to eutrophication in marine organisms. The fan mussel *Pinna nobilis* L. is the largest endemic bivalve in the Mediterranean Sea under strict protection. The population of *P. nobilis* has been greatly reduced during the last decades as a result of recreational and commercial fishing for food, the use of its shell for decorative purposes, and incidental killing by trawling and anchoring. Moreover, in a previous study we reported that the presence of *Lophocladia lallemandii* colonising *P. nobilis* induces a biological stress and oxidative damage to the fan mussel [2]. Nowadays, *P. nobilis* is under strict protection and all forms of deliberate capture or killing them are prohibited (Council directive 92/43/EEC). The aim of the present work was to determine the antioxidant enzyme response and markers of oxidative damage in digestive gland of *P. nobilis* growing under anthropogenic pressure. *P. nobilis* (20 individuals) were collected from two locations along Mallorca waters during May-June 2011 attending to different degree of human impact. The first station was located in a marine protected area off Cabrera Archipelago National Park (Western Mediterranean), located 9 km southeast of Mallorca Island and was considered as a clean non-polluted area. The second set of stations because of the low *P. nobilis* densities, the difficulties to find large specimens and in order to minimize the impact in their populations were collected in two sites (Magalluf and Port d'Andratx) with similar characteristics and individuals were considered as human impacted. Digestive glands from each specimen were immediately dissected out on board and frozen with liquid nitrogen. Enzymatic activities of catalase, glutathione peroxidase and glutathione reductase were significantly increased in the impacted area ($p<0.05$), whereas no differences were reported in superoxide dismutase activity (Figure 1). Catalase protein levels determined by western blot were significantly higher in the exposed group ($p<0.05$). Malondialdehyde as marker of lipid peroxidation reported no significant differences, whereas a significant increase in protein oxidation was evidenced in the impacted area ($p<0.05$). In conclusion, the anthropogenic activities induce an oxidative stress situation in digestive gland of *P. nobilis* evidenced by an increased antioxidant enzyme activities and protein oxidation.

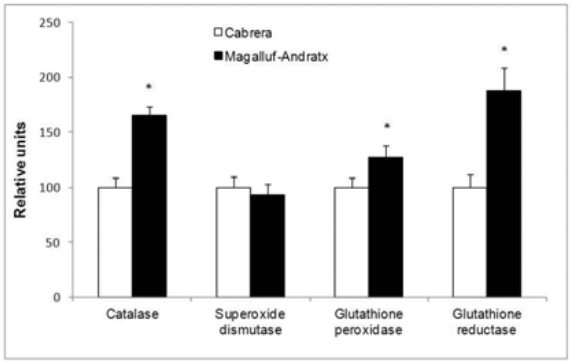

Fig. 1. Antioxidant enzyme activities in digestive gland of *Pinna nobilis* from a clean area (Cabrera) and a polluted area (Magalluf-Andratx). (*) Significant differences analysed with one-way ANOVA. $P<0.05$ was considered statistically significant. Values are expressed as mean ± S.E.M.

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PHYSICOCHEMICAL AND ECOTOXICOLOGICAL EVALUATION OF THE ROVINJ COSTAL AREA SEDIMENTS, NORTHERN ADRIATIC, CROATIA

E. Durmiši [1]*, D. Vujaklija [2], A. Bielen [3], R. Duran [4] and B. Hamer [2]
[1] Juraj Dobrila University of Pula - edurmisi@unipu.hr
[2] Ruder Boškovic Institute, Croatia
[3] Faculty of food and biotechnology, Croatia
[4] Pau University, France

Abstract
The aim of the study was to characterize marine sediments for following studies of microbial biodiversity, gene mining and bioprospecting. Further, data on the sediment quality in the Eastern Adriatic regarding heavy metals, PAHs and PCBs concentrations are urgently needed, because the environmental authorities have to define limits for contaminants in sediments for different use of marine resources. We collected sediment at 5 locations in Rovinj costal area according human activities. Sediment chemical analyses and leachates toxicity sort our sites S5 and S4 as pristine areas, and ranked sites regarding degrees of contamination (S5<S4<S3<S2<S1) and decreasing phytotoxic effects (S5›S4›S1›S2›S3).

Keywords: Sediments, Chemical analysis, Ecotoxicology, North Adriatic Sea

Mediterranean coastal sediments are particularly contaminated with metals and organic compounds such as organotins, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyl (PCB) congeners [1]. Croatia doesn't have defined limits of contaminants in sediments for different use of marine resources: e.g. bays, beaches, villages, ports, marina service areas and others [2]. The French regulatory management of contaminated sediments is based on two levels (N1 and N2) of contaminant concentrations in the whole sediment (Table 1) [1].
We collected sediment at 5 locations in Rovinj costal area taking into account degrees of pollution and applied French regulations. Open sea site (S5) was used as a reference point, while other locations are under different influence as industrial and urban runoff waste: local harbour (S1), Marina (S2), traffic; Lim out (S3), and mariculture; Lim middle (S4) (Figure 1).

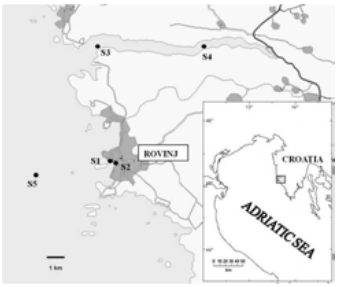

Fig. 1. Location of the sampling sites in the Rovinj costal area

PAH analyses: The PAHs were identified and quantified using HPLC system HP 1050 by a modification of the method previously described [3].
PCB analyses: The procedure used for PCB analyses was under standard protocols [3].
Heavy metals analyses: Heavy metals were quantified using atomic-adsorption spectrometer Perkin Elmer 200 analyst 600 [3].
Genotoxicity: The genotoxic effect of sediment was estimated by umu-test according to standard ISO procedure with slight modification [1]. Serial dilutions (7) of leachates were used in triplicates, with maximal sediment equivalent dose 33.33 g/L [4].
Phytotoxicity test: Germination test was conducted at 25ºC over 72 h test period using seeds of Flax (*Linum usitatissimum*) [1].
Results
Physico-chemical data in whole sediments and reference levels (N1 and N2) are displayed in Table 1. Several pollutants are present at higher concentrations than N1 level (Cu, Ni and PAHs) and few have values close to N1 (As, Pb and PCBs). Chemical pollution decreases according QN1, sum of ratios between contaminant concentration and legal N1 level in investigated sediments as follows: S1>S2>S3>S4>S5. Phytotoxicity assay using Flax seeds showed inhibition of germination, root length reduction and root biomass production with 5 ml of leachates samples ranged sediments by decreasing effect: S5›S4›S1›S2›S3 (Table 1).

Tab. 1. Physicochemical and ecotoxicological evaluation of marine sediments.

Parameters	Units	Locations					N1	N2
		S1	S2	S3	S4	S5	Legal level	Legal level
Fine particle (< 63 µm)	%	19,6	45,1	94,3	95,0	16,3	-	-
As	mg kg^{-1} d.m.	9,223	23,440	8,126	13,850	3,985	25	50
Cd	mg kg^{-1} d.m.	0,265	0,092	0,083	0,091	0,073	1,2	2,4
Cu	mg kg^{-1} d.m.	69,95	30,59	13,77	18,45	4,77	45	90
Ni	mg kg^{-1} d.m.	7,93	14,15	28,59	41,16	8,49	37	74
Pb	mg kg^{-1} d.m.	24,38	6,95	1,83	1,35	3,69	100	200
Zn	mg kg^{-1} d.m.	115,60	50,66	71,75	88,00	31,87	276	552
PAHs	mg kg^{-1} d.m.	10,609	9,867	4,555	0,028	0,103	1,50	15
PCBs	mg kg^{-1} d.m.	0,278	0,170	0,058	0,021	<0,010	0,50	1
QN1	-	**8,63**	**6,58**	**3,04**	**1,11**	**0,00**	-	-
Genotoxicity (Umu-test)	Emg5 - IR	**<1.5**	**<1.5**	**<1.5**	**<1.5**	**<1.5**	-	-
Phytotoxicity (G-test)	GI(%)	**65,1**	**62,7**	**56,5**	**84,2**	**100,0**	-	-

QN1 = Σ (sum) ratios between contaminant concentration / legal level(N1)
Values close to level N1
Values higher than level N1
Emg5 - IR = induction rations of Equivalent mg of Sediment (IR>1.5 mean positive result)
GI(%) = Germination index (sum of seed germination inhibition, root lenght and biomas production)
Site No. 5 presents control pristine marine sediment of Rovinj costal area

For genotoxicity determination serial dilutions of leachates were used, with maximal sediment equivalent dose 33.33 g/L. The results of umu-test without metabolic activation of analyzed samples were all negative (IR < 1.5), i.e. leachates (metal contamination) did not resulted with genotoxic activity/effects on used test bacteria (Table 1).

Conclusions
In general sediment chemical analyses and leachates toxicity results sort sites S5 and S4 as pristine areas, and ranked sites regarding degrees of contamination (S5<S4<S3<S2<S1) and decreasing phytotoxic effects (S5›S4›S1›S2›S3). According French marine sediment quality guidelines, sediments from Rovinj area even the "hot spot" as local harbour doesn't contain contaminants higher than N2 threshold, what's mean there is no potential ecological impacts on the aquatic environment.

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PERMETHRIN EFFECTS ON THE ACETYLCHOLINESTERASE ACTIVITY IN THE BRAIN AND MUSCLE OF THE TICK-LIPPED MULLET *CHELON LABROSUS*.

W. Masmoudi [1], M. Ben Aoun [2], R. Besbes [3], M. Romdhane [4] and M. El Cafsi [5]*
[1] Institut Supérieur de la Pêche et de l'Aquaculture de Bizerte, Rimel, BP 15, Bizerte 7080, Tunisie
[2] Faculté des Sciences de Bizerte, Zarzouna 7080, Tunisie
[3] Institut National des Sciences et Technologies de la Mer, Route de Kniss, Monastir, Tunisie
[4] UR Ecosystèmes et Ressources Aquatiques, Institut National Agronomique de Tunisie, 43 av. Charles Nicolle, 1082 Tunis, Tunisie
[5] UR Physiologie et d'Ecophysiologie des Organismes Aquatiques, Département des Sciences Biologiques, Faculté des Sciences de Tunis, Campus universitaire, 2092 Tunis, Tunisie - mhamed.elcafsi@gmail.com

Abstract
In the present work we have highlighted the neurotoxicity of the permethrin, a pyrethroid insecticide by measuring the acetylcholinestrase activity in the brain and muscle of the thick- lipped mullet *Chelon labrosus*. In vivo permethrin's exposure (5µg/l and 10µg/l) after 24 h, 7 days and 30 days revealed a maximal decrease of the acetylcholinesterase activity in both brain and muscle after a week of exposure.

Keywords: Pesticides, Monitoring, Mediterranean Ridge

In Tunisia, mullet species as *Chelon labrosus* (thick-lipped mullet) are very exploited in inland aquaculture. Specimens coming from hatcheries are growing in lake dams freshwater. These ecosystems are submitted to the impact of anthropogenic activities. In fact, pesticides are very used by farmers around the lake dams. These synthetic compounds could have negative effects on the physiological performances of the reared fish species. For this fact, we will point out the effect of the permethrin a very used pyrethroid insecticide on the acetylcholinesterase activity in the brain and muscle of the mullet. The acetylcholinesterase is an enzyme responsible to the nervous transmission in the fish.

Juveniles of the thick-lipped mullet (10-12 cm) obtained from a fish hatchery and acclimated in freshwater were transferred in aquariums and exposed to 5 and 10 µg/l of permethrin for a maximal period of a month. Sacrifices were carried out after 24h, 7 days and 30 days. After each sampling, fish were dissected; the brain and a fragment of muscle were removed and kept frozen in liquid nitrogen until the acetylcholinesterase analyses. The activity of acetylcholinesterase expressed as nmoles/min/mg proteins was determined according to the Ellman et al. [1]

Basal levels of the acetylcholinesterase activity in the brain and muscle of the mullet were 165 and 306 nmoles/min/mg proteins respectively. According to the literature no data are yet available about the acetylcholinesterase activity in the brain of Chelon labrosus species. However, the level of brain acetylcholinesterase activity in the wild mullet species, *Mugil cephalus* was about 126 nmoles/min/mg proteins [2]. The permethrin was observed to cause dose dependant decrease of the acetylcholiesterase activity in both brain and muscle of the mullet. The Results shown in figure 1 and 2 indicated that the permethrin treatment at 5 and 10 µg/l caused an inhibition of the AChE activity in both brain and muscle of the mullet compared with control fish reared in clean water. In fact, after 24 h of exposure, a significant decrease of the enzyme activity by 42 - 69 % in brain and 51 - 48 % in muscle was observed for the both doses: 95 and 150 nmoles/min/mg proteins at 5 µg/l and 50 and 158 at 10 µg/l respectively. According to the USEPA a significant inhibition of the acetylcholinesterase by 20 % is caused by a neurotoxic effect [3]. This decrease was more accented after 7 days; in fact the inhibition rate reaches 83 % in the brain enzymatic activity (26 nmoles/min/mg proteins) at a dose of 10µg/l. In the other hand, we have registered an enhancement in the AChE activity in both brain and muscle after a month of permethrin exposure: 111 and 187 nmoles/min/mg proteins respectively. It seems that the toxic effect of the permethrin in the mullet species is maximal after a week of exposure. Our results highlighted the neurotoxicity of the permethrin in the mullet species. This disruption could have an impact in the physiological performances of this species exploited in aquaculture.

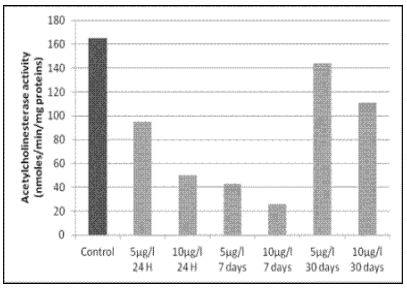

Fig. 1. Dose and time exposure effects of the permethrin on the acetylcholinesterase activity in the brain of the thick-lipped mullet

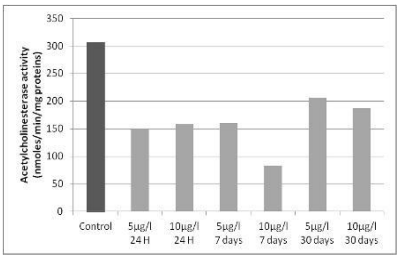

Fig. 2. Dose and time exposure effects of the permethrin on the acetylcholinesterase activity in the muscle of the thick-lipped mullet

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THE USE OF PROTISTS AS BIOLOGICAL MODEL IN ECOTOXICOLOGY: FROM LABORATORY TO ENVIRONMENTAL POLLUTION ASSESSMENT IN A CLIMATE CHANGE PERSPECTIVE

A. Gomiero [1]*, A. Dagnino [2], S. Sforzini [2], G. Fabi [1] and A. Viarengo [2]
[1] CNR - Institute of Marine Sciences - alessio.gomiero@an.ismar.cnr.it
[2] Dep. of Science and Tecnological Innovation - University of Piemonte Orientale

Abstract
Despite of an increasing number of surveys describing adverse effects in marine organisms, few previous studies have addressed protists. In this study the free-crawling marine ciliate *Euplotes crassus* was first validated as novel biological model and then utilized both as test organism for the screening of sediment toxicity using sediments from both coastal and estuarine areas and to study the changes of temperature-related pollutant toxicity in a thermal based toxicological study with oxytetracycline and copper. Further investigations were carried on evaluating the biological and ecological effects of ocean acidification on protozoa by exposing the organism to artificial seawater pH increments in an open flow system.

Keywords: Ecotoxicology, Sediments, Zoobenthos, Thermal pollution, North-Central Mediterranean

In recent decades, the levels of contaminants in the marine environment have increased as a consequence of anthropogenic activities, leading to serious ecological and human health problems. In aquatic systems, partition and bioavailability of these chemicals strongly depend on biological processes, redox potential, ionic strength, pH, activities of organic and inorganic chelators and scavenging processes [1]. Studies on the interactions between ciliates and environmental pollutants are scarce compared with other microorganisms despite the fact that ciliates are easy to culture and considered to be reliable biological models and hence good candidates for use in bioassays [2]. As single cells, directly exposed to the external environment, protozoa may be more sensitive to environmental alterations than the cells of higher organisms that are part of differentiated and complex biological structures. Hence, the potential of protists as both biological model and a predictive tool for hazard and risk assessment in the water and sediments quality criteria as well as in the evaluation of biological effects of climate change and ocean acidification has been evaluated. *E. crassus* were isolated from samples collected in the Tyrrhenian Sea (Italy). Ciliated protozoa were grown in ISO standardized artificial seawater (34 ‰, pH= 8.0) [3] and kept at 24±1°C under oxygen saturation. Organisms were fed with *D. salina*, kept in dark conditions and analyzed during their logarithmic growth phase. Toxicity tests were performed under strictly controlled laboratory conditions; afterwards the organism was validated as bioassay by both a pilot biomonitoring study in the Venice Lagoon and several toxicological studies combining thermal, pollutants and pH changes treatments. Two endpoints of high ecological value, mortality (Mry) and replication rate (RpR), were set up and evaluated in combination with two sublethal biomarkers of stress, endocytotic rate (Ecy) and lysosomal membrane stability (NRRT, [4] Gomiero *et al.*, 2012). The sensitivity of *E. crassus* bioassay has been evaluated by exposing the organisms to lethal and sub lethal concentrations of widely occurring inorganic pollutants, such as essential (Cu^{2+}) and non-essential (Hg^{2+}) heavy metals, as well as to the organic pollutant toxicant model benzo[a]pyrene (BaP) and mixtures of them. The results of validation test showed a significant direct dose/response relationship for all investigated stress index underlying that such pollutants can severely alter physiological and ecological processes of the protozoa such as reduction in food uptake and inhibition of growth, hence influencing survival and replication rate [5,6,7]. Several mechanisms have been proposed to explain metal-induced cellular toxicity. One of the most accepted is the tendency of free metals ions to participate, by Fenton reaction, in the ROS formation. With regard to cellular targets for metals toxicity, lysosomes might be the main sources of ROS generation [8]. Furthermore a pilot biomonitoring program was developed in the Venice Lagoon by collecting sediments from four sites according to their different pollutant's abundance and distribution. The results of the biomonitoring program showed a significant inhibition of RpR, Ecy and NRRT, paralleled by a small and slightly increased Mry of exposed specimen. Interestingly, these outcomes demonstrated that only a combination of mortality and sublethal biomarkers was able to characterize an exposure-related stress syndrome [9]. This research was also oriented towards the study of climate changes effects on environmental pollutants toxicity thus the single cell biological model was also exposed to sub lethal levels of single compounds and binary mixtures of Cu and the oxytetracycline (OTC), an antibiotic commonly used in aquaculture, under five increasing temperatures from 25 up to 31 °C. The outcomes of temperature-related toxicity test showed that the selected toxicants presented opposite behaviors as both protozoa's Mry, RpR, Ecy and NRRT rates increased following increasing thermal gradient in OTC related treatments. On the contrary a decline of tolerance to Cu related treatments were observed in targeted organisms. Furthermore, results of tests combining binary mixtures of toxicants showed a complex pattern of responses. According to the results of a recent ocean acidification model developed under EU-EPOCA project [7,8], the effects of acidification on marine organisms were studied under two combinations of temperature and pH (28,0°C, $7{,}8_{pH}$; 32°C, $7{,}5_{pH}$) simulating changes of seawater chemical and physical conditions expected within 50-100 years from now on in the Tyrrhenian Sea. The preliminary outcomes will be reported. Overall, biological responses indicate a high potential for using protozoa both as biological model and as bioassays to assess environmental risk in marine coastal systems.

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IMPACT DU STRESS ENVIRONNEMENTAL SUR LA BIODIVERSITÉ DES ANNELIDES POLYCHÈTES DU LITTORAL EST D'ALGÉRIE

Zoubeida Meghlaoui [1]*, Tarek Daas [1], Ouided Maamcha [1] and Patrick Scaps [2]
[1] Université Badji Mokhtar Annaba, Algérie - zoubeida.meghlaoui@hotmail.fr
[2] Université Lille 1- France

Abstract
The polychaetes occupy a prominent place in the food chain. They are used as bioindicators of pollution of the marine environment. This work was carried out in order to assess the variations in activity of glutathione-S-transferase (GST) as an enzyme involved in the detoxification process and compare the diversity of polychaetes species between different study sites. The establishment of an inventory of Polychaeta allowed the identification of several annelid species. The estimated GST activity shows a low activity level at ElKala site and induction at the site of Skikda.

Keywords: Biodiversity, Annelida, Polychaeta, Pollution, Algerian Sea

Introduction
Les annélides polychètes sont les taxons les plus abondants en termes de biodiversité [1], et l'un des groupes de macroinvertébrés les plus utilisés dans les études à caractère écotoxicologique [2]. L'annélide polychète *Perinereis cultrifera* (Grube, 1840) appartenant à la famille des Nereididae. Elle est considérée comme une espèce sentinelle de la pollution. Notre travail a permis l'identification de plusieurs espèces d'annélides polychètes et d'un dosage de l'activité de la GST au niveau de 3 sites : El-Kala, Annaba et Skikda.

Matériels et Méthodes
La récolte a été effectuée du mois de février au mois de juillet de l'année en cours. L'identification des espèces a été réalisée selon la classification taxonomique de Fauvel [3]. La mesure de l'activité GST a été réalisé selon la méthode de HABIG et al.[4].qui consiste à homogénéiser à 4°C dans du tampon phosphate 0,1 M, pH 6. Les homogénats ainsi obtenus ont été centrifugés pendant 30 mn à 15 000 trs/mn.et le surnageant a servi comme source d'enzyme.

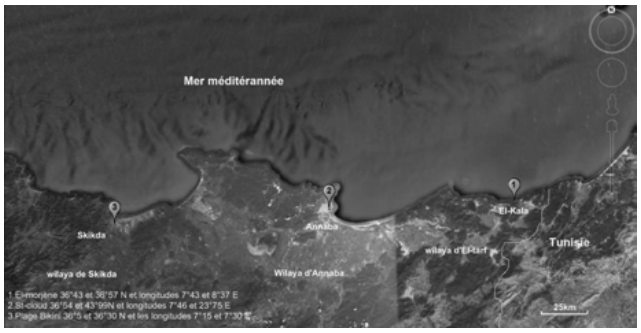

Fig. 1. Sites d'étude du littoral algérien

Résultats et Discussion
Nos résultats montrent une diversité au niveau des sites d'étude : *Nereis falsa, Platyneries dumerillii, Perineries marionii, Lepidonotus clava, Nereis diversicolor*, au niveau des différents sites d'étude.Le graphe montre une augmentation dans le site de Skikda et Annaba qui est dû à la présence du complexe pétrochimique et des activités industrielles.Il a été démontré que l'activité de la GST du néréidien *Laeonereis acuta* peut être induite suite à une exposition à des métaux lourds) [5] et [6] ou à un bloom de cyanobactéries [7].

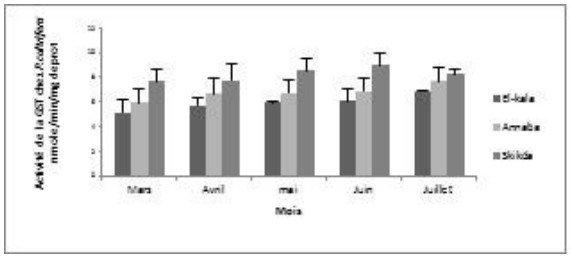

Fig. 2. Variations mensuelles de l'activité de la GST (nm/min/mg de protéines; m ± s; n =4) chez les individus de *P. cultrifera* récoltés au niveau des trois sites d'étude

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MULTIXENOBIOTIC RESISTANCE SYSTEM AND OXIDATIVE STRESS RESPONSES IN RAGWORMS EXPOSED TO FIELD PAH/METALLIC CONTAMINATION IN THE BERRE LAGOON (FRANCE).

X. Moreau [1]*, L. De Jong [1], J. Issartel [1], O. Radakovitch [2], S. Rigaud [2], J. Garnier [2] and L. Malleret [3]
[1] Institut Méditeranéen de Bidiversité & d'Ecologie, Aix-Marseille University (France) - xavier.moreau@imbe.fr
[2] Centre de Recherche et d'Enseignement de Géosciences de l'Environnement, Aix-Marseille Université (France)
[3] Laboratoire Chimie de l'Environnement, Aix-Marseille University (France)

Abstract
This study was aimed at determining the levels of defense (antioxidative enzyme activities and MXR protein density) and damage (lipid peroxidation) biomarkers in *Hediste succinea*, living in polluted areas of the Berre lagoon. All oxidative balance endpoints and the MXR membrane density were increased in a PAH predominantly polluted area. In a metallic predominantly contaminated site, where significant PAH levels were also found, only membrane MXR density was increased. The increase of lipid peroxidation suggests that these organisms are submitted to pro-oxidative living conditions. These damages can result from reactive oxygen species produced during PAH biotransformation. The MXR protein induction is explained by their role in PAH cell expulsion. These biomarkers enlighten the survival of *H. succinea* in Berre lagoon.

Keywords: Polychaeta, Pollution, Pah, Metals, Gulf of Lyon

In the « BERTOX » program (INSU/EC2CO/AP–AO 2011), which aimed at improving the knowledge in the relationships between pollutants, biogeochemical dynamics of sediments and their impacts on the macro- and micro-fauna, we have determined the levels of some "defense" and "damage (lipid peroxidation) " biomarkers in *Hediste succinea*, living in polluted areas of the Berre lagoon. Some of our questions were: do the contaminants limit the diversity of the macrofauna living in the lagoon? What are the biological mechanisms allowing the species present today to survive in this ecosystem? For this purpose, endpoints of the oxidative balance (enzymatic activities of the superoxide dismutase- SOD, of catalase- CAT, glutathione peroxidase- GPx and lipid peroxidation- Tbars) and the membrane density of MultiXenobiotic Resistance (MXR) proteins, proteins belonging to the first line of cellular defense, were studied. We have collected the specimens of *H. succinea* in the sediments from an area especially contaminated with polycyclic hydrocarbons (PAH) located in the north of the Vaïne part of the lagoon (Vn), from a central area of the Vaïne part of the lagoon (Vc) where trace metallic elements are predominant and from a presumably non polluted one (B9). Results show that all endpoints of the oxidative balance as well as the membrane density of MXR were increased in the PAH predominantly polluted area, as compared with organism collected in B9 site. In the metallic predominantly contaminated site, Vc, where significant PAH levels were also found, only the membrane density of MXR was increased as compared with the one of specimens from B9 site. The increased values of lipid peroxidation in *H. succinea* collected in the PAH contaminated area suggest that these organisms are submitted to pro-oxidative living conditions that can cause membrane degradation. These damage can result from an over production of Reactive Oxygen Species (ROS) by cytochrome P_{450}, an enzymatic complex involved in PAH biotransformation. However, the organisms are able to survive in these polluted sites probably by inducing the synthesis of membrane MXR proteins that are involved in the expulsion of PAH compounds (as we have previously shown in other aquatic invertebrates – Saez et al., 2008). In addition to this induction of MXR proteins, the increase in the enzymatic activities reflects the ability of the organisms to detoxify hazardous ROS and thus maintain their homeostasis to evolve in this contaminated environment. It can be hypothesised from these results that *H. succinea* not only possess but also are able to induce the biological mechanisms which allow a resistance to the pollution (essentially HAP pollution), mechanisms that were probably not induced in other organisms living by the past in the Berre lagoon and that have disappeared from the ecosystem.

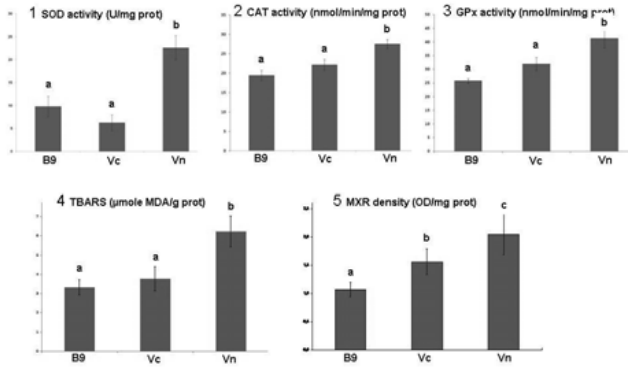

Fig. 1. Enzymatic activities of SOD (1), CAT (2), GPx (3) and lipid peroxidation (Tbars) (4) and MXR membrane density (5) measured in *Hediste succinea* collected in an unpolluted area (B9), in a PAH and metallic (MTE > PAH) polluted area (Vc) and in a PAH polluted area (Vn) of the Berre lagoon (France). Two different letters mean a significant difference between groups (ANOVA, Tukey test, $p < 0.05$).

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SUNSCREEN PRODUCTS AS EMERGING POLLUTANTS TO COASTAL WATERS

D. Sánchez Quiles [1]*, A. Tovar Sánchez [1], A. Massanet [1], M. Makhani-Farahani [1], G. Basterretxea [1], J. L. Benedé [2], A. Chisvert [2], A. Salvador [2], I. Moreno [3] and J. Blasco [3]

[1] Mediterranean Institute for Advanced Studies, IMEDEA (UIB-CSIC), Balearic Islands, Spain - dsanchez@imedea.uib-csic.es

[2] Department of Analytical Chemistry, Facultad de Química, Universitat de València

[3] ICMAN-Instituto de Ciencias Marinas de Andalucía (CSIC)

Abstract

The purpose of this study was to evaluate the role of sunscreen as source of chemicals to the coastal marine system. Concentrations of UV filters included in the formulation of sunscreens, such as benzophehone-3 (BZ-3), 4-methylbenzylidene camphor (4-MBC), TiO_2 and ZnO, are detected in nearshore waters. Concentrations varied along the day and were highest in the surface microlayer. We experimentally demonstrate growth rate of populations of the marine diatom *Chaetoceros gracilis* declines in response to sunscreen products. Dissolution of sunscreens in seawater also releases inorganic nutrients (N, P and Si forms) that can fuel algal growth. Our results show that sunscreen products are a significant source of organic and inorganic chemicals that reach the sea with potential ecological consequences on the coastal marine ecosystem.

Keywords: Trace elements, Coastal systems, Balearic Islands

1. Introduction

A growing awareness of the risks associated with skin exposure to ultraviolet (UV) radiation over the past decades has led to increased use of sunscreen cosmetic products leading the introduction of new chemical compounds in the marine environment. Despite of coastal tourism and recreation are the largest and most rapidly growing activities in the world, the evaluation of sunscreen as source of chemicals to the coastal marine system has not been addressed.

In this study we estimate the potential effect of commercial sunscreen released in nearshore waters by beachgoers. We conduct field and laboratories studies to evaluate the presence of chemicals products released from sunscreens in coastal seawater and its effect on the marine phytoplankton. Particularly, (1) we present the results for UV chemical filters levels in different fractions of surface marine waters of three Majorca areas; (2) we evaluate the contribution of sunscreen products to the total dissolved P in nearshore waters of a populated beach in Majorca island; and (3) we test the effect of sunscreens on the growth rate of a marine diatom (i.e. *Chaetoceros gracilis*).

2. Results

Chemical analysis of the surface nearshore waters of three areas around Majorca Island showed that four of the main chemicals used in commercial sunscreens were detected in the surface waters, with the highest concentrations measured in the unfiltered fraction of the surface microlayer (SML) (i.e. BZ-3: 580 ± 50 ng L^{-1}; 4-MBC: 113 ± 7 ng L^{-1}; and TiO_2: 38 ± 7 µg L^{-1}; ZnO: 10.8 µg L^{-1}). Levels of these chemicals co-varied throughout the day reaching the highest concentrations between 14:00 and 18:00 h (Figure 1), suggesting a common source for these products.

Our results also show the release of some inorganic nutrients from sunscreens (i.e. PO_4^{3-}, NO_3^-, and NH_4^+). A total of 13 commercial sunscreens tested provided final concentrations in water of 2 ± 5 µmol g^{-1} of PO_4^{3-}, 0.2 ± 0.4 µmol g^{-1} of NO_3^-, 0.001 ± 0.002 µmol g^{-1} of NO_2^-, 2 ± 2 µmol g^{-1} of SiO_2 and 0.02 ± 0.01 µmol g^{-1} of NH_4^+. It is particularly notable that on the average the release of PO_4^{3-} occurs in relatively high molar ratios compared to nitrogen forms.

We tested the effect of sunscreens on the growth rate of the marine phytoplankton *Chaetoceros gracilis*. The acute toxicity was measured by calculating half maximal effective concentration (EC_{50}) after 72h incubation in presence of different amounts of sunscreen, resulting in an average of 125 ± 71 mg L^{-1}. Our results demonstrate the toxicity of the commercial sunscreen for marine phytoplankton, and confirm previous studies of toxicity carried out with individual organic and inorganic UV filters on marine organisms [1, 2].

The present work includes a culture study "in vitro" of the marine angiosperm *Posidonia oceanica* in presence of growing amounts of sunscreen. Our preliminary results confirm that *P. oceanica* absorbs components derived from sunscreens in its tissues, such is TiO_2, which effects remains to be explored.

3. Conclusions

More than half of today's world population live in coastal areas, and estimates for the future suggest that in three decades from now nearly 75 percent of the world's population will live along coasts. This fact, combined with data showing that sun protection products are one of the fastest growing products globally, points to sunscreens as a potential pollutant with implications for the coastal marine ecosystem. The results presented here suggest that sunscreens in coastal waters may produce deleterious effects in the coastal ecosystem, either, by inhibiting growth of some marine phytoplankton species or by adding essential micronutrients which may stimulate the growth of others.

Acknowledgements

This work was funded by the ISUMAR project (CTM2011-22645) of the Spanish Ministry of Economy and Competitiveness. We thank A. Massanet and M.J. Alonso for technical assistance. We thank Joaquin Marcos for helping us with the TOC/Abstract graphic image. We thank Ajuntament de Calvià for the field support.

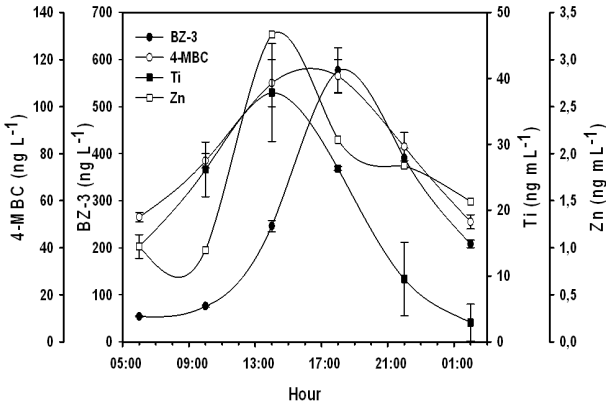

Fig. 1. Concentration of BZ-3, 4-MBC, Zn and Ti in the unfiltered (Total) fraction of the surface microlayer (SML) samples from Palmira Beach. Error bars represent the standard deviation (n=3).

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Session

Oxygen depletion

Modérateur : **Nadira Aït Ameur**

NUTRIENTS, OXYGEN AND CO_2 FLUXES IN COASTAL ALGERIAN WATER (ALGIERS AND BOU-ISMAIL BAYS).

N. Aït Ameur [1]*, F. Louanchi [1], M. Boulahdid [1], M. Zerrouki [1], N. Eddalia [1], M. Azzouz [1] and B. Boudjellal [1]
[1] Ecole Nationale Supérieure des Sciences de la Mer ENSSMAL - nameur@gmail.com

Abstract
Climate change, population increase, industrialization and agricultural activities are effecting eutrophication in estuaries and coastal waters. The Mediterranean Sea, as a semi-enclosed sea must be very sensitive to global change and is impacted by human activities. Coastal cities has been identified as hot spots for several pollution types. Along the Algerian coast we present the evolution of nutrients and oxygen in two bays : Algiers and Bou-Ismail. We also present the distribution of pH and CO_2 air-sea exchange in these areas. This work is part of the international "MerMex, MISTRALS" program which aims at studying the viability of the Mediterranean Sea for the next century.

Keywords: Coastal waters, Eutrophication, Oxygen, Algerian Sea, Air-sea interactions

Introduction

The world's climate has changed, and human activities are continuously contributing to greenhouse gases emission and water pollution. The drivers causing coastal eutrophication are set within a large framework of multiple human-induced stressors, including overfishing, chemical contaminants, coastal habitat degradation and invasive species [1]. Eutrophication is a global phenomenon with significant effects on food webs, water quality, and biogeochemical cycles [1]. The Mediterranean Sea showing short-term response to anthropogenic forcing can be considered as an ocean model. In this context, acidification, eutrophication status, sea water warming and change in biodiversity are the key topics in assessing the viability of the Mediterranean Sea for the next century. The Algerian coastal areas characterized by high biodiversity are very sensitive to human activities. For instance, every year, millions of cubic meters of untreated wastewater pour into the bay of Algiers, the latter being also influenced by the fresh water input from 2 rivers. The Bou Ismail bay extends on about 50 kms in the west of Algiers, and presents an accelerating process of degradation following the development of anthropogenic activities since the last 10 years. Few data are actually available concerning the distribution of pCO_2 in surface waters for the Algerian basin of the Mediterranean sea. In this work, we present sea water nutrient content and dissolved oxygen and how these parameters have evolved over 20 and 10 years respectively for Algiers and Bou Ismail bays, taking advantage of historical data collected in the same zones [2] and present day cruises. We also present the role of these areas as source or sink for atmospheric CO_2 in spring 2012.

Material and method

More than 20 stations were sampled in the two bays between 3 and 100 m depth. The dissolved O_2 was measured using the Winkler method [3]. The mean and standard deviation on the replicate is 2±0.2 µmol/kg. The nutrients (nitrogen, phosphorus) were measured with the auto analyzer SAN PLUS (Skalar, 1996). The mean and standard deviation on the replicate was 0.03±0.0001 µmol/kg. The pH and Total alkalinity (TA) were measured according to Dickson recommendation [4]. TCO_2 and pCO_2 were calculated using Mehrbach dissociation constants for carbonate system in sea water [4]. Accuracies are, 0.002 for pH, 4µmol/kg for TA, 5 µmol/kg for TCO_2 and 6 µatm for pCO_2.

Results and discussion

Averaged phosphorus concentration has increased in the two bays over time. That explains a decrease in N/P ratio. The N/P ratio decreases from 1.6 in 1989 to 0.79 in 2012 in the Algiers bay and from 4 in 1996 to 0.4 in 2011 for the Eastern part of the Bou Ismail bay. Boulahdid et al [5] have shown a difference in N/P distribution between the western part (N/P=16) and the Eastern part (N/P=2) of Bou Ismail bay in 1996, probably caused by higher demography on the eastern coast of the bay. Recent observations do not show this difference as the demography and urbanization have gained the western part of the bay as well. Therefore, we suppose that N/P ratio decrease is a consequence of an increasing trend in the volumes of untreated domestic waters that reach the bay, as well as a change in river inputs following some rainfall changes over the years.

Tab. 1. Data for Algiers and Bou-Ismail bay: mean and (standard deviation) for nitrogen, phosphorus and dissolved oxygen. Air-sea CO_2 fluxes (FCO_2), the negative value indicate sink for atmospheric CO_2, positive value indicate source of CO_2 for the atmosphere.

	Bou-Ismail bay		Algiers bay		
	Mai-2002	April-2012	1989	April-2011	April-2012
Nitrogen (µmol/l)	0.83 (1.2)	0.26 (0.14)	0.63 (0.3)	0.17 (0.08)	0.82 (0.4)
Phosphorus (µmol/l)	0.13 (0.02)	0.52 (0.54)	0.39 (0.25)	0.39 (0.05)	0.48 (0.02)
O_2 (mg/l)	8.62 (0.28)	6.22 (0.65)	No data	6.98 (0.63)	6.99 (0.88)
FCO_2 mmol/m²/day	No data	-15.79	No data	+ 0.37	- 0.27

Dissolved O_2 is of about 8 mg/l on average for Bou Ismail bay in 2002 and around 6 mg/l for 2012 in the two bays. The dissolved oxygen is a good indicator of eutrophication for coastal waters. According to IFREMER [6], an oxygen decreasing trend is an indicator for eutrophication risk. However, the Bou Ismail bay is also under a strong influence of the Algerian current hydrodynamics which may contribute to the ventilation of these waters. Concerning the sea surface pCO_2, the distribution is controlled by the temperature, and river inputs. In spring 2012, the eastern part of Bou Ismail bay acts as a sink for atmospheric CO_2 (-15.8 mmol/m^2/day on average). In the Algiers bay, the pCO_2 distribution shows a clear contrast: near-shore waters are influenced by river input with low pH and low TA and therefore act as a source of CO_2 for the atmosphere (+4.35 mmol/m^2/day on average), while the waters off the coast, more influenced by the Algerian current, act as a sink with a mean flux of -2.75 mmol/m^2/day.

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HYPOXIA IN THE BLACK SEA NORTH WESTERN SHELF : FROM EUTROPHICATION TO CLIMATIC STRESSORS

Arthur Capet [1]*, Jean-Marie Beckers [1] and Marilaure Grégoire [2]
[1] GHER - Université de Liège - arthurcapet@gmail.com
[2] Laboratoire d'Océanologie - Université de Liège

Abstract
The dynamics of seasonal hypoxia, which affects the Black Sea north-western shelf since the mid 1970's until present days, is investigated by means of a 3D biogeochemical model. Comparison of the model results with in-situ data reveals that the phenomenon may have been underestimated after the mid 1990's due to the distribution of observations. We investigate the mechanism of hypoxia at seasonal scale, and identify the main drivers of its interannual variability. While high nutrients discharge caused severe hypoxia in the 1980's, it was sustained in the 1990's by the pool of organic matter accumulated during the previous years in the sediments layer. With an increasing intensity, climatic stressors intensifies the response of hypoxia to nutrient discharge, and affect the seasonal dynamics of hypoxia by extending its temporal scale.

Keywords: Black Sea, Oxygen, Models, Benthic-pelagic coupling, Continental shelf

As many other stratified continental shelves exposed to eutrophication (Diaz and Rrosenberg, 2008), the Black Sea North-western shelf (NWS) is affected by seasonal hypoxia : the summer stratification isolates bottom waters from the atmosphere and prevents ventilation to compensate for the large consumption of oxygen due to respiration in the bottom waters and in the sediments.

We used a 3D coupled physical biogeochemical model to investigate the dynamics of bottom hypoxia in the Black Sea NWS at seasonal and interannual scales (1981-2009). The model integrates the biological model presented in Grégoire et al.,2008, within the hydrodynamical 3D model GHER (Capet et al., 2012) and includes a dynamical representation of organic matter in the sediment layer (i.e. resuspension and benthic diagenesis) (Stanev et al., 2012 ; Soetart et al. 2000). Model skills are evaluated with 14500 in-situ oxygen measurements available in the NOAA World Ocean Database and the Black Sea Commission data. Specific validation procedures prove the model's ability to resolve the seasonal cycle and interannual variability of oxygen concentration as well as the spatial location of the oxygen depleted waters and the resolution of the specific threshold of hypoxia ($[O_2]< 62$ mmolO/m³). Spatial variability and seasonal fluctuations complicate the monitoring of hypoxia leading to contradictory conclusions when different sets of data are considered. Noteworthy, the recovery process was overestimated after 1995 due to the concentration of observations in areas and months not typically affected by hypoxia. This stresses the urging need of a dedicated monitoring effort in the NWS of the Black Sea focused on the areas and the period of the year concerned by recurrent hypoxic events.

The severity of hypoxia for a given year is quantified by an index H which combines the aspects of spatial and temporal extension of hypoxia, and is equivalent to the maximal spatial extension if the duration is equal to the average. In order to explain the interannual variability of H and to identify and disentangle its main drivers, a multilinear stepwise regression analysis ($p < 0.01$) is applied on the long time series provided by the model. This statistical model gives a general relationship (Fig. 1.) that links the intensity of hypoxia to eutrophication and climate related predictors. It is known that hypoxia is caused by an enrichment of river waters in nutrients (e.g. Diaz and Rosenberg, 2008). Here we show that the accumulation of organic matter in the sediments, during the years of high nutrient discharge, continues to cause an important benthic oxygen demand, even after the reduction of discharge (in the early 1990's for the Black Sea NWS), with a typical inertia timescale of 9.3 years.

This introduces an important aspect in the dynamics of recovery from eutrophication by riverine discharge management. The major climate-related driver of hypoxia is the sea surface temperature (SST) in March, which fixes the solubility of Oxygen in sea water, hence the pool of oxygen content in the bottom watermass, before it is locked by the summer stratification. Also, high SST in the late summer extends the duration of the stratification period, which increases the damages caused by hypoxia since the last days of the stratification is when the bottom waters bear the lowest oxygenation levels, eventually reaching anoxia and causing the release of hydrosulphide from the sediments. Higher summer temperature observed in the Black Sea for the last decade thus adds a new challenge in the management of eutrophication as it intensify the sensitivity to the nutrient discharge.

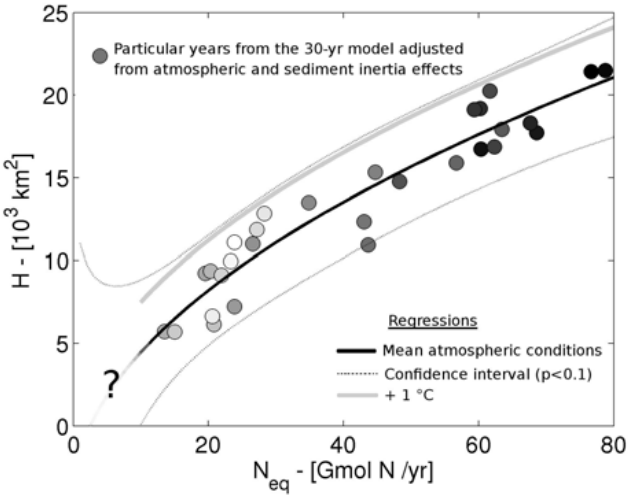

Fig. 1. The role of atmospheric drivers and sediment inertia on the intensity of hypoxia, as revealed by the stepwise regression, allows to redraw the distribution between H, the intensity of hypoxia, and N, the riverine nitrogen discharge, for mean atmospheric conditions and equilibrated sediment pool of organic matter. The effect of warming (+1°C) on the H(N) relationship is indicated by the gray line. This statistical relationship is not validated for the low level of nitrogen discharge that were not experienced during the period of the modeling experiment (1981-2009).

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EVENTS OF HYPOXIA IN RELATION TO CIRCULATION PATTERNS IN THE NORTHERN ADRIATIC SEA

Tamara Djakovac [1]*, Nastjenjka Supic [1] and Robert Precali [1]
[1] Rudjer Boskovic Institute - djakovac@cim.irb.hr

Abstract
Marked hypoxia has been often observed in the northern Adriatic (NA) bottom layers during autumn. Assuming that the frequency of these events is significantly affected by the circulation regime in the NA, and not exclusively due to eutrophic pressure, datasets of bottom dissolved oxygen volume ratio at two stations in the area are compared to the velocity of geostrophic currents for the period 1972-2010. Significant correlations were obtained pointing the importance in circulation patterns.

Keywords: Oxygen, Currents, North Adriatic Sea

Introduction Marked hypoxia in the bottom layer frequently develops progressively from August to November in the northern Adriatic. The region is under the impact of the Po River, one of the largest in the Mediterranean (Fig. 1) which nutrient richer waters can spread over the entire northern Adriatic region, remaining in a large portion entrapped within gyres, which usually extend from the surface to 10-20 m, or even more (Supic N., pers.comm.). An anticyclonic gyre often forms in the north-eastern Adriatic and is marked by the southward Istrian Coastal Countercurrent (ICCC; [1]). Alternatively, river waters do not spread significantly across the northern Adriatic and the region largely belongs to the Adriatic-wide cyclonic gyre. Thus, events of hypoxia/anoxia resulted from a combined effect of excess primary production and reduced lateral advection due to gyre formations [2]. To verify the importance of lateral advection, datasets of dissolved oxygen volume ratio of bottom layers of some northern Adriatic areas during the period 1972-2010 were correlated to the velocity of geostrophic currents of different direction. **Material and Methods** Dissolved oxygen volume ratio in bottom layers of two stations (SJ107 and SJ108), located along the transect Po River Delta-Rovinj (Fig. 1) was determined by the Winkler titration technique described in Strickland and Parsons (1972).

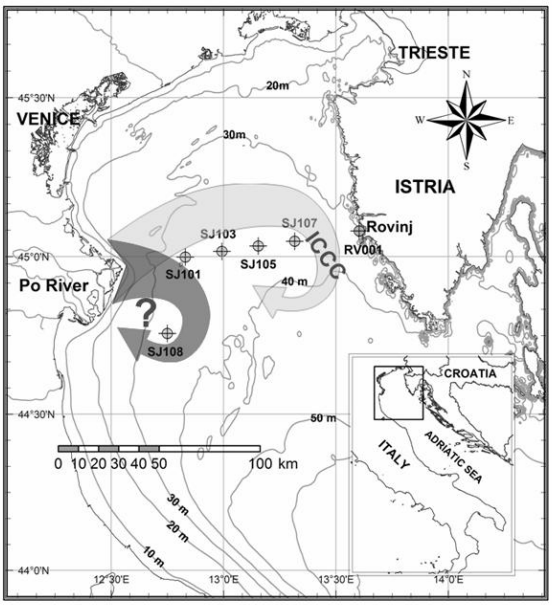

Fig. 1. Northern Adriatic map with station locations and geostrophic currents.

Geostrophic surface currents relative to 30 dbar between stations were computed as described in [1]. **Results and Discussion** The correlations between current velocities and hypoxia events were statistically significant (Fig. 2a, b). At the eastern, more oligotrophic station SJ107, southward geostrophic current (ICCC), which indicates the presence of an anticyclonic gyre (Fig. 1), appeared along with hypoxia events (Fig. 2a).

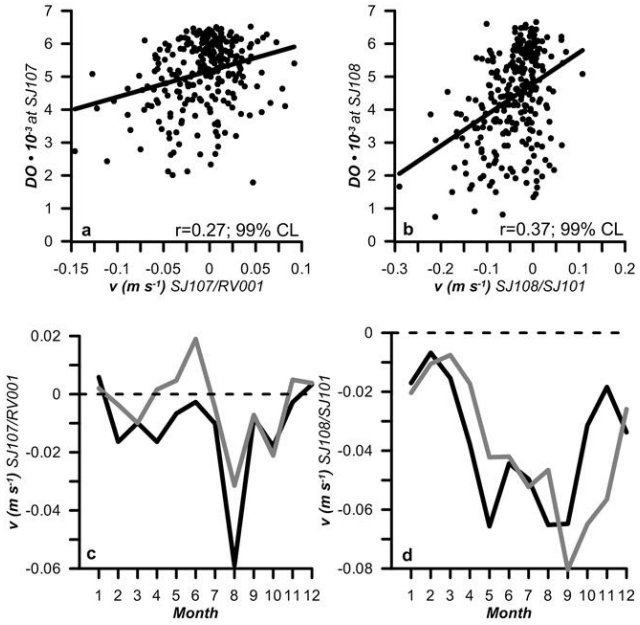

Fig. 2. A) Bottom dissolved oxygen volume ratio (DO) at station SJ107 in relation to the component of surface geostrophic current relative to 30 m between stations SJ107 and RV001; b) Same as a) but for stations SJ108 and SJ101; c) Seasonally cycle of geostrophic currents component between stations SJ107 and RV001 in years with (black) or without (gray) hypoxia event; d) Same as c) but for stations SJ108 and SJ101. Positive currents indicate inflow into the NA.

This gyre seems to form by the end of winter and persists throughout spring and summer, increasing the advection of low-salinity waters (enriched in nutrients) eastward, consequently with oxygen consumption in bottom layers in autumn (Fig. 2c). But, in years when hypoxia event does not occur, the gyre forms much later, in summer (Fig. 2c). Unexpectedly, in the western, more eutrophic part of the region (station SJ108), which is more directly influenced by nutrient inputs, low bottom oxygen concentrations coincided with intense surface southward current between stations SJ108 and SJ101 (Fig. 2b). This current seems to be present throughout the year (Fig. 2d), concurrently with hypoxia in bottom layers from August to September, that points to a presence of another anticyclonic gyre near SJ108 (Fig. 1). **Conclusion** The results indicate that particular circulation patterns, especially when gyres form, are an important cause of hypoxia in the northern Adriatic.

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DEEP SEA OXYGEN TREND IS THE MEDITERRANEAN SEA OUT OF BREATH ?

D. Lefèvre [1]*, C. Tamburini [1], A. Robert [1], S. Martini [1] and -. ANTARES collaboration [2]
[1] MIO, Institut Méditerranéen d'Océanologie, UMR 7294, UM 110 Aix-Marseille Université, Université du Sud Toulon-Var, CNRS/INSU, IRD - dominique.lefevre@univ-amu.fr
[2] ANTARES Collaboration. CPPM, Campus de Luminy, 13288 Marseille

Abstract
A long term time series at the ANTARES MOOSE fixed moored site is on going since 2008 to monitor hydrological parameters. A special focus has been carried out in situ oxgen concentration evolution and its associated dynamics. Results over 3 yeras exhibit a annual decrease of 2.5 µM O2 with a variability assiciated to hydrological and biological events at the basin scale.

Keywords: Oxygen, North-Western Mediterranean, Time series, Pelagic

The role of the ocean and the biological pump is the CO_2 system regulation in relation with global warming is now recognised (IPCC 2007). This climate change will induce some evolution in oceanic circulation, impaction surface oceanic stratification, decrease in cascading or convection events (Bopp et al. 2002); major process in deep water ventilation. Some extreme events have already been observed in the Mediterranean Sea Méditerranée (Schröder et al., 2006, Font et al. 2007, Fuda et al. 2007, Canals et al. 2006, Bourin et al. 2008, Schröder et al. 2012). The long term study of in situ oxygen concentration and its associated dynamics is a key index of the ecosystem evolution (Keeling and Garcia, 2002). The surface production fluxes are also controlled by the mixed layer depth and associated temperature. Almost 50% of surface production, proxy of the biological pump functioning, is exported as organic matter to the deep sea (Ducklow & Carlson, 1992) as dissolved of particulate organic material. These exports are the main conveyor of carbon and energy to the mesopelagic and bathypelagic zone which is then buried in the sediment. The export flux intensity and the organic material quality (dissolved semi labile or refractory, or particulate organic material) will set the marine micro-organism activity in the deep ocean and will impact the in situ oxygen concentration. This study presents a unique time series of in situ oxygen concentration and its associated dynamics at the fixed moored station MOOSE-ANTARES on going since 2008. The oxygen time series exhibits an annual decrease of 2.8 µM O_2 (figure 1). The trend is comparable at 2300 m and 2000 m depth.

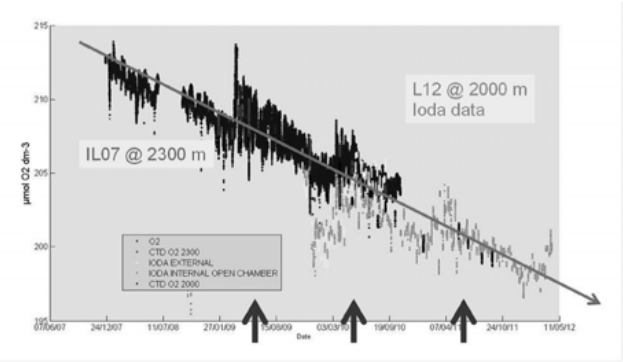

Fig. 1. *In situ* Oxygen concentration time series since 2007 at the ANTARES site observed at 2300m and 2000m. Black and grey coloured points are respectively from 2300 m and 2000 m. Arrows are related to hydrological events observed at the ANTARES site. The observed drift for the 2007-2012 period correspond to a decrease of 2.8 µM a-1. Oxygen measurements are measured with an Aanderaa optode 3830. The calibration was performed using CTD-O2 profiles in the vicinity of the mooring site.

Some annual variations are observed during the February-March period, most likely associated with hydrological events occurring in the Gulf of Lions. Indeed, deep water convection occurs with more or less intensity every year and in some occasion this mixing occurs on the whole water column. Cascading events also occur in the Gulf of Lions in winter under wind and temperature forcing. This has a direct effect on mesopelagic and bathypelagic water ventilation as well as redistributing nutrients and organic carbon along the water column. Alongside a time series of oxygen dynamics has been monitored at 2000 m depth using the innovative instrumentation $IODA_{6000}$. In situ incubation was performed over 5 days cycles since 2009. The background oxygen consumption rate is 0.12 µM O_2 d^{-1} and some seasonal variation are observed which may be related to the main hydrological events and primary production events at the basin scale At different scale, the hydrodynamic and surface primary production, carry the role of fertilising the deep ocean and may trigger some unexpected intense biological activity (Tamburini et al. 2013). These two on going and unique time series offers insight in the bathypelagic ecosystem functioning with higher oxygen consumption rates than expected.

Acknowledgments: We thank MOOSE observation network for their help the logistics and financial support. We thank Esonet NoE, Eurosites FP7, CPER Oceanomed PRIMA for their financial support.

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Session

Transitional habitats
Biological and chemical process

Modérateur : **Axel Romaña**

TOXICITY OF POLYCYCLIC AROMATIC HYDROCARBONS TOWARDS NATURAL PHYTOPLANKTON FROM COASTAL MEDITERRANEAN LAGOONS

Hiba Ben Othman [1]*, Elodie Lanouguère [2], Asma Sakka Hlaili [1] and Christophe Leboulanger [2]
[1] Laboratoire de Cytologie Végétale et Phytoplanctonologie, Faculté des Sciences de Bizerte, Université de Carthage, Zarzouna 7021, Bizerte, Tunisia - benothmanhiba@yahoo.fr
[2] UMR 5119 ECOSYM, CNRS-IRD-Université Montpellier II-Ifremer-Université Montpellier I, SMEL 2 rue des Chantiers, F-34200 Sète, France

Abstract

Toxicity of PAH mixture against natural phytoplankton was evaluated on two coastal Mediterranean lagoons: Thau (France) and Bizerte (Tunisia), exposed to increasing concentrations of synthetic PAHs in mixture (up to 441 µg L^{-1}). Toxicity endpoints used were both structural (taxonomic composition) and functional (photosynthetic potential). At short term, a dose–response relationship was observed in the two experiments, with significant changes in photosynthetic potential and phytoplankton community structure. The Fv/Fm-based EC50s showed that Thau phytoplankton community was more sensitive to PAH mixture than the Bizerte one. Similarity analysis enlightened the difference in taxonomic composition between the two systems, and the strong structuring pressure exerted by the PAHS; toxicity of the mixtures was dose- and species-dependent.

Keywords: Lagoons, Phytoplankton, Ecotoxicology, North-Western Mediterranean, South-Western Mediterranean

Introduction

Widely distributed in the marine environment, PAHs are of great concern because of their toxic and carcinogenic properties [1]. They are common constituents of complex pollution. An estimated total input of 230,000 metric tons of PAHs is released annually to the aquatic environment [2] and may accumulate in the sediments especially in coastal Mediterranean lagoons. A number of changes mediated by chemical or microbial activities, meteorological events or dredging, can release PAHs from the sediment into the water column. The aim of this study was to assess the impact of PAH mixture on the photosynthetic efficiency of PSII and phytoplankton community structuring in microcosms inoculated from Thau and Bizerte lagoons.

Materials and Methods

Fifteen 5 L microcosms were inoculated with phytoplankton assemblages collected from coastal stations in Bizerte (Tunisia) or Thau (France) lagoons. Replicate of controls (T) and four-level of contaminated microcosms were prepared, with increasing concentrations of PAHs mixture from 1.5 to 441 µg/L. PAHs concentrations were analytically controlled.

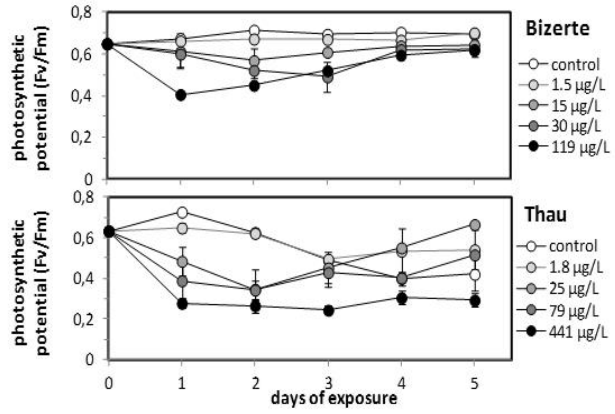

Fig. 1. Toxicity of PAHs mixture on photosynthetic efficiency of PSII (Fv/Fm) of phytoplankton communities.

The microcosms were incubated *in situ* and samples collected from each bottle after 24, 48, 72, 96 and 120h to measure the relative photosynthetic efficiency of PSII (Fv/Fm) using PAM fluorometry (AquaPen-C, PSI, Czech Republic). Fv/Fm parameter after dark adaptation was selected as functional endpoint to detect the toxic effects [4]. Lugol-preserved samples of phytoplankton were counted and identified using an inverted microscope. Data were processed using PAST freeware (Bray-Curtis similarity indices for taxonomic composition), and the EC50 was estimated according to the Hill dose-response model.

Results and discussion

After 24h exposure, PAHs were toxic to photosynthetic parameters. Thau and Bizerte community EC50 were 297µg L^{-1} and 75µg L^{-1} respectively. Photosynthetic efficiency (Fv/Fm) decreased at the highest PAH concentration for Thau and Bizerte lagoon relative to the control (from 0.65 to 0.27 and 0.4, respectively). This significant inhibition remained unchanged throughout the exposure in Thau, suggesting a persistent degradation of PSII efficiency. For Bizerte phytoplankton community, the highest concentration was not lethal, and Fv/Fm parameter fully recovered after 120h (Fig.1).

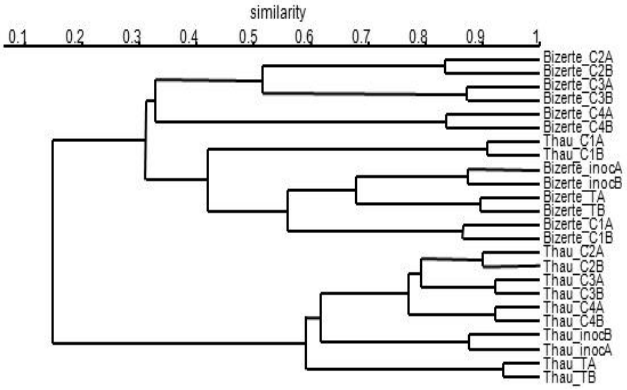

Fig. 2. Effect of PAHs mixture on community structure after 24h exposure. Composition similarity is expressed by Bray-Curtis distance. Sample name indicates origin (Thau, Bizerte) and contamination level (T for control, Cx for levels of PAHs) for duplicate analysis (A,B).

For Thau, a significant increase of Fv/Fm was observed for the three lower concentration compare to control after 120h. Tolerance acquisition towards PAHs mixture appears greater for Thau than for Bizerte phytoplankton community. The similarity analysis enlightened the difference in taxonomic composition for two lagoon ecosystems, and for each one, the species diversity was strongly driven by the contamination level (Fig.2).

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VARIABILITÉ INTERANNUELLE DE LA TRANSPARENCE DES EAUX D'UN CANAL RELIANT DEUX LAGUNES MÉDITERRANÉENNES (TUNISIE SEPTENTRIONALE)

Besma Chaouachi [1]*, Abdessalem Shili [2], Domia Menif [3] and Oum Kalthoum Ben Hassine [1]
[1] Faculté des Sciences de Tunis, Université Tunis El Manar. Tunisie. - Besma.Chaouachi@fsb.rnu.tn
[2] Institut National Agronomique de Tunisie. Université de Carthage.
[3] Faculté des Sciences de Bizerte, Université de Carthage Tunisie.

Abstract
La transparence des eaux du canal Tinja dépend du vent mais aussi du sens et de la durée du courant lequel est tributaire du niveau de l'eau dans la lagune Ichkeul. Les transparences mensuelles moyennes calculées à partir des mesures quotidiennes (1992-96) montrent des maximums (73 à 107 cm) pendant l'été ou l'automne par courant continu vers la lagune Ichkeul et des minimums (12 à 30 cm) en hiver ou au printemps par courant circulant vers Bizerte. Les transparences moyennes relativement faibles (<30 cm) coïncident avec des vents forts. Durant les périodes de transition séparant les courants continus et lorsque les vents sont calmes, un mélange s'effectue entre les eaux claires provenant de la lagune de Bizerte et les eaux turbides de l'Ichkeul.

Keywords: Hydrology, South-Central Mediterranean, Lagoons, Monitoring

Le canal Tinja long de 5 km et profond d'environ 1 m relie la lagune Ichkeul (1 m de profondeur moy) à la lagune de Bizerte (7 m de profondeur moyenne). Celle-ci s'ouvre en permanence sur la mer Méditerranée par le goulet de Bizerte (long de 7 km et profond de 12 m). L'écosystème Ichkeul-Bizerte a connu de grandes modifications suite aux variations des conditions du milieu et à l'édification des barrages de retenue d'eau douce sur le bassin versant de l'Ichkeul. Pour ces raisons, une écluse sur le canal Tinja a été mise en service pour mieux gérer les réserves en eaux douces de l'Ichkeul et préserver l'originalité de cet écosystème (Fig. 1).

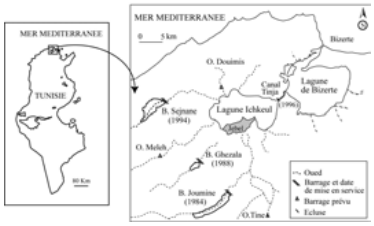

Fig. 1. Situation du complexe lagunaire Ichkeul-Bizerte (Nord de la Tunisie)

La transparence des eaux du canal Tinja a été évaluée tous les matins (mars 1992-septembre 1996) à l'aide d'un disque de Secchi (DS). Parallèlement, le sens du courant du canal Tinja, entrant ou sortant par rapport à la lagune Ichkeul a été régulièrement relevé. La transparence mensuelle moyenne des eaux (Fig. 2) a fluctué entre un minimum de 12 cm (mars, courant sortant) et un maximum de 107 cm (août, courant entrant) et les vitesses mensuelles moyennes du vent ont varié de 1,7 à 5,6 m/s. Durant les années hydrologiques 1991 à 1996, les transparences mensuelles les plus élevées ont été observées pendant les saisons estivales et automnales (août à novembre) par courant entrant dans la lagune Ichkeul. Les moyennes mensuelles maximales ont varié entre 73 et 107 cm. Les transparences mensuelles les plus faibles ont été enregistrées en périodes hivernales et printanières (février et mars) lorsque le courant est dans le sens Ichkeul-Bizerte et les valeurs calculées pour chaque année, ont été comprises entre 12 et 30 cm. Les transparences mensuelles relativement faibles, inférieures à 30 cm ont été observées essentiellement par courant continu vers Bizerte et correspondent à des vitesses moyennes du vent relativement élevées et allant jusqu'à 5,6 m/s. En effet, le vent fort remet les particules en suspension, augmente, de ce fait, la turbidité des eaux et limite l'énergie lumineuse disponible pour le phytoplancton [1]. Le début et la durée des courants continus vers Bizerte ou Ichkeul, variables d'une année à l'autre, dépendent des apports en eaux douces lesquels ont été réduit par la mise en eau des barrages. En considérant l'ensemble des courants continus répartis sur toute la période d'étude, les DS moyens calculés ont été compris entre 13 et 34 cm pour les courants sortants continus de l'Ichkeul qui ont duré 2 à 5 mois. Pendant ces derniers, les transparences évaluées dans le canal sont celles de la lagune Ichkeul. Celle-ci a une faible profondeur, par conséquent, le vent remue les particules argileuses du fond et celles provenant du bassin versant. Pour les périodes des courants entrants continus dans l'Ichkeul qui ont été de 3 à 7 mois, les DS moyens relevés dans le canal et proches de ceux du bassin de Bizerte ont varié entre 42 et 93 cm. Les fonds de la lagune de Bizerte, plus profonde, sont moins susceptibles d'être remis en suspension par le vent.

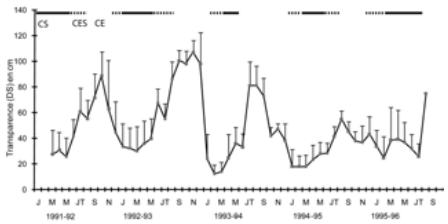

Fig. 2. Evolution des transparences (cm) moyennes des eaux en relation avec le sens du courant du canal Tinja. Les barres verticales représentent l'écart-type. CE. : courant entrant continu dans l'Ichkeul ; CS : courant sortant continu de l'Ichkeul ; CES. : courant entrant-sortant.

Au cours des périodes de transition (quelques jours à 3 mois) séparant les courants continus et lorsque les vents sont calmes, un mélange s'effectue entre les eaux claires provenant de la lagune de Bizerte et les eaux turbides de l'Ichkeul et les transparences mesurées au niveau du canal sont intermédiaires entre celles des deux plans d'eau. Bien que les échanges entre la lagune Ichkeul et celle de Bizerte soient régis par l'écluse, le canal Tinja continu à jouer son rôle capital dans le transfert hydrobiologique entre les deux milieux lagunaires. Certains travaux se sont intéressés à la transparence du canal et ont estimé les débits sur la base de relevés quotidiens ([2], [3]) ou mensuels [4] d'une année hydrologique. Nos mesures quotidiennes, sur environ cinq ans nous permettrons d'accéder à une bonne estimation des débits solides, de définir le rôle du canal Tinja dans leur transport et d'évaluer l'effet des aménagements hydrauliques (barrages et écluse) sur ces débits.

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ECHANGE HYDRO-SALIN DANS LE COMPLEXE LAGUNAIRE BIZERTE-ICHKEUL (TUNISIE SEPTENTRIONALE)

Besma Chaouachi [1]*, Abdessalem Shili [2], Domia Menif [3] and Oum Kalthoum Ben Hassine [1]
[1] Faculté des Sciences de Tunis, Université Tunis El Manar, Tunisie. - Besma.Chaouachi@fsb.rnu.tn
[2] Institut National Agronomique de Tunisie, Université de Carthage, Tunisie.
[3] Faculté des Sciences de Bizerte, Université de Carthage, Tunisie.

Abstract
Le suivi quotidien sur environ cinq ans des échanges entre la lagune Ichkeul et celle de Bizerte *via* le canal Tinja a permis d'analyser certaines variations hydrobiologiques de l'écosystème. La lagune de Bizerte s'est déversée dans la lagune Ichkeul pendant 5 à 9 mois selon la pluviométrie de chaque année. La salinité mensuelle moyenne du canal Tinja a varié de 7,9 à 46,3. Durant les années pluvieuses ou normales, les salinités minimales mesurées dans le canal reflètent celles de la lagune Ichkeul et les salinités les plus élevées sont proches de celles de la lagune de Bizerte. Cependant, au cours des périodes très sèches, les salinités maximales, dépassant celles de l'eau de mer, peuvent résulter des eaux en provenance de l'Ichkeul. Ces salinités exceptionnelles engendrent la disparition des espèces à affinité dulçaquicole.

Keywords: South-Central Mediterranean, Hydrology, Monitoring, Lagoons

La lagune de Bizerte d'environ 150 km^2 de surface, communique avec la lagune Ichkeul par le canal Tinja. Largement ouverte à la mer, la lagune de Bizerte présente des salinités peu fluctuantes et proches des salinités marines. La lagune Ichkeul, de position continentale, est alimentée par les apports d'eau douce en période hivernale et d'eau marine en période estivale. Elle possède une surface variable entre l'été et l'hiver (78 km^2 à 110 km^2) et des salinités qui fluctuent en fonction du bilan hydrique. Les trois barrages construits au niveau du bassin versant de l'Ichkeul ont diminué les apports d'eau douce alimentant l'écosystème lagunaire et ont perturbé ses caractéristiques hydrologiques. Depuis 1996, les échanges entre les deux lagunes sont contrôlés par l'écluse de Tinja. Au cours de la présente étude qui s'étend de mars 1992 à août 1996, des prélèvements journaliers ont été effectués le matin au niveau des eaux de surface de la station Tinja. La salinité de l'eau (psu) a été déterminée à l'aide d'un conductimètre et le sens du courant a été noté au moment de chaque relevé. Les données de précipitations (mm) ont été fournies par l'Institut National de la Météorologie. La période d'étude étalée sur environ 5 ans comprend des années à pluviométrie normale (proche de 600 mm/an) et d'autres exceptionnelles par défaut ou par excès (Fig. 1).

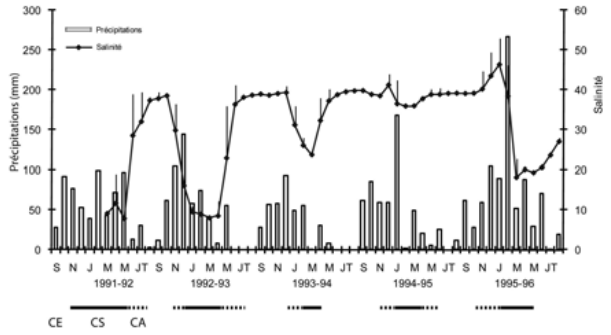

Fig. 1. Relation entre les précipitations, le sens du courant et les salinités des eaux du canal Tinja. Les barres verticales en haut de la courbe représentent l'écart-type. CE: courant entrant dans l'Ichkeul; CS: courant sortant de l'Ichkeul; CA: courant alternant.

De plus, au cours de ces années d'étude ont été mis en service le troisième barrage (Sejnane, fin 1994) et l'écluse de Tinja (avril 1996). La salinité suit de près les variations du niveau de l'eau de l'Ichkeul lequel est influencé par la pluviométrie. Les salinités mensuelles moyennes calculées à partir des données quotidiennes ont été comprises entre 7,9 (mai 1992) et 46,3 (janvier 1996). Pendant les cinq années hydrologiques 1991-1996, la lagune de Bizerte s'est déversée dans la lagune Ichkeul durant 5 à 9 mois suivant les précipitations annuelles. Suite à des années normales ou pluvieuses successives, les salinités mensuelles minimales sont relevées dans le canal Tinja par courant sortant de la lagune Ichkeul. C'est le cas des années 1991-92 et 1992-93 dont les salinités (environ 8), représentent celles de l'Ichkeul. Les salinités mensuelles maximales enregistrées (37,3 et 38,6) par un courant émanant du plan d'eau de Bizerte reflètent les salinités de ce dernier. En moyenne, durant une année pluvieuse ou normale, les eaux circulent dans le sens Bizerte-Ichkeul ou dans le sens inverse pendant 6 mois. Au cours de l'année 1993-1994 particulièrement sèche, la salinité annuelle moyenne des eaux du canal Tinja a été relativement importante (35,3). La lagune Ichkeul s'est déversée dans la lagune de Bizerte pendant seulement 3 mois. La salinité mensuelle minimale, enregistrée aussi par courant sortant de l'Ichkeul a été relativement élevée (23,7 en mars) du fait d'une pluviométrie très déficitaire (375 mm). La salinité maximale, relevée par courant entrant continu dans la lagune Ichkeul correspond encore aux salinités des eaux de la lagune de Bizerte (39,7 en août) influencées par le faible apport en eaux douces et la forte évaporation. Pour les années 1994-95 (normale) et 1995-96 (très pluvieuse), consécutives à 1993-1994 très déficitaire, les salinités mensuelles maximales (41,2 en 1994 et 46,3 en 1996) correspondent aux périodes d'alternance entre courant sortant et entrant, mais montrent l'influence majoritaire du plan d'eau de l'Ichkeul et non pas de Bizerte. Toutefois, malgré les précipitations abondantes enregistrées la seconde année (1995-1996) et par conséquent, le niveau élevé des eaux dans la lagune Ichkeul et la durée relativement longue du courant vers la lagune de Bizerte (7 mois), la salinité minimale mesurée dans le canal par courant sortant est restée relativement élevée (18,2 en mars) du fait des salinités encore fortes du plan d'eau de l'Ichkeul. De plus, la mise en service du barrage Sejnane a contribué à la restriction des apports en eau douce alimentant la lagune et donc à l'augmentation des salinités. Celles-ci, très élevées, ont engendré la disparition des espèces d'eau douce particulièrement, le poisson *Barbus callensis* et la Magnoliophyte *Potamogeton pectinatus*, principale source trophique des oiseaux aquatiques hivernant à l'Ichkeul. Il en découle que suite à une succession d'années sèches et surtout après la mise en service du barrage Sejnane, il est possible d'enregistrer dans le canal Tinja, des salinités maximales, dépassant largement les salinités marines, par courant sortant de l'Ichkeul. Or, l'écluse de Tinja, destinée à contrôler les échanges entre les deux lagunes devait maintenir dans l'Ichkeul une réserve d'eau à faible salinité. L'analyse des fluctuations dans le canal Tinja donne des informations importantes sur l'évolution intersaisonnière et interannuelle des conditions du milieu dans l'écosystème lagunaire. Celles-ci régissent la distribution des peuplements floristiques [1] et faunistiques ([2], [3]) notamment les espèces dulcicoles et les espèces marines migratrices.

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EFFECT OF THE CONCENTRATION AND PREY TYPES ON THE INGESTION OF THE INVASIVE CTENOPHORE *MNEMIOPSIS LEIDYI* (AGASSIZ, 1865) IN THE BERRE LAGOON (FRANCE)

Floriane Delpy [1]*, Marc Pagano [1], Jean Blanchot [1] and Delphine Thibault-Botha [1]
[1] Aix-Marseille Universite Institut Mediterraneen d'Oceanologie - floriane.delpy@univ-amu.fr

Abstract
The potential impact of the ctenophore *Mnemiopsis leidyi* on the zooplankton community of the Berre Lagoon was studied. *Mnemiopsis* did not reach any satiety level when fed with *Artemia salina* nauplii, even for concentration as high as 700 nauplii L^{-1}. *Mnemiopsis* displayed also a very narrow selection for its prey type, feeding particularly upon nauplii of copepods and rotifers when offered natural zooplankton assemblage. This species can then control the copepods community through a top-down control, which in turn can have a negative impact on the control of the eutrophication. The fish recruitment could be also impacted by food competition and occasional predation of *M. leidyi* on eggs and larvae.

Keywords: Alien species, Biodiversity, North-Western Mediterranean, Food webs

Introduction Observed in the mid 1980's for the first time in the Black Sea, the ctenophore *Mnemiopsis leidyi* has been extended its invasive range both through the Baltic and North Seas and the Mediterranean Sea. Large bloom of this species was first reported in the Berre Lagoon (south east of France) in 2005. An impact of this invasive species on the zooplankton community has been already reported in several regions, feeding particularly on copepod populations [1]. This study aims to evaluate the effect of prey concentration on the ingestion rate of *M. leidyi* and the potential selectivity of preys among natural zooplankton assemblage of the Berre Lagoon.

Material and Method Response of the ingestion rates of *Mnemiopsis leidyi* when fed *Artemia salina* nauplii was studied over a large range of concentration (1-700 ind L^{-1}). Ctenophores were individually placed in 13.2 L containers placed over a rotating table, and remaining prey items were estimated after 15h at 20 °C in the dark. Selectivity ability of *M. leidyi* was studied according to the same protocols with natural zooplankton assemblages of the Berre Lagoon. The electivity indices were calculated according to [2].

Results and Discussion The functional response of *M. leidyi* to prey concentration on *A. salina* showed a linear increase from $0.4 \pm 0.2 \times 10^{-2}$ µgC µgC^{-1} j^{-1} (1.7 ± 0.1 mgC m^{-3}) to $722.1 \pm 58.5 \times 10^{-2}$ µgC µgC^{-1} j^{-1} (559.4 ± 7.4 mgC m^{-3}) (Figure 1).

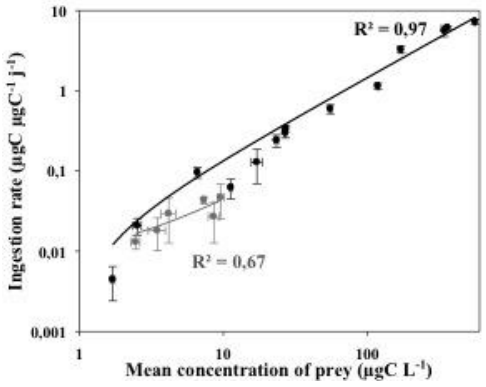

Fig. 1. Ingestion rate of *Mnemiopsis leidyi* (µgC µgC^{-1} j^{-1}) as a function of mean concentration of prey (µgC L^{-1}) (A. salina in black and natural zooplankton in grey).

Ingestion rates on natural assemblage present a similar increase from $1.3 \pm 0.2 \times 10^{-2}$ µgC µgC^{-1} j^{-1} (2.5 ± 0.2 mgC m^{-3}) to $4.7 \pm 2.2 \times 10^{-2}$ µgC µgC^{-1} j^{-1} (9.6 ± 0.5 mgC m^{-3}). The lack in reaching a satiety level suggests a superfluous feeding, preys captured are therefore often partially digested, then regurgitated by the ctenophore [3].

Moreover, an active selection of copepod nauplii and rotifers was observed with mean electivity indices of 0.23 ± 0.13 and 0.14 ± 0.18 respectively (Figure 2).

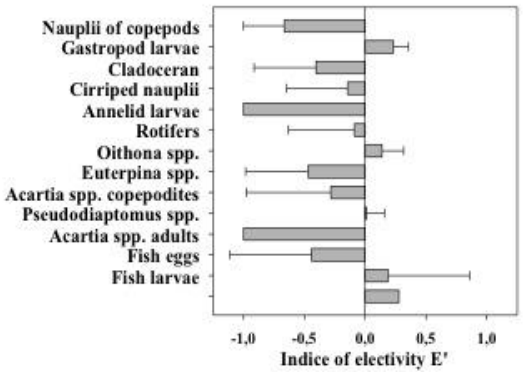

Fig. 2. Indices of electivity E' for each taxa present on the natural zooplankton assemblage.

Indeed, small size organisms are preferentially consumed by the ctenophore [4]. Zooplankton community used during this series of experiments was dominated by copepod nauplii (62.4 ± 14.7 %). In accordance with the optimal foraging theory, *M. leidyi* has a feeding strategy concentrating its effort of capture upon the more abundant preys. This behavior has been already observed for cyddipid larvae of this species [5]. The lack of a satiety level and the active selectivity of preys can largely explain the drop in copepod abundance following *M. leidyi* proliferations observed during the in situ survey conducted since 2010 in the Berre Lagoon. Moreover, the occasional selectivity of fish eggs and larvae (Figure 2), associated to a food competition on zooplankton, could also affect the fish recruitment.

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BENTHIC COMPARTMENT IN EUTROPHIED MEDITERRANEAN LAGOONS : NUTRIENT SINK OR SOURCES?

V. Ouisse [1]*, A. Fiandrino [1], R. De Wit [2], D. Munaron [1], M. Fortune [1], J. Oheix [1], C. Jouhanneaud [1], M. Baleux [1], M. Durozier [1], N. Garcia [3], P. Raimbault [3], R. Buscail [4], D. Aubert [4] and N. Malet [5]

[1] Ifremer Laboratoire Environnement Ressources Languedoc-Roussillon - vincent.ouisse@ifremer.fr

[2] UMR 5119, Univ Montpellier 1 & 2, CNRS, IRD, Ifremer

[3] OSU Pytheas, Institut Mediterraneen Oceanology

[4] Univ Perpignan, CEFREM, CNRS, UMR 5110

[5] Ifremer Laboratoire Environnement Ressources Provence Azur Corse

Abstract

Since the 1960s, the Mediterranean lagoons have accumulated high quantities of the elements N and P in their sediments, which may induce a restoration delay of the lagoons. The present study aims to quantify the sedimentary stocks and benthic fluxes of N and P in order to asses the internal N and P loadings to the pelagos and to estimate the time needed for restoration of an acceptable eutrophication status of Mediterranean lagoons. Nitrogen and phosphorus benthic fluxes were estimated using undisturbed cores in 6 stations distributed along an eutrophied gradient in French Mediterranean lagoons. The preliminary results obtained in spring highlighted a clear efflux of nitrogen in higher eutrophied sediments.

Keywords: Lagoons, Nutrients, Eutrophication, Sediments, North-Western Mediterranean

Since the 1960s, Mediterranean lagoons have been particularly affected by large nitrogen and phosphorus watersheds inputs leading to significant changes in ecosystem structure, functioning and services [1]. In the context of Water Framework Directive (WFD), most public policies and management of Mediterranean lagoons have been focused on reducing the external nutrient loadings (N and P) to achieve ecological restoration. Nevertheless, these Mediterranean lagoons have accumulated high quantities of N and P and stocked them internally, particularly in their sediments. These stocks may represent a risk for retarding the restoration of the lagoons. The present study aims to quantify the sedimentary stocks and benthic fluxes of N and P in order (1) to asses the internal N and P loadings to the pelagos and (2) to estimate the time needed for restoration of an acceptable eutrophication status of Mediterranean lagoons. In spring, summer and autumn, nitrogen and phosphorus benthic fluxes were estimated using undisturbed cores in 6 stations distributed along an eutrophied gradient in French Mediterranean lagoons. The cores were incubated in laboratory over a 20h dark/light cycle in *in situ* temperature conditions to measure benthic fluxes. The total nitrogen and phosphorus concentration in sediment was also quantify in the top 5 cm of each core to link stocks and benthic fluxes.

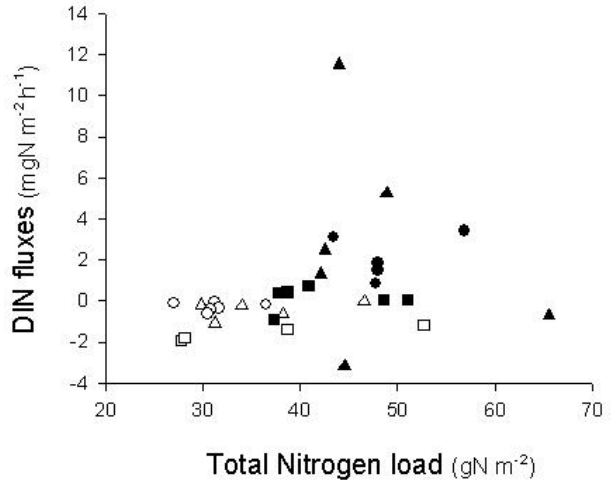

Fig. 1. Benthic fluxes (dissolved inorganic nitrogen) during light along eutrophied Mediterranean lagoons in spring. Shapes and colours (open or close) of symbol correspond to each sampling station

Our preliminary results obtained in spring highlighted a clear efflux of nitrogen for the most eutrophied sediments (close symbol in Fig. 1 and 2), but we also showed that the benthic N and P fluxes are linked to the O_2-DIC community metabolism (uptake of DIN and DIP by marine Magnoliophyta, net release in net heterotrophic systems).

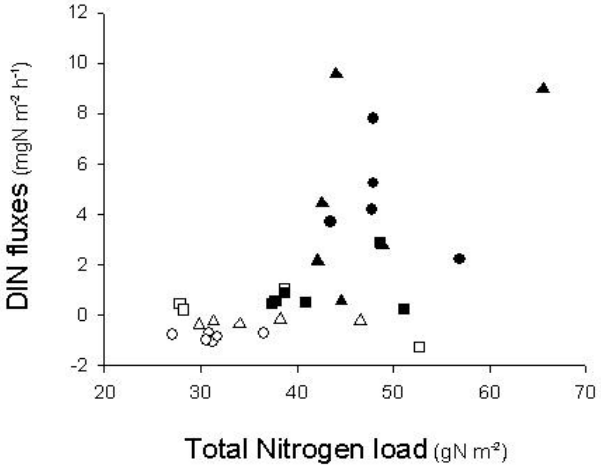

Fig. 2. Benthic fluxes (dissolved inorganic nitrogen) during night along eutrophied Mediterranean lagoons in spring. Shapes and colours (open or close) of symbol correspond to each sampling station

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MOBILITY AND FLUXES OF TRACE ELEMENTS AND NUTRIENTS AT THE SEDIMENT-WATER INTERFACE OF A CONTAMINATED LAGOON

O. Radakovitch [1]*, S. Rigaud [2], R. Couture [3], B. Deflandre [2], E. Metzger [4], D. Cossa [5] and C. Garnier [6]
[1] CEREGE - University Aix-Marseille - radakovitch@cerege.fr
[2] EPOC - University Bordeaux I
[3] Dept Earth Environmental Sciences- University West Waterloo
[4] BIAF - Angers University
[5] IFREMER - Centre Méditerranée
[6] PROTEE - Toulon University

Abstract
The early diagenesis of Fe, Mn, trace elements and nutrients and their exchange at the sediment water/interface were studied in the Berre Lagoon, a polluted Mediterranean lagoon in France. This process was studied at one site under contrasting oxygenation conditions and on two other sites. The concentration profiles were combined with one-dimensional steady-state transport-reaction modelling and thermodynamic speciation calculations to define and calculate diagenetic reactions controlling the mobility of the elements. The results show that fluxes at the sediment-water interface are essentially dependent on the localisation of their remobilisation and immobilisation reactions under the interface, which is governed by the benthic water oxygenation conditions and kinetic competition among those reaction and diffusion processes.

Keywords: Geochemistry, Pollution, Trace elements, Interfaces, Gulf of Lyon

The early diagenesis of the major carrier phases (Fe and Mn minerals), trace elements (As, Co, Cr, Hg, MeHg, Ni) and nutrients (ΣNO_3, NH_4^+, ΣPO_4) and their exchange at the sediment water/interface were studied in the Berre Lagoon, a polluted Mediterranean lagoon in France. This process was studied at one site under two contrasting oxygenation conditions (strictly anoxic and slightly oxic) and on two adjacent sites with perennially well-oxygenated water. From the concentration profiles of the primary biogeochemical constituents and trace elements of the pore and bottom waters, as well as the total and reactive particulate phases, we were able to locate and identify the diagenetic reactions controlling the mobility of trace elements in the sediments and quantify their rates by coupling one-dimensional steady-state transport-reaction modelling and thermodynamic speciation calculations (PHREEQ and PROFILE models).

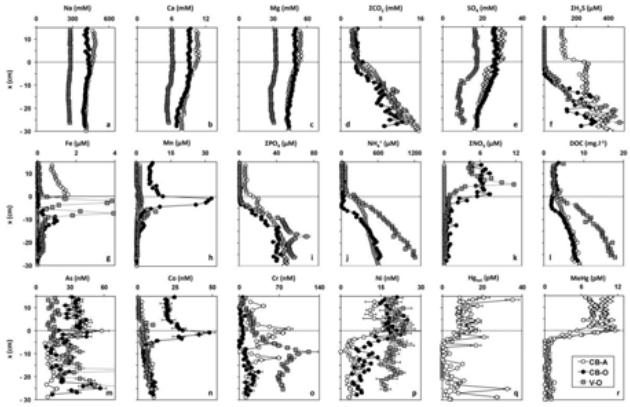

Fig. 1. Concentration profiles of major species (a–l) and trace elements (m–r) in pore and overlying waters on two diferents sites CB and V of the Berre lagoon. CB-A and CB-O correspond to anoxic and slight oxic conditions. The horizontal dashed line represents the sediment/water interface.

Under oxic conditions and in the absence of benthic organisms, the main redox reactions were identified vertically in the surface sediments and followed the theoretical sequence of oxidant consumption: $O_2 > SNO_3/MnO_2 > Fe(OH)_3 > SO_4^{2-}$. However, under anoxic conditions, only MnO_2, $Fe(OH)_3$ and SO_4^{2-} reduction were present, and they all occurred at the interface. We identified the main biogeochemical controls on the mobility of As, Cr, Hg, MeHg and Ni in the surface sediments as the adsorption/desorption and/or coprecipitation/codissolution with Fe oxy-hydroxides. In contrast, Co mobility was primarily controlled by its reactivity towards Mn oxy-hydroxides. In sulphidic sediments, As, Hg and MeHg were sequestered along with Fe sulphides, whereas Co and Ni precipitated directly as metallic sulphides and Cr mobility was enhanced by complexation with dissolved organic ligands. The fluxes of trace elements at the sediment-water interface are essentially dependent on the localisation of their remobilisation and immobilisation reactions under the interface, which in turn is governed by the benthic water oxygenation conditions and kinetic competition among those reaction and diffusion processes. Under oxic conditions, the precipitation of Fe or Mn oxy-hydroxides in the surface sediments constitutes the most efficient mechanism to sequester most of the trace elements studied, thus preventing their diffusion to the water column. Under anoxic conditions the export of trace elements to the water column is dependent on the kinetic competition among the remobilisation during the reductive dissolution of Fe and/or Mn oxy-hydroxides, diffusion and immobilisation with sulphides. We also show that benthic organisms in the perennially oxygenated site have a clear impact on this general pattern. Based on our extensive dataset and geochemical modelling, we predict that the planned reoxygenation of the entire lagoon basin, if complete, will most likely limit or reduce the export of the trace elements from the sediments to the water column and therefore limit the impact of the contaminated sediment. This work was performed with the financial help of two French INSU-EC2CO programs: BERTOX and BIOMIN, and is related to the WP3 of the MERMEX-Chantier Mistrals program.

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INVESTIGATION OF NUTRIENT FLUXES IN THE SEDIMENTS OF HOMA LAGOON (IZMIR BAY, THE AEGEAN SEA)

Emine E. Yurur [1]* and Hasan B. Buyukisik [2]
[1] Celal Bayar University, Faculty of Art and Science, Biology Department, 45140 Manisa TURKEY - ehyurur@gmail.com
[2] Ege University, Faculty of Fisheries, Hyrobiology Department 35100 Izmir TURKEY

Abstract
Nutrient flux experiments in Homa Lagoon (Izmir Bay, The Aegean Sea) were first performed between January 2006 and December 2006 monthly. At the beginning and of the autumn it fluxes from sediment to water, whereas it binds from water to sediment in the middle of the autumn. Nitrification and denitrification processes are of great importance for Homa Lagoon. The size of the grains is variable and is thought to lead to spatial variation in fluxes. <\/div>

Keywords: Nutrients, Lagoons, Sediments, Izmir Bay, North-Central Mediterranean

Introduction
The nutrient transition between the water column and sediment is performed with pore water. This transition is determined with various factors such as the type (NH_4^+, NO_2^-, NO_3^-) and speed of the nutrient, the amount and distribution rate of the organic matter, temperature, available nutrients in the sediment and bottom water, porosity, and physical and biological reactions occurring on the sediment surface [1,2]. Due to these features, lagoonal areas are special ecosystems which have a critical importance in biogeochemical cycles [3]. This study was carried out to determine the sediment structure of Homa Lagoon (Izmir Bay) and the contribution of sediment to the water column.

Materials and Methods
Grain-size distributions of the region were determined with the sediment samples collected from 17 stations in the research area. Sediment samples were collected with a Gravity corer 4.7 cm in diameter. Sediment parameter calculations were based on [6] parameters. Nutrient and Nutrient Flux calculations were based on [4] calculations while Nutrient Flux calculations were based on [5] calculations.

Results
While the increase in organic matter is compatible with the amount of fine material the increase in organic carbon is compatible with the clay / silt percentage. Significant reductions observed in the concentration of dissolved oxygen in June, August, and September indicate the presence of heterotrophic activity in the lagoon. Significant increases in salinity were observed in August and November. Silicate fluxed from sediment to water during the summer months most. Nitrate fluxed both from sediment to water and from water to sediment in the summer and winter months. Nitrite fluxed from water to sediment. Reactive phosphor fluxed from sediment to water in the summer months and bound to sediment in the middle of the winter and in the fall. Ammonia fluxed both from sediment to water and from water to sediment in the winter months, and from water to sediment in the summer months.

Discussion
That NO_2^- fluxes occur from water to the sediment all year-round indicates the effectiveness of the nitrification process in the lagoon. Negative values in the NH_4^+ and the nitrification of NH_4^+ at top layer of the sediment show the presence of an important process in the lagoon. Since the organic carbon binds to the fine material, it is evident that mineralization and accumulation of the organic carbon in the sediment will increase. Coarse material (like sand) can allow more RP to flow into the environment from the sediment. The flux of RS from the sediment into the water occurs mostly during the summer months while NO_3^- flux occurs both to the sediment and to the water in the winter and summer months.NO_2^- flows to the sediment significantly except in the summer months. Both due to nitrification and due to denitrification, RP flows from the sediment to the water in the summer while it binds to the sediment in the middle of the winter and in the autumn. Here, the limitation of RP can be mentioned especially in winter and autumn months. Changes occur in NH_4^+ throughout the year. During the winter months, there is a flux both from the sediment to the water and from the water to the sediment. However, the flux in the summer months is only from the water to the sediment. Therefore, it has been revealed how important the process of nitrification and denitrification in the area is and that the lagoon sediment is a good phosphate trap. In addition, it has been determined that the lagoon is becoming rich in nutrient due to waters flowing from non-point sources, and especially from the Gulf of Izmir.

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COMITÉ 4

Microbiologie et Biotechnologie marines

Président : Milton Da Costa

Rapports des modérateurs

Blue biotechnology

Balbina Nogales Fernández, Universitat de les Illes Balears, 07122 Palma de Mallorca , Spain

Résumé

This session included presentations on relevant topics for marine biotechnology such as the production of biofuel using algal biomass, production of antioxidants by algae and sponge symbionts, optimization production of bioactive molecules, development of antifouling agents and improvement of hydrocarbon biodegradation. There was a very active discussion with the speakers and the audience, in relation to aspects that are of concern for marine biotechnologists. The issues discussed were: (1) importance of conservation of biodiversity in relation to the exploitation of marine invertebrates, particularly endangered species, for the discovery of novel compounds; (2) bottlenecks in the development of biotechnology applications down to the final user, such as in the production cost of biofuel from algae or the characterization and production of bioactive molecules; (3) need for consortia with multidisciplinary expertise for the development of marine biotechnology solutions that are useful and safe for people and the environment; (4) need for cooperation with industry and the importance in developing new professional figures for knowledge- and technology-transfer, serving as a bridge between researchers and industry.

Extremophiles

Josefa Antón, Univ. Alicante, Spain

Résumé

The total duration of the session was around 50 minutes, half of which was dedicated to the debate. The debate, very vivid in a relaxed and friendly atmosphere, focused mainly on two issues:

i/ The difficulty of working with samples from extreme environments, more specifically in high salt and high pressure samples. Particularly active was the discussion about the Dead Sea sediment presentation, since this is likely one of the most difficult samples we could think of. Several attendants gave their opinion and advice on this issue.

ii/ The ecological meaning of antimicrobial peptides and antibiotics. It was argued that these molecules could be acting as chemical messengers between microbial cells in nature rather than just ways of killing ?enemies?. Several examples and opinions were provided. In addition, there was a discussion on our lack of knowledge about how microbes ?behave? in nature, away from laboratory cultures.

HAB (Harmful Algal Bloom)

Antonella Penna, University of Urbino, Italy

Résumé

The HAB session included ten contributions about the ecology, molecular biology and taxonomy of HAB species in the Mediterranean basin. The session discussed recent advances on HABs, with interesting exchanges regarding the role of human impact via eutrophication on the toxic bloom development in Mediterranean coastal sites such as enclosed bays or lagoons. This has negative effects on marine ecosystems and services, since many Mediterranean coastal areas are exploited for aquaculture activities. Often the algal blooms caused massive mussel kills. It was highlighted that the development of operational tools for rapid detection of microalgal species and timely prediction is a high priority for such important Mediterranean farming areas. In south Mediterranean lagoons, harmful blooms were also triggered by environmental factors that were studied in models for forecasting future HAB events.

The speakers described the temporal distribution of several toxic species, among them a new toxic diatom, Nitzschia bizertensis, a new domoic acid-producing diatom. The specific role of dinoflagellate cysts that represent the reservoir for bloom events was also discussed. It was demonstrated that resting stages accumulate in surface sediments of coastal areas subjected to human eutrophication; the dinoflagellate cyst assemblages are proposed as bioindicator of eutrophication.

Further, different molecular approaches, mostly based on qPCR techniques, have been illustrated for various purposes, as the molecular phylogeny and statistical parsimony distribution of harmful Pseudo-nitzschia species, or the quantification of ribosomal genes per cell as molecular markers for taxonomic and physiological studies. Recent advances on the the qPCR based assay proved useful to estimate the abundance of toxic Ostreopsis cf. ovata cells in the marine aerosol implicated in the human respiratory syndromes in the Mediterranean Sea.

The debate continued on the toxic blooms of Ostreopsis cf. ovata that produce palytoxin-like compounds harmful for the marine biota and humans. In a in vitro assay under controlled conditions, O. cf. ovata produced mucilage with toxic effects. Mucilaginous filaments are associated with toxicity on Artemia salina bioassay. This is an important finding on the key-role of mucilage in growth strategy and micropredation process of Ostreopsis sp. in the benthic ecosystem.

Interactions Prokaryotes-Eukaryotes

Gulsen Altug, Istanbul University, Turkey

Résumé

A brief presentation of the subject was given by the moderator. emphasizing the global importance of these interactions. For example, relationships between bioactivity and occurrence of proteobacteria in sponges have medical and environmental significance. The general comments were converging: to provide future drugs against diseases, such as antibiotic-resistant infections, cancer and malaria, there may be possible resources.

The five presentations contributed to clarify: host associated bacterial diversity, toxicity of cyanobacterial strains on some host organisms, algal-bacterial interactions, bacteria and environmental changes on the coral surface, changes in primary productivity and chlorophyll content. The communications and debates were focused. Future studies will likely reveal environmental changes on the coral surface, and the role of coral mucus and beneficial microbes in coral health.

Marine - Omics / ABS

Frank Oliver Glöckner, MPI-Bremen & Jacobs University Bremen, Germany

Résumé

The introduction emphasized that the advent of the new Omics techniques has revolutionized how marine biodiversity and function can be addressed. Especially mass-spectrometry and proteomics have shown to be effective methods to investigate the active workhorses ? the enzymes ? in single organisms as well as in whole communities. Applications include all three domains of life, from marine Bacteria and Archaea to small and large Eukaryotes. The broader application of Omics only contributes to our knowledge and understanding of the marine ecosystem, but provides prime targets for new biotechnological applications. This raises the issue of equitable access and benefit sharing (ABS) between provider states and users of biodiversity, which is of special interest for the Mediterranean Sea.

Seven communications were presented and followed by an intense discussion. Starting with two talks focusing on the investigation of aromatic compounds degradation pathways as well as the lifestyle of the Roseobacter clade, the follow up speakers expanded the application of proteomics to the Dinoflagellate Catanella under metallic stress conditions and Chrysophsins in farmed sea Bass mucus. Before moving on to the important question of intellectual property management and access and benefit sharing, the EU project Micro B3 with its Ocean Sampling (OSD) day on 21 June 2014 was presented. The cumulative OSD samples, related in time, space and environmental parameters, will provide insights into fundamental rules describing microbial diversity and function. They will also be a perfect use case for model contracts on ABS as well as data and material transfer agreements of samples under national jurisdiction. To facilitate the use of Marine Genetic Resources in the Basin, a pool of genetic resources for the Mediterranean was proposed in the last talk as a simple and fair mechanism to enable access and avoid conflicts of interests between Mediterranean States.

The discussion started with very practical issues on the exchange of data between different researchers. Still a huge heterogeneity of tools and exchange formats exists, hampering to easily synthesise and analyse data across studies. Bioinformatic skills are often a bottleneck at the marine biological labs and research sites to support the workflow from data acquisition to submission. It became clear that Omics technologies need to be applied complementarily and data need to be combined to get a more ?complete? view on marine ecosystems functioning. The technological progress has also opened the road for new applications for all colours of biotechnology. To fully unfold this potential for the bioeconomy in the Med, a commonly accepted stable legal framework for marine genetic resources is of utmost importance.

Microbial diversity

Monia El Bour, INSTM, Tunisie

Résumé

The introduction emphasized that marine microbial diversity investigations have progressed in scale from optic microscopic counting to the newest gene sequencing generations and modern molecular ?omics tools (metagenomics, metaproteomics, etc), which have greatly contributed to the rapid advancement of our understanding of microbial diversity and its functions in the world oceans. Much remains to be found since deep exploration of marine microbial diversity has just begun.

Eleven communications were presented and followed by an intense discussion. The speakers described several aspects of marine microbial diversity for several zones of the Mediterranean Sea and Black Sea, considering their metabolic active forms, xenobiotic pollutant tolerance, trophic levels and pathogen influence mainly for bacterial communities and virulent forms present in water columns or sediments. For several pathogens the effect of sediment characteristics on their survival was highlighted by in vitro assays. Further, epiphytic microbial communities were described for species of sponges or seaweeds with hypotheses about these marine host-microorganisms interactions or symbiosis.

The debate made clear that deep investigations on fonctionality and metabolic processes for marine microbiota are still needed for a large number of marine organisms and sites in the Mediterranean Sea basin. Therefore monitoring surveys for microbial diversity should be intensified to determine their metabolic pathways and interactions with macro-organisms and substrates under different conditions. Besides, a clear need was expressed to intensify in vitro assays under controlled conditions to assess the specific influence of biotic or abiotic parameters in different metabolic marine processes

Microbial pathways

Gian Marco Luna, CNR - ISMAR, Venice, Italy

Résumé

This session, attended by some 100 researchers, began with a brief introduction about recent discoveries, and some future perspectives of research, on microbial processes in the surface and deep waters of the Mediterranean and the Black Sea. The following flash talks did cover a very broad range of topics, ranging from nitrogen fixation in the photic and aphotic zones to bacterial bioluminescence, from the effect of temperature on microbial activities to how dense water transiting can modify processes in deep waters. Other interesting contributions concerned microbial food webs in Mediterranean coastal areas, and the role of eukaryotic predation.

Following the brief communications, the scientific debate arose. Overall, this led to an intense discussion, and a vivid participation by a large percentage of the audience. A number of potential future research priorities emerged from the debate: the need to understand relationships between processes and climate variability, the necessity to study fast-emerging, yet poorly known microbial processes (e.g. dark CO2 fixation and heterotrophic N2 fixation in deep waters), the requirement for a better identification of the controlling factors and drivers (including some geological drivers, such as the seafloor morphology). An interesting discussion was about the role of high pressure devices to measure microbial rates at in situ pressure, an important issue deserving future investigations. The combination of metagenomics, molecular ecology, remote sensing of microorganisms and modeling will undoubtedly help to decipher the role of marine microbes in the functioning of the Mediterranean and Black Sea.

Phytoplankton

Asma Sakka Hlaili, Faculté des Sciences de Bizerte, Tunisie

Résumé

The communications presented dealt mainly with (1) temporal and spatial dynamics of phytoplankton; (2) size structure and diversity of phytoplankton (3) algal succession and controlling physical-chemical factors and (4) fast shift of phytoplankton structure including algal blooms.

The presentations were followed by a general discussion concerning mainly two points: (1) the identification of species bio-indicators of local or global changes (eutrophication and acidification of seawater, climatic warm, chemical contaminations?); and (2) novel approaches and methods for in situ monitoring of phytoplankton. In particular, the combination of automated flow cytometry and remote sensing achieved optimal in situ observations of phytoplankton and provided relevant data sets that are needed to understand the role of phytoplankton in biogeochemical cycles and the impact of environmental changes on the community of primary producers.

Session

Blue biotechnology

Modérateur : **Balbina Nogales**

ETUDE *IN VITRO* DE L'ACTIVITÉ ANTIOXYDANTE DE QUELQUES ESPÈCES ALGALES AU NIVEAU DES CÔTES DE LA CHEBBA

Rihab Ben Abdallah [1]*, Hamadi Fetoui [2], Imed Jribi [3] and Karima Belghith [4]
[1] Faculté des Sciences de Sfax - rihab_b86@hotmail.com
[2] Unité de recherche UR11ES72 : Toxicologie-Microbiologie Environnementale & Santé
[3] Unité de recherche UR11ES72 : Biodiversité et écosystèmes aquatiques
[4] Laboratoire des Biotechnologies Végétales Appliquées à l'Amélioration des Cultures (LBVAAC)

Abstract
Quatre espèces algales ont été récoltées de la région de la Chebba : deux algues brunes (*Dictyota dichotoma* (*Dd*) et *Cystoseira crinita (Cc)*) et deux algues vertes (*Anadyomene stellata (As)* et *Flabellia petiolata (Fp)*) pour étudier leurs teneurs en phénols totaux, flavonoïdes, tannins condensées et statut antioxydant. L'analyse de ces extraits algaux a montré une richesse en polyphénols, flavonoïdes et en tannins condensés, possédant un statut antioxydant puissant. Ce qui confirme l'intérêt applicatif de ces algues comme source de nouveaux composés antioxydants qui pourraient être utilisés dans différents domaines

Keywords: Algae, Tunisian Plateau

I. Introduction : Les algues présentent un intérêt nutritionnel connu et exploité depuis de nombreuses années, notamment par les populations du Sud-Est asiatique. Récemment, et vue leur richesse en produits naturels, la recherche tunisienne s'est orientée vers l'identification de nouvelles molécules qui suscitent un intérêt croissant en vue de leur application en cosmétique, en pharmacologie et en médecine. Dans ce contexte, nous nous sommes intéressés à l'étude de quatre espèces algales prélevées de la zone de Chebba afin d'identifier leurs caractéristiques physicochimique et antioxydante.

II. Matériel et méthodes :

II.1. Extraction par macération : On met la substance végétale émincée et pilée dans un récipient en contact prolongé avec des solvants organiques de polarité croissante (Hexane ; Acétate d'éthyle; Méthanol) pendant 24h d'agitation à température ambiante afin de calculer les rendements.

II.2. Détermination des teneurs en composés bioactives Le dosage des composés phénoliques est déterminé par la méthode colorimétrique par le réactif de Folin Ciocalteu (1). Le dosage des flavonoïdes est déterminé par la méthode colorimétrique par le tri chlorure d'aluminium (AlCl3) (2).Les teneurs en tanins condensés dans les échantillons ont été déterminées par le Vanilline en milieu acide (3).La capacité antioxydante totale est basée sur la réduction du Mo(VI) en Mo(V) et la formation du complexe molybdo-phosphate qui présente une coloration verte (4).

III. Résultat et discussion :

III.1. Extraction des composés actifs algaux : Les résultats présentés dans le tableau 1 montrent que le méthanol présente le meilleur rendement pour les quatre espèces algales. Ces algues sont plus riches en composés polaires qu'en composés apolaires.

Tab. 1. Rendement des différents extraits algaux.

	Extrait à l'Hexane	Extrait à l'acétate d'éthyle	Extrait au méthanol
Dd	0,66%	1,60%	3,01%
Cc	0,30%	0,64%	2,88%
As	1,47%	0,91%	10,39%
Fp	8,00%	5,80%	15,70%

III.2.Détermination des teneurs en composés bioactives: L'analyse des extraits en composés phénoliques a montré que l'extrait méthanolique à partir de l'algue verte *Anadyomene setellata* est la plus riche en ces composés (37 méq AG / g extrait) (Tableau 2). Bien que, l'éthanol et le méthanol fussent les meilleurs solvants que d'autres en extrayant les composés phénoliques, en raison de leur polarité et de leur bonne solubilité pour ces composés, nos résultats ont prouvé que le méthanol et l'acétate d'éthyle étaient les meilleurs solvants pour extraire les composés phénoliques, suivi de l'hexane.

Tab. 2. Les teneurs en composés bioactives des différents extraits algaux.

	Dd	*Cc*	*As*	*Fp*
	Teneur en phénols totaux (méq Acide gallique/g extrait)			
E.H	9.55	8.82	19.37	13.801
E. AE	14.41	13.49	26.80	20.55
E.M	10.80	11.69	37.94	26.80
	Teneur en flavonoïdes (méq quercétine/g extrait)			
E.H	7.5	62.38	49.70	19.22
E. AE	11.65	9.96	3.75	52.16
E.M	3.19	3.198	5.22	1.80
	Teneur en tanins condensés (méq Catechine/g extrait)			
E.H	7,5	6,23	4,97	1,92
E.AE	11,654	9,96	3,75	5,21
E.M	3,198	3,198	5,22	1,801
	Statut antioxydant (méq acide ascorbique/g extrait)			
E.H	3,99	6,28	5,43	6,05
E.AE	42,65	57,02	43,25	16,07
E.M	55,90	16,55	6,81	22,34

E.H : Extrait hexanique, E.AE : Extrait à l'Acétate d'éthyle, E. M : Extrait méthanolique

De plus, la détermination quantitative des flavonoïdes totaux par la méthode du trichlorure d'aluminium révèle que l'extrait à l'hexane et à l'acétate d'éthyle est la plus riche en flavonoïdes avec des teneurs qui peuvent atteindre 63 méq QE au niveau de l'extrait hexanique chez *Cc* et 50 méq QE au niveau de l'extrait à l'acétate d'éthyle chez *Fp* (Tableau 2). L'examen de ces résultats permet de mettre en évidence une corrélation linéaire significative (r^2 =0,59, $p \leq 0.05$) entre la teneur des extraits en flavonoïdes et en composés phénoliques. Ceci est logique étant donné que les flavonoïdes représentent les composés majoritaires des polyphénols. Dans le même contexte, l'analyse des extraits algaux en tannins condensés révèle que l'extrait à l'acétate d'éthyle présente les teneurs les plus importants en tannins avec des taux qui peuvent atteindre 11,65 méq catéchine / g extrait chez *Dd* et 9 ,96 méq catéchine / g extrait chez *Cc*. D'autre part, l'analyse du statut antioxydant des espèces algales a montré que les extraits à l'acétate d'éthyle présentent les capacités les plus élevées qui peuvent atteindre 57 méq AA d'extrait chez *Cc*. L'extrait methanolique chez Dd présente également des capacités antioxydantes importantes (55 méq AA) par apport aux autres espèces (Tableau 2). Ces résultats sont en accordance avec ceux de Kumaran et al (2007) qui ont montré que l'activité antioxydante potentielle qui peut atteindre 245 à 376 mg AA /g extrait chez des fractions algales méthanoliques.

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ARTIFICIAL NEURAL NETWORK MODELLING FOR SELF-POLISHING COATINGS IN MARINE APPLICATIONS

Levent Cavas [1]*, Zeynelabidin Karabay [1], Gurbuz Comak [1] and Cagin Kandemir-Cavas [2]
[1] Dokuz Eylül University, Faculty of Science Department of Chemistry - levent.cavas@deu.edu.tr
[2] Dokuz Eylül University, Faculty of Science, Department of Computer Science, Izmir-Turkey

Abstract
An artificial neural network (ANN) modelling was developed to estimate the effect of the fibre addition on self-polishing percentages of a lanolin-based material used to prevent biofouling formation.

Keywords: Biotechnologies, Fouling, Chemical analysis, Aegean Sea

Introduction
Analysing complex data and predicting relationship between components [1] or reactants [2] are usually difficult as the entire system is dependent upon more than a few variables, which indicates the number of dimensions of the system. ANN could provide invaluable information in such complex cases as it would be able to create a function for these kinds of non-linear systems where complexity is enormous [3]. Lanolin is commercially obtained from sheep wool. It has so far been widely used in many biotechnological applications [4-5]. Fibre-reinforced lanolin-based material is recommended for propeller protection as an eco-friendly solution for preventing biofouling organisms. Biofouling has a lot of negative effects not only for propellers and ships' hull but also for bridges [6]. Self-polishing percentage (SP %) of lanolin-based material depends on a number of parameters such as fiber type and content (%), temperature and rotary rate.

Materials and Methods
The lanolin based material (LBM) was provided by the Henleys Propellers & Marine LTD, New Zealand. The commercial fibres, Rockforce® MS730-Roxul®1000 and Rockforce® MS675-Roxul®1000, were kindly provided by Lapinus Fibres, the Netherlands. In order to study the self-polishing percentages of the LBM, LBM was applied into the glass surfaces (26x76 mm) and then exposed to rotary test by a rotary rate controlled magnetic stirrer (Heidolph MR Hei-standard). Function approximation by the means of MATLAB® 2012b ANN Toolbox used in this study is basically error-based learning, which is based on Levenberg-Marquardt backpropagation. First, an ANN network, a function was developed with existence data, inputs and outputs (SP %). The network was subsequently tested with a number of randomly selected inputs.

Results and Discussion
Fibre type, fibre content (%), rotation time and rate were used as input rates and the self-polishing percentage as an output and calculated as;

$SP\% = ((w_i - w_f)/w_i))*100$

where SP%, wi and wf are expressed as self-polishing percentage, initial weight of plate and final weight of plate, respectively. Figure 1 shows the comparison of experimental and ANN Network modelling results. The correlation created using ANN network gives reasonable accuracy as the regression is 0.9154.

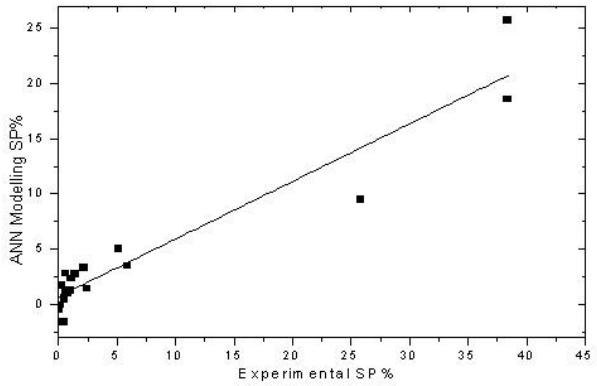

Fig. 1. A comparison of SP% results of ANN Modelling and experimental studies. 20 samples out of 210 were arbitrarily selected for comparison study.

A total number of 190 data were used to form the ANN network where 90%, 5% and 5% were used training, validation and test, respectively. In the present study, the plates coated by LBM remarkably prevented biofouling. However, the control plates were covered by micro- and macro-fouling organisms such as *Bugula* sp., *Balanus* sp., *Hydroides* sp., *Navicula* sp. and *Achnanthes* sp. It is suggested that the addition of particular fibres into LBM significantly increase the mechanical durability of the material, thereby increasing antifouling activity. ANN modelling tool brings new approach to analyse complex data and estimate better eco-friendly antifouling formulations for marine applications.

Acknowledgements
We would like to thank 7th Framework Programme (Carboncomp, Grant agreement no.: 286413) for financial support.

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AIR-LIFT PHOTOBIOREACTOR PRODUCTIONS OF *CYLINDROTHECA CLOSTERIUM* AND *NITZCHIA* SP.

Zeliha Demirel [1]*, Esra Imamoglu [1], Ender Cimen [1] and Meltem Conk Dalay [1]
[1] Ege University, Faculty of Engineering, Department of Bioengineering, Izmir, 35100, Turkey - zelihademirel@gmail.com

Abstract
Diatoma species, which are widely distribute in marine coastal waters, were collected "Exploring Marine Resources For Bioactive Compounds: From Discovery to Sustainable Production and Industrial Applications (MAREX)". *Cylindrotheca closterium* and *Nitzchia* sp. were isolated from Aegean Sea in Izmir, Turkey. The aim of this study was to determine the effect of nitrogen on the growth rates, lipid yields and fatty acid compositions of C.closterium and Nitzchia sp. in the air lift photobioreactor. Lipid concentrations were determined gravimetrically and fatty acids were analyzed by GC-MS. Biomass concentration and doubling time were also measured. Both of the diatoms were showed the same tendency. As a result of, the existence of nitrogen has a positive effect on the biomass and the lipid content for both diatoms at the same light intensity.

Keywords: Diatoms, Izmir Bay, Biomass, Chemical analysis

Introduction
Diatoms are an important group of phytoplankton's that are widely distributed in the oceans, but are also found in fresh and brackish water, which are taking the attention with their siliceous in cell walls [1]. The aim of this study was to determine the effect of nitrogen in the culture medium on the growth rate, lipid yields and fatty acid composition of two species of diatoms, *C.closterium* and *Nitzchia* sp.

Material and Methods
C. closterium (JQ886456) and *Nitzchia* sp. (JQ886457) were isolated from Aegean Sea in Izmir, Turkey. The cultures were grown under 20±2 ºC in N and N-free F/2 media at 56 µmol photons m^{-2} s^{-1} with 12:12 light and dark period in air lift PBRs for 13 days. The determinations of the biomass were carried out by the measuring the absorbance values using a spectrometer and by counting the cells in a Neubauer chamber using a microscope. The specific growth rate (µ) of the cells was calculated from the initial log phase of growth for at least 48 h, as $\mu = lnX2 - lnX1/dt$, where X_2 is the final cell concentration, X_1 is the initial cell concentration and dt=X_2-X_1.
Photobioreactor cultivations were harvested by centrifugation and washed with distilleted water. They were stored at −20 °C until lyophilization. Oil was extracted from dried algal biomass by a modified method of Bligh and Dyer [2]. The lipid concentration was determined gravimetrically. Fatty acids were analyzed by GC-MS [3].

Result and Discussion
Microalgal production of triglycerides and fatty acids plays an important role in some energy, aquaculture, nutraceuticals and pharmacological applications [4, 5]. F/2 media were prepared both with and without nitrogen to determine the effect of nitrogen availability in the medium for *C. closterium* and *Nitzchia* sp in air-lift PBRs (Fig 1, 2). At the end of the period, nitrogen cultures reached the maximum biomass, although nitrogen-free cultures were not shown significant rise. The fatty acids compositions determined by the GC-MS during the stationary phases of growth were shown in Table 3.

Acknowledgements; This project is a part of MAREX-245137 and the authors wish to thank EU- FP7 for the financial support.

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EVALUATION OF DIFFERENT PARAMETERS ON BIOMASS AND EXTRACT YIELDS OF SEAWEEDS TO OPTIMIZE ITS BIOTECHNOLOGICAL PRODUCTION FOR INDUSTRIAL APPLICATIONS

Gamze Turan [1], Cigdem Demirkaya [2], Zeliha Demirel [3]* and Meltem Conk Dalay [4]
[1] Ege University, Fisheries Faculty, Department of Aquaculture, 35100 Bornova, Izmir, Turkey
[2] Ege University, Faculty of Engineering, Department of Bioengineering, 35100 Bornova, Izmir, Turkey
[3] Ege University, Department of Bioengineering - zelihademirel@gmail.com
[4] Ege University, Faculty of Engineering, Department of Bioengineering, 35100 Bornova, Izmir, Turkey

Abstract
The objective of this study, which is supported by an EU Project called ***MAREX***, was to investigate the growth and bioactive molecule yields of native green seaweed species, *Ulva rigida*, which distributed along the coast of Turkey and has high potential for industrial applications. Results of the study indicated that *Ulva* growth and extract yield percentages were significantly different among the treatment groups of different nitrogen-enriched F/2 medium, temperature, salinity, aeration, illumination, etc. and it was concluded that *U. rigida* may be produced via biotechnological processes or optimized culture conditions in a sustainable medicinal chemistry program with the aim of developing *Ulva*-based agents to the stage where they are available for various industrial applications.

Keywords: Biotechnologies, Aegean Sea, Algae

Material and Methods :

- **Seaweed Collection:** *Ulva rigida* samples were collected from the coast of Inciralti (38°24' 42 N, 27°02' 29 E), Izmir Bay, Izmir, Turkey.
- **Seaweed Optimization Studies:** Collected *Ulva* individuals were placed in the growing vessels where a total of 17 treatment groups were applied. Growth rates of *Ulva* were measured daily and presented as percentage. Experimental treatment groups were included: Group 1 (200% nitrogen), Group 2 (100% nitrogen), Group 3 (0% nitrogen), Group 4 (with $\%_0$ 25 salinity), Group 5 (with $\%_0$ 50 salinity), Group 6 (with $\%_0$ 100 salinity), Group 7 (no aeration), Group 8 (low aeration), Group 9 (high aeration), Group 10 (no light-dark treatment), Group 11 (low light), Group 12 (high light), Group 13 (20 ^{0}C), Group 14 (30 ^{0}C), Group 15 (low *Ulva* density), Group 16 (moderate *Ulva* density), and Group 17 (high *Ulva* density).
- **Crude extracts from the seaweeds:** The lyophilised *Ulva* samples were extracted with 80% ethanol using Soxhlet apparatus and the extract yields were measured volumetrically and presented as percentage.
- **Statistical Analysis:** All data with three replicates were analyzed using SPSS statistic program ($P \leq 0.05$) and represented as mean ± sd.

Results and discussion :

Overall, biomass and extract yields of *Ulva* were experiment treatment group-depended (Figure 1). *Ulva* growth was found to be quite manageable for production. The highest biomass yield was recorded as 2.80 %.day^{-1} in Group 4 (with $\%_0$ 25 salinity) , followed by 1.89 %.day^{-1} in Group 9 (high aeration) and 1.45 %.day^{-1} in Group 13 (20 ^{0}C).

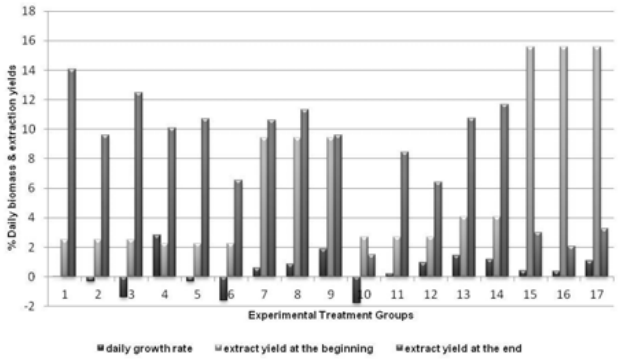

Fig. 1. Ulva Biomass as daily growth rate (%0. day-1) and extraction yields as percent dry weight (% dry weight) results among the seventeen experimental treatment groups.

Ulva has a significant increase in extract, such as 14 % of its dry weight in Group 1 (200% nitrogen), followed by 12% in Group 3 (0% nitrogen), 11 % in Group 8 (low aeration) and Group 14 (30 ^{0}C) and 10 % extract yield in Group 5 (with $\%_0$ 50 salinity), Group 7 (no aeration), and Group13 (20 ^{0}C).

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ROLE OF SIDEROPHORES PRODUCED BY *ALCANIVORAX BORKUMENSIS* DURING BIOREMEDIATION PROCESSES

R. Denaro [1]*, S. Mazzola [1], L. Genovese [1], M. Genovese [1], F. Crisafi [1], D. Russo [2] and M. Yakimov [1]
[1] Institute for Coastal Marine Environment IAMC CNR - renata.denaro@iamc.cnr.it
[2] Dpt. Animal Biology and Marine Ecology. University of Messina

Abstract
Hydrocarbonoclastic bacteria exhibit genetic and phisiological features to use hydrocarbons as sole source of carbon and to compete for the uptake of nutrients. As an example the iron uptake system includes the production of siderophores, small high-affinity iron chelating compounds. We identified the siderophore produced by *Alcanivorax borkumensis*, which behaves as a shuttle transferring iron from marine environment within the cell. Such siderophore belongs to the hydroxamates group and it is one of the few isoxazolidine found in nature which mimics the antibiotic action of the β-lactams. The alternance of dominant members of microbial communities in oil polluted marine samples and in pure cultures, revealed that the siderophores produced by Alcanivorax sp act as inhibitor factors during the competition for substrates.

Keywords: Pollution, Petroleum, Biotechnologies, Messina Strait

Bioremediation in marine environment is a promising cheap biotechnology which proposes the recovery of hydrocarbons-polluted sites exploiting the self-cleaning capacity of the sea. A special group of hydrocarbons-degrading marine bacteria (HCB), namely *Alcanivorax* sp., *Cycloclasticus* sp., *Thalassolituus* sp., *Oleispira* sp., *Oleiphilus* sp., exhibit both genetic and phisiological features to use hydrocarbons as sole source of carbon and energy and to compete for the uptake of nutrients. Among these, iron is one of the essential nutrients for the success of in situ biodegradation by microrganisms. In fact, for in situ biocatalysis, the iron is one of the limiting factors because of its very low availability in marine environment. To bypass this matter, bacteria have developed the capability to produce siderophores, small high-affinity iron chelating compounds which behave as a shuttle taking iron from marine environment and transferring it within the cell. Bacterial siderophores have been associated to many biotechnological application: drug delivery, bacterial communication, antibiotic function, iron chelator in iron metabolism diseases, inducers of bacterial growth, quorum sensing, but up to day there are very few study on the role of siderophore within natural occurring biodegradation processes.

The aim of the present study was to study the role of siderophores produced by *Alcanivorax borkumensis* during the processes of bioremediation.

We have performed a first screening on the production of siderophores both in solid and liquid CAS-assay using HCB as samples. *Alcanivorax*, *Thalassolituus* and *Oleispira* were positive to the test, on the contrary, *Cycloclasticus* didn't show siderophore activity, data confirmed by the the lack of genes involved in siderophore production in *Cycloclasticus* genome.

After the first screening we decided to proceed with the isolation and characterization of the siderophore produced by the most known hydrocarbonoclastic strain, *Alcanivorax borkumensis*. *Alcanivorax* produces a siderophore which belongs to the hydroxamates group and is one of the few isoxazolidine found in nature, very similar to pesudomonine produced by *Pseudomonas fluorescens*, it seems to mimic the antibiotic action of the β-lactams and show a high affinity for iron. Experiments carried out in pure culture of *Alcanivorax borkumensis* showed that when the growth was in the medium containing optimal concentration of iron we were not able to detect siderophores production. On the contrary, in iron limiting conditions we have registered the highest siderophore activity during the esponential phase of growth. Moreover, at the same phase we didn't registered significant differences in the rate of tetradecane degradation between optimal and iron limiting conditions, suggesting that siderophores play a pivotal role in natural environment during biodegradation processes.

One of the interesting feature of microbial siderophores is that some of the microbial community members (helpers) are usually the most active in the production of siderophores, such siderophore–iron complexes can be used by the no-siderophore-producer (cheaters). In the present study we observed whether such crossfeeding occurs among the HCB strains during bioremediation processes. We monitored the growth of *Cycloclasticus* (no siderophores-producers) in a medium amended with siderophore produced by *Alcanivorax*. We observed that the addition of siderophore didn't facilitate *Cycloclasticus* growth in iron-limiting conditions. On the contrary, siderophores seemed to have an inhibitor effect on the growth of *Cycloclasticus* during the first 10 days.

At the moment we are not able to explain this behaviour. On the basis of our previous studies, we know that during treatment of bioremediation of oil-polluted marine sediments, an alternance of *Alcanivorax* and *Cycloclasticus* as active dominant members occurred. Further studies are suggested to verify if *Alcanivorax* is able to modulate, by the use of siderophores, interspecific interaction during the processes of bioremediation for the competition of substrates.

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FIRST IDENTIFICATION OF BACTERIOCIN PRODUCING *LEUCONOSTOC* LACTIC ACID BACTERIA FROM *OREOCHROMIS NILOTICUS* FISH FARMED IN TUNISIA

R. El Jeni [1]*, M. El Bour [1], P. Calo-Mata [2], B. Bouhaouala-Zahar [3] and J. Barros-Velázquez [2]
[1] INSTM Institut National des Sciences et Technologies de la Mer. - eljeni.rime@gmail.com
[2] School of Veterinary Sciences, University of Santiago. Lugo Spain
[3] Institut Pasteur de Tunis (IPT)

Abstract
The characterization of lactic acid bacteria of *Leuconostoc* genus, isolated from different organs of Nile Tilapia, was carried out in order to assess their antibacterial activities against different pathogen species of bacteria. Universal primers p8FPL / p806R was used to molecular identification of isolates. Thus, twelve LAB with important antibacterial activities were identified as members of *Lc. Mesenteroides* (8 strains), *Lc. Pseudomesenteroides* (3 strains) and *Lc. Citreum* (1 strain). These antimicrobial activities were sensitive to proteinase K and revealed the eventual proteinaceous nature of these substances. These results highlighted the first report on bioactive *Leuconostoc* strains isolated from freshwater fish in Tunisia with local potential for their further probiotic use experiments.

Keywords: Aquaculture, Fishes, Tunisian Plateau

Introduction

The genus *Leuconostoc* includes Gram-positive lactic acid bacteria hetero-fermentative, aero-anaerobes and catalase free. They are present most often in association with plants, meat or milk and dairy products. The antimicrobial effect due to bacteriocins produced by*Leuconostoc sp.* was observed for the first time in 90's years [1] including *Leuconostoc mesenteroides* Y105 from goat's milk [2]. The present data highlighted for the first time the isolation of *Leuconostoc* from different organs of freshwater fish *Oreochromis niloticus* (Tilapia) with large antibacterial activities against several food borne pathogens for human or in aquaculture.

Material and Methods
LAB were isolated from samples of skin, gills and intestine of tilapia *Oreochromis niloticus* collected from a northern dam in Tunisia used to farming activities. First isolation of the strains studied was realized in MRS (Liofilchem, Italy) agar medium with incubation at 20ºC for 48h. Antimicrobial activity was assessed for the isolates using well diffusion agar technique [3] in addition to test of sensitivity to proteinase K. Their molecular identification was performed using universal primers set p8FPL/p806R.

Results and discussion
Cultural methods were applied for the isolation of twelve lactic acid bacteria that were identified by morphological and molecular methods as members of *Lc. mesenteroides, Lc. pseudomesenteroides* and *Lc. citreum* (Figure 1). The results of their bioactivities showed that these strains display large antibacterial activities against several pathogen species of bacteria (Figure 2). Previous data signalled *Lc. citreum* and *Lc. mesenteroides* both from fermented fish [4]. The present study revealed *Leuconostoc* genus related to freshwater Tilapia *Oreochromis niloticus* environment with mainly isolated species of *Lc. Mesenteroides, Lc. Pseudomesenteroides* and *Lc. Citreum*. The Proteinase K test indicated probably proteinaceous nature of the bioactive coumpound(s) of the identified *Leuconostoc* species [5]. Nevertheless, further tests continue to be done to suitable characterization of eventual antibacterial peptides using proteomic approach in order to finalize bacteriocin compounds related to*leuconostoc* species identified.

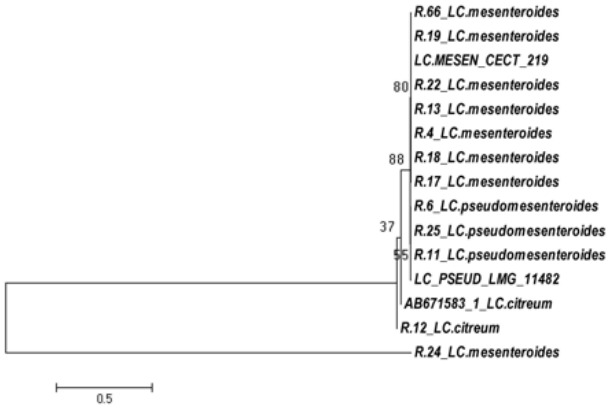

Fig. 1. Phylogenetic analysis of the nucleotide sequences of the 16S rRNA gene of *Leuconostoc* by means of the neighbor-joining method. Numbers above and below branches indicate bootstrap values from neighbor-joining analysis.

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HIGH LIPID INDUCTION IN LOCALLY ISOLATED MICROALGAE FOR BIODIESEL PRODUCTION

Samy Bayoumy [1], Laila M. Farahat [1]* and Abo-Alkhair Badawi [2]
[1] Egyptian petroleum Research Institute (EPRI) - lailafarahat@yahoo.com
[2] National Research Center

Abstract

Study of increasing lipid production from fresh water microalgae (*pleurochloris pyrenoidosa*) was conducted by subjecting it to chemical stress, including some factors such as the effect of NaCl, $NaNO_3$ with different concentrations and environmental stress such as pH. A significant increase in lipid content from 19% to 35% was detected when increasing NaCl concentrations from 5 to 17 g/L and on addition of 8 g/L $NaNO_3$. The growth measurement showed a positive correlation and maximum lipid content was recorded at pH 4. The extracted lipid from (*pleurochloris pyrenoidosa*) indicates that oleic acid the most common fatty acid content in biodiesel represents 57.94%.

Keywords: Algae, Salinity, Growth, Nile Delta

Introduction: Microalgal lipids are the oils of the future for sustainable biodiesel production. Microalgae offer a very promising source of biomass due to very high productivity comparing to other oil crop plants in addition to its potential of being incorporated with CO_2 mitigation (1). High lipid productivity of fast growing algae is a major prerequisite for commercial production of biodiesel which can be considered a biodegradable, renewable and non-toxic biofuel. However under optimal growth conditions, large amounts of algal biomass are produced but with relatively low lipid while species with high lipid content are typically slow gowing. Under nufavorable environmental stress chemically or physically conditions microalgae alter their lipid biosynthesis toward the formation and accumulation of neutral lipid from 20 to 50% mainly in the form of triatheyl glycerol (TAG) (2). **Material and Methods :** The microalgae (*pleurochloris pyrenoidosa*) was isolated from local fresh water collected from El-Mahmoudea canal in Alexandria. It was preserved and grown in BG11 medium, tested for lipid productivity by cultivating it in a cylindrical glass photo bioreactor with four liter of working at 26°C ± 1. The culture was grown under light intensity of 3000 lux using fluorescent tubes and aerated with compressed air. The isolate was studied under different pH values (4-11), different NaCl concentrations (5-17g/l) and $NaNO_3$ (5-20g/l) and incubated for 21 days. The total lipids were extracted by mixing chloroform –methanol in proportion in 1 to1 according to (Bligh and Dyer's method) (3). All statistical analysis were performed according to the T-test one-way ANOVA test.

Results & discussion : *Pleurochloris pyrenoidosa* isolated from fresh water canal (Mahmoudia canal) in Alexandria has a high lipid content reached (19%) with good growing rate which can considered suitable as a raw material for biodiesel production. A significant increase in lipid content was recorded on addition of $NaNo_3$ concentration 8 g/l while the growth is not affected (4). The desired salt concentration were added at early stationary phase, the culture were withdrawn after 21 days of incubation, although the growth of microalgae was decreased by increasing NaCl concentration from 5 to 17 g/L, lipid content with enhanced at the same time by 73% (5). pH was the important environmental factor affecting cells growth and products formation. Status of external pH can determine complex physicochemical parameters such as membrane permeability and cell morphology (6). pH value was varied from 4 to 11, max lipid content of pleuchlochris pyrenoidasa was recorded at pH 4.

Tab. 1. Effect of different pH values on OD, D.W (g/l) and lipid content (%) of *Pleurochlorispyrenoidosa* after 21 days.

pH	O.D	Dry weight g/l	Lipid per dry weight
control	23.86 ± .11 a	4.98 ± .17 a	19.003 ± .63 a
4	16.24 ± .63 b	2.66 ± .18 ac	36.65 ± 1.27 b
5	17.39 ± .40 b	3 ± .58 ac	23.29 ± .69 c
6	22.75 ± .28 a	5.01 ± 1. 7 a	14.086 ± .40 d
10	20.14 ± .07 d	3.49 ± 1.15 ac	31.95 ± 1.50 e
11	18.75 ± .52 e	3.23 ± .26 ac	18.29 ± .35 a
12	8.56 ± .29 f	2.15 ± .12 c	13.02 ± .52 d
F ratio	175.000	1.775	105.717
P value	*	*	*

Each value is mean of 3 replicat ± standard error of means. *= significant at Pvalue ≤ 0.05.

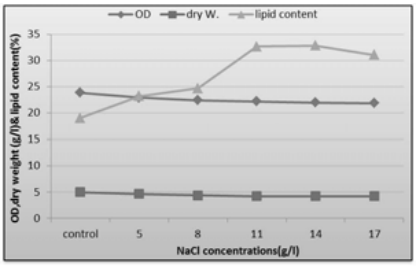

Fig. 1. Effect of different NaCl concentrations on OD, D.W and lipid content of *Pleurochlorispyrenoidosa* after 21 days.

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EFFECT OF LIGHT INTENSITIES ON THE GROWTH OF *PICOCHLORUM* SP.

Esra Imamoglu [1]*, Zeliha Demirel [1] and Meltem C. Dalay [1]
[1] Ege University, Faculty of Engineering, Department of Bioengineering, Izmir, 35100, Turkey - esraimamoglu@yahoo.com

Abstract
The aim of this study was to compare three different light intensities (30, 55 and 80 µmol photons m^{-2} s^{-1}) on the growth of *Picochlorum* sp. for batch cultivations. Experiments were carried out in 250 ml Erlenmeyer flasks containing 150 ml of F/2 medium at the shaking frequency of 150 rpm under the temperature of 25 °C for 12 days. After 12 days of cultivation period, the maximum specific growth rate of 0.141 day^{-1}, which correspond to the doubling time of 4.93 day was obtained for *Picochlorum sp*. with the agitation rate of 150 rpm at 25 °C under the light intensity of 55 µmol photons m^{-2} s^{-1}. When the light intensity was increased from 55 to 80 µmol photons m^{-2} s^{-1}, the biomass production was negatively affected due to the light saturation level of the cells.

Keywords: Algae, Biomass, Aegean Sea

Introduction
Microalgae constitute a diverse group of photosynthetic microorganisms which are distributed in a huge range of ecosystems and account for about 50% of global organic carbon fixation. Microalgal biomass is mainly used for aquaculture, animal feeding and for the extraction of high-added value compounds, used as nutraceuticals or dietetic complements in human nutrition [1]. *Picochlorum* sp. is a unicellular halotolerant green algae due to its growth rate under adverse conditions is a good candidate for outdoor culture. The characteristics of its lipid profile make *Picochlorum* sp. a promising candidate for biodiesel production and the high content in the carotenoids (lutein and zeaxanthin) indicates that the microalgae could also be a good source for natural eye vitamin supplement, which could be obtained as co-products [2]. This study on the determination of the light intensity was carried out to maximize the growth of *Picochlorum* sp. for batch cultivations.

Material and Methods
Microalgae Growth Conditions; *Picochlorum* sp. was isolated from Aegean Sea in Izmir, Turkey and deduced from the analysis of 18S rRNA encoding gene with the accession number of JQ981946. *Picochlorum* sp. was cultured under three different continuous light intensities (30, 55 and 80 µmol photons m^{-2} s^{-1}) in 250 ml Erlenmeyer flasks containing 150 ml of F/2 medium at the shaking frequency of 150 rpm under the temperature of 25 °C for 12 days. Illumination was provided by LED downlight lamp (Cata 10 W CT-5254) from the top of the orbital shaking incubator. Irradiance was measured in the center of the flask with a quantum meter (Lambda L1-185).
Analytical procedures; these investigations were carried out by the measurements of the absorbance value (556 nm). The number of cells was determined by counting in a Neubauer chamber using an Olympus phase-contrast microscope. Chlorophyll-a in the cells was extracted with 100 % (v/v) methanol solution. The Chlorophyll-a amount was determined spectrophotometrically by measuring the light absorption at different wavelengths (665 and 750 nm). The amount of protein was also determined using Bradford method with Brilliant Blue G 250 dye. The specific growth rate (µ) of the cells was calculated from the initial logarithmic phase of growth for at least 48 h, as $\mu = \ln X_2 - \ln X_1/dt$, where X_2 is the final cell concentration, X_1 is the initial cell concentration and dt is the time required for the increase in concentration from X_1 to X_2. Doubling time was also calculated as $DT = \ln 2/\mu$. Statistical analysis was made by analysis of variance (ANOVA). Results are expressed as mean ± standard deviation from duplicate samples.

Result and Discussion
The effects of 3 different light conditions on the growth of *Picochlorum* sp. were simultaneously investigated for 12 days of cultivation period. The experiments were performed under the same growth conditions. As shown in Fig. 1a, the similar absorbance values of 1.097±0.05 and 1.095±0.02 were obtained on the 12^{th} day at the light intensity of 80 µmol photons m^{-2} $s^{-1}$and at the light intensity of 30 µmol photons m^{-2} s^{-1}, respectively. The cell concentration reached the maximum value (4.16 x 10^7 cells ml^{-1}) at the light intensity of 55 µmol photons m^{-2} s^{-1} on the 12^{th} day of cultivation period (Fig. 1b). On the other hand, Chlorophyll-a concentration reached the maximum level of 8.72±0.05 mg/mL at the light intensity of 55 µmol photons m^{-2} s^{-1}, which was about 35% higher than the other light intensities at the end of the period (Fig.1c). No protein production was determined at the first 4 days of cultivation period under the light intensity of 80 µmol photons m^{-2} s^{-1}.

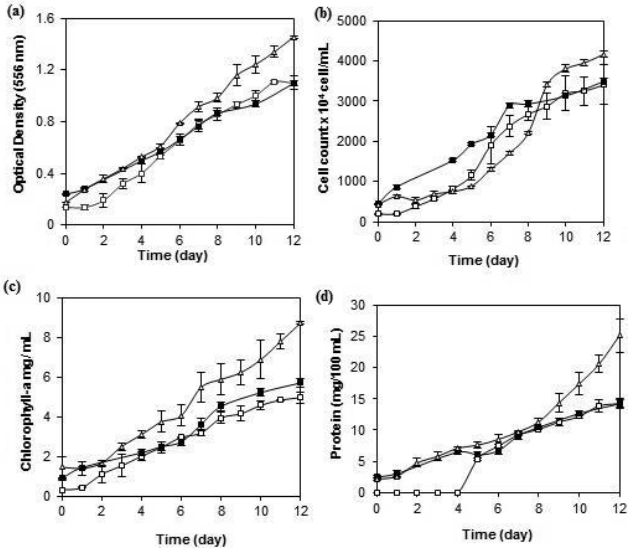

Fig. 1. Effect of different light intensities on the growth of *Picochlorum* sp.: (a) absorbance value, (b) cell count, (c) chlorophyll-a concentration and (d) protein concentration. close square: 30 µmol photons m^{-2} s^{-1}, open triangle: 55 µmol photons m^{-2} s^{-1}, open square: 80 µmol photons m^{-2} s^{-1}.

As reported by Vega et al. [2], the maximum biomass and cell density reached at the stationary phase by *Picochlorum* sp HM1 in batch cultures was 1.8 g DW L^{-1} and 4.4 x 10^7 cells mL^{-1}, respectively at 25 °C and under a continuous photon irradiance of 100 µE m^{-2} s^{-1}. In this study, the temperature degree was selected based on the reported paper by Vega et al. [2].
As shown in Table 1, the maximum specific growth rate of 0.141 day^{-1}, which correspond to the doubling time of 4.93 day was obtained for *Picochlorum sp*. with the agitation rate of 150 rpm at 25 °C under the light intensity of 55 µmol photons m^{-2} s^{-1} after 12 days of cultivation period.

Acknowledgements This project is a part of MAREX-245137 (Novel marine bioactive compounds for European industries) and the authors wish to thank EU- FP7 for the financial support.

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ANTIOXIDANT ACTIVITIES IN *SARCOTRAGUS SPINOLOSUS* AND *CRAMBE CRAMBE* (PORIFERA, DEMOSPONGIAE) ASSOCIATED BACTERIA

E. Perino [1]*, A. Horta [2], R. Manconi [3], R. Pronzato [1] and R. Pedrosa [2]
[1] Dip. di Scienze della Terra, dell'Ambiente e della Vita (DISTAV), Università di Genova, Italy - erica.perino@unige.it
[2] Grupo de Investigação em Recursos Marinhos (GIRM), ESTM, Instituto Politécnico de Leiria (IPL) Peniche, Portugal.
[3] Dip. Scienze della Natura e del Territorio (DIPNET), Università Sassari, Italy

Abstract
We evaluated the antioxidant potentialities of 55 bacteria strains associated with two Mediterranean sponge species. This evaluation was carried out by their ability to interact with the stable free radical 1,1-diphenyl-2-picrylhydrazyl (DPPH). Three of them showed a % of DPPH reduction of more than 40%.

Keywords: Biotechnologies, Mediterranean Ridge

Introduction
Since sponges are simple and sessile organisms; during evolution they have developed potent chemical defensive mechanism to protect themselves from competitors and predators as well as infectious microorganisms. These natural products have interesting biomedical potential, pharmaceutical relevance and diverse biotechnological applications. Furthermore, more sponge-derived compounds are in clinical and preclinical trials (*e.g.*, as anticancer or anti-inflammatory agents) than compounds from any other marine phylum [1]. Since chemical synthesis of natural products can be problematic and expensive due to their structural complexity. Sponges are known to host a large community of microorganisms, which can represent a significant percentage (up to 50–60%) of the sponge biomass [2-3]. Current data suggest that at least some of the compounds are of bacterial origin [4], and several reviews discussed the role of symbionts in sponge chemistry and the pharmacological, ecological implications. In this study we performed a screening of antioxidant activities of sponge associated bacteria from the two common Mediterranean sponges: *Crambe crambe* and *Sarcotragus spinosulus*. Both sponges are known to possess an array of bioactive compound.

Material and methods
We collected by SCUBA *C. crambe* in Lugurian Sea (NW Mediterranean Sea, Italy) and *S. spinosulus* in Sardianian Sea (NW Mediterranean Sea, Italy). After collection the sponges were rinsed for remove the non-associated bacteria and the bacteria was collected and isolated. The bacteria obtained were then selected and then grown for obtain biomass. The biomass achieve after the washed-out of the broth was then freeze-dry and extracted with DCM:MeOH 1:1. The antioxidant potential of the crude extracts was evaluated *in vitro* by their ability to interact with the stable free radical 1,1-diphenyl-2-picrylhydrazyl (DPPH).

Results and Discussion
We tested 55 sponge associated bacteria strains and three of them showed more than 40% of DPPH reduction (Fig. 1).

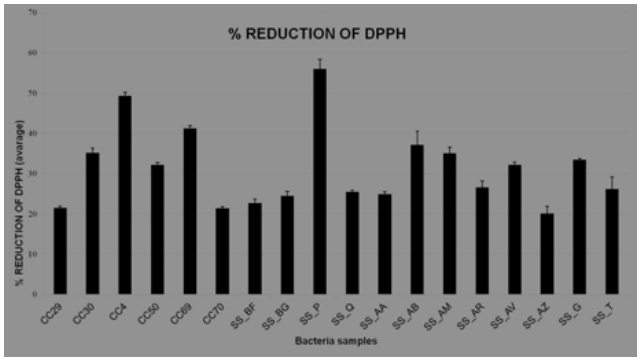

Fig. 1. Sponge associated bacteria that have had more than 20% of DPPH reduction. (CC – Bacteria from *Crambe crambe* specimens, SS – bacteria from *Sarcotragus spinosulus* specimens.

The lower IC_{50} (the concentration of an inhibitor where the response is reduced by half) obtained from one *S. spinosulus* bacteria extract were: 0,851 mg/ml (0,732-0,988). These results on experimental antioxidant activities in sponge associated bacteria crude extracts are certainly positive, although further analysis will be needed to assess 1) the stress factors that can improve the antioxidant activities and 2) the molecules involved in the antioxidant capacity.

Acknowledgments: Research funded by EU-7FP: BAMMBO, contract n. 265896.

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Session

Extremophiles

Modérateur : **Josefa Antón**

METABOLOMICS TO UNVEIL INTRASPECIFIC DIVERSITY: THE CASE OF THE EXTREMELY HALOPHILIC BACTERIUM *SALINIBACTER RUBER*

J. Antón [1]*, A. Peña [2], M. Lucio [3], M. Gomariz [4], P. Schmitt-Kopplin [3] and R. Rossello-Mora [5]
[1] Universidad de Alicante - anton@ua.es
[2] Universitat de les Illes Balears
[3] German Research Center for Environmental Health
[4] Universidad Miguel Hernández
[5] IMEDEA- CSIC-UIB

Abstract
We have analyzed the potential of high resolution ion cyclotron resonance Fourier transform mass spectrometry (ICR-FT/MS) as a tool to unveil microdiversity within the species *Salinibacter ruber*. This extremely halophilic bacterium thrives in hypersaline environments close to saturation, such a crystallizer ponds from solar salterns, which are very frequent in the Mediterranean coast. Previous studies indicated that the species is very homogeneous according to the 16S rRNA gene sequences of the isolated strains although they displays a high genomic microdiversity. Here, we show that this high microdiversity is mirrored by a amazingly high diversity of its metabolomic potential.

Keywords: Corsica Trough, Bacteria, Salinity, Balearic Islands

In a previous work (Rosselló-mora et al., 2008)), ICR-FT/MS proved very useful to discriminate among 28 S. ruber strains isolated from three different geographical areas (Mediterranean, Atlantic and Peruvian, indicating that the metabolites responsible for the differences among geographical groups were generally associated with cell membranes, such as fatty acids and terpenoids. In a further study (Peña et al., 2010), this technique was useful to unveil phenotypic differences among two extremely closely related strains coexisting in the same saltern pond. These two strains (M8 and M31) shared around 90% of their genomes but presented differences in the abundance of genes coding for sulfotransferases and glycosyltransferases. Accordingly, the metabolomic analysis indicated differences in sulfonated and glycosylated metabolites among the two strains, which were considerably higher in the extracellular fraction of the cultures. These differences were remarkable considering the high similarities between the two strains.

In order to investigate the extent of metabolomic diversity within the species S. ruber, we have undertaken an ICR-FT/MS study (Antón et al., 2013) of a collection of 57 strains isolated from two Mediterranean solar salterns: 22 from the Salinas de Campos in Mallorca and 35 from Bras del port in Alicante, both in the Western Mediterranean region. Each set of strains were simultaneously isolated from a water samples and were thus coexisting in the same environment. MAldi-TOf and 16S rRNA gene analysis indicated that all the strains were very closely related and were not resolutive enough to unveil differences among them. On the other hand, pulsed field gel electrophoresis analysis of the genomes digested with restriction enzymes indicated a very high heterogeneity in the strain collection since in no single instance were the genomic patterns repeated. In addition, none of the strains displayed the same patterns of the old strains originally used in 2000 for the description of the species, in spite of the fact that they had been isolated from the same ponds analyzed in this study.

For each of the 57 strains, three fractions were analyzed: extracellular, cellular soluble (cytoplasm) and cellular insoluble (membrane and envelopes). Each set of strains was analyzed independently. In each case, a collection of 5 "old" strains was also analyzed for comparative purposes. The metabolomic diversity displayed by the analyzed strains was amazingly high, with thousands of metabolites, only a few hundreds of which could be annotated by comparison with available databases. This high diversity was specially remarkable in the extracellular fraction. Indeed, this extracellular diversity was so high that almost every strain behaved in a different way, which hampered any clustering or comparison among them. The intracellular soluble and insoluble fractions, however, were amenable to comparison. According to the composition of these fractions, strains could be grouped into metabolomic OTUS (m-OTUS) that were delineated according to their discriminiative metabolites. With the species metabolome, the metabolic classes including the highest number of metabolites were, in this order, lipid metabolism, metabolism of other amino acids, biosynthesis of other secondary metabolites and metabolism of terpenoids and polyketides. Lipid metabolism seemed to be the most versatile metabolic network in S. ruber, as also indicated by the wide diversity of lipids found among the discriminative metabolites in other metabolic classes. In addition, it was also remarkable the high number of metabolites related to antibiotic and bioactive compounds that were responsible for the differences among m-OTUs. Finally, metabolomic differences were found between old and new strains isolated from the same ponds that could be not be explained based only in the genomic differences among old and new strains and could thus be related to extended exposure to laboratory conditions.

Overall, these results point to a microniche diversification of the species in nature wider than previously though and have implications for the search of compounds of biotechnological interest.

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EFFECT OF DIFFERENT BIOREMEDIATION TECHNIQUES ON PETROLEUM BIOMARKERS AND ASPHALTENE FRACTION IN OIL POLLUTED SEA WATER

N. S. El-Gendy [1]*, H. R. Ali [1], M. M. El-Nady [1], S. F. Deriase [1], Y. M. Moustafa [1] and M. I. Roushdy [1]
[1] Egyptian Petroleum Research Institute - nourepri@yahoo.com

Abstract
Treatment of petroleum hydrocarbon polluted sea water with *Pseudomonas aeruginosa* Asph2 and corn steep liquor CSL significantly enhanced the progress of biodegradation BD, with statistically highly significant difference between natural weathering NW and both bioaugmentation BA (P = 2.92e-14) and biostimulation BS (P = 3.56e-13) at 95% confidence interval (α = 0.05). BA significantly improved BD of total petroleum hydrocarbon TPH and asphaltene by ≈ 23% and 17% compared to BS (P = 2.0693e-5 and P = 1.4e-3, respectively). BD of biomarkers; pristane Pr, phytane Ph, diasteranes, hopanes, steranes and terpanes were very apparent, while Oleanane was more recalcitrant.

Keywords: Nutrients, Biotechnologies, Bacteria, Pollution, Suez Canal

Introduction
The incidence and threat of aquatic pollution by petroleum hydrocarbons in Egypt has resulted in extensive research [1]. Although, mechanical and chemical techniques are the commonly applied methods in Egypt for getting rid of oil spills, the Egyptian oil industry views bioremediation of oil polluted sites as a top priority research field [2]. The present study was carried out to assess the capability of treatment of oil polluted sea water with special emphasis on BD of recalcitrant asphaltene and petroleum biomarkers through different bioremediation processes.

Experimental work
Batch bioremediation processes were carried out over a period of one month at room temperature and 150 rpm. NW; natural ability to degrade the contaminant, BS; through acceleration of bioremediation capacity of the naturally occurring microorganisms by addition of CSL and BA; by adding CSL and augmenting indigenous community with halotolerant *Pseudomonas aeruginosa* Asph2 previously isolated from the oil polluted sea water under study, for its ability to degrade asphaltenes [3]. Gravimetric analysis and liquid column chromatography were applied to follow up BD of different petroleum hydrocarbons fractions. Gel Permeation Chromatography GPC and Gas Chromatography with mass-selective spectrometry GC-MS were used to follow up BD of asphaltene and biomarkers, respectively.

Results and discussion
Generally efficiencies of bio-treatments for BD of TPH and different petroleum fractions were ranked in the following decreasing order BA>BS>NW. BD of petroleum fractions ranked in the following decreasing order saturates>aromatics>asphaltene. Recording ≈ 14%, 69% and 84% for saturates, ≈ 6%, 55% and 82% for aromatics and ≈ 7%, 38% and 55% for asphaltene in NA, BS and BA, respectively. The resin fraction showed nearly no biodegradation in all biotreatments except for BA, recorded ≈ 87%. It was noticed that; there were obvious correlations between some of the studied parameters and represented by eq.1 and 2.

Z=-0.375+17.3e^(-((X-52.3)/32.8)^2)+3.608Y^0.4 (1)

where Z is microbial growth ln(TCFU/mL), while X and Y are the percentage decrease in surface tension and TPH, respectively.

f(x)=ax^b (2)

where, x is % BD of asphaltene, f(x) is % decrease in asphaltene molecular weight, a and b are constants = 1.002 and 0.9796, respectively. GC-MS analysis revealed that, although there was no significant effect on biomarkers in NW flasks. There was a remarkable degradation of Pr, Ph, steranes, hopanes, diasteranes and terpanes in BS and BA flasks, with the superiority of BA flasks. This indicates the good synergetic activity of *P. aeruginosa* Asph2 with indigenous microbial population.

Conclusions: The encouraging results from this study, would present CSL as a powerful, cheap, readily available and effective source of nutrients for BD of petroleum contaminants in the aquatic environment. The recorded high BD percentage of recalcitrant resin, asphaltene and biomarkers in BA flasks encourage the superiority of using the BA technique with previously isolated strains over BS.

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THE USE OF AN OPTICAL METHOD TO EVALUATE PROKARYOTIC OXYGEN CONSUMPTION UNDER HIGH PRESSURE CONDITION

Marc Garel [1]*, Séverine Martini [1], Dominique Lefèvre [1] and Christian Tamburini [1]
[1] Aix-Marseille University, Mediterranean Institute of Oceanography (MIO), 13288, Marseille, Cedex 9, France Université du Sud Toulon-Var, 83957, La Garde Cedex, France CNRS-INSU/IRD UM 110 - marc.garel@univ-amu.fr

Abstract

Planar-optode-oxygen sensors are emerging as a new method to measure prokaryotic oxygen consumption. We propose to adapt this methodology to high-pressure bottles with the aim of measuring oxygen consumption (1) from high-pressure bacterial cultivation and (2) from natural microbial assemblages under *in situ* pressure conditions.

Keywords: Deep waters, Oxygen, Bacteria, Bathyal, Gulf of Lyon

The heterotrophic prokaryotes are the main contributor to organic matter degradation in the ocean and particularly in the deep ocean. Nowadays, a classical way to evaluate the prokaryotic carbon demand needs the estimation of both prokaryotic heterotrophic production (PHP) and prokaryotic respiration (PR). PHP measurements in deep-sea waters are relatively well documented and the importance of maintaining the in situ pressure conditions to avoid bias of the real deep-sea activities have been highlighted [1]. However, nowadays no accurate methodology is available to measure directly, under in situ pressure conditions PR throughout the water column from the surface to the deep ocean. PR is usually derived from bacterial production and prokaryotic growth efficiency (PGE) measurements. For the latter only few estimates are available for surface waters [2] and none for deep-sea waters under in situ conditions. This study is challenging to measure PR under in situ pressure conditions. We have adapted to high-pressure bottles a non invasive method to measure prokaryotic oxygen consumption activities [3–5] (Fig 1).

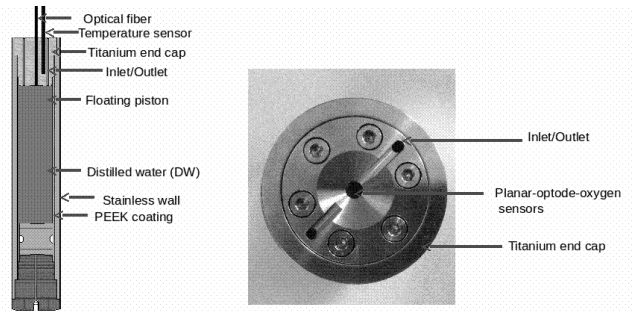

Fig. 1. At left schematic diagram of high pressure bottle with titanium top end cap. At right view of below of Titanium end cap with Planar-optode-oxygen sensors mounted on saphir window.

This methodology is based on fluorescence quenching where molecular oxygen quenches the luminescence of planar-optode-oxygen sensor. We first investigated the accuracy, detection limit, precision and response time of oxygen concentration measurements in relation to an increase of hydrostatic pressure within the incubation chamber. The results show that the use of sensor under in situ pressure conditions needs preconditioning at in situ pressure and temperature prior to perform any measurements. Secondly, a model strain (Photobacterium phosphoreum ANT-2200) has been used to estimate biological oxygen consumption. Finally, theexperimental setup will be used for natural prokaryotic assemblages oxygen consumption rates measurements from surface to deep-sea waters.

Results and Discussion

Pressure affects the physiology and metabolic activities from heterotrophic prokaryotes (see review of Tamburini et al. [1]). However to our knowledge, few study deal with pressure effect on oxygen consumption byheterotrophics prokaryotes [6]. The first main result show that the sensor need 24h preconditioning at working pressure and temperature to prevent disturbance of dissolved oxygen signal. The disturbance time is ranged between 0.5 and 14 h. After preconditioning pressure influence on sensor is predictable and reversible (about 4% lower response per 10 MPa of pressure) [4]. Preliminary experiments have been performed usinga pure culture of the strain P. phosphoreum ANT-2200 to measure biological oxygen consumption at 0.1 and 22 MPa (13°C). The result shows an oxygen consumption 1.5-fold higher than at atmospheric pressure during the log phase.

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PRODUCTION ET CARACTERISATION DE PEPTIDES ANTIMICROBIENS D'ARCHEES HALOPHILES EXTREMES ISOLEES DE LA SALINE DE SFAX EN TUNISIE

Fadoua Ghanmi [1]*, Donyez Frikha [2] And Sami Maalej [3]
[1] Laboratoire De Microbiologie, Unité Biodiversité Et Ecosystèmes Aquatiques Environnementaux (UR11ES72) - faddou.ghanmi@hotmail.fr
[2] Université De Sfax
[3] Université De Sfax

Abstract
L'étude des interactions antagonistes entre 36 isolats d'archées halophiles extrêmes de la saline de Sfax, nous ont permis de détecter 12 souches productrices d'antimicrobiens. Ces substances antimicrobiennes sont stables à une température atteint jusqu'au 90°C et supporte une large variation de pH allant de 1 à 10. Trois biomolécules dont le principe actif est de nature peptidique/protéique, nommées Hal ETD5, Hal ETD8 et Hal SS1R12, ont été sélectionnées suite au traitement protéolytique par la protéase halophile.

Keywords: Bacteria, Tunisian Plateau

Introduction
Les archées halophiles extrêmes sont des microorganismes extrêmophiles qui exigent des concentrations de sel très élevés pour croitre dans des environnements hypersalins (3-5M), lacs salés, marais salants, les sebkhas, la mer morte et les salines. De nombreuses études ont montré que les archées, de la famille des Halobacteriaceae dominent ces écosystèmes [1]. La production de peptides antimicrobiens, appelés halocines est l'un des mécanismes de défense utilisés par les archées halophiles pour dominer leurs concurrents. La production des halocines est une caractéristique quasi-universelle des halobacteriales.

Matériel et méthodes

Souches utilisées, milieu et conditions de culture
Une collection de 36 souches halophiles a été criblée pour la détection de souches productrices d'antimicrobiens. Ces souches ont été isolées de la Saline de Sfax au niveau de deux stations TS18 et M1 de salinité respective 39 et 20%. Les isolats testés ont été cultivés dans le milieu SW 25 %. Le pH du milieu a été ajusté à 7,2 par KOH 2M. Les cultures ont été réalisées dans des erlenmeyers de 250ml contenant 50ml du milieu liquide SW 25%.

Test de l'activité antimicrobienne
L'activité antimicrobienne a été détectée dans le surnageant de la culture productrice par la méthode de diffusion en puits [1, 2].

Effet de la dénaturation thermique, pH et enzymes protéolytiques
Dans le but d'étudier la stabilité des antimicrobiens à la dénaturation thermique, le surnageant de la culture productrice a été exposé à différentes températures (37 à 100°C), dans un bain-marie pendant 15min. La stabilité du surnageant à la variation du pH a été déterminé par l'ajustement du surnageant a différents valeurs de pH comprises entre 1 à 10. Après 2h d'exposition à 37°C, l'activité résiduelle a été déterminée [2]. Pour identifier la nature peptidique/protéique des antimicrobiens produites par les souches testées, le surnageant a été exposé 15 min à 50, 100, et 200µl de surnageant de protéase halophile.

Résultats et discussion
Nos résultats sur la production des antimicrobiens par les archées halophiles nous ont permis de révéler, parmi la collection de 36 isolats, 12 souches productrices d'activités antimicrobiennes a l'encontre d'une ou plusieurs souches cibles. Les zones d'inhibition observées s'étendent de 6 à 35 mm. Le dendrogramme présenté par la figure 1 montre que les 12 souches productrices se répartissent au moins en 3 sous groupes (groupes I, II III). Ceci suggère l'existence de différentes halocines produites par ces souches d'archées. L'étude de la stabilité des biomolécules actives au traitement thermique montre que les produits de la souche SS1R14 reste stable à une température atteint jusqu'au 90°C, alors que les substances des autres souches résistent à une température qui ne dépasse pas 80°C. De plus, ces substances antimicrobiennes ont marquées une grande stabilité aux variations de pH. Le traitement par la protéase montre que seule l'activité antimicrobienne des trois souches ETD5, ETD8 et SS1R12 diminue ou disparait complètement après un traitement pendant 2h à 45°C. Leurs principes actifs, de nature peptidique/protéique ont été respectivement nommés HalETD5, HalETD8 et HalSS1R12. L'identification moléculaire de ces souches sur la base du gène codant pour l'ARNr 16S montre que ETD5 et ETD8 sont apparentées à l'espèce *Halobacterium salinarum* alors que SS1R12 est une *Haloterrigena thermotolerans*.Ces résultats sont en accord avec les travaux de Kavitha et al. (2011) qui suggèrent que la production de l'halocine KPS1 par la souche d'archée halophile Haloferax volcanii est maximale à une température de 40°C, pH 7 et thermolabile à partir d'une température de 80°C. Nos études sont actuellement en cours pour purifier ces 3 halocines, déterminer leurs tailles, leurs spectres d'activité ainsi que leurs modes d'action.

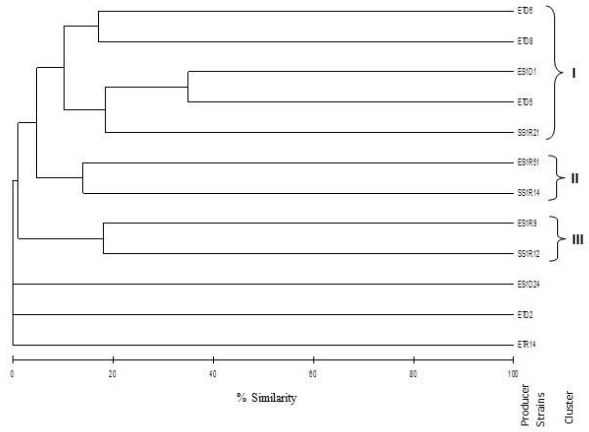

Fig. 1. Dendrogramme présentant le regroupement des souches d'archées halophiles, en fonction de leurs production des antimicrobiens, par l'utilisation d'un logiciel statistique Primer5.

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IMPACT DE LA SALINITÉ SUR LA DIVERSITÉ DES COMMUNAUTÉS DE PROCARYOTES ET VIRALES DE LA SALINE DE SFAX EN TUNISIE

Sami Maalej [1]*, Ines Boujelben [1] and Anton Josefa [2]
[1] Faculté des Sciences de Sfax - sami.maalej@fss.rnu.tn
[2] Département de Physiologie, Génétique et Microbiologie, Université d'Alicante, Alicante, Espagne

Abstract
La diversité des communautés de procaryotes et virales de la saline de Sfax a été étudiée au niveau de trois bassins de la saline de Sfax couvrant un gradient de salinité de 14 à 35% (saturation en sel). Nos résultats montrent que l'abondance des particules virales augmente avec la salinité pour atteindre environ 10^{10} VLM/ml au niveau de la table de cristallisation du sel. Quatre morphotypes viraux ont été détectés par microscopie électronique de transmission avec des proportions différentes en fonction de la salinité. De plus une interaction spécifique des halovirus avec les communautés d'archées a été détectée au niveau de la table de cristallisation du sel.

Keywords: Biodiversity, Tunisian Plateau, Coastal systems

Introduction
Les environnements hypersalins sont des écosystèmes aquatiques qui renferment les abondances virales les plus importantes pouvant atteindre 10^9 VLP/ml [1]. Dans ces environnements, où la prédation semble disparaitre, les halovirus représentent les facteurs biotiques les plus importants dans la structuration des communautés de procaryotes. Les communautés d'archées et de bactéries de la saline de Sfax ont fait l'objet de quelques publications [2]. Les résultats montrent que, pour les eaux de salinité > à 25%, les archées dominent les bactéries. Dans ce travail nous avons focalisés sur l'impact de la salinité sur la diversité des communautés virales et leurs interactions avec les communautés de procaryotes.

Matériel et méthodes
La saline de Sfax, située au Centre-Est de la Tunisie (34°39=N, 10°42=E) a été échantillonnée en octobre et mai 2009 au niveau des bassins C4, M1 et TS18 de salinité respective 14, 19 et 36%. Les échantillons d'eaux ont été fixés avec du paraformaldéhyde (7% de concentration finale) puis filtrés sur filtre millipore de porosité de 0,2 µm. Les cellules de procaryotes ont été marquées au DAPI pour le total cellulaire, alors que les communautés d'archées et de bactéries ont été déterminées par la technique FISH après hybridation respective avec les sondes Arc915 et EUB338 et observation par microscopie à épifluorescence [3]. Pour les communautés virales, après filtration des eaux sur filtre Anodisc 0,02 µm, l'abondance a été estimée par marquage au SYBER Green Gold, alors que la microscopie électronique de transmission (Joel JEM-2010) a servie pour la caractérisation morphologique. Pour déterminer la proportion des différents morphotypes viraux, plus de 900 particules virales ont été examinées.

Résultats et discussion
Dans ce travail, nous avons montré que l'abondance des communautés de procaryotes augmente avec la salinité et atteint $2{,}7 \times 10^8$ cellules/ml. Ces communautés sont dominées par les archées du genre *Halorubrum* et *Haloquadratum* au niveau de la station TS18 de saturation en sel (environ 60% du total cellulaire), alors que les bactéries du genre Salinibacter dominent au niveau de C4 et M1. Les particules virales de la saline de Sfax sont environ 10 fois plus abondantes que les cellules procaryotes hôtes pour atteindre plus de 10^{10} VLP/ml. De plus, 4 morphotypes viraux ont été détectés par microscopie électronique de transmission. Les virus sphériques dominent les eaux de la saline de Sfax pour atteindre 80% de la densité virale totale au niveau de la station C4. En fonction de la salinité, la densité des virus sphériques diminue en faveur des virus en forme citron et tête-queue. Ces résultats suggèrent une meilleure adaptation de ces morphotypes à la salinité. De plus, en fonction de l'augmentation de la salinité et de la densité des archées, un accroissement dans le rapport RVP (rapport virus procaryote) a été observé. Ce résultat suggère que pour des salinités proches de la saturation, les interactions halovirus-archées sont dominantes et jouent un rôle déterminant dans le contrôle et la structuration des communautés de procaryotes dans ce type d'environnement.

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GEOMICROBIOLOGICAL INVESTIGATION OF THE DEAD SEA SEDIMENTS USING 16S RRNA GENE SEQUENCE LIBRARIES: BACTERIAL AND ARCHEAL LIFE UNDER EXTREME CONDITIONS

Camille Thomas [1]*, Aurèle Vuillemin [1], Daniel Ariztegui [1] and The D. S. D. D. P. Scientific Team [2]
[1] University of Geneva, Section of Earth and Evironmental Sciences, Switzerland - camille.thomas@unige.ch
[2] Complete list of DSDDP scientists at www.icdp-online.org.

Abstract
A geomicrobiological investigation of various evaporitic facies of the Dead Sea sediments has been carried out within the framework of an ICDP drilling project. 16s rRNA gene sequences obtained from unique samples recovered from 0 to 200 m below lake floor show a relative diversity both in archaeal and bacterial sequences. The presence of these organisms in such sediments implies a potential ability to cope with concentrations of total dissolved salt as high as 340 g. L^{-1}. Although bacterial sequences have been found, Euryarcheota sequences from the Halobacteriaceae family seem to dominate in the Dead Sea subsurface.

Keywords: Evaporites, Bacteria, Levantine Basin

The ICDP Dead Sea Deep Drilling Project (DSDDP) is an internationally funded project that aims to reconstruct the paleoenvironmental and paleoseismicity histories of the Dead Sea Basin, in the Levant region. Several cores have been retrieved from two localities in the middle and western part of the lake and are currently being analyzed for petrographical, mineralogical and geochemical purposes. Here we present the preliminary results of a geomicrobiological investigation of the longest core (457 m), with emphasis on the ecological characteristics of the main facies of these hypersaline sediments. Climatic conditions in the Levant area have been recorded as specific lithological associations in the Dead Sea sediments. During the last glacial periods, humid conditions developed in the Dead Sea Basin leading to an increase in the lake level and stratification in an upper mixed layer and lower hypersaline anoxic brine [1]. These periods are characterized by facies of alternating evaporitic aragonite laminae and detrital mud laminae. During comparatively drier episodes, gypsum becomes the dominant precipitating mineral phase. Halite precipitates as the main phase during interglacial periods consecutively to increasingly arid conditions and heavy evaporation. Alternating aragonite and detrital mud occurs during short termed stratifications of the lake following heavy rainfall episodes. Today, increasingly harsh conditions coupled with the use of water from the Jordan catchment area by adjacent countries have led to salinities in the Dead Sea water column more than ten times higher than sea water. The Dead Sea sediments record the paleo-salinities of the lake basin enabling a comprehensive study of its biosphere in close relationship with extreme paleoclimatic variations. Multiple 16S rRNA gene sequences have been retrieved from halite at 0.24 m and 200 m depth, from gypsum at 67 m depth and in alternating aragonite and detrital mud laminae from 2m depth. In general, the highest microbial diversity is found in the oxic halite intervals. Nevertheless, the bacterial sequences recovered show little adaptation to hypersaline conditions and are thought to be weakly to not active in the sediments. They are dominated by β-proteobacteria of the Burkholderia genus for halite and gypsum samples. Their origin is discussed as organic matter has been identified within fluid inclusion of the halite. Among others, the halite samples also display sequences of γ-Proteobacteria of the Aeromonas genus and Deinococcus sequences specially adapted to high levels of radiations and dessication. Only four different bacterial sequences have been recovered from gypsum, all of the Burkholderia Ralstonia genus. All the five bacterial sequences from the aragonite intervals are unknown or fall within a candidate division in the KB1 group, closely linked to sequences retrieved from hypersaline environments like deep sulfidic brine pools of the Red Sea [2]. As a comparison, sequences from an aragonitic laminae found immediately below a microbial mat along the Dead Sea shore show much larger diversity and more numerous sequences, mainly of the KB1 group, Halanaerobiales order, and Desulfohalobiaceae order. Archaeal sequences are exclusively from the Euryarcheota phylum, and largely dominated by the Halobacteriaceae family. Most of the retrieved sequences are those of Archaea needing high salinities (over 150 $g.L^{-1}$) to thrive. Halite and gypsum samples exhibit strong similarities with only Halobacteriaceae sequences, regardless of the depth. The shallowest sample also shares similarities with sequences found in a microbial mat in pools along the Dead Sea shore. This indicates a rather stable and well developed archaeal community in the vicinity of the Dead Sea. The aragonitic laminae sample displays a unique and strikingly different community largely dominated by sequences from the division MSBL1, first described in the deep anoxic brine pools of the Mediterranean Sea [3]. This community seems to be specifically adapted to those anoxic conditions with high Mg^{2+} also encountered in the brine pools. Their metabolic activity is still questioned and could imply a role in the sulfur cycle as can be inferred from their closer branching group Gold Mine SAGMA-F/G and their association with the KB1 bacterial division members. A second hypothesis is an involvement in methanogenesis [3], also supported by the co-occurrence of one sequence of Methanomicrobia in this same level. The latter is similar to a group found at the brine water interface of the Shaban Deep, in the Red Sea deep brine pool and is thought to stand steep salinity gradient [4], also found in the stratified paleo-Dead Sea, during aragonite precipitation periods. These preliminary results report for the first time the existence of microbes in the deep sediments of the Dead Sea. They also set the emphasis on the variety of the Dead Sea sediment microbiomass. Although extreme, this environment hosts microbial communities that are able to cope to a different extent with the steep salinity gradients and high divalent cation concentrations. Finally it seems that the environmental conditions, originally ruling the lake chemistry and mineral precipitations, are indirectly setting the prerequisites for the development and conservation of specific microbial assemblages in the Dead Sea sediments.

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ETUDE DE LA BIODÉGRADATION D'UN PÉTROLE BRUT TUNISIEN PAR LA MICROFLORE BACTÉRIENNE INDIGÈNE DU PORT DE TEBOULBA, TUNISIE

I. Zrafi [1]*, R. Boughattas [2], A. Ghrabi [1], A. Bakhrouf [2] and D. Saidane-Mosbahi [2]
[1] Centre de Recherches et des Technologies des Eaux (CERTE), Technopole Borj Cédria, BP 273, 8020 Soliman, Tunis, Tunisia - zrafi_ines@yahoo.fr
[2] Laboratoire d'Analyse, Traitement et Valorisation des Polluants de l'Environnement et des Produits, Faculté de Pharmacie, Monastir, Tunisia

Abstract
Ce travail consiste à réaliser une bioaugmentation *in vitro* par utilisation d'une microflore bactérienne indigène d'un port pollué par les hydrocarbures (Port de Teboulba, Tunisie) dans des essais expérimentaux de bioremédiation. Les rendements de la biodégradation sont évalués par extraction du pétrole résiduel après incubation, son fractionnement par CPL et son analyse par CG/SM et les pourcentages de biodégradation (%B) sont ainsi calculés. Les Résultats obtenus montrent l'efficacité de la biodégradation d'un pétrole brut par cette microflore dans les conditions expérimentales après leur optimisation.

Keywords: Biomass, North-Western Mediterranean, Coastal waters, Pollution

Introduction La suppression de la pollution par le pétrole repose principalement sur la dégradation biologique par les micro-organismes [1]. D'où la nécessité de l'intervention de l'Homme. Par ailleurs la composition et l'efficacité de la microflore seront fonction de plusieurs paramètres physicio-chimique [3]. La bioaugmentation consiste à utiliser une microflore ou un micro-organisme ayant la capacité de biodégrader le pétrole d'où la nécessité d'une prédétermination des conditions optimales pour le bon déroulement de la biodégradation.

Matériel et méthodes Nous avons choisi d'étudier, in *vitro*, l'efficacité d'une bioaugmentation dans la bioremedation d'eau de mer polluée par un pétrole brut tunisien de type Zarzatine. - *Pétrole utilisé:* Le pétrole utilisé est un pétrole tunisien de type Zarzatine fourni par la raffinerie STIR-Jarzouna et dont les caractéristiques sont les suivantes (densité : 810 ; Viscosité est de 3,4 à 20°C ; BSW (eau de sédimentation): 0,05). - *Biomasse bactérienne:*La biomasse bactérienne utilisée est une microflore indigène d'eau de mer du port de teboulba en Tunisie cette microflore a été acclimatée à différentes doses du pétrole. - *Test de bioremediation:* Les essaies de biodégradation sont réalisés en utilisant un plan d'expérience. Des témoins négatifs sont aussi préparés en ajoutant un inhibiteur de croissance bactérienne (Hgcl2). - *Détermination des taux de dégradation:* Après incubation le pétrole résiduel est extrait, fractionnés par CPL et analysé par CG/FID. L'évolution quantitative des différentes fractions du pétrole (HCS), (HCA) en présence et en absence de la biomasse bactérienne est ainsi étudiée. Les pourcentages de biodégradation (B%) correspondant à chaque condition sont calculés par rapport aux témoins.

Résultats

1. Optimisation de la dégradation du pétrole Pour mieux étudier les effets des paramètres qui réagissent lors de la bioremédiation la variation des pourcentages de la biodégradation des HCS et des HCA a été déterminée dans les différentes conditions déterminés à l'aide du logiciel « MINITAB 15.0» les courbes de variation de la moyenne de la réponse pour chaque facteur étudié à part ainsi que les courbes de contour ont été tracées (Figures 1).Seul le facteur concentration en pétrole à un effet négatif (-7,17), alors que les facteurs concentration en microflore et temps ont un effet positif respectivement de 5,83 et 10,87.

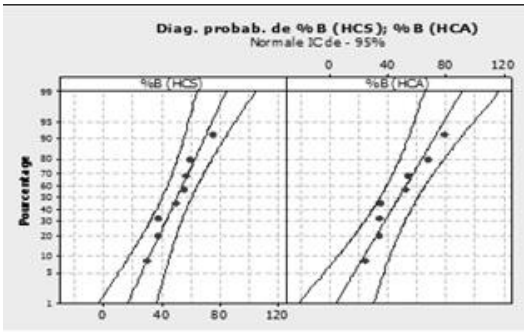
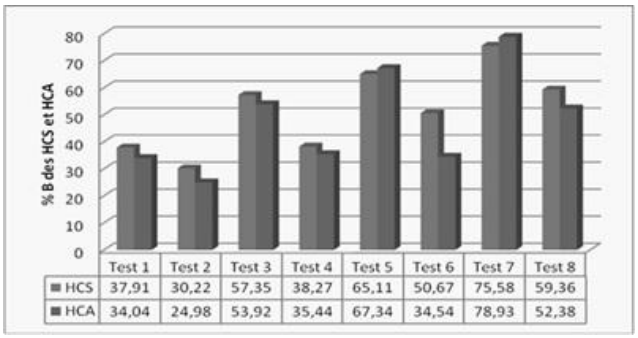


Fig. 1. **Courbe de probabilité normale du modèle M1 de la microflore M-EM.**
%B : pourcentage de biodégradation ; HCS : fraction saturée et insaturée non aromatique, HCA : fraction aromatique

2. Rendement de la biodégradation dans les différents milieux d'étude
L'examen des résultats relatifs des HCS et des HCA montre l'efficacité de la microflore M-EM dans les conditions expérimentales (Figure 2).



	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8
HCS	37,91	30,22	57,35	38,27	65,11	50,67	75,58	59,36
HCA	34,04	24,98	53,92	35,44	67,34	34,54	78,93	52,38

Fig. 2. **Courbe de probabilité normale du modèle M1 de la microflore M-EM.** %B : pourcentage de biodégradation ; HCS : fraction saturée et insaturée non aromatique, HCA : fraction aromatique.

En effet, nous avons enregistré une dégradation sginificatives dans les conditions du test 7 dont les pourcentages atteignent plus de 70%.

Conclusion L'optimisation par les plans d'experience, nous a permis à déterminer les conditions optimales du procédé de bioremédiation du pétrole brut par la microflore indigène acclimatée de l'eau de mer de Teboulba qui s'est démontré efficaces à l'échelle du laboratoire ce qui montre l'intérêt d'une éventuelle application à grande échelle.

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Session

Harmful Algal Bloom (HAB)

Modérateur : **Antonella Penna**

DISTRIBUTION OF A TOXIC DINOFLAGELLATE (*LINGULODINIUM MACHAEROPHORUM*) IN BIZERTA LAGOON

Mouna Bellakhal Fartouna [1]*, Meher Bellakhal [1], Souad Turky [2] and Lotfi Aleya [3]
[1] EMA- Institut Supérieur de Pêche et d'Aquaculture de Bizerte - nephertitim@yahoo.fr
[2] Institut des Sciences et Technologie de la Mer
[3] Laboratoire de Chrono-Environnement, UMR CNRS 6249, Université de Franche –Comté

Abstract
Recent studies associate *Lingulodinium machaerophorum* to YTX toxicity. Our study shows that cysts of *L. machaerophorum* exist in the sediments of Bizerta Lagoon. Distribution of this dinoflagellate showed concentrations of about 82.42 cysts g^{-1} wet sediment with the highest average registered in the station 25 and 1.45 cysts g^{-1} wet sediment at station 91. Temperature average was about 25.11°C and salinity about 28.72 psu. Cysts of *L. machaerophorum* were striated at their base with grana on the distal ends. Most of them showed fully developed processes. Cyst distribution was mainly related to shellfish aquaculture farms areas.

Keywords: Dinoflagellates, Toxins, Toxic blooms, Lagoons, Tunisian Plateau

Introduction
Dinoflagellates are the most diverse group of phytoplankton in coastal and estuarine environments and one of the most important primary producers. They are known to cause outbreaks of harmful algal blooms (HABs) in coastal waters around the world, and can be extremely toxic, threatening local aquaculture and wild life. Among dinoflagellates, many species have been shown to produce resting cysts as a part of their life cycle. In the present work we studied the distribution of the harmful dinoflagellate (*L. machaerophorum*) in Bizerta Lagoon which is a semi-enclosed area located in northern Tunisia.

Materiel and methods
Sampling was carried out on June 2012 at 123 stations with 1km equidistance. Surface sediment was collected with a Van Veen Crab and water column with submersible pump. Temperature, salinity, pH and O_2 were measured with a WTW 25i multiparameter probe. The top 3cm of sediment samples were placed in black plastic containers and stored in the dark at 4°C. Ovoid germination was prevented by means of hermetic conservation. To calculate the water content, subsamples of 20g were oven dried at 60°C for 7 days. After 7 days, water content was calculated by the following formula: Water % = [(Ww-Wd) *100]/Ww Ww=wet weight Wd= dry weight. The resting cysts (RCs) were expressed as cysts g^{-1} dry sediment = cysts g^{-1} wet sediment / [1-(water content/100)] RCs were separated from the sediment fraction according to the modified gradient density method using Ludox CLX. Subsamples (1 g) were suspended in 20 ml of sucrose 24 % and sonicated for 3 min at 100 Hz in Wiseclean DAIHAN sonicator. The sonicated suspension was sieved through 120 µm and 20 µm mesh sieve. The slurry remaining on the 20 µm mesh sieve was washed with sucrose solution and placed in 50 ml Falcon tube for sonification (3 min at 100 Hz). The slurry was processed for cyst concentration and separation from the sediment using 20 ml of Ludox CLX (density 1.3 g cm^{-3}). The tube was centrifuged for 30 min at 3000 rpm at 16°C. This unstable phase containing RCs was extracted and sieved through 20 µm nylon membrane. The resulting sample was rinsed with distilled water and collected with 5 ml of filtered sea water and sonicated. Aliquot of final sample were counted in sedimentation chamber with an inverted microscope (Leica DM).

Results and discussion
Lingulodinium machaerophorum (Deflandre and Cookson, 1995) = *L. polyedrum* (Stein) Dodge, 1989 (Motile stage) = *Gonyaulax Polyedra* (Schiller, 1937). *L. machaerophorum* is a toxic dinoflagellate that produces yessotoxins (YTX). The toxic syndromes of YTX are not well defined in humans, but *L. machaerophorum* is often associated with the mortality of fish and benthic organisms. This species has been known to form blooms off the coast of California [1], and commonly forms blooms in the Adriatic Sea (along the Italian and Yugoslavian coastlines) [2], in Scottish Sea [3], Moroccan Atlantic coast [4] and Bizerta lagoon [5]. The first reported toxicity of this species found a toxin profile similar to the toxins of *Alexandrium catenella*, however, most recently more in-depth studies have linked this species with production of YTX. In the present study temperature average was about 25.11°C and salinity 28.72 psu. Cysts of *Lingulodinium are* striated at their base with grana on the distal ends. Most of them showed fully developed processes. Our species reaches a maximum abundance of 82.42 cysts g^{-1} at station 25 and 1.45 cysts g^{-1} wet sediment at station 91. It was absent from 43 stations. Cyst distribution is mainly related to shellfish aquaculture farms areas. Indeed the highest relative abundances of *L. machaerophorum* were recorded at the stations with low salinity due to dilution by river discharge. Moreover the increase of cyst forming of the phototrophic *L. machaerophorum* could be correlated to the increase of available nutrient. According to ANOVA, the abundance of *Lingulodinium* varies significantly with stations (ANOVA, F = 4.3455, p = 0. 039). We see in the figure below the highest concentrations are recorded at S25, S57 and S95.

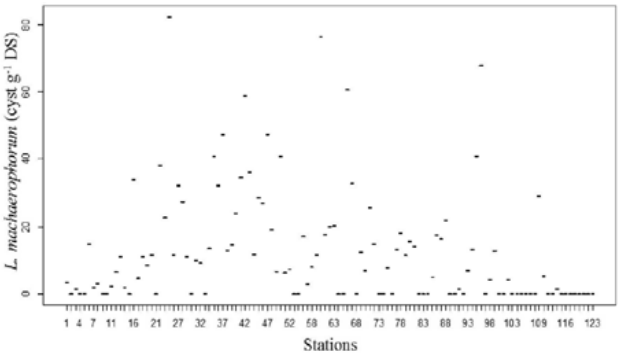

Fig. 1. Boxplots depicting the variation of *Lingulodinium* abundance according to sampling sites.

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SUMMER HARMFUL ALGAL BLOOMS (HABS) IN A COASTAL BASIN DEVOTED TO THE MUSSELCULTURE AND IMPLICATION FOR THEIR MANAGEMENT

Carmela Caroppo [1]*, Giuseppe Portacci [1] and Giorgio Alabiso [1]
[1] National Research Council Institute for Coastal Marine Environment - carmela.caroppo@iamc.cnr.it

Abstract
In recent years HABs in Mar Piccolo in Taranto (Northern Ionian Sea) are becoming more frequent with heavy effects on the mussel production. A bloom due to the diatom *Cylindrotheca closterium* was responsible for massive mussel kills in summer 2008. The development of operational tools for rapid detection and timely prediction is a high priority for such important Italian farming area.

Keywords: Phytoplankton, Coastal management, Aquaculture, Blooms, Gulf of Taranto

Introduction
Mar Piccolo in Taranto (Gulf of Taranto, Mediterranean, 17° 13' -17° 19' E, 40° 28' - 40° 30' N) is a coastal area consisting in two sub-basins (Seno I and Seno II) strongly utilized for an intensive commercial mussel (*Mytilus galloprovincialis*) farming. Harmful algal blooms (HABs) have been responsible for massive mussel kills since 1938 [1] but in the last years the problem is worsening and recurrent summer anoxia crisis due to phytoplankton blooms are becoming more frequent. Particularly, in 2008 a heavy reduction (~ 35%) of the total commercial mussel harvest was detected in Mar Piccolo with a valued loss of ~ € 13 millions. Furthermore, the lost of the seeds compromised the harvest of the following year. The aim of this work was to assess phytoplankton abundances and composition during the summer of 2008 and to discuss the development of tools to managing and mitigating the effects of HABs in one the most important farming sites in Italy.

Material and Methods
Samplings were carried out in two stations located in Mar Piccolo in Taranto from June to September 2008. Water samples were taken at the surface using a 5 liter Niskin bottle. Environmental data were recorded by an Idromar IM5260 multiprobe. Phytoplankton samples were fixed with Lugol solution (larger phytoplankton) and pre-filtered glutaraldehyde (picophytoplankton). Larger phytoplankton was examined and counted according to the Utermöhl method [2] while picophytoplankton by using the procedure described in [3].

Results and discussion
In Mar Piccolo temperature ranged between 22.2 and 29.1 °C both registered in the Seno II. Salinity averaged values were slightly higher in Seno II (37.3 ± 0.4 psu) than in Seno I (36.8 ± 0.5 psu). Phytoplankton abundances (Fig. 1a) ranged between 99.9 and 3237.4 cells x 10^3 l^{-1}. The highest values were detected at the Seno II where in July a bloom of the diatom *Cylindrotheca closterium* (up to 3000 cells x 10^3 L^{-1}) was monitored. This diatom is known as a producer of foam, discoloration and repellent odour [4]. Furthermore, this species is considered responsible for the production of mucilage in the Northern Adriatic Sea where it is regularly the dominant species in large and aged phytoplankton aggregates [5]. The high stability of the column water, the input of nutrients and the increase of temperature could have promoted the growth of such opportunistic species.

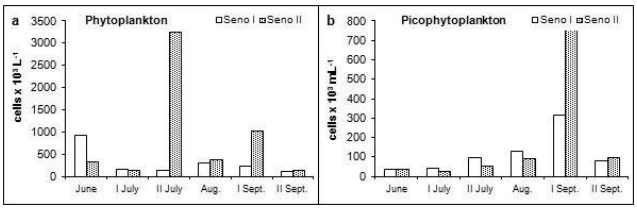

Fig. 1. Phytoplankton (a) and picophytoplankton (b) abundances (cells x 10^3 L^{-1} and cells x 10^3 mL^{-1}, respectively) in Seno I and Seno II in summer 2008.

Picophytoplankton abundances showed values comprised between 23.8 and 750.9 cells x 10^3 L^{-1} with a peak in September (Fig 1b). The community was represented mainly by prokaryotes (phycocyanin-rich and phycoerythrin-rich cyanobacteria) and their summer blooming in brackish environments has been already detected [6]. Our data will be useful to develop and implement plans for monitoring and management of HABs. These plans would include the integration of observation, forecast and communication into an action plan for rapid response to HABs [4]. Initiatives are urgently needed to improve the communication with authorities responsible for environmental protection, economic development and public health to continue previous experiences in the frame of the sustainable musselculture in Mar Piccolo [7].

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QUANTIFICATION OF THE TOXIC DINOFLAGELLATE *OSTREOPSIS* SPP. BY QPCR ASSAY IN MARINE AEROSOL

S. Casabianca [1]*, A. Casabianca [1], P. Riobó [2], J. Franco [2], M. Vila [3] and A. Penna [1]
[1] University of Urbino - silvia.casabianca@uniurb.it
[2] Unidad Asociada CSIC-IEO, Instituto de Investigaciones Marinas (IIM-CSIC), Vigo, Spain
[3] Institut de Ciències del Mar (ICM-CSIC), Barcelona, Spain

Abstract
We report the application of a qPCR based method for estimation of the toxic benthic dinoflagellate *Ostreopsis* cf. *ovata* in the complex matrix of marine aerosol at Sant Andreu de Llavaneres (northwestern Mediterranean Sea). Toxic events in humans have been reported during *O.* cf. *ovata* blooms and were attributed to palytoxin (PLTX)-like compounds produced by this microalga. *O.* cf. *ovata* abundance in marine aerosol during the bloom varied in the range of 1−102 cells per filter. No PLTX was detected in the aerosol filters by analytical determinations, and the estimation of PLTX like-compound concentrations in microepiphytic assemblages varied between 0.1 and 1.2 pg/cell.

Keywords: Dinoflagellates, Aerosols, Genetics, Biotechnologies, North-Western Mediterranean

Marine aerosols are airborne particles of biological origin containing algal cells, bacteria, spores, and viruses, which are carried out by bubbles to the sea surface microlayer and to the atmosphere. Since the summer of 2005, in the Mediterranean Sea, growing concerns regarding exposure to harmful marine aerosols associated with toxic benthic dinoflagellate *Ostreopsis* spp. blooms have been reported, as they represent major health and economic risks to human populations [1]. *O.* cf. ovata is a toxic microalga that produces non protein palytoxin (PLTX) and PLTX analogs [2] such as ovatoxins (OVTXs) [3]. In this context, we developed a qPCR assay for the estimation of *O.* cf. *ovata* cells in marine aerosol during a bloom together with a determination of PLTX-like compounds using hemolytic assay and liquid chromatography. Marine aerosol samples collected at two stations at Sant Andreu de Llavaneres were analyzed by qPCR using designed primers for 204 bp specific amplified fragment [4]. In the air, the presence of a high concentration of biotic and abiotic particles could lead to cross-reactivity and bias in PCR assays. The inhibitory activity of the filter matrix was excluded in spiking experiments. Moreover, due to the stringency of washes of the aerosol complex matrix filters, *Ostreopsis* cellular loss needed to be evaluated. In order to normalize *O.* cf. *ovata* abundance in aerosol filters a recovery rate, ranging from 65 to 20%, was applied to qPCR results. The two sampling stations showed variable cell numbers ranging from 1 to 102 (Tab. 1) [5]. In order to obtain the correct quantification of *O.* cf. *ovata* cells, macroalgae and surface seawater samples were analyzed by qPCR assay. Abundance ranged between 7.0 x 10^4 and 7.6 x 10^5 cells/g fw in macroalgae and between 3.5 x 10^3 and 1.1 x 10^5 cells/L in seawater. A significant positive correlation (n = 6, Spearman r = 0.9276, P = 0.0167) was found between *O.* cf. *ovata* abundance in the surface seawater and marine aerosol samples collected at Station S on the beach, showing that higher abundance in the seawater is directly linked to an increased abundance of airborne *O.* cf. *ovata* cells. Instead, no significant correlation was found between the abundance in surface water and marine aerosol samples collected at Station A far from the beach (n = 5, Spearman r = −0.9, P = 0.0833). The palytoxin content, by analytical determinations ranged from 0.1 to 1.2 pg/cell in macroalgae during the bloom. It was not possible to define the palytoxin content in aerosol filters because of the LOD of the analytical assays employed. In conclusion, the developed qPCR assay is a highly sensitive and specific quantification method for toxic *O.* cf. *ovata* in a complex matrix, such as marine aerosol. In the future, the application of the developed molecular assay together with the analytical technique and epidemiological studies in areas affected by toxic blooms will allow us to relate the *Ostreopsis* abundance in marine aerosol with respiratory syndromes in humans.

Tab. 1. Quantitative PCR assay of *Ostreopsis* cf. *ovata* abundance in marine aerosol samples collected at Stations S and A at Sant Andreu de Llavaneres beach.

Sample n° and sampling day on August	Time interval (h)	Filtered air volume (m^3)	Total LSU rDNA copy number/filter[a]	Abundance/filter	Abundance/filter with recovery rate[c]	Abundance/filter (166 m^3)[d]
1S 17th	11:00 - 18:00	209	447 ± 161	0.2 ± 0.1	1 ± 0.4	1 ± 0.3
2S 17th	18:00 - 02:15	243	520 ± 260	0.2 ± 0.1	1 ± 0.6	1 ± 0.4
3S 18th	02:20 - 08:35	184	788 ± 394	0.4 ± 0.2	2 ± 0.9	2 ± 0.8
4S 18th	08:38 - 17:36	271	15174 ± 349	7.1 ± 0.2	36 ± 0.8	22 ± 0.5
5S 18th	17:42 - 01:20	225	6245 ± 1271	2.9 ± 0.6	15 ± 3	11 ± 2.2
6S 19th	01:30 - 07:54	194	12845 ± 1494	6 ± 0.7	30 ± 3.5	26 ± 3
1A 17th	12:20 - 18:00	166	78091 ± 2934	36.5 ± 1.4	101 ± 3.8	102 ± 3.8
2A 17th	18:00 - 02:23	255	16906 ± 3036	7.9 ± 1.4	40 ± 7.1	26 ± 4.6
3A 18th	02:38 - 08:26	170	n.d.[b]	n.d.[b]	n.d.[b]	n.d.[b]
4A 18th	08:31 - 17:25	269	9211 ± 576	4.3 ± 0.3	22 ± 1.3	13 ± 0.8
5A 18th	17:30 - 01:00	221	57429 ± 1795	26.9 ± 0.8	75 ± 2.3	56 ± 1.8
6A 19th	01:00 - 07:50	200	6398 ± 1538	3 ± 0.7	15 ± 3.6	12 ± 3

[a]Mean values measured in triplicates ± standard deviation (SD).
[b]Not detected.
[c]Abundance per filter in samples from 1S to 6S and samples 2A, 4A, 6A were obtained considering a recovery rate of 20%; abundance per filter in samples 1A and 5A were obtained considering a recovery rate of 36%.
[d]Abundance per filter normalized to smaller volume of filtered air (166 m^3).

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APPLICATION OF BAYESIAN NETWORKS TO MODEL RELATIONSHIP BETWEEN TOXIC DINOFLAGELLATE KARENIA SELLIFORMIS AND HYDROCLIMATIC CONDITIONS IN GABES GULF

Wafa Feki [1]*, Asma Hamza [1], Malika Belhassen [1] and Ahmad Rebai [2]
[1] Institut des Sciences et Technologies de la Mer - wafafeki@yahoo.fr
[2] Centre de Biotechnologie de Sfax

Abstract
The growth of bloom-forming phytoplankton has been known to be mostly affected by abiotic environmental factors such as light, temperature, salinity and concentrations of organic and inorganic nutrients but little is known about the effect of environmental factors on occurrences of K. selliformis blooms as this species has been recently identified. Therefore, our study uses Bayesian network to apprehend the relationship between this species and hydroclimatic parameters. We found that development of K.selliformis was induced essentially by salinity, atmospheric temperature, rainfall and evaporation.

Keywords: Dinoflagellates, Salinity, Models, Gulf of Gabes

Introduction

Karenia selliformis occur regularly since 1994 in many coasts of Gabes Gulf (south of Tunisia) and it was responsible for an intensive fish kill [1] and serious problem of shellfish toxicity in this area [2], [3].
The data base collected in phytoplankton monitoring in the Gulf of Gabes during the past ten years showed that species bloomed frequently along the year and affect a specific area situated in Boughrara lagoon [4].
Otherwise, general linear model don't permit us to identify a particular parameter that induce the spatiotemporal distribution. Our goal, from the REPHY data, was to identify the main constraining variables (hydroclimatic parameters) that regulate occurrences of *K.selliformis* in Gabes gulf. The application of a Bayesian network permits us to describe the essentials parameters that regulate development of this dinoflagellate in ours coasts.

Material & Methods

Data were collected in the framework of the National Phytoplankton Monitoring Program in the shellfish harvest areas from 1995 to 2007 in Gabes Gulf. Fifteen sites are weekly sampled and phytoplankton is enumerated with Uthrmöhl method. Hydroclimatic parameters were simultaneous collected.
Meteorological data were provided by the Tunisian National Meteorological Institute). The tide amplitude in this coast was obtained from Tunisian Hydrographic and Oceanographic Services.
A Bayesian network consists of a graphical structure and a probabilistic description of the relationships among variables. It was learned from data using the R package « deal ».

Results & discussion

The plot obtained with this model (Fig.1) revealed a clear direct relationship between *K.selliformis* and salinity, atmospheric temperature, evaporation and rainfall. Salinity exceeding the limit of 42 psu suggested previously by Feki et al. [5] seems to be a regulator of the blooms and also of the related biological processof *K. selliformis*. The direct effects of atmospheric temperature, evaporation and rainfall are difficult to apprehend, we suspect that these could be indirectly related to salinity.

Tide, originally suspected to enhance species distribution and booms dispersion [4], seems to have an indirect effect likely related to sediment disturbance and might therefore contribute to resuspension events inducing nutrients release thatwere normally tied up in dissolved organic matter, in bacteria, or in the bottom sediment.

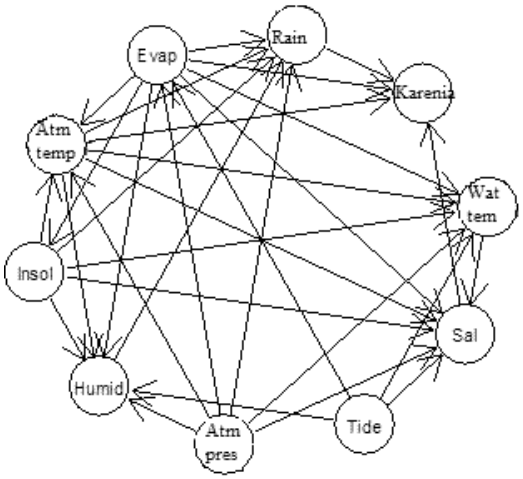

Fig. 1. Fig.1: Bayesian network plot: direct relationship between *K.selliformis* and hydroclimatic parameter.

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RECENT DINOFLAGELLATE CYSTS IN SURFACE SEDIMENTS FROM AN ENCLOSED BAY SUBJECT TO HUMAN EUTROPHICATION (SARONIKOS GULF, AEGEAN SEA)

A. Giannakourou [1]*, A. Venetsanopoulou [1], K. Pagou [1], M. Balci [2] and N. Balkis [3]
[1] Hellenic Centre for Marine Research, 46km Athinon-Souniou, Mavro Lithari, Anavissos, Athens-Greece - agiannak@hcmr.gr
[2] Istanbul University, Institute of Science, 34134 Vezneciler, Istanbul-Turkey
[3] Istanbul University, Faculty of Science, Department of Biology, 34134 Vezneciler, Istanbul-Turkey

Abstract
In coastal waters, many planktonic organisms produce resting cysts that have the potential to remain viable in the sediments for decades. These cysts probably derive from bloom processes and are able to refuel new blooms. The aim of this study is to explore the dinoflagellate cyst bank in surface sediments from Saronikos Gulf, an enclosed Bay in the Eastern Mediterranean Sea. A quantitative and qualitative study was performed in order to characterise dinoflagellate cyst assemblages, relate cysts to physico-chemical conditions and use them as bioindicators of eutrophication.

Keywords: Dinoflagellates, Aegean Sea, Eutrophication, Sediments

Red tide blooms have become fairly frequent worldwide and dinoflagellates in particular are a subject of increasing interest. A 'seed population' hypothesis consists of dinoflagellate resting cysts able to survive for long periods in the sediment and eventually inoculating the water column under favourable germination conditions [1]. Resting cysts may have a crucial ecological role as important seedbeds for the initiation of blooms [4]. The last decade scientific papers highlight the use of cyst signals as indicators of eutrophication and industrial pollution [2].
Sediment samples (0-10cm) were collected seasonally (December to September 2011) from Saronikos Gulf, an enclosed bay near Athens. Elefsis Bay (S1) is highly polluted by industrial activities and the shipyard area of Piraeus harbor (Fig 1). Subsamples (1 cm^3) from each sediment sample were further processed in the laboratory [3]. At least 200 cysts were counted and identified under the microscope (x 200). Cysts were photographed with an image PRO analysis system and then selected live species were isolated with a micropipette and transferred into tissue culture multi-well plates for germination.

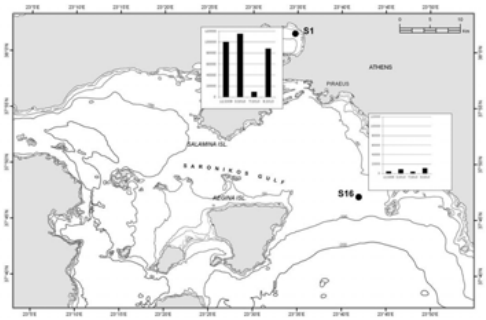

Fig. 1. Sampling stations at Saronikos Gulf. Bars represent dinoflagellate cyst abundance/g dry sediment.

Total cyst density varied from 1380–155000g^{-1} dry sediment. A 10fold higher abundance was recorded at station S1 (Fig. 1). Calcareous Peridiniales contributed more than 60% to the total abundance with the dominance of *Scrippsiella* group. Non calcareous Peridiniales occupied 12-19% of the total population (*Protoperidinium conicum, P.. cf minutum, Zygabigodinium lenticulatum*) whereas Gymnodiniales and Gonyaulacales were 5-11% και 9-15% respectively, (*Alexandrium cf affine, A. minutum, Lingulodinium polyedrum, Protoceratium reticulatum, Gymnodinium catenatum/nolerii).* Station S16 was characterised by non calcareous Peridiniales (46-67%), with the species *Protoperidinium conicum, P.cf minutum, P. sp.1).*

Cysts at station S1 were represented 84% by autotrophic dinoflagellates whereas the heterotrophic taxa had higher relative abundances (57%) at S16.

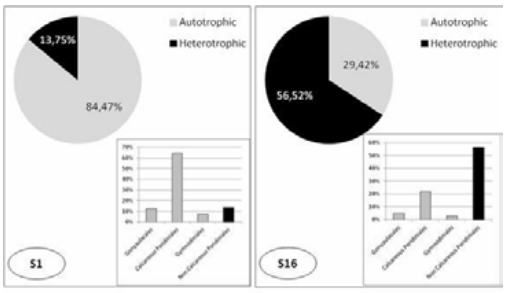

Fig. 2. Relative abundance of heterotrophic and autotrophic cyst taxa and % contribution of different dinoflagellate groups.

Several features of dinoflagellate assemblages reflect intense signal of eutrophication and industrial pollution at station S1. 1) very high values of cyst concentrations probably reflecting an increase in phytoplankton production 2) dominance (>50%) of one group (Scrippsiella) 3) significant amounts of specific cyst types such as *Lingulodinium polyedrum, Zygabigodinium lenticulatum* (extreme nutrient impact), *Polykrikos kofoidii* (hyper-eutrophication), *Protoperidinium conicum (*industrial pollution, significant presence of diatoms). However, more information from regional surveys should be collected in order to define certain cyst groups/species as proxies of different environments.

Acknowledgements This work was supported by the Joint Research and Technology Program Greece_Turkey 2010-2011 (GSRT Research Project 10TUR/1-30-2 EYDE ETAK 1438).

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INSIGHTS ON THE TOXIC EFFECT OF "*OSTREOPSIS CF. OVATA*" ON "*ARTEMIA SALINA*": THE ROLE OF DIRECT/INDIRECT CONTACT WITH MICROALGAL CELLS

V. Giussani [1]*, V. Asnaghi [1], F. Sbrana [2], M. Faimali [3], G. Greco [3], V. Piazza [3], M. Vassalli [2] and M. Chiantore [1]
[1] DISTAV - Genoa University - valentina.giussani@edu.unige.it
[2] CNR - Institute of Biophysics (IBF)
[3] CNR - Institute of Marine Sciences (ISMAR)

Abstract
Studies focused on the role of mucilage produced by *O. ovata* cells suggest its key-role in growth strategy and, possibly, during the process of micropredation. The aim of the present study is to highlight the potential toxic effect associated to mucilaginous filaments, performing a toxicity bioassay on *A. salina*.

Keywords: Ecotoxicology, Ligurian Sea, Dinoflagellates

Introduction
In the last decade, the harmful benthic dinoflagellate *Ostreopsis* cf. *ovata*, which produces many palytoxin congeners, has bloomed in the Mediterranean region with increasing frequency, intensity and distribution, causing mortality of benthic organisms and human health problems ([1]). An eco-toxicological investigation performed by Faimali et al. (2012, [3]) put in evidence an unexpected high sensitivity of the model organism *A. salina* towards *O*. cf. *ovata* and suggested that toxic effects on invertebrates arise only in presence of whole microalgal cells. In fact, the toxic effect of the growth medium alone (free of cells but possibly containing dissolved toxins) was not relevant if compared to the whole culture (growth medium + cells). Studies focused on the role of mucilage produced by *O. ovata* cells ([4], [5]) suggested its key-role in growth strategy and, possibly, during the process of micropredation. A conspicuous presence of microfilaments and of their connections with the cell wall was highlighted, but, so far, an active toxicological role of the mucilaginous matrix surrounding the microalgal cells was not yet proved. The aim of the present study was to highlight the potential toxic effect associated to mucilaginous filaments, carrying out a toxicity bioassay on *A. salina*. In order to put in evidence mucilaginous filaments associated to the cell wall, Atomic Force Microscopy (AFM) investigation was performed.

Materials and methods
Laboratory cultures of *O. ovata* were obtained from environmental samples collected from June to August 2012 in Quarto dei Mille (Genoa, NW Mediterranean Sea, Italy). Algae from the strain were cultured into sterilized plastic flasks closed with transpiring caps. All flasks were maintained at 20 °C ±0.5 °C in a 16:8 h light:dark (L:D) cycle (light intensity 85–135 µE m^{-2} s^{-1}) inside a thermostatic culture chamber. Cell counts were performed in three replicates for each flask every two days. Toxicity test was prepared on II-III stage larvae of the crustacean *A. salina* according to Artoxkit M, obtained by Microbiotest Inc., modified as in Faimali et al. 2012. In order to investigate the toxic effect due to direct or indirect contact with *O. ovata* cells, larvae were exposed different treatments: 1) untreated *O. ovata* culture; 2) filtered *O. ovata* cells, kept separated from *A. salina* during the incubation by using a 10 µm filter in order to let mucilaginous filaments pass through; 3) filtered *O. ovata* cells, kept separated by using a 0.22 µm filter, in order to stop mucilaginous filaments; 4) control (0,22 µm Filtered Natural Sea Water). Algal cell concentration of 400 cells/ml was prepared for each treatment (three replicates). Mortality of *A. salina* larvae was recorded after 48 hours. Few drops of *O. ovata* culture were laid on a glass slide and observed with a commercial AFM equipped with an optical microscope. Topography images were acquired in tapping mode.

Preliminary results
Our preliminary results show that a direct contact with *O. ovata* cells is required to cause high mortality percentages of *A. salina*. Lower (about 30% mortality) but significantly higher if compared to the other treatments, mortality values were recorded after treatments that allowed the mucilaginous filaments pass through the 10 µm net. On the contrary, treatments that did not allow filaments pass through the filter (0.22 µm mesh filter) resulted in no evident toxic effect.

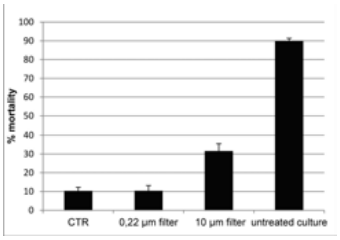

Fig. 1. Mortality (M±ES, N=3) after 48 h of *Artemia salina* exposed to several treatments of *O. ovata* culture.

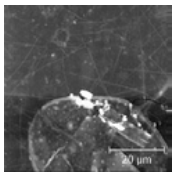

Fig. 2. Mucilaginous filaments and theca of *O. ovata* cell observed with a commercial AFM equipped with an optical microscope.

Future perspective
Given the preliminary results, we are carrying out a more complete toxic bioassay during three culture growth phases (exponential, stationary, senescent), combining the same experimental design performed by Faimali et al. (2012, [3]) with the present experiment, in order to better elucidate toxicity dependence of direct/indirect contact and to put in evidence potential differences depending on the growth phase within the algal life cycle.

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TOXIC *PSEUDO-NITZSCHIA* SPP. IN THE NORTHWESTERN ADRIATIC SEA: CHARACTERIZATION OF SPECIES COMPOSITION BY GENETIC AND MOLECULAR QUANTITATIVE ANALYSES

A. Penna [1]*, S. Casabianca [1], F. Perini [1], M. Bastianini [2], E. Riccardi [3], S. Pigozzi [3] and M. Scardi [4]
[1] Department of Biomolecular Sciences, Section of Environmental Biology, University of Urbino, Pesaro, Italy - antonella.penna@uniurb.it
[2] CNR-ISMAR Castello 1364/b - 30122 Venezia, Italy
[3] CRM, Viale Vespucci 2, 47042 Cesenatico, Italy
[4] Dip. di Biologia, Università Tor Vergata, 00133 Via della Ricerca Scientifica, Roma, Italy

Abstract
Various genetic aspects of the toxic diatom *Pseudo-nitzschia* species in the northwestern Adriatic Sea were investigated. Phylogenetic analyses identified strains belonging to *P. delicatissima, P. calliantha, P. pungens* and *P. mannii*. The quantitative real-time PCR (qrt-PCR) assay was developed to estimate the number of rDNA copies and their variation among *Pseudo-nitzschia* species and strains in relation to physiological activities and/or adaptative strategies. Northwestern Adriatic *P. delicatissima* strains produced domoic acid at low concentrations.

Keywords: Diatoms, Genetics, Toxic blooms, Central Adriatic Sea

In the northwestern Adriatic Sea, nothing is known regarding the genetic diversity and geographical pattern of *Pseudo-nitzschia* species, and relatively little is understood regarding the chemical toxin composition of *Pseudo-nitzschia* populations. Genetic approaches can play a fundamental role in solving taxonomic issues, as well as in geographical distributions and the level of genetic differentiation of populations [1]. Further, molecular method of qrt-PCR has the capacity to characterize the target rDNA copy number of a species or population in relation to physiological activities, such as adaptation strategies to the environment [2]. We aimed to identify and characterize strains of *Pseudo-nitzschia* spp. sampled in northwestern Adriatic area with regard to phylogenetic relationships, geographical patterns and quantitative content of nuclear rDNA. The sampling site was located at Pesaro, 500 m off the coast, in the northwestern Adriatic Sea (43° 55'50''N; 12°53'51''E). Net samples were collected throughout the water column. A total of 108 monoclonal strains were established and maintained in f/2 medium at 20 °C on 12:12 h light:dark cycle at an irradiance of 100 µmoL photons m-2 s-1. All strains were processed for phylogenetic (neighbour-joining, NJ; maximum parsimony, MP; maximum likelihood, ML; Bayesian Inference, BI), geographical (statistical parsimony analysis), molecular (real time quantitative-PCR), statistical and chemical toxin content analyses as described in [3]. Northwestern Adriatic Sea strains were included in the *P. calliantha, P. delicatissima, P. mannii and P. pungens* (clade I) genetic lineages. Networks of haplotypes inferred from Adriatic and worldwide strains revealed two main haplotypes in P. delicatissima from the Mediterranean and north Atlantic, with a single panmictic population in *P. calliantha, and Adriatic P. pungens* strains sharing the most frequent haplotype. The quantitative analysis of the ITS-5.8S copy number of Pseudo-nitzschia strains showed that the three species of P. delicatissima, P. calliantha and P. pungens (clade I) had a different average rDNA copy number, 39±22, 62±30 and 83±67, respectively. The difference was significant (P=0.0017) only in the case of the *P. calliantha* versus *P. delicatissima* comparison. Strains of *Pseudo-nitzschia* species were isolated monthly, and the rDNA copy number per cell did not show any differences among strains of either *P. calliantha* (P=0.1554) or P. delicatissima (P=0.1405), whereas a significant difference was found among *P. pungens* strains (P=0.0061). *P. pungens* rDNA copy number showed that the only significant difference was found between strains isolated in December and January (P=0.0150), potentially related to trophic conditions of seawater (Fig. 1). The presence of DA was detected only in seven strains of *P. delicatissima* and in one case DA reached the quantifiable amount of 0.063 fg cell-1[3].

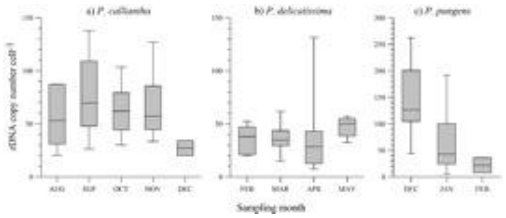

Fig. 1. The rDNA copy number per cell of northwestern *P. calliantha, P. delicatissima* and *P. pungens* strains determined by qrt-PCR and sampling period.

The genetic characterization of toxic *Pseudo-nitzschia* species may greatly improve our understanding of the composition and diversity of the *Pseudo-nitzschia* complex in the northwestern Adriatic Sea. Molecular qrt-PCR analysis offers more specific and sensitive tools to investigate the relationships between diversity and the ecological function of a species in the marine environment.

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FACTORS DRIVING A LATE SUMMER/AUTUMN BLOOM OF *PSEUDO-NITZSCHIA* SPP.AND DOMOIC ACID IN BIZERTE CHANNEL (TUNISIA SW MEDITERRANEAN)

I. Sahraoui [1]*, I. Bouchoucha [1], M. Daly Yahia [1], H. Hadj Mabrouk [1] and A. Sakka Hlaili [1]
[1] Faculté des Sciences de Bizerte - ineskalif@yahoo.fr

Abstract
This study examines the dynamic of a *Pseudo-nitzschia* spp. bloom which has developed in late summer/autumn 2011 in Bizerte channel. *Pseudo-nitzschia* spp. reached highest cell densities (~2 × 10^5 cells l^{-1}) on 27 September, at the same time that domoic acid (DA) was detected (~1.56 µg DA l^{-1}). The Canonical Correspondence Analysis (CCA) results revealed that dissolved organic phosphorus (DOP) and nitrate were the main drivers of this bloom. This is the first time that DOP is proposed as a potential factor in *Pseudo-nitzschia* spp. bloom promotion.

Keywords: Toxic blooms, Diatoms, Lagoons, South-Western Mediterranean

Introduction
Recently, late-summer/autumn blooms of *Pseudo-nitzschia* spp. have been increasingly observed in Bizerte lagoon system [1], a semi-enclosed shallow water body subjected to intensive anthropogenic influences. Moreover, elevated levels of DA in the local seawater (0.5 – 2 µg DA l^{-1}) have already been documented, emphasizing the beginning of autumn as a potential period of risk for ASP events [1]. The potential role of organic nutrients in the development and persistence of *Pseudo-nitzschia* spp. blooms remains largely unexplored in spite of ample evidence elsewhere that the organic pool may exert an important role in the occurrence of *Pseudo-nitzschia* spp. blooms and toxicity [2]. The purpose of this study is to explore the potential role of organic nutrients in *Pseudo-nitzschia* spp. late-summer/autumn bloom development in Bizerte channel.

Materials and Methods
Sampling was carried out weekly, from 5 August to 18 October 2011, at one station located in Bizerte Channel. Water temperature and salinity were recorded *in situ* using a microprocessor conductivity meter (WTW-LF-197, Brives B.V., Germany). Seawater samples were taken from 2m depth for inorganic (nitrate, nitrite, phosphate and silicate) and organic (dissolved nitrogen (DON) and dissolved phosphorus (DOP)) nutrient analyses [3]. Sub-samples for identification and enumeration of *Pseudo-nitzschia* spp. were analysed following the Utermöhl method [4]. The bloom sample collected on 27 September was analyzed for DA, following the Mafra method [5].

Results and discussion
During this study, densities of *Pseudo-nitzschia* spp. were frequently of 10^4 order of magnitude, except on 27 September when they exemplified a bloom concentration of ~2.5 10^5 cells l^{-1}. The CCA results showed a significant positive relationship between DOP, nitrate and *Pseudo-nitzschia* spp. bloom development (Fig. 1).

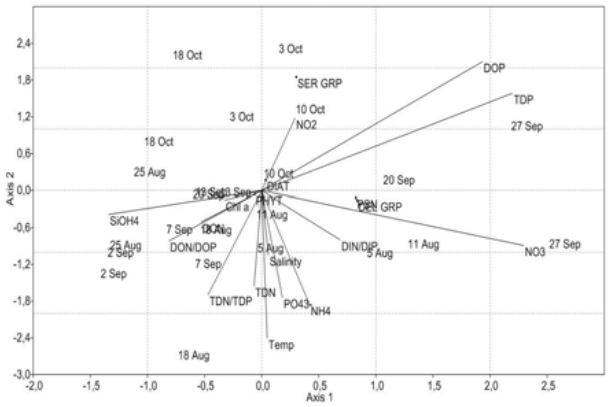

Fig. 1. CCA ordination diagram showing the relationships between environmental variables and *Pseudo-nitzschia* species distribution.

Utilization of DOP by phytoplankton is possible by the activity of several enzymes, e.g. alkaline phosphatase and C-P lyase, which are in general stimulated by critical dissolved inorganic phosphorus levels in the water [6]. DA was also detectable in the bloom sample with a concentration of 1.56 µg DA l^{-1}. The detected DA level may still be a sufficient amount to close shell?sh harvesting and cause toxic effects on seabirds and marine mammals in adjacent waters.

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NITZSCHIA BIZERTENSIS SP. NOV.: A NEW TOXIC DIATOM ISOLATED FROM A SOUTHWESTERN MEDITERRANEAN LAGOON OF BIZERTE

A. Sakka Hlaili [1]*, D. Bouchouicha Smida [1], I. Sahraoui [1], N. Lundholm [2], W. Kooistra [3] and H. Hadj Mabrouk [1]
[1] Fac. Sci. Bizerte, Univ. Carthage, Tunisie - asma_sakka@yahoo.fr
[2] Univ. Copenhagen, Danmark
[3] Stazione Zoologica, Italie

Abstract
The abundance of toxic diatoms was monthly (November 2007 - February 2009) investigated in the lagoon of Bizerte. These microalgae were present over almost all the sampling period and exhibited a pronounced bloom in August 2008 (3 10^6 cells L^{-1}). The characterization of diatom strains, isolated from seawater, by light/electronic microscopy and molecular analyses allowed to identify a new species *Nitzschia bizertensis*. This specie was characterized by (1) linear-lanceolate valves with 1.38 - 2.91 µm width and 32.52 - 81.73 µm length (2) numerous fibulae in the eccentric raphe and (3) high density of interstriae. The domoic acid (DA) was detected in batch culture of *N. bizertensis* (4500 – 9500 pg DA mL^{-1}). *Nitzschia bizertensis* represents a new domoic acid-producing diatom and is the second toxin producing *Nitzschia* species

Keywords: Diatoms, Lagoons, Toxins, South-Western Mediterranean

Introduction
The occurrence of potentially toxic (PT) diatom blooms has increased in the Bizerte Lagoon [1], which is an important shellfish culture area. Some species of these algae were reported as toxic by of Amnesic Shellfish Poisoning (ASP) and thus may harm human health and represents a serious threat for both aquacultured and wild shellfish. Therefore, we investigated the temporal and spatial dynamics of harmful diatoms in the Bizerte Lagoon. We described species isolated from this area and examinated their toxicity in batch culture.

Materials and Methods
Diatom samples were collected monthly, from November 2007 to February 2009, at several stations in the Bizerte Lagoon, using a plankton net (20 µm diameter). Cell abundance was determined under inverted light microscope [2]. Several strains of PT diatoms were isolated, from seawater, and cultured in f/2 medium [3]. The batch cultures were maintained at a temperature of 20 °C, an irradiance of 100 µmol photons m-2 s-1 and a light:dark cycle of 12h:12h. The ultrastructure of the strains was examined using electron microscopy (scanning and transmission) and their genomes were sequenced at LSU and SSU units using the molecular biology techniques. DA in the whole culture (cells plus medium) was analyzed using a the ELISA test.

Results and discussion
During the study, the PT diatoms were abundant in warm, turbid and ammonium-rich waters. These algae exhibited several peaks of density, but the most pronounced bloom was in August 2008 (3 10^6 cells L^{-1}). Previous studies, in Bizerte Lagoon, showed that PT diatoms were exclusively represented by species of *Pseudo-nitzschia* [1]. In contrast, PT diatoms, isolated during our study, belong to the genus Nitzschia. Cells were described by light and electron (transmission/scanning) microscopy as well as genetically, using the nuclear rDNA regions: SSU, ITS1, 5.8S, ITS2 and D1–D3 of the LSU. The morphological and phylogenetic studies and comparisons with previously described Nitzschia species revealed the presence of a new species: *Nitzschia bizertensis* sp. nov. The linear-lanceolate valve (1.38 - 2.91 µm width and 32.52 - 81.73 µm lengt) was characterized by high density of interstriae (35.1 - 53.2 per 10 µm). The canal raphe was extremely eccentric with a central nodule and contains numerous fibulae (7.6 - 18.6 per 10 µm). In batch culture, *N. bizertensis* was able to produce the DA and cellular content varied from 2.3 to 3.6 10^{-2} pg DA $cell^{-1}$. The total DA level varied over time. It was high in exponential growth phase, and thereafter continued to increase during the stationary phase, when it reached 4500 – 9500 pg DA mL^{-1}.

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ETUDE DES MICROALGUES ÉPIPHYTES TOXIQUES ET DU PHYTOPLANCTON TOXIQUE DE LA BAIE D'ANNABA ALGÉRIE

Imen Zard [1]* and Hocine Frehi [1]
[1] Université Badji Mokhtar, Laboratoire Bioressources Marines, Annaba, Algérie - www.imen-zard@hotmail.fr

Abstract
L'étude des microalgues et des épiphytes toxiques sur les feuilles de posidonie de la baie d'Annaba, nous a permis d'enregistrer que les dinoflagellés (*Alexadrium catenella* et *Gymnodinium catenatum)* toxiques sont présents en périodes printanières et estivales, pour les épiphytes, on a recensé la présence de *Prorocentrum lima* et *Ostreopsis ovata*

Keywords: Dinoflagellates, Algerian Basin, Toxic blooms, Phytoplankton

Introduction

Sur un total de 4000 espèces, 60 à 80 est le nombre d'espèces de microalgues potentiellement nuisibles [1]. Introduites généralement par les eaux de ballaste via le trafic maritime, elles s'adaptent et se concentrent dans les eaux côtières, ce qui est le cas de la baie d'Annaba. Cette étude a pour objectif de recenser les espèces microalgues planctoniques et épiphytiques toxiques dans la baie d'Annaba.

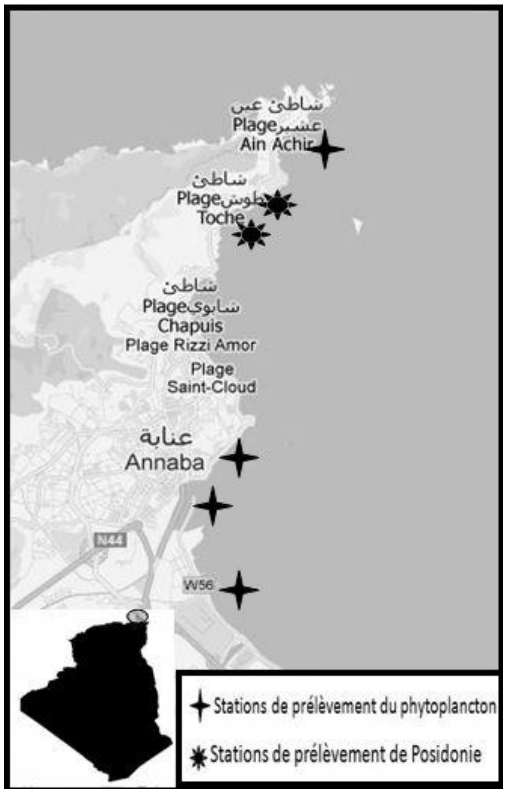

Fig. 1. Zone d'étude

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Matériel et méthodes

Pour l'étude des épiphytes, les feuilles de posidonie prélevées à une profondeur de 3m à 4m, un grattage sur les feuilles de posidonie est réalisé, les espèces récoltées sont fixées au formol (5%). Un filet à plancton de 20µm de vide de maille a été utilisé pour l'échantillonnage du phytoplancton. Un multiparamètre type HANA été utilisé pour mesurer les différents paramètres physiques (Température, salinité, oxygène dissous, pH).

Résultats

Tab. 1. Microalgues recensées durant la période d'étude.

Espèces (épiphytes)	Densités	Période	Toxicité
- *Prorocentrum lima*	18-25 Cell.g^{-1} 87 Cell.g^{-1}	Hiver-printemps Eté	Acide okadaique [2]
- *Ostreopsis ovata*	3 Cell. g^{-1} 26 Cell. g^{-1}	Hiver Eté	Palytoxines [3]
Espèces (phytoplanctoniques)	**Densités**	**Période**	**Toxicité**
- *Lingulodinium polyedra*		Juillet 2012	Yessotoxines [4]
- *Dinophysis caudata* - *Dinophysis tripos* - *Dinophysis sacculus*		Mars- Aoute 2012	Dinophysis toxines
- *Alexandrium catenella* - *Gymnodinium catenatum*	10^6 Cell.L^{-1} 2,3. 10^6 Cell.L^{-1}	Avril 2012 Juillet 2012	Saxitoxines/Gonyautoxines[5] Gymnodimines

Conclusion

Sur la baie d'Annaba, nous avons constaté que les microalgues toxiques se développent dans les zones abritées à faible brassage, généralement en périodes chaudes ,en effet, les concentrations les plus élevées des microalgues épiphytes et planctoniques ont été enregistrée en périodes printanières et estivales, nous pouvons dire que dans les aires eutrophes de la baie d'Annaba, on a enregistré des proliférations importantes d'espèces toxiques en occurrence *Alexandrium catenella* et *Gymnodinium catenatum.*

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Session

Interactions Prokaryotes-Eukaryotes

Modérateur : **Gulsen Altug**

INTERSPECIFIC COMPARISONS OF HOST- ASSOCIATED BACTERIAL DIVERSITY SUPPORT COEVOLUTION OF HAHELLACEAE AND GORGONIAN CORALS

Marie La Rivière [1]*, Joaquim Garrabou [2] and Marc Bally [1]
[1] Mediterranean Institute of Oceanography (MIO - UM 110) - marie.la-riviere@univ-amu.fr
[2] Institut de Ciències del Mar (ICM)

Abstract
Elevated temperature and bacterial infections cause recurrent mortalities of gorgonian corals in benthic communities of the Mediterranean coralligenous habitat. To gain an understanding of the disease outbreaks, a comprehensive overview of the gorgonian-associated microbial diversity is required. In this study, we explored the bacterial ecology of 3 sympatric gorgonian species and our results indicate that the host-bacteria partnership is highly specific, stable and possibly shaped by evolution.

Keywords: Bacteria, North-Western Mediterranean, Cnidaria, Mortality, Symbiosis

Introduction
In marine coastal ecosystems, mass mortality events and disease outbreaks of benthic invertebrates are increasing in frequency. Microbial interactions appear to play a key role in coral health and it has been proposed that a disruption of the integrity of the coral holobiont (the cnidarian host and its associated microbiota) in response to environmental stress can trigger diseases [1]. In North-Western Mediterranean, recurrent mass mortalities linked to high seawater temperatures and infections by pathogenic bacteria have been recorded in populations of several species of gorgonian corals [2]. The increasing threat caused by climate change can have particularly severe impacts on these long-lived, slow-growing macroinvertebrates and a better understanding of factors involved in gorgonian health and disease becomes an urgent need to elaborate future conservation measures. On the basis of the current knowledge on microbial interactions in tropical corals, we hypothesized that determining patterns of host-microbes associations in different gorgonian species might help to reveal common mechanisms through which bacterial communities and holobiont health status are interlinked. Thus, the main aim of the present study was to establish a comparison of baseline composition for bacterial assemblages in 3 sympatric gorgonians, *Eunicella singularis*, *Eunicella cavolinii* and *Corallium rubrum*, that were severely affected during the mortality events.

Material and Methods
The 3 gorgonian species *E. singularis*, *E. cavolinii* and *C. rubrum* were sampled in summer 2008 and winter 2009 at the Riou Island site (Marseilles, France). For each species, apical branch tips of 3 colonies were collected at a depth of 20 m. Total genomic DNA was extracted using a phenol-chloroform protocol. For T-RFLP analysis, bacterial 16S rDNA was amplified by PCR using fluorescent-labeled universal primers. PCR products were digested by *CfoI* and *MspI* endonucleases and the terminal-restriction fragments data collection for each sample was used for multidimensional scaling (MDS) analyses as previously described [3]. Clone libraries were generated by amplification of the 16S rDNA using universal primers and subsequent cloning in pGEM®-T vector. The sequences of the selected clones were determined and compared with the Genbank database using the Blast program. A phylogenetic tree of sequences belonging to the dominant ribotype clusters identified in libraries was generated by the PhyML algorithm using the online phylogeny.fr workflow (http://www.phylogeny.fr).

Results and Discussion
For each of the gorgonian species *E. singularis*, *E. cavolinii* and *C. rubrum*, the T-RFLP peak profiles obtained from 3 independent colonies were highly conserved. Furthermore, MDS ordination of T-RFLP profiles from summer and winter samples did not show seasonal pattern but revealed a clustering of bacterial assemblages by host species, suggesting that gorgonians harbor stable and species-specific bacterial communities. To assess the phylogenetic composition of bacterial communities, 16S rDNA clone libraries were compared for gorgonian colonies sampled in summer. Both the *E. singularis* and *E. cavolinii* libraries were strongly dominated by a unique ribotype affiliated to the *Hahellacae* family of Gammaproteobacteria. This ribotype accounted for 95.8% and 83.3% of the sequences from *E. singularis* and *E. cavolinii*, respectively. Interestingly, a closely related ribotype (>95% similarity) was previously identified as the dominant bacterial associate in the sympatric gorgonian *Paramuricea clavata* [3]. A Blast similarity search against the GenBank database revealed that the ribotype associated with the *Eunicella* spp. showed the best similarity score (>98% similarity) with a group of bacterial sequences from the tropical gorgonian *Gorgonia ventalina*. In the *C. rubrum* library, sequences related to *Hahellaceae* were detected at a low frequency, accounting for 8.8% of the clones. A phylogenetic analysis of representative sequences from the identified groups of *Hahellaceae* ribotypes evidenced a host-dependant clustering (Fig. 1), although the sequences recovered from *C. rubrum* were also related to *Endozoicomonas* and *Spongiobacter* bacteria isolated from other marine invertebrates. Unexpectedly, the phylogenetic tree of the sequenced bacteria corresponds to the systematic classification of their hosts and is not correlated with the geographic separation of gorgonian species. This suggests that *Hahellaceae*-affiliated symbionts may co-evolve with each host species and represent stable, obligate associates of the holobionts. These data support the view that *Hahellaceae* bacteria could play a pivotal role in gorgonians.

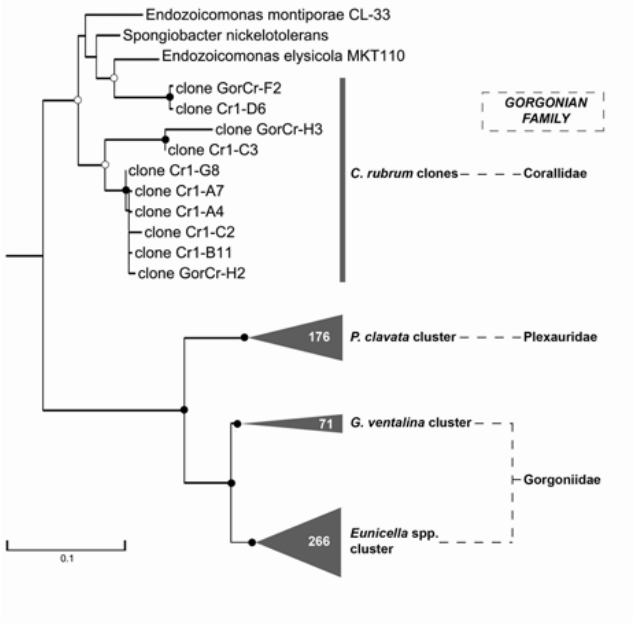

Fig. 1. Phylogenetic tree showing the relationships of *Hahellaceae* ribotypes obtained from gorgonians. Branch support values of >75% (filled circles) and 50 to 74% (open circles) and the number of sequences in each cluster are indicated.

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TOXICITY OF TWO CYANOBACTERIAL STRAINS ON *MYTILUS GALLOPROVINCIALIS* HEMOCYTES

Patrizia Pagliara [1]* and Carmela Caroppo [2]
[1] DiSTeBA - University of Salento - patrizia.pagliara@unisalento.it
[2] National Research Council, Institute for Coastal Marine Environment, Taranto, Italy

Abstract
Cyanobacteria may produce a wide range of currently unknown toxins. Within this frame, the toxicity of two cyanobacterial strains (*Cyanobium* sp. and *Synechococcus* sp.) was tested on mussels (*Mytilus galloprovincialis*). Results evidenced that the two cyanobacteria did not affect the vitality of the individuals, but they exerted a toxic effect on the morphology and functionality of the mussels' hemocytes.

Keywords: Cyanobacteria, Mollusca, Toxins, Ionian Sea

Introduction
Massive proliferations of cyanobacteria have become a worldwide environmental problem because of the severe impacts on ecosystem functioning, by inducing as an example, disturbances to relationships among organisms and changes in biodiversity. Considering that 25 to 75% of cyanobacterial blooms are toxic [1, 2, 3], it is important to assess the risk for human and animal health. Cyanobacteria are able to produce a great variety of several secondary metabolites and unknown substances, considered potent toxins [see 4 for review]. In this work we studied the effects of twenty-four hours interaction between two coccoid unicellular cyanobacteria strains (*Cyanobium* sp. ITAC108 and *Synechococcus* sp. ITAC107) and *Mytilus galloprovincialis* individuals.

Material and Methods
Two cyanobacteria belonging to *Cyanobium* and *Synechococcus* genera were previously isolated from the sponge *Petrosia ficiformis*, collected in the Ionian Sea. Cyanobacteria were cultured in laboratory conditions and used to test their toxicity against *Mytilus galloprovincialis.* Mussels individuals were exposed to the cyanobacteria for 24h under control conditions. The Neutral red test was performed to assess toxicity of the two cyanobacterial strains against mussels hemocytes. Aliquots of hemolymph were also fixed and stained to evaluate changes in hemocytes morphology.

Results and discussion
Cyanobium sp. ITAC108 and *Synechococcus* sp. ITAC107 did not induce effect on mussels survival, but their hemocytes resulted modified in morphology and functionality. Mussels treated with *Cyanobium* sp. ITAC108 showed a lower lysosomal membrane stability than in controls, as revealed by the Neutral red assay. By the same test we verified that *Synechococcus* sp. ITAC107 interaction with mussels completely inhibited the hemocytes ability to incorporate the dye into lysosomes. Furthermore, we observed that the two cyanobacterial strains modified cell morphology of hemocytes that became round.
Between the two strains, *Synechococcus* sp. **ITAC107** seems to be more dangerous for mussel hemocytes, affecting their functionality.

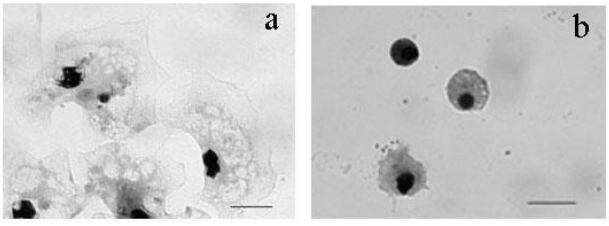

Fig. 1. Hemocytes from control mussels (a) and from cyanobacteria treated molluscs (b)

In Invertebrates, hemocytes mediate cellular defence; morphology and functionality changes of these cells represent a risk for animals health, since they could become more susceptible to disease. Our data evidenced a clear toxicity of the two tested cyanobacterial strains, even if no causative compound has been identified so far. In a previous work [5] we already evidenced the hemolytic activity of *Synechococcus* sp. ITAC107 and the ability of the two strains to interfere with sea urchin embryonic development. Further research is needed not only to identify new cyanobacterial bioactive metabolites, but also to investigate on possible additive, synergistic or antagonistic effects of the toxins they produce.

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DIVERSITY AND DISTRIBUTION OF BACTERIA ASSOCIATED WITH THE CORAL *OCULINA PATAGONICA* IN THE WESTERN MEDITERRANEAN SEA

Esther Rubio Portillo [1]*, Alfonso Angel Ramos Esplá [1] and Josefa Antón Botella [1]
[1] Universidad de Alicante - esther.portillo@ua.es

Abstract

This study has applied culture-independent methods to examine the structure and composition of bacterial communities inhabiting in three different microhabitats (mucus, coral tissue and skeleton) of the coral *Oculina patagonica*, across two sites of the Western Mediterranean Sea, during a year. Differences among coral compartments and seasonal effects were detected; bacterial diversity was higher in coral tissue than in the mucus and skeleton, increasing during warm months in the three compartments.

Keywords: Symbiosis, Bacteria, Cnidaria, South-Western Mediterranean

Introduction

Corals consist of symbioses among the coral animal, endosymbiotic algae commonly referred to as zooxanthellae (Symbiodinium), and a large and diverse community of associated bacteria, archaea, fungi and viruses and this consortium has been termed "the holobiont"[1, 2]. The structure of the coral host provides three different potential microhabitats (a surface mucus layer, tissues and skeletal matrix) which have unique physiochemical characteristic that influence the bacterial community structure [3].

Materials and methods

In this study we have characterized bacterial communities of *Oculina patagonica* from three different microhabitats such as mucus, tissue and skeleton, and changes in microbial communities related to temperature. We have collected coral colonies every three months during a year, in two different locations of Alicante coast: Alicante harbour and the Marine Reserve of Tabarca, between 3-5 m. The prokaryotic community of the three different microhabitats has been analyzed by denaturing gradient gel electrophoresis (DGGE) of 16S rRNA gene fragments PCR amplified from DNA extracted from each of the coral compartments

Results and discussion

A total of 135 sequences were analysed and grouped into 56 phylotypes. Coral-associated microbial species were similar between two localities, although differences among coral microhabitats and seasonal effects were detected (Fig. 1). Bacterial 16SrRNA gene diversity was higher in the tissue than in the skeleton and mucus, increasing during warm months in three compartments. *α-Proteobacteria*, Bacteroidetes and Chlorobi were found in all three compartments while *δ- Proteobacteria* and Nitrospira were only detected in the tissue and skeleton, respectively. *α- Proteobacteria were* the most abundant in the mucus (75%) and tissue (47%), with phylotypes similar to *Pseudovibrio sp*. and *Roseobacter sp*., which could involved in cycling of nitrogen [3] and sulfur [4] within the holobiont, dominating in the mucus and tissue, respectively. During warm months, under heat stress, we found changes in bacterial communities associated with *Oculina patagonica* .In tissue the number of phylotypes related with *Bacteroidetes* increased while *α- Proteobacteria* and *δ-Proteobacteria* dicreased; stressed skeleton tissues harboured less *Chlorobi* and *Bacteroidetes*. Furthermore, *a* higher proportion of putative opportunistic bacteria belonging to *Acidobacteria, Chloroflexi* and *Cyanobacteria* were detected in the different coral compartments.

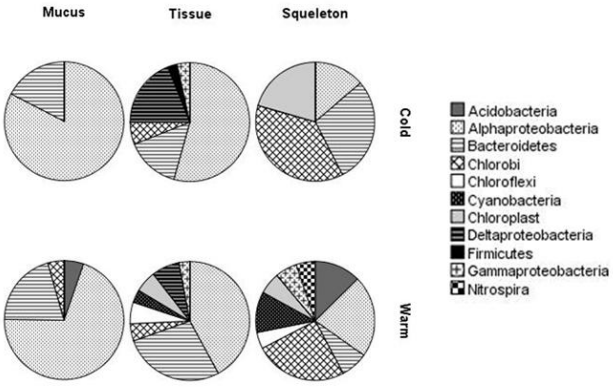

Fig. 1. Division-level diversity of bacterial 16SrRNA gene sequences obtained from the three different coral microhabitats (mucus layer, coral tissue and skeleton), and differences between cold and warm months.

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TEMPORAL CHANGES IN SIZE-BASED PRIMARY PRODUCTIVITY AND CHLOROPHYLL CONTENT OF THE CILICIAN BASIN

Nebil Yücel [1]*, Zahit Uysal [1] and Süleyman Tugrul [1]
[1] Institute of Marine Sciences Middle East Technical University - nebil@ims.metu.edu.tr

Abstract
Changes in size-based primary productivity (PP) and chlorophyll (CHL) content were followed in monthly intervals (May 2010 - October 2011) at two stations (coastal, offshore) located in the Cilician basin of NE Med. PP varied in the range 0.024 – 14.42 and 0.007 – 1.48 in the euphotic zone, with water column averages of of 1.52 and 0.25 mg C. m^{-3} h^{-1} for the shelf and offshore, respectively. While larger cells (>5µm) and picoplankton have dominated nutrient rich shelf waters in an alternating manner, picoplankton remained as the sole contributor for the offshore waters. PP and CHL (n: 108, r: 0.356, P<0.01) were positively correlated in shelf waters. Annual primary productivity was estimated to be 65.4 g $C.m^{-2}$ for the offshore and 151.2 g $C.m^{-2}$ y^{-1} for the shelf waters of the Cilician basin for the 2010-2011 periods.

Keywords: Primary production, North-Eastern Mediterranean, Phytoplankton, Chlorophyll-A, Carbon

Introduction
Offshore waters of the eastern Mediterranean have oligotrophic properties [1]. However, river-fed coastal waters of wide self zone and bays in the Cilician basin of NE Mediterranean display either mesotrophic/eutrophic properties with daily PP rates ranging from 38.5 mgC m^{-2} d^{-1} in the offshore to 250 mgC m^{-2} d^{-1} in the coastal waters in 1991 and 1992 [2].

Material and Methods
Two stations (one with 50 m and the other with 200 m total depth), located in the Cilician basin (Fig. 1) were visited monthly from May 2010 to Oct 2011. To measure total and size fractionated PP, ^{14}C added seawater samples were incubated *in situ* during midday for about 3 hours. CHL was measured by the conventional fluorometric method and nutrients by the colorimetric methods using a multichannel auto-analyzer [3].

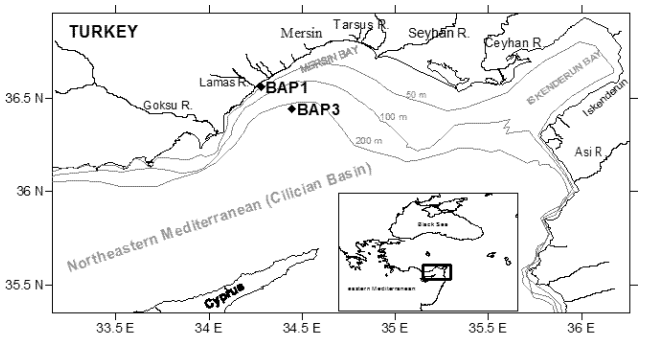

Fig. 1. Locations of the sampling stations visited monthly in the shelf zone of Cilician basin.

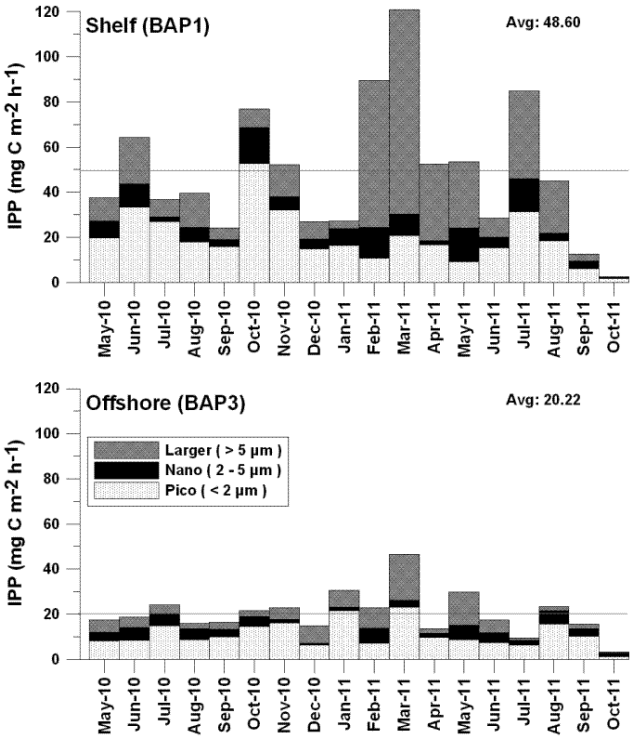

Fig. 2. Depth integrated PP at stations BAP1 (total depth = 40 m) and BAP3 (total depth = 100 m) stations.

Results
Rates of Integrated Primary Production (IPP) fluctuated monthly between 2.45 – 121 and 3.3 – 46.5 mgC.m^{-2} h^{-1} with the annual means of 48.6 and 20.2 mgC.m^{-2} h^{-1} for the shelf and offshore, respectively. Larger cells (>5µm) dominated phytoplankton composition during the first half (from February 2011 to July 2011, except June 2011) and picoplankton to dominate the rest of the year in shelf waters fed by river inputs decreasing markedly during the dry period. Picoplankton also dominated PP production in nutrient poor offshore waters throughout the year. Seasonal primary productivity rates were estimated as 32.6, 55.4, 57.3, 5.9 g $C.m^{-2}$ for the coastal and 12.9, 25.3, 14.6 and 12.58 g $C.m^{-2}$ for the offshore location, for winter, spring, summer and autumn, respectively. Based on POC/CHL ratios of cells, picoplankton (3.8) in shelf and nanoplankton (4.7) were the most active group of the algal total cells in the study area. Phosphate and nitrite+nitrate varied between 0.02-0.08 and 0.05-11.56µM in the study area, respectively.

Acknowledgements: This study was supported by METU BAP-07-01-2009-01 and BAP-07-01-2011-001 projects.

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Session

Marine - Omics / ABS

Modérateur : **Frank Glöckner**

MARINE PROTEOGENOMICS: SCREENING AND CHARACTERIZING MICROBIAL BIODIVERSITY WITH NEW OMICS TOOLS

Jean Armengaud [1]*, Guylaine Miotello [1] and Joseph A. Christie-Oleza [1]
[1] CEA, DSV-iBEB-SBTN-LBSP Institut de Biologie Environnementale et Biotechnologies - jean.armengaud@cea.fr

Abstract
Mass spectrometry is becoming essential for identifying and characterizing the different forms of life and their intimate mechanisms ([1-4]). We applied proteogenomics to study the lifestyle of environmentally relevant marine bacteria belonging to the *Roseobacter* clade. We revealed the different adaptive strategies they have adopted ([5-6]). We recorded large proteomic datasets to better annotate their genomes and proposed a pan re-annotation of the whole clade ([7]). Furthermore, we defined specific biomarkers to screen for new *Roseobacter* isolates on the basis of genomic and proteomic data. As a proof of concept, we sampled Mediterranean Sea water, analyse tens of isolates and could describe new specific bacteria belonging to a given genus ([8]), as well as to a more extended group of bacteria, the *Roseobacter* clade.

Keywords: Bacteria, Analytical methods, Biodiversity, Biotechnologies, Gulf of Lyon

Mass spectrometry is becoming essential for identifying and characterizing the different forms of life present on Earth and their intimate, complex, functional mechanisms. We recently reviewed the different applications of mass spectrometry and proteomic approaches in the field of environmental microbiology ([1], [2], [3]). Profiling approaches by whole-cell MALDI-TOF mass spectrometry or specific biomarker searches are reliable, quick and cost-effective methods for screening for new microorganisms and assessing microbial diversity. Several examples will be given to illustrate the potential of mass spectrometry in environmental microbiology, with specific emphasis on marine proteogenomics. Proteogenomics consists of high-throughput identification and characterization of proteins by extra-large shotgun tandem mass spectrometry approaches and the integration of these data with genomic data ([4], [5]). We compared twelve *Roseobacter* exoproteomes and revealed the different adaptive strategies these marine bacteria have adopted ([6]). We also recorded large proteomic datasets in order to better annotate their genomes and proposed a re-annotation of the whole marine *Roseobacter* clade ([7]).

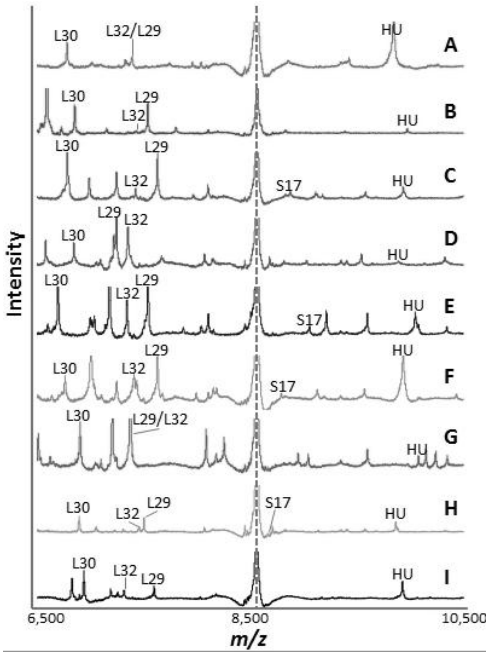

Fig. 1. Whole-cell MALDI-TOF spectra of nine *Roseobacter* representatives. Spectra were acquired on a MALDI-TOF BiflexIV mass spectrometer (Bruker daltonics) . The *m/z* range where the HU, L29, L30, L32, and S17 proteins are detected as monoprotonated ions is shown.

Furthermore, we defined specific biomarkers to screen for new *Roseobacter* isolates on the basis of genomic and proteomic data. Today, the analysis of environmental samples with the whole-cell MALDI-TOF mass spectrometry approach still represents a challenge due to the enormous microbial diversity existing on earth and the lack of a comprehensive database [8]. We defined widely distributed biomarkers for bacteria belonging to the *Roseobacter* clade. Figure 1 shows the highly divergent pattern of biomarkers for nine representative bacteria analyzed by MALDI-TOF mass spectrometry. These nine representatives were : *Oceanicola batsensis* HTCC2597, *Pelagibaca bermudensis* HTCC2601, *Roseobacter denitrificans* OCh114, *Phaeobacter gallaeciensis* 2.10, *Oceanibulbus indolifex* HEL45, *Roseobacter litoralis* OCh149, *Roseobacter* sp. MED193, *Roseovarius nubinhibens* ISM and *Dinoroseobacter shibae* DFL12.We could predict by proteogenomics the exact masses of three relevant biomarkers: HU, L29 and L30 proteins for all the sequenced organisms from the clade. We screened a collection of 93 isolates from water sampled from Mediterranean Sea and grown on marine medium. The three biomarkers resulted in six possible *m/z* (monoprotonated and diprotonated ions) amongst a list of 103 theoretical values. From the systematic MALDI-TOF analysis of these 93 isolates, we could identify and document three new *Roseobacter* strains: a novel representative of the *Phaeobacter* genus, a member of the *Thalassobacter* genus, and another *Ruegeria* strain (unpublished data). The later isolate originated from sea water sampling during a phytoplankton bloom. Due to its simplicity and effectiveness, this technique could be of immense value for monitoring bacteria.

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POOLS OF GENETIC RESOURCES AS A TOOL TO FACILITATE ACCESS AND BENEFIT SHARING IN THE MEDITERRANEAN

Jesús M. Arrieta [1]*, Sophie Arnaud-Haond [2] and Carlos M. Duarte [3]
[1] IMEDEA. CSIC-UIB. Miquel Marqués 21. 07190 Esporles. Mallorca. Spain - txetxu@imedea.uib-csic.es
[2] Unité Halieutique Méditerranée (HM) du Département Ressources Biologiques et Environnement (RBE)- UMR 212 - Ecosystème Marin Exploité (EME) Bd Jean Monnet, BP 171, 34203 Sète Cedex - France
[3] Oceans Institute, University of Western Australia, Crawley 6009, Australia

Abstract
The appropriation of Marine Genetic Resources (MGRs) such as natural products or genes derived from marine organisms for medicine, cosmetics, and other industrial uses is growing exponentially. There are ongoing efforts to provide policies for equitable access and benefit sharing to these resources. However, there are a number of unresolved issues, which need to be addressed and which are particularly pressing in the Mediterranean. We propose a common pool of genetic resources for the Mediterranean as a simple and fair mechanism to simplify access and avoid conflicts of interests between the different Mediterranean states.

Keywords: Biodiversity, North-Central Mediterranean

Human appropriation of MGRs has been growing rapidly in the last few decades with over 18,000 [2] natural products and >6000 [1,2] genes of marine organisms associated to patents deposited worldwide. Gene patenting covers all major phyla in the tree of life from prokaryotes to vertebrates and the number of species involved in gene patenting has been growing at a rate of about 12% per year [2]. Yet, access to MGRs is limited by the availability of technological resources as demonstrated by the fact that 90% of the international patent applications belong to only 10 countries [1]. The Convention on Biological Diversity (CBD) and the Nagoya Protocol aim to achieve sustainable and equitable utilization of genetic resources by defining the ownership of genetic resources and thus, making it possible to reach bilateral agreements between the provider country and the users. Despite these efforts, tracing the benefits and the ownership of genetic resources remain challenging due to a lack of a clear mandate to disclose the geographical origin of the source organisms involved in gene patents. Moreover, the distribution of most species spans over different countries, further complicating negotiations between provider countries and final users of genetic resources. While all the caveats listed above are shared by both marine and terrestrial genetic resources worldwide, they are particularly relevant for the marine genetic resources of the Mediterranean. While the CBD defines clearly the ownership of MGRs within the national jurisdictions according to the Law of the Sea, there are significant sources of conflict in a relatively narrow sea like the Mediterranean. There are also significant differences in technological development between Mediterranean countries. The Mediterranean is home to >17,000 species of which a large proportion are endemic species, only occurring the Mediterranean [3]. Yet, these endemic Mediterranean species are shared among different Mediterranean states. Therefore, we propose that access to Mediterranean MGRs should be regulated through a common pool of genetic resources. In this framework, Mediterranean MGRs would be accessed under a common set of rules, thus simplifying access procedures for users and avoiding the conflicts due to MGRs shared by several states and the territorial disputes derived from the implementation of the exclusive economic zones in a such a narrow basin. Moreover, the organization managing this pool of MGRs should help ensuring fair access and benefit sharing for all the Mediterranean states and implement measures for capacity building in those countries less able to exploit their MGRs.

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EXPLOITATION DE LA BIOTECHNOLOGIE MARINE PARTAGE JUSTE ET EQUITABLE DES AVANTAGES ET BIOLOGIE DE SYNTHÈSE

Jean-François Bloch [1*]
[1] consultant - jfbloch@ymail.com

Abstract
Les ressources génétiques marines sont de formidables sources pour le développement de nouveaux produits industriels dans de nombreux domaines. Il est déjà difficile de mettre en place des accords permettant un accès et le partage des avantages (APA) de l'exploitation de ces produits. Ce partage des bénéfices va se complexifier avec l'émergence des technologies de biologie synthétique qui n'utiliseront plus la ressource génétique en tant que telle mais uniquement une information dérivée de cette ressource.

Keywords: Biotechnologies, Bacteria, Biodiversity, Economic valuation, Extra-Mediterranean regions

Il ne fait pas de doute que les ressources génétiques marines ont un potentiel considérable d'exploitation commerciale. Les principaux secteurs susceptibles d'utiliser les ressources issues de la biodiversité sont les industries des sciences de la vie, et notamment les secteurs de la santé, de la chimie, de la cosmétique, de l'environnement, de l'alimentaire et de la bioénergie. L''APA découlant de l'exploitation aussi bien à des fins de recherche que commerciales des ressources génétiques marines soulèvent dès à présent de très nombreuses questions difficiles à résoudre.

Pourtant aujourd'hui un nouveau domaine est en pleine émergence: la biologie de synthèse. Si son acceptation sociétale n'est pas encore acquise et nécessitera un dialogue entre la communauté scientifique, les responsables politiques et les citoyens, l'usage de cette dernière est déjà effectif dans les laboratoires. Elle a pour but de concevoir de nouveaux systèmes biologiques en faisant de l'ingénierie rationnelle à partir d'informations. Ces informations peuvent bien sûr provenir de travaux sur des ressources génétiques marines. Selon les méthodes classiques de biotechnologie est extrait un gène spécifique d'un organisme pour être transféré dans un autre organisme, pour produire la protéine associée à ce gène. Avec cette nouvelle biologie la synthèse d'un gène peut se faire par des techniques chimiques ou des méthodes bioinformatiques. Certes la route est toujours longue, difficile et aventureuse pour aller de la prospection de la biodiversité marine jusqu'au produit commercialisé même avec les nouveaux outils de biologie synthétique. Il y aura toujours à chaque étape du développement des intervenants différents ayant des intérêts à la fois complémentaires et divergents. Il faudra encore prendre en compte les problématiques de la propriété industrielle pour l'exploitation commerciale. La mise sur le marché de nouveaux produits est rarement l'œuvre du bio prospecteur seul. L'exploitation actuelle de la biodiversité nécessite de mettre en place des partenariats entre les bio prospecteurs (universités, entreprises privées...) et les structure de R&D (laboratoires publics ou privés). Mais le spécialiste de la biologie de synthèse aura-t-il encore besoin d'une relation directe avec le bio prospecteur puisqu'il n'a plus techniquement besoin que de l'information souvent déjà publiée. L'accès à l'information devient plus important que l'accès aux produits. La bio prospection n'est que la phase amont des programmes qui ambitionnent de développer un produit issu de la biodiversité. L'entreprise du secteur marchand aussi vertueuse soit-elle a pour objectifs un produit ou un processus viables économiquement. Quelle sera alors la valeur réelle de la biodiversité ? Comment mettre en place une traçabilité de la ressource génétique marine dans les processus de création de nouveaux produits et procédés ? Quels seront les nouveaux partenariats pouvant garantir à chacun un juste retour conformément à la convention de la biodiversité? De nouveaux modèles efficients devront être imaginés et réalisés pour atteindre l'objectif d'un partage juste et équitable des avantages issus de l'utilisation de la biodiversité marine, en tenant compte des différents acteurs économiques de la chaîne de valeur et en y intégrant, dès maintenant, ce nouvel outil qu'est la biologie de synthèse. Il sera certainement nécessaire d'imaginer de nouveaux partenariats pouvant garantir à chacun un juste retour conformément à la convention de la biodiversité. Ainsi il faudra élaborer des modèles efficients permettant une juste mise en œuvre de l'APA de l'utilisation de la biodiversité marine pour tous les acteurs en y intégrant dès maintenant ce nouvel outil qu'est la biologie de synthèse.

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PROTEOME MODIFICATIONS OF THE TOXIC MARINE DINOFLAGELLATE *ALEXANDRIUM CATENELLA* UNDER METALLIC STRESS CONDITIONS

E. Dumont [1]*, F. Herzi [1], A. Sakka [2], T. Balliau [3], S. Mounier [1] and N. Jean [1]
[1] Université du sud Toulon-Var - estelle.dumont1@gmail.com
[2] Faculté des sciences de Bizerte (Tunisie)
[3] PAPPSO, Ferme du Moulon, 91190 Gif-sur-Yvette

Abstract

In this report, the study of *Alexandrium catenella* submitted to metallic stress (lead or zinc) was performed by 2D-electrophoresis. Comparisons of reference cultures and contaminated cultures were done in order to detect protein spots of interest, which were identified. The function of these identified proteins allowed us to speculate on the mechanisms by which *A. catenella* manage to survive in metal contaminated environments.

Keywords: Dinoflagellates, Metals, North-Western Mediterranean, Phytoplankton, Pollution

Introduction

The use of proteomics is more and more popular in aquatic toxicology [1]. With this method, the explanation of the stress tolerance could find an answer [2, 3]. Indeed, proteins are the last response of species against biotic or abiotic stress. The dinoflagellate *Alexandrium catenella* is a toxic phytoplankton which can cause harmful algae blooms (HABs). The occurence of these HABs have increased in recent years and could be induced by anthropogenic inputs resulting in eutrophication of the ecosystems [4]. Previously, in a coastal marine ecosystem perturbed by anthropogenic inputs (Bay of Toulon, trace metal contaminants [5]), the prevalence of dinoflagellates [6] and *Alexandrium* blooming [7] were shown. Our aim is to investigate how *Alexandrium* can survive in metal contaminated conditions and cause HABs.

Material and methods

A. catenella strain ACT03 was isolated in 2003 from the Thau lagoon (France, UMR 5119, Université Montpellier 2). Axenic cultures of this strain were maintained on f/2 medium [7], grown at 20°C and 135 µmol photons. m^{-2}. s^{-1} (light: dark cycle 12: 12). The culture medium was supplemented or not (reference) with different quantities of trace metals metal (Pb or Zn). Extraction of soluble and membrane proteins was realized before 2D-electrophoresis. Spots of interest were picked, and proteins were identified by LC-MS/MS (France, Ferme du Moulon, Gif-sur-Yvette).

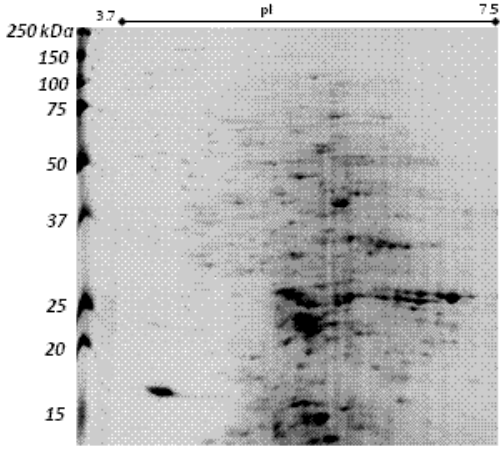

Fig. 1. 2D-electrophoresis map of the soluble proteome from referential *A. catenella* culture

Results and discussion

The proteins were characterized by their appearance/disappearance, or by their overexpression/underexpression, on the protein maps obtained from the *Alexandrium* cultures exposed to trace metals, in comparison to maps obtained for referential cultures. By this way, our objectives were (*i*) to find stress proteins potentially involved in the *Alexandrium* resistance to metal contamination, (*ii*) to understand the role of proteins in the dinoflagellate predominance and in the HAB expansion in marine perturbed ecosystems, (*iii*) to define *Alexandrium* protein markers of metal stresses. On the one hand, an increase in ATP synthesis, but also in the photorespiration, could explain how the toxic *Alexandrium* can survive under metal stresses. This dinoflagellate produced more energy (ATP) and reduced the level of reactive oxygen species (ROS) due to the photorespiration, so, the oxidative stress was decreased. On the other hand, a decrease in photosynthesis was observed. This phenomenon allowed *Alexandrium* to limit the production of ROS, and in the same way, the oxidative stress.

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EVIDENCE OF CHRYSOPHSINS IN FARMED EUROPEAN SEA BASS MUCUS REVEALED BY A COMPLEMENTARY LC-ESI-MS AND MALDI-TOF APPROACH

Sonia Fekih-Zaghbib [1]* and Balkiss Bouhaouala-Zahar [2]
[1] INNTA National Institute Nutrition and Food Technology - fekihsonia@gmail.com
[2] Institut Pasteur Tunis

Abstract
Mass spectral profiling of fresh mucus from farmed *Dicentrarchus labrax* using MALDI-TOF and LC-MS spectrometry was carried out to investigate the infective/healthy status. As result, we identified antibacterial peptides (AMP) and three Chrysophsins within the mucus which display broad-spectrum bactericidal activity against Gram-negative and Gram-positive bacteria (MICs < 0.5 μM). Furthermore, sensitivity to yeast *Candida albicans* was shown by means of interesting MICs of less than 2 μM. We also demonstrated that the fish pathogen *Aeromonas salmonocida* is sensitive to Chrysophsins (MICs ranging between 5 and 14 μM). Our data provides evidence that Chrysophsins are secreted by immune cells, released in mucus of non-challenged farmed European sea bass and are therefore important widespread components of Teleostei defense against disease.

Keywords: Mediterranean Ridge, Analytical methods

Introduction Understanding the biological–ecological variables that modulate host–pathogen interactions is essential for a proper conservation and management of marine and fisheries resources [1]. The most important interaction is the acquisition of immunity after exposure to the pathogen in cultured and wild fish populations [2]. Fish epidermal mucus, one of the main components of innate immunity, is considered as the first immune barrier [3]. AMPs isolated from skins and gills of teleosts are cationic and amphipathic peptides displaying antimicrobial activities [4]. Most of them are structurally belonging to linear α-helical peptide group and members of the Piscidin family [5-8]. Indeed, recent studies demonstrated the widespread tissue distribution of that Piscidin and Piscidin-like AMPs suggesting their pivotal play in the nonspecific immune defense of teleost [9]. However, corresponding AMPs released from mucus have not been further investigated until now. This prompted us to investigate the mucus secreted antimicrobial peptides in non-challenged farmed sea bass fish in Tunisia coast.

Material and Methods A Maldi-Tof molecular mass mapping of pre-purified mucus is carried out on mucus samples of healthy *Dicentrarchus labrax* collected from a brackish 1,000-ha lagoon tunisian aquaculture station located in the open Bay of Hergla. Three peptides fractions selected by ESI-MS analysis were purified by HPLC and MICs of purified peptides were determined using our validate Hancock broth dilution assay [10]. ESI-MS primary sequence elucidation of purified antimicrobial peptides is submitted to the MS-Tag database search program of the Protein Prospector proteomics server (http://prospector.ucsf.edu). A Swiss Prot Database search confirmed the peptide identity.

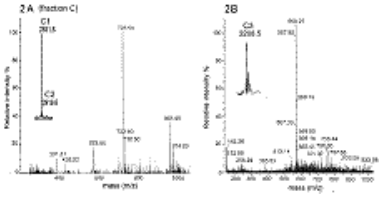

Fig. 1. **LCMS-IT and MALDI-TOF profiles of purified peptides C1, C2 and C3.** 2A, ESI-MS spectrum of fraction C; The inset shows the MALDI-TOF profile of C fraction with C1 and C2 peaks. 2B, ESI-MS spectrum of fraction C3; The inset shows the MALDI-TOF profile of peak C3.

Results and discussion Using MALDI-TOF and LC-ESI-MS analysis of eluted mucus fraction from a Vydac C4 column at 33-35% acetonitrile, we identified three peptides present in moderately high abundance with masses in the expected fitting values to Chrysophsins. We used peptide sequence tag query to confirm results obtained by manual peptide mass fingerprint analysis. Therefore, Chrysophsins1, 2 and 3 highly cationic and known Piscidin-like peptides of respectively, 25, 25, and 20 amino acids have been identified. Their common C-terminal RRRH sequence is most likely related to the strongly bactericidal and hemolytic activity of those AMPs [7]. Human tested pathogens, (i.e. *E. coli* and *S. aureus*) were found to be more susceptible to the mucus expressed AMPs than fish pathogen (i.e. *Aeromonas salmonocida*) which was sensitive to less than 15 μM. Direct estimation by MS tools of comparative AMP levels expression in mucus may throw light on the antimicrobial peptide functions in relation with the immune response in aquaculture conditions. Our data demonstrated that Chrysophsins are effective component closely associated to healthy farmed European sea bass. Our approach based on mucus MALDI-TOF followed by LC-ESI-MS analysis for exploring AMP proteome is helpfulness and highlights the MS approach to address an efficient analysis of anti-infective status within the mucus of perciforms.

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THE MICRO B3 PROJECT: MARINE MICROBIAL BIODIVERSITY, BIOINFORMATICS, BIOTECHNOLOGY & THE OCEAN SAMPLING DAY INITIATIVE

F. O. Glöckner [1]*, A. Klindworth [2], R. Kottmann [2], M. Bicak [3], D. Field [3] and -. the Micro B3 Consortium [4]
[1] Jacobs University Bremen - fog@mpi-bremen.de
[2] Max Planck Institute Bremen
[3] University Oxford
[4] contact@microb3.eu

Abstract
The EU project Micro B3 which stands for marine, microbial biodiversity, bioinformatics and biotechnology started on January 1st, 2012. Its main goal is to make the vast amount of data from marine microbial research available for better environmental modeling and innovative biotechnological applications. The Micro B3 project is financed by an EU "Ocean of Tomorrow Grant" with a total of €9 million for a period of four years. 32 partner institutions from 14 countries participate in the project, which unites leading experts from eight disciplines. Central to the project is the creation of an integrative database and the development of a legal framework for genome-based environmental research as well as to coordinate a global, orchestrated site-based and fixed-in-time sampling effort - the Ocean Sampling Day.

Keywords: Biodiversity, Biotechnologies, Bacteria, North-Central Mediterranean

Introduction
The integrated research project Micro B3 (Biodiversity, Bioinformatics, Biotechnology, www.microb3.eu) brings together teams of experts in bioinformatics, computer science, biology, ecology, oceanography, bioprospecting, biotechnology, ethics and law. The consortium's main aims are to merge the existing bodies of expertise in ecosystems biology, the processing and interpretation of data, modelling and prediction, and the development of intellectual property agreements for the exploitation of high potential commercial applications. At its core, Micro B3 aims to develop an innovative, transparent and user friendly open-access system, which will allow seamless processing, integration, visualisation and accessibility of the huge amount of data collected in ongoing sampling campaigns and long-term observations. This will, in turn, offer new perspectives for the modelling and exploration of marine microbial communities for biotechnological applications (Teeling and Glöckner 2012).

Fig. 1. The Micro B3 Logo and Keywords

Ocean Sampling Day
A key boost to Micro B3 will be provided by the Ocean Sampling Day (OSD, www.oceansamplingday.org), scheduled to take place on the summer solstice, 21 June 2014. OSD will run worldwide, with pilots conducted in 2012 and 2013 to establish standardized sampling techniques.
Recent developments in sequencing technology make sequencing of whole microbial communities from the environment a widely used and affordable routine task. Consequently, large scale sampling and sequencing efforts such as the Global Ocean Sampling (GOS) Campaign, the Malaspina Cruise and the Tara Oceans Expeditions are now exploring marine ecosystems in space and time. In contrast to these circumnavigations, no orchestrated site-based and fixed-in-time sampling effort has been initiated so far. Micro B3 is now taking action to organise the Ocean Sampling Day. **The OSD is open to any interested lab across Europe and beyond.** The resulting cumulative samples, fixed in time and space supplemented with a broad set of geo-referenced environmental parameters, will contribute to determine a baseline of marine biodiversity and functions at the molecular level. To ensure maximum usefulness of these samples, sampling and data analysis will be done across all sites using agreed upon best practices developed within Micro B3. Herewith, a high level of consistency between data points across Europe and beyond is ensured. In particular all sites will be expected to comply to the MIxS minimum information checklists of the Genomic Standards Consortium (GSC, www.gensc.org) (Yilmaz et al. 2011).

Fig. 2. The Ocean Sampling Day Logo

The Mediterranean Sea
A region of special interest for OSD is the Mediterranean Sea. Its unique geographical and political position in the heart of Europe, the diversity of habitats as well as the dense set of all kinds of geological, oceanographic and environmental data render it a prime target for OSD. A close collaboration with the Mediterranean Science Commission (CIESM) has been established to foster the implementation of OSD-Med as part of Micro B3's global OSD. If you are interested in participating, please send an e-mail to osd-contact@microb3.eu.

Summary and Outlook
Micro B3 with its OSD initiative is set to significantly improve Europe's capacity for bioinformatics and marine microbial data integration, to the benefit of a variety of disciplines in bioscience, technology, computing, standardisation and law. We expect that the integrated data will provide a reference dataset for generations of experimentalists to come. It should further function as a starting point for site-based monitoring of microbial communities as proposed by the Genomic Observatories initiative (www.genomicobservatories.org, Davies et al. 2012).
Micro B3 is financially supported by the FP7 Ocean of Tomorrow Grant #287589.

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COMPARATIVE GENOMICS OF AROMATIC COMPOUNDS DEGRADATION PATHWAYS IN THE MARINE ROSEOBACTER CLADE

B. Nogales [1]*, C. Alejandro-Marín [1], J. Piña-Villalonga [1], M. Mas-Lladó [1], I. Brunet-Galmés [1] and R. Bosch [1]
[1] University of the Balearic Islands Dept. Biology - bnogales@uib.es

Abstract
Members of the Roseobacter clade predominate in marine environments chronically polluted with hydrocarbons. Genomic analyses shows that these bacteria might possess up to six pathways for aromatic hydrocarbon degradation. Our hypothesis is that bacteria of the Roseobacter clade have genetic structures and strategies for degrading and tolerating hydrocarbons that are different from those of the well-known marine hydrocarbon degraders, and that these differences might underlay their predominance in chronically-polluted marine environments. We have analysed gene organization for aromatic hydrocarbon degradation pathways in all available genomes from the Roseobacter clade. We present here the results for the beta-ketoadipate pathway, the one most frequently found in Roseobacter genomes

Keywords: Bacteria, Petroleum, Balearic Islands

The Roseobacter clade is a key component of marine bacterioplankton (Buchan *et al*., 2005), and plays key roles in biogeochemical cycles. They are generalist and metabolically versatile, with a suite of mechanisms for energy production and carbon acquisition that include aerobic anoxygenic phototrophy, litotrophy (carbon monoxide and sulfide oxidation), anaplerotic carbon dioxide fixation and chemoorganotrophy. Marine roseobacters are readily cultured in the laboratory and consequently there are more than sixty genera described. As a result, and due to their ecological interest, they have been the subject of many genome sequencing projects (there are about forty-three genome sequences, complete or as draft available so far). Comparative genomic analyses of members of the clade have been published (Moran *et al*., 2007; Newton *et al*., 2010).

Degradation of aromatic compounds by marine roseobacters was reported in year 2000, with the isolation of strains able to degrade aromatic compounds resulting from lignin degradation, and the confirmation of the presence of the protocatechuate branch of the beta-ketoadipate pathway in these bacteria (Buchan *et al*., 2000, 2004). More recently, genome analysis has revealed that marine roseobacters possess up to six catabolic routes for monoaromatic compound degradation, namely pathways for: benzoate, gentisate, homoprotocatechuate, phenylacetate, homogentisate, and protocatechuate (Moran *et al*., 2007; Newton *et al*., 2010). This has led to proposing a potential role for these bacteria in aromatic hydrocarbon degradation in marine environments. In addition, there are accumulating evidences showing a positive response of roseobacters after treatment with hydrocarbons in the laboratory (McKew *et al*., 2007; Lanfranconi *et al*., 2010), and their predominance of chronically-polluted environments (Nogales *et al*., 2007).

We are analyzing the catabolic potential for hydrocarbon degradation by isolates from the roseobacter clade obtained in Mallorca Island. As part of our research we are interested in analyzing genetic structures of aromatic compound degradation pathways in marine roseobacters, and therefore we are performing comparative genome analysis. We followed two different approaches. Firstly, we searched the available genomes for determining the presence of all genes involved in the six routes for aromatic hydrocarbon degradation proposed in marine roseobacters. We started with the protocachuate branch of the beta-ketoadipate pathway, which is the pathway most commonly found in these genomes (Newton *et al*., 2010). The key genes *pcaH* and *pcaG*, encoding the two subunits of protocatechuate 3,4 dioxygenase, were found in 70% of the genomes analyzed. In all but one of these genomes, the *pobA* gene for degradation of p-hydroxybenzoate, the precursor of protocatechuate, was also found. In most cases, *pobA* gene was located next to *pca* gene cluster and apparently under a common regulatory control, although this should be confirmed experimentally. Many differences in *pca* gene content and order were observed, but a basic structure of genes *pca(DC)HG* was observed. The presence of the LysR-like regulatory protein (PcaQ), and a hypothetical chaperone protein (Chp) was predicted in sixty percent of the roseobacter genomes analysed, confirming the proposed relevance of this regulatory mechanism of the protocatechuate pathway, as well as the importance of this putative uncharacterized chaperone in marine roseobacters (Buchan *et al*., 2004). Our second approach has been the generation of novel genomic data from a collection of seventeen roseobacters obtained from chronically-polluted environments in Mallorca Islands. As first approach, and with the aim of maximizing the exploration of the diversity of catabolic genes in these genomes, we grouped the isolates in four phylogenetically-coherent groups before pyrosequencing (Roche 454 technology). We analyzed the presence of genes for each one of the six predicted catabolic pathways in marine roseobacters. The genomic groups differed in the number of catabolic pathways that we could predict: one in group 3, three in group 4, 5 in group 2 and 6 in group 1. Genes for the protocatechuate pathway were present in all genomic groups. Except for group 2, these results agreed with the results of cultivation experiments, showing that the majority of the isolates were able to grow on protocatechuate as sole carbon and energy source.

Acknowledgments: Funds were obtained from Spanish MINECO project CTM2011-24886, and funds for competitive groups from the Government of the Balearic Islands (both with FEDER co-funding). C.A.M. acknowledges a FPI predoctoral fellowship from Spanish MINECO; J.M.P-V and M. M-Ll acknowledge predoctoral fellowships from Spanish MECD, and I.B-G acknowledges a predoctoral fellowship from the Government of the Balearic Islands (with FSE co-funding).

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Session

Microbial diversity

Modérateur : **Monia El Bour**

THE COMPARISON OF THE LEVEL OF METABOLICALLY ACTIVE BACTERIA IN THE NORTHERN AEGEAN SEA AND THE SEA OF MARMARA, TURKEY.

Gulsen Altug [1]*, Mine Cardak [2] and Pelin S. Ciftci Turetken [1]
[1] Istanbul University Fisheries Faculty Department of Marine Biology - galtug@istanbul.edu.tr
[2] Canakkale 18 Mart University

Abstract
In this study the ratio of capsulated bacteria to the total number of bacteria in the surface water samples were investigated in order to determine the number of metabolically active bacteria. The percentages of metabolically active bacteria were compared for the first time in the sea water samples which were taken from northern part of the Aegean Sea and southern part of the Sea of Marmara, Turkey.

Keywords: Bacteria, Marmara Sea, Aegean Sea

Introduction
Metabolically active bacteria have a well-developed polysaccharide capsule whereas inactive bacteria rapidly release the capsule. (the term "capsulated bacteria was used in reference to "capsule bearing bacteria"). Active bacteria constantly renewing their capsular envelope and release a significant fraction of the polysaccharide layer into the ambient water (Stoderegger and Hendl 2001).
The Aegean Sea and the Sea of Marmara, Turkey which have different hydrodynamic and trophic characteristics were compared regarding the level of metabolically active bacteria. Metabolically active bacteria level can defect regarding the contribution of capsulated bacteria count to the total number of bacterioplankton community. In this study the level of metabolically active bacteria were investigated in the sea water samples were taken from northern part of the Aegean Sea and southern part of the Sea of Marmara.

Material and Method
The 105 unit sea water samples were taken from various depths ranging from 0-30 cm in the 9 stations from Northern part of the Aegean Sea northern part of the Aegean Sea. The 60 unit sea water samples were collected from various depths ranging from 0-30 cm to 50 m in the 11 stations from southern part of the Sea of Marmara in 2006 and 2007 (Figure 1). Capsulated and non capsulated bacteria were discriminated using principally the same method as Stoderegger and Herndl 2001 [1], modified of Plante and Shriver (1998) [2] staining method.

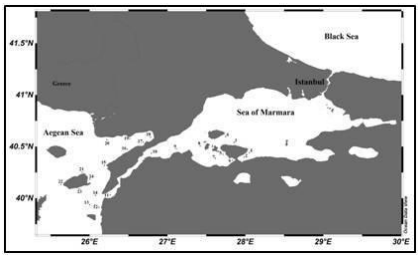

Fig. 1. Study Area

Resuls and Discussion
Contribution of capsulated bacteria to the total number of bacteria in the water samples was shown in Table 1.The highest metabolically active bacteria level was recorded in inner part of the Bandirma Bay (station 2) in the Sea of Marmara. According to the sampling area, bacterial activity level was recorded higher in the samples that were taken from the surface than other samples that were taken deeper. Metabolically active bacteria level were found higher in the eutrophic parts of the Sea of Marmara than the nothern part of the Aegean Sea.

Tab. 1. Level of Metabolically Active Bacteria %

Region	Station	Depth	Bacterial Metabolic Activation %			
			Summer	Autumn	Winter	Spring
Southern part of the Sea of Marmara	1	0-30 cm	32	24	20	28
	1	35 m	29	22	18	26
	2	**0-30 cm**	**36**	**29**	**20**	**33**
	2	25 m	30	26	19	27
	2	40 m	30	25	16	26
	3	0-30 cm	31	22	19	29
	3	35 m	30	18	14	27
	5	0-30 cm	33	20	15	29
	5	30 m	30	19	10	28
	6	0-30 cm	32	20	11	26
	7	0-30 cm	30	18	12	28
	9	0-30 cm	30	17	12	28
	9	25 m	32	17	10	27
	9	50 m	30	12	9	26
	10	0-30 cm	33	19	13	25
	10	25 m	31	17	12	27
	10	50 m	30	14	10	27
	11	0-30 cm	34	21	18	30
	11	10 m	33	15	12	31
	11	40 m	30	20	15	29
Northern part of the Aegean sea	12	0-30 cm	22	12	10	21
	13	0-30 cm	20	10	8	18
	14	0-30 cm	21	10	8	16
	15	0-30 cm	24	11	9	19
	15	50 m	22	8	6	20
	15	100 m	18	6	5	17
	15	200 m	16	5	5	14
	16	**0-30 cm**	**26**	**14**	**11**	**23**
	16	50 m	24	10	7	20
	16	100 m	20	10	6	17
	16	200 m	18	7	6	14
	16	300 m	14	4	3	11
	16	400 m	12	4	2	10
	16	500 m	12	2	2	22
	17	0-30 cm	24	12	10	20
	17	50 m	22	10	8	18
	17	100	20	10	6	14
	18	0-30 cm	18	9	7	16
	18	30 m	14	8	6	13
	18	60 m	12	5	4	10
	20	0-30 cm	17	9	7	15
	20	30 m	14	8	6	10
	20	70 m	10	5	5	8
	21	0-30 cm	24	10	7	18
	21	20 m	22	10	5	16
	21	40 m	20	9	5	15
	21	60 m	18	5	4	15
	21	80 m	18	4	4	14
	22	0-30 cm	21	10	8	17
	22	50 m	20	6	5	18
	22	100 m	15	4	3	12
	23	0-30 cm	23	13	10	13
	23	30 m	20	12	9	14
	24	0-30 cm	18	16	10	12
	24	30 m	15	13	9	10

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Acknowledgements
The authors thank TUBITAK for their financial support (Project number 105Y039). The authors also thank the crew of the R/V YUNUS-S.

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BACTERIA SCREENING OF BLACK SEA BEACHES BY CONVENTIONAL AND ALTERNATIVE POLLUTION INDICATORS

V. Badea [1]*, M. Manea [1], D. P. Balaban [1], M. Grigorian [1] and C. Nuca [1]
[1] Ovidius University of Constanta, Romania - badea_victoria@yahoo.com

Abstract
Given that various infections can be caused by the contact with the sand beach and sea water, our study has been focused on identifying other pathogenic bacteria species, in parallel with fecal coliforms and fecal streptococci from Mamaia beach. Knowing the existence of other potentially pathogenic bacteria species found in the sand beach and sea water, is needed for the future enlargement of the conventional indicators list of beaches pollution. Our epidemiological data suggest that global bacteriological monitoring of the sea water and sand beach quality offers a better protection for the people who uses this recreational beaches.

Keywords: Pollution, Bacteria, Black Sea

Introduction
Recreational use of marine waters is increasing in many countries. It is widely accepted that water and sand beaches with high indexes of fecal contamination can be potential sources of contamination and contribute to the dissemination of bacterial resistance. Our study was based on analytic control of bacteria contamination in the sands and sea water samples collected from Mamaia beach by using conventional indicator standards, in parallel with other potential pathogens bacteria species.

Material and methods
Dry sand, wet sand and sea water samples were collected from three different areas of the Mamaia beach (from both ends and from the central part of the beach) between 1 January and 30 December 2012. Each sand sample consisted of 100 g of surface sand that was collected at a maximum depth of 2 cm using sterile bottle and spatula. Each sea water sample consisted of 100 mL sea water collected in sterile bottle that was analyzed according to standard filtered membrane method. Bacteria species were isolated, after their initial growth in plates with differential media (CLED, McConkey, Bile Esculin Azide Agar) and identified by using the following biochemical tests: API20 Staph, API20 Strep - bioMérieux, Rapid ID NF Plus for non-fermentative bacteria, Rapid ID ONE - Remel, for fermentative bacteria. The data were statistically analized by using SPSS 17. The correlations were considered significant for p-value <0.05.

Results and discussion
A total of 560 bacteria species were present in the samples. From quantitative point of view, total coliforms isolated in the sea water had normal concentration (< 100 CFU/mL) in all samples harvested from Mamaia beach [1], except the ones obtained from the area near the site of communication with Tabacarie lake, where higher proportion of fecal coliforms flora (sea water - 160 CFU/mL; dry and wet sand - 350 CFU/g) were identified. The most frequent bacteria species identified in all three types of examined samples are presented in Table 1.

Tab. 1. Bacteria species identified in sand and sea water on Mamaia beach

Samples		Dry sand		Wet sand		Sea Water		Total
		Value	%	Value	%	Value	%	Value
Bacteria Species	*Escherichia coli*	60	34,7	77	44,5	36	20,8	173
	Proteus Sp.	10	26,3	12	31,6	16	42,1	38
	Klebsiella Sp.	10	31,3	12	37,5	10	31,3	32
	Pseudomonas Sp.	2	22,2	2	22,2	5	55,6	9
	Enterobacter	4	13,3	6	20,0	20	66,7	30
	Citrobacter	2	11,1	8	44,4	8	44,4	18
	Serratia Sp.	5	15,2	10	30,3	18	54,5	33
	Enteroccocus Sp.	32	40,0	28	35,0	20	25,0	80
	Staphylococcus aureus	43	29,3	51	34,7	53	36,1	147

A high correlation was found between *E. coli* from the sand (wet and dry) and adjacent sea water (Chi square test; p<0.0001) [2]. In the same time, there is a high correlation between the presence of *E. coli* and *Staphylococcus aureus* identified in wet sand and sea water (p=0.006) and in dry sand and sea water (p=0.01). Also, higher contamination for all three types of samples, collected in the summer compared to those collected in the winter, demonstrates that the human contamination is an important source of bacterial pollution for the beach [2], [3]. The presence of *Staphylococcus aureus* in the dry and wet sand is the proof of mainly human contamination. In this order, identifying this bacteria species on the beaches is needed in the future, because it could prevent possible contamination with methicillin-resistant *Staphylococcus aureus* and the possible transformation of public beaches in an environmental reservoir of this bacteria species [4]. The idea of introduction of the alternative indicators for the evaluation of the bacteriological pollution of the beaches is sustained in the world also by other authors [5].

Conclusions
Knowing the level of contamination of sea water and sand beaches allows us to implement the necessary specific prevention measures against the diseases generated by the use of contaminated sand and sea water of the costal area. Identification on the beach sand and sea water of other potentially pathogenic bacteria species makes it necessary that for the future to extend the list of conventional indicators with the alternative indicators.

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INFLUENCE OF MARINE COASTAL SEDIMENT TYPE ON PERSISTENCE OF WATERBORNE PATHOGEN BACTERIA

I. Boukef Ben Omrane [1]*, N. Zabboub [2], M. Martins [3], I. Lahiba [1], R. Mraouna [1] and M. El Bour [1]
[1] Laboratoire de Microbiologie Institut National des Sciences et Technologies de la Mer - imen.boukef@yahoo.fr
[2] Laboratoire du Milieu Marin, Institut National Des Sciences et Technologies de la Mer
[3] University of Aveiro – Portugal

Abstract

In present study, we assessed the effect of sediment characteristics (particle grain size and organic matter contents) on waterborne pathogen bacteria survival. The survival test was conducted *in vitro* in microcosms where the two pathogen species *Escherichia coli* (O55B5) and *Vibrio parahaemolyticus* (ATCC 17802) were separately incubated on lagoon sediments and brackish water brought from different coastal areas of Bizerte lagoon (Northern Tunisia).. The results obtained revealed (1) extended bacterial survival in sediments, (2) higher growth and lower decay rates of the two strains in sediments with high levels of organic matter and small grain size sediment, and (3) longer survival of *Vibrio paraheamolyticus* compared with *Escherichia coli*.

Keywords: Bacteria, Sediments, Organic matter, Mediterranean Ridge

Introduction:

Extended persistence of waterborne pathogen bacteria in coastal sediments and their potential remobilization during natural turbulence may induce an increased risk of human infections [1]. In aquatic ecosystems the sediments represent the main reservoir for almost heterotrophic bacteria due to high levels in nutrients and organic matter combined with different grain size that should influence microbial populations and their persistence [2] [3] [4]. Pathogen bacterial survival in sediments and their possible re-suspension constitute high threat of pollution with human or animal risk during recreational or faming activities principally in coastal shoreline [5]. The present study highlight the influence of coastal sediments on the survival of two waterborne pathogen species of bacteria: *Escherichia coli* and *Vibrio parahaemolyticus* assessed *in vitro* experiments using microcosms filled with three types of coastal sediments from Bizerte lagoon in Tunisia.

Material and Methods:

Microcosms consisted of Erlenmeyer flasks of 500ml and filled with sterilized sediment (200g, wet weight) collected from three different coastal stations, located in front of discharge areas in Bizerte lagoon. All microcosms were then filled with brackish water (300ml) inoculated separately with *Escherichia coli* enteroagregative and *Vibrio parahaemolyticus* strains (three microcosms for each species of bacteria for final concentration of 10^7cfu/ml). Three Microcosms filled each with one type of sterile sediment and brackish water were used as negative control. Suitable dissolved oxygen was provided for each microcosm carefully without disturbing the upper layer of sediment using aquarium air pumps. All microcosms were kept in dark at a temperature of 20±2°C. During experimentation, microcosm sediments were sampled for bacterial analysis (culturable and total cells count). Bacteria were detached from sediments aliquots by vigorous shaking for 120 s [6] and *E.coli* were selected on DL agar (incubated at 37°C after 24h) whereas. *Vibrio* were selected on TCBS agar (at 22°C for 24 h).. The total cells number (TC) were counted using the DAPI (4', 6-diamide-2-phenylindole-Sigma).

Results and discussion:

Sediments characteristics including particle grain size and organic matter and nutrient contents were measured at the beginning and the end of the experimentation. Sediments varied with a proportion of 81% of sand (>63µm) for sediment S1 to approximately 53% and 37% for S2 and S3 respectively. The results demonstrated that organic matter decreased during experimentation and bacterial concentration (10^7cfu/g) remained quite constant during the first ten days of the experiment for the two species of bacteria. Extended bacterial survival in sediment may be attributed to the greater content of organic matter provided than in seawater [2] [4]. The present results suggest that indicator and pathogen bacteria released into the coastal environment should accumulate in sediment, leading to increased persistence and therefore, their survival may induce an increased risk of human infection due to the re-suspension and release of these pathogens during natural turbulence.

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EFFECT OF ENVIRONMENTAL FACTORS ON *SALMONELLA TYPHIMURIUM* SURVIVAL IN MARINE WATER MICROCOSMS

S. Mejri [1], I. Boukef Ben Omrane [1]*, R. Mraouna [1], A. Amara [1], P. Got [2], A. Boudabous [3] and M. El Bour [1]
[1] Laboratoire de Microbiologie Institut National des Sciences et Technologies de la Mer - imen.boukef@yahoo.fr
[2] Ecologie des Systèmes Marins Côtiers", UMR 5119
[3] Laboratoire de Microbiologie et des Molécules Bio-Actives, Faculté des Sciences de Tunis

Abstract

The influence of temperature salinity and starvation on the occurrence of *Salmonella typhimurium* was investigated using laboratory (C52) and a local (H_{10}) *Salmonella* strains incubated in marine water microcosms and exposed to natural sunlight (48h). Monitoring of growth and survival in microcosms showed a gradual decline in cultivability, respiratory and metabolic activities. For both strains we noted some biochemical and antimicrobial modifications. The virulence of Salmonella was maintained during seawater incubation for the two strains.

Keywords: Bacteria, Salinity, Brackish water, Mediterranean Ridge

Introduction:

Salmonella enteritidis ser. Typhimurium is common etiologic agents of intestinal-based disease of animals and humans. Pathogenic microorganism such *Salmonella* are released directly or through wastewater to coastal areas [1]. Factors affecting the survival of allochthonous bacteria in marine environment include predation, osmotic stress, solar radiation, nutrient availability, bacteriophage, algae, and temperature [2, 3, 4]. Under unfavorable environmental conditions, *Salmonella* as other bacteria may react by modification of their physiological and structural characteristics and have a survival strategy, entering a viable but not culturable (VBNC) state [5, 6].

Material and methods:

Salmonella enteritidis ser. Typhimurium C52 and wild strain isolated from clams (H10) cells were collected by centrifugation (3000 rpm/15 min) and washed twice. Strains were inoculated in sterile and filtered (0.2µm pore size membrane,Nucleopre) seawater microcosms (final concentration 10^6 cfu/mL). Microcosms were placed "*in situ*" in sea water under environmental conditions (sunlight, temperature) during 48 hours. 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 respiratory (CTC) and metabolic activity (DVC) was performed during the experiment. The effect of sunlight on the virulence of Salmonella was studied using cytotoxicity test [7] and amplification of Pathogenicity Island.

Results and discussion:

The results of the evolution of cultivability and physiological states of *Salmonella typhimurium* C52 incubated in marine water microcosms (Fig.1) demonstrated that cellular activities, respiratory and metabolic activities decrease rapidly during the first 7 hours for the C52 strain (8.86%, 16.06% and 30.30% respectively). The H_{10} evolution during the first 7 hours is similar for the cultivability, but the percentage of respiratory (34.81%) and metabolic activities (50.58%) are largest than the C52 one. Whereas the rate of total cell count remains stable for the two strains.Results of the virulence test revealed the presence of two bands Hli and Hin, involved in the control system of variation phase in *Salmonella* strains and respectively amplify a region of 236 pb and 173 pb. One of these two bands is sufficient to detect *Salmonella* spp.

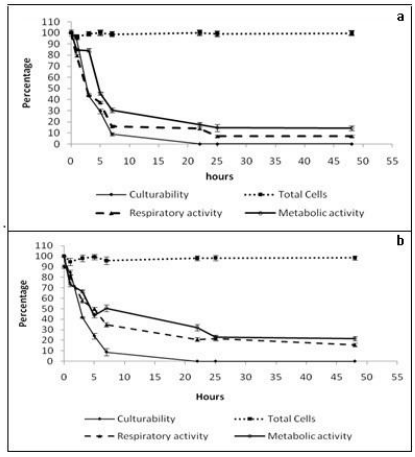

Fig. 1. Evolution of cellular activity of a *Salmonella typhimurium C52* (a) *and Salmonella* H_{10} (b) incubated in marine water microcosms

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EFFET DU FUMAGE SUR LE DÉVELOPPEMENT DE LA FLORE MICROBIENNE DU MULET (*MUGIL CEPHALUS*)

S. Ghouaiel [1], N. Bouriga [1]*, E. Faure [2], J. Quignard [3] and M. Trabelsi [1]
[1] Université de Tunis El-Manar, Faculté des Sciences de Tunis, Unité de Biologie Marine, 2092 Campus Universitaire, Tunisie - hanounawsset@live.fr
[2] LATP, CNRS-UMR 6632, Evolution biologique et modélisation, case 5, Université de Provence, Place Victor Hugo, 1331 Marseille cedex 3 France.
[3] Laboratoire d'Icthyologie, Université Montpellier II, place Eugène Bataillon, case 102, 34095 Montpellier cedex 5 France.

Abstract
Les résultats ont montré que les charges des différentes populations bactériennes testées dans l'échantillon de mulet frais sont réduites après les procédés de fumage de 0,5 à 2,5 ULog. Durant la conservation, les bactéries lactiques inhibées après le fumage à chaud, n'ont pas été détectées durant la conservation, par contre elles ont montré une prolifération de 1,5 ULog dans le cas du fumage à froid. La prolifération des staphylocoques durant la conservation est ralentie pour les filets de poisson fumés à chaud. Par contre, une importante prolifération des coliformes totaux (> 3ULog) a été notée tout procédé confondus.

Keywords: Bacteria, Biotechnologies, Fishes, Tunisian Plateau

Les filets de poissons sont répartis en deux lots. L'un subit un fumage à chaud à 75°C et l'autre un fumage à froid à 30°C. Une analyse bactériologique hebdomadaire a été réalisée par le dénombrement des populations des bactéries lactiques, coliformes totaux, staphylocoques, la charge mésophile totale et les bactéries lactiques sur les milieux de cultures sélectifs gélosés de Man, Rogosa et Sharpe (MRS) [1], Violet Red Bile Glucose (VRBG) [2], Chapman au mannitol et Tryptone Soja (TSA) [3] respectivement. Le dénombrement est réalisé par la méthode de Plate Counting Agar. La charge mésophile totale évolue progressivement au cours du stockage figure (1 et 2). Cependant, la croissance ne dépasse pas la limite inférieur « m » du plan d'échantillonnage à trois classes [4] ainsi les différentes pratiques de fabrication sont jugées satisfaisantes pour le fumage à froid. Tandis que, pour le fumage à chaud à partir de la deuxième semaine de stockage la concentration dépasse la valeur de « m » mais tout en restant inférieur à la valeur supérieur « M », le produit est alors jugé acceptable.Les résultats du dénombrement des bactéries lactiques présentes dans les différents échantillons montrent que le fumage à chaud provoque la destruction totale de la charge initiale en bactéries lactiques qui demeurent absentes dans les étapes suivantes du suivi. Cependant, le fumage à froid ne donne pas les mêmes résultats, mais plutôt une réduction de la charge en bactéries lactiques d'une moyenne de 0,5 ULog et un développement de la croissance à partir de la première semaine de stockage qui traduit la mise en place du processus d'altération. Le procédé de fumage a permis la réduction de la teneur en coliformes totaux d'une moyenne de 1,5 ULog. Les produits fumés à froid obtenus sont jugés satisfaisants, ce n'est qu'à partir de la deuxième semaine que la teneur de coliformes totaux dépasse la valeur inférieur « m » du plan d'échantillonnage à trois classes [4]. Pour les produits fumés à chaud la valeur de « m » spécifique à ce type de denrée alimentaire n'est dépassée qu'à partir de la troisième semaine.La population de staphylocoques présente initialement dans la chaire du poisson cru a été réduite d'une moyenne de 1,16 ULog pour le fumage à chaud et de 0,25 ULog pour le fumage à froid. L'augmentation de la température a permis lors du fumage à chaud une meilleure neutralisation des staphylocoques. Ainsi, lors du stockage la concentration de ces dernières, demeure inférieure à la limite inférieur « m » du plan d'échantillonnage à trois classes [4] et le produit est alors dit satisfaisant. Ce n'est pas le cas des échantillons de poisson fumé à froid, dont la concentration en staphylocoques dépasse la limite « m » d'une manière croissante tout au long du stockage. Le produit est alors dit « acceptable ».

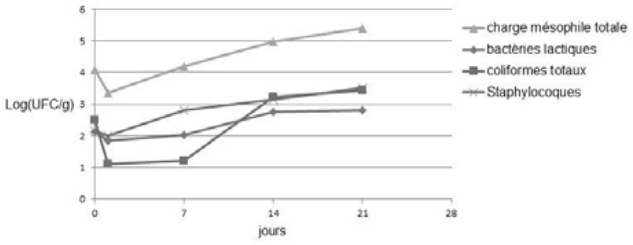

Fig. 1. Evolution de la charge des populations bactériennes avant et aprés le fumage à chaud

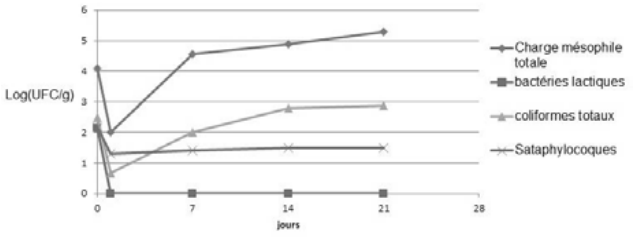

Fig. 2. Evolution de la charge des populations bactériennes avant et aprés le fumage à froid

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COMPARISON OF BACTERIAL DIVERSITY IN EASTERN MEDITERRANEAN, NORTHERN AEGEAN SEA AND THE SEA OF MARMARA

Mine Cardak [1]*, Gülsen Altug [2] and Pelin S. Ciftci Türetken [2]
[1] Canakkale 18 Mart University Marine Science and Technology Faculty - mine_bio98@hotmail.com
[2] Istanbul University, Fisheries Faculty, Department of Marine Biology, TURKEY

Abstract
In this study indicated that diversity of culturable heterotrophic aerobic bacteria with respect to the areas from which they were isolated were compared in the eastern Mediterranean, northern part of the Aegean Sea and the Sea of Marmara. Three marine areas which have different trophic was compared regarding diversities bacteria. The composition of culturable hetetrophic aerobic bacteria was investigated in sea water samples collected different time periods throughout 2002-2010 Forty-five bacteria species belonging to 18 families are reported in this study as the first records for the Sea of Marmara, Eastern Mediterranean..

Keywords: Bacteria, Marmara Sea, Biodiversity, South-Eastern Mediterranean

Introduction
There is a need for international long term monitoring bacterial abundance and quantitative bacteria composition and also understanding ecological roles of the most abundant species. The most active group with respect to substance cycling is aerobic heterotrophic bacteria (AHB) at the euphotic zone in the marine ecosystem (1).Bacterial composition may differ according to their exposure to environmental factors in the areas from which they are isolated (2). Although the Sea of Marmara is an important basin between the Mediterranean and the Black Sea, data concerning bacterial composition for an understanding of ecological roles of the most abundant bacterial species are still scant in the area. In t his study, the composition of culturable heterotrophic bacteria was investigated in the Sea of Marmara, Southern Mediterranean and Northern Aegean Sea.This paper also reports species of culturable heterotrophic aerobic bacteria as new records for the Sea of Marmara.

Materials and Methods
Sea water samples were collected from Beirut (Lebanon), Lattakia (Syria) and the off shore area extending from the eastern part of Andros Island to the southern part of Gökçeada and Thasos Island during the months of August in 2007 and 2008 and also different time periods between 2002 and 2010 from the Sea of Marmara (Fig. 1).
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Fig. 1. Study Area:Eastern Mediterranean,Aegean offshore area extending from the eastern part of Andros Island to the southern part of Gökceada and Thasos Island and Sea of Marmara.

The samples were transferred into 250-mL sterile brown glass bottles under aseptic conditions and processed on board the Istanbul University research vessel YUNUS-S.Identification analyses of bacterial strains were obtained using VITEC 2 Compact 30 (bioMérieux,France) automic micro identification system and HPC analyses were using spread plate method with Marine Agar were carried out (3).

Results and Discussion
This study increases the knowledge of composition and biochemical response of bacteria isolated from eutrophic and oligotrophic areas. 45 bacteria species belonging to 18 families are reported in this study as the first records for the sea of Marmara (Fig.2).

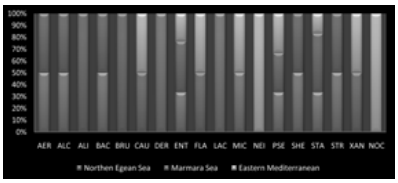

Fig. 2. There percentage distributions of the heterotropic aerobic bacteria family according to their isolate areas. AER:Aeromonadaceae, ALC:Alcaligenaceae, ALI:Alicyclobacillaceae, BAC:Bacillaceae, BRU: Brucellaceae, CAU:Caulobacteraceae, DER:Dermacoccaceae,ENT: Enterobacteriaceae, FLA:Flavobacteriaceae, LAC:Lactobacillaceae, MIC:Micrococcaceae, NEI:Neisseriaceae, PSE:Pseudomonadaceae, SHE:Shewanellaceae, STA:Staphylococcaceae, STR:Streptococcaceae, XAN:Xanthomonadaceae, NOC:Noctuoidea

The highest hetetrophic aerobic bacteria abundance was found in the coastal stations. This situation was evaluated to be a result of anthropological pollution input in the coastal areas. Species belonging to *Enterobacteriaceae* family was the most common taxonomic group in the Sea of Marmara, Northern Aegean Sea, Syria and Lebanon. Flavobacteriaceae family was the second most common group. Among all the strains, percentage of the Gram - bacteria in the coastal areas and the offshore area were 90 % and 2%,respectively. This situation suggests that those particular species have potential importance in organic matter turnover in these areas(2).Although these bacteria had not previously been reported from these areas, they may be ubiquitous in aquatic environments. The bacteria which were isolated from various marine environments have shown different compositions. There is a need for international long term monitoring studies for the purpose of detecting bacterial composition and their ecological roles in these areas.This study is intended to be first detailed description of the diversity of bacteria comparison of two different marine environments in order to put for the situation of the ecosystem as it is today.

AcknowledgmentsThe authors thank TUBITAK (Project No.105Y039) and the Istanbul University Scientific Research Projects Unit (BAP 588/14082006) for their financial support. The authors also thank the crew of the research wessel YUNUS-S for their help in sampling.

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COMPARATIVE STUDY OF EPIPHYTIC BACTERIA ASSOCIATED WITH *JANIA RUBENS* AND *PADINA PAVONICA*

A. Ismail [1], M. El Bour [1]*, L. Ktari [1], M. Ahmed [2] and A. Boudabbous [3]
[1] National Institut of Marine Sciences and Technology - monia.elbour@instm.rnrt.tn
[2] Royal Netherlands Institute for Sea Research, Yerseke, The Netherlands
[3] Faculty of Mathematical, Physical and Natural Sciences of Tunis, Tunisia

Abstract
Epiphytic bacteria from red alga *Jania rubens* and brown one *Padina pavonica*, were isolated and identified. A total of thirty seven different bacterial strains were isolated on pure culture, nineteen from *J. rubens* surface and eighteen from *P. pavonica*. Isolates were identified based on their 16S rDNA sequences. *Proteobacteria and Firmicutes* groups were represented on both algae surfaces However, *Bacteroidetes* phylum was only isolated from *J. rubens* contrary to *Actinobacteria* phylum, which was only represented on *P. pavonica* surface These results highlighted differences observed for the two algae isolates communities.

Keywords: Algae, Bacteria, Biodiversity, Gulf of Tunis

Introduction Seaweeds have long been shown to support abundant populations of bacteria [1]. Previous investigations suggested beneficial relationship between algae and their epiphytic bacteria, which may play a protective role, releasing compounds into the surrounding seawater preventing extensive fouling and helping algae to develop properly. Thus, several species of seaweed from various parts of the world have been shown to live with close associated heterotrophic epiphytic bacteria [2]. Nevertheless, for most marine algae little is still known about microbial populations colonizing their surfaces [3] and specificity related to special microenvironments on their surfaces [4]. As, red alga *Jania rubens* and brown one *Padina pavonica* are abundantly present along Tunisian coast, especially at the northern Cap Zebib rocky shore, we have been interested through the present study to assess culturable bacterial populations associated to their surfaces in order to determine bacterial diversity and compare results obtained for the two algae.

Materials and methods *Sampling and Isolation of epiphytic bacteria: J. rubens* and *P. pavonica* were collected in 2007 from Cap Zebib (37° 16.2' N, 10° 3.6' E) (Northern coast of Tunisia). All samples were transferred, in dark, in sterile plastic bags filled with water brought from the same location. Seaweed samples were washed three times with autoclaved seawater to remove free living and loosely associated bacteria [5].Isolation of epiphytic bacteria was done as described in our previous work [6]. Extraction of DNA, PCR and DNA Sequencing are described in our previous work [6], universal 16S rRNA gene primers B8F and U1492R were used for PCR. Partial sequences of 16S rRNA genes from *J. rubens* epiphytic bacterial communities, coded (J1-J19), were submitted to GenBank and have accession numbers: (JN391160) to (JN391178). Those from *P. pavonica* epiphytic bacterial communities have the following accession numbers: P1-P8 (FN652906-FN652913), P9 (FR695065), P11 (FR695066), P12 (FR695067), P14 (FR695068), P17 (FR695069), P18 (FR695072), P19 (FR695074), P20 (FR695070), P26 (FR695071) and P27 (FR695073).

Results and discussion A total of 37 morphologically different bacteria were obtained in pure cultures with 19 from *J. rubens* and 18 from *P. pavonica* surfaces. Isolates were affiliated to four major groups, *Proteobacteria, Bacteroidetes, Firmicutes* and *Actinobacteria*. *Proteobacteria* and *Firmicutes* group were represented on both algae However, *Bacteroidetes* phylum was represented only on *J. rubens* with 4 isolates assigned to *Cytophaga, Flavobacteria and Aquimarina* genus, contrary to *Actinobacteria* phylum, which was only represented on *P. pavonica* surface by 2 isolates closely related to *Brevibacterium* genus. We noticed a difference between bacterial proportion colonizing *J. rubens* and those colonizing *P. pavonica* surfaces as shown in figure 1. In previous study, quantitative and qualitative variations of the bacteria population were described and correlated with changes of environmental factors [2]. Whereas, in our study, the two algae were sampled from the same geographic location and at the same period, this suggests that heterotrophic bacteria are probably specie specific. Bacteria isolated from surface of some seaweed have been shown to release compounds that repel other fouling bacteria, suggesting they may protect their host from fouling by other organisms [7]. In addition, some seaweed species seem to require bacterial biofilms on their surfaces in order to develop properly [8]. Our results revealed that *Cytophaga, Flavobacteria and Aquimarina* genus were present only on *J. rubens*, contrary to *Brevibacterium* genus which was only represented on *P. pavonica.* These bacteria strains may be involved in protective role of specific host against other fouling bacteria or with useful role in development of the alga. Other studies need to be done in order to confirm these hypotheses.

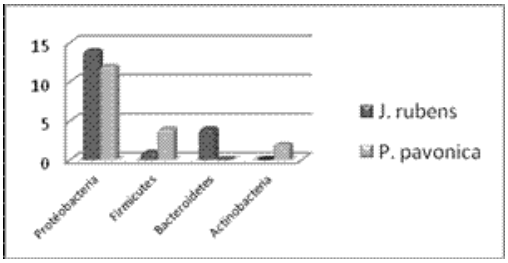

Fig. 1. Distribution of *J. rubens* and *P. pavonica* associated bacteria

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CHARACTERIZATION OF BACTERIAL SPONGE'S EPIBIONTS AND THEIR BIOACTIVITIES IN NORTHERN TUNISIAN COAST

Y. Benredjem Romdhane [1], K. Bouamama [1], J. Barros-Velazquez [2], A. Boudabbous [3], M. El Bour [1] and R. El Jeni [1]*
[1] Institut National des Sciences et Technologies de la Mer - eljeni.rime@gmail.com
[2] Department of Analytical Chemistry, Nutrition and Food Science, LHICA, School of Veterinary Sciences, University of Santiago de Compostela, E-27002 Lugo, Spain
[3] Laboratoire des Microorganismes et Biomolécules actives, Faculté des Sciences de Tunis, Tunis, Tunisia

Abstract
The bacteria associated with marine sponges represent a rich source of active metabolites. The aim of the present study is the isolation and characterization of epibiont sponge's bacteria with antimicrobial activities in Tunisian coasts. Thus, 54isolates were assessed from the northern coast in Tunisia and their antibacterial activities were characterized against several human and marine pathogens using the diffusion agar tests. Among the whole collection assessed less than half (43%) of isolates are active with 63% of these active bacteria inhibiting more than four sensitive strains tested. The active isolates were identified on basis of 16S rDNA sequences as *Proteus mirabilis* (9 isolates), *Enterococcus faecalis* (3 isolates) *and Serratia sp.* (11 isolates).

Keywords: Bacteria, Porifera, Gulf of Tunis

Introduction
Nowadays, sponges were considered as main source for natural products of pharmaceutical relevance that is partially correlated with their epibionts (1).The bioactivity of the isolated substances includes antiviral, antitumor, antimicrobial or generally cytotoxic properties and considerable biotechnological interest (2). The present study aimed to investigate antibacterial activities of epibiotic bacteria isolated from *Ircinia fasciculata, Ircinia spinosula and Hymeniacidon perlevis* collected from a northern Tunisian coast (Korbous)and molecular identification of these bacteria.

Materials and Methods
Three sponges species *Ircinia fasciculata, Ircinia spinosula and Hymeniacidon perlevis* were sampled by scuba diving at depths of 7m in Korbous (northern Tunisian coast) between 2005- 2007. Sponges samples were processed and loop full of sponge surface tissues. The homogenated and plated on different enriched media (Zobell marine agar, TCBS, DSC agar and TSA). The plates were incubated at 20°C for 7 days before selection of bacterial isolates morphologically and biochemically characterized. All isolates were tested for their antibacterial activities in triplicate using the agar diffusion method against the sensitive bacteria genus (*Aeromonas, Pseudomonas, Vibrio, Salmonella, Streptococcus, Staphylococcus aureus, E. coli, Enterococcus* and *Candida albicans*. The antibacterial activity was evaluated by measuring the inhibition zone (in mm). For all isolates, molecular identification by sequencing 16SrDNA was realized (extraction and PCR amplification using kit Qiagen, then DNA sequencing analysis by BLAST program).

Results and Discussion
Fifty four bacterial isolates were obtained from a total of three species of marine sponges. 43% of all isolates obtained, showed antimicrobial activity against at least one of pathogenic bacteria tested (Table 1). The active isolates were identified by PCR amplification and 16SrDNA gene sequencing. Among them, twenty were gram-negative, assigned to *Proteobacteria* (Gamma).Three strains were gram-positive. *Gamma-Proteobacteria* subclasswas represented by *Serratia sp.* (11 isolates) *and Proteus mirabilis* (9 isolates). Our results are in agreement with a previous review showing a high percentage of Proteobacteria isolates (1).Three Isolates (61- 74- 43) of *Proteus mirabilis*, one isolate(75) *of Enterococcus faecalis and* two ones (45-46) *of Serratia sp.* showed highest antimicrobial activity (between 20 and 21 mm of diameter). All the potential producers invariably showed inhibitor activity against Gram+ bacteria and particularly against *Staphylococcus aureus ATCC 6538. Proteus mirabilis* has the strongest activity against most of indicator bacteria tested. The strain 45 of *Serratia sp*. showed the largest antibacterial and antifungal spectrum activity against 10 pathogenic bacteria and *C. albicans*.

Tab. 1. Results of antimicrobial test performed for active isolates against several pathogen species

Strains code	species	Sensitive bacteria 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
59	*P. mirabilis*	–	–	–	–	–	–	–	–	–	–	–	++	+	–	+	–	–	–
61	*P. mirabilis*	–	–	–	–	–	–	–	–	–	–	–	+++	+++	++	++	–	–	–
66	*P. mirabilis*	–	–	–	–	–	–	–	–	–	–	–	++	+	+	–	–	–	–
67	*P. mirabilis*	–	–	–	–	–	–	–	–	–	–	–	++	++	++	+	–	–	–
74	*P. mirabilis*	–	–	–	–	–	–	–	–	–	–	–	+++	+++	+++	++	–	–	–
4	*P. mirabilis*	+	+	+	–	+	–	–	+	–	–	–	–	–	+	–	–	–	–
8	*P. mirabilis*	+	+	+	–	+	–	+	+	–	–	–	–	–	+	–	–	–	–
43	*P. mirabilis*	++	–	++	–	–	+++	–	–	++	–	++	+	+++	++	+++	–	–	–
52	*P. mirabilis*	–	–	–	–	–	+++	–	–	–	–	–	–	++	+++	+++	–	–	–
68	*P. mirabilis*	–	–	–	–	–	–	–	–	–	–	–	–	++	++	++	–	–	–
47	*E. faecalis*	–	–	+	–	–	++	–	+	++	–	–	++	+++	++	+++	–	–	–
75	*E. faecalis*	–	–	–	–	–	–	–	–	–	–	–	+++	+++	++	++	–	–	–
42	*Serratia sp.*	–	+	–	++	–	–	++	++	–	–	–	+	++	++	++	–	–	–
44	*Serratia sp.*	–	–	–	–	–	++	–	–	–	–	–	+	+++	++	+++	–	–	–
45	*Serratia sp.*	++	–	++	–	++	++	–	–	++	++	++	+	+++	+++	+++	–	–	–
46	*Serratia sp.*	–	+	++	++	–	+++	++	++	–	–	–	++	+++	++	+++	–	–	–
48	*Serratia sp.*	–	–	–	–	–	–	–	–	–	–	–	++	–	–	–	–	–	–
49	*Serratia sp.*	–	–	++	–	–	–	–	–	–	–	–	++	+	+++	+++	–	–	–
50	*Serratia sp.*	–	–	–	–	–	–	–	–	–	–	–	++	–	–	++	–	–	–
51	*Serratia sp.*	–	–	++	–	–	–	–	–	–	–	–	++	–	–	++	–	–	–
54	*Serratia sp.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
55	*Serratia sp.*	–	–	++	–	++	–	–	–	–	–	–	–	+++	+++	++	–	–	–
56	*Serratia sp.*	–	–	–	–	–	–	–	–	–	–	–	–	+++	+++	++	–	–	–

(-): negative antibacterial activity; +: weak inhibition (? en mm: 7-10); ++: moderate inhibition (? en mm 10-15); +++: strong inhibition (? en mm > 15).
1: Escherichia coli O126B16; 2: Aeromonas salmonicida; 3 : A. hydrophila;4: Salmonella typhimurium; 5: Streptococcus serotype B; 6: Staphylococcus aureus; 7: Vibrio anguillarum; 8: Pseudomonas fluorescens; 9 : S. aureus ATCC 25923; 10: Pseudomonas cepacia; 11 : V. tapetis CECT4600; 12: S. aureus ATCC 6538; 13; E. coli ATCC 8739; 14: E. feacalis ATCC 29212; 15; C. albicans ATCC 10231; 16: V.alginolyticus, 17 : P.aeruginosa ATCC 27853; 18: E. coli ATCC 25922.

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HEAVY METAL TOLERANCE OF SEDIMENT BACTERIA ISOLATED FROM COASTAL CITY (IZMIR,TURKEY)

Asli Kacar [1]*, Ali Kocyigit [2] and Esin Uluturhan [1]
[1] Dokuz Eylul University Institute of Marine Sciences and Technology - asli.kacar@deu.edu.tr
[2] Ege University, Department of Biology

Abstract
In this study, it was aimed to determine of heavy metal resistance of bacterial isolates from coastal city sediment (Izmir Bay). Thirty isolates (*Bacillus, Marinibacillus, Halobacillus*) were identified by phylogenetic analysis and these strains were investigated in respect of the MICs of heavy metals (Hg, Cu, Cd, Cr, Ni and Pb). The MICs of heavy metals were different for each strain but the general order of resistance to the metals was found to be as Ni>Pb>Cu>Cr>Cd>Hg. It can be concluded that bacterial isolates were sensitive to Hg but were highly resistant to Ni (13mM) and Pb (6mM). Additionally, the highest concentrations of metals were found in the inner part of the bay, where intensely industrialized compared to the middle and outer parts of the bay.

Keywords: Izmir Bay, Bacteria, Biodiversity, Sediments

Introduction
Izmir Bay is located on the Eastern Coast of the Aegean Sea in Turkey. The area along the Izmir coast is densely populated. Since it includes extensive agricultural lands, food and chemical industries, there is a lot of industrial and domestic discharge [1]. Heavy metals are major pollutants in the coastal environment [2]. Presence of these metals in the marine environment may pose a serious threat to the environment because of their ability to persist for several decades. Heavy metal resistant microorganisms could be useful as indicators of potential toxicity to other forms of life and are important in studies of genetic transfer in metal resistance mechanism. Thus, bacterial strains will develop their capacity to survive under toxicological stress and will be of importance in future bioremediation strategies [3].

Materials and Methods
Sediment samples were collected using Van Veen Grab from surface sediments in Izmir Bay at five locations. Heavy metal analyses were performed by AAS (Varian Spectraa) [4]. Samples for microbiological analyses were inoculated on ZoBell 2216e Medium and R2A Agar Medium. Bacterial colonies showing different morphological characteristics were selected and thirty isolates were identified by phylogenetic analysis using 16S rDNA sequences. The Minimum Inhibitory Concentrations for each bacterial isolate was determined using Mueller–Hinton Agar containing Hg, Cd, Cr, Cu, Ni, Pb [5].

Results and Discussion
The highest concentrations of metals were found in the inner part of the bay (especially, Zn: 279mg kg^{-1}, Cr: 169 mg kg^{-1}), where intensely industrialized (chemical industries, textile industries, antifouling paints, chlorine-alkali plants and a very busy harbour) compared to in the middle and outer parts of the bay. Thirty bacterial isolates were obtained from Izmir Bay sediments and phylogenetic analysis using 16S rDNA indicated that the strains belong to *Bacillus, Marinibacillus, Halobacillus (M. campisalis, B. simplex, B. megaterium B. halmapalus, B. marisflavi, B. pumilus, B. indicus, B. subtilis, B. aguimaris, B. firmus, B. thurigiensis, B. safensis, B. endophyticus, B. cereus, B. baekryungensis, H. Campisialis*). Minimum inhibitory concentrations of heavy metals are shown in Table 1. Bacterial isolates showed higher tolerance to Ni (13mM) and Pb (6mM). On the other hand, Hg was the highest toxic metal against to the all isolates. In various studies, it has been reported that the sediment bacteria existed in heavy metal contaminated environments. Nithya et al., [5] found that sediment bacteria which were isolated from Palk Bay (India) and which exhibited high resistance against Cd, Pb, Co, As, Hg were subjected to 16S rRNA analyses and identified as *B. arsenicus, B. pumilus, B. indicus, B. clausii* and they suggest that sediment bacteria could be biological indicators of heavy metal contamination. Although bacteria are sensitive to low concentrations of heavy metals, in specific environmental conditions, they rapidly adapt to the conditions so that they can reproduce in the presence of heavy metals. Therefore, the isolates may be useful as indicators of potential toxicity of heavy metals in coastal area and they could be designed as bioremediation tools by advanced studies.

Tab. 1. **MIC concentrations of bacterial isolates against heavy metals**

Bacterial Isolates	Heavy metals and resistance concentrations (mM)					
	Hg	Cd	Ni	Cr	Cu	Pb
Marinibacillus campisalis	0,01	0,6	4	0,8	1	4
Bacillus simplex	0,01	0,2	11	2	2	2
Bacillus megaterium	0,01	0,2	8	2	2	2
Bacillus halmapalus	0,01	0,4	4	0,8	0,8	2
Bacillus sp.	0,02	1,0	8	2	2	6
Bacillus marisflavi	0,01	0,2	6	2	2	4
Bacillus sp.	0,01	0,2	13	2	2	4
Bacillus simplex	0,01	0,08	10	0,8	2	4
Bacillus pumilus	0,01	0,1	10	2	2	6
Bacillus simplex	0,01	0,08	2	2	2	2
Bacillus indicus	0,01	0,2	2	2	2	2
Bacillus simplex	0,01	0,08	8	0,8	2	2
Bacillus subtilis	0,01	0,04	8	2	2	4
Bacillus aguimaris	0,04	2,0	10	2	2	4
Bacillus firmus	0,01	0,04	2	2	2	2
Bacillus thurigiensis	0,01	2,0	8	2	2	6
Bacillus aguimaris	0,06	0,1	10	2	2	4
Bacillus simplex	0,01	0,06	6	2	2	4
Bacillus aguimaris	0,01	0,2	10	2	2	2
Bacillus simplex	0,01	0,2	10	0,8	2	2
Bacillus subtilis	0,01	0,2	13	2	2	4
Bacillus safensis	0,01	1,0	2	2	2	4
Bacillus simplex	0,01	0,2	10	2	2	4
Bacillus simplex	0,01	0,2	6	2	2	2
Bacillus subtilis	0,01	0,1	6	2	2	4
Bacillus endophyticus	0,01	0,1	8	2	2	6
Halobacillus campisialis	0,01	0,2	4	2	2	4
Bacillus simplex	0,01	0,1	10	2	2	2
Bacillus cereus	0,01	2,0	10	2	2	6
Bacillus baekryungensis	0,01	0,2	8	2	2	2

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INVESTIGATION OF *STAPHYLOCOCCUS AUREUS* IN SMOKED TROUTS

Ulviye Karacalar [1]*, Hasmet Cagirgan [1], Tansel Tanrikul [1] and Erol Toksen [1]
[1] Ege University Fisheries Faculty Aquaculture Department - ukaracalar@yahoo.com

Abstract
The well-known food-borne pathogen, *Staphylococcus aureus*, rarely has been implicated in cases originating from consumption of smoked seafoods. This bacterium may be contributed through human handling of the raw seafood and products.The aim of the presented work was the risk assessment of distribution and prevalence of *Staphylococcus aureus* in smoked fish. There were totally analyzed 50 samples of fish.Staphylococcus aureus was detected in % 4 of analyzed samples . The Food and Drug Administration (FDA) [1] established that effective doses of staphylococci enterotoxins can be achieved when populations of *Staphylococcusaureus* are greater than 10^2organisms per gram of contaminated food. This limit was not exceeded in any of the studied samples

Keywords: Diseases, Fishes, Aegean Sea

Introduction
Safety of fish products and their quality assurance is one of the main problems of food industry today. *S. aureus* is one of the major bacterial agents causing foodborne diseases in humans worldwide [2]. These bacteria are salt-tolerant and therefore can contaminate all cured preparations such as cold smoked fish, caviar and fish-based preserves [3]**.** Fish contains large amount of proteins and their breakdown into amino acids support the growth of *Staph.aureus.* Even though fish are smoked, the heat supplied might not kill all the pathogens. Smoked fish could be stored satisfactorily for three weeks at 5°C and less than one week at 10°C. The need for proper refrigeration cannot be over-emphasized. The finished product should not be distributed until it has been properly cooled to 4.2° C or below. Furthermore, because of perishable nature of smoked fish, it is imperative that finished product be maintained in a refrigerated condition at 4.2° C or below until consumed . Most food poisoning outbreaks related to smoked fish have been related to abusive storage temperature conditions. The isolated *S.aureus* were due to the contamination of fish during capture and subsequent unhygienic handling and processing [4]. Isolated *Staphylococcus aureus* in fishery products and fish processing factory workers. Small numbers of this bacterium in fishery products is not a serious problem but food poisoning may occur if the product is handled carelessly during processing, resulting in high multiplication. Therefore, consumption of such products may cause a risk of *Staphylococcus aureus* intoxication in consumers. The purpose of the present work was to study the incidence of *Staphylococcus aureus* in fishery products and fish processing factory workers.

Material and Methods
The samples (25 g) were weighed into sterile stomacher bags, diluted with 225mL buffered peptone water (BPW) (Oxoid, Unipath, Hampshire, UK) and homogenized in a Stomacher (Classic) about 10 min. The samples were further diluted with buffered peptone water (BPW), and 0.1 mL portion of various dilution levels were spread on the surfaces of Baird-Parker agar (BP) (Oxoid) supplemented with tellurite and egg yolk emulsion (Oxoid) and incubated at 37C for 32-48h. Convex, black, shiny colonies with narrow white magrin surrounded by clear zone were regarded as *S. aureus.* These colonies were confirmed by conducting gram staining, coagulase test, catalase test and anaerobic utilization of glucose and mannitol [5].

Results and Discussion
In this study, random samples of fifty smoked fish were taken at regular intervals.This samples were divided into decimal groups and total numbers of Staphylococcus aureus were determined. After enumeration on the groups were defined respectively 1.0×10^1cfu/g, 2.7×10^1cfu/g,1.2×10^2cfu/g, 1.7×10^1cfu/g and 3.0×10^1.

Tab. 1. The total numbers of *Staphylococcus aureus* in sample groups

Groups	1	2	3	4	5	Recomended
Staphylococcus aureus (cfu/g)	1.0×10^1	2.7×10^1	1.2×10^2	1.7×10^1	3.0×10^1	$< 10^2$

(10 samples in each group)

According to these data we assume that the isolated *Staphylococcus aureus* were due to the contamination of fish during sampling and subsequent unhygienic handling and processing [5].

Tab. 2. A characteristics of *Staphylococcus aureus* in seafood [6]

Bacteria	Estimated minimal Infectious dose	Sympthoms	Associated seafood	Importance
Staphylococcus aureus (cfu/g)	toxin level 10^5- 10^6	vomiting,diarrhoea weakness	contamination from infected persons	frequency of intoxication

Isolated *Staphylococcus aureus* in fishery products and fish processing factory workers. Small numbers of this bacterium in fishery products is not a serious problem but food poisoning may occur if the product is handled carelessly during processing, resulting in high multiplication(>1×10^5 cfu/g). Therefore, consumption of such products may cause a risk of *Staphylococcus aureus* intoxication in consumers. As the *Staphylococcus aureus* is an indicator of hygiene and sanitary conditions, the presence of this organism indicates the unhygienic condition during processing, storage etc. The contamination of the product could be due to a food poisoning. It is recommended to use sanitary gloves for handling processing foods to reduce the problem of *Staphylococcus aureus* contamination.

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VIBRIO DIVERSITY ASSOCIATED WITH THE INVASIVE SEAWEED *CAULERPA RACEMOSA* (CHLOROPHYTA, CAULERPACEAE)

L. Rizzo [1]*, S. Tredici [2], G. Pizzolante [2], P. Alifano [2], L. Stabili [3] and S. Fraschetti [2]
[1] Ca' Foscari University of Venice - Italy - lucia.rizzo@unisalento.it
[2] University of Salento - Italy
[3] IAMC-CNR, Taranto - Italy

Abstract
We analysed the diversity of *Vibrio* bacteria associated with the non-indigenous species *Caulerpa racemosa*. The surface of the macroalgae constitutes a suitable substrate for the colonization of eukaryotic and prokaryotic microorganisms. This algae may gain vital elements from the associated bacteria, which, in turn, protect their hosts from micro- and macrofouling by the production of bioactive compounds, possibly playing a key role in the spread of this non-indigenous species.

Keywords: Alien species, Algae, Bacteria, Coastal systems, South Adriatic Sea

Introduction

The ecological threats of invasive seaweeds on ecosystem functioning have been largely documented in the marine environment [1]. Their effects vary according to the spatio-temporal scale considered. Knowledge of the mechanisms involved in the spread of these species is therefore critical.

Caulerpa racemosa is a non-indigenous species, introduced from the Red Sea. It was observed for the first time in the Mediterranean Sea in Libya in 1990 [2]. From then on, it has colonized all available habitats and substrata leading to profound alterations of indigenous assemblages [3,4].

Here, we investigated the *Vibrio* community colonizing the surface of the invasive *Caulerpa racemosa*. Several seaweeds live associated with many bacteria, leading to interactions with potential relevant functional significance [5]; however, the mechanisms underlying the processes of cospeciation and host–symbiont specificity, are poorly understood.

Material and Methods

C. racemosa was collected within the Marine Protected Area of Torre Guaceto (Brindisi, Italy) at shallow water depth, on a rocky substrate. In the laboratory, the seaweed was washed in sterile seawater (0.2 µm pore-filtered) and homogenized for 90 s in a sterile Waring blender at 5°C. Serial dilutions of the homogenate were plated onto TCBS agar (thiosulphate/citrate/bile salts/sucrose agar) to characterize the *Vibrio* community.

In addition, abundances of vibrios on the surface of *Caulerpa racemosa* have been quantified. Phenotypic characterization of the isolates was also performed by several morphological cultural tests, completed with 16S rDNA sequence analysis using EzTaxon-e, a prokaryotic 16S rRNA Gene sequence database[6]. DNA alignment of the 16S rDNA sequences was carried out using BLAST® software.

Results and Discussion

The results of microbiological cultural analysis using TCBS agar documented that vibrios accounted for 1.1 X 10^3 cfu/ml thus representing about the 4% of the total *C. racemosa* surface culturable bacteria. 16S rDNA amplicons, obtained by polymerase chain reaction (PCR) using 16S rRNA gene-specific primers, was employed in order to characterize the *Vibrio* community at species level (Tab. 1)

Tab. 1. Vibrios isolated from the surface of Caulerpa racemosa: 16s rDNA sequence identity using EzTaxon-e sequence database.

ISOLATES	SEQUENCE IDENTITY	HOMOLOGY (%)
V -1	*Vibrio jasicida* TCFB 0772^T	100.00 %
V -2	*Vibrio neptunius* LMG 20536^T	99.70 %
V -3	*Vibrio owensii* DYO5^T	99.85 %
V -4	*Vibrio campbellii* ATCC 25920^T	99.07 %
V -5	*Vibrio sagamiensis* LC2-047^T	99.15 %
V -6	*Vibrio maritimus* R-40493^T	99.50 %
V -7	*Vibrio diabolicus* HE800^T	99.89 %
V -8	*Vibrio tubiashii* ATCC 19109^T	99.88 %

The association observed between the community of *Vibrio* and *Caulerpa racemosa* has an ecological and epidemiological significance and the seaweed may therefore function as a particular habitat providing specific environmental conditions for the microbial colonization, taking into account that some isolated *Vibrio* species are quite different from those in the surrounding environment [7,8].

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DETECTION OF *ESCHERICHIA COLI* WITH *UIDA* GENE IN MARINE ENVIRONMENT OF KAPIDAG PENINSULA (MARMARA SEA)

N. Sivri [1]*, M. Balci [2], N. Balkis [3], M. Jones [4] and M. Allen [4]
[1] Istanbul University, Engineering Faculty, Environmental Engineering Department - sivrin@gmail.com
[2] Istanbul University, Institute of Science, 34134, Vezneciler, Istanbul, Turkey
[3] Istanbul University, Faculty of Science, Department of Biology, 34134, Istanbul, Turkey
[4] Plymouth Marine Laboratory (PML), Prospect Place, The Hoe, PL1 3DH, Plymouth, UK

Abstract
The aim of this study is to detection of the fecal coliform bacterium *Escherichia coli* in marine environment of Kapidag Penunsula, using the polymerase chain reaction and gene probes, based on amplifying regions of the *uidA* gene. Nine sampling stations were selected from Kapidag Peninsula (Marmara Sea). The seawater samples were taken and primary hydrographic parameters (temperature, salinity, and dissolved oxygen) were recorded seasonally from 2010-2011. The results reveal that in all stations *E.coli* found with *uidA* gene and faces bacteriological pollution. Analysis of *uidA* gene using PCR showed temporal and spatial genetic homogenity in these *E.coli* populations. Waste water treatment management strategies will be great help to solve the sources of fecal pollution at the study stations.

Keywords: Bacteria, Bio-indicators, Surface waters, Pollution, Marmara Sea

Introduction
Monitoring of water-borne pathogens is important to safeguard public health. Recreational water quality assessment utilizes various indicator organisms to establish the sanitary quality of a particular body of water. *Escherichia coli* being present in very high numbers in the gut of warm-blooded animals, is widely used as an indicator of faecal pollution, to estimate the risk of exposure to other types of pathogenic organisms present in animal or human wastes [1]. Detection of *E.coli* remains a key factor in determining the microbiological quality of surface sea water. Use of uid-targeted PCR for the direct detection of *E. coli* may be useful and faster than other methods. After DNA extracted of *E.coli* from the polluted surface sea water, we use tructural region designated uidA was performed using primers UAL-1939 and UAR-2105 for detection. PCR-DGGE technology was adapted for specific detection and profiling of *E. coli* populations differing in a fragment of the functional uidA gene. The uidA gene product is a frequently used enzymatic marker for *E. coli* identification in recently developed detection media. In this study, various limitations inherent in the traditional culture methods, the feasibility of using the polymerase chain reaction (PCR) to monitor *E.coli* was investigated.

Materials and Methods
Monitoring stations were selected locations at coastal ecosystem of Kagidag Peninsula, seasonally in 2011-2012. Six stations (K1-K6), taken from surface, were coastal area and three stations and different depths (5 m, 10 m, 20 m and 30 m) of open sea were north, west and east locations (Figure 1). The enteric bacteria were isolated using the MPN Method and the detailed analyses were applied [2]. To determine the specificity of uidA for E.coli detection, DNA was extracted from exponential cultures [3]. A 0.166-Kb fragment was amplified from the *uidA* gene of *E. coli* using primers UAL-1939 (5'-TATGGAATTTCGCCGATTTT-3') and UAR- 2105 (5'-TGTTTGCCTCCCTGCTGCGG-3') [4].

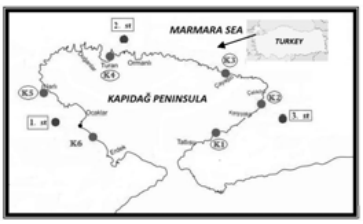

Fig. 1. Study area of Kapidag Peninsula

Results and Discussion
The set of primers, UAL-1939 and UAR-2104, located at the carboxyl coding region of the uidA gene produced amplified DNA bands of 166 kb for E.coli (Figure 2a-b). Except K1 and K6, we shown all the stations have same band for E.coli. This result pointed to parallel emphases that these stations were selected at locations that were either highly urbanized or where the coastal ecosystem was heavily deteriorated. Especially, K1 and K6 stations are used as a public beach during summer months. So, not only E.coli but also other enteric bacteria could be shown in these stations and recorded during sampling period. And the bands were indicated the differences between stations and depths. But the samples of the depth of 30 m weren't shown the same results. It means that, these samples included different species of enteric bacteria except *E.coli*.

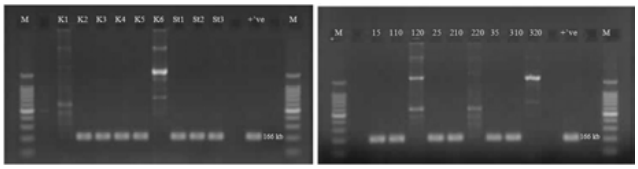

Fig. 2. A. Surface samples b. Depths of stations 1,2,3

Results of the present study show that the PCR is a potentially powerful technique for the rapid detection of enteric bacteria in routine water quality monitoring. In addition, in this study indicate that PCR provide a powerful supplement to conventional methods for more accurate risk assessment and monitoring of pathogenic bacteria in the marine environment. The ability to rapidly monitor for various types of microbial pathogens would be extremely useful not only for routine assessment of water quality to protect public health, but also allow effective assessments of water treatment processes to be made by permitting pre- and post-treatment waters to be truly analyses [1]. At the last, because of the indigenous nature of *E. coli* considerations must be made about the importance of this bacterium as an indicator of recent fecal contamination and the necessity of knowing the source of contamination if public health is to be protected.

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Session

Microbial pathways

Modérateur : **Gian Marco Luna**

SPATIAL DISTRIBUTION AND VERTICAL VARIATION IN BACTERIOPLANKTON ASSEMBLAGES ACROSS THE MEDITERRANEAN SEA

R. Alvariño [1], M. M. Varela [1], M. Álvarez [1]*, E. Teira [2] and V. Hernando-Morales [2]
[1] Instituto Español de Oceanografía (IEO) Centro Oceanográfico da Coruña - marta.alvarez@co.ieo.es
[2] Universidade de Vigo

Abstract
We analysed the vertical variation of bacterioplankton assemblage composition along a transect of 3500 km in the Mediterranean Sea, to determine the factors driving bacterioplankton community structure. Bacterioplanckton community composition (BCC) was assessed by a fingerprinting method, automated ribosomal intergenic spacer analysis (ARISA). Non-metric Multidimensional Scaling (nMDS) showed that the BCC in the surface waters of the eastern and western sub-basins of the Mediterranean Sea was significantly different. We also found the occurrence of a vertical profile of bacterial communities across the water column, related to different variables as the depth of collection (pressure), and salinity and temperature values. Our results suggest both spatial and environmental factors control bacterioplankton community structure.

Keywords: Bacteria, Biogeography, Deep waters, Vertical profile, North-Western Mediterranean

Prokaryotes are key players in sea ecosystems both in terms of biomass and phylogenetic diversity and for their role in biogeochemical cycles. Only recently, due to the development and advance of molecular tools, marine scientist undertook the investigation of microbiome distribution and adaptation to specific environmental conditions in oceans. The MedSea is a marginal sea with high temperature and salinity through the water column and with an anti-estuarine circulation pattern, where the formation of deep water occur both the western and eastern basin (i.e. renewal time of the water masses is < 100 years). These characteristics make the Mediterranean Sea a very special ecosystem in terms of biodiversity hotspots. However, most of the reports on ecological structuring of prokaryotes in the Mediterranean Sea have been conducted on a small number of stations, generally located in a narrow area [1, 2]. In this paper, we studied the vertical and longitudinal distribution of bacterial populations in different sampling stations located across the whole Mediterranean Sea.

Sampling was carried out during the cruise M84/3 held on April 2011 on the R/V Meteor. Sampling stations were located along a longitudinal transect of ~3500 km in the Mediterranean Sea. Water samples were collected from the subsurface, meso- and bathypelagic layers. Prokaryotic abundance was evaluated by epifluorescence microscope and BCC by applying automated ribosomal intergenic spacer analysis (ARISA) [3].

Prokaryotic abundance decreased throughout the water column of eastern and western Mediterranean basins. Non-metric multidimensional scaling (nMDS) analysis showed that the subsurface and deep (meso- and bathypelagic) waters host significantly different bacterial communities. Furthermore, nMDS displayed that the surface bacterial community structure in the eastern and western sub-basins of the Mediterranean Sea were significantly different (Figure 1).

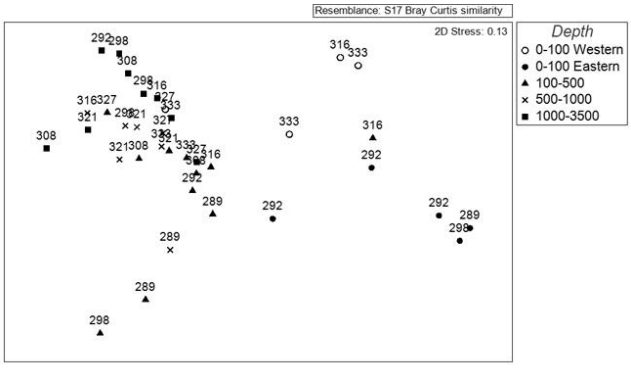

Fig. 1. Non-metric multidimensional scaling (nMDS) results based on qualitative ARISA fingerprinting of the samples across the water column, showing the distribution of surface (circles), upper mesopelagic (triangles), lower mesopelagic (crosses) and bathypelagic (squares) samples.

To evaluate the relevance of spatial and environmental variables (depth, salinity, oxygen, temperature, nitrate, silicate, latitude and longitude) driving the distribution pattern of BCC we carried out a DISTML analysis (distance-based linear models). According to the DISTLM model, depth explains 11.57% of the variation observed in the BCC. Temperature and salinity also contribute significantly (11.56% and 5.83%, respectively) to the variability of the BCC (Figure 2).

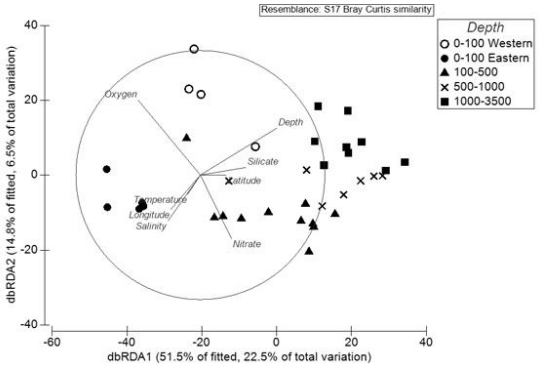

Fig. 2. Distance-based redundance analysis (dbRDA) ordination of the presence ⁄ absence ARISA dataset overlaid with the partial correlations of the tested environmental variables

Our results indicated that the bacterial populations are stratified across the water column according to environmental variables, such as temperature and salinity. Recent investigations have found that these parameters showed a correlation with zonation of bacterial communities in the Mediterranean Sea [1]. These results demonstrated that bacterial taxa distribution was spatially patterned, exhibiting different populations in the surface, meso- and bathypelagic realms of the eastern and western Mediterranean sub-basins.

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UNCOUPLING BETWEEN DINITROGEN FIXATION AND PRIMARY PRODUCTIVITY IN THE EASTERN MEDITERRANEAN SEA

E. Rahav [1], B. Herut [2], . Stambler [1], E. Bar-Zeev [1], M. R Mulholland [3] and I. Berman-Frank [1]*
[1] Bar Ilan University, - ilana.berman-frank@biu.ac.il
[2] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa., Israel
[3] Department of Ocean, Earth and Atmospheric Sciences, Old Dominion University, Norfolk, Virginia, USA

Abstract
We measured dinitrogen (N_2) fixation and primary productivity (PP) during the stratified summer period in different water regimes of the Eastern Mediterranean including the Cyprus Eddy (CE) and the Rhodes Gyre (RG). Low N_2 fixation rates were measured throughout the basin excluding 10 fold higher rates in the RG and CE. Corresponding PP increased from east to west with relatively higher productivity recorded in the RG and CE. These measurements demonstrate that N_2 fixation in the photic zone contributes only negligibly by direct inputs to PP (i.e. cyanobacterial diazotrophs) and is in fact uncoupled from PP. In contrast, N_2 fixation was significantly coupled to bacterial productivity (BP) and to net-heterotrophic areas suggesting that heterotrophic N_2 fixation may in fact be significant in this ultraoligotrophic system.

Keywords: Cyanobacteria, Phytoplankton, Primary production, Bacteria, Levantine Basin

N_2 fixation controls total nitrogenas the supply of new nitrogen (N) to the N poor surface waters of the ocean by diazotrophs usually stimulates both the autotrophic and heterotrophic communities of the planktonic and microbial food webs [2]. Thus, N_2 fixation should be positively correlated to PP in two ways: 1) Directly, via photoautotrophic diazotrophs currently assumed to be the dominant component of the diazotrophic community in the photic zone with sunlight providing the required energy for the energetically expensive process of N_2 fixation. 2) Indirectly via the contribution and recycling of the products of this "new N" (i.e. either assimilated N; ammonia leakage, breakdown of diazotrophic blooms, etc.) stimulating PP by non-diazotrophic photoautotrophs. In this study we evaluated the contribution and relationship of N_2 fixation from the photic layer to PP in different water provinces of the Eastern Mediterranean. To this end we measured *in-situ* N_2 and carbon fixation from different depths within the photic zone and performed on-board microcosm experiments in 11 different locations throughout the Levantine basin, including the cyclonic RG and anti-cyclonic CE, over 3 consecutive years (2007-2009) during the stratified period. Measured PP rates across the Levantine basin revealed an east-west gradient with lowest values at the easternmost stations getting progressively higher toward the western Levantine stations (~200 and > 2000 µmol C m^{-2} d^{-1} respectively). In contrast, areal N_2 fixation rates did not exhibit the spatial trend observed for PP and were low throughout the whole basin (0.8 to 3.2 µmol N m^{-2} d^{-1}), except for the CE and RG where rates higher by an order of magnitude were measured (~ 20 µmol N m^{-2} d^{-1}). Furthermore, the percent contribution of the biologically fixed N to PP ranged from 0.7 to 2 % (n=96) except for both gyres (> 6 %, n=24). Our results show that during the stratified period, excluding the RG and CE, N_2 fixation was uncoupled from PP across the Levantine basin (P= 0.3, n= 19, Figure 1), which contrast studies from varying oceanic regions demonstrating a positive correlation of PP with N_2 fixation in the photic illuminated layer under stratified conditions (R^2= 0.54, P = 2 x 10^{-6}, n= 26). This uncoupling in the Eastern Mediterranean may be explained by examining the characteristic composition and structure of the pelagic primary producers and the resulting microbial food web. We suggest that in this system, where heterotrophic bacteria compete with the primary producers for the limited nutrients [3], heterotrophic N_2 fixation can be significant and may extend also deep into the aphotic depths.

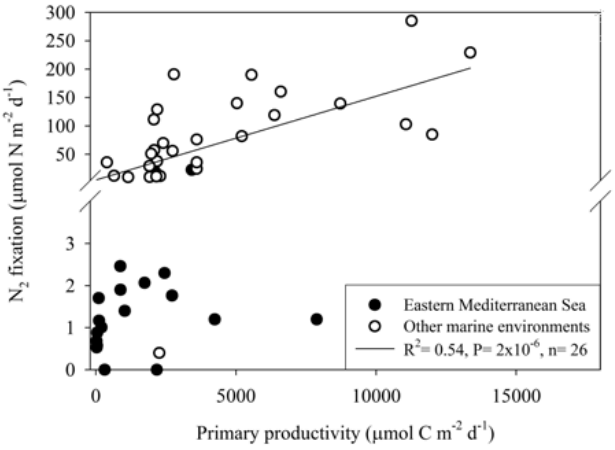

Fig. 1. Correlation between N_2 fixation rates and PP for the illuminated photic depths of varying marine environments, including the Eastern Mediterranean Sea, anti-cyclonic eddies within the Mediterranean Sea, DYMAMED station in the Western Mediterranean Sea, Station ALOHA near Hawaii, South China Sea, the tropical and subtropical western North Pacific, the Gulf of Mexico, Atlantic Ocean, the Baltic Sea, and the south Pacific Gyre.

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SEASONAL TEMPERATURE EFFECTS ON MARINE HETEROTROPHIC PROKARYOTIC ACTIVITIES IN THE BAY OF MARSEILLE

B. Céa [1]*, F. van Wambeke [1], D. Lefèvre [1], L. Chirurgien [1], N. Garcia [1], M. Lafont [1], B. Charriere [1], J. Ghiglione [2] and G. Grégori [1]

[1] MIO, Mediterranean Institute of Oceanography - benjamin.cea@univ-amu.fr

[2] Laboratoire Arago, Banyuls s/Mer

Abstract

The annual variations of temperature effects on heterotrophic prokaryotic production and respiration and on macromolecular hydrolysis (phosphatase and protease) have been investigated during one year in the Bay of Marseille. We present the Q10 data range, variability, seasonal trends and their consequences on the functioning of degradation pathways within the microbial food web under increased temperatures

Keywords: Temperature, Bacteria, Enzymes, Geochemical cycles, North-Western Mediterranean

The dynamics of heterotrophic prokaryotes are influenced by many parameters, particularly in coastal areas (temperature, nutrients, organic matter inputs (allochtonous, autochtonous) abundance of communities, urban/human pollution…). Hence, to understand the impact of one forcing factor it's necessary to study one parameter at a time. Temperature, with OM availability, is one of the main factor influencing heterotrophic prokaryotic activity [1]. It is not well known how this temperature control varies seasonally, and if this control is different according the heterotrophic process studied. This study investigates temperature effect at the fixed French observatory station SOMLIT in the Bay of Marseille (60 m depth). Natural samples were incubated at 8 different temperatures ranging from 10 to 30°C encompassing the in situ temperature, to estimate total community respiration (CR), heterotrophic prokaryotic production (BP), phosphatase activity (phos) and leucine aminopeptidase (prot) activity. Samples have been collected monthly during one year (from 01/02/12 to 28/02/13).

Figure 1 displays an example of temperature kinetics obtained on the 9 July survey. At 26°C, BP optimum is reached then shows a temperature inhibition, while phos and CR continuously increased and leucine aminopeptidase reached a plateau at 26°C.

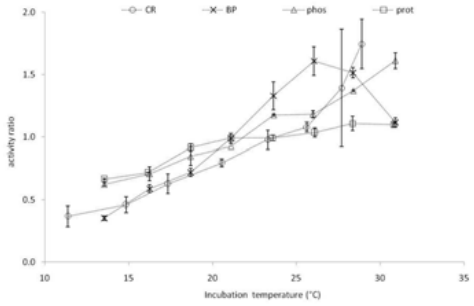

Fig. 1. Temperature kinetics obtained on the 9 July survey for 4 activities: community respiration (CR), bacterial production (BP), phosphatase (phos) and leucine aminopeptidase (prot) Activity ratio is the activity measured at a given temperature divided by the activity measured at in situ temperature.

Q10 factor describes the relative process increase for a temperature raise of 10°C within the Arrhenius law domain. Q10 is estimated from the linear part of the linear regression plot of Ln (rate) versus 1/T, T being expressed in °K. Q10 of Community respiration (Q10CR), heterotrophic prokaryotic production leucine aminopeptidase (Q10BP) and phosphatase (Q10phos) showed the greatest values and ranges, varying annually up to 4 times (Figure 2).

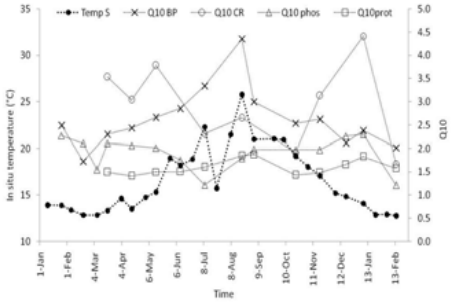

Fig. 2. In situ sea-surface temperature (Temp S, 1 m depth) and Q10 evolution during the Jan 2012-Feb 2013 survey: Q10 of community respiration (Q10 CR), of bacterial production (Q10 BP), of phosphatase (Q10 phos) and of leucine aminopeptidase (Q10 prot).

(Q10phos) showed the greatest values and ranges, varying annually up to 4 times (Figure 2). Q10CR ranged from 1.67 to 4.41. Q10BP ranged from 1.72 to 4.36. Q10phos showed a lower variability, ranging from 1.21 to 2.30. Finally, Q10 of leucine aminopeptidase (Q10prot) exhibited the lowest variability, ranging from 1.41 to 1.87. Q10BP was positively correlated to the in situ temperature, decreasing in winter down to 1.72 in cold waters (13°C), and reaching up to 4.36 in summer in warmer waters (26°C). At the opposite, Q10phos and Q10CR are more or less decreasing with increasing in situ temperatures. Such results would have consequences on temperature effects on the bacterial growth efficiency, as BP and RB had different Q10 values. We'll discuss seasonal trends, possible links with development of the phytoplankton bloom and limiting factors and we'll examine what are the consequences of slight increases of temperature on the functioning of degradation pathways within the microbial food web in the context of global change.

Acknowledgments

We thank SOMLIT network for their help in the logistics and provision of physical and biogeochemical data. Financial support was provided by a grant from the Region Provence Alpes Côte d'Azur to BC and the French national program EC2CO.

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EVIDENCE FOR TOP-DOWN CONTROL OF ULTRAPHYTOPLANKTON IN THE GULF OF GABÈS (EASTERN MEDITERRANEAN BASIN, TUNISIA).

I. Hamdi [1], M. Denis [2]*, A. Belaaj Zouari [3], H. Khemakhem [1], M. Bel Hassen [3], A. Hamza [3] and S. Maalej [1]
[1] Université de Sfax, Faculté des Sciences
[2] Institut Méditerranéen d'Océanologie - michel.denis@univ-amu.fr
[3] Institut National des Sciences et technologies de la mer, Tunisie

Abstract
The Gulf of Gabès, one of the largest continental shelves in the oligotrophic to ultra-oligotrophic Eastern Mediterranean Basin, is a very highly productive area under strong anthropogenic pressure. The ultraphytoplankton (< 10 µm) summer distribution determined In the Gulf by flow cytometry in June 2008 unveiled a very abundant and unknown cell group. In contrast, the abundance of usually observed photosynthetic cell groups was found abnormally low considering the absence of nutrient limitation, which would suggest a top-down control of ultraphytoplankton by predation activity. Flow cytometry analysis of samples collected in the same area in July 2012 yielded similar results. Cell sorting followed by scanning electron microscopy revealed the presence of choanoflagellates, however the unknown cell group could not be identified.

Keywords: Phytoplankton, Gulf of Gabes

Introduction
The Eastern Mediterranean Basin is the most oligotrophic region [1] in the Mediterranean Sea. In contrast, the Gulf of Gabès, one of its largest continental shelves, is highly productive, contributing about 65% to the Tunisian fish production. Nitrate is never fully exhausted [2], probably upon the effect of re-suspension favoured by very large tides, and also of Saharan dust deposit [3]. We report here the first investigation in the Gulf of Gabès of ultraphytoplankton (< 10 µm) distribution at the single cell level by using flow cytometry.

Materials and Methods
This study was conducted from 12 to 16 June 2008 in the frame of the national POEMM project (Planktonic Ecosystem and Oceanographic Monitoring and Management), on board of the R/V HANNIBAL.

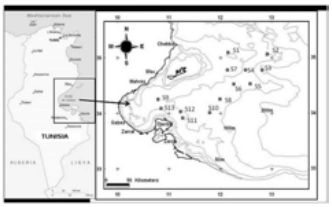

Fig. 1. Location of the study area to the South-East of Tunisia (Gulf of Gabès). Stations occupied during the POEMM Summer cruise (15-16 June 2008) are numbered in the order of their sampling.

A second cruise took place in the same area in July 2012 and provided a new set of samples to undertake further investigations. Autotrophic pico-nanoplankton analysis and sorting by flow cytometry (FCM) was conducted at the Regional Flow Cytometry Platform for Microbiology (PRECYM, http://precym.com.univ-mrs.fr) of the Mediterranean Institute of Oceanography (MIO) in Marseille (France). The observations of sorted samples were performed by HRSEM (high resolution scanning electron microscopy) JSM-6320F (JEOL Company) at the electron microscopy facility of CINaM (Centre Interdisciplinaire de Nanoscience de Marseille).

Results and discussion
FCM resolved 5 cell groups nanoeukaryotes (photosynthetic eukaryotic cells belonging to the size class 3-20 µm), picoeukaryotes (<3 µm), *Prochlorococcus* and *Synechococcus* and one cluster of unknown cells (UC) that was the most abundant (0.1-2.9 10^6 cells.cm^{-3}) and apparently >2 µm. These cells were characterised by low red and orange fluorescence signals whereas from their apparent size, they should emit a red fluorescence signals at least as large as that of nanoeukaryotes.

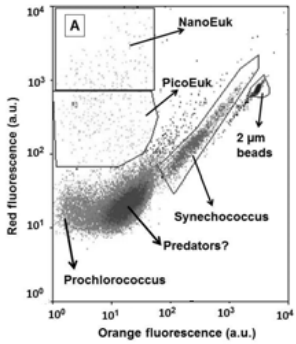

Fig. 2. Group-resolving flow cytometry cytogram.

The ultraphytoplankton abundance was similar to that observed in winter in the eastern Mediterranean Basin [4], well below that reported in the western Mediterranean Basin in spring [5]. Because nutrients in the Gulf of Gabès are never fully exhausted, the abnormally low abundance level was explained by predation activity applying a top down control on the ultraphytoplankton. The 2012 samples enabled sorting cells of the UC group and their observation by scanning electron microscopy. Though a choanoflagellate species could be detected, the dominant cells in the UC group could not be identified. DNA sequencing is considered to achieve their identification. Despite this unresolved question, results support the existence of a top-down control of photosynthetic pico- and nanoplankton, insuring a rapid transfer of matter and energy to higher trophic levels, consistently with the well-known high productivity of the Gulf of Gabès. Nanoflagellates are likely candidates to run this top down control.

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VARIATION SPATIO-TEMPORELLE DE LA DISTRIBUTION ULTRAPLANCTONIQUE DANS LE GOLFE DE GABÈS (TUNISIE)

I. Hamdi [1]*, S. Maalej [1], A. Hamza [2], A. Bouain [2] and M. Denis [3]
[1] UR 05 ES 05 Biodiversité et écosystèmes aquatiques. Faculté de sciences de Sfax, 3000, Tunisie. - ineshhamdi@yahoo.fr
[2] Laboratoire milieu marin, Institut National des Sciences et Technologies de la Mer, Sfax, 3018, Tunisie.
[3] Aix-Marseille Université, Université du Sud Toulon-Var, CNRS/INSU, IRD, MIO, UMR 7294, 163 avenue de Luminy, 13288 Marseille cedex 09, France

Abstract
Les variations spatio-temporelles des communautés ultraphytoplanctonique et bactérioplanctonique (≤10µm) dans le Golfe de Gabès ont été étudiées lors de deux campagnes, juin 2008 et mars 2009. Les résultats obtenus ont été confrontés aux variations des paramètres environnementaux afin de connaître l'influence de ces derniers sur l'abondance de chacune des populations résolues par cytométrie en flux.

Keywords: Gulf of Gabes, Cyanobacteria, Phytoplankton, Water transport

L'étude de la distribution spatiale de l'ultraplancton dans le Golfe de Gabès a été réalisée lors de deux campagnes (juin 2008 et mars 2009) conduites dans le golfe de Gabès sur la zone située entre 33°N-36°N et 10°E-13°E. Au cours de chacune de ces deux campagnes, 14 stations réparties entre la côte et le large ont été échantillonnées à différentes profondeurs. Les échantillons destinés à l'analyse par cytométrie en flux ont été fixés à bord avec du paraformaldehyde puis congelés dans l'azote liquide et conservés à -80°C jusqu'à leur analyse sur la plate-forme régionale de cytométrie pour la microbiologie (PRECYM, http://precym.com.univ-mrs.fr/) du MIO à Marseille. Les groupes de cellules ont été différenciés à partir des signaux de fluorescence et de diffusion de chaque cellule.

L'étude de l'ultraphytoplancton a permis de reconnaître quatre groupes cellulaires, dont deux groupes d'eucaryotes, pico- et nanoeucaryotes ainsi que deux groupes de cyanobactéries, *Prochlorococcus* et *Synechococcus*, l'analyse du bactérioplancton a signalé la présence de deux groupes cellulaires distincts qui ont été identifiés comme étant des cellules HNA (high nucleic acid) et des cellules LNA (low nuleic acid). Les relations entre abondances cellulaires, concentrations des éléments nutritifs et autres variables environnementales ont été recherchées.

Les différences de situations entre période estivale et printanière ont été déterminées et montrent que durant la saison printanière le milieu était particulièrement riche en cyanobactéries en comparaison avec la période estivale, contrairement aux eucaryotes qui étaient plus présents en juin 2008 essentiellement dans la région côtière. Cet enrichissement cellulaire est favorisé par la présence de certains éléments nutritifs à certains niveaux de la colonne d'eau ainsi que par l'action de quelques paramètres physiques tels que la densité et la salinité.

L'analyse du bactérioplancton a prouvé que l'abondance du bactérioplancton était nettement inferieure durant la compagne de juin 2008. Au cours de la période printanière, le milieu était toujours assez riche en cellules HNA essentiellement dans la région du large de la zone d'étude la ou se développe également les cyanobactéries, contrairement à la période estivale qui l'a précédé ou les cellules LNA formaient la majorité des cellules bactériennes présentes dans le milieu.

Tab. 1. Concentrations moyennes des différents groupes ultraphytoplanctoniques (*Synechococcus*, *Prochlorococcus*, picoeucaryotes et nanoeucaryotes) et bactérioplanctoniques (groupement HNA, et LNA) résolues par cytométrie en flux dans les stations échantillonnées au cours des compagnes juin 2008 et mars 2009 au large et vers la cote de la zone d'étude, et les moyennes en paramètres physiques (température, salinité et densité) ainsi que les moyennes correspondantes en éléments nutritifs.

	juin-08		mars-09	
	COTE	LARGE	COTE	LARGE
PRO. 10^3 (cell.cm^{-3})	47,32±69,89	25,55±26,85	32,52±18,86	19,52±15,67
SYN. 10^3 (cell.cm^{-3})	8,93±5,11	2,54±1,66	11,65±20,88	17,29±16,25
PICO. 10^3 (cell.cm^{-3})	11,94±8,83	2,96±2,23	1,89±2,49	0,73±0,64
NANO.10^3 (cell.cm^{-3})	3,01±2,75	1,50±1,35	0,24±0,20	0,26±0,21
LNA. 10^6 (cell.cm^{-3})	12,32±7,63	16,40±10,29	26,20±15,36	51,83±35,59
HNA. 10^6 (cell.cm^{-3})	2,85±1,18	3,96±1,35	24,08±23,88	80,90±20,80
TEMP (°C)	23,07±0,33	19,78±2,03	14,68±0,38	15,12±0,39
SAL (psu)	38,33±0,12	37,52±0,12	37,93±0,68	37,64±0,29
DENS (Kg.m^{-3})	26,52±0,16	26,87±0,69	28,31±0,53	27,98±0,24
$Si(OH)_4$ (µM)	2,92±0,56	2,96±0,58	1,40±0,93	1,17±0,67
NO_2^- (µM)	0,08±0,04	0,09±0,05	0,10±0,05	0,12±0,04
NO_3^- (µM)	1,73±0,56	1,75±0,49	0,68±0,19	0,57±0,17
NH_4^+ (µM)	0,61±0,21	0,66±0,25	0,37±0,17	0,44±0,20
PO_4^{3-} (µM)	0,06±0,02	0,06±0,02	0,08±0,04	0,06±0,04

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EFFECT OF DENSE WATERS ON THE DIVERSITY AND METABOLISM OF PLANKTONIC BACTERIA IN THE SOUTHERN ADRIATIC SEA

Gian Marco Luna [1]*, Lucia Bongiorni [1], Jacopo Chiggiato [1] and Katrin Schroeder [1]
[1] CNR ISMAR - gianmarco.luna@ve.ismar.cnr.it

Abstract
During winter, the northern Adriatic Sea is subjected to cold outbreaks, resulting in generation of cold and dense waters which sink and eventually move southward. This water mass contributes to ventilate deep waters in the Eastern Mediterranean Sea, and can potentially influence prokaryotic diversity and metabolism at large spatial scales. We collected water samples of dense bottom currents in the Southern Adriatic Sea in March 2012, and measured bacterioplankton diversity (using fingerprinting techniques and 16S rDNA pyrosequencing) and key functional variables of microbial metabolism (heterotrophic C production, respiration and degradation rates). Our results indicate that bacterial diversity and metabolism are influenced by the dense water passage, and this has important consequences for the ecosystem functioning of the entire area.

Keywords: South Adriatic Sea, Bacteria, Biodiversity, Deep waters

Planktonic microbes are key players in the fluxes of matter and energy in the sea [1], yet their diversity, distribution and functional response to episodic events (such as dense water inputs) are poorly known. Heterotrophic bacteria process about half of the net primary production and play a dominant role in the microbial carbon pump, by altering and transforming labile organic matter into refractory forms that persist in the ocean [2]. An uncoupling between prokaryote-mediated production and degradation processes can have important consequences on the functioning, carbon sequestration and the ecological efficiency of marine ecosystems [3], especially in the warm Mediterranean Sea [4].

During the winter, the northern Adriatic Sea is typically subjected to intense cooling associated with dry and cold north-easterlies (the Bora wind). The resulting water mass (Northern Adriatic Dense Water, NAdDW), cold and dense, sinks and flows southward [5], typically reaching the proximity of Bari in the early spring. NAdDW eventually mixes with other Adriatic water masses to form the Adriatic Deep Water (ADW), which contributes significantly to the ventilation of deep water in the whole Eastern Mediterranean [6]. This episodic event has the potential to influence prokaryotic diversity and metabolism at large spatial scales, with unpredictable effects which deserve in-depth investigations.

In spring 2012, we collected seawater samples along three transects in the Southern Adriatic Sea during the outflow of dense water generated after a severe cold spell occurred in early February 2012. Several stations were clearly sampling the veins of the dense water, with potential density anomaly as high as 29.7 Kg/m and temperature as low as 10.5°C (Figure 1).

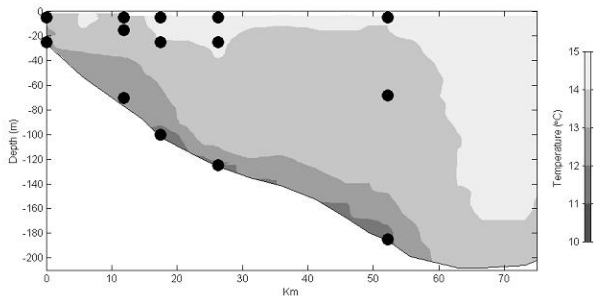

Fig. 1. Isoclines of temperature along one of the sampled transects. Dots indicate the sampling depths and location.

We measured bacterial diversity and key functional variables of prokaryotic metabolism, including prokaryotic heterotrophic carbon production rates (using the 3H-leucine incorporation method), potential respiration rates (via the Electron Transport System assay) and organic matter degradation activities (aminopeptidase, ß-glucosidase and alkaline phosphatase). Biodiversity was assessed by a combination of molecular fingerprinting (Automated Ribosomal Intergenic Spacer Analysis, ARISA) and 16S rDNA tag pyrosequencing.

In sub-surficial layers, the specific water masses were identified basing on their distinct temperature-salinity characteristics and the oxygen content. The analysis of bottom waters indicated that NAdDW samples, when compared with LIW samples collected at similar depths, were characterized by higher abundance of prokaryotes, higher respiration and organic matter degradation rates, while the carbon production rates were apparently unaffected by the dense water passage. Significant differences in the community composition of deep bacterial assemblages were observed between NAdDW and the other water masses. Our results indicate that diversity and metabolism of bacterioplankton are influenced by the dense water passage, suggesting that this episodic event may have large-scale consequences for the ecosystem functioning and the biogeochemical cycles in the Southern Adriatic Sea.

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TEMPORAL SURVEY, PRESENCE AND ACTIVITY OF BIOLUMINESCENT BACTERIA AT THE DEEP ANTARES STATION (MEDITERRANEAN SEA, 2200M DEPTH)

S. Martini [1]*, S. Guasco [1], V. Michotey [1], L. Casalot [1], M. Garel [1], D. Lefevre [1] and C. Tamburini [1]
[1] Mediterranean Institute of Oceanography (MIO) - severine.martini@univ-amu.fr

Abstract
Bioluminescence is of major interest in the dark-deep sea and among all organisms able to produce light, bacteria are the most abundant ones. This chemical reaction is regulated by the *lux* gene operon and provoked by the enzyme luciferase. Water-sampling, CTD-profiles and continuous bioluminescence reccords have been done to characterize presence and activity of such bioluminescent micro-organisms among the year 2011 as well as possible links with environmental variables. Molecular analyses have been performed on 16S-DNA and 16S-RNA to characterized, quantify and detect the presence of *lux* genes and active *lux* genes.

Keywords: Deep waters, Bacteria, North-Western Mediterranean

Darkness is one of the major characteristic of deep-sea environment that can be disturbed by a biological phenomenon named bioluminescence. Bioluminescence is the process of light emission by living micro- or macro-organisms. Amongst the bioluminescent organisms, marine luminous bacteria are ecologically versatile and can be found as free-living forms, epiphytes, saprophytes, parasites, symbionts in the light organs of fishes and squids, and commensals in the gut of various marine organisms [1, 2]. Metagenomic analysis from deep eastern-Mediterranean water samples shows a surprising high number of *lux* genes directly involved in bacterial bioluminescence [3].

The ANTARES site is located 40km off the french Mediterranean coast at 2475m depth. The site is firstly dedicated to the high energy particles (i.e. neutrinos) research. This structure has also been equipped with deep photonic sensors which also provide data on bioluminescence from deep-sea organisms. These datasets provide an extraordinary approach for real-time and high-frequency deep sea ecology studies. Water-samples and environmental time-series at this deep location is one original way to answer two main questions. Firstly, how bacteria are related to the high variability of bioluminescence intensity observed throughout the year? Secondly how the environmental variables may impact this bioluminescence intensity?

The dynamic of bacterial bioluminescence in the deep-sea-water samples have been collected over the year 2011, at the ANTARES site. Samples have been collected for ARN and ADN analyses in January, March, May, June, August and October 2011.

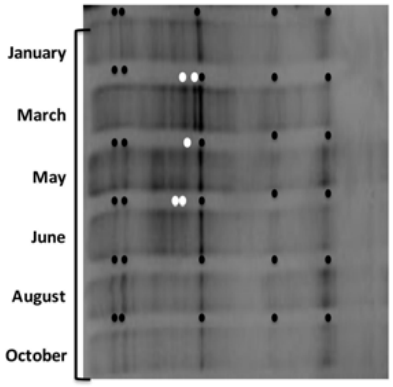

Fig. 1. Bacterial diversity analysis by fingerprint (16S rDNA DGGE) of 2011 water samplings. Black dots represent main bands appearing on almost all sampling periods and white dots represent main bands appearing only for specific sampling times.

At the same time, a CTD-profile is performed in order to characterize the environmental variables into the sampled-water mass. Filters sampled are analyzed in order to characterize presence and activity of *lux* genes. We performed DNA extraction, amplification and quantification using qPCR with several primers defined at lab. qPCR done on DNA-samples from October 2011 contains higher number of *lux* genes ($1.36x10^2 \pm 2.04x10^1$) than other samples during the year. Pyrosequencing has been performed on specific DGGE-bands to determine strains occurring into the water mass. Possible links between the presence of bioluminescent active genes and environmental variables have been highlighted.

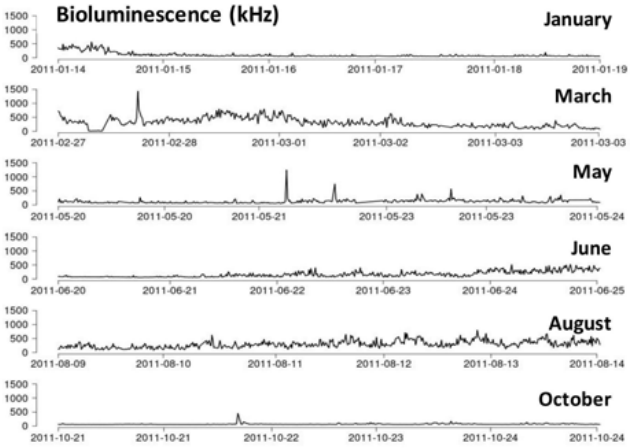

Fig. 2. Time series of bioluminescence intensity (kHz) recorded using photomulipliers at 2000m depth at the ANTARES station. The photon emission rate is recorded few days before and after the water sampling.

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DINITROGEN FIXATION IN APHOTIC OXYGENATED MARINE ENVIRONMENTS

E. Rahav [1]*, B. Herut [1], E. Bar-Zeev [2], M. R Mulholland [3] and I. Berman-Frank [4]
[1] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa 31080, Israel - eyalrahav@gmail.com
[2] Yale University
[3] Department of Ocean, Earth and Atmospheric Sciences, Old Dominion University, 4600 Elkhorn Avenue, Norfolk, Virginia 23 529-0276, USA.
[4] Mina and Everard Goodman Faculty of Life Sciences, Bar-Ilan University, Ramat Gan 52900, Israel.

Abstract
Most N_2 fixation studies are designed to fit the traditional assumption that phototrophic diazotrophs have an ecological advantage in the illuminated layer that has sufficient energy to drive this costly process. In this study we measured N_2 fixation in the fully oxygenated, NO_3^- rich and aphotic mesopelagic layer of the Levantine Basin and Gulf of Aqaba. Aphotic N_2 fixation ranged from 0.02 to 0.38 nmol N L^{-1} d^{-1} and accounted for 35 -77 % of the total integrated rates. The rates obtained were correlated with bacterial productivity and heterotrophic diazotrophs were identified. We suggest that heterotrophic N_2 fixation may be supported by sinking organic material and high C:N micro-environments (such as TEP), and that aphotic waters may represent a significant source of new N via N_2 fixation that is not currently included in N budgets.

Keywords: Deep sea ecology, Levantine Basin, Bacteria

Biological dinitrogen (N_2) fixation mediated by prokaryotic organisms (diazotrophs) contributes new nitrogen (N) to oceanic basins where primary production is limited by the availability of dissolved inorganic N. Thus, most oceanic N_2 fixation studies are restricted to the illuminated euphotic layer where photoautotrophic diazotrophs are dominated [1]. Phylogenetic and N_2-fixation data show that heterotrophic diazotrophs from α, β, γ, δ and ε-proteobacteria, as well as methanogenic archaea are distributed in geographically diverse oceanic environments including systems with high dissolved inorganic N concentrations, and deep oxygen minimum zones (OMZ) [2].

In the Eastern Mediterranean Sea (EMS), new nitrogen inputs via N_2 fixation in the euphotic zone are generally very low with rates ranging from 0.01 to 0.3 nmol N L^{-1} d^{-1} and contributing only 1-2% to new production in the Levantine Basin (LB) [3,4]. In the Gulf of Aqaba (GA), a single study reported low N_2 fixation rates ranging from ~0.05 to 2 nmol N L^{-1} d^{-1}, yet no information is found on their contribution to new and primary production [5].

In our search for N sources required to sustain primary productivity in these oligotrophic environments, we describe here for the first time, significant N_2 fixation rates from the aphotic, oxidized waters of the LB and GA. Aphotic depths yielded N_2 fixation rates ranging from 0.02 to 0.38 nmol N L^{-1} d^{-1} at all locations. Rates obtained at the GA during the mixed period averaged 0.10 ± 0.10 nmol N L^{-1} d^{-1} and 0.30 ± 0.10 nmol N L^{-1} d^{-1} during stratification. In the LB station, aphotic N_2 fixation was uniformly low during the mixed period; 0.01 ± 0.01 nmol N L^{-1} d^{-1} and increased during the stratified period; 0.12 ± 0.09 nmol N L^{-1} d^{-1}.

Integrated water column N_2 fixation from the surface to the deepest depth sampled (720 m) revealed that aphotic N_2 fixation accounted for ~ 50 % of the total N_2 fixation in the LB stations and 37 to 75 % in the GA station. The substantial role of aphotic N_2 fixation in the LB and the GA is especially important given the low rates of euphotic N_2 fixation (below detection to 0.1 nmol N L^{-1} d^{-1} in the LB and 0.35- 0.60 nmol N L^{-1} d^{-1} in the GA during summer) of both these nutrient-poor environments [3-5]. Furthermore, N_2 fixation rates obtained in both the euphotic and aphotic depths were positively correlated with bacterial productivity (BP) (R^2 = 0.70, p = 0.001, n = 12 and R^2 = 0.58, p = 0.003, n = 10 respectively), while no correlation was apparent between N_2 fixation rates and primary productivity (PP).

Previous molecular characterization of diazotrophs actively expressing *nifH* genes from the euphotic zone of the LB and GA demonstrated a diverse array of heterotrophic bacteria and cyanobacterial phylotypes [2]. Our phylogenetic analyses of *nifH* from the aphotic depths in the LB substantiate our data revealing that diazotrophic phylotypes were predominantly comprised of heterotrophic bacteria, including α and γ proteobacteria.

Our results provide new evidence that heterotrophic bacterial N_2 fixation is a considerable source of new N in the aphotic zones of both LB and GA. Yet these regions have not been previously considered a significant source of N_2 fixation as they are dark, oxygenated (~ 200 µmol L^{-1}), and NO_3 – rich (up to 6.24 µM). Why should heterotrophs fix N_2 in inhibitive NO_3 -rich environments, how could they overcome the high oxygen concentrations detrimental to nitrogenase activity, and what energy sources enable this costly process in the absence of sunlight?

Accordingly, we propose that N_2 fixation within the aphotic oxygenated environments is promoted and enhanced by microenvironments rich with organic carbon (C). Thus, we describe a plausible scenario of microenvironments based on planktonic "hot spots" that include microgelatinous transparent exopolymer particles (TEP), heavily colonized by bacteria, and defined as protobiofilms. In aphotic (energy poor) zones of oligotrophic systems these protobiofilm shuttles contribute significantly to the organic carbon pool; the high C: N ratios of TEP [6] can enhance C availability (as DOC, POC) for heterotrophic metabolism, while the relatively low N concentrations in TEP may promote heterotrophic N_2 fixation. Moreover, bacterial colonization on such particles causes high metabolic consumption of oxygen typically resulting in decreasing oxygen gradients from the surface to the anaerobic centre of the aggregates [7]. Thus, we suggest these anaerobic, high C, low N environments will promote the presence and significant activity of heterotrophic diazotrophs at depth.

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SPRINGTIME CONTRIBUTION OF DINITROGEN FIXATION TO PRIMARY PRODUCTION ACROSS THE MEDITERRANEAN SEA

E. Rahav [1]*, B. Herut [1], A. Levi [2], M. R Mulholland [3] and I. Berman-Frank [2]
[1] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa 31080, Israel. - eyalrahav@gmail.com
[2] Mina and Everard Goodman Faculty of Life Sciences, Bar-Ilan University, Ramat Gan 52900, Israel.
[3] Department of Ocean, Earth and Atmospheric Sciences, Old Dominion University, 4600 Elkhorn Avenue, Norfolk, Virginia 23 529-0276, USA.

Abstract
Dinitrogen fixation rates were measured during early spring across the Mediterranean Sea surface waters. N_2 fixation rates, measured using $^{15}N_2$ enriched seawater, were lowest in the eastern basin and increased westward with a maximum at the Strait of Gibraltar (0.10 - 2.35 nmol N L^{-1} d^{-1}, respectively). These rates were 3-7 fold higher than N_2 fixation rates measured previously in the Mediterranean Sea during summertime. Higher contribution of N_2 fixation to primary production (4- 8 %) was measured in the western basin compared to the eastern basin (~2%). Our data indicates that these differences between basins may be attributed to changes in N_2-fixing planktonic communities; while heterotrophic diazotrophy may play a significant role in the Eastern Mediterranean; autotrophic diazotrophy has a more dominant role in the Western basin.

Keywords: Bacteria, Pelagic, Primary production, North-Eastern Mediterranean, North-Western Mediterranean

Reported rates of N_2 fixation from the Mediterranean Sea (MS) are limited to a few studies from the last six years and most are restricted to surface waters and the summer season. Typical rates of N_2 fixation during summer from both the eastern and western basins of the MS are generally low, ranging from undetectable to ~ 0.15 nmol N L^{-1} d^{-1} (reviewed in Berman-Frank and Rahav, 2012 [1]), however, N_2 fixation rates at the central zone of the Ligurian Sea station in the NW Mediterranean (i.e. DYFAMED) are higher ranging from 2-17 nmol N L^{-1} d^{-1} [2].

Here we present first direct measurements of N_2 fixation rates in surface-waters across the MS during springtime (Figure 1). N_2 fixation rates obtained across the MS exhibited a strong zonal gradient from the eastern to western basins. The lowest N_2 fixation rates were measured in the eastern basin, ranging from 0.10± 0.02 nmol N L^{-1} d^{-1} in the Ionian Sea, to 0.15± 0.01 nmol N L^{-1} d^{-1} at station affected by the Rhodes Gyre. N_2 fixation rates increased gradually toward the west ranging from 0.22 ± 0.03 in the Tyhrranean Sea to 2.35± 1.12 nmol N L^{-1} d^{-1} at the westernmost station at the Strait of Gibraltar. The springtime rates of N_2 fixation at all stations were 3-7 fold higher than measurements published previously during summertime.

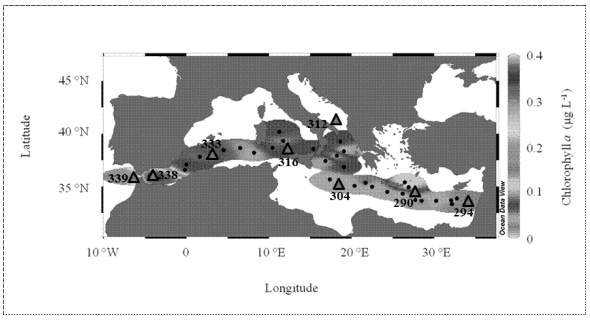

Fig. 1. Map of the sampling locations (triangles): NW Levantine basin (St. 290), anticyclonic Shikmona eddy (St. 294), Ionian Sea (St. 304), Adriatic Sea (St. 312), Tyrannian Sea (St. 316), Alboran Sea (St. 333), Strait of Gibraltar (St. 338) and Gulf of Cadiz (St. 339). Background (circle): Spatial distribution of chlorophyll *a* concentrations in surface waters (6-8 m) along the Meteor M84/3 cruise track (n= 94).

The eastern MS stations sampled exhibited low nutrient and chlorophyll concentrations and N_2 fixation did not correlate with primary production (R^2= 0.18, n=9, t-test, P> 0.05). This suggests that N_2 fixation is attributed mainly to heterotrophic bacteria or that diazotrophs and non diazotrophic phytoplankton is limited or co-limited by different nutrients. On contrary, higher NO_2+NO_3 and chlorophyll concentrations were measured in the more productive western MS. Concurrently, N_2 fixation rates were also higher (ANOVA, P < 0.05) and correlated with primary production (R^2= 0.82, n=12, t-test, P< 0.05), suggesting photoautotrophic associated N_2 fixation.

To further test estimate the relative contribution of autotrophic versus heterotrophic diazotrophy we measured N_2 fixation rates obtained under ambient light and complete dark (48 h). In the western basin, light:dark estimates of N_2 fixation were always > 1, suggesting the predominance of autotrophic N_2 fixation. In the eastern basin light:dark N_2 fixation rates were < 1 suggesting a preponderance of heterotrophic diazotrophs (Figure 2).

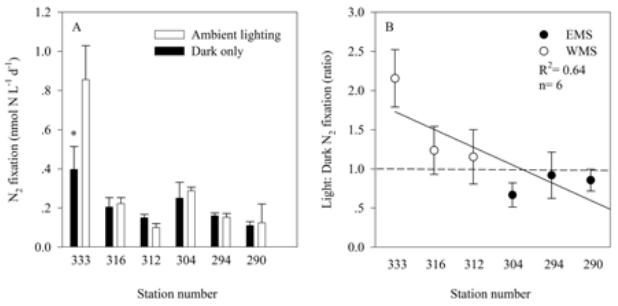

Fig. 2. A) N_2 fixation rates of surface-waters from stations across the Mediterranean Sea for bottles incubated under ambient lighting (white bars) and in complete darkness (dark bars). The asterisk above the columns represents statistically significant differences (one-way ANOVA, P< 0.05) for mean values of N_2 fixation rates in each station, and B) the resulting ratio between rates of N_2 fixation from ambient lighting and dark incubations. n= 3 for each incubation type at each station.

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PLANKTONIC DYNAMIC IN TWO DIFFERENT COUPLED MARINE COASTAL ECOSYSTEMS IN NW MEDITERRANEAN SEA

B. Serranito [1]*, D. Jamet [1], L. Stemmann [2], B. Rossetto [1] and J. Jamet [1]
[1] Université du Sud Toulon-Var, Laboratoire PROTEE EA 3819, Equipe Ecologie et Biologie des Milieux Aquatiques (EBMA). BP 20132, 83957 LA GARDE cedex, France - b.serranito@hotmail.fr
[2] Université Pierre et Marie Curie-Paris6, UMR 7093, Laboratoire d'Océanographie de Villefranche, 06230 Villefranche sur Mer, France.

Abstract
This study, investigating monthly planktonic abundance from 1995 to 2012 in Toulon bays, allowed identifying drivers of plankton dynamics and trophic interactions in two shallows coastal bays characterized by a different pollution degree. On average, we detected three phytoplanktonic blooms in both bays per year, driven by abiotic factors like rainfalls and temperature. Data didn't suggest evident seasonal relationships between phytoplankton and zooplankton taxonomic groups.

Keywords: Plankton, Population Dynamics, Pollution, North-Western Mediterranean

The aims of this study was to understand the mechanisms driving phyto- and zooplankton productions and their shifts in communities in two neighboring coastal ecosystems differently affected by pollution. Plankton represents the first stage of the marine trophic web and because its rapid response induced by environment modifications, it is a good indicator of human impact and climate changes ([2]). In addition, plankton, especially phytoplankton, acts on carbon cycle and on sequestration of anthropogenic carbon dioxide ([1], [6]). Little Bay (S_1:43°06'N, 5°55'E) is a shallow and semi-enclosed bay harboring military port and an effective industrial activity. This bay is characterized by a low hydrodynamics and longtime resident water ([4]). This geographic situation conferred it to get urban runoffs particularly during rainfalls and to be concentrate in heavy metals (zinc, lead, copper and cadmium) ([3], [5]). Little Bay and its related results will match with a polluted notified ecosystem. Large Bay (S_2:43°05'N, 5°56'E) is a shallow ecosystem, largely opened to the Mediterranean Sea without a direct influence from the port. This particularity allows increasing the hydrodynamic and reducing its capability to concentrate pollution. Previous studies indicated that the Large Bay would be less polluted than Little Bay ([5]). Results and conclusions about the Large Bay will contribute to modelize a classical Mediterranean shallow coastal marine ecosystem. Planktonic abundance was estimated by monthly subsurface samplings in the two bays from 1995 and 2003 (respectively for zooplankton and phytoplankton). Zooplankton samples were performed using a 90-µm mesh net. Zooplankton samples were conserved in 5% formaldehyde. Aliquot of 20 L of water sampled was reducing in 50 ml by inverse filtration using a 1.2 µm mesh membrane to estimate microphytoplankton abundance; samples were preserved in Lugol solution. Cells recognizing and counts were performed under inverted microscopy. Temperature, Salinity and dissolved Oxygen were also measured by micro-processor oxymeter WTW OXI 196 at 3 meter depth at each site. Nutrient concentrations ($N\text{-}NO_3$ and $P\text{-}PO_4^{3-}$) were obtained from 2005 to 2007 using spectroscopy method. Currently, our preliminary investigations indicated a seasonal pattern for phytoplankton abundance. Indeed, between 2 and 3 phytoplankton blooms occurred each year in both bays. The first one occurred in early-spring and was driven by increasing of temperature and photoperiod. The second and third blooms were produced in mid-spring and early-autumn because of important rainfalls which increased nutrients concentrations. Correlations between nutrients and biotic factors suggested phosphate as a limiting factor for phytoplankton production, especially in Large Bay. Trophic correlations between phyto- and zooplankton abundance were not significant. However, some zooplankton peaks seemed to be correlated with the increasing of phytoplankton community. So, effect of phytoplankton size on zooplankton predation was studied.

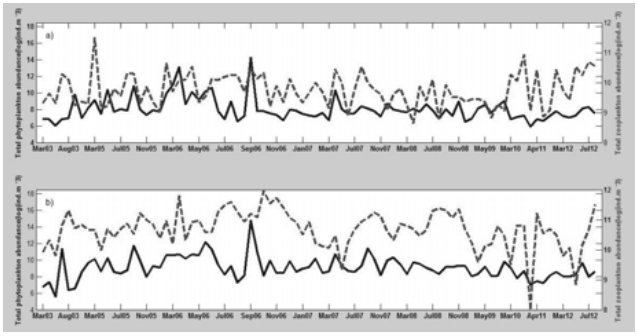

Fig. 1. Interannual evolution of phytoplankton (solid line) and zooplankton (dotted line) in Large Bay and Little Bay of Toulon (NW Mediterranean Sea) (respectively a and b).

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Session

Phytoplankton

Modérateur : **Asma Sakka Hlaili**

PHYTOPLANKTON COMMUNITY IN BOKA KOTORSKA BAY (SOUTH-EASTERN ADRIATIC SEA)

Dragana Drakulovic [1]*, Sladjana Krivokapic [2], Milica Mandic [1] and Aleksandra Redžic [1]
[1] Institute of Marine Biology - ddragana@t-com.me
[2] Department of Biology, Faculty of Natural Science and Mathematics, University of Montenegro

Abstract
Microplankton composition was analysed in the inner and middle part of Boka Kotorska Bay, during July 2009. The impact of human activity on this area has been greater and faster as a consequence of increased settlement in coastal area. Value of microplankton reached up to 10^6cell L^{-1} and species indicators of nutrient-enriched waters were noticed.The microplankton communities consisted mainly of diatoms throughout period of investigation.

Keywords: Phytoplankton, South Adriatic Sea

Introduction Boka Kotorska Bay is a unique coastal ecosystem in the south-eastern Adriatic Sea. In this area, anthropogenic influences has become evident, for assessment of any negative impact of human activities, it is essential to determine phytoplankton assemblages in marine areas [1]. The results presented in this study describe summer aspect of phytoplankton community structure in the Boka Kotorska Bay.

Materials and methods Sampling was carried out in July 2009 twice per month, at 5 stations in the inner part (Kotor Bay) and middle part (Tivat Bay) of Boka Kotorska Bay (Fig.1). Samples were taken using 5l Niskin bottles at three depths at three positions and at five depths at two positions (Fig.1). Nutrients (nitrates, nitrites and phosphates) concentrations were determined using standard methods [2]. After sampling, phytoplankton was preserved in 250 ml bottles using a 2% neutralized formaldehyde solution. Cells were identified and enumerated using Leica inverted microscope in subsamples of 25 ml after 24 h of sedimentation, following Utermöhl [3].

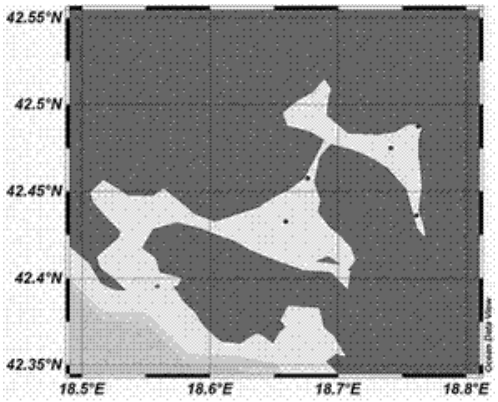

Fig. 1. Investigated area

Results Nutrients (phosphates, nitrates and silicates) ranged from low values to the maximum values of 0.581, 9.915 and 14.014 µmol L^{-1}, respectively. In July 2009, the highest value of microplankton was found in the inner part of the Bay - Kotor Bay (2.84 x 10^6cells L^{-1}). Second smaller peak of microplankton (1.35 x 10^6cells L^{-1}) was also noticed in the inner part of the Bay. In the middle part of the Bay -Tivat Bay microplankton abundances were lower on the order of 10^5 cells L^{-1}. Higher values of microplankton in the Kotor Bay are caused by lower water dynamics and higher nutrients inflow.

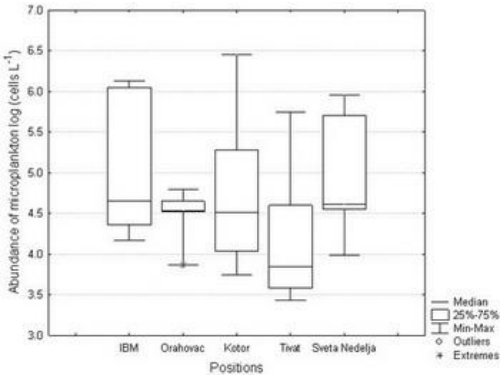

Fig. 2. Abundance of microplankton (cells L^{-1})

Dominant phytoplankton group during July 2009 was diatoms (with maximum of 2.83 x 10^6 cells L^{-1}), as was already noticed [4]. Presence of dinoflagellates were lower with highest values up to 10^4 cells L^{-1}. Frequently present diatom species were: *Chaetoceros affinis, Navicula* spp., *Pseudo-nitzschia* spp. and *Thalassionema nitzschioides*. The majority of the dominant diatoms recorded in this study prefer nutrient - enriched conditions, indicating increased inflow of nutrients. Often occurred dinoflagellates were: *Dinophysis fortii*, *Gonyaulax* spp., *Gymnodinium* spp. and *Prorocentrum micans*. Stronger input of nutrients in summer period of stratification can be explained with increased tourism and problem that works on wastewater treatment plants have not been completed yet. Some noticed species were toxic indicating that in future studies emphasis needs to be on that. **Conclusion** The high frequency of the eutrophic species, especially *Thalassionema nitzschioides* and peaks of phytoplankton abundance on the order of 10^6 cells L^{-1} in summer, both suggest increased anthropogenic influences in Boka Kotorska Bay. The presence of the potentially toxic and toxic phytoplankton species such as *Pseudo-nitzschia* spp., *Dinophysis* species and *Prorocentrum micans* indicate the importance of monitoring and research in the case of possible occuring of toxic algal blooms in this area.

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NEAR REAL-TIME *IN SITU* MONITORING OF PHYTOPLANKTON BY REMOTE FLOW CYTOMETRY: EVIDENCE OF SPORADIC EVENTS ON THE COMMUNITY STRUCTURE AND DYNAMICS

G. Gregori [1]*, M. Thyssen [1], M. Denis [1], J. Grisoni [2], L. Mousseau [3] and M. Pedrotti [3]
[1] Medit. Instit. Oceanography MIO - gerald.gregori@univ-amu.fr
[2] Observatoire Océanologique de Villefranche
[3] Laboratoire Océanographique de Villefranche

Abstract
Relevant phytoplankton data sets are needed to understand its role in biogeochemical fluxes but also the influence of environmental changes on the community composition and succession schemes. In this study, in situ high frequency automated flow cytometry and remote sensing were combined to characterize the phytoplankton community structure and dynamics. The presented results concern the fast shift in phytoplankton structure (includind Habs) induced by (i) an early spring bloom in the North western Mediterranean Sea and (ii) the occurrence of sporadic event in one of the biggest Mediterranean brackish lagoon.

Keywords: Phytoplankton, North-Western Mediterranean, Monitoring

The Mediterranean ecosystem has been forecasted as one of the most sensitive areas as far as the forthcoming climate change is concerned. It is also one of the hotspots for the planet's biodiversity. In addition, water management in the Mediterranean region is a strategic issue as highlighted in numerous publications (CIESM Monographs). Increase in temperature is also an important issue as it will lead to dry and windy periods (see references in Durrieu de Madron et al 2011). Stratification will be balanced by important water mixing, with amplitudes that should be higher than the ones currently observed. In addition, atmospheric pollution (induced by human activities) and natural dust deposits will affect surface marine ecosystems. The first may damage cells; the second may add valuable nutrients for phytoplankton growth. Phytoplankton is the very first level of the food web and thus fuels the entire ecosystem. As all of the perturbation mentioned above will happen on short time scales (few days maximum, sometimes only few hours), they will escape the traditional long term times series with usual weekly or monthly sampling strategies. Furthermore, each of these events will have specific influences on the phytoplankton structure and functionality. The dominance of one of these events may completely modify the behavior of the phytoplankton community, and thus affect (i) the usual succession scheme, (ii) the trophic structure, and (iii) the biogeochemical processes of a studied area. Although phytoplankton resilience to environmental changes was shown to be strong as observed in very nutritive areas such as the North Sea, the situation in oligotrophic areas (such as in the Mediterranean Sea) is not obvious, since phytoplankton communities are driven by nutrient pulses and light . Phytoplankton found in oligotrophic areas is known to quickly react to short events, some picophytoplankton groups evidencing a two order of magnitude increase in abundances within few hours following a strong wind event (Thyssen et al 2008b). Autotrophic picoplankton has been shown to be of importance at the onset of the spring bloom, and it is hypothesized that any change could induce an influence on the settlement of the usual succession pattern of the spring bloom, and by consequence on the herbivorous food web and higher trophic layers. These various changes in the community structure are strongly influenced by hydrology, nutrient content, irradiance, chemical contents, and turbulence conditions. The understanding of the role of all of these variables can only be studied by building a sampling system able to take into account the various frequencies of the observed features. This is why the MIO is working with a high frequency automated in situ flow cytometer. This instrument, coupled to other *in situ* sensors, is the heart of an automated platform capable to analyse several times per hour the abundance and diversity of phytoplankton groups associated with the environmental variables. This new automated platform has been tested on the EOL Buoy offshore Villefranche-sur-mer and in the Berre Lagoon, both in the North Western Mediterranean Sea, and has massively increased the number, quality and availability of the observations.

Fig. 1. Picture of the EOL Buoy (a) and of the cytometer installed on it (b)

The results clearly evidence the influence of sporadic events (wind) on the fast reaction of ultraphytoplankton and bring new insights on the *in situ* functioning of this compartment. Analyses performed at the single cell level up to twice an hour show rapid shifts, not only in abundances but also in the cell cycles of the various groups observed. Interestingly, all the groups do not behave the same way : some phytoplankton groups (the smallest) tend to benefit from these shifts in environmental conditions, while some others (particularly the biggest) do not. The high-throughput and high quality of the data recorded during this project could feed directly into marine observation and data network. The aim of such a network is to help industry, public authorities and researchers to find and use the data in a more effective way to develop new products and services.

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PICOPLANKTON COMMUNITY STRUCTURE RELATED TO ENVIRONMENTAL FACTORS FROM A SPRING CRUISE IN THE GULF OF GABÈS (TUNISIA, EASTERN MEDITERRANEAN SEA)

W. Medhioub [1]*, A. Belaaj-Zouari [1], A. Hamza [1], C. Brunet [2] and M. Belhassen [1]
[1] National Institute of Marine Sciences and Technologies - medhwalid@yahoo.fr
[2] Stazione Zoologica Anton Dohrn di Napoli

Abstract

The spatial distribution of pigments was recorded throughout the Gulf of Gabes (South Ionian Sea) in April 2011, and was related to patterns of the physical structure and the nutrient concentrations. Three distinct water masses were identified based on the temperature and salinity (T–S) analysis. There was no significant difference in the mean nitrogen and phosphate, concentrations between the different water masses. High Chlorophyll a was recorded in typical surface MAW station. Four taxonomic groups were detected throughout the three water masses. The cyanophytes and diatoms groups were dominant in the MAW and MMW especially in surface stations. However, the prymnesiophytes and chlorophytes were poorly represented at the MAW stations.

Keywords: Gulf of Gabes, Pigments, Vertical profile

Introduction

The Gulf of Gabès (south-east coast of Tunisia) is an important nursery for several species of fish. It is one of the key places for fishing activity in Tunisia and is a highly productive zone, one of the highest in the eastern Mediterranean. Quantifying the picoplankton community composition in this area is essential to understanding the structure and the dynamics of marine ecosystems. It is also important to evaluate the role of the physical and chemical processes on the biological responses of the ecosystem. The present paper investigates the picotoplankton community distribution in mid-spring with a high spatial resolution (21 stations and 3-5 depths in a 0-200 m layer) coupled to various environmental factors.

Samples collection and pigments analysis Sampling was performed during a cruise on board the R/V Hannibal from 20th to 26th April 2011 in the Gulf of Gabès. In each station, measurements of temperature, salinity and water density were collected. Sub-samples (2 L) for the pigments analysis were successively filtered through GF/D and GF/F Whatman filters. Pigments measurements were conducted following the method of [3].

Results and discussion

Three major water groups were identified . The first group, included coastal stations situated to the west of 11°E longitude and was characterized by range temperature (between 15.5°C and 17.7°C) and salinity (between 37.7 and 37.9 PSU) referred as the Mediterranean Mixed Waters (MMW) [1]. The second group, represented the stations situated between 11.3°E and 12.9°E longitude with range temperature (between 14.7 and 17.7°C) and salinity (between 37.2 and 37.5 PSU) identified as the Modified Atlantic Water (MAW) [1] . The third group, included offshore stations situated between 12.5° and 12.9°E and was characterized by low temperature (between 14 and 14.7°C) and salinity (between 37.4 and 38.8 PSU) referred as Ionion Waters (IW) [2]. Nitrate and phosphate concentration showed some local maxima in the MAW and MMW, especially in surface stations.

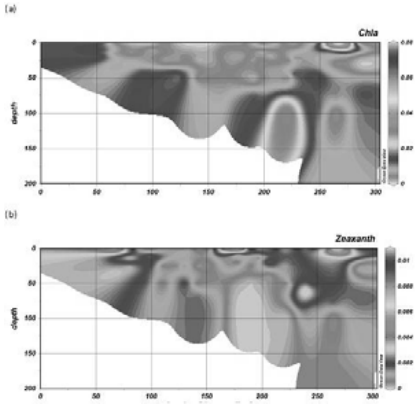

Fig. 1. Vertical profiles of (a) Chlorophyll a (µg l^{-1}), (b) Zeaxanthin (µg l^{-1})

Almost all the pigments were detected in the GF/F filters. No significant signals were reported in the GF/D filters. Chlorophyll a concentrations from picoplankton (GF/F) were generally low than 0.02 µg l^{-1} and did not exhibit a clear spatial pattern except for the presence of subsurface maxima in the typical MAW station with a maximum of 0.08 µg l^{-1} (Fig.1a) . The contribution of each taxonomic group in the picoplanktonic community was characterized by the omnipresence of cyanophytes throughout the three water masses with higher dominance especially in the MAW and MMW surface station (Fig.1b). This result could be justified by the ability of this group to develop adaptation processes related to environmantal factors. The MAW station was essentially dominated by the diatoms group which contributed up to 59% of total chlorophyll a. Chlorophytes and prymnesiophytes were poorly represented throughout the MAW station. The most relevant result of this study showed the dominance of picoplankton classes during the spring period which was in agreement with results already documented in this area [1].

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RE-EVALUATING THE RELATIONSHIP BETWEEN SIZE STRUCTURE AND METABOLISM OF THE PHYTOPLANKTON COMMUNITIES IN THE ALBORAN SEA

J. M. Mercado [1]*, D. Cortés [1], T. Ramírez [1], E. Liger [2], I. Sala [1], S. Sallés [1], L. Yebra [1] and B. Bautista [3]
[1] Instituto Español de Oceanografía Centro oceanográfico de Málaga - jesus.mercado@ma.ieo.es
[2] Departamento de Física Aplicada II. Universidad de Málaga, Málaga, Spain
[3] Departamento de Ecología. Universidad de Málaga. Málaga, Spain

Abstract
Shifts in the taxonomical composition of the microplankton size fraction along the coast-offshore gradient modulated the usage of light and nutrients by phytoplankton communities of the Alboran sea. These changes could not be predicted from differences in community size structure.

Keywords: Phytoplankton, Alboran Sea, Diatoms, Primary production, Nutrients

Introduction. The size constraints are often used to explain the macro-ecological distribution patterns of the phytoplankton. Thus, predominance of communities dominated by large cells in upwelling or variable environment areas is related to their higher growth rates and carbon-specific photosynthesis in comparison with small phytoplankton [1]. In contrast, dominance of picoplankton in open ocean is normally attributed to its relatively higher affinity for nutrients. These hypotheses have been tested in the Alboran Sea by comparing biomass size distribution and metabolic features of phytoplankton communities isolated in the northern coastal upwelling and the western Alboran anticyclonic gyre.

Materials and Methods. The sampling was carried out in the northwest Alboran Sea between 9-14 May 2008. Ten stations distributed into two transects following a gradient perpendicular to the coast line were sampled. Abundances of *Prochlorococcus*, *Synechococcus*, eukaryotic picoplankton and nanoplankton were determined by flow cytometry. Abundance of dinoflagellates and diatoms were determined by the Utermöhl's technique. For each group, cell bio-volume was calculated by using the most appropriate formulas according their geometric shape. Light absorption properties of the phytoplankton community were estimated from filters according to [2]. Uptake rates of inorganic carbon, nitrate and ammonium were estimated from incubations onboard in medium enriched with sodium bicarbonate-^{13}C, potassium nitrate-N^{15} and ammonium-N^{15} sulphate.

Results and Discussion. Diatom contributed by 60-80% to the phytoplankton biomass in the coastal stations while dinoflagellates dominated in the anticyclonic gyre stations (63-25%). Pico-plankton biomass was lower than 7% in the coastal stations and increased up to 15-20% in the anticyclonic gyre stations. Among the diatoms, *Chaetoceros* cells with equivalent spherical diameter (ESD) lower than 50 µm were the main size-class contributing to the community biomass (Fig. 1). The ratio of chlorophyll *a* to POC (Chl/POC in Fig. 2) was significantly higher in the coastal stations than in the anticyclonic gyre indicating that <50 µm diatoms had higher chlorophyll *a* cell content. Theses changes run parallel to increase in the efficiency of light absorption (a* in Fig. 2). Furthermore, light absorption efficiency and ESD mean of the diatom community were positively correlated. The biomass specific rates of carbon (*V*DIC) and nitrate ($V NO_3$) uptake were about four-fold higher in the coastal stations that in the anticyclonic gyre. *V*DIC and $V NO_3$ were correlated with <50 µm diatoms biomass and ESD mean of the whole diatom community. $V NH_4^+$ in the coastal stations was from 5 to 20 times lower than the corresponding $V NO_3^-$. On the contrary, $V NH_4^+$ was higher than $V NO_3^-$ in the anticyclonic gyre stations. $V NH_4^+$ was correlated negatively with *V*DIC as well as abundance of diatoms, pico-eukaryotes and nano-eukaryotes. The reported data indicate that acclimation strategies dependent on the taxonomical composition of the diatom community modulated the light usage and nutrients of the whole community. Several authors have demonstrated that the slope of the size-scaling function of the phytoplankton metabolic rate is far from the expected one (the so called 3/4 rule) [3]. These authors attributed the deviation between the metabolism rates predicted from their cell size and those measured to the acquisition of taxa-specific physiological strategies by species in certain size class. Our data support this hypothesis and emphasize the necessity of considering the acclimation capacity of the communities to predict their role in the carbon budgets.

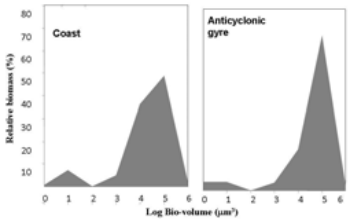

Fig. 1. Examples of biomass size-class distribution of the phytoplankton communities collected in coastal and anticyclonic gyre stations.

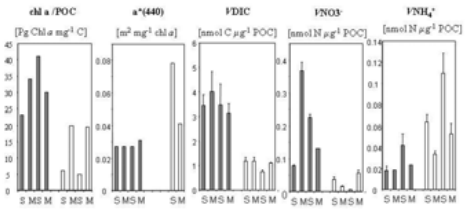

Fig. 2. Physiological performances of the phytoplankton communities sampled in the coastal (dark columns) and anticyclonic gyre stations (white columns). S, surface samples; M, sub-surface chlorophyll a fluorescence maximum samples. Chl/POC: ratio of chlorophyll a to particulate organic carbon concentration; a*(440), 440 nm light absorption efficiency; *V*DIC, $V NO_3^-$ and $V NH_4^+$ biomass specific uptake rate of inorganic carbon, nitrate and ammonium, respectively.

Acknowledgements This research was supported from the projects CTM2006-00426/MAR and CTM2009-07776 financed by Innovation and Science Department of the Spanish Government. The present work is a contribution to the EU 7th Framework project "Policy-oriented marine environmental research for the Southern European Seas (PERSEUS, pro. nº287600)

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ETUDE QUALITATIVE ET QUANTITATIVE DES PEUPLEMENTS PHYTOPLANCTONIQUES DE LA BAIE DE BOU-ISMAIL

Dina Lila Soualili-Mezali [1]* and Mustapha Boudjenah [1]
[1] Université Abdelhamid Iben Badis, Faculté des Sciences de la Nature et de la Vie - soualilid@yahoo.fr

Abstract
Cette étude est une contribution à l'évaluation quantitative et qualitative du phytoplancton récolté au niveau de deux sites « les Trois Suisses » et « le Vivier ». A cet effet, l'analyse des paramètres physicochimiques n'a montré aucune différence significative entre les deux sites (test U de Mann - Whitney). Par ailleurs, deux blooms ont été identifiés en (Mai) et en (juillet-Aout), caractérisés par la dominance des diatomées. La comparaison des diagrammes rang-fréquence, a permis de mettre en évidence des communautés pionnières qui apparaissent à chaque fois au stade 1, donc un début de succession caractérisée par des espèces engendrant.

Keywords: Blooms, Diatoms, Dinoflagellates, Toxic blooms, Algerian Sea

Les changements dans les structures de la communauté du phytoplancton, peuvent avoir des implications importantes pour l'ensemble de l'écosystème marin, à travers la chaîne alimentaire et les cycles biogéochimiques [1]. Le but principal de cette étude est d'explorer la diversité des peuplements phytoplanctoniques et de statuer sur les capacités productives des sites étudiés. Les échantillons mensuellement ont été prélevés en 2011. Les mesures des paramètres (pH, la salinité, l'oxygène dissous, la température) ont été effectuées à l'aide d'un Multiparamètre. Les échantillons du phytoplancton ont été fixés au Lugol, les dénombrements étant effectués en microscopie inversée d'après la méthode de [2]. Différentes métriques ont été calculées (diversité globale, richesse spécifique et indice de Shannon). Sur l'ensemble des variables étudiées (la salinité, la température, l'ammonium, les nitrites, les nitrates et le phosphore), peu de différences ont été décelées entre les deux stations. Par ailleurs, les teneurs en éléments nutritifs analysés restent toujours inférieures à 0,2mg/l. Un total de 306 espèces a été identifié dans les deux sites, représenté par 69% de diatomées et de 31% de dinoflagellés. Par ailleurs, au mois de Mai, dans "le Vivier" se sont les diatomées, qui dominent avec 76%, alors que dans le site "les Trois Suisses", le pourcentage des diatomées est similaire à celui des dinoflagellés (Fig 1 et Tab 1). La comparaison des diagrammes rang-fréquence mensuels a mis en évidence des communautés pionnières au stade 1, donc on a présence d'espèces engendrant, représentées par des diatomées sauf en Mai dans "le Vivier".

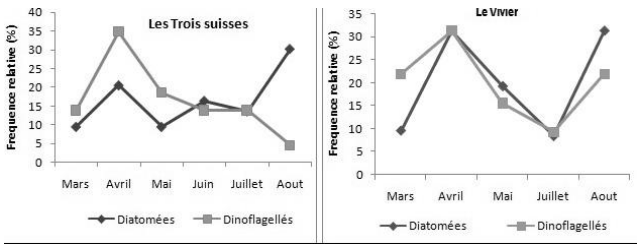

Fig. 1. Répartition mensuelle en pourcentage des diatomées et des dinoflagellés au niveau des deux sites.

Tab. 1. Genres de diatomées et de dinoflagellés dominants dans les deux sites.

Mois	Genres de diatomées dominants		Genres de dinoflagellés dominants	
	Les trois suisses	Le vivier	Les trois suisses	Le vivier
Mars	Chaetoceros	Chaetoceros	Ceratium	Peridinium
Mai	Coscinodiscus	Rhizosolenia	Ceratium	Ceratium Prorocentrum
Juillet	Navicula	Navicula	Ceratium	Prorocentrum
Aout	Nitzschia	Navicula	Amphidinium	Katodinium

Enfin, les assemblages phytoplanctoniques essentiellement constitués de diatomées montrent que ces sites sont en bonne santé et cela est confirmé par la rareté des espèces Chaetoceros curvisetus, Leptocylindricus danicus et Skeletonema costatum citées par [3] comme espèces indicatrices d'eutrophisation.

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SURFACE PHYTOPLANKTON COMMUNITY STRUCTURE WITHIN THE DEEP WATER CONVECTION CONTEXT IN THE NORTHERN MEDITERRANEAN SEA, AN AUTOMATED FLOW CYTOMETRY APPROACH.

M. Thyssen [1]*, G. Grégori [1], S. Alvain [1], F. Artigas [2], C. Bachet [1], V. Cornet [1], M. Denis [1], O. Grosso [1], A. Lefebvre [3] and D. Lefevre [1]

[1] CNRS - melilotus.thyssen@univ-amu.fr

[2] ULCO

[3] IFREMER

Abstract

Relevant phytoplankton data sets are needed to understand its role in biogeochemical fluxes but also the influence of environmental changes on the community composition and succession schemes. In this study, in situ high frequency automated flow cytometry and remote sensing were combined to extrapolate at the basin scale the phytoplankton community structure. The presented results concern the deep water convection zone in the north western Mediterranean Sea.

Keywords: North-Western Mediterranean, Mapping, Monitoring, Ocean colours, Phytoplankton

Phytoplankton plays a major role in oceanic biogeochemical processes (mainly carbon, nitrogen, silicate, phosphate, iron cycles) since it converts inorganic material into organic matter, the feeding source of the entire marine food chain. Some phytoplankton groups are distinguished by specific metabolic pathways, or indicate a specific trophic system, or evidence an adaptation to given environmental conditions, and as such, they are defined as plankton functional types (PFT, [1]). The most common traits found behind the concept of PFT are diazotrophy, calcifiers, silicifiers, mixotrophy, size classes, motility, DMS-producers. For a better understanding of the role of phytoplankton community structure and dynamics, there is a need for significant data sets that include sub-meso and hourly scale resolutions because the system is highly dynamic (daily cell cycles, prey-predator relationships and hydrodynamism at the meter scale). This can be achieved by combining *in situ* high frequency single cell analysis ([2], [3], [4]) and remote sensing novel PFT discrimination from water-leaving radiance (PHYSAT, [5], [6]). Combining both techniques helps in understanding the impact of highly hydrodynamical areas on phytoplankton community structure, phytoplankton succession schemes and finally, on the food chain structuration and the potential organic matter export. To study the influence of the deep water convection phenomenon in the Northern Mediterranean Sea, known to uplift nutrients into the euphotic layer and further trigger the onset of spring phytoplankton bloom, an automated high frequency (every hour) and remotely controlled flow cytometry (FCM) analysis of surface waters was conducted (Figure 1) during two DEWEX cruises in February and April 2013 in the frame of the MERMEX project. A previous example of successful coupling between remote sensing (PHYSAT) and automated FCM associated with a FerryBox equipment in the North Sea (INTERREG IVA "2seas" DYMAPHY project) leading to regional North Sea mapping of community structure will be presented as a support to the present investigation in the northwestern Mediterranean Sea. Preliminary results from the DEWEX cruises will be presented. They will be used to empirically calibrate the PHYSAT algorithm for the description of PFT from satellite normalized water-leaving radiance anomalies, in order to map the distribution of the main PFT at the basin scale.

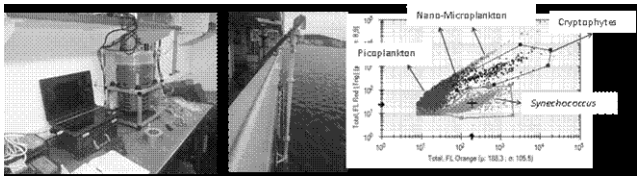

Fig. 1. A. Automated flow cytometry dedicated to the phytoplankton analysis. B. Continuous water collecting system onboard the N/O Le Suroit (IFREMER). C. A cytogram resuming the main phytoplankton groups analysed. Pictures of the microphytoplankton were collected in April 2013 and will be presented.

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COMITÉ 5

Ressources vivantes et écosystèmes marins

Co-Présidents : Ferdinando Boero et Cemal Turan

Rapports des modérateurs

Ageing techniques and growth

Kapiris Kostas, Greece

Résumé

Several studies were presented relating to the relative growth, biometry, relationships between total length-weight, age of some small pelagic, benthopelagic, and pelagic species. The relative growth of Engraulis encrasicolus is positive, according to many morphometric characters, isometric and negative, in other cases, depending on the sex, in the Gulf of Annaba (E. Algeria). The sexual dimorphism of Dentex maroccanus in different age groups was presented with regard to absolute growth in specimens caught in NE Algeria.

Other communications presented reproductive aspects of Engaulis encrasicolus and Sardina pilchardus from E. Algeria; the age and growth and the otolith?s length-total length relationships in both sexes of Sphyraena sphyraena along the Tunisian coasts and of Balistes capriscus in the Gulf of Gabes; the absolute and relative growth of both sexes of Thunus thynnus as estimated in 11,715 specimens caught by japanese long lines along Algerian coasts; the age and growth of both sexes of the decapod Metapenaeus affinis studied in individuals caught in the Bay of Izmir (Turkey) which is the first report coming from the whole Mediterranean basin.

Ageing techniques and reproduction

Fatima Zohra Bouhali, Algérie

Résumé

Cette session, la dernière du 40ème Congrès, a débuté par une courte introduction donnant une idée générale sur deux aspects (âge et la reproduction), avant de donner la parole aux six auteurs présents.

Les discussions et les questions furent peu nombreuses, à part quelques interventions concernant l'importance de la communication entre tous les pays de la Méditerranée via le réseau de recherche de la CIESM qui favorise chercheurs et étudiants.

Aquaculture - growth

N/A

Résumé

Modérateur absent

Aquaculture - Invertebrates

Serpil Serdar, Ege University, Faculty of Fisheries, Izmir, Turkey

Résumé

The session started with a general introduction by the moderator, who recalled the importance of invertebrates, their general phylum characteristics and the rationale for their aquaculture. The first communication focused on the growth of mussel (Mytilus galloprovincialis) in two tunisian sites, as affected by bacteriological load. Others presented the depuration time and ability of Manila clams (Ruditapes philippinarum) with respect to Escherichia coli, Salmonella typhimurium and Vibrio parahaemolyticus; larval recruitment and mortality of Crassostrea gigas spat in a Mediterranean lagoon. The last speaker sudied the growth and survival rate of carpet shell clam (Tapes decussatus) in high stocking density in Turkey. The concluding general debate concerned the main reasons of oyster spats? mortality, availability of bacteriological load and virus in aquaculture areas, clam culture and depuration techniques and systems.

Biodiversity hotspots

Mohamed Menioui, Maroc

Résumé

Les communications étaient très diverses, comprenant i/ Populations structure of the endemic species Paranemonia vouliagmenjensis, Attika, Greece par (V. Anagnostou); ii/ species richness and anthropogenic pressures in French coralligenous assemblages (F.Holon); iii/ First results of fish diversity associated with Posidinia oceanic meadows in the Aegean Sea (Kalogirou); iv/ Les actiniaires des rivages tunisiens, inventaire et distribution (S. Tekaya); v/ Biodiversity in the sea of Marmara and the affecting factors par A.Yuksek. Le débat a largement porté sur la zone 'Hotspot' présumée de la biodiversité au sud des côtes marocaines. La côte marocaine est baignée par des eaux à hydrologie particulière due aux upwellings et les espèces nouvelles qui y ont été observées se situent une zone de transition entre le courant froid des Canaries et le courant chaud NW africain.

Cartilaginous fish distribution

Mohamed Nejmeddine Bradai, Tunisie

Résumé

The session was introduced by the moderator by a brief presentation on the Status of elasmobranches in Mediterranean and Black Sea focusing on distribution, threats, by-catch and on the lack of knowledge on biology, ecology, systematic and critical habitats of this group.

The ten programmed communications were presented. The main topics highlighted have concerned the observation and monitoring of some species, by-catch, critical habitats and age determination. One of these communications reported the main outcomes of a three-year research programme of GFCM launched in 2010 to improve the knowledge and asses the status of elasmobranchs in the Mediterranean and Black Sea. The programme will be extended for the next three years.

Following the diagnostic of the situation of elasmobranchs in the Mediterranean and Black Sea, the participants recommended some priorities for Sharks of the region:

· Developing research programs on systematic, general biology, ecology and population dynamics for species of concern.

· Identifying and mapping critical habitats.

· Taking action to collect reliable statistics on landings and Bycatch of elasmobranchs and to develop research programs to reduce elasmobranchs bycatch.

Cartilaginous fish ecology

Sebastián Biton Porsmoguer, MOI, Marseille, France

Résumé

What is the sharks situation in the Mediterranean Sea? Eighty-five species of sharks and rays were identified in this area. Among them 40 percent are either endangered or threatened according to the IUCN. Mediterranean Sea is a very important reproduction area for sharks, especially for the great white shark (Carcharodon carcharias) and sandbar shark (Carcharhinus plumbeus) in Italian and Tunisian waters for example. In the last decades, in the Mediterranean Sea, sharks and rays strongly declined in both diversity and abundance. The intensive exploitation and growing market of fins, meat and cartilage are the main reasons to explain these tendencies.

During the two last centuries, the landed biomass of the four most important pelagic sharks, decreased by ninety-seven percent for the Blue shark and by ninety-nine percent for the Shortfin mako, Hammerhead and Thresher shark. The scientific community during the last ten years studied three relevant biological aspects of sharks: reproduction, growth, and diet. Forty-three species were studied for reproduction, only 12 species for age and growth, and 35 species for their diet. We can conclude that many species still need to be studied. Moreover, many other biological and ecological aspects need to be developed for these species. For example: Stock assessment, Migration, Genetic analyses, Parasites, Pathologies, Modelling, and Conservation. We all know the important role that sharks used to play in the structure and functioning of the marine ecosystems and we have to find solutions for conservation of their populations and to propose new projects to study all these species and aspects.

During the session cartilaginous fish ecology, the different presentations showed interesting results about biological and ecological aspects of many cartilaginous species. They concerned the diet of Dasyatis pastinaca, Rostroraja alba, Prionace glauca and Isurus oxyrinchus, and the reproduction and size of maturity of Galeus melastomus, Squalus megalops, Squalus blainvillei and Dipturus oxyrinchus. Finally, we could see different methods to determine the age and growth of Dipturus oxyrinchus and Squalus megalops. Different methods are used: identification of prey in the stomach for the diet and study of vertebrae for determinate the age for example. Most of the cartilaginous species studied were benthic and not targeted. They were captured by commercial fisheries and especially by trawler vessels. The conservation of this species is a very important objective.

Connectivity

Anne Chenuil, France

Résumé

Scientific knowledge of marine connectivity is an important matter, both from a fundamental point of view (connectivity begin a primordial parameter affecting adaptation, speciation, thus ecology and evolution in general) and for for biodiversity management and conservation purposes ((i) extinction risk is increased by excessive fragmentation, (ii) the design of marine protected areas (MPAs) and MPA networks gains a lot from taking into account connectivity patterns) (e.g. posters 4201-4211). Connectivity among marine populations of a given species can be considered as made up of three components: habitat connectivity, species ability to actively disperse, and water mass connectivity (which can enhance or oppose other components). We can also distinguish three approaches to characterize connectivity: (1) habitat mapping, (2) approaches focusing on species (direct approaches studying behavior or life cycles, or population genetics approaches, which patterns result from the three components) and (3) physical oceanography characterizing and modeling the movements of water masses using, with a strong dominance of Lagrangian models, by far the most adequate tools. Recent research programs often include work packages dedicated to habitat mapping. One poster (4213) dealt exclusively with habitat connectivity (coralligenous). Marine caves are examples of highly fragmented habitats (e.g. poster 4204) and water column habitats represent the most connected category of habitats.

The majority of posters (six or seven) presented population genetic data, and two posters dealt with physical oceanography (4201-4209). Combined approaches are rare both in the literature and in this session (one poster compared physical and genetic connectivity matrices (4212). This reflects a general difficulty which may be due to knowledge gaps concerning the biology of the studied species: (i) season of emission of planktonic offspring, (ii) behavior of the species, in particular vertical movements which represent the necessary behavior information for Lagrangian models (and sufficient to reach a satisfying realism), and (iii) physical characteristics such as buoyancy of the life stage submitted to water currents (and its evolution during development). Thus can we predict the future of connectivity studies? Already more than 800 papers report population genetic data from Mediterranean marine species. However, despite this number, understanding of common or particular processes and patterns of marine connectivity remains extremely partial. This is due to both the absence of studies combining different approaches, the limits of most genetic studies (low sampling size and unsuitable distribution of localities, use of a single genetic marker) and the absence of synergies among studies (shared sampling locations among study species are exceptional instead of being the rule (but see Poster 4202). Improvements will be obtained owing to the availability of universal genetic markers (Chenuil et al., 2010; Gérard et al, in press, Marine Genomics) (posters 4214-15), new sequencing and genotyping technology (NGS-NGG), comparative approaches among species with common sampling schemes, studies to obtain basic biological knowledge on behavior and life cycles, and finally on close collaboration between physicists and biologists (ex of the French research group, the GDR ?MARCO?).

Ecological trends

Vesna Macic, Inst. Marine Biology, Kotor, Montenegro

Résumé

In this context were presented findings for 'flag species' such as the seagrass Posidonia oceanica, for economically important species such as the fish Micromesistius poutassou and for invasive species such as the alga Caulerpa racemosa. Although this session was limited to a small group of four presentations, important issues like monitoring and acquisition of long time series of data were raised during the presentations and the general discussion.

Improved monitoring programs and greater availability of existing data in a number of countries were underlined as a necessity for appropriate evaluation of ecological trends.

Functional traits

Claudia Kruschel, Croatia

Résumé

The session went well. It started with an introduction to the subject of functional traits and functional diversity by the moderator, touching on research areas that are recently reevaluating the usefulness of functional trait information to answer open and fundamental questions in ecology and evolution, including community assembly (e.g. along environmental gradients), the relationship between biodiversity and ecosystem processes and function, and our ability to predict ecosystem service maintenance in the face of strong anthropogenic drivers and stressors.

All participants kept to the three minute agreement, and so there was ample time for a debate. The main subject of the debate period was the presentation given by Leonid Svetlichny on the migratory behavior of the copepod Calanus euxinus in the Black Sea. These organisms are spending nights in anoxic and colder depths, which seems to result in an eightfold decrease in metabolism. The debate circled around the possibility of an alternative explanation for the behavior. Suggestions included predator escape as the primary selection for the migratory behavior followed by selection for tolerance to anoxia favored by the gain of fitness via energy

conservation. Also discussed was the importance of seasonality in the sampling scheme and possible seasonal variation in the migratory behavior.

Overall the new format was really appreciated There is a lot to say in 3 minutes!

Gelatinous plankton distribution

Davor Lucic, University of Dubrovnik, Croatia

Résumé
Nine communications were presented in which the authors point to the following topics:

a) the role of oceanic transport and climatic/oceanographic conditions in redistributing existing jellyfish populations at regional and basin scale;

b) population dynamics and seasonal changes in gelatinous plankton diversity and distribution;

c) the influence of environmental factors on the distribution and abundance of gelatinous plankton.

Special interest and discussions were given to presentations that included modeling and simulation of dispersion and aggregation of species. It was underlined that for better knowledge of the distribution and abundance of gelatinous organisms a better understanding of their life cycles is needed. To this end, it is necessary to combine all available information, from reports of citizen science to the results of scientific research and modeling simulations.

Gelatinous plankton ecology

Tamara Shiganova, Shirshov Inst. of Oceanology, Acad. of Sciences, Moscow, Russia

Résumé
In recent years native gelatinous species considerably increased population size and distribution in the coastal areas of the Mediterranean Sea, some of them expanding into the Sea of Marmara and even in the Black Sea. In addition non-native gelatinous species are recorded more and more often, particularly in the eastern basin of the Mediterranean.

This session discussed recent findings.

The debate highlighted the interest of the various talks regarding the ecological aspects of the gelatinous species (mainly Mediterranean) studied. The appendicularian study in the Adriatic Sea , the presentation of gelatinous species blooms in Spanish waters, and the impacts, distribution patterns and adaptative strategy of Mnemiopsis leidyi attracted most of the discussion. In the latter case, the variability of morpho- physiological features, genetic diversity, patterns of spatial and temporal population dynamics in the Black, Azov, Caspian, Baltic, and several areas of the Mediterranean seas are seen as a response to different conditions of salinity, temperature, prey concentration. It was concluded that ecology study of increasing populations of gelatinous species are crucial for understanding changes in ecosystem functioning. Special attention should be paid to non-native species, in particular to the aggressive invader Mnemiopsis leidyi.

Good Environmental Status, assessment

Slim Gana, SAROST, Tunisie

Résumé
At the start of the session, the concept of "Good Environmental Status" and how to undertake assessment according the Marine Strategy Framework Directive (MSFD-2008/56/EC), was introduced. MFSD establishes a framework for marine environmental policy up to the 200 nm limit of the European EEZ, while the European Water Framework Directive (WFD) (Directive, 2000/60/EC) develops the concept of ecological status for assessing the quality of water bodies.

MSFD requires Member States to carry out an Initial Assessment, based on existing data, of their marine waters covering three key elements:

- An analysis of the essential features and characteristics and current environmental status of their waters;

- An analysis of the predominant pressures and impacts (including human activity) on their waters;

- An economic and social analysis of the use of their waters and the cost of degradation of the marine environment

The issue of GES assessment was not addressed by all the presentations. During the discussion, given the spatial extent of the MSFD, the need for innovative approaches and descriptors required to allow meaningful monitoring and assessment was mentioned. On the basis of an operational, management-oriented definition, we discussed the available methodologies that could be used for coastal and marine assessment, with an emphasis on integrated approaches (i.e. ecosystemic) accounting for physico-chemical and biological components, and combining both pelagic and benthic symptoms of degradation, thus keeping with the holistic nature of the MSFD.

Regarding the implementation of the MSFD in non-EU Mediterranean countries, the bottom-up approach was recommended by strengthening the awareness of young engineering groups working in national institutions dealing with environmental issues.

Good Environmental Status, indicators

Beatriz Guijarro, IEO, Palma, Spain

Résumé

The aim of the Marine Strategy Framework Directive (MSFD) is to protect the marine environment across Europe. This directive sets a target of Good Environmental Status (GES) which must be achieved in EU marine waters by 2020. According to the MSFD, the GES are defined as ?the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, objective and productive?. GES means that the different uses made of the marine resources are conducted at a sustainable level, ensuring their continuity for future generations. The Ecosystem Approach to Management is a central point in the MSFD, as it integrates the connections among different compartments of the ecosystem: from the structure and evolution of the water resources (physical and chemical conditions and hydrodynamics) to the maintenance of biodiversity and the effect of human activities, such as pollution and fishing exploitation.

The communications had in common the need of monitoring different compartments of the ecosystem while covering a wide range of topics, areas and species. Some presentations discussed foraminifera, barnacles, mussels or fish, as potential indicators of water pollution. Another showed a synthetic indicator of phytoplankton group composition to be used in the assessment of chlorophyll concentrations and two presentations focused on fishery exploitation and the analysis of trends for demersal species.

Good Environmental Status, tools & methods

Marc Bouchoucha, France

Résumé

The acronym G.E.S. refers to two different concepts. The first one stems from the Water Framework Directive and means ?Good Ecological Status?. The second one, more recent, is the ?Good Environmental Status of the Marine Strategy Framework Directive.

These two concepts are somewhat different. According to WFD, good ecological status is achieved if all the basic components of the ecosystems are in a good status whereas, according to the MSFD, good environmental status is achieved if all the functions of the ecosystems are fulfilled.

The session 21 presentations refer either to the good ecological status and are related to one of the five particular ecological indicator of the WFD or to the good environmental status and provide more ecosystem functioning data. In practice today, the two definitions are often confused in scientific literacy and the following functional definition is often found: ?good environmental status means the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations (?)

In any case the conceptual scheme to assess the status and its evolution toward GES is more or less the same. Data are collected directly or by the way of operational tools. They serve to feed models or indicators to provide information which is compared to reference conditions in order to assess environmental status. Data are also used to evaluate pressures that enter in some models or indicators conception.

For a number of those steps, especially within the MSFD framework and its 11 descriptors with large spatial application, need for additional scientific information or further development has been identified. Also, increasing scientific knowledge on the marine environment and its processes is required and, to tackle that objective, innovative tools are needed.

In session 21, the presentations were diverse in their coverage (a gap analysis tool, operational tools, models, satellite imagery analysis, video system, a models prediction assessment, a model of reference conditions, a tool to assess difference between reference conditions and evaluated status or a anthropogenic pressures modelling) but each of them enlightened a tool that fulfil one of the numerous scientific identified gaps within the MSFD framework.

Indo-Pacific aliens biology

Bella Galil, Israel

Résumé

Introduction of Indo-Pacific biota into the Mediterranean Sea interferes with multiple aspects related to marine life, including the conservation of biodiversity, structure and function of ecosystems, sustainable exploitation of natural resources, and it negatively impacts upon industries and poses threats to human health.

Recognition of the significant threats posed by NIS is evident in the European Community Marine Strategy Framework Directive (MSFD) and Biodiversity Strategy. Of the eleven descriptors that constitute the basis for the evaluation of ?Good Environmental Status? (GES) of marine ecosystems in the MSFD, NIS are second only to biodiversity. Of the 887 multicellular NIS reported in the European Seas, 677 from the Mediterranean Sea, over the period 1970-2012 their numbers grew by 204%! The Suez Canal, a pathway unique to the Mediterranean Sea, is responsible for an increased inflow of new thermophilic NIS into the warming sea.

Yet, the UNEP MAP "Draft Decision on the Ecosystems Approach including adopting defition of Good Environmental Status (GES) and targets" to be voted upon in the 18th Ordinary Meeting of the Contracting Parties to the Barcelona Convention and its protocol, on 3 December 2013, excludes species introduced through the Suez Canal from its NIS & IAS GES. Today we received ample scientific evidence as to the prevalence and impacts of Indo-Pacific NIS in the Mediterranean ? we can not ignore it, and we can not allow UNEP MAP to ignore it.

In conclusion: all presenters were present, with smooth delivery of results. The session was well attended, in fact, people were streaming in thru the session. Post presentation discussion engaged the audience and session ended with lively applause.

Indo-Pacific aliens impacts

Jamila Ben Souissi, Institut National Agronomique de Tunisie, Tunisie

Résumé

This session offered the opportunity to the many participants to exchange their views and experience as well as identifying several areas of common interests in the Mediterranean and Black Seas. The participants highlighted that both economic and ecological impacts of alien species are poorly documented and that several issues, such as drastic regulation of ballast waters, should be addressed as a matter of urgency. According to several case studies presented (mainly in Eastern basin), certain species heavily and negatively affect key environmental and economical sectors, such as fishing, aquaculture and tourism, in addition to human health.

The discussion emphasized that prevention is the best way to avoid newcomers. Various tools exist to prevent the introduction of NIS but unfortunately the laws are rarely enforced. According to some participants, it is too early to estimate the environmental impacts in the Mediterranean region because the ecosystem is not yet stable. Participants deplored the lack of data in Libyan waters (a key area for the settlement of lessepsian migrants), which prevents an efficient early warning system to alert neighbor countries.

Comparative studies in countries with long period records of NIS were recommended in order to highlight the changes in biodiversity (collapse of endangered endemic species in favour of invaders, etc?). The eradication of NIS, once established, becomes very difficult, and so attempts should be made to exploit them for value when possible (the example of Siganid fishes, toxic Tetraodontidae, gelatinous megaplankton, was given). Particular attention should be paid to anti-Lessepsian migration and to developing a database of bioinvaders' impacts.

Indo-Pacific aliens records

Tarek Temraz, Suez Canal University, Egypt

Résumé

The record of indo-pacific aliens into the Mediterranean session commenced with a brief introduction on the different routes of migration especially the aquatic corridors such as Suez Canal and the role of aquaculture through intentionally or accidently released organisms. The discussion focused on the need for accurate and precise taxonomy to allow proper identification of migrated species, especially macrophytes and fishes. Proper use of the following terms ?aliens/non indigenous/ exotic? as well as awareness of the new range of occurrence as the case of Oculina patagonica and whether it is endemic to the Mediterranean or migrated from the Atlantic. The role of Suez Canal as a main route of migration to be stopped or to be monitored via early monitoring stations about potential migrants, was hotly debated.

E. Azzurro emphasized the need to know the exact number of alien fish species in the Mediterranean Sea through reconstruction of

occurrence records collected from published literature into one database. The database includes so far 85 Lessepsian migrant species, 44 migrants from the Atlantic, plus others introduced by man for a total of 172 fish taxa. Furthermore, Azzurro presented a new interactive website (SEAWATCHERS) acquiring geo-referenced observation of exotic fish species along the Mediterranean. The website generated 74 records in 10 months including the questionable record of Abudefduf saxatilis.

M. Verlaque updated the CIESM website of exotic macrophytes in the Mediterranean to include 129 taxa. S. Katsanevakis presented the European Alien Species Information Network (EASIN) as an efficient tool to create distribution map for alien species into the Mediterranean depending on the introducing pathway of alien species.

B. Cicek illustrated the importance of conducting monitoring programs to reveal exotic species as he recorded Caulerpa taxifolia for the first time along the northern coast of Cyprus. D. Golani emphasized the role of temperature rise and the deepening of the Suez Canal in the invasion of Lessepsian Red Sea fish species into the Mediterranean where no less than 33 species migrated in less than one decade, creating faunal shift.

E. Serrano, stressed the role of temperature rise in estimating the spread of Oculina patagonica along the Iberian Peninsula. J. Zaouali, identified the role of floating cages as providing a substrate for exotic species along the Tunisia coast. T. Temraz recorded Plototus lineatus for the first time along the Egyptian coast of the Mediterranean.

Marine Mammals, Turtles and sea Birds

Adriana Vella, Malta

Résumé

This session was introduced by considering the reasons why marine mammals, turtles and seabirds are important indicator - and flagship - species in the Mediterranean. This fact together with the clear gaps of knowledge on the various species inhabiting the Mediterranean Sea promotes the relevance of research and monitoring of these species. Climate change and the various anthropogenic impacts on these species were also introduced, paving the way to the interesting presentations of six speakers that presented their scientific work and findings. The papers presented covered topics from monk seals, sea birds and cetaceans to species association studies and impacts of climate change on turtle nesting beaches. Fin whale stranding data were found to furnish useful life history knowledge that would be important in population dynamics considerations, while monk seal and seabird studies in selected sites brought in vital information on the presence of these species adding interesting insight on the distribution of these species. The work on species associations in Central Mediterranean also contributed useful knowledge to better appreciate the complex and changing dynamics of species distributions and different species associations. Long-term and year-round studies are essential in order to understand such dynamics.

Various questions were discussed, yieding a lively debate on the need to work further on how these diverse species distribute themselves according to their life history needs, seasonality, and climatic changes affecting marine life in the Mediterranean Sea. A discussion on whether fixed marine conservation areas or more widespread conservation management is required for these large distance ranging species in the Mediterranean was also briefly considered. The discussion was relevant to the effective and long-term conservation of these species in a region where various proposals have been brought forward but with limited success on effective long-term conservation research, monitoring and management of the various species. It was agreed that greater collaborative work among Mediterranean scientists is required and that CIESM is an ideal forum to sustain and develop further such collaborations.

MPAs conservation and management

Nataliya Milchakova, Inst. of Biology of the Southern Seas (IBSS), Sevastopol, Ukraine

Résumé

Fifteen communications were presented in this session by scientists from nine countries bordering the Mediterranean and Black Seas; most works have been conducted in the Mediterranean basin, with only two of them in the Black Sea. At present MPAs are supposed to cover 4.56% of the Mediterranean Sea area and 1,76% of the Black Sea (?Status of MPAs in the Mediterranean Sea?, 2012; Milchakova, 2011). But only 49% and 14% of them have a management plan, and many of them lack coherence and ecological representativity.

The results presented did reflect the different aspects of conservation planning and management, biodiversity and population structure, and the socio-economic impact of MPAs. Many presentations have demonstrated the role of MPAs in biodiversity conservation, including cetaceans, fish, mussels and macroalgae species. Proposals for new MPAs to be created by 2020 were presented, as well as data using the MARXAN techniques in conservation planning, and the impacts of OWF on marine biota.

One of the main conclusions is that, without national and international strategies, conservation planning and management, MPAs and their ecosystem cannot be saved, especially in the most vulnerable coastal areas.

Physiology
N/A

Résumé
Modérateur absent

Population dynamics
N/A

Résumé
Modérateur absent

Rarity and extinction
S. Planes, CNRS, France

Résumé
Absence de résumé

Rocky shores and artificial reefs
Pierre Cresson, Ifremer, La seyne sur Mer, France

Résumé
Presentations in this session revolved around three main questions:

First, what are the main ecological functions of rocky zones? The first answer can be it is one the major biodiversity hotspot in the Mediterranean. Five presentations were devoted to a better assessment of this biodiversity, investigating parameters such as community composition, dominant species or demography, and then trying to find environmental variables explaining these patterns. This zone is also crucial, as it is involved in reproduction or recruitment of numerous fish and invertebrates, as shown in two presentations.

Then, how anthropogenic threats affects rocky shore functioning? Amongst others, invasive species, like Caulerpa spp., overfishing or chemical pollution are threats of great concern, and the effect of such pressures on coastal ecosystems composition and functioning formed also an important part of this session.

Finally, the last question of this session concerned artificial reefs ? are they more than ?human-made reefs?? Artificial reefs are currently considered efficient tools to restore and to manage coastal zones. They can effectively play this role, but only if they show a similar functioning with natural rocky zones. Results ensuring this similarity were presented, for example by comparing community composition, trophic organization or kinetics of colonization.

It was a dense but interesting session, with 14 presentations given by researchers from numerous countries and with results gathered from various Mediterranean and Black Sea shores. This diversity reflects the importance of this topic in current Mediterranean research, and also the importance of these zones in the whole functioning of the Mediterranean Sea.

Soft bottoms
Charles F. Boudouresque, France

Résumé
A variety of soft bottom habitats were described from the Mediterranean and Black Sea, from beaches and shallow waters down to abyssal depths, with or without a canopy of seagrass or metazoan epibionts. In addition to these habitats, the Mediterranean harbors a unique type of habitat, the Posidonia oceanica meadow, whose characteristics are intermediate between soft and hard bottoms, via the building of a semi-hard bottom, the ?matte?. Soft bottoms occupy more than 99% of the Mediterranean surface area, even in coastal zones, such as the Port-Cros National Park (98.7%). For many policymakers and stakeholders, and even for some scientists,

muddy and sandy habitats (with the exception of P. oceanica meadows) are a sort of desert, with very low species diversity. They are therefore (in their opinion) the perfect place for dumping dredged sediments, sewage discharge, coastal development and land reclamations and restoration programs such as the setting up of artificial reefs. As a matter of fact, species diversity can be quite high in soft bottoms habitats (not only in P. oceanica meadows), as reported in several presentations. In addition, it is worth noting that species diversity is not only (if definitely not!) ?How many species?? but more correctly ?What species are present?? Many habitats with naturally poor species diversity are actually of higher heritage value than habitats whose high species richness results from human impact. The giant bivalve Pinna nobilis, both emblematic and vulnerable, was the subject of several presentations.

Soft bottoms are habitats under siege, as largely reported during the session: trawling (especially in P. oceanica meadow), anchoring, dumping, beach replenishment, sewage outfall, solid waste from sea surface boats and invasive species. The Australian Chlorobionta (?green alga?) Caulerpa cylindracea is invading many soft bottom habitats at a Mediterranean-wide scale, though local (short-lasting?) regression of the invasion may occur, as reported in Malta. Managers? attention is (logically) focused on P. oceanica meadows, though their regression (if any) may be slight in some areas (e.g. Corsica), while other impacts on soft bottom habitats occur under the general indifference of the authorities and of most scientists.

Species interactions

Chafika Rebzani, Université Houari Boumédiène, Alger, Algérie

Résumé

This was a dense session, comprising various, interesting, but quite diverse themes (17 speakers) about benthic communities and their interactions with the environment. These organisms (endemics, invasives species) are a good bioindicator of changes of the Mediterranean littoral environmental quality.

The session included interesting presentations on topics concerning the organism and their relationships and, in fine, the protection and preservation of the biodiversity through appropriate conservation strategies. However no discussion was possible given the time constraints (3mn by 17 speakers).

A diversity of topics was covered, ranging from community structure (6 presentations), mollusks (5), echinoderms (2), sponges (2), and corals (2).

Traceability - fish

N/A

Résumé

Modérateur absent

Traceability - Invertebrates

Evrim Kalkan, Turkey

Résumé

Broadly speaking, genetic traceability is based on the identification of both animals and animal products through the study of their DNA. In this concept, DNA profiling is simply used for identifying the similarities and differences between individuals, species and populations. Following the progress in molecular methods, DNA data are frequently used for the determination of source populations, the estimation of genetic differences between populations and the verification of the claimed population of origin from sea foods. Nowadays, genetic tracing techniques are very useful for the effective conservation management of natural species resources.

Under this session (Traceability- invertebrates), five studies related with the population genetic structure and genetic diversity of nine invertebrate species (Paracentrotus lividus, Arbacia lixula, Sphaerechinus granularis, Psammechinus microtuberculatus, Diadema setosum, Pinctata radiata, Octapus vulgaris, Eunicella cavolini and Pachygrapsus marmoratus) were represented. Considering all these studies, it was seen that the genetic structure and diversity of both indigenous and non- indigenous species in the Mediterranean Sea are not known in great detail. The findings presented suggest the need to acquire more information about the population structure, diversity and differentiation of the invertebrates to be able to better monitor the changes occurring in the Mediterranean ecosystem.

Unique ecosystems

Ricardo Aguilar, Spain

Résumé
Cold water coral reefs, long-lived black corals communities, sponge aggregations and other important habitat forming organisms are becoming more and more important on the understanding and knowledge of the deep-sea in the Mediterranean region. Many of these habitats can be found on geological features like submarine canyons, seamounts, knolls, mud volcanoes, caves, etc., that provide an environment that allows the settlement of species and communities that have declined or disappeared from other areas, are rare or new to science; therefore making them unique ecosystems.

The Mediterranean region is considered a biodiversity ?hotspot?, but the influence of this sea goes beyond the Gibraltar strait. Unique ecosystem that shares the biological richness of the Mediterranean can be found in the Atlantic Ocean. Do they are Mediterranean or Atlantic ?hotspots? ?

Water column habitats - 1

Mouna Bellakhal, Tunisie

Résumé
This session, where eight presentations were presented, dealt with the diversity and ecology of pelagic habitats.

The discussion was relevant and rewarding and included two key recommendations :

- recognize the importance of dormant stages and resting cysts while investigating bio-ecological cycles of pelagic and benthic species that are closely related to the sediment and to the water column. It is imperative to consider these phases of dormancy in order to understand and elucidate the dynamics and interactions with the environmental conditions.

- the second recommendation proposes the standardization of studies of phytoplankton biomass would facilitate the understanding of the dynamics, migration and introduction of marine species in the Basin. For example systematically recording Chl a and nutrients together with phytoplankton biomass may help the understanding of the dynamics of pelagic species.

Water column habitats - 2

Boris Espinasse, MIO - UMR 7294, Université Aix-Marseille, France

Résumé
Dans un premier temps la discussion a traité de l'extension du sprat (petit poisson pélagique) dans le Golfe du Lion aux dépens de la sardine et de l?anchois, et donc de l?adaptation de cette espèce à des températures qui ne lui convenaient pas précédemment. La discussion a ensuite tourné autour de l?importance d?une approche intégrative, de l?identification des processus physiques et du couplage benthos/pélagique pour mieux comprendre la dynamique de populations des espèces.

Water column habitats - 3

B. Quéguiner, CNRS, France

Résumé
Absence de résumé

Session

Ageing techniques and growth

Modérateur : **Kostas Kapiris**

CROISSANCE RELATIVE ET BIOMÉTRIE CHEZ L'ANCHOIS *ENGRAULIS ENCRASICOLUS* (LINNÉ, 1758) DU GOLFE D'ANNABA, EST ALGÉRIEN

N. Benchikh [1]*, S. Ladaimia [1], F. Bouhali [1], A. Diaf [1] and A. Djebar [1]
[1] Université Badji Mokhtar – Annaba. Laboratoire d'Ecobiologie des Milieux Marins et Littoraux. Université Badji Mokhtar Annaba,Algérie. - nadira.benchikh@yahoo.fr

Abstract
Ce travail est une contribution à l'étude de la Croissance relative et les relations biométriques chez l'anchois *Engraulis encrasicolus* (linné, 1758) du golfe d'Annaba, Est algérien.La croissance relative et les relations morphométriques basées sur le traitement statistique des données de variables biométriques de l 'anchois commun durant l'année 2012. Chez la population *Engraulis encrasicolus* (Linné, 1758).les résultats de la croissance relative est de type allométrie majorante chez *E.encrasicolus* avec (b=3,360/N = 178) et en ce qui concerne la morphometrie on note une allométrie de croissance isométrique sur 10/14 critères métriques, Les 4 autres paramètres restants (Lpo, Do, Hc, Ec) montrent une allométrie minorante et à mis en évidence une disparité du type de croissance morphologique lorsqu'on compare les deux sexes.

Keywords: Fishes, Growth, Biometrics, Algerian Sea

Introduction
En Méditerranée, les petits pélagiques tels que les sardines, anchois, maquereaux, sprats ou encore sardinelles totalisent presque 58% des débarquements totaux annuels de pêche [1]. La pêche le long des côtes algériennes cible particulièrement la faune ichtyologique et surtout les poissons bleus de valeur moindre dont les captures représentent presque 93%. L'anchois *Engraulis encrasicolus* et la sardine *Sardina pilchardus* sont les espèces les plus importantes en termes d'intérêt commercial et de biomasse [2, 3]. Nous présentant ici les résultats sur la croissance relative à la longueur total - masse éviscérée et les relations biométriques de *E. encrasicolus* du golfe d'Annaba, Est Algérien.

Matériel et méthodes
Un échantillonnage de 178 anchois provenant des débarquements de sardiniers et chalutiers pratiquant dans le golfe d'Annaba durant l'année 2012. Des données de variables morphométriques basé sur 15 critères métriques d'une population de l'anchois commun *E. encrasicolus* (Linné, 1758) des côtes Est d'Algérienne. La longueur totale et la masse éviscérée ont été respectivement exprimées en cm et en g. La conformité du coefficient d'allométrie est déterminée par le test t de Student [4].

Résultats et discussion
Pour la croissance relative la taille-poids éviscère Chez *E. encrasicolus on à trouvé* une croissance de type allometrie majorante chez la population totale ; les males et les femelles les valeurs de la pente(b) sont respectivement: 3,360; 3, 280 et 3,262. Ces résultats concordent avec ceux trouvés dans les côtes Est algériennes [5]. Contrairement aux résultats observé dans plusieurs régions de la méditerranée qui montrent une croissance isométrique dans la baie de skikda [6] et dans les côtes Algéroises [7]. En ce qui concerne l'étude morphométrique, chez la population total 10/14 paramètres qui sont : longueur à la fourche , longueur maxillaire, longueur standard, longueur céphalique, longueur pré-dorsale, longueur post-orbitaire, longueur prés-pectorale, longueur post-pectorale, longueur pré-anale, et l'hauteur du pédoncule caudal présentent une isométrie de croissance, alors que Les 4 paramètres restant (la longueur prés-orbitaire ,le diamètre orbitaire, la hauteur et l'épaisseur du corps) montrent une allométrie minorante ce qui explique que ces paramètres croient moins vite que la longueur céphalique et la longueur total.

Chez les mâles l'analyse des paramètres métriques montre que 11 paramètres présentent une isométrie de croissance qui sont : longueur à la fourche, longueur maxillaire, longueur standard, longueur céphalique, longueur pré-dorsale, longueur post-orbitaire, longueur pré-orbitaire. longueur pré-pectorale, longueur post-pectorale, longueur pré-anale, et diamètre orbitaire ,par contre on trouve que l'épaisseur du corps et la hauteur du pédoncule caudale (Ec, HPc) croient plus rapidement que la longueur total (allomètrie majorante) ,sachant qu' un seul type d'allomètrie minorante de croissance est observé pour la hauteur du corps (Hc) .

Cependant chez les femelles on trouve 12/14 paramètres métriques qui présentent une isométrie de croissance qui sont : longueur à la fourche , longueur maxillaire, longueur standard, longueur céphalique, longueur pré-dorsale, longueur post-orbitaire, longueur pré- pectorale, longueur post-pectorale, longueur pré-anale, diamètre orbitaire , la hauteur du corps et la hauteur du pédoncule caudale ;Cependant les deux autres caractères la longueur prés-orbitaire et l'épaisseur du corps se croient rapidement par rapport à la longueur total et la longueur céphalique avec une allometrie majorante . Néanmoins il serrait judicieux de corrélé ces changement avec les facteurs environnementaux [8] car L'analyse de la dynamique des petits pélagiques nécessite des programmes de recherche à long terme et pluridisciplinaires combinant l'éco-biologie, l'halieutique et l'hydrologie [9].

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AGE ET CROISSANCE DU BROCHET DE MER *SPHYRAENA SPHYRAENA* (OSTEICHTHYES, SPHYRAENIDAE) DE LA CÔTE TUNISIENNE (MÉDITERRANÉE CENTRALE)

Mohamed Issam Draief [1]*, Bachra Chemmam-Abdelkader [2], Mohamed Ben Salem [1] and Christian Capapé [3]
[1] Laboratoire de Biotechnologie, Biodiversité et Changements climatiques Faculté des Sciences de Tunis 2090 El Manar II - issam.draief@yahoo.fr
[2] Institut National des Sciences et Technologies de la Mer (INSTM)
[3] Laboratoire d'ichtyologie, case 104, Université Montpellier II, Sciences et techniques du Languedoc, 34095 Montpellier, France.

Abstract
L'étude de l'âge et de la croissance du brochet de mer *Sphyraena sphyraena* de la côte tunisienne, est fondée sur la lecture de 284 otolithes de spécimens. Cette étude a permis d'estimer les paramètres de croissance de l'espèce selon le modèle de Von Bertalanffy. Une clé âge-taille et une clé âge poids ont été présentées séparément pour les mâles, les femelles et sexes confondus. Pour l'ensemble de l'échantillon, la longueur asymptotique est estimée à 50,1cm, le coefficient K à 0,158 an^{-1}et l'âge théorique t_o à-2, 29 ans. La relation entre le rayon de l'otolithe R en cm et la longueur totale en cm a été calculée.

Keywords: Fishes, Gulf of Tunis, Growth

Introduction
Le brochet de mer *Sphyraena sphyraena (Linnaeus, 1758*) de la côte de Tunisie a fait l'objet d'une seule étude biologique concernant la période de reproduction, le sex-ratio et la maturité sexuelle [1]. Il a donc paru intéressant et utile de présenter dans ce travail, les premières données sur l'âge et la croissance de cette espèce qui possède, de surcrôit, un intérêt économique certain [2].

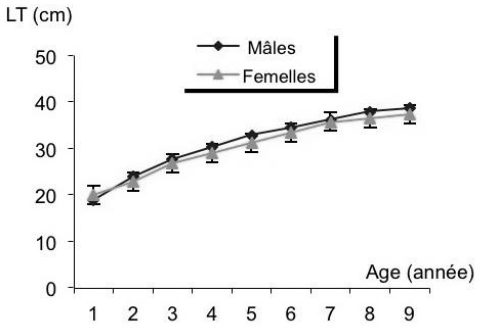
Matériels et méthodes
L'étude de l'âge et de la croissance du brochet de mer (*S. sphyraena* L, 1758) de la côte de Tunisie a porté sur 284 spécimens, de longueur totale comprise entre 18,7 cm et 46,8 cm et pesant entre 69,8g et 2350g. La détermination de l'âge a été effectuée à partir de la lecture de l'otolithe *in toto*. Pour valider la méthode de l'estimation de l'âge, l'allongement marginal est suivi mensuellement. Les croissances linéaire et pondérale ont été transcrites conformément au modèle mathématique de croissance de Von Bertallanfy [3]. La longueur totale correspondant à chaque âge est rétro calculée par la méthode de Lee [4]. La relation taille poids $W= aL^b$ est établie pour l'ensemble de l'échantillon.

Résultats et discussion
Le test de normalité de Shapiro-Wilk est W = 0.982, avec p = 0.0012, ce qui nous permet de dire que notre échantillon est extrait d'une population normalement distribuée. La figure 1 montre que l'allongement marginal présent deux minimums, l'un en février traduisant l'apparition d'anneau d'arrêt de croissance hivernal et l'autre en juin relatif à la période de ponte L'anneau d'arrêt de croissance hivernal plus net a donc été retenu pour estimer l'âge approximatif du *S. sphyraena,*

Fig. 1. Variations mensuelles de l'allongement marginal (AM) des otolithes de *S.sphyraena*.

La courbe de croissance linéaire montre que les mâles ont une croissance légèrement plus rapide que les femelles à partir de 2 ans (Fig. 2). Les équations des droites de régression, reliant le rayon de l'otolithe et la longueur totale du de corrélation de 0,96 montre une forte corrélation entre les variables LT et R_0 pour les mâles comme pour les femelles. Il est donc possible de déterminer la taille du spécimen à partir du rayon de l'otolithe et inversement, LT= 3,985 Ro + 1,967.

La méthode de rétro calcul a permis de considérer neuf groupes d'âge. La relation taille poids est exprimée par la relation $WT=4,89x10^{-3}Lt^{2,.96}$



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AGE ET CROISSANCE DE *BALISTES CAPRISCUS* (TELEOSTEI: BALISTIDAE) DU GOLFE DE GABES

Hichem Kacem [1]* and Lassad Neifar [1]
[1] Université de Sfax- Faculté des Sciences - hichemkacem2007@yahoo.fr

Abstract
La lecture des coupes fines du 1er rayon de la première nageoire dorsale de 463 spécimens de *Balistes capriscus* (Gmelin, 1788) du golfe de Gabès (Tunisie) a permis de déterminer les paramètres de croissance en longueur de cette espèce. Ces paramètres, pour les deux sexes combinés, sont les suivants $LF\infty$ = 417,3 mm, K = 0,237 an^{-1}, t_0= -0,102 années.

Keywords: Growth, Fishes, Gulf of Gabes

Introduction

Balistes capriscus (Gmelin, 1788) occupe une aire de répartition extrêmement vaste. Elle est largement trouvée dans les eaux tropicales et tempérées tout au long des côtes Est et Ouest de l'océan Atlantique [1]. Depuis ces dernières décennies une augmentation considérable de la production du baliste a été constatée le long des côtes tunisiennes et en particulier dans le golfe de Gabès. La production est passée de 34 tonnes en 1990 à 187 tonnes en 2009 [2]. L'étude de l'âge et de la croissance de cette espèce, constituent un préalable indispensable pour une pêcherie durable.

Matériel et méthodes

Un total de 463 spécimens (206 mâles et 257 femelles), de longueur à la fourche comprise entre 139 et 427 mm et de poids total allant de 90,04 à 1967,41 g, provenant de la pêche au chalut benthique, ont été examinés durant la période comprise entre Juin 2005 et Juin 2009. La détermination de l'âge est réalisée par la lecture des coupes fines du 1er rayon de la première nageoire dorsale. L'observation des coupes obtenues est réalisée en lumière transmise à l'aide d'un système d'analyse d'image composé d'une loupe, d'une caméra, d'un PC et du logiciel TNPC. Le rayon total des tranches (Rt) et les rayons à la formation de chaque zone hyaline (Ri) sont mesurés. Le nombre des zones hyalines est aussi déterminé pour l'estimation de l'âge des balistes. La longueur à la fourche correspondant à chaque âge est rétro-calculée par la méthode de Lee [3]. Les croissances linéaire sont ajustées au modèle de Von Bertalanffy. Les paramètres $L\infty$, K et t_0 sont déterminés à l'aide d'un logiciel informatique FISAT.

Résultats et discussion

Les variations mensuelles de l'allongement marginal ont montré que les valeurs minimales sont enregistrées au mois de février aussi bien pour les mâles que pour les femelles. Les tailles des balistes aux différents âges sont rétro-calculées, en tenant compte de l'existence d'une corrélation significative entre la longueur à la fourche du poisson et le rayon de la 1ère épine de la nageoire dorsale ($r = 0,897$, $p \leq 0,01$). L'âge maximum des poissons péchés était de 5 ans. Les équations de croissance linéaire obtenues sont:

Mâles : $LF = 420,7\ [1-e^{-0,233\ (t+0,123)}]$;

Femelles : $LF = 417,0\ [1-e^{-0,238\ (t+0,074)}]$;

Sexes confondus : $LF = 417,3\ [1-e^{-0,237\ (t+0,102)}]$.

La comparaison biogéographique de la croissance linéaire de *B. capriscus* a mis en évidence des différences interrégionales (tab. 1). En effet ces dissemblances pourraient parvenir soit de l'échantillonnage, soit elle est liées à des variations génétiques, mais sont aussi largement dépendantes des conditions environnementales, tant physiques que biotiques [4].

La présente étude montre que l'âge maximum des balistes du golfe de Gabès est de 13 ans. Ceci est en accord avec les travaux de Johnson et Saloman [5] pour des balistes du Nord–Est du golfe du Mexique. En revanche l'âge maximal de ce poisson à l'Ouest du golfe de Guinée [6] et sur les côtes Sud -Est du Brésil [7] ne dépasse pas 11 ans. De nombreuses études ont montré que *B. capriscus* atteint la maturité sexuelle au bout de 2 ans mais ce poisson peut être mature à partir d'un an [8]. Par ailleurs, Manooch [9] a montré que l'âge de la première maturité sexuelle est atteint au Sud-Est des États-Unis au bout de 3 ans. Ce résultat a été aussi obtenu chez *B. capriscus* du golfe de Gabès. Les variations de l'âge de la première maturité sexuelle pourraient être dues à l'effet des conditions biogéographiques différentes ou bien à une augmentation de la pression de pêche.

Tab. 1. Paramètres de l'équation de Von Bertalanffy à la croissance linéaire de *Balistes capriscus* (sexes confondus) dans différentes localités.

Localités/ Auteurs	LF					$L\infty$	K	t_0
	I	II	III	IV	V			
Sénégal [10]	90,0	170,0	238,0	290,0	324,0	407,0	0,31	-3,4
Nord-est du golfe de Mexique [5]	124,1	232,7	306,8	357,3	391,8	466,0	0,38	-0,189
Côtes Sud-est du Brésil [7]	94,8	182,0	250,8	305,0	347,7	509,5	0,268	-0,005
Golfe du Gabès	131,8	192,2	240,1	276,4	307,1	417,3	0,237	-0,102

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AGE AND GROWTH OF THE JINGA SHRIMP, *METAPENAEUS AFFINIS* (H. MILNE EDWARDS, 1837) IN THE BAY OF IZMIR, TURKEY

Kostas Kapiris [1]*, Gulnur Metin [2] and Ilker Aydin [2]
[1] Hellenic Centre for Marine Research - kkapir@hcmr.gr
[2] Ege University, Faculty of Fisheries

Abstract
Seasonal sampling data – from November 2008 to January 2011 - were analyzed to determine the age and the growth of *Metapenaeus affinis* (jinga shrimp). The males presented 2-year modes, while females one more. The CL∞ and the k values were estimated to be 49,75 mm and 0,68 years-1 for females and 35,42 mm, 1,33 years-1, for males. The φ' value for the females was 2,84, while for males 3,22.

Keywords: Growth, Decapoda, Coastal waters, North-Eastern Mediterranean

Introduction
M. affinis is a dominant and highly valued penaeid shrimp along the Persian Gulf, Arabian Sea, S. China Sea and Hawaii [1]. It was recently noted in the Mediterranean (2008), at the inner part of Izmir Bay (Turkey) [2]. Age and growth of the species has also been described in Iran [3], Kuwait [4] and India [5]. This is the first work describing its age and growth of the species in the Mediterranean waters.

Material and methods
A total of 3038 jinga shrimp specimens were collected in a seasonal basis, from November 2008 to January 2011, in the Bay of Izmir (Turkey) by trammel nets. The samples were separated by sex and the carapace length (CL) was measured. Bhattacharya's method (FiSAT package) was used to identify and isolate the different, normally distributed, size groups per sex, taking into account the values of separation index (SI) for the different age group, the number of the identified age groups, and the standard deviation (S.D.). The Von Bertalanffy (VBGF) parameters (CL∞, k, to) were estimated using the non-linear regression (Statgraphics). The growth performance index φ' in the jinga shrimp was estimated using the equation $\varphi' = \log_{10}k + 2\log_{10}CL\infty$.

Results and Discussion
The general pattern showed that the males exhibited 2-year modes, while females showed more (3 year modes in summer). The same number of cohorts has been identified in Iran [3]. The FiSAT estimated modal mean lengths of males ranged from 19,25 (in winter) to 29 mm CL (Autumn) and the SIs appeared to be quite satisfactory. In females, the estimated modal lengths ranged from 24 to 31 mm CL (Table 1). The VBGF parameters for the females and males were: CL∞=49,75 mm, k=0,68 y^{-1}, to=-0,99 y and 35,42 mm, 1,33 y^{-1},
-0,05 y, respectively. Similar growth pattern of the same species has been estimated in Iran [3] and in Kuwait waters [4]. The growth coefficient (k) confirms different growth rates between sexes, but, like all penaeids, the species seems to grow faster than other decapods. The φ' value for the females and males was 2,84 and 3,22, respectively. Both k and φ' values suggest that males grow faster than females in the Izmir area.

Tab. 1. Identified age groups of males and females *M. affinis* during the seasonal sampling cruises, using Bhattacharya's method

Females					Males			
Season	Mean CL[a]	±S.D.[b]	N_c	S.I.[d]	Mean CL	±S.D.	N	S.I.
Winter	29	4	1547		19,25	1,8	117	
					27,66	0,8	16	2,56
Autumn	28	2	562		21,47	1,79	91	
					29	0,84	110	2,4
Spring	31	3	322		22,54	1,69	400	
Summer	24	2	134		26,18	1,26	306	
	28	2	193	2				
	39	1	33	7,3				

a Cephalothorax (mm), b Standard deviation, c Number of individuals, d Separation index

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RELATION TAILLE-POIDS, PONTE DE L'ANCHOIS ET DE LA SARDINE DU LITTORAL EXTRÊME EST ALGÉRIEN

S. Ladaimia [1]*, F. Z. Bouhali [1], N. Benchikh [1], A. Diaf [1] and A. B. Djebar [1]
[1] Université Badji Mokhtar – Annaba. Laboratoire d'écologie des milieux marins et littoraux (E.M.M - souad-lad@hotmail.fr

Abstract
La reproduction, la relation taille-poids de l'anchois *Engraulis encrasicolus* et de la sardine *Sardina pilchardus* ontété étudiées le long du littoral extrême Est algérie. Pour l'anchois la sex-ratio est constante, alors qu'elle est en faveur des femelles chez la sardine. Les périodes de reproduction ont lieu d'avril à octobre pour l'anchois et entre novembre et avril pour la sardine. Ces deux espèces ont une allométrie majorante.

Keywords: Reproduction, Algerian Sea

Introduction
L'anchois *Engraulis encrasicolus* et la sardine *Sardina pilchardus* sontdeux poissons téléostéens côtiers, petits pélagiques qui peuplent les côtes Algériennes et plus particulièrement l'extrême Est de l'Algérie. Ce sont les espèces dont l'exploitation a une importance stratégique sur le plan économique et social. Les prises annuelles moyennes varient ente 900 et 3714 tonnes pour la sardine et entre 59 et 490 tonnes pour l'anchois. [1]
Dans notre travail, nous nous somme intéressés à l'étude de la biologie reproductive et de déterminer les relations taille-poids de l'anchois et de la sardine, peuplant le littoral extrême Est algérien.

Matériels et méthodes
La présente étude a concerné la côte extrême Est algérienne. Près du port de pêche d'El kala et au cours d'un cycle annuel, un échantillonnage mensuel entre Septembre 2011 et août 2012 a été effectué. Nous avons réussis de collecter un total de 4241 poissons dont 1953 anchois et 2288 sardines qui ont été analysés dans le laboratoire. Pour chaque spécimen les paramètres suivants ont été relevés: la longueur totale(Lt) en centimètre près, le poids total(Pt), éviscéré(Pev), le poids des gonades(Pg) et le poids du foie(Pf) en g près. Le sexe est déterminé après dissection des poisons et observation macroscopique de leurs gonades.

Résultats et discussion
Chez la population d'anchois, La sex- ratio globale est égal à 0.98. Après traitement statistique par utilisation du test de Khi-deux (χ^2), on a trouvé qu'elle est constante (χ^2=0.27), on assiste donc à un équilibre entre les mâles (965) et les femelles (988), quant à la sardine la sex-ratio est égal à 0.82 elle est en faveur des femelles. Le suivi des variations mensuelles des valeurs moyennes du rapport Gonado-Somatique (RGS), nous a permis de situer la période de ponte de l'anchois qui s'étale entre Avril et Octobre (saison chaude). Les glandes sexuelles sont au repos de novembre jusqu'à février (saison froide). Quant à la sardine, la période de ponte s'étale de novembre jusqu'au Avril (saison froide), le poisson est en repos sexuel pendant la saison chaude (entre mai et octobre) Fig.1 (a,b). Nos résultats concordent avec ceux trouvés sur les côtes Est algériennes [2] et celui des côtes tunisiennes [3], [4]. En fait, la longue durée de la période de reproduction des deux espèces étudiées est expliquée par la faible amplitude des variations de l'environnement en méditerranée au cours d'un cycle annuel, où on ne note pas des variations saisonnières bien marquées L'analyse des variations mensuelles du Rapport Hépato-Somatique (RHS) Fig.1 (a, b), montre que l'anchois et la sardine sont des poissons de type gras et le foie n'intervient pas dans l'accumulation des lipides essentiels à la reproduction qui se fait d'abord sous la peau, dans le mésentère avant de passer dans les gonades pour assurer les besoins énergétiques lors de la reproduction. Les résultats de la relation taille-poids établie pour l'anchois et la sardine montrent qu'elle est de type allométrie majorante et les valeurs de b sont supérieurs à 3. Ils sont de l'ordre de 3.32 et 3.26 respectivement. Ce qui signifie que le poids éviscéré croit plus rapidement que la longueur totale chez les deux espèces.

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DIMORPHISME SEXUEL ET CROISSANCE DU DENTÉ *DENTEX MAROCCANUS* DES CÔTES D'EL KALA (NORD-EST DE L'ALGÉRIE).

Rima Mohdeb [1]* and M. hichem Kara [1]
[1] Laboratoire de Bioressources Marines, Université BADJI Mokhtar, Annaba, Algérie. - rimamohdeb@yahoo.fr

Abstract
La morphologie du denté *Dentex maroccanus* (Valenciennes, 1830) des côtes d'El Kala est caractérisée et montre un dimorphisme sexuel pour la majorité des critères métriques considérés. La distribution des fréquences des tailles met en évidence six groupes d'âge. Les paramètres des modèles de croissance linéaire absolue et de la relation taille-poids sont donnés.

Keywords: Algerian Sea, Growth, Biometrics, Mediterranean Ridge

Introduction

Dentex maroccanus est un poisson sparidé qui vit en Atlantique Est, au Sud et à l'Est de la Méditerranée. Sur les côtes Est de l'Algérie, il occupe une place relativement importante dans les captures commerciales. Cependant, sa biologie reste très peu connue sur les côtes nord africaines (Chemmam-Abdelkader et *al*., 2002 et 2004). Ce travail aborde la morphologie, la dynamique et la croissance de *D. maroccanus* des côtes d'El Kala.

Matériel et méthodes

Au total, 806 individus ont été échantillonnés entre juin 2011 et septembre 2012 (10,5 cm <Lt< 26,8 cm; 15,22 g <Pt< 267,21 g). Leur morphologie est décrite par vingt et un caractères métriques et dix caractères numériques. Pour déceler un éventuel dimorphisme sexuel, nous avons utilisé le test t de Student, adapté aux axes majeurs réduits (Myrat, 1959). Les couples âge-longueur sont définis par la méthode indirecte de Battacharya en utilisant le programme FiSat II. La croissance linéaire absolue est décrite par l'équation de Von Bertalanffy (1938). La relation taille poids est donnée pour chaque sexe séparément.

Résultats et discussion

La majorité des caractères métriques considérés montrent un dimorphisme sexuel. La structure des tailles par sexe révèle l'existence de six cohortes (figure. 01), aussi bien chez les mâles que chez les femelles. Le modèle de croissance linéaire absolue s'écrit comme suit: $Lt = 21,94(1 - e^{-0,58(t-0,58)})$ pour les mâles et $Lt = 24,27(1 - e^{-0,45(t-0,24)})$ pour les femelles. Les équations de croissance relative sont $P = 0,0087L^{3,17}$ chez les mâles et $P = 0,031L^{3,05}$ chez les femelles. La comparaison de nos résultats avec l'unique travail consacré à cette espèce en Méditerranée (Chemmam-Abdelkader, 2002), montre que la croissance des dentés d'El Kala est plus rapide que celle des dentés des côtes Tunisiennes,aussi bien pour les mâles que pour les femelles.

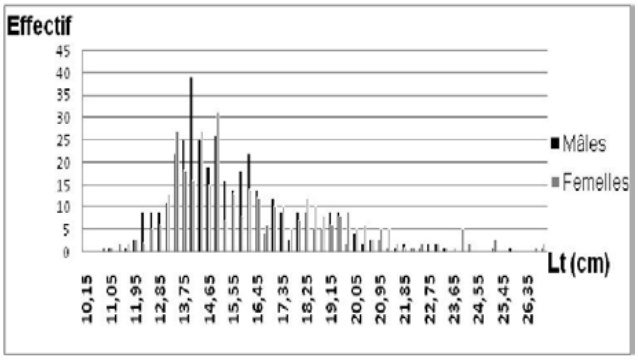

Fig. 1. Distribution des fréquences des tailles des mâles et des femelles de *Dentex maroccanus* des côtes d'El Kala.

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CROISSANCE DU THON ROUGE *THUNNUS THYNNUS* (LINNAEUS, 1758) DES CÔTES ALGERIENNES

Ahmed Nouar [1]* and Naciba Labidi [1]
[1] Laboratoire Halieutique, FSB/USTHB - nouarahmed@live.fr

Abstract
Les captures de thon rouge *Thunnus thynnus* (Linnaeus, 1758) effectuées en Algérie de 2005 à 2009 par des palangriers japonais ont permis la détermination des paramètres de croissance par analyse des structures de taille sur un effectif total de 11715 individus dont 5302 mâles et 6413 femelles : $L\infty$ = 360,35cm, K = 0,09 an-1 et t0 = - 0,976 an-1 pour les mâles; $L\infty$ = 346,15cm, K = 0,098 an-1, t0 = - 0,903 an-1 pour les femelles et $L\infty$ = 373,33cm, K = 0,084 an-1, t0 = - 1,038 an-1 à sexes confondus. Les relations biométriques de l'espèce sont établies, en particulier la relation taille – poids indispensable pour la détermination de la croissance pondérale.

Keywords: Growth, Algerian Sea

Introduction
En Algérie, *Thunnus thynnus* est pêchée accidentellement par les senneurs et les petits métiers. Depuis 1995 en accord avec la Commission Internationale pour la Conservation des Thonidés de l'Atlantique (ICCAT) des quotas de pêche sont définis. Sur le plan scientifique, une seule étude concerne la croissance de cette espèce [1].

Matériel et méthodes
Les données proviennent des captures des campagnes de pêche commerciale des grands migrateurs réalisées par des palangriers japonais dans les eaux sous juridiction nationale algérienne. De 2005 à 2009, ces navires capturent le thon rouge du 15 avril au 1er juin. L'analyse des structures de taille sur un effectif total de 11715 individus dont 5302 mâles et 6413 femelles a permis la détermination des paramètres de croissance de l'équation de Von Bertallanfy par le logiciel FISAT II [2], en appliquant la méthode de Powell-Wetherall (1987, in [3]) pour la détermination du $L\infty$, la méthode de [4] pour K et de [5] pour to. Les relations biométriques concernent les longueurs totale (LT) et à la fourche (LF) ainsi que les poids total (WT) et éviscéré (WE).

Résultats
Les paramètres de croissance de *T. thynnus* sont reportés dans le tableau 1., avec les résultats des travaux entrepris en Méditerranée par d'autres auteurs [6], [7], [1]. La valeur de la longueur asymptotique L_∞ des mâles est supérieure à celle des femelles, en accord avec nos résultats sur les répartitions des tailles où les mâles sont, en moyenne, plus grands que les femelles. Les valeurs des paramètres K et t_0 sont proches pour les deux sexes. L'équation de la croissance linéaire est :
Mâles : $LF = 360{,}35\ (1 - e^{-0{,}090\ (t + 0{,}976)})$,
Femelles : $LF = 346{,}15\ (1 - e^{-0{,}098\ (t + 0{,}903)})$,
Sexes confondus : $LF = 373{,}33\ (1 - e^{-0{,}084\ (t + 1{,}038)})$

Tab. 1. Paramètres de croissance de *Thunnus thynnus*

Auteurs	Sexe	L_∞ (cm)	K (an)	t_0 (an)
Présente étude Nouar et Labidi, 2013	Mâles	360,35	0,090	- 0,976
	Femelles	346,15	0,098	- 0,903
	Confondus	373,33	0,084	- 1,038
Hattour, 1978	Confondus	330	0,095	- 0,370
Farrugio, 1980	Confondus	351,13	0,080	- 1,087
Chalabi et al., 2001	Confondus	298,5	0,240	- 0,860

Les résultats des relations biométriques sont consignés dans le tableau 2. La relation linéaire (LT/LF) indique une allométrie majorante de la longueur totale traduisant une croissance rapide de cette variable par rapport à la longueur à la fourche. Quant aux relations taille - poids liées aux états biologique et physiologique du poisson, la valeur du coefficient (légèrement inférieur à 3) indique une allométrie minorante du poids par rapport à la taille chez *T. thynnus* pour la période avant la ponte (avril et mai). Tenant compte des résultats de la croissance en longueur et ceux de la relation taille – poids, l'équation de croissance en poids est :
Mâles : $WT = 659{,}95\ (1 - e^{-0{,}090\ (t + 0{,}976)})^{2{,}3369}$
Femelles : $WT = 527{,}67\ (1 - e^{-0{,}098\ (t + 0{,}903)})^{2{,}135}$
Sexes confondus : $WT = 652{,}31\ (1 - e^{-0{,}084\ (t + 1{,}038)})^{2{,}2446}$

Tab. 2. Relations biométriques de *Thunnus thynnus*

Relation	Sexe	Equation
Longueur totale (LT) en fonction de la Longueur à la fourche (LF)	Confondus	LT = 1,0357 LF + 18,002
	Mâles	LT = 1,0441 LF + 16,091
	Femelles	LT = 1,026 LF + 20,067
Poids total (WT) en fonction de la Longueur à la fourche (LF)	Confondus	$WT = 0{,}0011\ LF^{2{,}2446}$
	Mâles	$WT = 0{,}0007\ LF^{2{,}3369}$
	Femelles	$WT = 0{,}002\ LF^{2{,}135}$
Poids éviscéré (WE) en fonction de la Longueur à la fourche (LF)	Confondus	$WE = 0{,}0005\ LF^{2{,}3744}$
	Mâles	$WE = 0{,}0003\ LF^{2{,}4671}$
	Femelles	$WE = 0{,}0009\ LF^{2{,}2593}$

>

Discussion
Thunnus thynnus pêchée en Algérie présente des tailles allant de 68 à 308 cm, avec dominance des mâles dans les premières et dernières classes de taille et celle des femelles dans les classes intermédiaires. Nos résultats basés sur l'analyse des structures de taille montrent que la croissance des mâles est supérieure à celle des femelles. Quelque soit le sexe, la longueur asymptotique est supérieure à la longueur maximale observée, ce qui n'est pas le cas en utilisant l'analyse des structures d'âge. En raison du manque de données et d'un dimorphisme sexuel peu apparent chez cette espèce les résultats de croissance à sexes séparés sont rares aussi bien en Méditerranée qu'en Atlantique. Ces travaux déterminent les paramètres par analyse des structures d'âge dont son application pour nos données présente des difficultés notamment pour l'attribution de l'âge aux différentes classes mal représentées dans nos échantillons issus d'une pêche limitée à 45 jours (du 15 avril au 1er juin). En comparaison avec les travaux méditerranéens, nos résultats satisfaisants sont proches de ceux de [7] qui utilise la lecture des vertèbres pour la détermination de l'âge.

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Session

Ageing techniques and reproduction

Modérateur : **Fatima Zohra Bouhali**

ALTERATIONS IN TESTICULAR STRUCTURE OF MALE GRASS GOBY (*ZOSTERISESSOR OPHIOCEPHALUS*) IN BIZERTA LAGOON, TUNISIA.

Ibtissem Louiz [1], Mossadok Ben Attia [2] and Oum Kalthoum Ben Hassine [1]*
[1] Unité de Recherche de Biologie intégrative et Écologie évolutive et fonctionnelle des Milieux Aquatiques, Faculté des Sciences de Tunis, Université Tunis-El-Manar, 2092 El Manar, Tunisie - kalthoum.benhassine@gmail.com
[2] Laboratoire de Biosurveillance de l'Environnement, Faculté des Sciences de Bizerte, Université de Carthage, 7021 Zarzouna, Tunisie

Abstract
Testicular histology of mature grass goby (*Zosterisessor ophiocephalus*) collected in Bizerta lagoon showed several types of histological lesions. A high prevalence of these lesions was detected in stations influenced by discharges of industrial and/or urban activities. These results highlight the reproductive disturbance of gobies from Bizerta lagoon.

Keywords: Pathology, Reproduction, Pollution, Fishes, Tunisian Plateau

Introduction: Bizerta lagoon, a site of important halieutic and aquaculture activities, is located in an economically important area in northern Tunisia. This lagoon is faced to many anthropogenic pressures including urbanisation, industrial and agricultural activities. Thus, wastewater discharges lead to the chemical contamination of the lagoon by various toxic compounds. As a possible consequence of this state of disturbance, annual fish productivity of this lagoon records a drop which is accentuated from a year to another. Therefore we chose to study the prospective impact of this pollution on male Grass goby reproduction using a histopathological approach.

Materiel and methods: Five sampling stations, representative of the different anthropic pressures present in the study area, were chosen (NJ: Njila, MB: Menzel Bourguiba, MR: Maghrawa, MJ: Menzel Jemil et ML: Menzel Abderrahmen). A relatively undisturbed site [1] located at the seawards entrance of Ghar el Melh lagoon (GH) was selected as a reference station. A total of 25 adult males gobies were collected in breeding period that extending from March to Mai. These specimens were immediately processed for gonad histology.

Results and discussion: Histological sections of gonads revealed many types of histological lesion associated with degenerative changes.

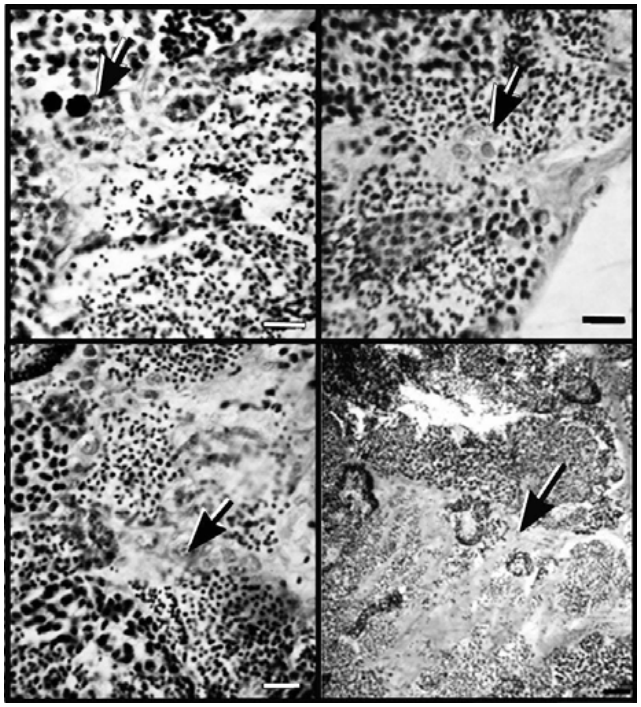

Fig. 1. Testis histological section showing some examples of degenerative findings include: (a) syncyatic cells« CSyn »; (b) hypertrophied Sertoli cells nuclei « SeCH »; (c) vacuolated germ cells (d) increased gaps in the interstitium between lobules « IG ». (H&E stained). Bar indicates 10 µm.

Histopathological alterations diagnosed in the testis of male from MB site were important and included germ cell syncytia (100 %) (Fig. 1a) associated with a high prevalence of Sertoli cell nuclei hypertrophy (67 %) (Fig. 1b) as well as misshapen seminiferous tubules. In ML and MJ stations, we noticed that testis exhibited increased gaps in the interstitium between lobules (IG) with huge span filled with connective tissue (13% and 10%, respectively) (Fig. 1d, Tab. 1).
These testes have as well vacuoles in the interstitial tissue (Fig. 1c) and melano-macrophage centers (MMCs) (Tab. 1). Predominance of histopathological lesions present higher values in MB station (Table 1), situated near of an industrial zone and exhibiting a high contamination by organotins [2], polycyclic aromatic hydrocarbons (PAHs) [1] and estrogen-like compounds [1] that can cause endocrine disruption in fish [3, 4].

Tab. 1. Testis histological lesions finding and associated prevalence and severities. N: sample size; P%: prevalence of histological lesions; S%: percentage of the gaps surface areas.

Sites	N	CSyn P%	SeCH P%	CSyn cell /view	CMM P%	IG S%
GH	4	0	0	0	0	4
NJ	3	0	0	0	0	5
MB	3	100	67	5.5	33	4
MR	2	0	0	0	0	4
MJ	3	50	0	2.3	50	10
ML	10	30	60	0.2	40	13*

Conclusion: The present work confirms that *Z. ophiocephalus* has been subjected to reproduction disturbances and showed histopathological lesions related with pollutants exposure.

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SEX-RATIO, PONTE ET TAILLE À LA PREMIÈRE MATURITÉ SEXUELLE CHEZ S*ARDINA PILCHARDUS* (WALBAUM, 1792) DES CÔTES EST ALGÉRIENNES.

F. Bouhali [1]*, S. Ladaimia [1], N. Benchikh [1], A. Diaf [1] and A. Djebar [1]
[1] Laboratoire d'Ecobiologie des Milieux Marins et littoraux, Université Badji-Mokhtar, Algérie. - fatima.bouhali@yahoo.fr

Abstract
Trois aspects de la reproduction de *Sardina pilchardus* (walbaum, 1792) ont été étudiés: sex- ratio, période de ponte et taille à la première maturité sexuelle. La sex-ratio globale est en faveur des femelles (SR = 44,21 ; χ^2 = 25,77). La période de ponte s'étale d'Octobre à Mars. La taille à la première maturité sexuelle est de 11,28 cm pour les femelles et de 11, 50 cm pour les mâles.

Keywords: Fishes, Spawning, Reproduction, Algerian Sea

Introduction
En Algérie, la pêche pélagique est dominée au débarquement par la sardine qui représente 71% total capturé, les espèces concernées sont: la sardine (*Sardina pilchardus*, l'allache (*Sardinella aurita*), le chinchard (*Trachurus trachurus*) et le maquereau (*Scomber* scombrus) représentant en tonnage débarqué 80% des pêcheries [1]. Nous abordons dans cette étude, l'analyse des différentes phases de l'évolution du cycle reproducteur de *S. pilchardus.* Le stock ne peut se maintenir que si la biomasse féconde est suffisante pour compenser les prélèvements effectués par les pêcheries. Les connaissances de la taille de première maturité sexuelle, sa maturation ovarienne, sa ponte et sa phase de récupération ou repos sexuel sont nécessaires pour calculer la dimension du stock et son potentiel de renouvellement. Par ailleurs, dans la perspective d'étudier les stades larvaires et juvéniles, il est primordial de caractériser la reproduction tant aux niveaux spatial que temporel.

Matériel et méthodes
Durant un cycle de 12 mois (juillet 2010 et juin 2011) on a un effectif de 2266 individus collectés à partir des débarquements du port d'Annaba et el kala. La longueur totale a été mesurée en centimètre près,Le poids total (Pt), le poids éviscéré (Pév) et le poids des gonades (Pg) ont été pesé au gramme près. Le sexe et les stades de maturité sexuelle sont déterminés macroscopiquement grâce à l'échelle de maturité sexuelle [2].

Résultats et discussion
L'étude de la sex-ratio globale de *S. pilchardus* montre une dominance des femelles par rapport aux mâles (SR = 44,21; x^2 = 25.77). Les immatures sont moins représentés dans notre échantillon (14,87%). Cette dominance des femelles est aussi observée sur les côtes Tunisiennes [3], Cette dominance des femelles peut être expliquée par des différences de croissance selon le sexe [4, 5].
L'évolution du RGS nous a permis de situé la période de reproduction entre octobre et mars avec un pic en janvier.
La taille à la première maturité sexuelle (L50) est égale à 11,28 cm pour les femelles et à 11,5 cm pour les mâles. Ces valeurs sont proches à celles dans le même golfe (11,5 cm pour Mâles, 11,8 cm pour les femelles) [6]. Un résultat proche a été signalé sur les côtes tunisiennes (12,3 cm pour les femelles et 11,8 pour les mâles) [3], et elles sont inférieures à celles démonté dans les côtes Marocaines partie Atlantique [5] (16,3 cm pour Mâles, 17,5 cm pour les femelles).

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REPRODUCTIVE STRATEGIES OF NW MEDITERRANEAN DEEP-SEA FISH COMMUNITY

U. Fernandez-Arcaya [1]*, H. Murua [2], J. C Drazen [3], L. Recasens [1], E. Ramirez-LLodra [1], G. Rotllant [4] and J. B Company [1]
[1] Institut of Marine Science (ICM, CSIC) - ulla@icm.csic.es
[2] Azti Tecnalia
[3] University of Hawaii at Manoa
[4] IRTA

Abstract
The reproductive strategies and fecundity of 13 species of the NW Mediterranean deep-sea fish community (750-2250 m depth) were analyzed. The results were compared with previous published data of shallower-living NW Mediterranean species . The results showed that all species analyzed present group-synchronous ovarian organization. All the species present the general pattern of large eggs and low Total Fecundity (TF) in comparison with shallower distributed fish species. TF is positively correlated with fish length. However, no significant relationship between length and depth was found, suggesting that the environmental factors associated with depth play an important role in determining fecundity.

Keywords: Continental margin, Demersal, Fishes, Life cycles, North-Western Mediterranean

Introduction Understanding reproductive strategies and the assessment of fecundity are fundamental in the study of biology and population dynamics of fish. Little is known about ovarian organization and fecundity in fishes, especially in deep-sea species. Fecundity values are related to several factors, such as food supply, population density, allocation of energy to reproduction and fish size [1],[2]. Fecundity is predicted to decrease with depth because of the assumed lower food availability in deep-sea habitats [2],[3]. This paper presents for the first time a comparative study of reproductive strategies of NW Mediterranean deep-sea fish, showing new data on fecundity and eggs size of the most abundant species. The results are discussed in relation to Mediterranean deep-sea environmental characteristics.

Material and methods Sampling was conducted between 700 and 2250 m depth, seasonally in 2008/9 and 2012/13. All the specimens from 13 different species were sexed, measured and the reproductive stage was macroscopically identified. In the laboratory, mature gonads were analyzed histologically to confirm macroscopic examination and the absence of post-ovulatory follicles. A sub-sample of 10 gonads per species, when available, was selected for oocyte-size frequency distribution analyses. A portion of these subsamples was stained, filtered, photographed and analyzed by image analysis software. The diameters of 100 oocytes were measured to determine the size of advanced yolk oocytes. Total fecunditywas calculated as: $TF= [O_i/W_i] \times W_0$; where *Oi* is the number of oocytes in the advanced vitellogenic stage, *Wi* is the weight of the ovary subsample, and *Wo* is the ovary weight [4]. Relative total fecundity (RF) was also estimated by dividing TF by the gonad-free weight of the fish. The results were compared with previous published data on shallower-living species. To evaluate length and depth influence on TF and RF of the NW Mediterranean fish community, linear regression were performed.

Results and discussion The oocyte size-frequency distribution results showed that all the species analyzed present two cohorts of oocytes in mature ovaries, suggesting group-synchronous oocyte development. This pattern is found in most of demersal species inhabiting cold marine waters [1]. The TF and RF of these 13 species were calculated for the first time in the present study. Marked differences in fecundity often reflect different reproductive strategies. In fact, over the species analyzed, TF was highest in the shallowest species *Phycis blennoides* (1643899 eggs/female), while the lowest TF was observed in the deepest vivipary species *Cataetyx alleni* (844 eggs/female). It is commonly accepted that total fecundity is positively correlated with fish length [1], [3] and the deep-sea fishes analyzed here were not an exception, where a positive relationship between mean TF and mean size of each species was observed ($P < 0.05$) (Figure 1). A positive relation between TF and depth was also found. The results are in accordance with previous published data from Atlantic fishes, were a similar pattern was observed [3]. This similarity between deep Mediterranean and deep Atlantic fishes suggest that rather than temperature, other environmental factors related to depth (i.e. low food availability, competition) might be determinant in the life histories of the deep-sea species. Even with our intense sampling survey, only a few mature females were found of *Phycis blennoides*, *Lepidion lepidion*, *Mora moro* and *Coryphaenoides guentheri* , suggesting biannual spawning as an adaptive response to the low food availability in deep-sea habitats, particularly in the oligotrophic Mediterranean Sea.

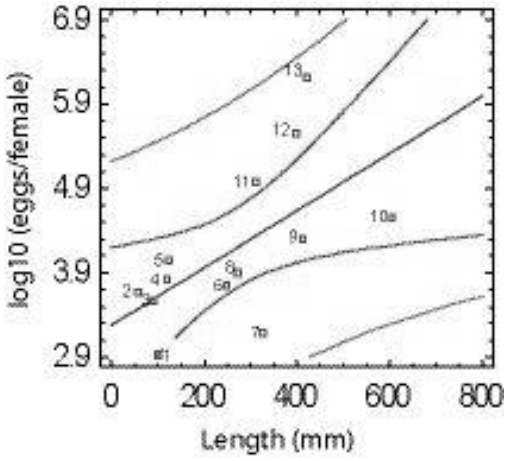

Fig. 1. Average total fecundity (eggs/female) in relation to average fish length of females in 13 species of NW Mediterranean; 1 *Cataetyx alleni*, 2 *Coryphaenoides guentheri*, 3 *Notocanthus bonaparte*, 4 *Bathypterois mediterraneus*, 5 *Lampanyctus crocodilus*, 6 *Lepidion lepidion*, 7 *Alepocephalus rostratus*, 8 *Chaoliodus sloani*, 9 *Cataetyx laticeps*, 10 *Nettastoma melanorum*, 11 *Mora moro*, 12 *Epigonus telescopus*, 13 *Meluccius merluccius.* r^2=35, p=0.01

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ASSESSING GROWTH BAND COUNTS FROM DORSAL-FIN SPINES FOR AGEING THE LONGNOSE SPINY DOGFISH

Vasiliki Kousteni [1]* and Persefoni Megalofonou [1]
[1] Department of Biology, Section of Zoology-Marine Biology, University of Athens, Greece - bkousten@geol.uoa.gr

Abstract
Age and growth of longnose spiny dogfish (*Squalus blainville*, Risso 1826), from the Eastern Mediterranean Sea, was studied by counting the bands at the external surface of the second dorsal-fin spines. The von Bertalanffy parameters were estimated separately for females and males.

Keywords: North-Eastern Mediterranean, Elasmobranchii, Growth

Introduction
In previous studies the age and growth of the longnose spiny dogfish were investigated by counting either the vertebral rings [1] or the growth bands in sections of the second dorsal-fin spine [2]. The aim of this study is to estimate the age and growth of the species using the external growth bands of the whole dorsal-fin spine and to compare the results of the method used with those of the previous studies in the Mediterranean Sea.

Materials and Methods
Out of 810 longnose spiny dogfishes that were sampled between 2004 and 2012 in the Greek Seas, 685 specimens were used for age estimation. Since the tip of the first dorsal-fin spine tends to be more worn down, leading to an underestimation of age, the second dorsal-fin spine was chosen for age estimation. All spines were read three independent times by the same reader. Out of the three readings the first one was rejected. Consequently, when the two last readings differed by 1 year the estimates were selected alternately, when they differed by 2 years the mean of the two readings was taken into account while those that differed for more than 2 years the spines were excluded from the analysis (±2-yr criterion). For large individuals with worn or broken spines, age was calculated according to Ketchen's method (1975) [3]. Since, Ketchen's correction curve was made for *Squalus acanthias* from the Pacific Ocean, a new correction curve was developed for *Squalus blainville* from the Eastern Mediterranean Sea. The precision of age estimations was calculated using both the coefficient of variation (CV) and the average percent error (APE). The total length-at-age data were fitted to the von Bertalanffy growth model.

Results and discussion
Our results showed that the point where the first annulus is formed was not affected by the fish size. The examination of embryos revealed also that spines were formed during the early stages of embryonic development. The obtained CV and APE precision indices, confirmed that the two last readings of the whole spines (CV= 8, APE= 5.7) were more reliable than the first one and the comparison between them indicated no appreciable bias (Fig. 1). Age estimations of large specimens with broken spines was obtained using modified Ketchen's correction curve $Y= 0.5634X^{2.3429}$ (where X= the diameter of the spine base in mm and Y = the missing annuli of the spine due to being worn).
Finally, age estimations of 2 specimens with broken spines as well as of 567 specimens that met the ±2-yr criterion were used in growth analysis (Fig. 2). It was noticed that females reached higher age (28 yrs) than males (22 yrs). Differences were also found in the von Bertalanffy growth parameters between females and males (females: $L\infty$ = 1097 mm, K = 0.031, t_0 = -5.58 yrs; males: $L\infty$ = 665 mm, K = 0.080, t_0 = -3.35 yrs). The comparison of the growth parameters for longnose spiny dogfish from the Greek Seas with those from the Sicilian Channel [1] and the Gulf of Gabès [2], revealed differences that could be attributed either to the different ageing methods followed or to the differences in growth rates between different stocks.

Acknowledgements
This research has been co-financed by the European Union (European Social Fund - ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

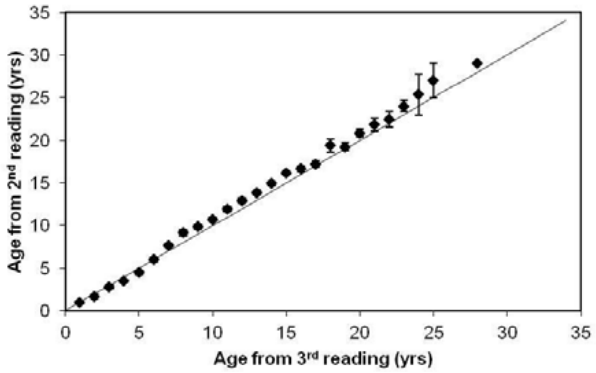

Fig. 1. Age bias plot showing means and 95% confidence intervals of age estimations for 569 longnose spiny dogfishes caught in the Eastern Mediterranean Sea during the period 2004-2012. The one to one equivalence is also represented.

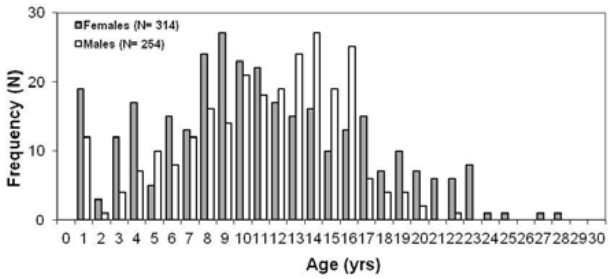

Fig. 2. Age frequency distribution of female and male longnose spiny dogfishes caught in the Eastern Mediterranean Sea during the period 2004-2012 (one hermaphrodite that was found is excluded from the graph).

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REPRODUCTION OF FEMALES OF THE DEEP-WATER PINK SHRIMP *PARAPENAEUS LONGIROSTRIS* (LUCAS, 1846) IN THE SOUTH ADRIATIC SEA (MONTENEGRIN COAST)

Olivera Markovic [1]*
[1] Institute of Marine Biology - omarkovic@ac.me

Abstract
The deep-weater pink shrimp, *Parapenaeus longirostris* (Lucas, 1846) is one of the most important commercial species in the Montenegrin trawl fishery. This paper describes reproductive patterns of females of this species. An estimate of the gonadosomatic index showed permanent reproductive activity all year around with two maxima, one in May and other in December. The carapace length at which 50 % of females were mature was at a carapace length of 20.9 mm CL.

Keywords: Decapoda, Reproduction, South Adriatic Sea

Introduction
The deep-water pink shrimp (*Parapenaeus longirostris*) inhabits the entire Mediterranean [1]. This species occurs in the deeper central Adriatic, in the Pomo-Jabuka pit, and in the southern Adriatic where is spread over the entire shelf area [2]. Despite the fact that in the Montenegrin traw fishery it represents the main target group of decapods, studies of this species have been mostly focused on population dynamics, while data on their reproduction are lacking.

Materials and Methods
Sampling was carried out on a monthly basis from September 2009 to August 2010. The samples were taken from commercial bottom trawlers which operates in the territorial Montenegrin waters at depths ranging from 50 to 250 m (Fig. 1.).

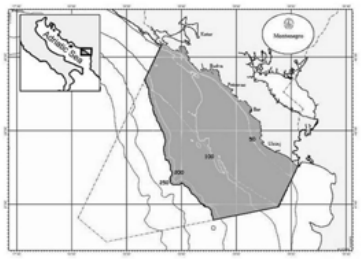

Fig. 1. Map of the study area

A total of 1550 specimens were measured, of which 83.3 % were females and 16.7 % males. The following parameters were measured: carapace length, total weight, weight of mature ovaries, sex of each specimen, and maturity stages of the females. The sex ratio, size at first maturity and the gonadosomatic index were estimated. Sexual ratio were calculated by size class, expressed as the ratio of females to the total number of specimens. Maturity for females was determined according to the scale proposed by MEDITS. Females with mature ovaries were used to determine the GSI which is defined as the ratio of the weight of the gonad (GW) to the total body weight of a female (TW). Finally, the percentages of maturity by size for females were calculated in order to determine the size at 50% first maturity, adjusting a logistic model.

Results and Discussion
The specimens showed a range in size between 15 and 37 mm CL with an overall average length of 27 mm CL. Females were larger than males. The carapace length of females ranged from 18 to 37 mm, with a mean size of 28.2 mm, while the carapace length of males ranged from 15 to 27 mm CL with an average of 21.6 mm CL. The overall sex ratio was in favor of females (0.83). The sex ratio by size class showed male predominance in the size range 16-22 mm while at lengths greater than 22 mm dominant sex were females and at lengths over 31 mm only females were observed. The carapace length at which 50 % of females were mature was calculated to be 20.9 mm. Dissimilar sizes for first maturity in different studies must be viewed with caution, because sample sizes and compositions may greatly influence the results found [3]. The gonadosomatic index of females showed a peak in autumn and winter while the minimum reproductive activity occurred in June.

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ETUDE COMPARÉE DE LA SEX-RATIO ET DU CYCLE SEXUEL DE *VENERUPIS DECUSSATA* DANS DEUX LAGUNES TUNISIENNES: LAGUNES NORD DE TUNIS ET DE BOUGHRARA

Jihed Fradi [1], Ines Haouas Gharsallah [1], Okbi Rjeibi [1] and Nedra Zamouri Langar [1]*
[1] INSTM, Tunisie - nedra.zamouri@instm.rnrt.tn

Abstract
Une acquisition des connaissances biologiques et écologiques d'une espèce est primordiale pour identifier le stock exploitable et permettre sa valorisation tout en élaborant les bases de sa gestion rationnelle. La palourde, *Venerupis decussata* est le bivalve le plus exploité en milieu naturel sur les côtes tunisiennes. Une acquisition des connaissances biologiques et écologiques de cette espèce est primordiale pour identifier le stock exploitable. Dans ce contexte, une étude comparative de la sex-ratio et du cycle sexuel de la palourde a été menée dans deux lagunes : l'une au nord (lagune nord de Tunis) et l'autre au sud tunisien (lagune de Boughrara).

Keywords: Bivalves, Life cycles, Lagoons, Tunisian Plateau

Introduction
La palourde, *Venerupis decussata*, est le bivalve le plus exploité en milieu naturel sur les côtes tunisiennes. Une acquisition des connaissances biologiques et écologiques de cette espèce est primordiale pour identifier le stock exploitable et permettre sa valorisation tout en élaborant les bases de sa gestion rationnelle. Dans ce contexte, une étude comparative du sex-ratio et du cycle sexuel de cette espèce a été menée dans deux lagunes tunisiennes.

Matériel et méthodes
Dans chacune des lagunes, nord de Tunis et de Boughrara (figure 1), l'échantillonnage est réalisé d'une manière mensuelle, depuis le mois de mars 2010 jusqu'au mois d'août 2011.

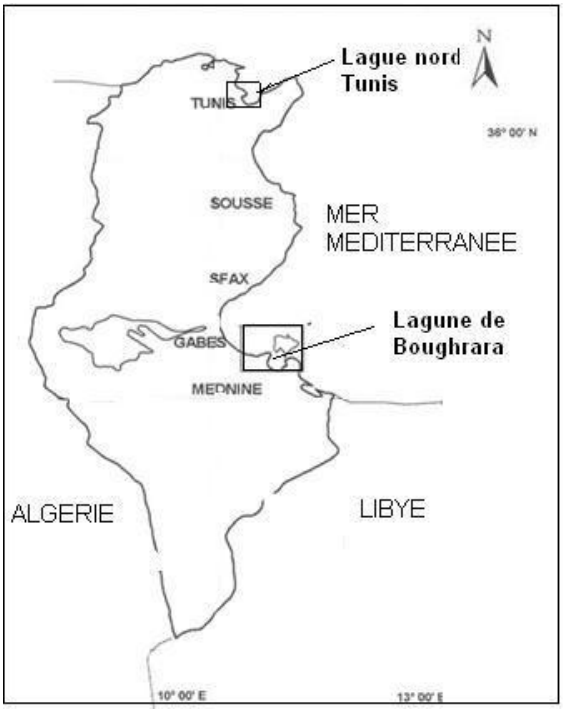

Fig. 1. Situation géographique des lagunes nord de Tunis et de Boughrara

L'étude de la sex-ratio a été effectuée pour une totalité de 977 individus de la lagune nord de Tunis et 1074 individus de la lagune de Boughrara. Cet indice est calculé globalement puis selon les saisons et selon les tailles. Sa variation saisonnière et selon la taille a été mise en évidence par le test de conformité χ^2 [1] au seuil de probabilité de 5%. Le cycle sexuel est abordé suivant deux approches : · la première qualitative : observations des frottis des gonades et de l'état du pied et l'histologie de la gonade. · la seconde quantitative : cycle pondéral.

Résultats et discussion
L'étude de la sex-ratio dans les deux lagunes a mis en évidence une dominance des mâles sauf pendant la période de la ponte où les femelles sont majoritaires. Par ailleurs, la dominance des femelles est remarquée pour les petites tailles dans la lagune nord de Tunis et pour les grandes tailles dans la lagune de Boughrara. Nos résultats diffèrent de ceux de Zamouri-Langar [2] qui a montré que, dans la lagune nord de Tunis, la sex-ratio est de 1:1,04 en faveur des femelles.
L'analyse de l'évolution temporelle du cycle pondéral, de l'état du développement des gonades, ainsi que les coupes histologiques a montré la présence d'une ponte principale en été, des émissions secondaires en automne et l'absence de phase de repos sexuel dans les deux lagunes étudiées. Néanmoins, la ponte principale débute en juin pour la lagune de Boughrara et en juillet pour lagune nord de Tunis. Nos résultats sont en accord avec les observations de [3] et de [4] qui ont montré la présence de deux périodes d'émissions gamétiques pour la population marocaine de palourdes, de la côte Atlantique et de la lagune de Mouley Bousselham. En revanche, [5] indiquent que pour la palourde d'El Hofra, et de Borj Ungha (golfe de Gabès, Tunisie), la gamétogenèse se déroule depuis mars jusqu'à décembre avec une seule phase d'émissions des gamètes (octobre/décembre) et une courte phase d'inactivité sexuelle. Ces auteurs supposent que la pollution par les métaux dans ces deux zones a engendré une perturbation du cycle reproducteur des palourdes.

Conclusion
La détermination de la sex-ratio ainsi que la description du cycle sexuel de la palourde *Venerupis decussata* dans les deux lagunes tunisiennes garde une signification "provisoire" puisqu'elles restent sous l'influence des fluctuations des paramètres du milieu.

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Session

Aquaculture - growth

Modérateur : **Soliman Abdel Rahman**

GROWTH PERFORMANCE OF GREY MULLET, *MUGIL CEPHALUS*, AND CLAM, *RUDITAPES PHILIPPINARUM* IN IN INTEGRATED MULTITROPHIC SYSTEM

Soliman H. Abdel Rahman [1]*, Fatma A. Abdel Razek [1] and Mohammed A. G. El Absawy [1]
[1] National Inst. Oceanography & Fisheries - soliman2410@gmail.com

Abstract
Integrated systems were developed to mitigate negative impacts of intensive fish culture on environment and to increase profit. This IMTA system was established in NIOF, Alexandria and consisted of 3 seabream intensive tanks and 2 successive ponds for mullet and clam culture. Feed was supplied to seabream tanks only. Mullet grow on wastes of seabream tanks from 50 to 800 g in 240 days, and clams grow from 1.2 to 7.5 g in the same period. Feed efficiency increased by 25% and return on investment by 30% in IMTA. Dissociated ammonia decreased from 81at inlet of seabream tanks to 62µMole/l at the outlet of the IMTA system.

Keywords: Aquaculture, Nutrients, North-Eastern Mediterranean

Introduction
As a result of domestication success of gilthead seabream in the last 30 years, the production of this species in Mediterranean countries exceeded 140,000 ton in 2011 [1]. Sea bream is fed diets containing between 40-45% protein, but it consume only 25-30% of this protein and the rest is discharged to the environment as excretory products[2] . Researchers developed an integrated multitrophic system "IMT" to mitigate eutrophication impacts and increase profitability [3]. Intensive culture of seabream is a new field in Egypt, and some experimental IMT systems are in operation. Utilizing grey mullet and manila clams as detritus consumers are of great importance for this new business. Both species are endemic to Egyptian coastal water, consume detritus and of high economic value. This study was conducted to evaluate the use of flathead grey mullet, *Mugil cephalus* and manila clam, *Ruditapes philippinarum* as biological convertors of detritus produced from intensive seabream culture.

Material and Methods
Water flow from intensive seabream tanks (120 m^3 total water capacity, stocked at 2.5 kg fish/m^3) were discharged into two successive 300 m^2 earth ponds. First pond stocked with 50 g mullet fingerlings (1000 fish), and the second stocked with 1.2 g clam juveniles (15000 indv.). Seabream was fed with 42% commercial feed. No feed supplied to other ponds. The experiment continued for 250 days. Protein content in animals, ammonia-N and nitrate-N concentrations in water were measured using APHA standard methods [4]. Monitoring and control systems continuously measured water flow, water temperature, pH and oxygen in all compartments of the system.

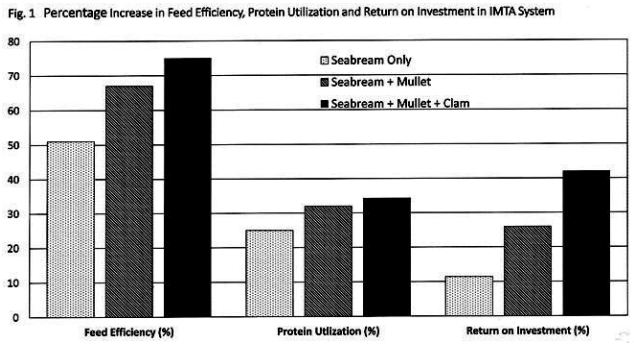

Fig. 1. Percentage increase in feed efficiency, protein utilization and return on investment using IMT system

Results and Discussion
Grey mullet grow from an average initial body weight of 50 g/fish to 801 g/fish during the rearing period (240 days) and the total biomass increased from 50 kg/pond at start up to 720 kg/pond at the end of the experiment. Manila clams increased in average weight from 1.2g to 7.5g/indiv. and the total biomass increased from 18.2 kg/pond to 86.5 kg/pond. Feed efficiency increased by 25% and return on investment by 30% in IMTA (Fig. 1).

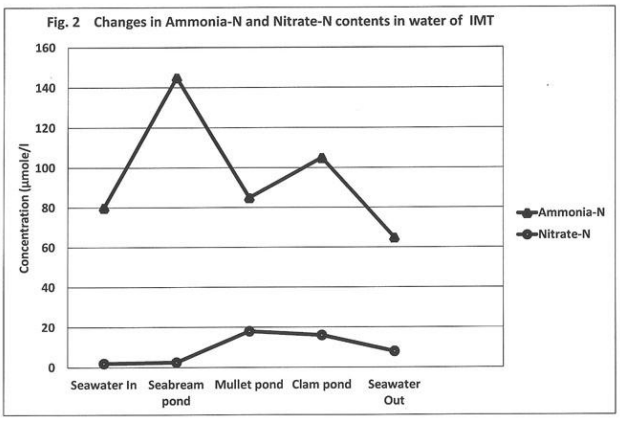

Fig. 2. Change in Ammonia-N and Nitrate-N in different locations of IMT

Water temperature ranged between 18^0C in winter to 27^0C in summer and salinity ranged between 34-36 ppt. Nitrate-N level was 2.1 µMol/L at the seawater input, increased to 17 µMol/L in fish ponds as a result of the high input of diet, and decreased at the outlet to 6.5 µMol/L. Ammonia-N was relatively high at the source (80 µMol/L) in fish ponds increased to 145.5 µMol/L in seabream tanks and maintained high level at mullet pond then decreased at the entrance of clam pond , increased to 105.6 µMol/L at the outlet of clams pond and finally decreased at the outlet to a low value of 62 µMol/L (Fig. 2). Ammonia and nitrate levels in different sites of the project revealed that their concentrations at the output are less than that of the input level. These results suggest that these compounds are being absorbed or oxidized in the sedimentation pond.

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BILAN DE SURVEILLANCE HISTOPATHOLOGIQUE DE LA PALOURDE (*RUDITAPES DECUSSATUS*) LE LONG DU LITTORAL TUNISIEN

H. Attia El Hili [1]*, C. Ben Salah [1], W. Ayari [1], N. Ben Amor [1] and H. Dardour [1]
[1] Institut des Sciences et Technologies de la Mer, Salammbô, Tunisie - hedia.attia@instm.rnrt.tn

Abstract
Un suivi histopathologique de la palourde *Ruditapes decussatus* a été effectué pendant quatre années au niveau de treize zones de production naturelle réparties le long du littoral tunisien. Les parasites détectés sont: des protozoaires (*Perkinsus* sp.) parasites à déclaration obligatoire ; des stades larvaires de trématodes digènes : sporocystes, rédies et métacercaires; des procaryotes intracellulaires de type Rickettsien ou Clamydien, et enfin des grégarines observés chez un seul individu. Les prévalences des trématodes digènes, en particulier le stade métacercaire, sont souvent significativement supérieures à celles des autres parasites. Lorsque l'on considère séparément chaque zone d'échantillonnage, aucune corrélation entre *Perkinsus* sp. et les trématodes digènes en terme de prévalence n'a été détectée.

Keywords: Diseases, South-Eastern Mediterranean

Introduction

En Tunisie, la palourde (*Ruditapes decussatus*) est présente pratiquement tout le long du littoral tunisien. Elle fait l'objet d'une surveillance zoo sanitaire pour le dépistage des parasites notamment ceux à déclaration obligatoire : La Perkinsiose dont l'agent pathogène est *Perkinsus olseni* (protozoaire, *Apicomplexa*). Le présent travail récapitule les résultats de quatre années de surveillance anatomo-pathologique des échantillons de palourdes provenant de 13 zones de production.

Matériel et méthode

Le suivi a concerné 13 zones de production et il a été réalisé de l'été 2004 à l'été 2008. Une centaine d'individus par échantillon et par zone de production ont été prélevés en hiver et en été. Les organes de chaque individu ont été fixés dans une solution de Davidson pour une étude histologique. L'identification des parasites a été est réalisée grâce à l'examen microscopique de chaque coupe colorée à l'Hémalun- Eosine.

Résultats et discussion

Le dépistage parasitaire a montré la présence de *Perkinsus* sp. parasite à déclaration obligatoire ; des stades larvaires de trématodes digènes : sporocystes, rédies et métacercaires; des procaryotes intracellulaires de type Rickettsien ou Clamydien, et enfin des grégarines observés chez un seul individu. En terme de prévalence les trématodes digènes, en particulier le stade métacercaire, sont souvent significativement supérieures aux autres parasites (figure 1). Les prévalences des infestations parasitaires par des stades larvaires de trématodes digènes au niveau des zones de production ne sont pas liées ni à la période de prélèvement. ni à la zone de production. Cependant des auteurs ont montré l'importance des facteurs biotiques comme la température [2], la densité de la population-hôte amont et la présence des macrophytes [3] qui peuvent être des facteurs potentiels régissant la répartition et la transmission des trématodes digènes. Les prévalences de l'infestation parasitaire du protozoaire *Perkinsus* sp. au niveau des zones de production ne sont pas liées ni à la période de prélèvement. ni à la zone de production. Ces résultats ne concordent pas avec certaines études. Ainsi, Villalba *et al.* en 2001 [5] ont dénoté une corrélation positive entre l'élévation de la température et l'augmentation des prévalences et des degrés d'infestation. Alors que Park et Choi en 2001 [4] ont constaté qu'aussi bien les prévalences que les intensités d'infestation à *Perkinsus* chez l'espèce *philippinarum* de la côte ouest de la Corée sont assez élevés même à une température de l'eau de l'ordre de 3,1°C. Les résultats montrent par ailleurs que l'infestation aux procaryotes intracellulaires de type Rickettsien ou Clamydien ne concerne que quelques zones de production et elle est surtout localisée au niveau des branchies. Les prévalences les plus élevées ont été observées en hiver au niveau de deux lagunes : le lac de Tunis et le lac Biban qui sont des zones relativement fermées. Les grégarines qui sont des Protistes sporozoaires ont été observées au niveau des branchies chez un seul individu. Ils sont souvent associé à une réponse inflammatoire localisée mais sans effet appréciable sur la santé des animaux [1]. Par ailleurs, quand on compare les prévalences à *Perkinsus* sp. et aux trématodes digènes pour chaque zone d'échantillonnage, aucune corrélation entre ces parasites n'a été détectée.

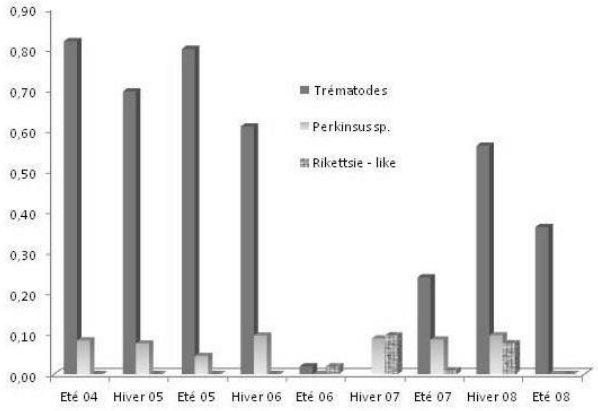

Fig. 1. Prévalence de *Perkinsus* sp., de Trématode digène et de Rickettsie-like chez *Ruditapes decussatus* dans la lagune de Bizerte.

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SIZE AT MATURITY OF *SQUALUS MEGALOPS* (MACLEAY, 1881) AND *SQUALUS BLAINVILLEI* (RISSO, 1826) FROM THE GULF OF GABÈS

Sondes Marouani [1], Hasna Kadri [1], Abderrahmane Bouain [1] and Mohamed N. Bradai [1]*
[1] Faculté des sciences de Sfax BP.802 - mednejmeddine.bradai@instm.rnrt.tn

Abstract
Size at maturity was estimated for *Squalus megalops* and *Squalus blainvillei* from the Gulf of Gabès (Tunisia). Females of *S. blainvillei* and *S. megalops* reach maturity at 62.5 cm TL and 56.41 cm TL, respectively. Males mature at 44.39 cm TL for *S. megalops* and 52.3 cm TL for *S. blainvillei*.

Keywords: Reproduction, Gulf of Gabes

Introduction
Both *Squalus megalops* and *S. blainvillei* are viviparous aplacental demersal sharks. The former is distributed throughout the Mediterranean Sea [1] while the occurrence of *S. megalops* was recently confirmed in the area [2]. In the Mediterranean Sea, data on the biology of *S. blainvillei* were scarce [3] while those on *S. megalops* were lacking. Maturity size is crucial for quantitative analysis of the populations and is useful in fisheries management. This study aims to estimate size at maturity for both dogfishes *S. megalops* and *S. blainvillei* off the Gulf of Gabès.

Materials and methods
A total of 630 specimens of *S. megalops* (323 males and 307 females : 18.8 – 76 cm TL) and 232 individuals of *S. blainvillei* (108 males and 124 females : 23.8 - 100 cm TL) collected from the commercial catches in the Gulf of Gabès during the period between January 2007 and May 2009 were examined. Sexual maturity stages (juveniles, subadults and adults) for both sexes were determined according to Braccini *et al.*, (2006) [4]. The size at maturity L50 was defined as the length at which 50% of the individuals were mature.

Results and Discussion
In the Gulf of Gabès, *S. megalops* matured at 62.5 and 74.22% of their maximum length respectively for males and females whereas *S. blainvillei* matured at 62.26 and 63.41% of their maximum length respectively for males and females.

Both males and females of *S. blainvillei* reached first sexual maturity at larger size than *S. megalops* (Tab. 1).

Tab. 1. Size at maturity in *Squalus blainvillei* and *Squalus megalops* from different localities

Species	Location	TL max (cm)	Maturity (mm TL)	Maturity $\%TL_{max}$
Squalus blainvillei	Central Mediterranean Sea (Present study)	♀100.0 ♂83.4	62.5 (L50) 52.3 (L50)	63.41 62.26
	Western Mediterranean Sea (Sion *et al.*, 2003)	♀78.5 ♂66.4	60.1 (L50) 45.0-51.0	77.0 68.0-77.0
	Eastern Mediterranean Sea (Kousteni & Megalofonou, 2011)	♀77.9 ♂79.9	65.4 45.7	-- --
Squalus megalops	Central Mediterranean Sea (Present study)	♀76.0 ♂69.0	56.4 (L50) 44.3 (L50)	74.22 62.5
	South Africa, SE Atlantic (Watson & Smale, 1998)	♀78.2 ♂57.2	50.0 (L50) 40.0 (L50)	64.0 70.0
	SE Australia (Braccini *et al.*, 2006)	♀63.5 ♂47.0	45.9-49.5 (L50's) 37.3-39.8 (L50's)	72.0-78.0 79.0-85.0

;

In both species females matured sexually at a larger size than males. Comparisons between populations show that *S. blainvillei* off the Gulf of Gabès, off Western Mediterranean [3] and off Eastern Mediterranean Sea [5] reaches maturity at a comparable size.

Compared to populations studied of Australia [4] and South Africa [6], *S. megalops* off the Gulf of Gabès reaches maturity at a greater size.

In fact, there is considerable geographical variation in the size at maturity for *Squalus* species. Besides, regional variation in elasmobranchs reproductive parameters is common, but, some part of the variation in *Squalus* species could be a result of taxonomic confusion [7].

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REGIME ALIMENTAIRE DE *ROSTRORAJA ALBA*, RAIE BLANCHE, DANS LE GOLFE DE GABES (TUNISIE)

Hasna Kadri [1]*, Sondes Marouani [1], Abderrahmen Bouain [1] and Mohamed N. Bradai [1]
[1] Faculté des Sciences de Sfax - hasnakadri@yahoo.fr

Abstract
L'étude du régime alimentaire de *Rostroraja alba* a été réalisée sur 320 individus capturés dans le golfe de Gabès. L'analyse du régime alimentaire révèle que les téléostéens sont les proies essentielles suivis par les crustacés et les mollusques.

Keywords: Food webs, Elasmobranchii, Gulf of Gabes

Introduction *Rostroraja alba* est une espèce atlanto-méditerranéenne en danger critique d'extinction en Méditerranée [1]. Aucune étude sur le régime alimentaire de cette raie n'a été fournie dans cette zone. Dans ce travail, nous contribuons à la connaissance du régime alimentaire de *R. alba* dans le golfe de Gabès par l'analyse de certains indices alimentaires.

Matériel et méthodes Les contenus stomacaux de 320 individus (30 < LT< 160 cm), sont examinés pour l'étude du régime alimentaire. Pour chaque individu, nous notons le sexe, la longueur totale (LT) au cm près et l'état de réplétion est noté. Les proies sont identifiées, recensées puis pesées. l'indice de l'importance relative (IRI%) combinant les pourcentages d'occurrence (F%), numérique (N%) et pondérale (M%) a été utilisé pour décrire l'alimentation de cette espèce [2].

Résultats et Discussions Le coefficient de vacuité calculé pour les 312 estomacs pleins est de 2.56 % indiquant la voracité de l'espèce. Ce coefficient ne varie pas en fonction du sexe (x_2 = 0,13 ; dl=1 ; p>0,05) mais varie en fonction de la taille (x_2 = 0,02 ; dl=2 ; p<0,05). L'analyse des proies ingérées montre que cette espèce présente un spectre alimentaire peu varié renfermant quelques groupes zoologiques et un comportement de prédation aussi bien pélagique que benthique. La présence des Rajidae dans certains contenus stomacaux de *Rostroraja alba* montre la compétition interspécifique qui existe entre les habitants d'un même biotope
(Tab.1).

Tab. 1. Valeurs des différents indices alimentaires chez *Rostroraja alba* dans le golfe de Gabès.

Proies ingérées	F%	N%	M%	IRI%
Crustacés	41,35	30,23	5,01	15,73
Crevettes	35,58	24,65	4,38	
Penaeidae	35,58	24,65	4,38	
Crabes	8,97	5,58	0,63	
Téléostéens	73,08	48,10	49,67	77,11
Sparidae	20,51	14,22	13,83	
Congridae	2,24	0,74	0,75	
Serranidae	3,53	2,01	1,89	
Carangidae	19,23	14,07	15,99	
Clupeidae	9,29	6,11	5,50	
Mullidae	7,37	4,77	4,88	
Labridae	0,64	0,52	0,51	
Soleidae	0,64	0,15	0,29	
Scombridae	0,64	0,30	0,14	
Belonidae	2,24	0,82	0,52	
Triglidae	0,64	0,45	0,70	
Céphalopodes	18,59	7,37	15,57	4,60
Octopodidés	6,09	2,38	3,44	
Loligolinidae	8,01	3,57	11,19	
Sepiolidae	3,21	1,04	0,83	
Gastéropodes	1,60	0,52	0,09	
Annélides	5,45	2,46	0,61	0,18
Sipunculiens	9,94	3,80	1,02	0,52
Echinodermes	3,85	1,12	0,50	0,07
Elasmobranches	3,85	2,38	26,43	1,20
Rajidae	3,85	2,38	26,43	

L'analyse du régime alimentaire révèle que les téléostéens sont les proies essentielles suivis par les crustacés et les mollusques. L'analyse multivariée (MANOVA) a montré que la consommation des téléostéens, crustacés et mollusques varie en fonction de la taille mais pas en fonction du sexe et des saisons (Tab.2).

Tab. 2. MANOVA et ANOVA de Wilk's lambda et des différents groupes (DF = degré de liberté ; W,L = valeur de Wilks Lambda ; F= la valeur approximative de F ; H, df = hypothèse de df ; E, df = erreur de df ; Sig = significative).

	MANOVA						ANOVA		
	DF	W.L	F	H.df	E. df	Sig.	Crustacés	Téléostéens	Céphalopodes
Saison	3	0,93	1,87	21,00	1487,97	0,21	0,00	0,94	0,10
LT	2	0,97	1,25	14,00	1036,00	**0,00**	0,03	0,41	0,10
Sexe	1	0,96	3,17	7,00	518,00	0,13	0,58	0,22	0,66
LT * Saison	3	0,93	0,97	42,00	2433,09	0,52	0,19	1,00	0,38
Saison * Sexe	6	0,95	1,16	21,00	1487,97	0,27	0,27	0,70	0,17
LT * Sexe	2	0,93	2,87	14,00	1036,00	**0,00**	0,54	0,01	0,68
LT * Saison * Sexe	6	1,00	1,24	0,00	521,00	**0,02**	0,00	0,00	0,00

Nos résultats corroborent avec ceux d'autres auteurs [3] qui soulignent que le régime alimentaire de *R. alba* est surtout constitué de téléostéens, crustacés et céphalopodes.

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AGE ET CROISSANCE DU POCHETEAU NOIR, *DIPTURUS OXYRINCHUS* (LINNAEUS, 1758), DANS LE GOLFE DE GABES (TUNISIE)

Hasna Kadri [1]*, Sondes Marouani [1], Abderrahmane Bouain [1] and Mohamed N. Bradai [1]
[1] Faculté des Sciences de Sfax - hasnakadri@yahoo.fr

Abstract
Dipturus oxyrinchus du golfe de Gabès montre un seul arrêt de croissance par an, il se situe entre mars et avril. Les femelles atteignent des tailles et des âges plus importants que ceux des mâles. La croissance chez les mâles est plus rapide. Les paramètres biologiques de Von Bertallonfy sont :L_∞= 123,9±2,56 cm, k= 0,08 ±0,04 et t_0= -1,26±0,04 pour les femelles et L_∞= 102,1±3,23 cm, k= 0,12± 0,0710^{-3} et t_0= -1,18±0,03 10^{-1} pour les mâles.

Keywords: Growth, Elasmobranchii, Gulf of Gabes

Introduction
Dipturus oxyrinchus est une espèce atlanto-méditerranéenne en danger critique d'extinction en Méditerranée [1]. Aucune étude sur l'âge et la croissance de cette raie n'a été abordée en Méditerranée. Dans ce travail, nous contribuons à la connaissance de l'âge et la croissance de cette espèce dans le golfe de Gabès.

Matériel et méthodes
L'âge de *Dipturus oxyrinchus* a été estimé à partir d'échantillons (n= 240) en provenance du golfe de Gabès de taille comprise entre 15,5 et 105 cm LT. Pour chaque poisson nous avons relevé la longueur totale (LT), la masse du poisson entier (Mp) et la masse du poisson éviscéré (Mev). Nous avons prélevé 8 à 10 vertèbres de chaque spécimen. Durant cette étude nous avons effectué des coupes fines sur les vertèbres. La lecture a été effectuée à l'aide d'une loupe binoculaire (Lumière réfléchie) munie d'un micromètre oculaire. Nous avons analysé les variations mensuelles de l'allongement marginal (AM).

Résultats et Discussion
Les marques d'arrêt de croissance s'inscrivent nettement sur les vertèbres. Egalement l'alternance des bandes opaques et des bandes translucides est clairement visible sur les vertèbres entières. Nous avons obtenu de faibles valeurs de l'indice du pourcentage moyen d'erreur (PME) (3,12 %) ce qui indique une bonne précision dans l'identification des vertèbres. L'analyse des fluctuations de l'allongement marginal des vertèbres en fonction du temps, nous a permis d'établir la date de formation de l'anneau d'arrêt de croissance et d'en valider la périodicité, un seul arrêt de croissance par an, il se situe entre mars et avril (fig.1)

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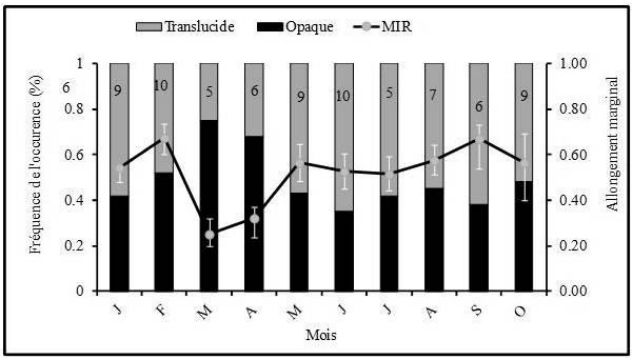

Fig. 1. Variations mensuelles de l'allongement marginal et des fréquences de bandes opaques et translucides dans les vertèbres chez *Dipturus oxyrinchus* du golfe de Gabès

Les paramètres de l'équation de Von Bertallonfy sont : L_∞= 123,9±2,56 cm, k= 0,08 ±0,04 et t_0= -1,26±0,04 pour les femelles et L_∞= 102,1±3,23 cm, k= 0,12± 0,07 10^{-3} et t_0= -1,18±0,03 10^{-1} pour les mâles. L'âge maximum observé est de 25 ans chez les femelles et de 22 ans chez les mâles (fig. 2).

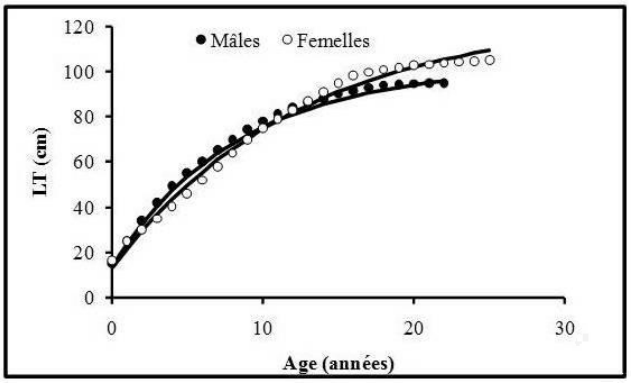

Fig. 2. Croissance des mâles et des femelles de *Dipturus oxyrinchus* du golfe de Gabès

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THE PRODUCTION OF TRIPLOID BROWN TROUT (*SALMO TRUTTA*) USING CAFFEINE TREATMENT

Funda Turan [1]*, Damla Yigitarslan [1], Fahriye Arslan [1] and Cemal Turan [1]
[1] Marine Science and Technology Faculty, Mustafa Kemal University, Iskenderun, Hatay, Turkey - turanfunda@yahoo.com

Abstract
In the present paper suitable conditions were determined for caffeine treatment that is safe and inexpensive for the induction of triploid brown trout. To suppress the second meiotic division, fertilized eggs were exposed to three different concentrations (5- 10 and 15-mM) caffeine solution for 10 min beginning at 15 min after fertilization. After that, the eggs were incubated at ambient temperature until hatching. Incidence of triploid fry was determined from flow-cytometric analysis. There was no significant difference in the mean triploid rates all caffeine treatments and not observed successful results in these groups.

Keywords: Aquaculture, Iskenderun Bay

Introduction
Triploidization as one of the modern genome manipulation methods in aquaculture is most often applied to salmonids. Triploids are organisms with three sets of chromosomes in their somatic cells instead of the usual two in diploids. The importance of triploid animals in aquaculture arises from this predisposition for sterility. Triploids can also be produced by crossing tetraploids with diploids (Liu et al., 2004). Chemical treatments such as cytochalasin B (CB) (Sun et al., 1992; Maldonado et al., 2001 and Liu et al., 2004) and 6-dimethylaminopurine (6-DMAP) (Yan and Chen, 2002 or Liu et al., 2004) are simpler than physical treatments because specific equipment is not required. However, CB is highly toxic, and careful handling is necessary. Moreover, both CB and 6-DMAP are very expensive and not realistic for large scale treatment in commercial hatcheries. Caffeine, a chemical that is a recognized food constituent in many countries, is safer and cheaper than either CB or 6-DMAP. Therefore, caffeine is a promising agent for the mass production of triploids (Okumura et al., 2007). But, triploid induction by caffeine treatment have been only reported exclusively in bivalves by Scarpa et al.1994 and abalon by Okumura et al., 2007, rainbow trout by Turan et.al., 2012. Therefore, in the present study we intended to ascertain whether induction of triploidy by caffeine treatment in the brown trout Salmo trutta

Materials Methods
The experiment was carried out in Kahramanmaras trout farm of Kiliç Holding Co. in Turkey. The fertilized eggs were exposed to three different concentrations (5- 10 and 15-mM) caffeine solution for 10 min beginning at 15 min after fertilization. Diploid controls were originated from the same parents but not subjecting them to caffeine treatment. A pool of fertilized eggs from different spawners was distributed in triplicate for each trial and one control group. The fertilization was carried out in water at a temperature of 9.5 ±0.5 ° C. The survival rate was evaluated after hatching (d.p.h). The larvae were sampled from each treatment group at 3 day after hatching (d.p.h) and fixed with 70% ethanol and stored at -20°C until analysis (Nomura et. al., 2004). For measurement of the relative DNA content, flow cytometry (FCM) was conducted using a BD FACS Canto flow cytometer. The method of FCM analysis followed the protocol described by Cakmak, (2011). Results are presented as mean±standard deviation of the mean and statistical testing to verify differences between the groups was carried out using a one-way analysis of variance.

Results and Discussion
Treatments for caffeine treatment triploidy induction and their corresponding survival and triploidy rates are shown in Table 1. The survival rate was ranged from 83.24% to 77.54%, and there was no statistical difference between experimental and control groups (Table 1). There was no adverse influence of caffeine treatment on survival fry in the present study. There was no significant difference in the mean triploid rates between caffeine treatments, and thus caffeine concentration had no significant effect on triploidy rates of brown trout fry. Up to date, there was no published information on triploidy induction by caffeine treatment in brown trout. On the other hand, Turan et al., (2012) reported that triploid percentages in rainbow trout were 45.40% in 15 mM caffeine treatment. This percentage may be low but indicate that caffeine treatment on triploidization of rainbow trout is effective. Therefore, further detailed investigation is required to examine the effect of caffeine treatment in order to realize a 100% triploid population which suggests that this kind of treatments can be dependent on species.

Tab. 1. Treatments for caffeine treatment triploidy induction and their corresponding survival and triploidy rates

Treatment	Time after fertilization (min)	Shock duration (min)	Survival rate*	Ploidy**	
				Percent Diploid (2n)	Percent Triploid (3n)
Control	15	10	82.51±4.96[a]	100	-
5 mM	15	10	80.42±3.63[a]	98.11	1.89
10 mM	15	10	81.64±3.54[a]	95.83	4.17
15 mM	15	10	83.46±4.39[a]	93.52	6.48

*Values (mean ± S.D. of triplicate) with same superscripts in each line indicate not significant differences (P<0.05).
**Based on the relative DNA content measured by flow cytometry

This is a first report to our knowledge regarding the potential use of caffeine treatment on induction of triploidy in brown trout. As described previously, caffeine treatment is simple, safe, and inexpensive. Furthermore, other dosage of caffeine should be tried for induction of triploidy of trout in order to get success.

Acknowledgements. We thank to Taner SEKER from the KILIÇ HOLDING Co. for allowing this experiment in their farm. Also, we thank the Izmir Institute of Technology for its support.

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CROISSANCE DE L'HUÎTRE *C. GIGAS* EN ÉLEVAGE DANS LA BAIE DE DAKHLA, MAROC

H. Zidane [1]*, M. Menioui [2], A. Mouradi [3], A. Orbi [4] and F. Zidane [5]
[1] Institut National de Recherche Halieutique - zidaneinrh95@hotmail.fr
[2] Institut Scientifique, Rabat, Maroc
[3] Université Ibn Tofail/Faculté des sciences Kénitra. Maroc
[4] Institut National de Recherche Halieutique, Casablanca, Maroc
[5] Université Hassan II, Faculté des sciences Ain chok Casa I

Abstract
Pour développer la filière ostréicole dans la région de Dakhla et afin qu'elle devienne une référence dans ce secteur d'activité, une étude comparative de la croissance de l'huître creuse en élevage a fait l'objet de ce présent travail. Les naissains T6 importés d'écloserie atteignent la taille commerciale en 7 mois. En parallèle, les premiers essais de captage de naissains sur des tuiles chaulées ont été réalisés en 2005. Les résultats ont montré que l'hydrodynamisme de la baie favorisent le captage de naissains et par la suite le développement d'une telle production.

Keywords: Aquaculture, Growth, Izmir Bay

Introduction
Dans le cadre de la gestion des zones conchylicoles, la constitution de base de données forment un référentiel nécessaire à l'évaluation du milieu. Les connaissances relatives à la variabilité spatio-temporelle des croissances permettent d'évaluer les tendances au niveau des cheptels. L'élevage de l'huître creuse C. gigas est pratiqué dans la baie de Dakhla seulement depuis 2004 pour pallier la faible production ostréicole de la lagune de Oualidia. Ainsi, le suivi de la croissance et de la mortalité de l'huître creuse mise en élevage dans la baie a été étudié durant la période 2004–2006 à DunaBlanca et 2005-2007 à Boutalha.

Matériels et Méthode
Deux lots de 3600 individus chacun sont distribués dans des poches ostréicoles et accrochées à des tables métalliques. Des prélèvements mensuels de 100 individus d'huître, ont été effectués et ont servi à l'étude comparative de l'évolution saisonnière des paramètres morphometriques et pondéraux.

Résultats et Discussion
Les paramètres hydro-biologiques de la baie [1, 2] sont favorables à une croissance allométrique et pondérale rapide des huîtres mises en élevage (fig. 1). Ainsi, quelque soit la zone d'élevage, une croissance en longueur rapide est enregistrée au cours de la première phase d'élevage avec des taux de croissance mensuels moyens de 30,9 ± 11% et 30,5 ± 25,9 % respectivement dans la zone de Duna Blanca et la zone de Boutalha. Aussi, les naissains d'écloserie pesant 1,15g atteignent un poids compris entre 60 et 80g au bout de 7 mois respectivement à Boutalha et DunaBlanca. Ce ci se traduit par un gain journalier de 1g/j pour les huîtres élevées à Boutalha et 0,7g/j pour les huitres élevées à Dunablanca.

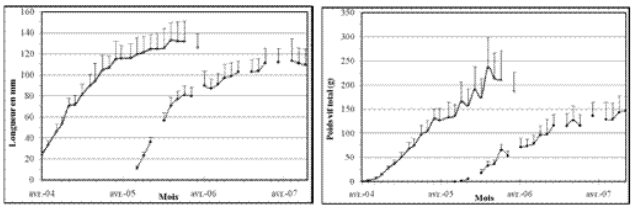

Fig. 1. Croissance en longueur et en poids vif des huîtres mises en élevage à Duna Blanca (avril 2004-mars 2006) et Boutalha (juin 2005-août 2007).

En comparaison avec des travaux antérieurs [3, 4, 5] qui ont montré qu'avec un poids de départ compris entre 15 et 30g, les huîtres atteignent, à 30 mois, un poids compris entre 58g et 99g (Tab.1), le cycle de production de l'huître creuse à Dakhla reste le plus court. Ce qui permettra aux ostréiculteurs de cibler les périodes de hausse demande.

Tab. 1. Taux de croissances de l'espèce *C. gigas* mis en élevage dans différents sites.

Région et l'auteur	Poids vif (g) après 12 mois	Poids vif (g) après 24 mois
Oualidia [4]	43g	120g
Marénne Oléron [5]	48g	60g
Arcachon [6]	15g (18 mois)	58g (30 mois)
Bretagne sud [6]	28g	99g
Baie de Dakhla (Duna Blanca) présente étude	127g	188g
Baie de Dakhla (Boutalha) Présente étude	79g	129g

Les analyses macroscopiques de la gonade couplées à l'évolution de l'indice de condition des huîtres ont montré que la maturité sexuelle se développe après trois mois d'élevage : les naissains mis en eau en avril 2004, voient leurs gonades se développer en juillet et la libération des gamètes se fait en Octobre 2004. Aussi, les premières évaluations de ce captage par les tuiles chaulées encouragent le développement d'une telle activité. Or l'évolution du taux d'accroissement des naissains d'huîtres captés, ne dépasse pas 35 cm pendant une année d'élevage, ce qui laisse penser que les naissains collectés sont des huîtres hybrides entre l'huître naines indigènes *Ostreola Stentina* et l'huître creuse introduite. Au cours de cet élevage le taux de mortalité ne dépasse pas 10%, il reste le plus faible en comparaison avec d'autres études [3].

Conclusion
Les performances de la croissance de l'huître dans la baie de Dakhla est du à la grande capacité nutritive de la baie; Cette dernière est relative à l'extension des projets aquacoles et touristiques dans la baie; ce qui nécessite un suivi régulier de l'évolution du degré de la capacité trophique de l'écosystème.

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Session

Aquaculture - invertebrates

Modérateur : **Serpil Serdar**

REPRODUCTIVE PERIODICITY OF SEA CUCUMBER *BOHADSCHIA VITIENSIS* (ECHINODERMATA: HOLOTHUROIDEA) IN HURGHADA AREA, RED SEA, EGYPT

Fatma Abdel Razek [1]*, H. A. Omar [1], S. H. Abdel Rahman [1] and N. A. El Shimy [2]
[1] National Institute of Oceanography and Fisheries Qayet Bay - fatma_abdelrazek@hotmail.com
[2] Zoology Department, Faculty of Science, Assiut University

Abstract
A small scale sea cucumber fishery began in Egypt in 1998 on the northern part of Red Sea coast fig. (1). By the year 2000, its fishery had expanded dramatically, leading to over exploitation. Evidence from previous study [1] indicates that four years after banning sea cucumber fishery in Egyptian Red Sea, some commercial species are returning to some of the sites, but there is no evidence of stock recovery. B. vitiensis was studied during 2003-2004 and a population analysis of 417 individuals showed significant abundance of males. Reproductive studies showed also that during June and July an intensive period of spawning occurred with size at 1st maturity of 24.5 and 26.1 cm for males and females respectively. The oocyte diameter of ripe females ranged from 87.5 to 162.5 µm during active spawning period.

Keywords: Reproduction, Red Sea, Echinodermata, Spawning

Introduction

Holothuroid fauna of the Red Sea attracted attention of many investigators for many years ago. In the various habitats of the Red Sea 98 holothuroid species were recorded, including *Bohadschia vitiensis* the subject of this study. Still, little is known about maturation and spawning periodicity of most commercial sea cucumber species in Egyptian Red Sea fisheries.

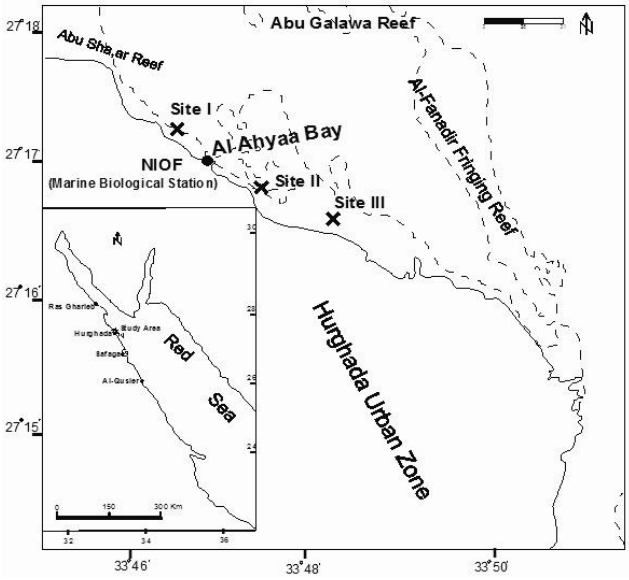

Fig. 1. Locations of sampling sites of *Bohadschia vitiensis*

Materials and method

Monthly samples of *B. vitiensis* of about 10-15 individuals were randomly collected by SCUBA divers from selected sites Fig. (1). Measured were done after relaxation in 2.5% $MgCl_2$ (w/v) to overcome the error resulting from contraction and relaxation. Gonads were removed and preserved. T.L & T. body wt. were recorded. G.S.I were calculated as Gonad weight/body weight X 100 . Four maturity stages were determined according to colour length & diameter of gonad tubules [2]. Oocyte diameters were measured.

Results & Discussion:

Population analysis were done, T.L range of *B. vitiensis* was from 16.0 to 42.0 cm. Which is consider one of the large species found in comparison with *H. atra* of T.L range from 9.5 to 28.5 cm [3]. There is a shift in sex ratio from unity towards significantly more males and this is not due to impact of fishing pressure as in case of *H. hawaiiensis* and *H. atra* [4]. The maximum reproductive activity was observed in summer and the minimum (resting) in late autumn and winter using G.S.I as well as tubule length and diameter as in tab. (1). There is a synchrony between males and females as in case of *H. scabra* [5]. More studies focusing on fecundity per size distribution and estimating the ideal size to capture to avoid over exploitation.

Tab. 1. Macroscopic characteristics of *B. vitiensis* gonads at each of the stages of sexual maturity

Stage of Maturity	Sex	Tubule Characteristics		GSI range
		T.L. (mm) range	Diameter range (mm)	
I Immature	♀+♂	2.5 - 21 .0	0.2 - 1.0	1.00 - 3.5
	♂	2.0 - 22.0	0.2 - 0.9	0.40 - 3.1
II Maturing	♀+♂	15.0 - 50.0	0.4 - 1.3	7.50 - 16.7
	♂	18.0 - 66.0	0.4 - 1.2	0.80 - 0.9
III Ripe	♀+♂	67.0 -130	1.9 - 2.5	28.2 - 9.7
	♂	90.0 -125	1.5 - 2.0	16.2 - 7.2
IV Spent	♀+♂	19.0 - 350	0.5 - 0.7	0.50 - 1.5
	♂	12.0 - 46.0	0.3 - 0.9	0.40 - 10.8

As mentioned before there are 4 stages of maturity in *B. vitiensis*. In immature and spent stages both female and male gonads appear alike in shape and color. While during mature and ripe stages differentiation appear between in shape and color. During maturing stage the tubules of female are Long, thick, branched and the ovary is pale red, while in male tubules are Long, thin, branched and creamy-white. During the ripe stage, the female tubules are Long, thick swollen, branched and red in color, while in male tubules are long, swelling with white beaded filaments. The female tubules have spherical oocytes mostly ripe of 75 - 150 micron in diameter and with clearly visible nucleus while the male tubules have numerous swimming spermatozoa.

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ETUDE COMPARATIVE DES PERFORMANCES DE LA CROISSANCE DE LA MOULE (*MYTILUS GALLOPROVINCIALIS*) EN MER OUVERTE ET EN MILIEU LAGUNAIRE

Rym Ben Kheder-Dhaoui [1]*, Imen Boukef Ben Omrane [2], Sondes Milliti [3] and Mohamed Chalgaf [1]
[1] Institut Supérieur de Pêche et d'Aquaculture ISPA Bizerte - benkheder_rym@yahoo.fr
[2] Laboratoire du Microbiologie, Institut National Des Sciences et Technologies de la Mer (INSTM), Rue du 2 mars 1934, 2025, Salammbô, Tunisie
[3] Faculté des Sciences de Bizerte

Abstract
Dans cette étude, nous avons comparé deux milieux en tant que site conchylicole : la lagune de Bizerte *vs* la baie de Bizerte (Tunisie). Cette étude porte sur les performances de croissance de *Mytillus galloprovincialis* dans les deux sites ainsi que les variations de la qualité bactériologique. Le choix de ces deux stations nous permettra d'évaluer l'influence des différentes conditions du milieu sur les moules élevées pendant 4 mois consécutifs du 20/02/2012 au 20/06/2012.

Keywords: Lagoons, Open sea, Mollusca, Mediterranean Ridge

Introduction

Mytilus galloprovincialis présente de nombreuses adaptations aux conditions environnementales. Outre leur valeur biologique, leur exploitation à des fins conchylicoles les classe avec les ostréidés parmi les bivalves de grande valeur économique générant des revenus financiers importants. En Tunisie, *Mytilus galloprovincialis* est présente sur les côtes nord jusqu'à la pointe du Cap Bon. Le cantonnement de cette activité dans la seule lagune de Bizerte témoigne de la sous exploitation de cette espèce en Tunisie. Une éventuelle saturation des capacités spatiales et biologiques de ces milieux exigus laisse envisager la conquête d'autres espaces et l'expansion de cette activité en mer ouverte. L'objectif de ce travail est de comparer les performances de croissance de la moule *Mytilus galloprovincialis* en mer ouverte et en milieu lagunaire en parallèle avec une étude bactériologique. Le choix de ces deux stations nous a permis d'évaluer l'impact des différentes conditions du milieu sur les moules élevées.

Matériels et Méthodes

Cinq lots de 100 individus de moules (*Mytillus galloprovincialis*) sont suspendus chacun dans la lagune de Bizerte et cinq autres lots en mer ouverte. Les paramètres physico-chimiques de l'eau (température, pH, salinité, oxygène dissous) sont mesurés *in situ* à l'aide d'une sonde multiparamétrique étanche. Le dosage de la *chlorophylle-a* est réalisé par une méthode fluorimétrique. Dans chaque station, quarante individus sont prélevés mensuellement pour l'étude biométrique, 6 individus pour l'étude biochimique (dosage des lipides [1] et des protéines [2]) et dix individus vivants sont échantillonnés tous les quinze jours pour l'étude bactériologique. Les dénombrements bactériens des coliformes totaux (CT), des *Vibrionaceae* (VB) et des bactéries hétérotrophes cultivables (BHC) sont effectués pour l'eau de surface et pour les moules.

Résultats et discussion

Les résultats révèlent une croissance meilleure dans la lagune avec un accroissement mensuel en taille de 0,9 cm *vs* 0,5 cm en mer et un gain en poids total de 7 g dans la lagune contre seulement 0,5 g en mer. Ceci peut être expliqué principalement par la température de l'eau ($T°C_{lagune} > T°C_{mer}$) ainsi que par la richesse nutritive de la lagune [3]. En effet le dosage de la *chlorophylle-a* montre des taux plus élevés dans la lagune d'une part (3,86 µg/l *vs* 2,19 µg/l en mer ouverte) et en fonction de la température d'autre part où les valeurs les plus élevées coïncident avec l'augmentation de la température de l'eau. Cette richesse nutritive du milieu lagunaire se traduit d'ailleurs par la colonisation rapide des élevages par des moules épibiontes issues de captage naturel responsables de mortalités importantes. Par ailleurs, les analyses biochimiques révèlent, quel que soit le site, que chez les moules les réserves énergétiques sont majoritairement composés de carbohydrates (75%). Ensuite, les protéines constituent le deuxième composé important avec une moyenne d'environ 20 % sans toutefois de différence majeure entre les deux lots. Les lipides, composé le moins abondant, affichent une différence de presque le double 3,28 % et 7,32 % respectivement chez les moules issues de la lagune et celles provenant de la mer. La chromatographie en phase gazeuse a identifié une quinzaine d'acides gras dans les lipides totaux des mollusques bivalves. Le profil lipidique des acides gras (AG) de la chair des moules révèle que la fraction des acides gras saturés (AGS) est la plus dominante dans les deux sites (44 %). Elle est représentée par l'acide myristique C14:0, l'acide acide stéarique C18:0 et l'acide palmitique C16:0 qui se trouvent en proportions quasi-similaires chez les moules issues des deux stations. A l'opposé, la prédominance des AGPI a été signalée chez d'autres espèces telles que *Argopecten purpuratus* [4] et *Nodipecten subnodosus* [5]. Les pourcentages élevés en AGS enregistrés seraient liés à la richesse du milieu en détritus organiques constituant une importante source de C14:0, C15:0, C16:0 et C18:0 comme mentionné par Freites *et al.* [6]. Les acides gras polyinsaturés représentent la fraction intermédiaire des acides gras totaux (36 et 41 % respectivement chez les moules issues de la mer et de la lagune). L'acide gras polyinsaturé le plus abondant chez les moules de la lagune est l'acide linoléique (C18 :2n-6 ; 23 %), il représente presque la moitié chez les moules de la mer (13 %). Les autres acides gras polyinsaturés existent presque avec les mêmes proportions chez les deux groupes analysés. Notons que les acides docosahexaenoïque (DHA, C22:6 n-3) et eicosapentaenoïque (EPA, C20:5 n-3) figurent également en parts presque égales chez les deux lots. Enfin, les acides gras monoinsaturés représentent la fraction la plus faible des acides gras totaux (17 %). Ce sont en majorité les acides gras C16:1 n-7, C18:1 n-9 et C18:1 n-7. Concernant l'étude bactériologique, des concentrations bactériennes plus importantes ont été détectées dans la lagune aussi bien dans l'eau de surface que dans les moules. Il est à noter que la charge en *Vibrionaceae* est corrélée avec la variation de la température et de la salinité. Le suivi d'un cycle d'élevage complet s'avère nécessaire pour une comparaison inter-sites plus globale ainsi qu'une étude modélisant la croissance de la moule en mer et en lagune en intégrant la température et la richesse nutritive du milieu.

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EFFECT OF DEPURATION ON MANILA CLAM (*RUDITAPES PHILIPPINARUM*) CONTAMINATED WITH *ESCHERICHIA COLI, SALMONELLA TYPHIMURIUM* AND *VIBRIO PARAHAEMOLYTICUS*

Mine Cardak [1]*, Fatma Arik Colakoglu [1], Ender Künili [1] and Serhat Colakoglu [2]
[1] 1Çanakkale Onsekiz Mart University, Marine Science and Technology Faculty,17100, Çanakkale-TURKEY - mine_bio98@hotmail.com
[2] 2The Ministry of Food, Agriculture and Livestock, 17100, Çanakkale-TURKEY

Abstract
Present study was performed to determine the depuration time and ability of manila clams contaminated with of *Escherichia coli, Salmonella typhimurium* and *Vibrio parahaemolyticus*. Manila clams were contaminated with each bacterium at the level of 7 $\log_{10}$ cfu g^{-1}. Then clams were analyzed in every 3 hours in the first 24 hour time period and in every 6 hours until the 72nd hour. Results of this study indicate that the depuration time for the commercial-sized *R. philippinarum* contaminated with the pathogenic bacteria at the level of 7 $\log_{10}$ cfu g^{-1} is 66 h.

Keywords: Bacteria, Marmara Sea, Bivalves

Introduction : *Ruditapes philippinarum*, manila clam, is a bivalve species which lives in sandy sediments of tidal flats or shallow coastal areas with a depth lower than 5m. Significant proportion of foodborne diseases arised from shellfishes are mostly caused by bacteria especially *Vibrio* spp., *Salmonella* spp., and *Esherichia coli* (1). Depuration is a common practice to reduce level of microorganisms in live shellfish processing. The aim of this study was to determine the depuration time and ability of manila clams contaminated with *E. coli ATCC 25922, S. typhimurium ATCC 14028* and *V. parahaemolyticus ATCC 17802* in depuration system according to legislations. **Materials and Methods** : *Ruditapes philippinarum* was harvested from offshore natural beds located in the Çanakkale Strait to Marmara Sea (Turkey). Sample contamination was conducted in 100 liters polyethylene tanks filled artificial seawater, which was inoculated with specific bacterial suspensions to reach the concentration of 8 $\log_{10}$ cfu ml^{-1}. The used inoculums were fresh overnight cultures of each organism (*E. coli, S. typhimurium, V. parahaemolyticus*). Appropriate amounts of the overnight broths were added to the uptake tank. Samples were removed from depuration tanks at 0, 3, 6, 9, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, and 72nd hours for analyses. Microbial groups were enumerated using the plate count method as described by Food and Drug Administration (3). **Results and Discussion** : Depuration process is utilized in bivalves to reduce the level of pathogenic microorganisms which have important proportion of shellfish-borne poisoning (4). This study was performed to determine the depuration time of *R. philippinarum* contaminated with *E. coli*, *S. typhimurium*, and *V. parahaemolyticus.* The depuration process was performed in 1000 liters of depuration tanks designed according to both Turkish Fisheries Legislations and European Commission Directives (5). Contamination of shellfishes via marine water by *E. coli* is mainly due to the disposal of wastewater and it indicates the possible presence of pathogenic microorganisms. Therefore, *E. coli* concentrations are recognized as shellfish quality indicator by national and international regulations. The legal limit of *E. coli* level for marketable live bivalves is 230 cfu $100g^{-1}$ (5). In *R. philippinarum*, after 66 hours of depuration, the count of *E. coli* was reduced to limit level from its initial count of 7.3 $\log_{10}$ cfu g^{-1} (Fig 1).

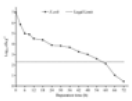

Fig. 1. Changes of *E. coli* level in *R. philippinarum* during depuration process.

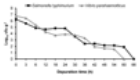

Fig. 2. Changes of *V. parahemolyticus and S. typhimurium* level in *R. philippinarum* during depuration process

In the first six hours, the level of *E. coli* has decreased rapidly to the level of 5 $\log_{10}$cfu g^{-1}. The decreasing continued and it was undetectable at 72th hour. Barile *et al*. (6) reported that *Chamelea gallina*, which was contaminated with 4 $\log_{10}$ cfu g^{-1} *E. coli*, can be marketable after 48 hours depuration. The results of this study indicated that *R. philippinarum* contained 6.2 $\log_{10}$ cfu g^{-1} of *S. typhimurium* achieved to regulatory standards after 60 hours of depuration. Initial level of *S. typhimurium* decreased sharply to 4.8 $\log_{10}$ cfu g^{-1} after 6 hours and it was undetectable at the 66th hour. (Fig.2) It was noticed that depuration time of *Salmonella* spp. requires a longer period of time than *E. coli*. *Vibrio* species, are naturally occurring bacteria in tropical and subtropical marine waters, and remain viable in this environment for very long times even in the absence of organic matter . Initial count of *V. parahaemolyticus* in *R. phliphinarium* was 6.7 $\log_{10}$ cfu g^{-1}. According to Turkish legislation on fisheries, *V. parahaemolyticus* should be negative in 25 g of meat and intravalvular liquid of marketed live shellfishes. This requirement was met in the experiment at 60th hour. Barile *et al.* (2009) noticed that *V. parahaemolyticus* was not determined in *M. galloprovincialis* after 36-48 hours of depuration.The differences between our findings and the others' mentioned above may be originated by the diversity in the depuration systems and bivalve species.(2) Pathogenic bacteria that are well known to survive in a marine environment for long times, can be accumulated to bivalves and poses health risk to consumers. Depuration helps to improve shellfish quality and helps to prevent consumers from foodborne diseases. A better knowledge of the parameters affecting the kinetics of the processes of depuration against various bacterial strains should be well documented with experimental studies in the future.

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DETERMINISM OF LARVAL RECRUITMENT OF *CRASSOSTREA GIGAS* IN MEDITERRANEAN LAGOON.

F. Lagarde [1]*, E. Roque d'Orbcastel [1], A. Perignon [2], S. Mortreux [1], M. Fuhrmann [1], P. Le Gall [1], A. Leurion [1], C. Chiantella [1], B. Bec [3], C. Roques [3], D. Bonnet [3], H. Cochet [4], M. Boj [1], E. Gervasoni [5], G. Miron [6], A. Fiandrino [1], S. Pouvreau [1] and F. Pernet [1]

[1] Ifremer - franck.lagarde@ifremer.fr

[2] CRCM

[3] ECOSIM/UMII

[4] Cochet-Environnement

[5] Cepralmar

[6] Université de Moncton/Canada

Abstract

We bring new items in connection with the origins of the natural recruitment variability of the Pacific oyster *Crassostrea gigas* in Thau lagoon. A poor relationship between " number of larvae" and "number of spat" in 2012 shows a biological lock around oysterculture areas during the metamorphosis in spite of better success of recruitment outside shellfish farming zone. A comprehensive analysis of environmental factors effects and the development of prognosis tools are planned to assist oysterfarmers in rationalization of natural oyster recruitment around Mediterranean lagoon.

Keywords: Bivalves, Aquaculture, Recruitment, Gulf of Lyon

Introduction

Unlike other shellfish farming area of the French Atlantic coast, the Mediterranean basin has never used the possibility of natural catchment for oysters [1,2]. The rising cost of spat associated with very high mortality [3] brings Languedoc producers to consider an in situ production of seed. Since 2010, the interannual variability in recruitment of oysters is analyzed in shellfish farming ecosystems off the Atlantic [1,2] and Mediterranean [4] French coasts by the national Velyger network [5] at the regional level through the project PRONAMED (PROduction de NAissain en MEDiterranée). This project, led by Ifremer and the Regional Committee of the Mediterranean Shellfish in partnership with Cepralmar, is twofold: to advance the understanding of environmental factors controlling the recruitment of *Crassostrea gigas* in a Mediterranean lagoon and identify potential blocking points in the reproductive cycle of this species within this particular environment.

Material and methods

The study focuses on Thau lagoon. The project allowed, in its first phase (2010-2011), the set up of a regional observatory of the natural oyster catchment in farming areas. The second phase (2012-2014) broadens the observatory across the lagoon in and out shellfish farming areas, and involves a thorough environmental monitoring including the study of phytoplankton and zooplankton communities as well as benthic organisms. A review of the reproductive strategy (gametogenesis, synchronization of spawning, quality and quantity of gametes) and the development of cohorts in relation to environmental fluctuations are investigated in this project.

Results and discussion

Our results showed a high interannual variability of settlement intensity in the shellfish farming areas of the Thau lagoon proving that oyster spat may be potentially harvested locally. In addition, the surviving oyster spat better resist the high rate mortality usually observed the following year: the spat captured in the Thau lagoon in 2010 show better resistance to mortality with survival rates of 62 to 78% in September 2011 [5] compared to survival rates observed by the Réseau d'observations conchylicoles (37% survival). Observations in 2012 (figure1) showed that oyster settlement in areas outside shellfish farming zones was important (up to 70 individuals per collector's cup compared to less than 5 individuals).

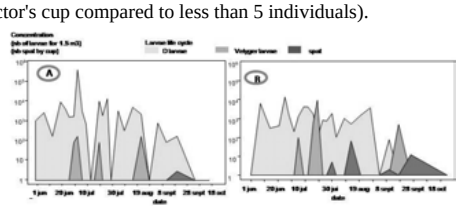

Fig. 1. Larval developpment and spat settlement inside (A) and outside (B) shellfish farming zones.

These results tend to show that Thau lagoon could host a potential oyster spat catchment area outside the farming zones. The potential of these catchment areas and their exploitability by the Mediterranean shellfish industry needs to be addressed. The second phase of the Pronamed project will attempt to answer this question by analyzing the overall influence of various environmental factors on the natural settlement [6]. An analysis of the dynamics of larval dispersal and connectivity between oyster populations will be proposed based on the model MARS-3D Thau [7.8]. Optimization of cultural practices around the management of collectors will be realized. The physiological quality of the larvae (energy reserves) will also be studied.

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CULTURE OF *TAPES DECUSSATUS* IN HIGH STOCKING DENSITY IN MERSIN BAY, IZMIR-TURKEY

Serpil Serdar [1]*, Aynur Lok [1] and Aysun Kucukdermenci [1]
[1] Ege University, Faculty of Fisheries, 35100, Bornova-Izmir, TURKEY - serpil.serdar@ege.edu.tr

Abstract
In this study, growth and survival rate of carpet shell clam (*Tapes decussatus*) were investigated in high stocking density in Mersin Bay, Izmir-Turkey throughout one year. Clams were sown 900 ind. /m^2 in plastic box. At the end of the study, clams shell length and total weight reached 30.54±0.42 mm and 5.63±0.21 g, respectively. Survival rate was calculated 20 % at the end of one year.

Keywords: Aquaculture, Bivalves, Aegean Sea

Introduction An effect of stocking density on growth and survival rate is a critical factor in shellfish aquaculture. Optimal stocking density in commercial culture is determined by site specific physical factors (horizontal seston flux), biological factors (species-specific filtration rate) and economic factors such as gear and labor coasts. Lower stocking densities will eventually result in less competition for food and faster growth rates, but this increase comes at the expense of more investment in gear, more labor to maintain it, and a higher lease requirement [1, 2]. On the other hand higher stocking density of shellfish leads to a higher return of harvestable product. Therefore the aim of this study was the effect of high stocking density on growth and survival rate of carpet shell clam in Mersin Bay, Izmir- Turkey.

Material and Methods This study was carried out in Mersin Bay (38º 12' 77"N, 26º 25' 46" E), Aegean Sea about 80 km west of Izmir, Turkey. Water temperature was measured using a mercury in glass thermometer (-10 to 100 ± 0.5 °C) and salinity was determined using a hand refractometer at the sampling area. Chlorophyll-a and seston concentration were determined according to [3] method for each month. Clams were sown at densities of 900 ind./m^2 in plastic boxes with three replicates. Initial of the study clam length, width, height and total weight were 27.52 ±0.17 mm, 19.10±0.14 mm, 11.87±0.10 mm and 3.61± 0.07 g, respectively. The shell length was measured on the anterior-posterior axis using a calliper (±0.1 mm). The instantaneous growth rate (K), was calculated using the following equation [4]; $K=(\ln W_2-W_1)/(t_2-t_1)$, $K=(\ln L_2-L_1)/(t_2-t_1)$. W_1 andW_2 are total wet weight. L_1 andL_2 are the shell length at the beginning and end of experiment time (in month), respectively. The duration of experiment (months) is expressed by (t_2-t_1). Survival (%) was estimated as (N_t/N_0) x 100, where N_t is the number of live clams removed from the culture area after t and N_0 is the number of clams at the beginning of the experiment.

Results and Discussion Water temperature and salinity were measured between 14ºC and 23ºC and 36-37 ‰ throughout the study, respectively. Chlorophyll-a concentration was determined the lowest value (1.98 µg l^{-1}) in January and the highest (7.20 µg l^{-1}) in May. Amount of seston ranged between 7.4 mg l^{-1} and 27.2 mg l^{-} By the end of the rearing cycle, clams reached 30.54 ± 0.42 mm shell length, 21.17 ± 0.36 width, 13.57 ± 0.26 height and 5.63 ± 0.21 g total weight (Fig. 1).

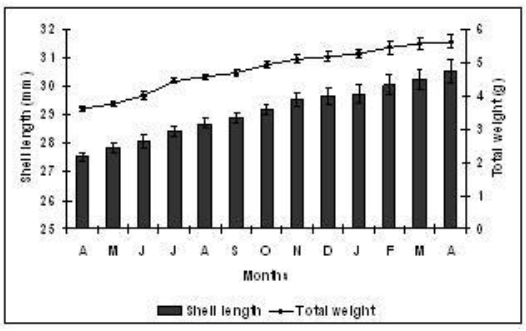

Fig. 1. Variations of shell length and total weight of clam.

Maximum growth rate of shell length, width, height and total weight was determined 0.0123 in June, 0.0139 in October, 0.0183 in September and 0.1018 in June, respectively (Fig. 2). The maximum growth rate was significantly higher in late spring compared to other periods of time. Survival rate was determined 20 % at the end of one year.

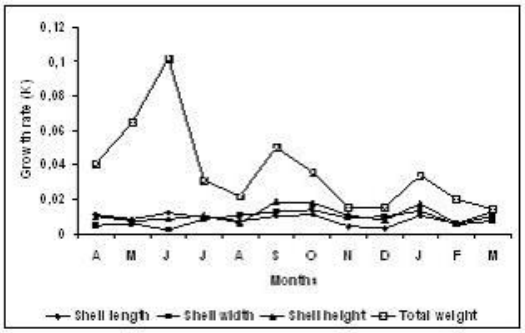

Fig. 2. Instantaneous growth rate of clam.

Clam growth is affected by environmental factors and stocking density. Temperature, salinity and food availability vary from location to location. Food availability in high density clam culture limits growth and survival rate because of competition [5]. In this study growth rate of clam was lower than Sufa Lagoon [6]. In conclusion, stocking density affects the growth and survival of clam and it is the aim of a farm manager to find the correct balance between optimal growth and optimal economic gain according to environmental factors.

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Session

Biodiversity hotspots

Modérateur : **Mohamed Menioui**

POPULATION STRUCTURE OF THE ENDEMIC SPECIES *PARANEMONIA VOULIAGMENIENSIS* IN VOULIAGMENI LAGOON (ATTIKA – GREECE)

Vasileios Anagnostou [1]*, Chariton C. Chintiroglou [1] and Panagiotis Damianidis [1]
[1] School of Biology, Aristotle University of Thessaloniki, 541 24, Thessaloniki, Greece - damian@bio.auth.gr

Abstract
The population of the endemic anemone *Paranemonia vouliagmeniensis* is studied in Vouliagmeni Lagoon, Greece. The spatial dispersion and the biometric characteristics of the species are investigated and analyzed and abiotic parameters are seasonally measured. The diameter of the pedal disc was used to determine the size classes which vary seasonally between 3 and 5. The distribution of the population is random and densities are affected by anthropogenic activities.

Keywords: Aegean Sea, Lagoons, Population Dynamics, Biometrics, Endemism

Introduction
Vouliagmeni Lagoon (known as Vouliagmeni Lake) is a geological karst formation in the coastal area of Attika, Greece (37°48´27.42"N, 23° 47´08.24"E). It totals an area of 7500 m^2 and exhibits euryaline lagoon characteristics. The lagoon is characterized by a unique ecosystem with particular environmental conditions and the presence of the endemic anemone *Paranemonia vouliagmeniensis* Doumenc, England, and Chintiroglou, 1987 (Actiniaria, Anthozoa) [1]. Vouliagmeni Lake is used as bath resort and human pressure is intense, therefore its biodiversity has been the subject of scientific research [2],[3]. The present work focuses on the study of the population structure and functions of the endemic anemone.

Materials and Methods
Five seasonal measurements and sampling surveys were carried out (May, August and November 2011 and February, May 2012). For each period of time the relative physicochemical characteristics of the lagoon water were measured. Samples of individuals were collected from three different stations. The biometric characteristics of 750 individuals of *P. vouliagmeniensis* were measured (diameter of pedal disc, mouth disc, body height, body diameter, length of tentacles and body weight in addition to the examination of the allometric relationship between these characteristics and biomass of anemones). The data obtained was treated using different statistical techniques and software (Excel, FiSAT). Modal progression analysis using Bhattacharya's method [4] was applied to biometric data of pedal disc and also used to form conclusions regarding the biological cycle of the species and the anthropogenic pressures.

Results and discussion
The environmental conditions are characterized by temperature from 21,2-22,7 °C, a pH of 7-7,3, DO_2 8,3-10,4 mg/l, conductivity 10.480-23.300 μs/cm, O.R.P. -115-(-15)mV and Salinity 7-18‰. Significant seasonal changes were observed in conductivity and salinity of the water.
Spatial dispersion of *P. vouliagmeniensis* in the three investigated sampling sites follows random distribution in space, something which is explained by the low observation of densities, as illustrated by maps using the Kernel density estimator [5]. Comparisons of the maps show correlations of anthropogenic disturbances in the observed densities and proved that the population has been reduced by more than 50% from previous recordings [6].
The biometrical results show that the diameter of pedal disc is a parameter indicating the age of the species and also the trend of the species to fix on the substratum, according to the age, in order to establish a more stable life style. The diameter of the pedal disc is also a reliable indicator for the study of age-classes of anemone. The seasonal variation of the number of age classes fluctuates between 3 and 5, showing that the life span of the species is approximately 5 years.
In general, *P. vouliagmeniensis* shows an extended reproduction period. The disturbance to the normal age representation of the population is also correlated to anthropogenic activities. Regular maintenance work conducted by the local authorities includes the cleaning of the bottom of the lagoon, by removing the benthic flora during the summer period, which destroys the appropriate habitat of young individuals. During the winter a recovery from this disturbance was detected.

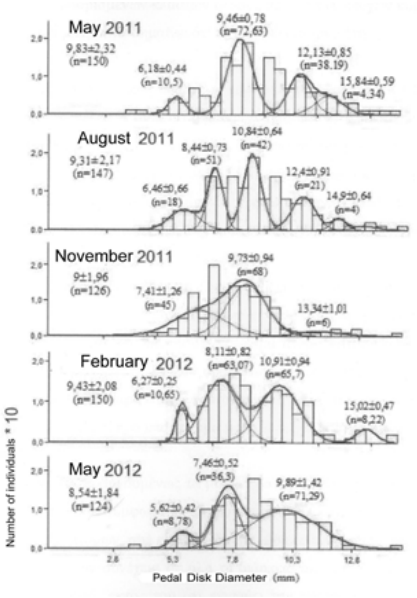

Fig. 1. Modal progression analysis (Bhattacharya's method) of basal disk diameter length classes of *Paranemonia vouliagmeniensis*.

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SPECIES RICHNESS AND ANTHROPOGENIC PRESSURES IN FRENCH CORALLIGENOUS ASSEMBLAGES

F. Holon [1]*, N. Mouquet [2], A. Doxa [2], P. Boissery [3] and J. Deter [1]
[1] Andromède océanologie et UMR ISEM Université Montpellier 2 - florian.holon@andromede-ocean.com
[2] UMR 5554 ISEM CNRS-UM2, univeristé Montpellier 2
[3] Agence de l'eau Rhône Méditerranée Corse

Abstract
Coralligenous concretions are biogenic reefs built by sciaphilic algae and animal builders. The resulting patchwork of complex micro-habitats and species present richness, biomass and productivity equivalent to tropical reefs. Hard to reach with classical diving methods, coralligenous concretions are poorly studied in comparison to their high ecological importance. RECOR is a monitoring network (Agence de l'eau RMC / Andromède océanologie) surveying coralligenous concretions at 120 stations along the French Mediterranean coast since 2010. We present here the first results concerning the totality of the 120 stations. We are interested in the link between anthropogenic pressures and species diversity distribution.

Keywords: North-Western Mediterranean, Biodiversity, Algae, Zoobenthos

Introduction

Coralligenous concretions are biogenic reefs built first by sciaphilic algae and secondly by animal builders [1]. The resulting patchwork of complex micro-habitats present richness, biomass and productivity equivalent to tropical reefs [2]. Hard to reach with classical diving methods, coralligenous concretions are poorly studied in comparison to their high ecological importance. RECOR is a monitoring network (Agence de l'eau RMC / Andromède océanologie) surveying coralligenous concretions at 124 stations along the French Mediterranean coast between 17 and 90 m depth (Fig. 1). Based on field date, the goals of this study are to describe species diversity and then link anthropogenic pressures and species diversity distribution.

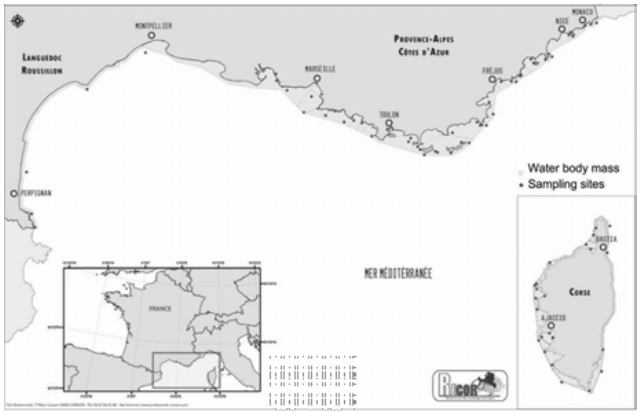

Fig. 1. Field sites (several stations per site, one station = one depth) sampled during the study (RECOR data)

Materials and methods

Each RECOR station (a minimum of one per costal body mass) was sampled once using 30 photographic quadrats (see [3] for the method, Fig. 2). A first index (CAI, coralligenous assemblages index) was used in order to describe the "ecological quality" of coralligenous habitats [4]. This index linked to anthropogenic pressures measured locally mixed bryozoans, major builders and sludge percent covers [4]. In the present study, anthropogenic pressures were obtained from "Agence de l'Eau RMC / IFREMER - Anthropogenic pressures data base" for each coastal body mass. We extracted data concerning land use, harbor number and size, fishing, population density, anchorage area, aquaculture, total N, etc.

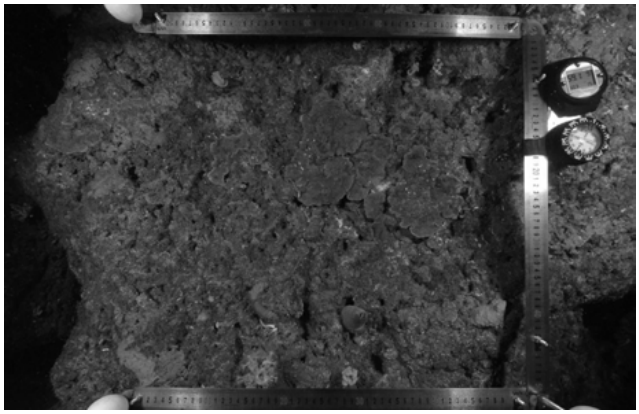

Fig. 2. Example of a photographic quadrat used for coralligenous assemblages sampling (30 quadrats per station are used).

Results and discussion

We present here the first results concerning species richness (non mobile macro-species) characterizing the 120 stations (-17 to - 90 m depth). Twenty two to 59 taxa (species or genus) were identified depending on the station. Encrusting red macroalgae covered 0 to 51 %, bryozoans 0 to 24 %, sponges 0 to 40 % and gorgonian 0 to 23 %. Quadrats were covered by 0 to 64 % of sludge, 0 to 8 % of organism rubble and 0 to 2 % of waste (old nets, bottles, etc). CAI calculated for each station remained relevant excepted in Corsica where assemblages seemed to be different and the index needs to be adjusted.
Statistical analyses are still in progress but results will be presented during the congress.
The link between species assemblages and water quality will be discussed.

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FIRST RESULTS OF FISH DIVERSITY ASSOCIATED WITH *POSIDONIA OCEANICA* MEADOWS IN THE AEGEAN SEA

E. Lefkaditou [1], S. Kalogirou [2]*, G. Petrakis [1], S. Kavadas [1], A. Siapatis [1], L. Pihl [3] and G. Christidis [1]
[1] Hellenic Centre for Marine Research, Institute of Marine Biological Resources
[2] Hellenic Centre for Marine Research Hydrobiological Station of Rhodes - skalogirou@hcmr.gr
[3] University of Gothenburg, Department of Biological and Environmental Sciences

Abstract
Spatial variation in density, and diversity of littoral fish species associated with nearshore *Posidonia oceanica* meadows from the Aegean Sea was studied during the period 2008-2009. A total of 318980 littoral fishes were collected with boat seine from 12 locations in the Aegean Sea, belonging to 47 families and 137 species. Total number of species per location varied between 25 and 54. Throughout the study, schooling planktivorous species such as *Spicara smaris*, *Boops boops* and *Chromis shromis* were dominant in terms of density. Mean number of individuals varied between locations and ranged between 600 and 4500. For most of the locations, diversity of species did not vary significantly.

Keywords: Fishes, Teleostei, Posidonia, Aegean Sea

Introduction
Posidonia oceanica meadows provide key ecological services to the coastal zone, ranking among the most valuable ecosystems in the biosphere and are protected by EU legislation (Habitat directive), the Bern and Barcelona Conventions and national legislations. Fishing regulations limit trawling activities near the shore (either above 50 m or a certain distance from the coast), which constitute an indirect protection measure for the species (EC Council Regulation N° 1967/2006 and national regulations). Important shallow coastal habitats, such as seagrass meadows, may provide a habitat for food, shelter, reproduction, settlement and serve as a nursery habitat with high quality for many fish species (Kalogirou et al. 2010; Kalogirou et al. 2012). In this study we focused on one of the most important habitat, *Posidonia oceanica* meadows. Through quantitative data collected over a broader spatial scale the aim of this study was to examine geographical differences in fish diversity associated to *P. oceanica* meadows in the Aegean Sea.

Materials and Methods
The study was performed at 12 shallow (5–35 m) locations in the Aegean Sea (Aegina, Chios, Eretria, Karistos, Koilada, Lesvos, Marmari, Neapoli, Paros, Rhodes and Salamina). All 12 locations selected for this study had sandy sediment with a patchy distribution of *P. oceanica* meadows. In Hellenic waters, the boat-seine fishing method, used in this study, is banned from 1 April to 31 September. For this reason the sampling was performed during 1 October to 31 March. Daylight sampling was undertaken at all locations in order to study spatial variation in fish diversity. The boat-seine fishing method was used to sample fishes from the *P. oceanica* habitats with the help of a local fishing boat. The seine is hauled at a constant speed of *c.* 0·3 m s^{-1}. The total time elapsing from deployment of the start line with an anchor to the time the seine was taken onboard was *c.* 35 min. Mesh-size decreased from the outer end of the wing towards the centre in the sequence 500, 180, 32–34, 12 and 11 mm, with a minimum mesh-size of 8 mm in the codend. Due to unequal sample size per location, three sweeps were randomly chosen from each locality. All fishes were immediately identified to species level Whitehead *et al*., 1986), weighed in g and measured (total length, *LT*). Fish species diversity for each sample was estimated using the Shannon-Weiner equation.

Results and Discussion
In total 137 species belonging to 47 families were identified during this study. Dominant species I terms of number of individuals included *Sardina pilchardus*, *Boops boops*, *Chromis chromis*, *Spicara smaris*, *Mullus surmuletus*, *Atherina hepsetus* and *Coris julis*. Number of species varied between locations and ranged between 25 and 54, with Chios Island representing the lowest number of species (25) and Karistos the highest (54) (Fig. 1). Mean number of individuals ranged between 600 and 4500, with Eretria representing the lowest (600) and Paros the highest (4500) (Fig. 2). Diversity of species between localities with Chios Island representing the lowest (0.6) and Karistos the highest (1.9).

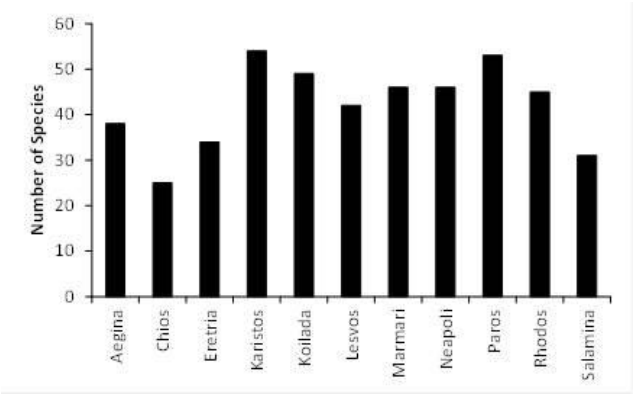

Fig. 1. Total number of species per location

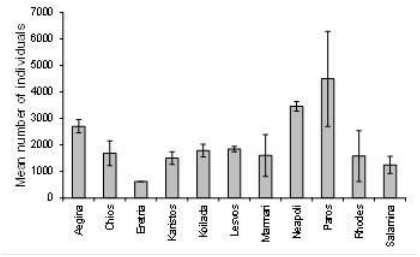

Fig. 2. Mean number of individuals per location

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DECADAL BIODIVERSITY PATTERNS IN MESOPHOTIC CORAL COMMUNITIES IN THE NW-MEDITERRANEAN

Edgar Casas-Güell [1], Núria Teixidó [2]*, Emma Cebrián [3] and Joaquim Garrabou [4]
[1] Institute of Marine Science (ICM-CSIC)
[2] Institute of Marine Science (ICM-CSIC) - nteixido@icm.csic.es
[3] Centre for Advanced Studies of Blanes (CEAB-CSIC)
[4] Institute of Marine Science (ICM-CSIC)

Abstract
The mesophotic coralligenous outcrops dominated by *Corallium rubrum* are among the most diverse marine benthic communities in the Mediterranean. To assess the potential impacts of perturbations associated to global change on these communities robust baselines are urgently needed. Here, we analyzed decadal trends on composition and diversity indices associated to *Corallium rubrum* communities in the NW-Mediterranean. Our results demonstrate the extremely low variability of the descriptors of the community in terms of similarity, species richness, diversity indices and evenness over one decade. Thus, this study provides baseline data to detect potential effects due to global change.

Keywords: Biodiversity, Rocky shores, Conservation, Global change, North-Western Mediterranean

Introduction
The Mediterranean Sea is considered a hot-spot for marine biodiversity [1]. Regardless of this important value, the Mediterranean Sea is threatened by the increase of disturbance regime associated to global change [2]. The mesophotic coralligenous outcrops dominated by *Corallium rubrum* are among the most diverse Mediterranean benthic communities [3]. Despite its importance, long-term descriptive and quantitative studies of its species composition and dynamics are few and rare. This study is devoted to characterize quantitatively the *C. rubrum* community structure over one decade.

Material and Methods
We analyzed photographic series obtained between 2000 and 2011 in two localities of the NW Mediterranean (Marseilles and Corsica). At each locality, three permanent plots of 3.200 cm^2 were photographically monitored using quadrats of 20x20 cm (400 cm^2) to facilitate species identification [4]. Long-lived sessile benthic species mainly belonging to encrusting algae, protozoans, sponges, anthozoans, polychaetes, bryozoans and tunicates were identified. We used cover area as estimate of abundance. For detailed analyses of diversity we calculated the species number and exponential Shannon-Wiener (exp(H')). In this way we converted the biodiversity values in effective number of species for further comparison over time [5]. Changes over time in abundance, species richness and diversity metrics were tested by PERMANOVA analyses [6].

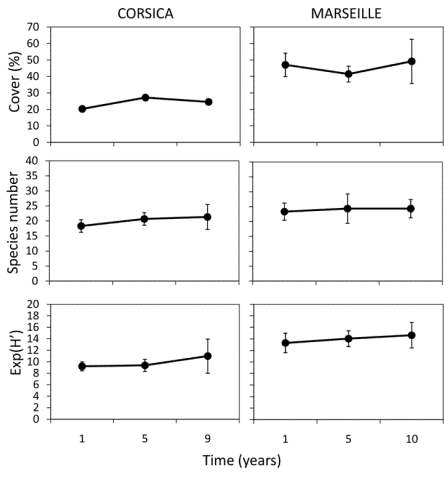

Fig. 1. Means (± SD) over time in Corsica and Marseilles for slow growing macrobenthic sessile species: relative cover area, number of species and diversity metrics (effective number of species).

Results
Our results demonstrate that there were no significant decadal changes in the community structure (in terms of specific composition and abundance). Likewise, there were no significant differences with all the diversity parameters analyzed over time in the two localities (Figure 1).

Discussion
The lack of robust baseline of biodiversity structure and dynamics for the rich mesophotic coralligenous outcrops is hindering the assessment of the impacts at community level which are already affecting these communities [7,8,9]. Our results are contributing to fill the current gap on and provided insights on the parsimonious dynamics of these emblematic Mediterranean communities.

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LES ACTINIAIRES DES RIVAGES TUNISIENS (CNIDAIRES,HEXACORALLIAIRES) : INVENTAIRE ET DISTRIBUTION

Saïda Tekaya [1]* and Amel Guettiti [1]
[1] Université de Tunis El-Manar, Département de Biologie - saida.tekaya51@gmail.com

Abstract
Plusieurs secteurs des rivages tunisiens ont été explorés. Cette prospection nous a permis d'identifier et de signaler pour la première fois la présence de cinq espèces d'actiniaires. *Anemonia viridis* est rencontrée dans presque toutes les stations prospectées. Les autres espèces sont *Actinia equina, Bunodactis verrucosa, Condylactis sp* et *Calliactis parasitica*. Elles ont été rencontrées seulement dans quelques sites. En outre, un aperçu sur les caractéristiques écologiques de chaque espèce est donné.

Keywords: Cnidaria, Tunisian Plateau

Introduction
En Tunisie, aucun travail sur la biodiversité des anémones de mer n'a été réalisé jusqu'à présent. Il y a seulement une étude sur les tentacules d'*Anemonia viridis* récoltée à Sousse et dont le but était la détermination de la composition chimique du venin (1). Le présent travail constitue une première contribution à la connaissance de la biodiversité et de la répartition géographique des actinies des côtes Tunisiennes.

Matériel et Méthodes
Plusieurs secteurs de la côte tunisienne appartenant à des étages bioclimatiques différents ont été explorés. Les prélèvement ont été effectués dans neuf stations réparties comme suit : Tabarka , Bizerte au nord du pays, le Golfe de Tunis (Salammbô et la Goulette), la région du Cap-Bon (Korbous, Hammamet et l'île Zembra), le Sahel (la Chebba), Sfax et Djerba au sud. Ces stations sont caractérisées par des rivages plus ou moins rocheux et une eau peu profonde. La station de Sfax était une plage polluée, surtout au niveau de la région de Thyna.
Notre travail a porté sur des échantillons récoltés tout au long du rivage, à des profondeurs variant de quelques centimètres à un mètre. Le substrat de fixation des actinies est rocheux dans la plupart des stations, cependant il est sableux au site de la Goulette.

Résultats
Cinq espèces ont été identifiées. Il s'agit d'*Anemonia viridis* (Forskal, 1775) , *Actinia equina* Linné, 1767, *Bunodactis verrucosa* Pennant, 1777, *Condylactis* sp et *Calliactis parasitica* Couch, 1838.
Caractères écologiques et Répartition des actinies signalées:
Les échantillons d'*Anemonia viridis* sont trouvés dans les plages rocheuses lorsque la lumière est peu intense, la mer à eau calme, renouvelable et à température de l'ordre de 20- 25°C. La taille des animaux augmente de la surface en allant vers la profondeur.
D'après nos résultats, cette espèce est particulièrement abondante à Tabarka, Bizerte, l'île de Zembra, le Golfe de Tunis et précisément les stations de Salammbô et de la Goulette. Elle présente un polymorphisme de couleur : au niveau des rivages les anémones ont l'extrémité des tentacules colorée en violet alors que vers la profondeur ils sont entièrement de couleur brune à grise. Cette distribution semble dépendre de l'éclairement et de la qualité de l'eau. Nos observations sont en accord avec les données bibliographiques (2-5)

Actinia equina, l'actinie rouge ou tomate de mer est une espèce des zones médiolittorale et infralittorale très commune en mer Egée (6). Elle est signalée en Méditerranée, Atlantique et mer du Nord (2-4). En Tunisie, nous l'avons rencontrée dans la région de Tabarka et à l'île de Zembra.

Bunodactis verrucosa est récoltée dans une plage sableuse de la station de la Goulette, pendant l'automne à 80 cm de profondeur environ, la colonne enfouie dans le sable où la lumière est peu intense, l'eau calme, renouvelable et la température de l'ordre de 24°C

Condylactis sp : Un seul spécimen a été récolté à Djerba.

Calliactis parasitica, vit dans un biotope en mode calme, de zéro jusqu'à 20 m de profondeur, en association avec l'algue verte *Enteromorpha*. Elle est souvent fixée sur une coquille de mollusque habitée ou non par un pagure (Bernard l'Ermite) (6). Cette espèce vit en symbiose avec le pagure. Elle est répandue en Méditerranée et en Atlantique jusqu'à la Manche (2, 7). C'est une espèce de la zone infralittorale et circalittorale (3). En Tunisie, elle a été rencontrée à la Goulette.

Discussion
Neuf stations dans les rivages tunisiens ont été prospectées. Cinq espèces d'Actiniaires sont identifiées. *Anemonia viridis* est rencontrée dans presque toutes les stations. Elle a montré un polymorphisme de couleur et une diversité morphométrique, en particulier les spécimens prélevés à Korbous sont de grandes tailles (10-15cm) alors que les représentants de la population de la plage polluée de Sfax sont remarquablement de petites tailles. Une étude biométrique des différentes populations est intéressante à réaliser dans un travail ultérieur. *Actinia equina* rencontrée en Tunisie est de grande taille (7-10cm) par rapport à ce qui est signalé dans la bibliographie (5-6cm) (7,6). Un polymorphisme de couleur des verrues est signalé pour *Bunodactis verrucosa* (5).

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BIODIVERSITY IN THE SEA OF MARMARA AND THE AFFECTING FACTORS

A. Yuksek [1]*, A. Kideys [2], A. Olgun [3], C. Polat-Beken [3] and H. Altiok [1]
[1] Istanbul University, Institute of Marine Sciences and Management - ayuksek@istanbul.edu.tr
[2] Institute of Marine Sciences, Middle East Technical University
[3] Environment Institute, Marmara Research Center-TUBITAK

Abstract
The ecosystem of the Marmara Sea of Marmara is defined "high" category by EBSA criteria. According to the IUCN Red List, four species are at CR level. The Sea of Marmara is an important migration area of fish and marine mammals migration area, and in the meantime, is under the pressure of over fishing and other anthropogenic factors.

Keywords: Biodiversity, Marmara Sea

The Sea of Marmara has fulfilled the first six criteria of EBSA (Ecologically or Biologically Significant Marine Areas) labelled "high" category. Being a transitional system between two hydrologically diverse sea basins (the Mediterranean and Black Sea), it is the migration route of protected marine mammals (Ozturk et al., 2001) and fish species of high economic value such as Xiphia gladius (Swordfish), Scomber scomberus (Atlantic Mackerel), Sardra sardra (Atlantic bonito), Pomatamus saltatrix (Bluefish), and Engraulis encrasicolus (European anchovy). These species inhabit the Sea of Marmara during specific periods of their life-cycle for breeding and feeding. The plankton rich waters of the Sea of Marmara serve as unique pasture for the larval stages of these species.

According to the IUCN Red List, the status of native Mediterranean marine fish species (2012) in the Sea of Marmara shows that 4 species are classified CR (Critically Endangered) namely (Squatina squatina, Oxynotus centrina, Rostroraja alba, and Pomatoschistus microps), a further 4 species are EN (Endangered) (Mustelus mustelus, Mustelus asterias, Squalus acanthias,and Thunnus thynnus), 6 species are VU (Vulnerable) (Merluccius merluccius, Labrus viridis, Umbrina cirrosa, Sciaena umbra, Dentex dentex, and Pomatoschistus minutus), 12 species are NT (Near Threatened) (Scyliorhinus stellaris, Dasyatis pastinaca, Raja clavata, Psetta maxima, Pleuronectes platessa, Platichthys flesus, Syngnathus acus, Scomber colias, Hippocampus hippocampus, Syngnathus typhle, Xiphias gladius, and Dicentrarchus labrax) and 26 species are classified LC (Least Concern). In addition, there are 2 protected and 16 important areas for migrant and water birds according to the RAMSAR Convention. Three major factors affect the biodiversity of the Sea of Marmara;

1. Natural pressures (Bottom layer dissolved oxygen)
2. Anthropogenic pressures
3. Over fishing and erroneous fisheries policies

The Sea of Marmara comprises a two-layered system. The density differences between the upper and lower layers influence the deep dissolved oxygen distribution. The waters of Mediterranean origin flowing from the Dardanelles Strait follow the southern shelf of the Sea of Marmara and spread to the north. For this reason, the lower layer is rich in dissolved oxygen in the southern region of the sea. This feature is an important factor affecting biodiversity. Dissolved oxygen determines the distribution of macrozoobenthic species which are found at the lower levels of the food web and are important components of the biodiversity. Macrozoobenthic distribution in the Sea of Marmara indicates that their abundance is high but their diversity is low in the northern Marmara shelf. This is a result of the increase in populations of certain species through their adaptation to hypoxic conditions. Biodiversity is greater in the southern shelf where the deep dissolved oxygen values are higher. Conversely, in the bays of Izmit and Gemlik, where there is both low circulation in deep waters and impacts of human-induced eutrophication, both abundance and biodiversity are very low because of extremely poor dissolved oxygen levels.

Unfortunately, over the last decade fish populations have dramatically decreased due to over fishing and the application of improper fishing techniques in the southern shelf of the Sea of Marmara. In addition, some methods such as bottom and beam trawling have particularly damaged habitats and adversely affected the macrobenthic diversity. Fisheries regulations must be improved for the southern shelf of the Sea of Marmara which is not heavily affected by pollution and benefits from better oxygenation due to Mediterranean waters and hence has a chance of maintaining favorable ecosystem conditions. Nowadays, even though recoveries in the pelagic system of Izmit Bay have been observed since local authorities applied preventative measures against pollution, the demersal system is still exposed to unfavorable conditions.

The assessments presented in this study may contribute towards the definition of "good environmental status" and targets for the Sea of Marmara as referred to in the EU MSFD. A biodiversity assessment for the Sea of Marmara is currently under preparation as part of a national scale project designed to support the technical implementation of this Directive.

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Session

Cartilaginous fish distribution

Modérateur : **Mohamed Nejmeddine Bradai**

OUTCOMES OF THE GFCM THREE-YEAR PROGRAMME ON ELASMOBRANCHS IN THE MEDITERRANEAN AND BLACK SEA

Pilar Hernández [1], Aurora Nastasi [1] and Federico Alvarez [2]*
[1] General Fisheries Commission for the Mediterranean (GFCM), Food and Agriculture Organization of the United Nations (FAO)
[2] Instituto Español de Oceanografía (IEO) - Centro Oceanográfico de Baleares, Palma de Mallorca, Spain - federico.alvarez@ba.ieo.es

Abstract
Reverse shark and ray populations' decline is one of the main objectives of national and regional management plans aimed at guaranteeing the sustainability of fisheries activities worldwide. The biological characteristics of the elasmobranchs make them severely vulnerable to fisheries which, nowadays, are targeting elasmobranchs species that in the past were discarded. This document reports the main outcomes of a three-year research programme of the General Fisheries Commission for the Mediterranean (GFCM) launched in 2010 to improve the knowledge and asses the status of elasmobranchs in the Mediterranean and Black Sea.

Keywords: Elasmobranchii, Conservation, Stock assessment, Black Sea, South-Central Mediterranean

Sharks, skates and rays, collectively referred to as elasmobranchs (Class Chondrichthyes) form a relatively small and evolutionarily conservative group that has functioned successfully in diverse ecosystems for over 400 million years. Despite their evolutionary success, many species are increasingly threatened with extinction as a result of human activities. Because of their biological characteristics such as slow growth, late maturity, and low fecundity, elasmobranchs have very low rates of population increase and limited recovering potential from overfishing (direct or indirect) and other threats, such as pollution and habitat destruction [1]. In light of this international organizations developed action plans, such as the FAO International Plan of Action for the Conservation and Management of Sharks and Rays 1998 (FAO IPOA-Sharks), the Action Plan for the conservation of the cartilaginous fishes in the Mediterranean (UNEP-RAC/SPA, 2003), the EC Action Plan for the Conservation and Management of Sharks, aimed at promoting responsible fisheries practices and environmental strategic policies which converge into the protection of the elasmobranch stocks. In this view, regional fisheries management organizations (RFMOs), such as the General Fisheries Commission for the Mediterranean (GFCM), have the fundamental role of providing administrations with indications based on the most accurate scientific background. In 2010, the GFCM started a three-year programme on elasmobranchs with the aim of identifying and filling priority gaps in the current knowledge of the status of elasmobranchs populations in order to better assess and manage their stocks in the Mediterranean and Black Sea. The programme was divided into three periods of activities. The first period was financed by the GFCM regular budget and included the organization of the First Expert Meeting on the status of Elasmobranchs in the Mediterranean and Black Sea (September 2010), which served as common ground for experts to share valuable information on research carried out in their respective countries and to collate the scarce and disperse knowledge on elasmobranchs in terms of life cycles, population dynamics, ecology, taxonomy and fisheries [2]. The meeting also selected seven species according to various criteria (existing data on age and growth, abundance, conservation status, economic value, knowledge of biological parameters) for which stock assessments were considered a priority. The second and third periods of activities were supported by the European Commission (Agreement Number SI2.603726) and included the workshops on Stock Assessment of selected species of Elasmobranchs (December 2011) and on age determination of elasmobranchs in the GFCM area (October 2012). During the stock assessment workshop, 8 stocks of 6 different elasmobranch species were assessed and discussed (Tab. 1). Identification of biological reference points (BRPs) and maximum sustainable yield (MSY) proxies and issues related to the biology, by-catch, growth parameters, trends in catches and sampling approaches of the species were also discussed [3]. The Workshop on age determination of elasmobranchs in the GFCM area consisted in a practical course on age reading and it was a hands-on exercise with an important training component. Prior to the meeting some preparatory work included the preparation of biological raw material with the assistance of the lecturer. A technical manual on age determination of Elasmobranchs, suited to both novice and experienced age readers, was prepared and is going to be published by the end of 2013 [4]. This detailed guide reviews the best methods for ageing sharks, skates and rays with emphasis on vertebral sections and image analysis techniques as applied to elasmobranch species from the Mediterranean basin. Finally, a bibliographic review to sum up the information gathered during the above mentioned meetings, including the outputs of the Workshop on Stock assessment was prepared and published in 2012 within the series GFCM Studies and Reviews [5].

Tab. 1. Summary of the assessments discussed during the Workshop on Stock Assessment of selected species of Elasmobranchs in the GFCM area (GSA=Geographical Sub-Area, 4=Algeria, 9=Ligurian and North Tyrrhenian Sea, 14=Gulf of Gabes, 15-16=Malta Island and South of Sicily, 29=Black Sea. References points: F_{rm}=0, $F_{30\%SSB}$ and $F_{0.1}$ for stocks n 1, 2, 4 and 6; F_{max}, $F_{30\%SSB}$ and $F_{0.1}$ for stocks 3, 5, 7 and 8).

n	Stock	GSA	Method and software	Stock Status
1	*Raja asterias*	9	Leslie matrix, catch curve and Y/R. Software: poptools and YPR NOAA	in overfishing
2	*Raja clavata*	9	Leslie matrix, SEINE and Y/R. Software: poptools and YPR NOAA	in overfishing
3	*R. clavata*	15-16	Catch curve and Y/R. Software: LFDA and Yield of CEFAS-FAO	in overfishing
4	*Scyliorhinus canicula*	9	Leslie matrix, SEINE and Y/R. Software: poptools and YPR NOAA	in overfishing
5	*S. canicula*	4	Catch curve and Y/R. Software: LFDA and YPR NOAA	in overfishing
6	*Galeus melastomus*	9	Leslie matrix, SEINE and Y/R. Software: poptools and YPR NOAA	in overfishing
7	*Glaucostegus cemiculus*	14	Catch curve and Y/R. Software: VIT and YPR NOAA	underexploitation
8	*Squalus acanthias*	29	Catch curve and Y/R. Software: VIT and YPR NOAA	uncertain

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CHONDRICHTHYAN BYCATCHES IN THE BEAM TRAWL SHRIMP FISHERY OF THE MARMARA SEA

A. Ismen [1], C. C. Yigin [1], H. Inceoglu [2], M. Arslan [1]*, B. Daban [1], S. Kale [1], E. Kocabas [2] and M. Sirin [2]
[1] Çanakkale Onsekiz Mart University, Marine Science and Technology Faculty, Çanakkale, Turkey - mukadderarslan@gmail.com
[2] Republic of Turkey of Food, Agriculture and Livestock, General Directorate of Agriculture Research and Policy, Bandirma-Balikesir, Turkey.

Abstract
Bycatch is of great concern both ecologically and in terms of fishery management, particularly in shrimp fisheries. The Deepwater Pink Shrimp (*Parapenaeus longirostris*) is the mean crustacean fishery of the Marmara Sea. The chondrichthyan bycatch in 117 tows of the beam trawl fishery was surveyed seasonally between October 2011 and February 2013 in the Marmara Sea. Eight species were recorded: *Raja clavata, Raja miraletus, Dasyatis pastinaca, Scyliorhinus stellaris, Scyliorhinus canicula, Torpedo marmorata, Squalus acanthias* and *Oxynotus centrina*. Bycatch per unit of effort and biomass are given for each species.

Keywords: Marmara Sea, Elasmobranchii, Trawl surveys

Introduction
The deep water pink shrimp *Parapenaus longirostris* (Lucas 1846) fishery is the main crustacean fishery in the Marmara Sea and is targeted by the beam trawl. It is now well known that bycatch is of great concern both ecologically and in terms of fisheries management, particularly in shrimp fisheries [4]. Elasmobranch by-catch is often not recorded [2], or where it is recorded, the species composition is unknown. This lack of information prevents the use of conventional stock assessment methods to determine the status of populations. The main purpose of this work is to identify chondrichthyan species in the bycatch of the Deepwater pink shrimp fishery and to estimate, by species, spatial distribution, catch per unit of effort (CPUE) and biomass.

Materials and Methods
Sampling was carried out between October 2011 and February 2013 with beam trawler vessel operating in the Marmara Sea as seasonally (Fig. 1). All chondrichthyan were separated from tow each fishing day. Each specimen was identified to species level, measured, weighed and sexed. The data of each tow were registered (date, latitude, longitude, tow speed, catch of shrimp and depth). Average tow speed was 2 mile h^{-1}. Biomass was calculated based on the swept area method [3].

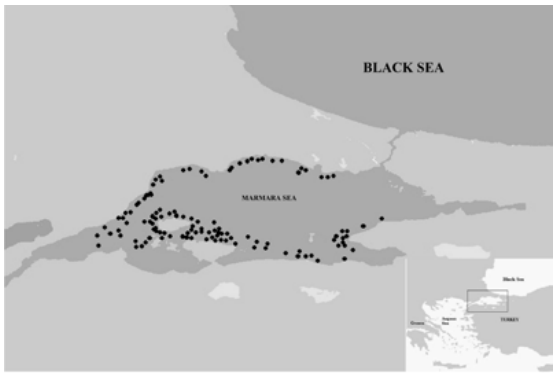

Fig. 1. Map of the study area with the sampling stations indicated by solid circle.

Results and Discussion
8 species (6 Families) have been recorded in the shrimp fishery by-catch (Table 1). The Rajidae and Dasyatidae have the highest number of species recorded in by-catch. Of the elasmobranch species 3% are taken as by-catch in the Marmara Sea. The low diverse by catch because of the sampling method or location. There are no long-term data available from which changes in catch rates of elasmobranch species can be examined. In the Marmara Sea, [1] and [7] surveyed numerically the by-catch rate of the elasmobranch 0.13%, 0.01%, respectively. Previous studies showed that elasmobranchs are impacted by a range of fisheries, both target (including gillnet, longline and dropline fisheries) and by-catch fisheries fisheries (including dropline and gillnet fisheries that target teleosts and trawl fisheries that target teleosts or prawns) [5]. The largest fishery in northern Australia is the Northern Prawn Fishery (NPF), elasmobranch contribute 4% of the total by-catch weight of this fishery [4]. Cedrola et al. (2005) reported that in shrimp fishery, all chondrichthyans are released at sea probably alive (handling time between tows averages 15 min and discarding occurs immediately after the opening of the nets) although post-capture mortality is unknown. Haul time is very variable (from several minutes to up to 3 h, with average haul of 85 min), and the post-mortality rate would be related to the tow duration. Although the survival rate of discarded fish is unknown, the ICES Report of Study Group of Elasmobranch Fishes in 1995 considered it to be quite high [6]. Walker and Hislop (1998) emphasized the need to identify the spatial distribution of the different life cycle stages of chondrichthyan species, and to reliably estimate fishing and discard mortality in order to understand the impact of fisheries on this species. This study is a first step of fisheries of our seas on these species.

Tab. 1. The weight (kg), CPUE (kg/h), Biomass (kg/km^2) and Depths of Chondrichthyan species caught in the Marmara Sea.

Species	Weight (kg)	CPUE (kg/h)	Biomass (kg/km^2)	Depth (m)
R. clavata	36.82	0.473	14.609	48-111
S. stellaris	1.31	0.022	0.691	55.6-87.4
R. miraletus	3.83	0.051	1.602	62-95
D. pastinaca	6.23	0.093	2.864	51.8-133
S. canicula	2.75	0.051	1.589	31.8-96
T. marmorata	1.85	0.032	0.976	53-133
S. acanthias	0.58	0.002	0.063	67.4-69.2
O. centrina	1.30	0.021	0.633	64.7-96

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THE MOST RELIABLE VERTEBRAE FOR AGE DETERMINATION IN DASYATIS PASTINACA

N. Basusta [1]*, A. Basusta [1], E. I. Ozer [1], M. Calta [1] and H. Girgin [1]
[1] Fisheries Faculty, 23119 Elazig, Turkey - nbasusta@hotmail.com

Abstract
This study was aimed to determine the most reliable vertebrae for age determination in *Dasyatis pastinaca*. For this purpose, total 23 fish samples were used. The first 32 vertebrae in the abdominal cavity were removed and prepared for age determination. Age readings were made by three independent readers. According to results, the vertebrae between 22 and 32 in the abdominal cavity were found more reliable for age determination in *D. pastinaca*. Because the lowest mean age, standard errors, ageing errors and absolute difference were obtained after 22nd vertebra. Precision of readers has been estimated from the percentage agreement of 3 readings. The agreement of 3 readers was found higher than 70% after 22nd vertebra. The highest agreement amongst readers was 78% in only 4 vertebrae.

Keywords: Elasmobranchii, North-Eastern Mediterranean

Introduction
Age determination is very important for fisheries biology research. Usually, vertebrae are used for age determination in cartilaginous fishes (Basusta et. al., 2008; Basusta and Sulikowski, 2012). But all vertebrae could not suitable for age determination. So, this study was aimed to determine the most reliable vertebrae for age determination in *Dasyatis pastinaca*.

Materials and Methods
In this study, total 23 *Dasyatis pastinaca* samples were provided from a commercial fishery trawler in Iskenderun Bay. The samples were transferred to Firat University Fisheries Faculty Fish Ecophysiology Laboratory in a freezer. The first 32 vertebrae in abdominal cavity were removed from each fish and prepared for ageing according to procedure (Turkmen et. al., 2005). The vertebrae were examined under a binocular microscope with 2x magnification and top lighting. Each vertebra was examined by three readers. A total of 2208 readings were made (32 vertebrae x 23 fish samples x 3 readers). The readers examined each bony structure independently without getting any information about fish such as length, weight and sex. Mean ages for each vertebra were estimated from readings of three readers (23 fish x 3 readers = 69 readings). Standard errors, ageing errors, absolute difference and percentage of precision of readers on each vertebra were calculated.

Results Discussion
This study was aimed to determine the most reliable vertebrae for age determination. According to results given in Table 1, the vertebrae between 22 and 32 in the abdominal cavity were found more reliable for age determination in *D. pastinaca*. Because the lowest mean age, standard errors, ageing errors and absolute difference were obtained after 22nd vertebra. Precision of readers has been estimated from the percentage agreement of 3 readings (Table 2).The agreement of 3 readers was found higher than 70% after 22nd vertebra. The highest agreement amongst readers was 78% in only 4 vertebrae (see Table 1).

Table 1. Mean age, standard errors, ageing errors, absolute difference and precision of readers on abdominal cavity vertebrae of *Dasyatis pastinaca*.

Vertebrae Number	Mean age (n=69)	Standard errors	Ageing errors	Absolute difference*	Percentages of precision of readers on each vertebra (Agreement of readers/number of readers)		
					3/3	2/3	1/3
1	3.94	0.31	2.57	1.40	39	52	9
2	4.29	0.31	2.57	1.05	35	43	22
3	4.46	0.31	2.57	0.88	30	61	9
4	4.61	0.31	2.55	0.73	26	65	9
5	4.68	0.31	2.58	0.66	26	61	13
6	4.81	0.31	2.56	0.53	22	70	9
7	5.75	0.27	2.25	0.41	35	57	9
8	5.75	0.31	2.55	0.41	26	65	9
9	5.75	0.31	2.54	0.41	26	61	13
10	5.74	0.31	2.55	0.40	43	43	13
11	5.74	0.31	2.55	0.40	43	48	9
12	5.74	0.27	2.25	0.40	39	57	4
13	4.96	0.30	2.52	0.39	39	52	9
14	5.71	0.31	2.54	0.37	57	35	9
15	5.70	0.31	2.55	0.35	57	35	9
16	5.68	0.30	2.50	0.34	52	43	4
17	5.68	0.30	2.53	0.34	52	43	4
18	5.01	0.30	2.53	0.33	52	43	4
19	5.67	0.29	2.45	0.32	52	43	4
20	5.67	0.30	2.49	0.32	57	43	0
21	5.65	0.29	2.41	0.31	61	39	0
22	5.64	0.27	2.28	0.30	70	30	0
23	5.62	0.29	2.38	0.28	70	30	0
24	5.61	0.28	2.35	0.27	70	26	4
25	5.10	0.28	2.34	0.24	78	22	0
26	5.58	0.28	2.30	0.24	74	26	0
27	5.58	0.23	1.89	0.24	78	22	0
28	5.49	0.26	2.19	0.15	74	22	4
29	5.23	0.25	2.05	0.11	78	17	4
30	5.41	0.25	2.06	0.06	78	17	4
31	5.38	0.26	2.12	0.03	74	22	4
32	5.32	0.27	2.25	0.02	74	22	4
Total mean (n=2208)	5.34	0.29	2.40	0.40			

*Absolute differences were obtained by subtracting the total mean value (5.34) from mean age value.

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ON THE OCCURRENCE OF THE GREAT WHITE SHARK (*CARCHARODON CARCHARIAS*) IN TUNISIAN COASTS

Mohamed Nejmeddine Bradai [1]* and Bechir Saidi [1]
[1] INSTM, Tunisie - mednejmeddine.bradai@instm.rnrt.tn

Abstract
Data concerning the presence of *Carcharodon carcharias* along the Tunisian coasts is presented. The capture by fishing gear, seasonality and population structure of the species in the area are analyzed and discussed based on 59 captures.

Keywords: Elasmobranchii, Fisheries, Tunisian Plateau

Introduction
Although the great white shark, *Carcharodon carcharias,* has never been the subject of specific studies along the Tunisian coasts, its presence in these waters has been known for a long time [1]. This paper presents the occurrence of the white shark off Tunisian coasts and contributes to the knowledge of its population in the Mediterranean Sea.

Materials and methods
Data on white sharks from the Tunisian coasts were performed by bibliographical researches and on our observations undertaken since 1992. For each case, whenever possible, the following data were collected: date and location of the record, total length (TL) in cm, mass in kg, sex, fishing method and depth.

Results and discussion
A total of 59 reliable captures of white sharks were reported along the Tunisian coasts from 1953 to 2012, most of them (57%) were registered after 2000. Sex and total length were reported for only 44 specimens, 24 females and 20 males. The total length of females and males ranged, respectively from 145 to 605 cm and from 165 to 485 cm. Length-frequency distribution showed that 48.78% were neonates and juveniles smaller than 200 cm TL (Fig.1). Four males and 11 females were adults of which two were pregnant. Captures were concentrated in the Gulf of Gabès (56%), where white shark was caught mainly by trawl and purse seine. Trawls capture only neonates and juveniles (TL<241 cm) during winter and spring with a peak in February while purse seine caught mainly adults through December to July (Fig.2). In the north coasts, 21 records were reported, most of them (76%) were in tuna trap which disappeared since 2004. Tuna trap captured mainly adult individuals between Mars and April (Fig.2). Some seasonal differences in the spatio-temporal occurrence of the species can be observed; along the northern and central Tunisian coasts, adult white sharks are in pursuit of tuna and migratory fish in spring and summer while juveniles are concentrated during winter in the Gulf of Gabes where temperatures are relatively higher. The occurrence of neonates, small juveniles and pregnant females shows that the Tunisian waters and mainly the Gulf of Gabès is a nursery for this species. Previous suggestion considers also Sicilian Channel and its adjoining environs as reproductive and nursery areas for the species [2; 3].

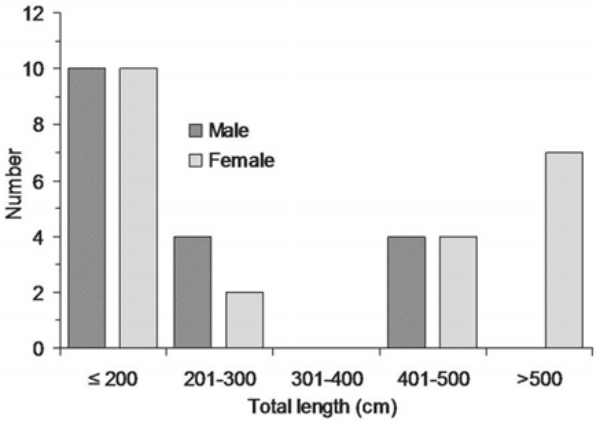

Fig. 1. Size distribution of White shark off Tunisian coasts

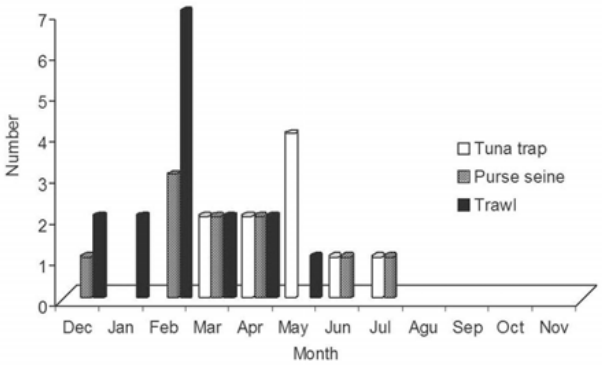

Fig. 2. Monthly accidental capture of White shark by fishing gear types

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STATUS AND TRENDS OF DEMERSAL ELASMOBRANCHES IN SARDINIAN SEAS (CENTRAL WESTERN MEDITERRANEAN)

M. Follesa [1]*, A. Cau [1], R. Cannas [1], A. Mulas [1], P. Pesci [1], C. Porcu [1] and A. Sabatini [1]
[1] Department of Life Science and Environment University of Cagliari - follesac@unica.it

Abstract
The status of demersal Elasmobranchs species in Sardinian Sea was investigated through data collected in 17 years of MEDITS trawl surveys carried out between 1994 and 2011. Both density and biomass indices of the totality of Elasmobranches caught in the macrostrata 10-800 m and in the shelf (10-200 m) showed statistical increasing trends. The species showed stable and/or statistical increasing trends of the abundance indices. Only one statistical decreasing trend was observed for both indices of *Squalus blainville* In spite of the general status of Elasmobranches in the Mediterranean, our analyses highlighted that the demersal cartilaginous species do not show any sign of decline in the Sardinian seas (Central western Mediterranean).

Keywords: Elasmobranchii, North-Central Mediterranean

Introduction
In many areas of the world as the Mediterranean sea, a decline in cartilagineous fish species landing has been observed [1]. There is evidence that the Elasmobranches of the Mediterranean are declining in abundance, diversity and range due to the intense fishing activity also in response to a rapid increasing demand for skin fins, meat and cartilage [2]. Their particular biological characteristics (low fecundity, late maturity and slow growth rates) also make Elasmobranches vulnerable to fishing pressure. Among 85 species estimated to be present in the Mediterranean, only 71 were assessed within the framework of the IUCN red list [3]. More than 40% are vulnerable and endangered to critically endangered. Within the 71 assessed species, 18 are data deficient [3]. In this paper the status of demersal Elasmobranches present in the Sardinian seas was estimated in order to give a further contribution to the knowledge of elasmobranches fisheries.

Material and methods
Data come from the trawl surveys MEDITS (MEDiterranean International Trawl Survey) carried out in the Sardinian seas between 1994 and 2011. All specimens of each species were numbered and weighed in each haul following the MEDITS protocol [4]. The mean occurrence (N° of positive hauls/total hauls planned for the survey*100) within the entire period of study was calculated at species level. The trend of biomass and density indices of each species collected during every annual survey were analyzed. The statistical soundness of the temporal trend was investigated by the Spearman test [5].

Results
Both density and biomass indices showed statistical increasing trends during the years 1994 – 2011 in the macrostrata 10-800 m and in the shelf (10-200 m) of Sardinian seas (Spearman test P=0.004 and P= 0.001 for 10-800 and P=0.002 of both indices for the shelf respectively). A stable trend was found in the slope (200-800 m). The species with the highest value of occurrence is *Scyliorhinus canicula* (44.1%) followed by *Galeus melastomus* (33.1%). The species showed stable and/or statistical increasing trends of the abundance indices (Tab.1). Only one statistical decreasing trend was observed for both indices of *Squalus blainville*. Captures of rare species, not comprised in Tab.1 (occurrence %<1), like *Dalatias licha*, *Leucoraja circularis*, *Centrophorus granulosus* were registered in several years.

Discussion
In contrast to what is reported for some areas of the Mediterranean basin, data collected in the Sardinian seas within the framework of MEDITS (1994 – 2011) scientific trawl surveys showed that both abundance and biomass indices are quite constant or even slightly increasing both in shelf and slope. Similar conclusion can be obtained considering the percent of the hauls in which the species were found, suggesting that the species are not to be considered as endangered or threatened. Only some concerns can be raised up for *S. blainville* that shows critical decreasing trends of abundance. Anyway, as reported by [6], the scarcity of knowledge on distribution, biology and ecology of some species, as well as trends in abundance, suggest the need to improve scientific investigation and enlarge it to all Mediterranean countries.

Tab. 1. Occurrence, minimum and maximum values of abundance indices (biomass and density) for Elasmobranches species caught in Sardinian seas between 1994 and 2011 with results of the relative Spearman test (S=stable; I=Increasing; D= decreasing). In bold statistical significant values.

Species and Threatened status IUCN	Depth range (m)	Occurrence %	Temporal trend			
			BI (kg/km^2)	Min-max	DI (n/km^2)	Min-max
Chymotus centrina (CR)	10-800	2.2	**I (P=0.02)**	0.07-0.62	**I (P=0.001)**	0.1-0.4
Chimaera monstrosa (NT)	200-800	2.5	S (NSD)	0.02-0.34	**I (P=0.02)**	0.2-7.3
Dipturus oxyrinchus (NT)	10-800	20.7	S (NSD)	5.86-19.06	S (NSD)	2.2-18.3
Dasyatis pastinaca (NT)	10-200	4.1	**I (P=0.05)**	10.76-99.82	**I (P=0.02)**	7.6-164.7
Raja clavata (NT)	10-800	28.7	**I (P=0.01)**	12.21-55.93	S (NSD)	15.3-75.8
Raja polystigma (NT)	10-800	28.3	S (NSD)	4.92-31.15	S (NSD)	17.4-102.9
Myliobatis aquila (NT)	10-200	0.7	S (NSD)	0.08-3.69	**I (P=0.03)**	0.4-2.2
Etmopterus spinax (LC)	10-800	18.9	**I (P=0.001)**	0.74-10.34	**I (P=0.002)**	10.6-97.7
Torpedo torpedo (LC)	10-200	1.6	S (NSD)	0.03-6.92	S (NSD)	0.4-11.4
Raja asterias (LC)	10-200	6.1	S (NSD)	0.09-61.79	S (NSD)	1.7-108.1
Raja miraletus (LC)	10-200	22.7	**I (P=0.003)**	2.65-18.65	**I (P=0.002)**	12.3-128.9
Galeus melastomus (LC)	10-800	30.3	S (NSD)	21.21-79.68	S (NSD)	451.4-1234.8
Scyliorhinus canicula (LC)	10-800	41.0	**I (P=0.02)**	16.22-67.64	S (NSD)	144.8-642.8
Squalus blainville (DD)	10-800	9.4	**D(P=0.0004)**	0.99-17.10	**D(P=0.0004)**	1.7-88.4
Torpedo nobiliana (DD)	10-800	2.3	S (NSD)	0.01-2.15	S (NSD)	0.1-1.6
Raja brachyura (DD)	10-200	6.5	**I(P=0.00008)**	0.01-88.66	**I(P=0.0002)**	0.07-159.3

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OBSERVATIONS OF CARTILAGINOUS FISH ON THE HEADS OF FRENCH MEDITERRANEAN CANYONS

Adrien Goujard [1]*, Maïa Fourt [1] and Pierre Watremez [2]
[1] GIS Posidonie, Université Aix-Marseille, Campus de Luminy, case 901, 13288 Marseille, France - adrien.goujard@univ-amu.fr
[2] Agence des aires marines protégées, 42 bis Quai de la douane, 29200 Brest, France

Abstract
The MedSeaCan and CorSeaCan campaigns managed by the French marine protected areas agency, explored the French Mediterranean canyons, and collected *in situ* images (videos and photographs) from 30 to 800 m depth using a ROV and a submarine. Species of Elasmobranchii and Holocephali were identified and geo-localised.

Keywords: North-Western Mediterranean, Canyons, Elasmobranchii

Introduction
The canyon exploration campaigns, MedSeaCan and CorSeaCan, took place between November 2008 and august 2010 using COMEX S.A. equipment and with a major contribution from the scientific team associated with the program. The aim was to establish a baseline of 43 sites relatively to habitats, protected and commercial species, ecosystems and anthropogenic impact, using the same methods and prospection gear.

Material and methods
On the continent, the study zone stretched from the Spanish frontier to Monaco and on the west coast of Corsica, from Cap Corse to the Bonifacio strait. The data processing of the 297 dives, representing 520 km, 550 hours of videos and over 20 000 photographs, was carried out by means of the ZOODEX information system (ZOOlogical data Exploration system) developed by GIS Posidonie [1].

Results and discussion
Extraction of information concerning Elasmobranchii and Holocephali reveals the observation of 14 taxons geographicaly referenced (Table I).

Tab. 1. Inventory and number of occurrences of cartilaginous fish observed during the MedSeaCan and CorSeaCan campaigns.

Order	Family	Taxon	Total number of occurrences on 43 sites investigated
		Unidentified Elasmobranchii	12
Carcharhiniformes		Unidentified Carcharhiniformes	14
Carcharhiniformes	Scyliorhinidae	*Galeus melastomus*	188
Carcharhiniformes	Scyliorhinidae	Unidentified Scyliorhinidae	5
Carcharhiniformes	Scyliorhinidae	*Scyliorhinus canicula*	98
Hexanchiformes	Hexanchidae	*Hexanchus griseus*	2
Holocephali	Chimaeridae	*Chimaera monstrosa*	36
Rajiformes	Rajidae	*Dipturus oxyrinchus*	1
Rajiformes	Rajidae	*Raja clavata*	5
Rajiformes	Rajidae	*Raja polystigma*	1
Rajiformes	Rajidae	Rajidae non identified	2
Squaliformes	Dalatiidae	*Etmopterus spinax*	54
Squaliformes	Dalatiidae	*Oxynotus centrina*	1
Squaliformes	Squalidae	*Squalus acanthias*	1
		Total	420

All the species are listed on the IUCN Mediterranean or world red list. Amidst the species observed, two specimens of *Hexanchus griseus* were sighted (with an estimated length of 2 and 2.5 m) and a specimen of *Squalus acanthias* captured, both being considered as vulnerable species. Moreover, a specimen of *Oxynotus centrina* (considered as critically endangered in the Mediterranean [2]) was photographed in the Lacaze-Duthiers canyon. The other most frequently observed species in terms of total occurrences were: *Galeus melanostomus*, *Scyliorhinus canicula* and *Etmopterus spinax*. Cartilaginous species were observed in nearly all canyons and mainly on soft bottoms between 90 and 700 m depth (Figure 1).

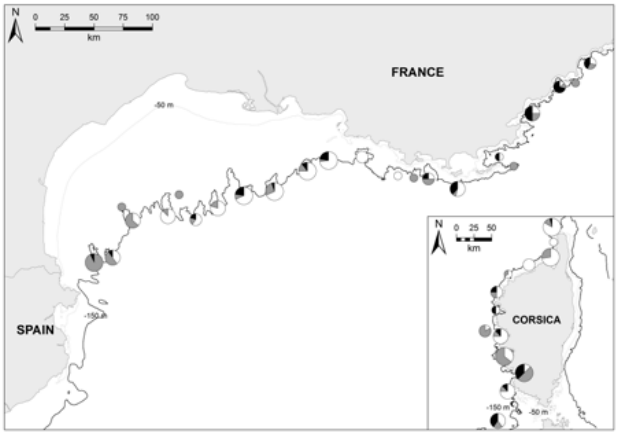

Fig. 1. Distribution map of the MedSeaCan and CorSeaCan observations of the three most frequently observed species: *Galeus melastomus* (white), *Scyliorhinus canicula* (gray) and *Etmopterus spinax* (black).

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MONITORING OF SANDBAR SHARK *CARCHARHINUS PLUMBEUS* (NARDO, 1827) IN SOUTHERN AEGEAN SEA

Anil Gulsahin [1]*, Halit Filiz [1], Hasan Cerim [1] and Gokcen Bilge [1]
[1] Mugla Sitki Kocman University, Faculty of Fisheries, - agulsahin@mu.edu.tr

Abstract
Boncuk Bay in the Gökova Special Environmental Protection Area (SEPA) is a critical habitat for sandbar shark (*Carcharhinus plumbeus*) since the bay has been used as a nursery area by this species. In 2012, a study entitled "The Observation of Sandbar Sharks in Boncuk Bay in Gökova Special Environmental Protection Area" was carried out by a scientific team from Mugla Sitki Kocman University Faculty of Fisheries under the project "Strengthening the System of Marine and Coastal Protected Areas of Turkey" managed by the GDPNA and implemented by UNDP with the financial support from GEF. As a result of the observations, we encountered sandbar sharks 49 times in 105 FDOs, and totally 93 individuals were counted.

Keywords: Biodiversity, Aegean Sea

Sandbar is a coastal shark, often in shallow waters associated with sandy or muddy flats, bays, estuaries and harbours, and also further offshore, particularly on banks, near islands, flats reefs and other topographic features in open waters (Grubbs et al 2007). Boncuk Bay is the famous breeding zone of this species in the Mediterranean Sea. There are few studies on the subject [1, 2, 3]. The aims of this study listed as determine the existence and habitation of sandbar shark in the area by in situ observations, possible threats affecting shark population and provide a documentary. Sandbar shark individuals in the Gökova SEPA were observed, counted and photographed via free diving method. The study period was between 12 May and 28 September 2012. A total of 21 field studies (in May: 3 days; June: 5 days; July: 4 days; August: 5 days and September: 4 days), and 105 free diving observations (FDOs) were made. The surface seawater temperatures were measured as 20.2 ± 0.4ºC in May, 23.3 ± 1.1ºC in June, 23.5 ± 0.2ºC in July, 26.6 ± 0.3ºC in August and 24.8 ± 0.5ºC in September. We encountered sandbar sharks 49 times in 105 FDOs, and totally 93 individuals were counted. Sandbar sharks observations are decreased in end of the June increased again in early August (Figure 1).

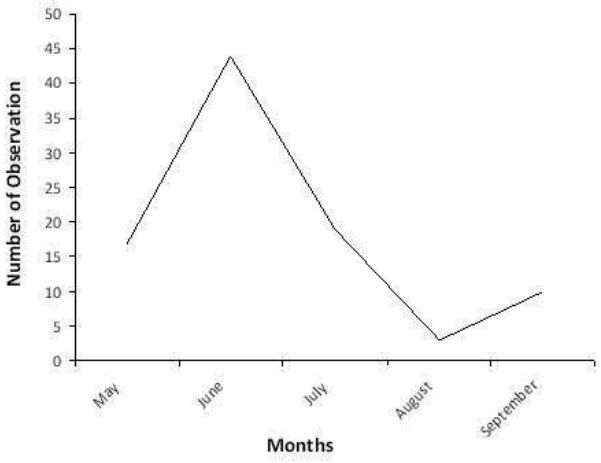

Fig. 1. Change in the number of observation by months.

The sharks are very active in the morning, most (84,3 %) observations were made in morning hours between 07:00 – 10:00 a.m (Figure 2).

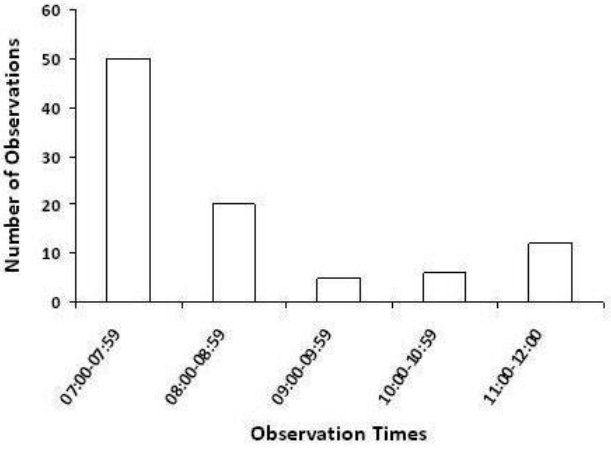

Fig. 2. Number of Sandbar Shark by observation times.

Boncuk Bay in the Gökova Special Environmental Area (SEPA), all kinds of fishing activities and boat trips in the area are prohibited. However activities that could threaten the sharks have been observed. These are ordered as follows, Illegal artisanal fishery applications were observed in protected area. From time to time, boat trips entered in the protected area to sharks for their guests. Some solid waste observed at the bottom of the area. Sailing boats discharged their bilge in open sea, but they are drifted to the Boncuk Bay via forced winds.

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BY-CATCH AND DISCARDS OF ELASMOBRANCHS IN THE ARTISANAL NET FISHERY IN A CORSICAN MPA (NORTH-WESTERN MEDITERRANEAN)

L. Le Direach [1]*, P. Bonhomme [1], M. Ourgaud [2], C. Boudouresque [2] and G. Cadiou [1]
[1] GIS Posidonie - Aix Marseille University - laurence.ledireach@univ-amu.fr
[2] Mediterranean Institute of Oceanography

Abstract
The high proportion of elasmobranchs in the discards of the artisanal fishery within and near the Scandola MPA suggests that those species do not benefit from the protection and pay a heavy tribute to gillnet and trammelnet fishing, even close to the shore.

Keywords: Elasmobranchii, Fisheries, Conservation, Coastal waters, North-Western Mediterranean

Introduction
A twelve year seasonal survey of the artisanal fishery within and near the Scandola MPA (Western Corsica, France) provided data on the catches and discards of elasmobranchs in the catches (gillnets and trammel nets). The fishing effort was concentrated near the coast in various reef habitats and *Posidonia* meadows down to 120 m coastal detritic bottoms. Fishermen targeted mainly demersal fish and the spiny lobster *Palinurus elephas*.

Material and methods
Discards of fish were evaluated onboard by recording all fishes (size and wet mass) caught by each net during 9 sampling periods (spring, summer and/or autumn), between 2001 and 2012. A minimum of 25 to 71 nets were sampled in each sampling period during about two weeks.

Results
The total fish discards were estimated at between 5 and 27% of the caught fish biomass according to the season (maximum in spring and summer). Among elasmobranch catches, discards reached 100 % of catch biomass in autumn and were never lower than 21% whatever the season. The contribution of elasmobranchs to the caught biomass was estimated at 11 to 25% whatever the season, but their mean contribution to discards was 49% and might attain 74% in summer. The composition of the caught biomass was 1/3 *Dasyatis pastinaca*, 1/3 *Raja* spp. and 1/3 of *Scyliorhinus* spp. (23%) and *Torpedo* spp. (6%).

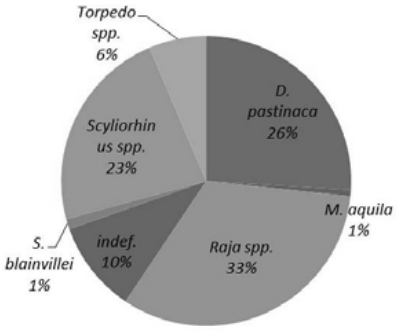

Fig. 1. Elasmobranchs caught in gillnets and trammelnets in Scandola fishery.

The ray *Myliobatis aquila* was scarce while sharks were quite rare, with less than 10 individuals observed during the total survey period. shark, namely *Etmopterus spinax*, *Galeus melastomus* and *Squalus blainvillei* were mainly encountered in spring. An unidentified species belonging to the protected genus *Squatina* has been observed only on one occasion. Unlike fishing habits in other countries, skate and ray are not targeted in the study area. However, there is now a growing interest of consumers for skate. As a result, the *Raja* species that were systematically discarded at the beginning of the study, are now kept for their wings (18% of elasmobranch discards in 2001 vs 0% in 2012). This explains why, among the elasmobranchs, the most frequently discarded species are *Scyliorhinus canicula* and *S. stellaris*, followed by *Dasyatis pastinaca* and *Torpedo* spp.

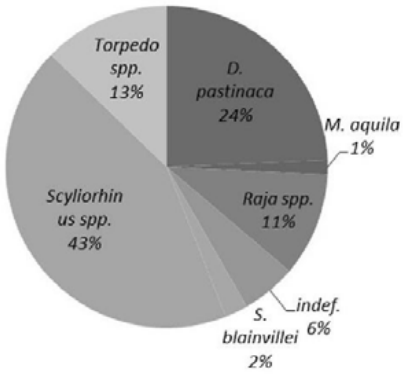

Fig. 2. Composition of elasmobranchs discards in gillnet and trammelnet fishery in Scandola MPA.

The yield in biomass of *Scyliorhinus* spp. was drastically divided by 6 in spring (188 vs 26 g/100 m respectively in 2001 and 2012). They were mainly caught by fishing nets (3.5-5 cm mesh size). The increasing use of one-wire nylon nets seemed to have enhanced catches of these species. The *Torpedo* spp. were caught by larger mesh sizes (5.5-7.5 cm) in the traditional trammel nets. The smallest mesh size (2-3 cm) used near the coast, mainly targeting red mullet (*Mullus* spp.), totalled 85 to 100% of its elasmobranch biomass discarded, which represents the highest value recorded. The highest individual mean biomass in the catches was that of *Dasyatis* spp. (3.8 kg ± 7.9 kg SD) and *Myliobatis aquila* (3.5 kg). The mean length was 47 to 58.4 cm (56.7 ± 19.8 SD) for *Raja* spp., 44.9 ± 6.4 SD for *Scyliorhinus* spp. and 40.2 ± 12.4 for *Torpedo* spp.

Discussion and conclusion
In Scandola, a few fishermen are authorized to fish in the buffer area of the MPA. Mean yields are not decreasing over time and the mean number of fishing vessels and gear recorded in the study area is relatively stable [1]. Those results must be considered as contributions to the assessment of the benefits of the protection in the area adjacent to the MPA. Nevertheless, neither the surface area of the tiny no-take zone, nor the buffer zone of the Scandola MPA, where only recreational fishing is banned, offer sufficient protection to elasmobranchs which are highly vulnerable to the artisanal gillnet and trammel net fishery, as evidenced by their dramatic decline in catches over the study period.

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BEHAVIOUR OF DEEP-SEA SHARKS OBSERVED IN THE SANTA MARIA DI LEUCA COLD-WATER CORAL PROVINCE

L. Sion [1]*, F. Capezzuto [1], R. Carlucci [1], A. Carluccio [1], A. Indennidate [1], P. Maiorano [1] and G. D'Onghia [1]
[1] Department of Biology - University of Bari - letizia.sion@uniba.it

Abstract
A total of 4 shark species (*Centrophorus granulosus, Dalatias licha, Etmopterus spinax* and *Hexanchus griseus*) were observed in the Santa Maria di Leuca cold-water coral province using the baited lander MEMO during 3 video surveys carried out in 2010 and 2011. The depth examined was between 547 and 790 m. The dominant behaviour of the sharks was investigation of the bait at the foot of the lander. Ingestion of the bait was only shown in *H. griseus* and *C. granulosus*.

Keywords: Behaviour, Deep sea corals, Elasmobranchii, Ionian Sea, South-Central Mediterranean

Baited cameras on benthic landers attract deep-sea fish in order to provide information on their abundance, diversity and behaviour [1]. As part of the CoralFISH 7FP EU project and OBAMA-PRIN research funded by the Italian Government, the baited lander MEMO (Marine Environment MOnitoring system) was deployed in the Santa Maria di Leuca (SML) cold-water coral province (Central Mediterranean) in June and November 2010, and March-April 2011. MEMO consists of a stainless steel metallic frame, 2 digital cameras, a multiparametric probe, a currentmeter, an acoustic modem, and an ICT infrastructure capable of managing the entire system. A total of ten deployments between 547 and 790 m were carried out, for a total time of about 90 hours of video records. During each deployment the lander was baited with specimens of *Scomber scombrus*. The different species were identified through morphological characteristics observed in the video frames. The total number of individuals by species was counted. The behaviour was noted with respect to investigation activity, response to the bait and ingestion of the bait. During the three surveys, a total of 4 shark species were recorded: *Centrophorus granulosus*, *Dalatias licha*, *Etmopterus spinax* and *Hexanchus griseus*. *C. granulosus* and *D. licha* were only recorded during one deployment. The former was seen to be attracted by the bait, to investigate and to feed on it; the latter was also observedto be attracted by the bait and investigating on it but without feeding on it (Fig. 1). *Etmopterus spinax* was recorded two times showing attraction to the bait without feeding activity in one deployment and an indifferent behaviour in another deployment. *Hexanchus griseus* were observed 8 times. Although all specimens were seen to be attracted by the bait with an investigation behaviour at the foot of the lander, only three attacked and ingested the bait and only one attacked and removed the bait from the plate of the lander without ingesting it (Fig. 2). During one deployment *H. griseus* was also observed to interact with *Paromola cuvieri* near to the bait [2]. The present results show that the dominant behaviour of deep-sea sharks observed in the SML coral province was investigation of the bait at the foot of the lander. Differently from the observations reported in the Eastern Mediterranean for *E. spinax* [3] and *H. griseus* [4], the bait was not always consumed by the arriving individuals. These could be explained by the fact that it is unlikely that scavenging activity is an important feeding pattern for any of the species observed [4].

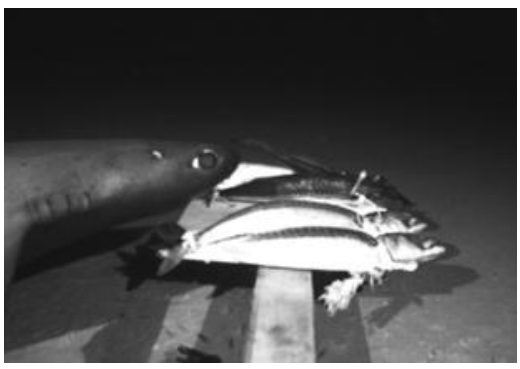

Fig. 1. Digital frame showing *Dalathias licha* in the SML coral province.

Fig. 2. Digital frame showing *Hexanchus griseus* in the SML coral province.

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FIRST RECORDS OF THE LITTLE SLEEPER SHARK, *SOMNIOSUS ROSTRATUS*, IN MALTESE FISHERIES' LANDINGS

Adriana Vella [1]*, Noel Vella [1] and Elizabeth Dent [2]
[1] University of Malta - adriana.vella@um.edu.mt
[2] University of Bath

Abstract
In 2011, two little sleeper sharks, *Somniosus rostratus*, were captured from the Central Mediterranean, making them the first two records of this shark species landed in the Maltese Islands. These records fall within the outer most eastern distribution range of the species

Keywords: Elasmobranchii, Fisheries, South-Central Mediterranean

Introduction
The little sleeper shark, *Somniosus rostratus* (Risso, 1826), is a deep-sea shark living in a depth range of 180m to 2220m, with a geographic distribution is limited to the Northeast Atlantic Ocean and the Mediterranean Sea [1,2,3], with absent to very rare occurrence in the Eastern Mediterranean basin [4, 5]. In 2009, it has been evaluated as Data Deficient by IUCN, due to its rarity possibly related to a natural low populationdensity and lack of records within scientific surveys [6, 7]. In the Mediterranean Sea, *Somniosus rostratus*, as being evaluated as Least Concern [8], as it occurs below the depth of many demersal fisheries, while the restricted fishing activities below 1000m in the Mediterranean offering protection to this deep-sea species. Nonetheless, this species is still vulnerable at shallower parts of its depth range, whereas the lack of scientific knowledge on the species and its small geographical distribution range make any data available on this species valuable.

Methods
As part of ongoing fisheries and conservation research and monitoring by the Conservation Biology Research Group of the University of Malta, since 2002, through the conduction of regular fish-market surveys. Detailed records of the landings are taken, including morphometric data of elasmobranch species. Any species found to be landed for the first time by local fisheries are collected for further investigation. This paper presents one such record, where two specimens of Somniosus rostratus were landed as by-catch on long-lines. Identification of these specimen was carried out in the Conservation Biology Research Lab. and undertaken on the basis of their morphological characters [2,9], namely body proportions, teeth and number of turns in the spiracle valve. Morphometric data were measured to the nearest mm or g for length or weight as indicated by FAO [4,5].

Results and Discussion
In June, 2011, two specimens of *Somniosus rostratus*, were landed at the Maltese fisheries. These two specimens represent the first two landing records of such species amongst the species landed in the Maltese Islands. They were caught together as by-catch on long-lines off the Northeast of Malta. They were identified on the basis of their morphological characters [9][2]. These two specimens were both females having a total length of 935mm and 1036mm (Figure 1) respectively. The smaller specimen was an immature female with a gonosomatic index [(GW/TW)*100] of 0.5, while a gonosomatic index of 19.2 was noted for the second specimen. Additionally the second specimen had expanded and round uteri full of yolk. The hepatosomatic index [(LW/TW)*100] was 12.4 and 9.7 respectively, indicating a large liver in both specimens, as expected in sub-adult and adult shark specimens [10].

Fig. 1. Specimen of *Somniosus rostratus* landed at the Fish market of the Maltese Islands in 2011.

These first-time fisheries records of *Somniosus rostratus* landed in Malta indicate that mature and near mature individuals of this species occur in the Central-Southern Mediterranean Sea. As this species is found to inhabit deep waters over 1000m in depth, the presence of mature individuals in relatively shallower waters may indicate important reproductive grounds. The presence of mature females of this species in shallower waters has also been reported in Spain [1]. So *Somniosus rostratus* females may seek shallower waters as females of several other species of sharks do. In so doing they become vulnerable to fishing activities undertaken in shallower waters.

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Session

Cartilaginous fish ecology

Modérateur : **Sebastián Biton Porsmoguer**

FEEDING HABITS OF SYMPATRIC DEMERSAL CHONDRICHTHYES

M. Albo-Puigserver [1]*, J. Navarro [1], M. Coll [1], R. Sáez [1] and I. Palomera [1]
[1] Institut de Ciències del Mar, ICM-CSIC, P.Marítim de la Barceloneta 37-49, 08003 Barcelona, Spain. - albo@icm.csic.es

Abstract

In the present work we describe the feeding habits of three coexisting chondrichthyans (*Galeus melastomus, Etmopterus spinax* and *Chimaera monstrosa*)in the Gulf of Lyon (North-Western Mediterranean Sea) during the summer 2011 at mean depths of 489 m. To examine their diet and potential interspecific differences, we combined two methodologies: the analysis of stomach content and isotopic mixing models. Our results showed clearly trophic segregation between *C. monstrosa* and the other two species, revealing the higher trophic position for this species.

Keywords: Demersal, Diet, Stable isotopes, Competition, Gulf of Lyon

Introduction Species that overlap niches lead to ecological divergence or competitive exclusion [1]. In marine ecosystems, segregation in feeding habits has been largely described as a common mechanism to allow the coexistence of several competing marine predators [2]. However, little is known for chondrichthyans, which play a pivotal role on the structure of marine food webs worldwide [3]. Here, we examine the feeding ecology of three abundant demersal chondrichthyans coexisting in the Mediterranean; *G. melastomus*, *E. spinax*, and *C. monstrosa*. To determine their diet, we combined stomach content analyses (SCA) and stable isotopic analysis (SIA).

Material and methods

SCA and SIA values were determined on mature *G. melastomus* (n= 34, body length = 22.73±1.89 cm), immature *E. spinax* (n= 36, body length = 12.83±2.59 cm) and mature *C. monstrosa* (n= 24, body length = 23.03±2.47 cm) sampled in the Gulf of Lyon (North-Western Mediterranean Sea) during the summer 2011. Because diet did not differ between sexes in the three species (PERMANOVA tests, all $p>0.05$,), we only compared the SCA and SIA values at species level. With SCA results, we estimated the Index of Relative Importance (%IRI) of each prey group. SIAR isotopic mixing models were used to determine the diet with SIA values [4]. Interspecific differences in %IRI, $\delta^{15}N$ and $\delta^{13}C$ were tested by using PERMANOVA tests.

Results and Discussion

Although SCA showed some discrepancies with SIA, both approaches revealed clearly trophic segregation between species (Fig. 1 and 2). *C. monstrosa* occupies a separate isotopic niche space, showing higher $\delta^{15}N$ and $\delta^{13}C$ values than *E. spinax* and *G. melastomus* ($p<0.001$; Fig. 1).

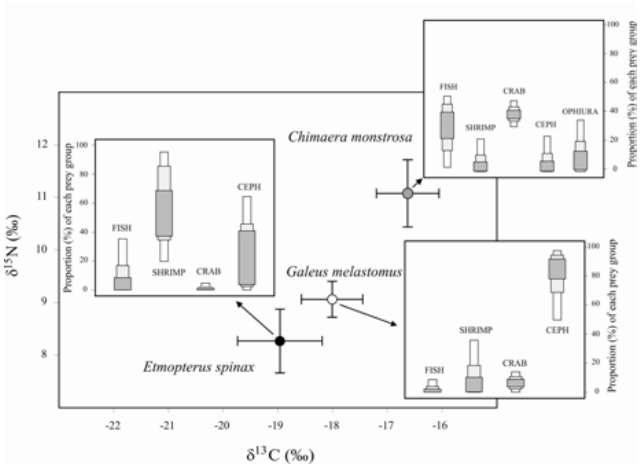

Fig. 1. Values of $\delta^{15}N$ and $\delta^{13}C$ (mean ± sd) of *Galeus melastomus*, *Etmopterus spinax* and *Chimaera monstrosa* and results of SIAR model (95%, 75% and 50% credibility intervals) showing estimated prey contributions to the diet of each species (CEPH = cephalopod).

The principal prey in the diet of *E. spinax* was the shrimps (SIAR output= 56 % and %IRI= 45%), *G. melastomus* showed a diet mainly composed of cephalopods (77% and 47%) and the diet of *C. monstrosa* was mainly composed of crabs (39% and 96.98%). *E. spinax* and *G. melastomus* have similar trophic levels, while *C. monstrosa* has a higher trophic level. Differences between methods may be due to the period of trophic information that integrates the SIA is broader than the information obtained from the SCA results [5]. In conclusion, the present study indicated that although there was a degree of overlap in some prey group, the three taxa segregate their trophic habits despite living in sympatry.

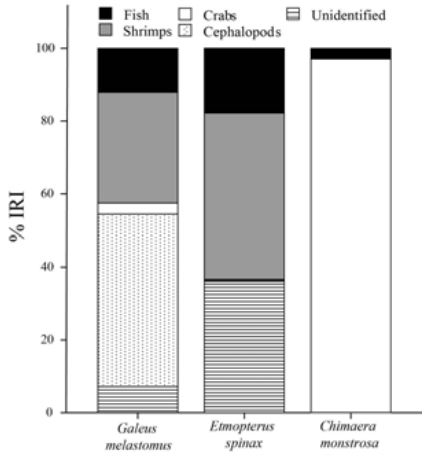

Fig. 2. Diet composition of *Galeus melastomus*, *Etmopterus spinax* and *Chimaera monstrosa* from the Gulf of Lyon (NW Mediterranean), expressed as percentage of the index of relative importance (%IRI).

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DIET OF THE SHORTFIN MAKO *ISURUS OXYRINCHUS* AND THE BLUE SHARK *PRIONACE GLAUCA* IN THE NORTHEASTERN ATLANTIC OCEAN

S. Biton Porsmoguer [1]*, D. Banaru [1], P. Béarez [2], I. Dekeyser [1], M. Merchán Fornelino [3], R. Míguez Lozano [4] and C. F. Boudouresque [1]

[1] MIO (Mediterranean Institute of Oceanography), Aix-Marseille University, campus de Luminy, case 901, 13288 Marseille cedex 9, France - sebastien.biton@univ-amu.fr

[2] Muséum National d'Histoire Naturelle, Département Ecologie-Gestion de la Biodiversité, 55 Rue Buffon, 75005 Paris, France

[3] Asociación Chelonia, C/ Aristóteles, 3 28027 Madrid, Spain

[4] Unidad de Zoología Marina, Instituto Cavanilles de Biodiversidad y Biología Evolutiva, Parc Científic, Universitat de València, Apdo 22085, 46071 València, Spain

Abstract

The diet of mostly juveniles of *Isurus oxyrinchus* and *Prionace glauca* is strongly dominated by teleosts (mainly *Scomberesox saurus*) and cephalopods (mainly *Histioteuthis* sp.), respectively.

Keywords: Diet, Elasmobranchii, Teleostei, Cephalopods, Gulf of Cadiz

Introduction

The shortfin mako *Isurus oxyrinchus* and the blue shark *Prionace glauca* are the elasmobranch species most affected by the sea surface longliners. These pelagic species have a slow growth rate and low fecundity [1] and are located in the highest level of the marine food web. They compete for the same alimentary sources with species which are the main target species of commercial fisheries, the swordfish *Xiphias gladius* and the tuna *Thunnus* spp. This study analysed the diet of the above mentioned elasmobranchs through the stomach contents of individuals captured by longliners from Vigo, Spain.

Tab. 1. Prey found in stomachs of the analysed species. For the meaning of %O and %N, see text.

Prey	*Isurus oxyrinchus*		*Prionace glauca*	
	%O	%N	%O	%N
Crustaceans	**3.9**	**1.0**	**8.7**	**2.6**
Galathea sp. (Decapoda)	2.0	0.5	-	-
Unidentified Decapoda	2.0	0.5	4.3	1.3
Isopoda	-	-	4.3	1.3
Cephalopods	**23.6**	**10.8**	**95.7**	**86.8**
Alloposus mollis	-	-	4.3	1.3
Ancistroteuthis lichtensteinii	2.0	0.5	4.3	1.3
Argonauta sp.	-	-	4.3	3.9
Brachioteuthis riisei	-	-	13.0	3.9
Gonatus steenstrupi	2.0	0.9	4.3	1.3
Heteroteuthis sp.	-	-	13.0	3.9
Histioteuthis elongata	3.9	0.9	-	-
Histioteuthis sp.	13.7	3.3	34.8	30.3
Illex coindetii	2.0	0.5	-	-
Lepidoteuthis grimaldii	-	-	13.0	2.6
Octopus sp.	-	-	4.3	1.3
Pteroctopus tetracirrhus	-	-	4.3	1.3
Sepiola atlantica	2.0	0.5	-	-
Taningia danae	-	-	4.3	1.3
Unidentified Sepiolidae	-	-	26.1	11.8
Unidentified cephalopods	7.8	4.2	43.5	22.4
Tunicates	-	-	**4.3**	**1.3**
Unidentified Salpida	-	-	4.3	1.3
Teleost	**80.4**	**85.0**	**13.0**	**6.6**
Balistes capriscus (Balistidae)	3.9	1.4	-	-
Scomber scombrus (Scombridae)	11.8	2.8	8.7	2.6
Scomberesox saurus (Scomberesocidae)	51.0	76.1	-	-
Thunnus alalunga (Scombridae)	3.9	0.9	-	-
Unidentified Bramidae	2.0	0.5	-	-
Unidentified teleosts	13.7	3.3	4.3	3.9
Sea turtles	**2.0**	**0.5**	-	-
Caretta caretta (Cheloniidae)	2.0	0.5	-	-
Cetaceans	**11.8**	**2.8**	**8.7**	**2.6**
Unidentified Odontoceti	11.8	2.8	8.7	2.6

Materials and methods

The study area was located between the Azores Archipelago and the Iberian Peninsula (15º-35º W and 30º-45º N). 82 shortfin makos and 54 blue sharks were studied between March and October 2012. Most individuals (respectively 95% and 82%) were juveniles, according to the size at sexual maturity [1, 2]. The identification (to the species or a higher taxon level) of the prey was carried out through the analysis of the vertebrae (teleosts and cetaceans) and the beak characteristics (cephalopods) [3, 4]. Frequency of occurrence (%O) is the percentage of non-empty stomachs containing a type of prey. Percent number (%N) is the percentage of individuals of a given prey versus the overall number of prey within non-empty stomachs.

Results and discussion

The number of stomachs containing prey was 51 (out of 82) and 23 (out of 54) for *I. oxyrinchus* and *P. glauca*, respectively. The diet of *I. oxyrinchus* is essentially (85%) based on teleosts (Table 1). More than 90% of individuals of teleost prey belonged to one species, *Scomberesox saurus*. In addition, remains of a loggerhead turtle *Caretta caretta* and several cetaceans were present. Literature data are in agreement with our results, but report a conspicuously higher diversity of teleost prey [e.g. 5]. As far as *P. glauca* is concerned, cephalopods represent the main prey (~87%), mostly consisting of *Histioteuthis* sp. Teleosts (mainly *Scomber scombrus*) and cetaceans were also consumed. Our results confirm some literature data [6], but strongly contrast with other data which report a mainly teleost diet [e.g. 7].

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EGG-CASES OF *GALEUS MELASTOMUS* (CHONDRICHTHYES, SCYLIORHINIDAE) IN SARDINIAN WATERS

Serenella Cabiddu [1]*, Giulia Atzori [1], Marco Mereu [1] and Francesco Palmas [1]
[1] University of Cagliari - cabiddus@unica.it

Abstract
In this paper some morpho-biometric aspects of *Galeus melastomus* egg cases in Sardinian waters were analysed. The egg case had a rounded vase-like shape and did not have tendrils. The mean length without posterior horns was 4.2 mm and mean width was 1.6 mm. Egg cases from Sardinian waters were smaller than those from Atlantic and other Mediterranean areas.

Keywords: Elasmobranchii, South-Western Mediterranean, Biometrics

Introduction
The blackmouth catshark, *Galeus melastomus* Rafinesque, 1810, a common deep-water bottom-dwelling shark, is distributed in the eastern Atlantic Ocean and in the whole Mediterranean Sea, where it is found from depths of 55 to 1750 m [1]. It is an oviparous species and leys its eggs in a protective egg case. Descriptions of egg cases in Mediterranean Sea are given by few authors [2,3,4,5,7], then the aim of this paper is to analyse some morpho-biometric aspects of egg cases in the Sardinian waters.

Materials and Methods
The total lengh of each egg-bearing female was measured (cm) and the egg cases were removed from the oviducts of fresh specimens, weighted (fresh weight in grams), described and measured (mean±SD; cm). The egg case length (ECL) was used as an independent variable for proportional dimensions of other egg case structures [6] (Fig. 1).

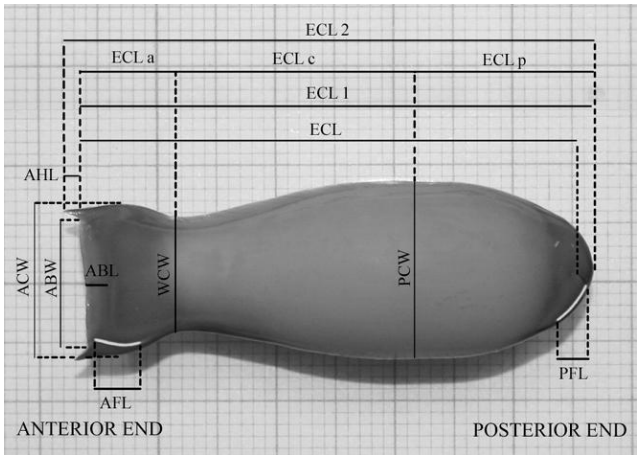

Fig. 1. Egg case measurements of *Galeus melastomus*.

Length of egg-bearing females was correlated with the egg-cases number, ECL and PCW.

Results and Discussion
A total of 41 egg cases (from 1 to 4 in each specimen) were found in 16 egg-bearing females between 45.1 and 52.7 cm of total length (49.1±2.0). The egg case had a rounded vase-like shape and did not have tendrils on either the anterior or posterior end. The surface was smooth in appearance and minute longitudinal ridges were visible running the length of both faces. Two white respiratory fissures on each side (one anterior and one posterior) were present. The egg case color changed from honey-brown to dark-brown related to stage of development. The length without horns (ECL) ranged from 35.9 to 43.8 mm (40.2±1.8), ECL1 ranged from 37.5 to 45.0 mm (41.9±1.6) and ECL2 ranged from 39.5 to 46.7 mm (43.9±1.8). The mean posterior case width (PCW) ranged from 14.4 to 7.4 mm (16.2±0.9) (40.2% ECL) and the posterior length was 17.1±1.2 mm (ECLa). Waist width (WCW) ranged from 8.9 to 12.8 mm (11.7±0.9) (29% ECL) and the anterior length was 17.5±1.5 mm (ECLb). The anterior egg case width (ACW) ranged from 11.0 to 13.4 mm (12.4±0.6) (30.8% ECL) and the central length was 7.5±0.7 mm (ECLc). Egg case height (CHI) ranged from 8.3 to 11.8 mm (9.9±0.8) (24.7% ECL). Anterior border was straight with two horns (AHL=2,1±0.4 mm). The anterior border width (ABW) was 9.7±0.6 mm and the anterior border length (ABL) was 1.5 mm. Posterior end showed two little horns in close proximity with one other. Anterior and posterior respiratory fissures length was 5.5 mm (AFL) and 4.1 mm (PFL) respectively. Fresh weight ranged from 1.6 to 3.6 g (2.2±0.5). Egg case seemed to develop proportionately and there was no relationship between the number and dimension with the size of females. Finally, dimensions of egg cases changed in relation to geographical area according to other authors [4]. Egg cases from Sardinian specimens were smaller than those from other Mediterranean areas and much smaller than those from Atlantic (Tab. 1).

Tab. 1. Measurements recorded in egg cases of *Galeus melastomus* from different areas (ECL1 and PCW in this study).

Authors	Area	length (cm)	width (cm)
	ATLANTIC		
Smitt (1893)	western coast of Africa	4.5-6.5	1.8-2.0
Le Danois (1913)	Off France	6	3
Iglesias et al. (2002)	Eastern north Atlantic	5.1-6.5	1.8-2.3
Costa et al. (2005)	southern Portugal	3.5-6.3 (5.4)	1.4-2.5 (2,1)
	MEDITERRANEAN		
Lo Bianco (1909)	Off Naples	4.5	1.8
Capapé and Zaouali (1977)	Tunisian coast	4.2-4.8 (4.6)	1.8-2.5 (2.1)
Tursi et al. (1993)	Ionian Sea	4.5-5.5	1.7-2.0
Capapé et al. (2008)	southern France	3.6-5 (4.5)	1.4-2.1 (1.8)
Rey et al. (2010)	Alboran Sea	4.1-4.7 (4,4)	1.5-1.7 (1.6)
This study (2013)	Sardinian waters	3.7-4.5 (4.2)	1.4-1.7 (1.6)

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ECOLOGIE DE *LEPIDOPUS CAUDATUS* (EUPHRASEN, 1788) DANS LE BASSIN ALGÉRIEN

Farid Hemida [1]*, Habiba Benrabah [1] and Christian Capapé [2]
[1] ENSSMAL - hemidafarid@yahoo.fr
[2] Université de Montpellier II

Abstract
Le sabre argenté, ou sebta dans la région d'Alger, porte le nom scientifique de *Lepidopus caudatus* (Euphrasen, 1788). L'étude de la distribution de *Lepidopus caudatus* a été réalisée à partir des données obtenues au cours de la campagne effectuée par le navire océanographique Thalassa (ISTPM, 1982) sur toute la côte algérienne. Les résultats obtenus sont relatifs aux répartitions géographique et bathymétrique. De plus, l'étude du peuplement caractéristique de *Lepidopus caudatus* a mis en évidence les espèces qui lui sont étroitement associées.

Keywords: Fish behaviour, Teleostei, Algerian Basin

Introduction
Le sabre argenté *Lepidopus caudatus* (Euphrasen, 1788) est un poisson osseux, appartenant à la famille des Trichiuridae. Il est capturé accidentellement, bien qu'évité soigneusement par les patrons de pêche. Les captures, qui pouvaient atteindre 1500kg par coup de chalut, sont rejetées en mer. Très comestible, vendu dans des pays des rives nord et sud de la Méditerranée, le sabre demeure étrangement absent des étals des marchés algériens. La pêche proprement dite de ce poisson n'existe pas, ce qui explique l'absence de toute étude sur les côtes algériennes.

Méthodes d'étude
La campagne Thalassa s'est déroulée d'Ouest en Est [1] :182 stations de chalutage ont été réalisées entre 15 et 820m de profondeur. Sept secteurs géographiques ont été prospectés: Béni-Saf et Arzew à l'Ouest; Bou-Ismail et Zemmouri au Centre; Jijel, Skikda et Annaba à l'Est. Deux indices ont permis l'analyse des répartitions horizontale et verticale: la fréquence relative (Fr) et le rendement R ou abondance relative (Ar). Les stations en dehors de la gamme de prospection ne sont pas considérées [2]. Les fréquences relatives (Fr) correspondent au nombre de stations ayant ramené l'espèce. Le peuplement, défini selon [3], caractéristique du sabre argenté a été analysé en calculant pour chacune des espèces de rang (i) son abondance relative (xi) et sa fréquence relative (yi). Les espèces très caractéristiques (très fréquentes et très abondantes) sont mises en évidence sur un diagramme a quatre cadrans [2] .

Résultats et discussion
L'espèce étudiée est présente le long de la côte algérienne avec des variations selon la région considérée. Le sabre argenté est très fréquent à l'est et très abondant au centre de la côte algérienne (tableau 1). Ce dernier se capture au chalut sur des fonds compris entre 80m et 600m. La tranche de profondeur la plus productive (figure 1) se situe entre 200 et 400m. Deux espèces sont étroitement associées à *Lepidopus caudatus*: *Micromesistius poutassou* (Gadidae) et *Parapenaeus longirostris* (Crevette, Penaeidae). D'autres espèces lui sont également liées, mais à un degré moindre: *Phycis blennoides*, *Merluccius merluccius* (Gadidae) et *Plesionika heterocarpus* (Crevette, Pandalidae). Le sabre argenté, poisson dont la chair est très fine et très appréciable n'est pas connu de la population algérienne. On gagnerait à le cibler préférentiellement pour, d'une part alléger la pression de pêche sur les espèces commercialisées et d'autre part fournir un aliment protéique abondant, commercialisable pour peu qu'on l'y habitue aux consommateurs de la région.

Tab. 1. Répartition de *Lepidopus caudatus* dans le bassin algérien

Région	NS	GP (m)	ZC (m)	N	S+	S-	ST	Fr	Ar
Ouest	72	20-796	93-568	90	17	29	46	3.6	1.96
Centre	31	30-641	83-555	90	5	11	16	3.1	5.62
Est	77	17-630	265-554	23	11	2	13	8.4	1.76

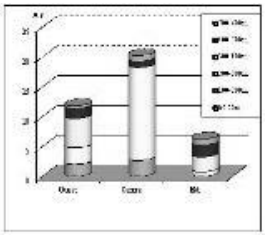

Fig. 1. Distribution bathymétrique de *Lepidopus caudatus*

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MATURATION OF THE OVARIES AND OVIDUCAL GLANDS OF THE LONGNOSED SKATE *DIPTURUS OXYRINCHUS* (CHONDRICHTHYES: RAJIFORMES)

C. Porcu [1]*, M. C. Follesa [1], M. F. Marongiu [1], A. Bellodi [1], D. Cuccu [1] and A. Cau [1]
[1] Dep. of Life Science and Environment Univ Cagliari - cporcu@unica.it

Abstract
Females maturity stages of the *Dipturus oxyrinchus* reproductive tract were analyzed and confirmed by an histological analysis. In particular, the oviducal gland microstructure was studied with several histological staining techniques in order to better understand the nature of secretions produced by its different zones throughout the reproductive maturation.

Keywords: Elasmobranchii, Reproduction, Life cycles, North-Western Mediterranean

Introduction Reproductive processes of Chondrichthyans are complex and till now their information are scarce. Knowledge of the gametogenesis and the development and maturation of secondary reproductive organs as the oviducal gland, is vital for understanding the reproductive biology of a species. For this reason, the aim of this paper is to describe the reproductive tracts development and gametogenesis in the longnosed skate *Dipturus oxyrinchus* (Linnaeus, 1758), a benthic species distributed in Mediterranean and in the Eastern Atlantic on sandy and muddy bottoms from 90 to 900 m in depth [1, 2].

Materials and Methods Longnosed skates samples were collected during experimental trawl surveys and during commercial hauls performed on bottoms off Sardinian waters (Central-Western Mediterranean Sea). Maturity stages were assigned using a maturity scale proposed in the ICES WKMSEL report (2010) [3]. Oviducal glands width was recorded in millimeters. Transverse and sagittal sections of ovaries and oviducal glands respectively, were fixed in 5% buffered formaldehyde, dehydrated, embedded in a synthetic resin (GMA) and sectioned (3.5 µm). Then, the ovary sections were stained with Harrys haematoxylin and eosin (H&E), instead sections of oviducal gland with either H&E and combined periodic acid-Schiff (PAS) and alcian blue (AB) to investigate the chemical nature of secretions.

Results Female longnosed skates have two ovaries, each located on the distal surface of the epigonal organ and containing developing follicles distributed on its surface. As in all other skates, each oviduct opens into an oviducal gland (OG). A complete macroscopic and histological description of the various maturity stages has been performed (Tab.1).

Tab. 1. Macroscopical and microscopical description of females maturity stages of *Dipturus oxyrinchus*.

Maturity stage	Macroscopic description	Microscopic description
1 Immature	Small and whitish ovary with undistinguishable ovarian follicles. Oviducal gland (OG) slightly visible (1.4-7.4 mm).	Vascularized epigonal organ. Primordial (>150 µm) and primary (>300 µm) follicles are present. OG not yet differentiated.
2 Developing	Ovary enlarged with follicles of different sizes (0.8-2.90 mm). OG in developing (5.7-34.3 mm).	Previtellogenic follicles appear (>1000 µm) with lipidic drops and complex follicular epithelium. OG with uniform *lamellae*. Serous and mucous glands distinguishable.
3A Spawning Capable	Enlarged yolk follicles of different sizes (3.1-28.7 mm). OG fully developed (45.5-52 mm).	Vitellogenic follicles (>4000 µm) surrounded by the thick *zona pellucida* and basement membrane are present. All OG zones are visible (club, papillary, baffle, terminal) with secretions present in the tubules.
3B Actively Spawning	Similar to stage 3A, however with the presence of egg capsules in the uterus.	Postovulatory follicles can be present. OG tubules full of secretion materials.
4A Regressing	Ovaries shrunken with follicles of different sizes (1.23-10.68 mm). OG completely formed (29.2-61 mm).	Follicles in all stages. Postovulatory and atretic follicles, in which basal lamina appear collapsed, are present. OG with the four zones visible with secretions in tubules.
4B Regenerating	Small follicles similar to stage 2 (1.4-5.36 mm). OG developed, reduced respect to stages 3, but, in general, larger than stage 2 (23.5-34.5 mm).	Like to Stage 2, there are follicles of different sizes. OG with tubules and *lamellae* are evident. Secretions are scarce respect to other stages.

Discussion
The main structure of the reproductive tract of D. oxyrinchus is shared by all rajid species as well as by oviparous sharks. In our study, the maturation of ovaries seems to be similar to all Rajidae species as described for the thornback ray *Raja clavata* [4]. The macroscopic observations for each maturity stage have been always confirmed by histological analysis. The main morphology and functionality features of the OG are comparable with almost all Chondrichthyans [5, 6]. Indeed, it was possible to discern histologically the four zones that it is composed (club, papillary, baffle and terminal). The development of OG throughout the reproductive maturation reflected the changes in size and chemical nature of secretions of secretory tubules. Histological staining techniques allowed to recognize that gland tubules begin to produce starting from the developing stage (mucins in the club, papillary and terminal zones). In spawning capable and actively spawning stages the secretory tubules were enlarged subsequently to the increase in size and number of the secretory granules. In regressing females the secretory activity was abundant yet, whereas in the regenerating specimens there was a lower affinity for dyes, due to a reduction of secretion materials produced.

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DIET OF COMMON STINGRAY, *DASYATIS PASTINACA* (LINNAEUS, 1758) IN THE GOLF OF GABÈS (SOUTH-CENTRAL MEDITERRANEAN)

Abdesselem Saadaoui [1]*, Bechir Saidi [1] and Mohamed Nejmeddine Bradai [1]
[1] Institut National des Sciences et Technologies de la Mer - saadaouiabdesselem@live.fr

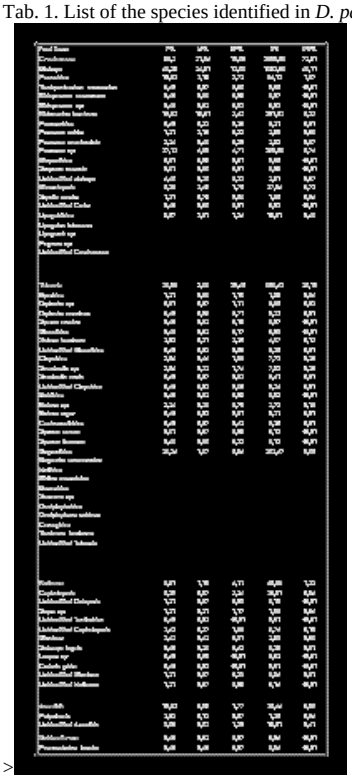
Abstract
The diet and feeding habits of the common stingray, *Dasyatis pastinaca*, in the Gulf of Gabès were studied from examination of 314 Stomach contents. Crustaceans were the most important prey component in the diet of *D. pastinaca* (%IRI =72, 91).Teleosts were second in importance (IRI%=25, 18). Changes in diet were observed and related to size of specimens.

Keywords: Diet, Gulf of Gabes, South-Central Mediterranean

Introduction
The bibliographic research highlighted a lack of aggregate knowledge on the biology of elasmobranchs in many parts of the Mediterranean [1]. The purpose of the present study was to provide a description quantitative of the diet and was to investigate feeding habits of common stingray, *Dasyatis pastinaca*, caught in Gulf of Gabès (Central Mediterranean).

Material and Methods
In order to study the diet and feeding habits of common stingray, a total of 314 specimens with a disc width (DW) between 12.7 and 70.0 cm were caught between June 2011 and January 2012 in the Gulf of Gabès. In the laboratory, stomach contents 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 [2].

Tab. 1. List of the species identified in *D. pastinaca stomach* contents.



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Results
Of the 314 stomach contents of *Dasyatis pastinaca* examined, 266 are full (83, 37%) and 48 are empty (16, 27%). Prey items was identified in stomachs belong five major groups: Crustaceans, Teleosts, Molluscs, Annelida and Echinoderms (Table1). Crustaceans were the dominant prey items (IRI%= 72, 91), followed by Teleosts (IRI%=25, 18). Molluscs, annelid and echinoderms were occasional preys. Changes in diet were observed and related to size of specimens. With increasing size, crustaceans decreased in importance, whereas teleosts and molluscs increased.

Discussion
The results indicate that *D. pastinaca* fed on benthic and demersal preys, and reveals that crustaceans are the most frequent prey. The present study provides broad support for the description of this species as a broad spectrum predator [3]. The composition of the diet of the common stingray changed with increasing size; crustaceans decreased in importance, whereas teleosts and molluscs became more dominants. Dietary shifts with size observed in this study, have been described for this species in another geographical area in Mediterranean Sea [4].

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Session

Connectivity

Modérateur : **Anne Chenuil**

CONNECTIVITY AMONG MPAS THROUGH PHYSICAL-BIOLOGICAL COUPLING: *POSIDONIA OCEANICA* EXAMPLE

Stefano Aliani [1]*, Anne Molcard [2], Carla Micheli [3] and Andrea Peirano [4]
[1] CNR ISMAR SP Forte S.Teresa, 19036 Pozzuolo di Lerici, La Spezia Italy - stefano.aliani@ismar.cnr.it
[2] LSEET Université du Sud Toulon-Var, BP 20132, 83957 LA GARDE CEDEX France
[3] ENEA Research Centre Casaccia, C.P. 2400, 00100 Roma, Italy
[4] ENEA Marine Environment Research Centre, PO 224 19100 La Spezia Italy

Abstract
Management of MPSs requires scientific perspective and knowledge. Multidisciplinary investigations may provide information on connectivity, that is an important issue for management of biodiversity. In this work we aim i) to use a simplified mathematical model to describe the possible time required to travel from the Corsica Channel to the Ligurian sea; ii) to show evidences of long distance dispersal of *Posidonia oceanica* seeds that may supply local populations in Eastern Liguria.

Keywords: Biodiversity, Ligurian Sea, Marine parks, Posidonia, Models

The establishment of effective MPAs networks in a modern perspective must be based on solid scientific knowledge and properly managed as EC pointed out through CoCoNet project. Multidisciplinary approach may describe the connectivity between nearby MPAs. This topic is fundamental because it explain the supply of MPAs with key biodiversity-building species, e.g. *Posidonia oceanica*. An example of coupled approach is reported. Monterosso al Mare meadow is within the MPA of 5 Terre (North Eastern Ligurian Sea). Stranded fruits and seeds have been recorded on local beach after massive fruiting of 1992, 1993 and 2004 [1]. Local supply has been considered as the major source for these fruits. However, *Lepas* spp. juv. (3-5 mm long) were found attached to the base of the fruits of some inflorescences (Figure 1).

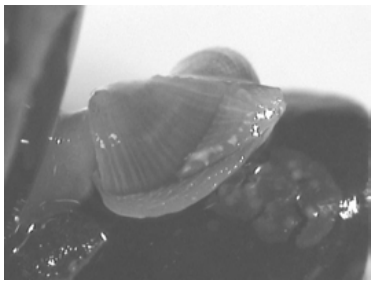

Fig. 1. A 5 mm long young specimen of *Lepas* sp. on a *P. oceanica* fruit.

This supports the hypothesis of long-distance supply as Lepas is a offshore species, so the possibility that floating fruits came from southern meadows of Corsica and Livorno (Tuscany) has been investigated by oceanographic modelling. The major large scale feature of the water dynamic in the surface layers of the Ligurian Sea is a cyclonic circulation active all year round, more intense in winter than in summer [2]. Southern waters to the Ligurian Sea occur in two main currents running along each side of Northern Corsica (Figure 2a).
A Lagrangian model forced by 10 years climatological data has been applied to study dispersion of passive tracers by simulating a high number of particles [3]. Laboratory experiments show that 1.7% of stranded fruits sunk after 9 days in a box with seawater. At least 12 days were necessary to the majority of fruits to show signs of corruption and loss of floatation. This period is in agreement with the growth of Lepad juveniles that reach 5 mm size in about 15 days. In the numerical experiment, 1000 particles were released in the Corsica channel (42.5°N, 9.625°E) corresponding to the main flow of the Tyrrhenian current (1996-2005).
The model showed that the percentage of particles that reach the Ligurian Coast (particles crossing the 44°N are considered stranded in Liguria) were 3% in 30 days. When particles were released from the closest meadow of Livorno the percentage reaching Liguria was about 10%.

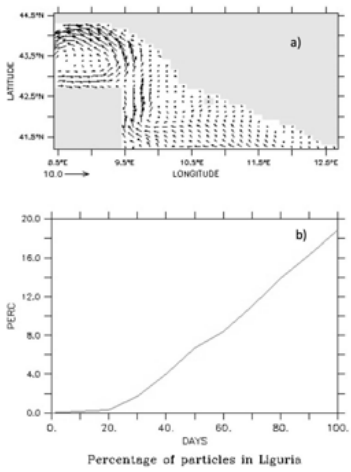

Fig. 2. a) Currents from Corsica to Liguria from circulation model, b) expected time for transport of particles from Corsica to Liguria.

A small part of the seeds found stranded in Monterosso (East Liguria) was from offshore and our coupled experiments suggest that connectivity is possible from the South. Times of transport are consistent with physical connection between the MPA of Monterosso al mare meadow and southern ones [1,4]. Coupling physical and ecological data provides unique and useful information to understand biodiversity patterns and functioning in MPAs [5]. This integrate knowledge is necessary for proper managements and a full comprehension of variability of currents gets as critical as ecological patterns to describe connectivity.

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CAN WE ESTIMATE MARINE CONNECTIVITY WITH GENETIC APPROACHES? A CASE STUDY ON NORTH WESTERN POPULATIONS OF TWO MEDITERRANEAN GORGONIANS

Didier Aurelle [1]*, Marine Pratlong [1], Kenza Mokhtar-Jamaï [2] and Jean-Baptiste Ledoux [3]
[1] Aix-Marseille Université UMR 7263 IMBE CNRS - didier.aurelle@univ-amu.fr
[2] Institut National de Recherche Halieutique (INRH), Casablanca Morocco
[3] Institut de Ciències del Mar CSIC, Barcelona, Spain; CIMAR/CIIMAR, Universidade do Porto, Porto, Portugal

Abstract
Genetic studies of octocoral populations in the Mediterranean Sea have revealed a pattern of strong and short distance genetic structure without apparent deep genetic break. In order to better understand such structuring we provide here an analysis of connectivity in the North-Western Mediterranean for two species: the red coral *Corallium rubrum*, and the red gorgonian *Paramuricea clavata*. We compare the results obtained by different methods aimed at estimating recent or long term components of gene flow. The results are discussed in the light of the biological characteristics of these species, of their evolutionary history and of the potential limits of the methods used.

Keywords: Genetics, Gulf of Lyon, Cnidaria

The management and conservation of natural populations need to take into account gene flow levels as indicators of recolonisation abilities and population connectivity. Population genetic studies of octocorals in the Mediterranean Sea have evidenced unexpected patterns of genetic structuring for species with a larval stage: microsatellite data have shown short to significant genetic differentiation at medium to short distance for the red coral *Corallium rubrum*, and the red gorgonian *Paramuricea clavata* ([1], [2], [3], [4], [5], [6],). Significant differences have also been observed between depths in the same site (e.g. between 20 and 40 m for the red coral; [6]). These significant differences have been mainly interpreted as the consequence of reduced mean dispersal abilities. Nevertheless a phylogeographic comparison between the most distant locations did not evidence any deep phylogeographic break for the red coral. This does not support long term isolation even through well-known genetic barriers such as the Almeria – Oran front ([1]). The sampling scheme may also have impacted the observed structure between distant locations ([1]). Moreover F_{ST} values and significance do not rely only on dispersal levels but also on effective size and population history (e.g. [7]) and real estimates of dispersal (i.e. not only F_{ST}) are still lacking for these species. We analyze here microsatellite data from *C. rubrum* and *P. clavata* in order to assess in a comparative way dispersal estimates in the North-Western Mediterranean Sea. The comparison will be done between these two species in the same area in order to look for some potential shared limits to gene flow. We will analyze populations from three distant regions: Marseille, Catalonia and Corsica, with an analysis between regions and between populations inside regions. These regions have been identified as different genetic clusters based on microsatellite data ([6]). This may reflect the impact of several non-exclusive phenomena: hydrographic barriers, lack of suitable habitats between regions, distance effect in a isolation by distance framework. A more precise study of connectivity is then required in this context. A regional analysis of connectivity will also be performed, with a focus on the Marseille area: in this region the populations of these species are separated in two main areas, South and North of the city which might correspond to different genetic groups as well ([6]). A connectivity analysis is interesting here both for understanding population dynamics and evolution but also for management purposes. Finally the question of gene flow between depths in each area will be discussed. It will shed light on the interaction between migration and local selective pressures. A methodological comparison will be done between different approaches for dispersal estimates in order to try to separate the short and long term components of gene flow. The first category of methods used here is assignment approaches which allow the detection of migrant individuals: it then deals with short-term / contemporary connectivity. This is useful in order to evaluate current recolonisation abilities of these species. The second category of methods relies on models dedicated to the estimation of long term migration rates and effective population sizes. This will give some insights in the evolutionary history of these species and their interaction with environmental heterogeneities and fluctuations.

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FURTHER INSIGHTS ON THE GENETIC STRUCTURE AND CONNECTIVITY IN *OCTOPUS VULGARIS* (MOLLUSCA, CEPHALOPODA) INFERRED BY MITOCHONDRIAL COI SEQUENCES

R. Melis [1], D. Cuccu [1], M. Mereu [1], A. L. Cau [1], S. Marcias [1], A. Cau [1] and R. Cannas [1]*
[1] University of Cagliari Dipartimento Scienze della vita e dell'ambiente - rcannas@unica.it

Abstract
The genetic variability of the COI gene was studied in the common octopus, *Octopus vulgaris* Cuvier, 1797. A total of 222 individuals from 7 sampling sites were analysed with the aim of elucidating patterns of genetic variation along the coasts of Sardinia (Western Mediterranean). A total of 17 different haplotypes were identified with four principal haplotypes recorded in all locations. The pairwise Fst and AMOVA revealed a high gene flow and the lack of significant genetic differentiation among populations. All COI sequences were compared with those available in GenBank for the species; the results obtained show a high sequence divergence among *O. vulgaris* from different geographic locations and emphasize the need for more detailed phylogeographic and/or taxonomic studies to exclude the presence of cryptic species.

Keywords: Genetics, South-Western Mediterranean, Systematics, Cephalopods, Fisheries

Octopus vulgaris is of great interest as a commercial species and therefore under pressure of intense fishing activity. Taxonomic problems regarding this species, whose status as a true cosmopolitan species or as a species complex is uncertain, are known to exist [1]. The aim of the present study was to use mitochondrial COI gene to determine the genetic structure and connectivity in *O. vulgaris* populations along the coast of Sardinia (Western Mediterranean). HCO-LCO primer pair [1] was used to amplify a region of the mitochondrial COI gene. A total of 222 specimens were analysed from 7 populations collected off the Sardinian coast. Additional sequences for all the species of genus Octopus were obtained from GenBank for comparison. All sequences were aligned and analysed with MEGA 5.1 and ARLEQUIN 3.5. Unbranched median joining networks were created in Haplotype Viewer to visualize the divergence between haplotypes. A 628 bp fragment of COI from 222 individuals yielded 17 haplotypes that differed for at a total of 16 sites (10 parsimony informative sites including 4 non-synonymous changes), the average number of nucleotide differences was 2.89. The mean genetic distance, calculated with the Tamura model was 0,008 (range 0,00163-0,01675). Four haplotypes were the most common (shared by 73, 55, 49, 25 individuals, respectively) and were found at all locations; the remaining haplotypes were found in 1-4 individuals (Fig 1). Two pairwise Fst were significant (CSA-SUP, CSA-CFE), but not after FDR correction. The analysis of AMOVA failed to identify significant genetic differentiation (overall Fst=0.00634, NS), with most of the total variation (99.4%) due to intrapopulation differences.

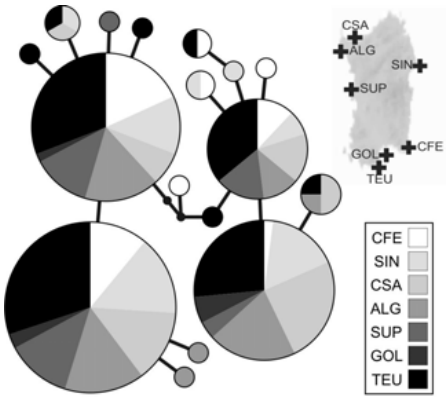

Fig. 1. Haplotype network of COI sequences of *O. vulgaris* from Sardinia, pie charts are drawn proportionally to the number of sequences.

Sardinian haplotypes were compared with homologous sequences archived in GenBank from Octopus vulgaris [1-4 and references therein] (Fig 2).In the final alignment of 508 bp, the most widespread Sardinian haplotypes were found to be shared with individuals from France, Spain, Turkey, Galicia, Senegal, South Africa and Saint Paul Islands. Some *O. vulgaris* sequences from Turkey (haplotypes 2, 3, 8, 9 in Fig 2) Japan and China (haplotypes 29-32 in Fig 2) resulted to be highly divergent from all the others. The results obtained show a high sequence divergence among *O. vulgaris* from different geographic locations and emphasize the need for more detailed phylogeographic and/or taxonomic studies to exclude/confirm the presence of cryptic species. Such information could give important insights in an evolutionary and fishery management perspective.

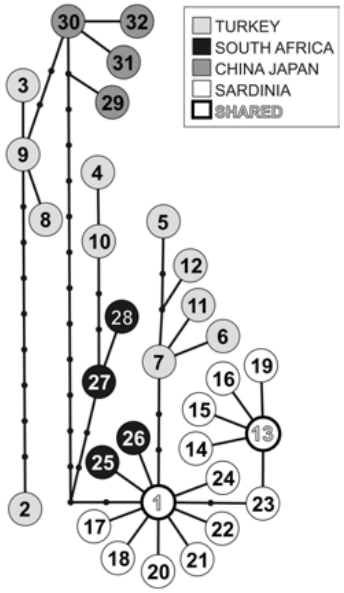

Fig. 2. Network of COI haplotypes of *O. vulgaris* from Sardinia compared with those from otained from GenBank sequences. Numbers within circles referes to the haplotype number.

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PLANCTONIC LARVAE DO NOT INVOLVE GENE FLOW IN THE EDIBLE SEA URCHIN *PARACENTROTUS LIVIDUS*

Gwilherm Penant [1], Didier Aurelle [1], Jean-Pierre Féral [1] and Anne Chenuil [1]*
[1] Institut Méditerranéen de Biodiversité et Ecologie CNRS UMR7263 Station marine d'Endoume - anne.chenui@imbe.fr

Abstract
Previous studies reported genetic differentiation between the Atlantic Ocean and the Mediterranean Sea, and between the Adriatic and other regions but no structure within basins. We completed these data with new mitochondrial and nuclear sequences and reanalyzed them. We found within-basin and within-region differentiation with each genetic marker, which was unexpected given the long planktonic larval phase. The easternmost population, from Lebanon, appeared strongly differentiated from other populations. A differentiation of the same magnitude was found for the northernmost population, Galway. Among basins, gene flow appeared unidirectional, from the Atlantic to the Mediterranean Sea. Atlantic and Mediterranean basins were estimated to have started diverging between 270 and 370 thousand years ago.

Keywords: Echinodermata, Conservation, Biogeography, South Adriatic Sea, North-Western Mediterranean

P. lividus is found from the Canary Islands and Mauritania to Ireland in the Atlantic Ocean, and throughout the entire Mediterranean Sea. Phylogeography and population genetics approaches using DNA markers are recent in *P. lividus* andonly based onmitochondrial DNA. They evidenced discontinuities between major ocean basins (i.e. between the Mediterranean and the Atlantic: Duran *et al.* 2004, Calderón *et al.* 2008, Maltagliati *et al*. 2010; between the Mediterranean and the Adriatic: Maltagliati *et al.* 2010). Within basins, a spatial genetic structure was observed with the COI marker along the Mediterranean Spanish coast (Calderón *et al.* 2012).

Nevertheless, this structure was not observed all years, was not consistent among all populations, and disappeared when cohorts were pooled. At a local scale Iuri *et al.* (2007) did not evidence any genetic structure in the region of Naples. For temporal comparisons, differentiation among cohorts was demonstrated using the bindin gene (Calderon & Turon 2010), appeared occasionally with COI (Calderón *et al.* 2012) and was not observed with microsatellites (Calderon *et al.* 2009).

One potential limitation of previous studies could be the use of a single locus for most of them. We reanalyzed the data from the three published large-scale studies (Duran *et al*. 2004, Calderon *et al*. 2008, Maltagliati *et al*. 2010) and combined them with new mitochondrial (COI) and nuclear (calpain EPIC) datasets. Both distance-based and frequency-based metrics were used for two reasons: (i) to compare new data with previous ones and (ii) because the frequency-based metric, not used in previous phylogeographic studies, appeared more appropriate to detect subtle genetic differentiation caused by relatively recent and contemporary processes, where migration-drift dominate over mutation.

We paid special attention to differentiation among populations within major geographical groups (i.e. Atlantic basin, Mediterranean basin and Adriatic basin), because increasing knowledge at this scale appeared essential for the protection of this exploited species. We characterized the direction and intensity of gene flow between the main groups of populations, using a coalescence analysis of isolation with migration processes to improve our knowledge on the evolutionary history of this species.

We revealed substantial genetic structure within basins, for the first time for this species, with each marker (Fig. 1) and unidirectional dispersal (gene flow) from the Atlantic to the Mediterranean compatible with sea surface currents. We estimated the beginning of the Atlantic Mediterranean divergence to be about 270-370 thousand years ago.

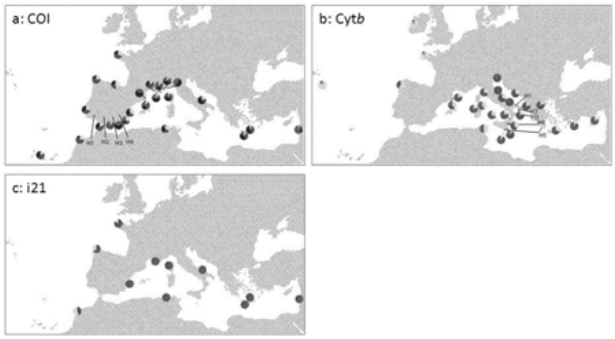

Fig. 1. Map of haplogroup distribution. Each color represents a group of related haplotypes (DNA sequences). a: mitochondrial cytochrome oxidase subunit1. (COI) b: mitochondrial cytochrome b. c: Nuclear EPIC (Exon primed intron crossing) of the calpain gene (i21).d: tested positions for the barrier for COI marker (cf ref. in press).

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CONNECTIVITY OF POPULATIONS OF *APOGON IMBERBIS* IN BAY OF MARSEILLE

Delphine Muths [1], Pierre-Alexandre Rastorgueff [2] and Pierre Chevaldonné [2]*
[1] Aix-Marseille University, Mediterranean Institute of Oceanography (M I O), 13288, Marseille, Cedex 9, France
[2] UMR CNRS 7263, IMBE, Aix-Marseille University, Station Marine d'Endoume, Rue de la Batterie des Lions, 13007 Marseille - pierre.chevaldonne@imbe.fr

Abstract
La structure génétique d'*Apogon imberbis* est explorée sur 200 poissons échantillonnés entre Carry-le-Rouet et La Ciotat, à 6 loci microsatellite et pour un fragment du gène mitochondrial. Les premiers résultats ne confirment pas l'hypothèse selon laquelle les caractéristiques biologiques de cette espèce laissaient supposer un niveau de structure conséquent en rade de Marseille qui aurait pû permettre de discuter les différentes hypothèses quant aux voies de colonisation des récifs du Prado.

Keywords: Genetics, North-Western Mediterranean, Fishes, Artificial reefs

L'un des objectifs du présent projet est d'apporter des éléments de réponse à la question suivante: d'où proviennent les colonisateurs des récifs artificiels du Prado? Au vu des connaissances accumulées sur certaines espèces, couplées à l'approche modélisatrice des courants déjà effectuée sur le site des récifs [1], l'hypothèse principale est que la colonisation des récifs se ferait essentiellement en provenance de la Côte Bleue et de l'intérieur de la baie de Marseille. Cette hypothèse est-t-elle vérifiée? Quelle proportion d'individus pourrait à l'inverse provenir des Calanques Sud? Un certain nombre d'espèce sont susceptibles de coloniser ces récifs artificiels et de nombreuses y sont déjà installées. Beaucoup de ces espèces ont des capacités de dispersion importantes, qui rendent impossible l'identification de l'origine des individus s'installant sur ces récifs. A l'inverse, certains organismes, particulièrement sédentaires et ne disposant pas de phase de développement très dispersive lors de leur cycle de vie, sont supposés présenter des niveaux de structure génétique conséquents qui permettraient de déterminer l'origine des colonisateurs des récifs. En l'état actuel des connaissances, les mysidacés du genre *Hemimysis*, vivant dans les communautés de roches ombragées ou de grottes, sont les seuls organismes de la région qui sont suffisamment caractérisés sur le plan génétique [2 ;3] pour pouvoir déterminer la provenance des colonisateurs des récifs. Or le recrutement de mysidacés n'est encore que rarement observé sur les récifs. L'idée est donc de s'intéresser à une autre espèce, inféodée aux mêmes habitats que les mysidacés, présentant également une dispersion supposée faible, donc un niveau de structure génétique similaire, mais qui est déjà observée en nombre sur le récif. C'est le cas du poisson sciaphile *Apogon imberbis*, vivant dans les entrées de grottes et dans les failles, et présentant une reproduction particulière puisque la fécondation est pseudo-interne et que le mâle incube les œufs pendant une semaine avant la libération des jeunes. L'objectif premier du projet est donc d'acquérir des données sur la structure génétique d'*Apogon imberbis* dans la baie de Marseille. Cette espèce présente-elle le même niveau de structure que les mysidacés ? Les patrons de structure sont-ils congruents entre les espèces ? Dans un second temps, les informations sur la structure génétique de cette espèce doivent permettre de mieux cerner les voies de colonisation des récifs du Prado. L'analyse des 200 poissons échantillonnés entre Carry-le-Rouet et La Ciotat (Figure 1), ainsi qu'une dizaine d'échantillons plus distants (Monaco), est réalisée à 6 loci microsatellite [4] et pour un fragment du gène mitochondrial. Les premiers résultats microsatellites montrent un certain niveau de structure entre les populations d'*A. imberbis* au nord et au sud de la baie de Marseille, l'analyse en clustering identifiant deux groupes génétiques distincts, ce qui semble cohérent avec la structure observée chez les Mysidacés. Les données mitochondriales ne révèlent aucune structure significative. Les niveaux de structure observés ne semblent pas assez élevés pour permettre de discuter les différentes hypothèses quant à la colonisation des récifs. Le génotypage des individus avec 2 marqueurs microsatellite supplémentaires est en cours et permettra sans doute d'affiner ces résultats.

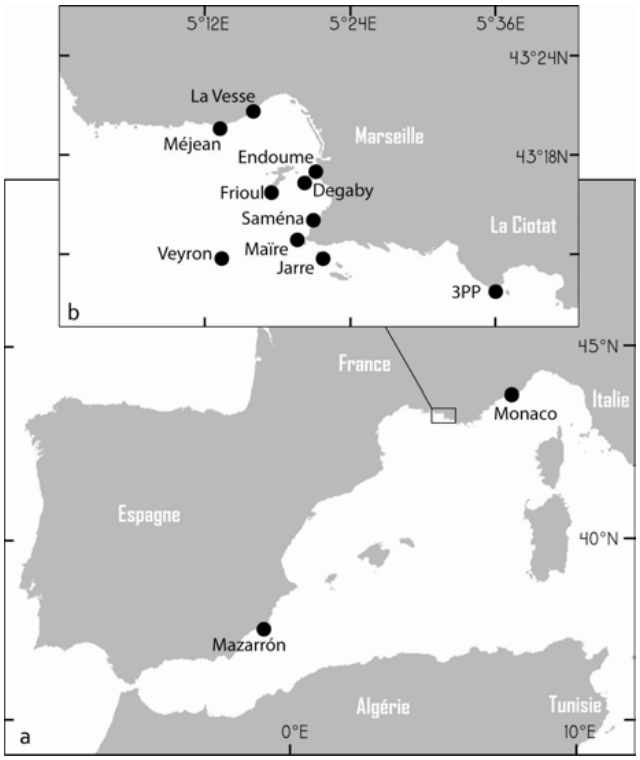

Fig. 1.

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FALL AND SPRING ZOOPLANKTON COMMUNITY STRUCTURES IN THE SOUTHERN ADRIATIC SEA: A PRELIMINARY SURVEY FOR WP3 AND WP11 ACTIVITIES (COCONET PROJECT).

L. Guglielmo [1]*, G. Zagami [1], A. Granata [1], R. Minutoli [1] and E. Hajderi [2]
[1] University of Messina - letterio.guglielmo@unime.it
[2] Zonja e Këshillit të Mirë

Abstract
The most part of the stations included in the CoCoNET project sampling plane have been previously investigated by the multinet BIONESS from bottom (sampling depth max: 800m) to surface, in October 2000 and April-May 2001. In both periods, higher values of zooplankton abundances and biomass were detected along the Italian than Albanian coasts. Zooplankton was mostly constituted by holoplankton in both seasons; in spring, the contribution of meroplankton increased with higher values along Albanian coasts, mainly due to bivalve and polychaete larvae. *Clausocalanus furcatus* and *Temora stylifera* adults and copepodites accounted for the main part of autumnal copepod assemblage whereas *Paracalanus parvus* and *Acartia clausi* for the spring one. Shannon diversity index reached the peak (3.14) in autumn along the Albanian coast at 20-40m.

Keywords: Zooplankton , South Adriatic Sea, Biodiversity, Pelagic, Coastal waters

The Adriatic Sea is a semi-enclosed and elongated basin, stretching roughly SE to NW for 800km from the Straits of Otranto to the Gulf of Venice. Conversely to the Northern basin, the Central and Southern ones are characterized by general oligotrophic condition [1]. Zooplankton assemblage oscillations are strongly affected by hydrographical and hydrodynamic conditions of the basins, with characteristic temporal and spatial patterns [2], [3]. But little is known about zooplankton vertical structure, below 50m depth probably due to the sampling depth which has never included any deeper community. The main aim of the present study is to provide detailed information on the zooplankton spatial and temporal community structure sampled by the electronic multinet BIONESS in order to set up and better finalize the WP3 and WP11 task actions in the CoCoNET project. In the framework of INTERREG Italy-Albania project 2000-2001, a total of 111 and 142 zooplankton samples were collected in autumn and spring, respectively, in a network of stations shown in figure 1.

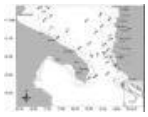

Fig. 1. Study area: sampling stations in autumn (circles) and spring (triangles)

Samples were taken by the electronic multinet BIONESS, equipped with ten 230μm mesh nets, a flowmeter for filtered water volume cubic meter estimates and a multiparameter probe system in order to measure physico-chemical factors. In October, temperature and salinity showed increasing surface trends from Italian (T = 19.8 °C, S ~ 37.6) to Albanian (T = 22°C, S ~ 38.7) coasts, determined by less salt water masses from Northern Adriatic Sea. In April, the horizontal salinity pattern exhibited two frontal systems along Italian and Albanian coasts, with a cyclonic gyre in the central part of the study area. On average, the Italian side was involved by colder and less salt waters. Zooplankton abundances and biomass were higher on the Italian (490.7±711.7ind.m^{-3}, 2.38±1.0mgm^{-3}; 358.4±711.7ind.m^{-3}, 8.28±13.5mgm^{-3} , in autumn and spring, respectively) than Albanian coasts (154.0±58.5 ind.m^{-3} , 2.38±0.96 mg m^{-3}; 118.4±43.0 ind.m^{-3}, 4.3±1.9 mg m^{-3}, in autumn and spring, respectively). In autumn, the peak abundance (6312.7ind.m^{-3}) was detected at 40-20m depth layer at the station 87 and the minimum (0.8 ind.m^{-3}) at 80-60m interval at the station 13, whereas the spring maximum (2728.0ind.m^{-3}) was recorded at 20-0m layer at the station 62 and the minimum (0.7ind.m^{-3}), at 300-200m at the station 52, respectively comparable to those measured in the same season by Miloslavic et al. [4]. Holoplankton accounted for the main part of the zooplankton in both seasons; in spring, meroplankton percentage increased with higher values along Albanian coasts (Fig. 2),

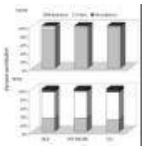

Fig. 2. Fall and spring percent contributions of holoplankton, meroplankton and other zooplanktonic forms to total abundances along Albanian, Italian coasts and in offshore waters.

mostly due to bivalve and polychaete larvae. Copepods constituted the dominant group in autumn (80.5%) and spring (58.9%), followed by chaetognaths (4.4%) and ostracods (3.8%), in fall, by salps (18.9%) and invertebrate larvae (4.1%), in spring. Autumnal copepod assemblage, constituted by 87 species (40 and 44 on the Italian and Albanian side), was dominated by few neritic species, such as *Clausocalanus furcatus* and *Temora stylifera* (adults and copepodites) accounting for about 26% of the total copepod abundances, which characterize the typical autumnal association in coastal, neritic and epipelagic waters of most of the Mediterranean regions [2]. Spring copepod population was represented by 68 species (43 and 56 on the Italian and Albanian sides, respectively). *Paracalanus parvus* and *Acartia clausi* dominated the spring assemblage in agreement with findings reported for this area ([2], [4]). Spatial and temporal diversity patterns of copepod assemblage oscillated within ranges slightly higher than that previously reported in this area [4], probably due to the greater sampling depth, with slightly higher values in autumn than in spring and along the Albanian (mean: 2.4 and 2.3, respectively in autumn and spring) than Italian coasts (2.0 and 2.2, respectively), with an absolute maximum of 3.1 at 40-20m layer at the station 42.

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A PRIORI IDENTIFICATION OF CONSERVATION UNITS USING LARVAL DISPERSAL SIMULATIONS IN THE GULF OF LIONS (NW MED SEA)

Katell Guizien [1]*, Mokrane Belharet [2], Charlotte Moritz [2] and Jean-Marc Guarini [2]
[1] CNRS - LECOB - guizien@obs-banyuls.fr
[2] UPMC - LECOB

Abstract
Numerical simulations of larval dispersal from a sedentary marine species combined with a population dynamics model showed that some unprotected areas of the Gulf of Lions (Narbonne to Agde and the Camargue) are the best locations for maximizing biodiversity persistence within a reasonable no-take reserve size (10 to 20 kms, [1]). When larval transfer at the regional scale was accounted for in a metapopulation model, the resilience of soft-bottom species increased by a factor 5 and enabled a wide regional distribution of the species. Yet, the latter does not reflect the spatial structure of vulnerability imprinted by connectivity.

Keywords: Conservation, Circulation models, Larvae, Gulf of Lyon

The Strategic Plan for Biodiversity 2011-2020 formulated a conservation objective of 10 % of coastal and marine areas by 2020. Such an objective clearly imposes a scientific basis for designing new Marine Protected Areas (MPAs) to sustain biodiversity and ecosystem services inside and outside the protected area [2]. Most marine sedentary species exhibit a planktonic larval phase during which offspring are transported and dispersed more or less passively by the flow due to limited motility ability compared to horizontal flow speed [3]. Ocean modelling works well for hindcasting realistic coastal circulation [4] and provides a comprehensive description of current variability useful for improving dispersal distribution and population connectivity estimates. Without overlooking the ultimate role of species' interaction to shape local diversity, ensuring marine sedentary species' self-persistence within MPAs would require that the design accounts for a dispersion period during reproduction [5].

Methods
Dispersal's role in conservation of polychaete populations which dominate the Gulf of Lion's muddy sands communities [6] was studied considering generic passive species (neutrally buoyant, no locomotion behaviour) with most frequent PLDs from 3 to 5 weeks. Simulations of Lagrangian dispersal of larvae released in the center of thirty-two spawning patches spanning from the 10 to 30 m isobaths along the Gulf of Lions coastline were carried using the three-dimensional currents and turbulent kinetic energy computed at a resolution of 750 m x 750 m for two years (2004 and 2006, [1][7]).
Connectivity matrices containing (1) local retention rates in each patch and (2) transfer exchange between distant patches were build from these Lagrangian larval dispersal simulations for 20 spawning periods lasting 10 days. Redistribution of offspring after yearly reproduction was described by these connectivity matrices in a discrete metapopulation model. The metapopulation model was modified from [8] to account for carrying capacity limit. Demographic parameters in the metapopulation model (propagule production rate, recruitment success and survival rate) were taken spatially uniform, disregarding the variability in organic matter content between 10 and 30 m water depth along the Gulf of Lions [6]. Survival rate was only varied according to species life expectancy. Minimum recruitement success required to ensure species persistence at both local or regional scale was then seeked for and taken as a measure of species resilience.

Results and Discussion
The spatial structure of local larval retention along the Gulf of Lions imprinted a large variability in recruitment successes required for local persistence of species along the Gulf of Lions coastline. In particular, the highest recruitment success (100 %) would not be sufficient for species local persistence in the Eastern and Western part of the Gulf of Lions. Connectivity between distant patches reduced recruitment success required for regional species persistence by a factor five whatever the species life expectancy. This increase of species resilience by connectivity, together with the spatial structure of local retention, in the Gulf of Lions reflects the recurrence of alternate transport to the East and to the West at time scales ranging from day to weeks in the central part of the Gulf of Lions [3].
Minimum recruitment success required for species persistence (would it be local whatever the location, or regional with connectivity) decayed exponentially when species life expectancy increased. When connectivity was kept constant every year, the relative spatial distribution of abundances of a two-year living species mirrored the cumulated import rates in recruitment patches. Thus, the spatial distribution of a species do not inform on locations important for species regional persistence (sources). When connectivity was set stochastically every year, the relative spatial distribution of the same species were on average more uniform along the Gulf of Lions. Groups of populations which were essential for species regional persistence were identified in the central part of the Gulf of Lions after removing sequentially some sites from the metapopulation. It demonstrates connectivity alone can imprint a spatial structure to species vulnerability. Yet, any factors affecting species demographic parameters, even when it applies uniformly at the regional scale, can blur the spatial structure of vulnerability due to connectivity.
In summary, extension of protection measures should target the central part of the Gulf of Lions where hydrodynamics favor a high local retention and efficient larval exchange for species regional persistence. More generally, the present study stress that marine protection spatial planning should account for not only species biological traits but also hydrodynamics.

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BIOSORPTION OF METHYLENE BLUE BY A BROWN ALGAE

Yeliz Ozudogru Cirik [1]*, Ilknur Ak [1] and Tolga Göksan [1]
[1] COMU Faculty of Marine Sciences and Technology
Terzioglu Campus Canakkale - yelizozudogru@hotmail.com

Abstract

Petalonia fascia, a brown alga, was used as a biosorbent to remove methylene blue (MB) from aqueous solutions. In this study, pH, contact time and initial metal concentration of MB were studied. Langmuir and Freundlich isotherm models were also investigated. The optimum pH value was 7 and the adsorption reached equilibrium at 50 min. According to Langmuir's model data, the maximum adsorption capacity (q_m) was 28.50 mgg^{-1}. Results showed that *Petalonia fascia* was effectively used as an alternative low cost biosorbent to remove MB from aqueous solutions. <\/div>

Keywords: Adsorption, Dardanelles, Algae

Introduction

Industrial wastes are one of the main sources of water pollution [1]. The wastes resulting from dye manufacturing are toxic and can cause serious environmental problems [2], so the removal of dyes from wastewater is important. Dyes are mainly used in textiles, plastics, tanneries, pharmaceuticals, leather, packed food, pulp and paper, paint and electroplating industries. Methylene blue (MB) is an organic and common type of colorant to dye cotton, wool, silk and many other materials. However, the use of MB can cause serious health problems [1,2,3]. In recent years, many low cost materials and techniques have been tested for the adsorption of dyes [4]. From these techniques, biosorption has been suggested as an alternative method due to its efficiency [5,6] and algae have been found to be a potential biosorbent [7]. *Petalonia fascia* (O.F.Müller) Kuntze is a brown marine macroalgae growing on stones and shells. In this study, removal of MB from aqueous solutions by *P. fascia* was studied.

Material and Methods

Petalonia fascia was collected from Canakkale Kepez area. The biomass was washed to remove some impurities and dried in an oven at 60°C until constant weight was reached. Dried biomass was ground and sieved. All the chemicals used in the study were analytical grade (Merck). For biosorption experiments, stock methylene blue (MB) solution (1000 mgL^{-1}) was used and five concentrations (5-10-20-50-100 mgL^{-1}) were prepared from stock solution using distilled water. As for pH and contact time trials, MB concentration was kept constant at 10 mgL^{-1}. The pH adjustments were performed by using 0.1 M HCl or NaOH. The MB concentrations in solutions were determined by spectrophotometer. 100 mg of each biosorbent was placed in a 50 mL Falcon tube and treated with 10 mL of MB solution. The Falcon tubes were shaken at 250 rpm at room temperature for 120 min, then samples were centrifuged at 3000 rpm and supernatants were measured by the spectrophotometer. The % removal of MB concentration was calculated according to Kousha et al. [4].

Results and Discussion

Effect of pH on the adsorption of MB

The % removals of MB in different pH values (3, 5, 7, 9) were given in Figure 1a. Accordingly, removal rates slightly increased between pH 3-9 (96.39% - 97.86%). These results were similar with the findings of the other studies [1, 3].

Effect of the contact time on the adsorption of MB

The amount of MB concentration q_t (mgg^{-1}) was calculated according to Cirik et al. [8]. Effect of time on biosorption by *P. fascia* was given in Figure 1b. Figure 1b shows that the maximum adsorption capacity was found to be 0.981 mgg^{-1} and adsorption reached equilibrium after 50 min.

Tab. 1. A comparison of Langmuir and Freundlich isotherm models for MB by *P. fascia*.

Langmuir isotherm			Freundlich isotherm		
q_m (mgg^{-1})	a_L	R_L^2	n_f	K_f (mgg^{-1})	R_F^2
28.50	0.185	0.715	1.106	4.316	0.981

Adsorption Isotherms

The equilibrium data were analyzed with Langmuir and Freundlich isotherms. The adsorbed amount in *P. fascia* showed positive correlation with the concentration of MB solution. The maximum adsorption capacity (q_m)was 28.50 mgg^{-1}. In this study, the Freundlich isotherm model (R^2= 0.981) showed a better fit than the Langmuir isotherm model (R^2= 0.715) (Table 1). In our study, *P. fascia* had a greater q_m value than the other adsorbents [3,9,10] and it could be used as an alternative low-cost material for MB adsorption.

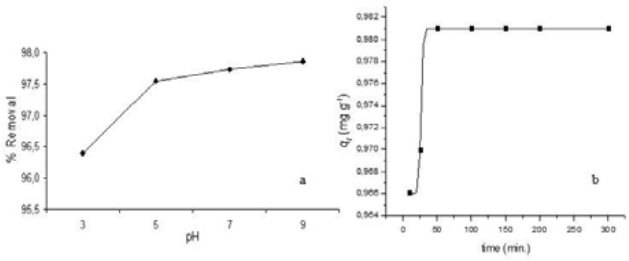

Fig. 1. Effect of pH (a) and contact time (b) on MB adsorption by *P. fascia.*

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INTRODUCING CONNECTIVITY IN MARINE PROTECTED AREAS MODELLING, A REMAINING CHALLENGE

Serge Planes [1]*
[1] CNRS - USR3278 - CRIOBE Université de Perpignan - planes@univ-perp.fr

Abstract
The success of marine protected areas in conserving fishing resources and protecting marine biodiversity relies strongly on how well they meet their planned management goals. Among these goals, clearly the concept of enhancing the fecundity of commercially harvested populations with the expectation of increasing local recruitment and furthermore augmenting local fishery yields is on the top list. However, proving local improvement of fisheries, require knowledge of connectivity and capability of local self-recruitment. Very few works have been done regarding this question and we collected data that demonstrated some trends together with some recent work on progress.

Keywords: Fisheries, Conservation, Life cycles, Marine parks, Mediterranean Ridge

Introduction – Networks of no-take marine protected areas (MPAs) have been widely recommended for both biodiversity protection and managing fisheries and an increasing number of networks have been planned or implemented (1). However, to promote population persistence, protected areas must simultaneously be self-sustaining and linked to other protected areas to promote recovery from local extinctions. Most marine animals produce tiny larvae with pelagic durations ranging from days to months. Prevailing oceanographic currents may transport these propagules over large distances to form demographically "open" populations that are linked by larval dispersal. However the spatial scale over which marine populations are connected by larval dispersal continues to generate controversy, due to lack of empirical data on how far larvae travel.

State of knowledge – Numerous works have been dedicated to better understanding of connectivity, and here, we describe two case studies, base on new genetic approaches (e.i. parentage) that illustrate some recent finding and their implications into management priorities. The first piece of empirical data comes from a work on clownfish (*Amphiprion percula*) in tropical seas that demonstrated that approximately 40% of larvae settling in an island MPA (Papua New-Guniea) were derived from parents resident in the reserve (Figure 1) (2).

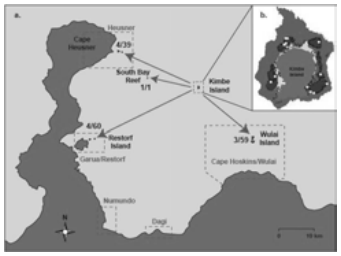

Fig. 1. Larval dispersal of orange clownfish from Kimbe Island to other designated marine reserves in western Kimbe Bay. *(A)* Proportion of recently settled juveniles at each of four locations that were progeny of Kimbe Island clownfish. Red boxes: proposed reserve boundaries (6). *(B)* Location of adult orange clownfish that produced larvae that successfully dispersed and settled on anemones away from Kimbe Island (white dots).

The work also located juveniles spawned by island residents that had dispersed as far as 35km to other proposed MPAs. These dispersers accounted for up to 10% of recruitment in the adjacent MPAs. These findings suggest that MPA networks can function to sustain resident populations both by local replenishment and through larval dispersal from other reserves. The second piece of work applied some genetic parentage analyses to measured larval dispersal from a single, managed spawning aggregation of squaretail coral grouper (*Plectropomus areolatus*) and determined its contribution to fisheries replenishment within five community up to 33 km from the aggregation (Manus Island, Papua New Guinea) (3). Within the community tenure area containing the aggregation, 17- 25% of juveniles were produced by the aggregation. In four adjacent tenure areas, 6- 17% of juveniles were from the aggregation. Larval dispersal kernels predict that 50% of larvae settled within 14 km of the aggregation (Figure 2). These results strongly suggest that both local and cooperative management actions can provide fisheries benefits to communities over small spatial scales.

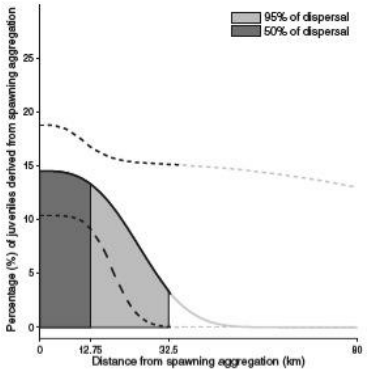

Fig. 2. Dispersal kernel based on the Ribbens function. The graph shows the relationship between proportion of juveniles from each of 66 sampled reefs that was assigned via parentage analysis to adults from the sampled spawning aggregation (*y*-axis) and reef distance from the aggregation (*x*-axis). Each data point corresponds to a reef. Solid black line: maximum likelihood fit of the function to these data, with vertical lines demarcating the distances within which 50% and 95% of successful dispersal is expected to occur. Dotted lines: minimum and maximum dispersal generated by parameters within the 90% confidence region of the best-fit parameters.

What next – None of these types of works were applied in the case of the Mediterranean Sea, however some genetic results are emphasizing local genetic differentiation suggesting some restriction in dispersal. Adding the fact that there is no reason that the retention processes will not operated in the case of the Mediterranean Sea, further work deployed in the Adriatic and the Black Sea within the COCONET project should provide insights for future plan for the Mediterranean Sea.

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CONNECTIVITY PATTERNS OF THE EUROPEAN GREEN CRAB IN THE ADRIATIC SEA: A COUPLED OCEANOGRAPHIC-GENETIC ANALYSIS

Marcello Schiavina [1]*, Ilaria A. M. Marino [2], Paco Melià [1] and Lorenzo Zane [2]
[1] Dipartimento di Elettronica, Informazione e Bioingengeria, Politecnico di Milano, via Ponzio 34/5, I-20133, Milano, Italy - m.schiavina@gmail.com
[2] Dipartimento di Biologia, Università di Padova, Via U. Bassi 3, I-35131, Padova, Italy

Abstract
Coupling Lagrangian simulation with genetic analyses, we investigated oceanographic and genetic connectivity among six locations of the Adriatic Sea for the European green crab (*Carcinus aestuarii*). Results reveal the role of circulation in determining the observed biogeographic pattern, which reflects a oceanographic subdivision of the Adriatic Sea into three sub-basins.

Keywords: North Adriatic Sea, Central Adriatic Sea, South Adriatic Sea, Biogeography, Circulation models

Introduction Identifying the spatiotemporal scale of connectivity among populations is crucial to understand the factors driving population dynamics, dispersal patterns and gene flow in marine species [1]. Coupled physical-biological models (CPBMs) are increasingly used to investigate mechanisms of larval dispersal and to contrast alternative hypotheses by simulation [2]. Integrating the outputs of CPBMs with population genetic models can provide new insights of verifying model predictions [3]. In this work, we investigated larval dispersal patterns of *Carcinus aestuarii* in the Adriatic Sea by coupling Lagrangian simulations (incorporating early-life-history traits) with a genetic marker analysis and comparing the connectivity matrices resulting from the two approaches. The aim of the work was to study the role of Adriatic Sea currents in determining retention and spillover patterns and their consequences on the genetic structure of the local European green crab populations.

Materials and methods
Genetic analyses were conducted on samples, collected in 2006, 2007 and 2008 from six sites along the Italian Adriatic coast (Marano, Venezia, Goro, Ravenna, Foggia, and Lecce), with an additional sample from the Ionian Sea (Taranto). Total genomic DNA was extracted using a salting-out protocol [4] and individuals (N=381) were genotyped at eleven polymorphic microsatellite loci. Population pairwise F_{ST} were determined with GENETIX, using 10000 permutations for all comparisons. Genetic divergence between populations was analyzed also using the AMOVA approach [5] to define groups of lagoon populations, which are geographically and genetically homogeneous and maximally differentiated from each other. Lagrangian simulations, limited to the Adriatic basin, were performed using daily average circulation fields produced by the Adriatic Forecasting System (AREG model [6]). 1000 larvae were released from each of the 6 sites according to a Gaussian distribution during the spawning season (every autumn, new and full moon [7]) in 2006, 2007 and 2008. Particles were tracked for 35 days (the average pelagic larval duration [7]) and their diel vertical migration was described as in [8]. For each site, connectivity with the others was calculated as the percentage of larvae whose final position fell within a 10-km-radius buffer from the destination site.

Results
Genetic data showed the existence of weak but significant genetic differentiation between samples (overall F_{ST} = 0.002; 95% CI = 0.000–0.004, p<0.01). Pairwise F_{ST} ranged from -0.001 to 0.005 and three values significant at the 5% level were found suggesting some genetic structure among samples (Table 1). Accordingly, AMOVA analysis identified 3 significantly differentiated groups of samples inside the Adriatic (F_{CT} = 0.002, p<0.01), the first including Marano, Venezia, Goro and Ravenna samples, the second including the Foggia sample and the third one represented by the Lecce and Taranto samples.

Table 2 shows the connectivity matrices obtained with the CPBM for the 3 years analyzed. In accordance with the results of the genetic analysis, Lagrangian simulations confirm the existence of a stronger connection among the four northern sites, which, in contrast, are isolated from the other two. The southernmost location (Lecce) is characterized by strong retention and occasional input from Foggia, confirming the observed genetic distance between these two populations.

Conclusion A coupled oceanographic-genetic analysis allowed us to derive potential dispersal patterns of *C. aestuarii* in the Adriatic Sea and, at the same time, to elucidate the genetic consequences of larval dispersal. Genetic analyses revealed the existence of weak but significant differentiation, apparently reflecting a oceanographic subdivision of the Adriatic Sea in three sub-basins. However, when dealing with such subtle differences the challenge is to discriminate between minor but real population structure and artifacts due to noise related to sampling errors [9].

Tab. 1. *Carcinus aestuarii* pairwise F_{ST}. Estimates of pairwise genetic differentiation (F_{ST} values) among 7 populations. Asterisk: significant values, uncorrected p < 0.05.

	Marano	*Venezia*	*Goro*	*Ravenna*	*Foggia*	*Lecce*
Marano	-					
Venezia	0.002	-				
Goro	0.002	0.001	-			
Ravenna	0.002	0.001	-0.001	-		
Foggia	**0.004***	0.000	0.000	0.002	-	
Lecce	**0.003***	0.003	0.002	0.001	**0.003***	-
Taranto	**0.003***	0.003	0.002	0.003	**0.005***	0.000

Tab. 2. Connectivity matrices resulting from Lagrangian simulations

	Marano	*Venezia*	*Goro*	*Ravenna*	*Foggia*	*Lecce*
Marano	33.23%	0.38%	0.73%	0.36%	0.00%	0.00%
Venezia	0.09%	1.22%	3.73%	1.03%	0.00%	0.00%
Goro	0.00%	0.02%	49.93%	5.42%	0.00%	0.00%
Ravenna	0.00%	0.00%	1.03%	5.51%	0.00%	0.00%
Foggia	0.00%	0.00%	0.00%	0.00%	0.11%	0.05%
Lecce	0.00%	0.00%	0.00%	0.00%	0.00%	87.86%

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AN ASSESSMENT OF HABITAT CONNECTIVITY AMONG CORALLIGENOUS AGGREGATIONS

E. Fakiris [1], E. Tzanatos [2]*, G. Papatheodorou [1], C. Koutsikopoulos [2] and G. Ferentinos [1]
[1] University of Patras, Department of Geology
[2] University of Patras, Department of Biology - tzanatos@upatras.gr

Abstract
Using data from the mapping of coralligène habitat in the Cyclades archipelago in 2007 we demonstrate a new simple methodology to assess habitat connectivity among the aggregations mapped. This methodology uses topological relations between individual coralligène aggregations to estimate the probability of an organism that leaves one (core) to encounter others. The results are discussed with regard to their management implications and potential method improvements.

Keywords: Mapping, Conservation, Aegean Sea

Introduction
In the Mediterranean, coralligène communities constitute the second most important "hot spot" for species diversity [1]. In order to protect coralligenous habitats, the formations significance as potential MPAs should be assessed. An important aspect for conserving marine metapopulations is the estimation of the probability to exchange individuals among patches of habitat (like coralligène), known as connectivity [2]. The aim of this work is to estimate connectivity among coralligène aggregations.

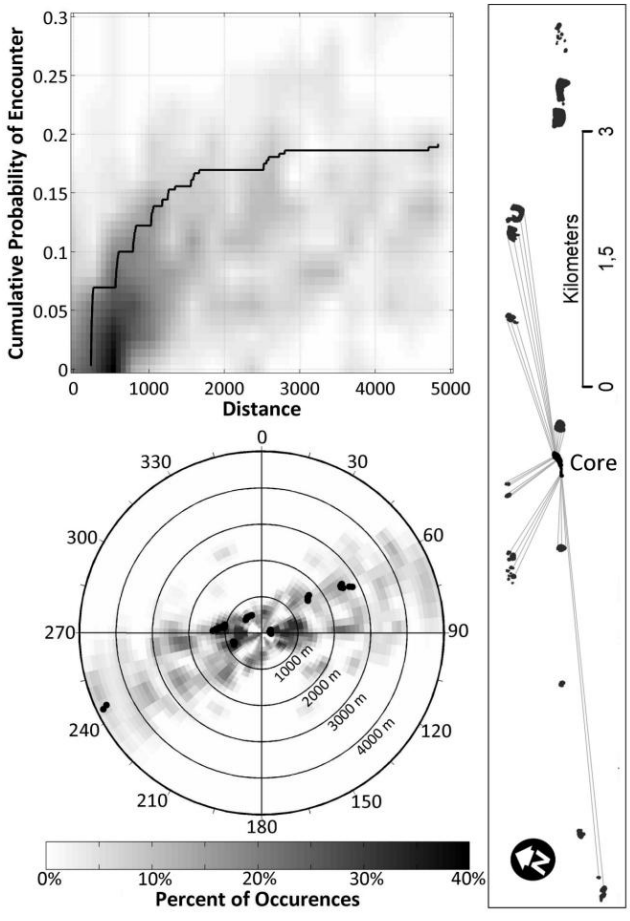

Fig. 1. Right: Spatial distribution example of coralligène aggregations surrounding a "core" one. Radial lines: directions of aggregations encountered. Top: Cumulative probability of encountering aggregations by movement distance. Bottom: Polar distribution of aggregations (black dots) surrounding the "core" (axes origin). Grey shaded areas: percentage of total number of co-occurring aggregations.

Methodology
A coralligène mapping survey was conducted in the Cyclades archipelagos (Aegean Sea) in 2007 on board the R/V FILIA using a dual frequency (100-500 kHz) Side Scan Sonar and a MKII Benthos ROV. Positional data were provided by GPS (accuracy: ~5-10m) and records mosaicking resulted to a pixel size of 1x1m. The outlines of evidently individual aggregations were manually digitized as Regions Of Interest and subjected to geometrical and acoustical analysis through the TargAn software [3]. Connectivity among the 48 aggregations mapped was defined as the total probability of an organism leaving a core aggregation to encounter others while moving across arbitrary directions and up to a maximum distance. It was estimated by summing the number of radial directions across which other aggregations were met, divided by 360^o.

Results
The evaluation led to the flagging of aggregations with high topological connectivity as potential MPAs. The most usual distances among neighbouring aggregations were estimated at 300-700m. High (20-30%) connectivity was found for less than 10% of the analyzed aggregations, corresponding to distances of 3.5-4.5 km covered. For any given aggregation, within one km of distance aggregations were encountered towards any direction, but for higher distances aggregations were mainly encountered in the orientations: 60-90^o and 220-270^o (Fig. 1). Considering the fact that in the areas mapped the isobaths had a general East-West (90^o-270^o) orientation, connectivity seems to be enhanced along that direction. This confirms the importance of current direction (which tends to follow the isobaths) for the distribution of coralligène formations, a finding very significant for the dispersal of planktonic organisms. Connectivity, as identified here, was correlated with depth and slope, indicating that the aggregations with high connectivity tended to be those at low depth ($r=-0.552$, $\alpha=0.05$, $p<0.001$) and high slope ($r=0.512$, $\alpha=0.05$, $p<0.01$).

Discussion
The quantification of individuals moving between patches of ocean seascapes remains a challenge [4]. Here we assessed connectivity as a product of the distance between aggregations and the cumulative arc covered by neighbouring aggregations, without referring to a specific organism. Hence, a promising next step would be to estimate the probability of model organisms moving among aggregations examining cases of active movement (e.g. fish migration) and passive diffusion (e.g. larval dispersal). Assessing connectivity in conjunction with the consideration of habitat quality through acoustical and geometrical analysis of sonar images [3] could lead to an improved tool for the evaluation of habitat suitability, using elements such as density, area and rugosity.

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COMPARATIVE STUDY OF THE *OPHIODERMA LONGICAUDA* SPECIES COMPLEX: DIVERGENT PATTERNS OF CONNECTIVITY AND ADAPTATION BETWEEN BROODING AND BROADCASTING LINEAGES.

Alexandra Weber [1]* and Anne Chenuil [1]
[1] UMR 7263 IMBE Station Marine d'Endoume - alexandra.weber@imbe.fr

Abstract
We compared the connectivity patterns of the brittle star species complex *Ophioderma longicauda*. The broadcast spawning lineages L1-L5-L6 displayed low genetic structure, whereas the brooding lineages L2-L3-L4 displayed very high genetic structure, even at a geographic scale of 1 km. This study demonstrated the importance of life history traits such as dispersal ability in connectivity levels.

Keywords: Echinodermata, Life cycles, Genetics, North-Eastern Mediterranean, North-Western Mediterranean

Studying connectivity in marine invertebrates is essential for implementing conservation strategies and to answer evolutionary questions about local adaptation. Closely related sympatric species with divergent life history traits represent excellent model species to infer the role of life history traits in connectivity because they display the same ecology, thus the differences in connectivity should only rely on their dispersal characteristics. The brittle star species complex *Ophioderma longicauda* is composed of three brooding (L2-L3-L4) and three broadcast spawning (L1-L5-L6) lineages occurring differently in the Atlantic and the Mediterranean [1]. To improve the phylogeography which was until now based on 127 individuals, we sampled 702 new individuals across its distribution range.

As the species status of lineages was unclear, we compared the reproductive cycles of the sympatric brooding lineage L3 and the broadcasting lineage L1 during the month of May 2012. We found that the lineages L1 and L3 were truly separated species because in addition to displaying different reproductive strategies (brooding vs lecitotrophic larva), they also displayed pre-zygotic isolation as lineage L3 reproduced in May whereas lineage L1 reproduced in July.

Regarding the differential distribution of lineages L1 and L3 in the eastern basin, we wanted to test whether the brooding species L3 was better adapted to the environmental conditions of the eastern basin (higher temperatures and salinity, oligotrophy) than the species L1. We conducted a thermotolerance experiment in Marseille, with L1 individuals from Marseille and Crete, and L3 individuals from Crete. We tested 3 temperatures (17°C, 26°C and 30°C) during 3 months. We observed that the lineage L1 resisted well at 17°C and 26°C, but displayed high mortalities at 30°C, whereas the L3 individuals did not display any differences among the three tested temperatures, suggesting a higher tolerance to the elevated temperatures for the species L3, potentially explaining their high abundance in the eastern Mediterranean.

829 individuals were analyzed for two genetic markers; the COI (mitochondrial) and the intron i51 (nuclear). Lineage L1 displayed low genetic structure as the majority of Φ_{ST} comparisons were non-significant and the haplotype network showed that all dominant haplotypes were shared among the Atlantic and the three Mediterranean basins (Figure 1). Nevertheless, L1 displayed genetic structure as F_{ST} comparisons were all significant (values ranging between 0.019-0.125). The i51 data displayed also low genetic structure, as the majority of F_{ST} comparisons were non-significant. The low number of samples for L5 and L6 did not allow population comparisons, but the haplotype networks suggested that there was also little genetic structure for those two lineages.

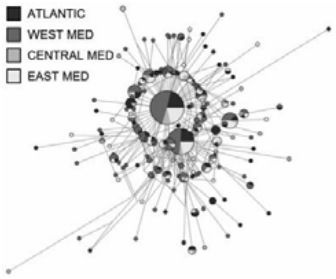

Fig. 1. COI haplotype network of *Ophioderma longicauda* broadcast spawning lineage L1, based on 509 individuals collected in the Atlantic and in the Mediterranean.

In contrast, the genetic structure observed for the lineages L2-L3-L4 was very high, since all F_{ST} and the majority of Φ_{ST} comparisons were significant (F_{ST} values ranging from 0.102 to 0.627) and the haplotype networks displayed high correlation with geography (Figure 2). The increased number of data suggested that lineages L3 and L4 were actually a single deeply structured mitochondrial lineage (which may be several species however) occurring in central and eastern Mediterranean. The i51 marker was monomorphic for all three lineages, indicating a loss of genetic diversity that occurred most probably at the apparition of brooding. Our data showed dramatic differences in genetic structure between closely related species differing almost only from their dispersal abilities, pointing out the strong influence of life history traits on connectivity.

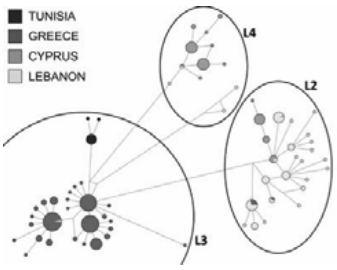

Fig. 2. COI haplotype network of *Ophioderma longicauda* brooding lineages L2-L3-L4, based on 298 individuals collected in central and eastern Mediterranean.

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Session

Ecological trends

Modérateur : **Vesna Macic**

ASSESSMENT ON 90 YEARS OF COASTAL DEVELOPMENT IN FRANCE AND CONSEQUENCES FOR *POSIDONIA OCEANICA* BEDS

J. Deter [1]*, A. Guibert [2], E. Freschet [3], P. Boissery [4] and F. Holon [1]
[1] Andromède océanologie UMR ISEM Université Montpellier 2 - julie.deter@andromede-ocean.com
[2] Andromède océanologie
[3] Andromède océanologie
[4] Agence de l'eau Rhône Méditerranée Corse

Abstract
Posidonia oceanica is a Mediterranean seagrass. Highly sensitive to environmental changes, it is used as an indicator of coastal water quality. Upper limits (0 to -15 m) of *P. oceanica* beds were mapped from historical (1920) and present aerial pictures. The comparison shows that upper limits are essentially stable (85 %) and regression (13 %) are mainly due to coastal artificialisation (65 %).

Keywords: Posidonia, North-Western Mediterranean, Coastal management, Global change

Introduction

Posidonia oceanica is a Mediterranean seagrass. The submarine meadows constituted by *P. oceanica* have important ecological (nursery, spawning, feeding, oxygenation) and economical roles (coast protection and sediment trapping). Highly sensitive to environmental changes, it is used as an indicator of coastal water quality [1]. Lots of papers mention local regressions of *P. oceanica* meadows in link with anthropogenic pressures [2,3] but a few ones consider large spatial and/or temporal scales [4-6].

Our comparative study considers the evolution of *P. oceanica* beds upper limits between 0 and -15 m at the scale of Provence Alpes Côte d'Azur, a French region. Knowing how slow *P. oceanica grows* (3-4 cm / year) [7], we expect majoritary stable limits. However, we expect high regressions around the most artificialized areas.

Materials and methods

The upper limits are mapped using historical (1922) and present (2012) aerial pictures. Spatial changes occurred for *P. oceanica* beds limits during these 90 years are analyzed in terms of concordance (stable upper limits), positive discordance (progression) or negative discordance (regression). Considering coastal development (harbour, buildings, aquaculture, pipes, etc) maps, we try to link the regressions with direct (physical holding) or indirect impact of development.

Results and discussion

The comparison shows that upper limits are essentially stable (85 % = 1021 ha) while regressions count for 13 % (6584 ha) and progression 1.1 % (83 ha). Recruitment (patches with concentric colonization) was clearly observed essentially next to Cavalaire-sur-mer. Regressions are mainly due to coastal artificialisation (48.7 % =21.4 % of direct impact + 27.3 % of indirect impact, see Figure 1) but 44 % remain with undetermined origins using pictures (several factors or the water body mass quality could be involved).

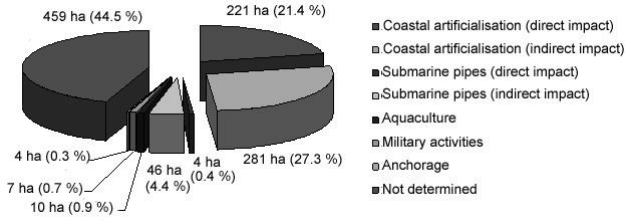

Fig. 1. Origins of *Posidonia oceanica* regression between 0 and – 15 m in Provence Alpes Côtes d'Azur region (France) between 1924 and 2012.

Anchorage causes 4.4 % of regression but is underestimated for three reasons. First, regressions around harbour areas are associated to harbour indirect impacts, anchorage impacts are hard to observe using aerial pictures and the bathymetric zone 0-15m is far less used for anchorage than 15-30 m where destruction can be locally massive.

The project is going on and we are now mapping the lower limits especially regression from dead matte observations. Until the summer the entire map will be available and used for the creation of "DONIA", a smartphone application helping boats to anchor outside of meadows. Reducing anchorage impacts on *P. oceanica* is the objective of this application based on 0-40 m maps and presently in development.

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INTENSIVE FRUCTIFICATION OF *POSIDONIA OCEANICA* (L.) DEL. ON THE COAST OF MONTENEGRO (SOUTH-EAST ADRIATIC SEA)

Vesna Macic [1]*
[1] Institute of marine biology - vmacic@ibmk.org

Abstract
Meadows of seagrass *P. oceanica* were monitored on 3 locations in Montenegro (Adriatic Sea). Basic phenological parameters and meadow density are indicating good state of the meadows. On all locations fructification was observed in May 2012, but very intensive was on two locations: cape Platamuni (30%) and Jaz (28%) while on location cape Ratac fructification was only 4%. By reporting of these events we will contribute to the evaluation of the state of marine ecosystems and consequences induced by the climate change.

Keywords: Phanerogams, Monitoring, South Adriatic Sea, Global change

Introduction
Importance of *Posidonia oceanica* (L.) Del. is very well known and this seagrass is listed as a protected species under several international conventions, it is marked as priority habitat in EU Habitat Directive [1] and it is protected by national legislation in Montenegro [2]. Monitoring of *P. oceanica* meadows was performed in order to be able to apply adequate management measures (as a part of a larger marine biodiversity monitoring project financially supported by Public enterprise Morsko dobro).

Material and Methods
The present study was carried out at 3 locations in Montenegro (South East Adriatic Sea): Jaz (18°49' 21.57"E 42°16' 36.22"N), Cape Platamuni (18°46' 56.44"E 42°16' 03.11"N) and Cape Ratac (19°03' 59.41"E 42°07' 18.30"N). *P. oceanica* meadow observations and samplings were performed by SCUBA diving in May 2012. Meadow density was recorded in situ by counting the number of leaf shoots present inside a square frame (40 x 40 cm in 5 replicate measurements), at a depth of 10 m. The rate of fructification was estimated within each quadrate, from the percentage of the shoots that had fruits. In order to examine phenological parameters, 10 orthotropic shoots were collected at a depth of 10 m.

Results and Discussion
The density of surveyed meadows varied from 388 to 404 shoots/m^2. Mean values for measured phenological parameters for all 3 locations, were similar (Fig. 1.), with almost identical LAI values for cape Platamuni and cape Ratac, while LAI values for location Jaz were slightly lower. All this parameters are indicating good state of the meadows [3], but furthmore very interesting was the intensive fructification. On all 3 locations fructification was observed in May 2012, but furthermore, very intensive was on two locations: cape Platamuni (30%) and Jaz (28%) while on location cape Ratac fructification was only 4%. Length of inflorescence peduncle was also as LAI the smallest at location cape Ratac and simillar for other two locations (Fig. 1). The number of mature fruits per inflorescence on collected shoots was from 1 to 3 and their length were 2.54 ± 0,32cm. So intensive fructification was expected because of the previously reported intensive flowering observed in November 2011 on locations cape Platamuni and Jaz [4]. But, on the coast of Montenegro in last 15 years flowering and fructification of *P. oceanica* has been reported only sporadically. It is truth that observation efforts increased in several last years, but so intensive flowering and fructification, together with huge biomass of reproductive material floating and accumulated on the beaches in the middle June 2012. couldn't pass unobserved if happened in at least previous 15 years. Because of all this, intensive flowering on the end of 2011 and fructification in the 2012 on the coast of Montenegro could be considered as unike in last 15 years. The multiple observations of intensive and widespread flowering events in the Mediterranean Sea, especially after warm summers have provided evidence that flowering could be induced by high seawater temperature [5]. By reporting of these events we will contribute to the evaluation of the state of marine ecosystems and consequences induced probably by the climate change.

Parameter	Location		
	Ratac	Platamuni	Jaz
No. adult leaves	4,10	4,10	3,90
No. intermediate leaves	2,50	2,90	2,50
No. juvenile leaves	1,00	4,42	1,20
Length, adult leaves (cm)	52,50	45,62	41,65
Length, intermediate leaves (cm)	41,31	38,95	33,10
Length, juvenile leaves (cm)	0,61	0,30	1,24
Length, sheaths (cm)	3,56	3,95	3,25
Coefficient A% (for adult)	51,44	29,40	34,70
Width, adult leaves (cm)	0,93	1,00	0,92
Width, intermediate leaves (cm)	0,88	0,95	0,87
LAI, adult (cm^2/shoot)	199,71	191,23	147,60
LAI, intermediate (cm^2/shoot)	91,82	108,07	72,98
LAI, (cm^2/shoot)	291,54	299,30	220,59
Meadow density (shoots/m^2)	387,50	400,00	404,16
Length, inflorescence peduncle (cm)	23,85	24,13	18,60
Total length of the inflorescence (cm)	27,75	28,82	22,87
Fruit length (cm)	2,6 (n=2)	2,76 (n=7)	2,35 (n=12)

Fig. 1. Mean values of phenological characteristics for orthotropic shoots of *P. oceanica* in Montenegro, on May 2012.

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CYCLIC FLUCTUATIONS OF BLUE WHITING (*MICROMESISTIUS POUTASSOU*) OVER 1950- 2011 IN THE NW MEDITERRANEAN

Paloma Martín [1]*, Francesc Maynou [1], Laura Recasens [1] and Ana Sabatés [1]
[1] Institut de Ciències del Mar, ICM-CSIC. - paloma@icm.csic.es

Abstract
Landings of blue whiting fluctuated with a periodicity of 6 to 8 years in the NW Mediterranean over the period 1950 -2011, independently of fishing effort. We show that these fluctuations are correlated with the winter Western Mediterranean oscillation index (WeMOi), but not with other major climatic modes, such as the North Atlantic Oscillation (NAO). In addition, recruitment is shown to be correlated with winter SST. We conclude that years with cold winters enhance recruitment in blue whiting, which appears as a strong year class in the catches in the following year.

Keywords: Fisheries, Fishes, Recruitment, North-Western Mediterranean

Introduction
Blue whiting is one of the species with highest landings off the northern Catalan coast (between 750 and 2500 annual tones in the last decade). It is fished exclusively by bottom trawl. Cyclic fluctuations in blue whiting landings have been observed since the mid XX century. These fluctuations cannot be explained by changes in trawl fishing effort, which in the last 70 years has undergone marked changes. Thus, other alternatives, in addition to fishing effort, are explored to unveil the underlying conditions which would explain the landings variability i.e. the species link to environmental conditions and intrinsic response to changes in abundance.

Material and Methods
Data and data source: Blue whiting landings 1950-2011 (from literature 1950-1961 and official statistics 1962-2011); length frequency during high (1988-1989) and low (2009-2011) landings periods ([1], [2]); recruitment and SSB data (1994-2011; [2]). Installed engine power 1971-2011, an approximate measure of trawl fishing effort, was examined to compare with the evolution of landings (data source: official statistics). Since landings consist mainly of ≥1 year old individuals, which coincide with the age at-first-maturity, landings were taken as a proxy for SSB. The environmental variables considered were: SST (data source: L'Estartit meteorological station); winter (December to March) Western Mediterranean oscillation index (WeMOi; www.ub.es/gc/menu.htm); and winter NAO index (www.cru.uea.ac.uk/~timo/projpages/nao_update.htm). The linear trend was removed from SST and landings data series. Data were analyzed through lagged cross- correlation, with 0, 1 and 2 years lags, and wavelet periodogram ([3]).

Results
Blue whiting landings showed a number of cycles over 1950-2011 with different periodicities, of around 8 years at the beginning (1950-1980) and shorter at present, of around 6 years (Fig.1). The years of high volume of landings coincided with high fisheries production in the winter months, while in the periods of low landings, these were distributed all along the year. Furthermore, the number of age classes was higher in the years of high landings (up to 3-4 age classes); and, with low fisheries production, landings were concentrated on age classes 1 and 2. Significant correlations ($p<0.05$) were found for recruits (class 0) and winter (December- January) SST (negative), and between landings and winter WeMOi (positive) with time lags of 0 and 1 year.

Discussion
Positive WeMOi phases, which correspond to low sea surface temperature, strong northerly winds and low precipitation ([4],[5]) are linked to high landings, with time lags of 0 and 1 year. In addition, low temperatures during the winter months (December to January), at the beginning of the reproduction period, result in good recruitment. The environmental conditions during positive WeMOi phases enhance intense winter convection events north of the study area (Gulf of Lions; [6]). Fluctuations in the intensity of this phenomenon have been related to interannual variations in primary production ([7]). These environmental conditions are likely to enhance survival of the early life stages during the winter months resulting in one strong cohort, which will be exploited the following years.

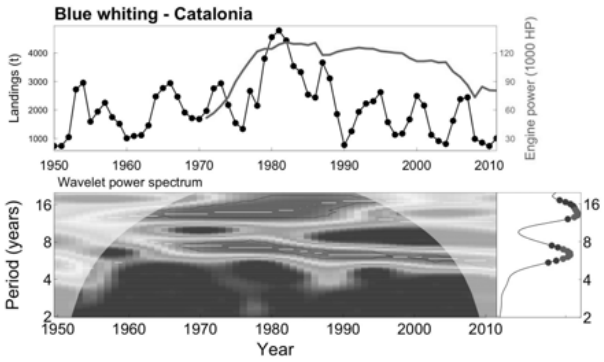

Fig. 1. Blue whiting landings and trawl fishing effort (upper panel); wavelets spectrum of the landings (bottom panel).

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THE EFFECT OF LIGHT INTENSITY ON THE INVASIVE ALGAE *CAULERPA RACEMOSA* IN FOURNI ISLAND, AEGEAN SEA, GREECE

Sarah Bartle [1], Scott Hayward [2] and Hazel Thornton [1]*
[1] Archipelagos, Institute of Marine Conservation, P.O. 42, Pythagorio, 83103, Samos, Greece - hazel@archipelago.gr
[2] University of Birmingham, School of Biosciences, Edgbaston, Birmingham, B15 2TT, UK

Abstract
Caulerpa racemosa is found predominantly in the Mediterranean Sea as an invasive algal species. Its presence has been seen to negatively impact native biodiversity and cause homogenisation of the environment. *C. racemosa* has a high degree of morphological plasticity and this study aimed to further current knowledge of the impact of light intensity on the growth morphology and abundance of this species around Fourni island complex, NE Aegean Sea.

Keywords: Aegean Sea, Alien species, Algae

Introduction
The green macroalgae, *Caulerpa racemosa* var. *cylindracea*, is an invasive species native to Australia that has rapidly spread across the Mediterranean since 1926 [1]. *C. racemosa* colonises a variety of substrata, and its dominating presence has been found to alter indigenous flora and fauna biodiversity [2]. It is thought that the algae's extensive morphological plasticity has contributed to its invasive success [1]. The aim of this study is to determine the effect of light intensity on the abundance and growth morphology of *C. racemosa* populations at littoral ecosystems of Fourni island complex, NE Aegean Sea, Greece to aid design of efficient control strategies for this invasive species.

Materials and methods
Data was collected in July and August 2012 at four different habitats types with differing light regimes, where *C. racemosa* was present. Each habitat was termed the following: shallow; data collected at 1m(±0.1m) depth, deep; data collected at 5m(±0.5m) depth, wall; data collected at 1m(±0.1m) depth from quadrats placed perpendicular to the sea floor on a rock wall, cave; data collected at 1m(±0.1m) depth inside a shallow open air cave-like habitat. Light intensity at each habitat type was recorded over a 72 hour period using an underwater datalogger. *C. racemosa* abundance was measured by photographic quadrat analysis using 30cmx30cm quadrats [5]. Percentage abundance was calculated per habitat using photo-Quad computer software [3]. Scrapings were collected at the deep and shallow habitat and morphological measurements concerning the stolen, fronds, ramuli and rhizomes were measured in the lab. One-way ANOVA was performed to analyse the abundance of *C. racemosa* data. Students T-test and Mann-Whitney U were performed to determine significance of variance between morphological measurements.

Results and discussion
Percentage abundance of *C. racemosa* was significantly different between habitats ($p<0.0001$) and greatest abundance was observed in the shallow habitat where light intensity was greater (Fig. 1), presumably due to increased photosynthetic rate. Morphological measurements demonstrated total stolen length ($p=0.04$, N=6); diameter of ramuli ($p=0.002$, N=157) and number of rhizomes ($p<0.005$, N=6) were significantly greater in the shallow habitat, creating a compact morphology allowing concentrated growth under favourable conditions. It is suggested that *C. racemosa* in low light intensity adopted an elongate growth form to increase surface area and escape unfavourable conditions. Stolen diameter and colouration of *C. racemosa* were not uniform across quadrat samples leading to the proposal that they are involved in reproductive stress strategies that occur under low light intensity [1].

Conclusion
This study confirmed that in the Aegean Sea, the invasive algae *C. racemosa* is sensitive to light intensity, and alters its growth, biomass production and morphology accordingly. The significant morphological differences followed the predictions made in light of the 'forager growth hypothesis' proposed by de Kroon and Knops [4]; where elongate morphs dominate low light habitats and compact morphs dominate high light habitats. Furthering the knowledge on this species may aid with accurately predicting the potential impacts an invasion may have in novel environments.

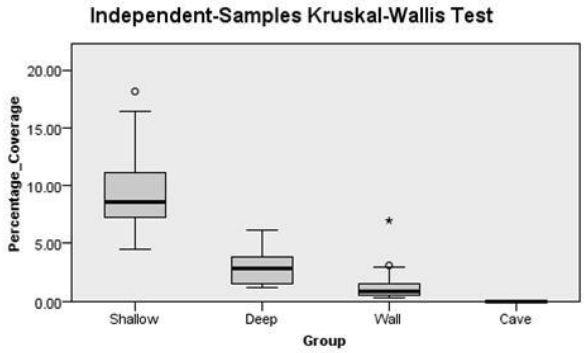

Fig. 1. Boxplot created by 1-way ANOVA of mean percentage coverage of *C. racemosa* in habitats of varying light intensity. $p=0.0001$. N=60. Mean percentage coverage of *C. racemosa* at shallow: 7.72%, deep: 3.58%, wall: 1.53%; cave: 0%. '**o**' represents outliers. ***** represents extreme outliers.

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Session

Functional traits

Modérateur : **Claudia Kruschel**

FUNCTIONAL DIVERSITY OF FEEDING MECHANISMS IN INFRALITTORAL COBBLE BEDS IN MALTESE HARBOURS AND NON-HARBOURS

Juan J. Bonello [1]*, Joseph A. Borg [1], Julian Evans [2] and Patrick J. Schembri [1]
[1] Department of Biology, University of Malta, Msida MSD2080, Malta. - juan.bonello@um.edu.mt
[2] Marine Biology and Ecology Research Centre, University of Plymouth, Plymouth PL4 8AA, UK.

Abstract
Cobble beds from Maltese harbour and non-harbour sites were characterised in terms of the functional diversity of feeding mechanisms. Given the nature of these two environments, differences in the overall feeding modalities of the respective species assemblages were expected; however, Maltese harbour and non-harbour sites were not very different in the frequency of the different categories of feeding traits. 'Suspension feeding' occurred in high frequencies in both harbours and non-harbours but harbours were distinguished from non-harbours by a higher frequency of 'deposit feeding'.

Keywords: Biodiversity, Coastal systems, Coastal waters, Infralittoral, Sicily Channel

Introduction
Functional characteristics are assumed to reflect adaptations to dominant environmental factors in a habitat. As a result, non-taxonomic aggregations of taxa into biological/ecological (i.e. behavioural, physiological and life history) categories might be an effective way of investigating mechanisms affecting species distributions and ecosystem function [1].

Cobble beds are intermediate between the epibiota of hard substrata and the infauna of soft sediments since they include elements from both habitats. Few studies have been made on Mediterranean cobble habitats and their ecology is practically unknown. In this study, the functional diversity of feeding mechanisms of cobble bed biotic assemblages from harbour and non-harbour sites was compared.

Material and Methods
Infralittoral cobble beds from four harbour sites (Tigné, Manoel Island A and B and Ta' Xbiex) and five non-harbour sites (Mgarr ix-Xini, Ix-Xatt l-Ahmar, Hondoq Bay, Wied ix-Xoqqa and Fomm ir-Rih Bay) were sampled. Four replicate 0.1m^2 core samples were collected from each bed. The cobble layer was removed from the corer and transported to the laboratory. The water depth and the thickness of each cobble bed were recorded.

In the laboratory, fauna retained by a 0.5-mm mesh were identified to the lowest possible taxon. Each species was assigned to one of six functional traits: 'suspension feeding' (using specialised entrapment mechanisms to capture suspended particles), 'deposit feeding' (feeding on particulate organic matter from the substratum), 'grazing' (feeding on sessile organisms attached to the substratum), 'macropredation' (capturing and killing non-microscopic organisms), 'deposit feeding/grazing', and 'multifunctional feeding' (having three or more different feeding mechanisms). This categorisation was used to generate a taxon X functional trait matrix. By multiplying trait category scores by species abundances and summing across all constituent species, a station X functional trait matrix was obtained. The matrix was normalised in terms of replicate percentage, where the total of each replicate was 100%. Statistical analyses were carried out using PRIMER v6 (Plymouth Routines In Multivariate Ecological Research, PRIMER-E Ltd.).

Results and Discussion
'Suspension feeding' was the dominant mechanism at all sites with three exceptions: Manoel Island B and Wied ix-Xoqqa where 'multifunctional feeding' was the dominant trait, and Manoel Island A, where 'deposit feeding' was dominant (Tab. 1). Harbours were distinguished from non-harbours by a higher frequency of 'deposit feeding', while non-harbours had a comparatively higher frequency of 'macropredation'.

Generally, Maltese harbour and non-harbour sites were not very different in the frequency distribution of functional traits, and 'suspension feeding' had similar frequencies in the two environments, against expectations [2]. Maltese harbours are characterised by higher turbidity levels than non-harbour sites [3], but the present results suggest that the degree of anthropogenic activity may not be high enough to significantly affect the frequency of the dominant feeding mode. Non-harbour sites differed from harbour sites by having a higher frequency of 'macropredation', mainly due to predatory polychaetes, such as species of Aphroditidae and Nephtyidae.

Tab. 1. Percentage mean (±SD) frequency of feeding traits within the nine sites.

	Suspension feeding	Deposit feeding	Grazing	Deposit feeding / Grazing	Macropredation	Multifunctional feeding
Ta' Xbiex	44.7 (5.3)	20.1 (5.6)	3.82 (2.7)	17.7 (6.6)	0.7 (0.8)	13.1 (5.2)
Tigné	45.1 (19.6)	16.0 (12.0)	5.5 (1.5)	20.3 (8.9)	1.4 (0.1)	11.7 (4.9)
Manoel Island B	16.3 (3.9)	33.4 (8.9)	8.6 (1.8)	3.8 (1.2)	1.0 (0.5)	36.8 (10.4)
Manoel Island A	31.9 (12.8)	37.9 (13.8)	4.3 (0.9)	5.4 (1.5)	1.0 (0.6)	19.6 (6.6)
Mġarr ix-Xini	47.4 (11.7)	9.5 (4.2)	8.0 (1.2)	18.6 (5.8)	2.1 (1.0)	14.3 (4.6)
Fomm ir-Riħ	41.5 (21.9)	20.8 (16.2)	4.5 (5.1)	17.8 (10.9)	3.1 (0.8)	12.2 (6.6)
Ħondoq	50.8 (20.4)	14.2 (9.8)	5.2 (3.8)	1.4 (0.6)	3.0 (2.9)	25.4 (12.9)
Xatt l-Aħmar	47.7 (29.2)	16.9 (11.7)	2.1(0.4)	3.4 (1.8)	15.9 (21.9)	14.1 (8.0)
Wied ix-Xoqqa	32.2 (7.4)	20.3 (3.7)	6.2 (3.0)	7.3 (3.2)	1.6 (1.1)	32.4 (5.5)

The structure of the cobble bed itself will impose limitations on the representation of certain functional groups. For instance, cobbles cannot support a high frequency of grazers, compared with other habitats such as algal forests, since cobbles only support turf species, therefore limiting opportunities for grazing.

No significant correlation between the abiotic factors measured (water depth, thickness of cobble layer and cobble granulometry) and the frequency of the different feeding mechanisms observed within harbours and non-harbours was found (BIO-ENV procedure). This suggests that factors other than those considered in the present study influence the distribution of traits.

Acknowledgements
This work was partially funded through the European Social Fund under the Strategic Educational Pathways Scholarship (STEPS) scheme grants.

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SEEKING THE EDGE - FISH ASSEMBLAGES AT HABITAT TRANSITIONS – KNOWING WHAT SPECIES DO

C. Kruschel [1]*, S. T. Schultz [1], I. Zubak [1], T. Bakran-Petricioli [2] and S. Dahlke [3]
[1] University of Zadar, Dept. of Maritime Sciences/CIMMAR, M.Pavlinovica bb, 23000 Zadar, Croatia - ckrusche@unizd.hr
[2] Div. of Biology, Faculty of Science, University of Zagreb, Roosveltov trg 6, 10000 Zagreb, Croatia
[3] Unversity of Greifswald, Biologische Station Hiddensee, Biologenweg 15, 18585 Kloster, Germany

Abstract
Current classification systems of marine habitats in the Mediterranean are based on homogeneous categories. However, the natural benthos is not homogeneous and there is a need to explicitly recognize and quantify the extent of habitat edges, the unique conditions and resources they offer, and the unique animal communities they support. We predicted that species seek edge habitats due to their predation mode or their ability to exploit more varied resources. We found a significant heterogeneity effect: edge habitats have higher fish abundance, species richness, and diversity than homogenous habitats. Species more abundant at edges have diets with significantly higher taxon diversity. Edge seeking species result in unique fish assemblages. Management of fish biodiversity should recognize the conservation value of edge habitats.

Keywords: Fish behaviour, Predation, Demersal, Coastal waters, North Adriatic Sea

Introduction
A large body of demersal-fish studies spanning the globe indicates that fish distribution is influenced primarily by habitat variability and differential habitat use. Habitat transitions and the resulting edge habitats may offer unique environments and resources that specifically attract edge seeking species and thus unique fish assemblages. Living on the edge of two habitats may result in reduced competition, give opportunity for specially adaptated predation modes, and offer more varied food resources. By matching life history and functional traits of species and guilds with the unique features at edges, one can predict which types of demersal fish are likely to prefer them. We predicted that (i) it is edge-seeking species that make fish assemblages at edges unique rather than random fish movement, (ii) species more abundant at edges are those that exploit a higher diversity of food taxa, and (iii) wait-chase predators seek out edges where they can await prey in the more complex of the source habitats followed by a burst chase into the more open adjacent source habitats. We further made predictions about other functional groups: cryptobenthic and ambush predators seek homogeneous habitats while highly mobile predators and planctivores not closely associated with the benthos display no preference.

Methods
Our sampling method was lure-assisted visual-census (1). We performed a total of 13806 random field transects at 135 outer coast study sites in Croatia, between May and October of each year from 2009 – 2012, spanning the N-S and E-W range of the Croatian Coast including 18 islands and five MPAs. We tested hypotheses on the effect of habitat use on resouce use with published data (2). The null hypothesis that the mean of a response variable (abundance of each individual species, and total abundance, total diversity, total richness) was the same in homogeneous and heterogeneous habitats was tested with a Wilcoxon signed-rank test. The null hypothesis that the mean number of unique food taxa per species is the same in homogeneous and heterogeneous habitats was tested with one-factor ANOVAs.

Results
A total of 158000 individual fish were detected and identified. They belonged to 82 identified species and 16 less specific taxonomic levels. Each observed fish was matched with one of the five homogeneous or their derived 40 heterogeneous habitat types. Our data demonstrate high habitat heterogeneity. Of all random transects, 30% intersected habitat edges. Highest values for abundance, richness, and diversity were never recorded in source but always in derived heterogeneous habitat. Edges associated with rock, sand, and *Posidonia* seagrass habitats contained significantly higher fish abundance, species richness, and diversity than homogenous habitats and the edge effect is not based on the random movements of fish originating from multiple adjacent source habitats. Significantly higher numbers of ambush predator species (14 > 1) and cryptobenthic taxa (24 > 4) were more abundant in homogeneous habitats than in heterogeneous habitats. Significantly higher numbers of wait-chase predator species (10 > 1) were more abundant in heterogeneous habitats (edges) than homogeneous habitats. We foound that 63% of the edge seeking species use the wait-chase predation mode. Species that are significantly and overall more abundant in heterogeneous habitats feed on significantly higher numbers of unique food taxa than taxa significantly and overall more abundant in homogeneous habitats. Efforts to understand and conserve the marine environment would benefit from a program of explicit recognition and quantification of habitat edges and their impacts on the faunal community (3).

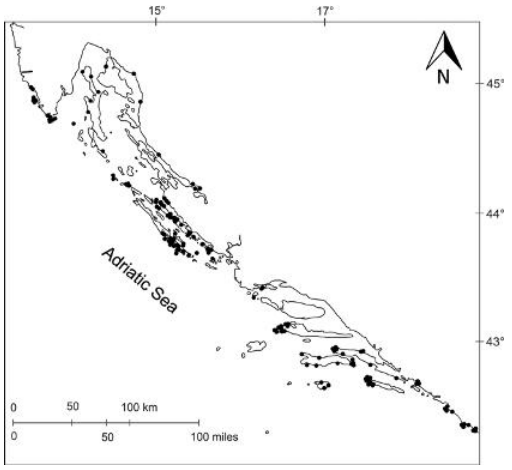

Fig. 1. Map locations (full black circles) representing the total of 135 study sites along the Croatian Adriatic coast visited between September 2009 and June 2012.

Acknowledgments The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement No. 287844 for the project "Towards COast to Coast NETworks of marineprotected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential" (COCONET) granted to SS and CK.

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LENGTH-WEIGHT RELATIONSHIPS OF MESOPELAGIC FISHES IN THE NORTH-WESTERN MEDITERRANEAN

M. Pilar Olivar [1]*, Balbina Molí [1] and Ainhoa Bernal [1]
[1] Institut de Ciències del Mar (CSIC) - polivar@icm.csic.es

Abstract
In the present study we analysed the length-weight relationships of the most common and abundant mesopelagic fishes of the northwestern Mediterranean: 11 Myctophidae, 1 Gonostomatidae, 1 Phosichthyidae and 1 Sternoptichydae. Data of fish length and weight were fitted to a power function, and estimations of the fitted equation parameters were given as background information for subsequent studies on body condition. The slope estimation was taken as indicative of the relative increase in weight in relation to growth in length. The small fish Cyclothone braueri has a lower allometric coefficient with significant negative value, than that corresponding to larger species such as myctophids (some of them showing positive allometric growth).

Keywords: Fishes, Growth, North-Western Mediterranean

The largest biomasses of the open ocean have been attributed to meso and bathypelagic fishes that occur together with small crustaceans, cephalopods and a few other invertebrates. The most common and abundant mesopelagic fishes in the western Mediterranean are lanternfish of the family Myctophidae and bristlemouth of family Gonostomatidae (1, 2). The diversity of these groups of species in the Mediterranean Sea is lower than in open oceans and the maximum sizes tend to be smaller than those reported for the same species in the Atlantic. They constitute a key component of the food web in oceanic waters, being commonly cited as prey for larger marine inhabitants (e. g. commercial pelagic fishes, cetaceans, marine birds). In the present study the body length- weight relationships of the most common and frequent mesopelagic fishes in the north-western Mediterranean were analysed. Information regarding to allometry in fish has been indicated as an important issue to approach body condition (3, 4); however related data are not always complete and lacks for many species, particularly for those inhabiting the water column, which are less frequently sampled in routine surveys. Information related to this issue has been already presented for some meso and bathypelagic species of the central Mediterranean (5). Mesopelagic fishes studied here were collected during winter (December 2009) and summer (July 2010) off Mallorca Island by means of different midwater trawls towed in the epipelagic layers (up to 80 m), the 400 m deep scattering layer (DSL) and benthic boundary layer (50 m above the bottom, BBL). After collection and identification on board, fishes were preserved in formalin 5%. Measures of fish length and weight were taken in the laboratory (length to the nearest mm and weight to the nearest mg). Weight and length data were fitted to a potential equation $W=aSL^b$, where W is the weight in mg, SL is the standard length in mm, *a* is the intercept and *b* the allometric coefficient. Fitting was performed after log transformation of data, and results are given as 95% confidence intervals (95%CI). Values of *b* significantly different from 3 indicated that growth in weight is relatively faster than that in length (positive allometry $b>3$) or lower (negative allometry $b<3$). Mathematically the values of the intercept, *a*, indicated the expected weight at SL 1 mm. As generally found in many other fish species, the obtained length-weight relationships for mesopelagic fishes in the present study as well, as in those from the central Mediterranean (5), fit a potential function with a coefficient of nearly 3 and correlation coefficients always close to 1 (Table 1). Significantly positive allometric relationships were observed for several myctophid species, i.e. *Benthosema glaciale, Ceratoscopelus maderensis, Diaphus holti, Lampanyctus crocodilus, L. pusillus, Lobianchia dofleini, Notoscopelus elongatus* and *Symbolophorus veranyi*. Significant negative allometry was only observed for the gonostomatid *Cyclothone braueri*, indicating a relatively slower growth in weight than in length across development. Therefore, this species/*C. braueri* tends to have a pronounced slender body shape in contrast to those species with positive allometry, such as myctophids. Differences in body shape could be related to the different behaviour of myctophids, characterized by performing extensive diel migrations from near the bottom to the epipelagic layers, whereas *Cyclothone braueri*, do not perform such migrations (1,2). Robust bodies with higher muscular and osteological development must contribute in the vertical migration, while the more attenuated shape of *Cyclothone braueri* reflects a less energetic demanding behaviour.

Tab. 1. Parameters of the allometric relationship between body length (SL mm) and weight (mg) for the most common and abundant mesopelagic fishes occurring in the upper 400 m of the water column in the western Mediterranean. a: intercept, b: slope (allometric coefficient), 95%CI: 95% confidence interval, n: number of individuals measured, r: correlation coefficient. Significant positive or negative allometry is marked in bold, black and grey, respectively.

	a	*b*	*95%CI*	*n*	*r*	*SL range*
F. Gonostomatidae						
Cyclothone braueri	0.008	2.769	0.173	113	0.9488	12-27
F. Sternoptychidae						
Argyropelecus hemigymnus	0.018	3.032	0.179	63	0.9744	13-34
F. Phosichthyidae						
Vinciguerria attenuata	0.010	2.942	0.190	26	0.9884	14-35
F. Myctophidae						
Benthosema glaciale	0.008	**3.093**	0.088	249	0.9751	14-47
Ceratoscopelus maderensis	0.005	**3.191**	0.048	188	0.9947	16-64
Diaphus holti	0.004	**3.360**	0.207	32	0.9866	25-53
Hygophum benoiti	0.015	2.938	0.133	34	0.9921	13-48
Hygophum hygomii	0.010	3.136	0.326	40	0.9533	39-58
Lampanyctus crocodilus	0.002	**3.345**	0.089	117	0.9898	22-128
Lampanyctus pusillus	0.004	**3.232**	0.059	238	0.9902	14-43
Lobianchia dofleini	0.005	**3.338**	0.279	53	0.9587	21-43
Myctophum punctatum	0.009	3.052	0.175	37	0.9864	19-60
Notoscopelus elongatus	0.004	**3.248**	0.069	209	0.9883	30-107
Symbolophorus veranyi	0.005	**3.181**	0.100	25	0.9974	23-90

Acknowledgements: This research was funded by Spanish program CTM2008-04489-C03-01-02.

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MATRIX MODEL OF GREEN ABALONE *HALIOTIS FULGENS*: IMPLICATION FOR CONSERVATION

Marisa Rossetto [1]* and Giulio A. De Leo [2]
[1] Politecnico di Milano - marisa.rossetto@nemo.unipr.it
[2] Hopkins Marine Station of Stanford University

Abstract
Demographic models are essential tools to explore alternative conservation and management strategies for exploited populations. We developed a size-based model for the marine mollusk green abalone *H. fulgens* that incorporates quantitative information on its life-history traits, including size-dependent fecundity and mortality. Analysis of the matrix model suggests that green abalone populations have very slow population growth rates and long expected recovery time (~15 years). Elasticity analysis indicates that protecting large, highly fecund individuals can be among the most effective ways to recover depleted populations.

Keywords: North-Central Mediterranean, Models, Mollusca, Conservation

Introduction Population models incorporating quantitative information on vital rates are powerful tools for analyzing the dynamic of age or size-structure populations and can contribute to species' protection by orienting conservation effort on the life stages expected to have the greatest influence on population growth [1]. Abalones (*Haliotis* spp.) are long-lived, slow-growing marine mollusks whose natural populations have undergone dramatic declines all over the world. Overfishing, ocean warming, and the spread of disease represent the major threats for abalone populations [2]. Native populations of green abalone *H. fulgens* have collapsed all along the California peninsula since the 1970s [4], and in USA, green abalone has been identified as 'species of concern' in 2004. Size-based matrix model are considered particularly appropriate to describe the dynamic of *Haliotis* spp., as many demographic traits of abalone are known to scale with body size [5]. Elasticity analyses of such models can guide management and conservation of endangered abalone populations by revealing the relative importance of the different life stages for population rate of increase.

Methods We developed a matrix model for green abalone consisting of ten size classes of 25 mm width, from 0 to 250 mm SL, of the form $\mathbf{n}(t+1)=\mathbf{A}\mathbf{n}(t)$, with $\mathbf{n}(t)$ being the vector of population densities in each stage at time t and $\mathbf{A}$ being the population projection matrix. The model incorporated size-dependent mortality [6], size-dependent fertilities and sexual maturation [7] and plasticity in body growth. We used the projection matrix $\mathbf{A}$ to analytically compute the maximum finite rate of population increase λ, the theoretical doubling time T, the stable stage distribution w and the reproductive value v. Elasticity analysis, indicative of the relative influence of each matrix elements on population rate of increase λ, was computed as in [9].

Results Computation on the green abalone matrix model provided a maximum finite rate of population increase λ equal to 1.05. The value of λ suggests that this species should recovery slowly, at a yearly rate of 5%. This corresponds to a theoretical doubling time (i.e. number of years for the population to double its initial density) of 15 years. The first size class, corresponding to individuals of one year old, largely dominated the stable stage distribution w representing more that the 90% of the stage distribution. Reproductive value v increased exponentially with size. The four largest size classes, between 175 and 250 mm SL, contribute altogether to the 80% of the reproductive value. The elasticity analysis indicates that the larger size class contributes the most to the population growth (Fig 1).

Discussion The low value of population rate of increase (λ =1.05) obtained for *H. fulgens* is reasonable given that abalones are long-living and slow growing animals. Population recovery for green this species is expected to occur on a long time scale, more than one decade. Similar results have been obtained for other abalone species, such as H. *corrugata* in California [10]. Matrix analysis shows that large abalones (above 175 mm SL) in the final stages of the stable population have more than three quarters of the reproductive potential, highlighting the importance of big, mature individuals to the overall egg production. Elasticity analysis indicates that the largest individuals have the greatest influence on the population growth rate, suggesting that conservation efforts aimed at protecting the large abalones may be successful in promoting population recovery. Marine reserves, such as those established in the region [11], are known to successfully protect larger individuals and can be hence a desirable option to be implemented to conserve endangered abalone populations.

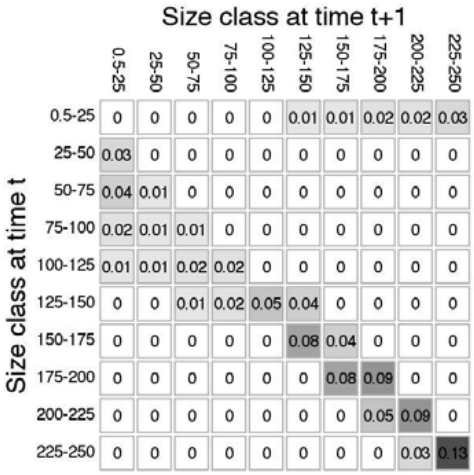

Fig. 1. Elasticity values for green abalone matrix elements. Darker boxes highlight elements with greater influence on population growth.

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ENERGY DENSITY AND LIPID CONTENT OF SARDINE (*SARDINA PILCHARDUS*)AND ANCHOVY (*ENGRAULIS ENCRASICOLUS*) IN THE CATALAN SEA, NORTHWESTERN MEDITERRANEAN SEA

Sonia Sánchez [1]*, Isabel Palomera [1], Marta Albo-Puigserver [1] and Miguel Bernal [2]
[1] Institut de Ciències del Mar, ICM-CSIC, P. Marítim, 37-49. Barcelona, Spain - soniasg9@gmail.com
[2] GFCM, FAO. Via Vittoria Colonna 1, 00193, Rome

Abstract
In order to develop a bioenergetic model and obtain the adequate data on energy allocation to growth and reproduction, samples of two small pelagic fishes (anchovy, *Engraulis encrasicolus* and sardine, *Sardina pilchardus*) were collected off the Catalan Sea to study their annual cycle in the context of Dynamic Energy Budget theory. Seasonal lipid content (% of wet weight, W_W) was determined in both species as well as the energy density (E_D, kJ g^{-1} W_W) of individuals from summer and winter by direct calorimetry. Sardine has higher lipid content than anchovy and both species present their maximum in spring. The E_D values obtained are 4,48 - 4,61 kJ·g^{-1} W_W for anchovy and 4,74 - 4,97 kJ·g^{-1} W_W for sardine. The present study provides for the first time energetic data from direct analysis in this region.

Keywords: Pelagic, Fishes, Models, North-Western Mediterranean

Introduction
Bioenergetic models can yield important information on the life cycle dynamics of the involved species. For *E. encrasicolus*, different models have already been implemented to distinct populations, e.g., Black Sea [1], Bay of Biscay [2] and northern Aegean Sea [3]. Due to the fact that the interaction between growth and reproduction is one of the most important trade-offs in fish, our aim is to obtain the required data to develop bioenergetics models for anchovy, *E. encrasicolus* and sardine, *S. pilchardus* detailing the energy allocation to growth and reproduction during an annual cycle. Here we present the first analysis to reach the data to implement these models: seasonal lipid content of muscle and energy density of individuals in the Catalan Sea.

Material and methods
Individuals of anchovy (total length (TL): 6,4 to 16,2 cm) and sardine (TL: 8,8 to 19,6 cm) were collected monthly off the Catalan Sea, from April 2012 to March 2013. For this study individuals of both sexes and different TL classes were selected and grouped seasonally. Fulton's condition factor (CF= W_W /TL^3) was determined on each fish and averaged in each group. Total lipid of both species was extracted from dorsal muscle according to the Folch method [4]. Finally, the lipids were weighed and expressed as % of W_W. The energy content was measured on individual fishes from summer (anchovy spawning season) and winter (sardine spawning season) by direct calorimetry by means of a Parr 6725 Semimicro Oxygen Bomb Calorimeter. Individuals were oven-dried at 70ºC to constant mass (24 to 48h). After determining their dry weight, they were mixed to obtain a homogenized powder of each individual. The E_D was determined in two samples (150 to 200 mg) from each individual.

Results and Discussion
The average of lipid content was calculated (fig. 1.) and, as expected, the values were higher in sardine, being more obvious in spring, when the maximum lipid content was recorded in both species (Sardine*:* 2,035% and anchovy 0,98%). Seasonal variation was also higher in sardine as well as the variance between individuals. Sardine fat content varies widely with season [5], as anchovy feeds during their spawning season [6], fact that could explain the fairly seasonal variation of lipid content in this species. According to the CF (fig. 1.), the maximum of lipid content in spring could be explained by an increase of feeding activity. More studies, as fat composition, are needed to better understand the seasonal changes in lipid content and their relationship with the energy reserves of the animal.
The E_D doesn't differ between summer and winter, nor between anchovy and sardine, even it seems to be fairly higher in sardine (tab. 1.). The values in E_D observed for anchovy (4,48 - 4,61 kJ·g^{-1} W_W) are similar to those observed in the Adriatic Sea [7] (3,34 – 5,6 kJ·g^{-1} W_W), whereas they are lower than the values of the anchovy in the Bay of Biscay [6] (6,04 – 8,44 kJ·g^{-1} W_W). More calorimetric determinations are needed, mainly at the begining of the spawning seasons (spring for anchovy and autumn for sardine) in order to infer the possible energy storage before the peak of spawning. Further calorimetric determinations on gonad and liver will provide us with adequate data to infer energy allocation to growth and reproduction during the annual cycle.

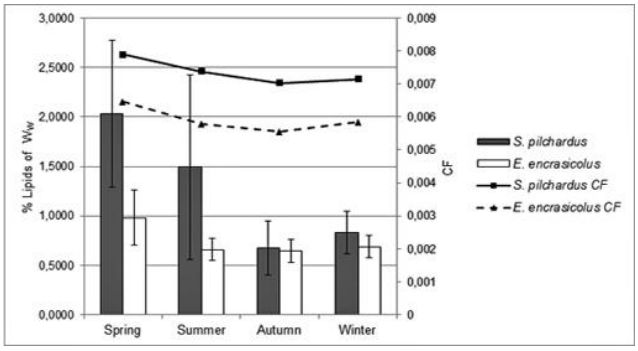

Fig. 1. Lipid content of muscle (bars) and CF (lines) of anchovy and sardine.

Tab. 1. Mean values (sd) for the E_D of anchovy and sardine.

	E. encrasicolus	*S. pilchardus*
Season	E_D kJ·g^{-1} W_W	E_D kJ·g^{-1} W_W
Summer	4,48 (0,20)	4,97 (0,36)
Winter	4,61 (0,09)	4,74 (0,15)

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ENERGY STRATEGIES OF *CALANUS* POPULATIONS FROM THE BLACK, MARMARA AND IONIAN SEAS

Leonid Svetlichny [1]* and Elena Hubareva [1]
[1] Institute of Biology of the Southern Seas - lsvetlichny@mail.ru

Abstract
Body size, oil sac volume, molting patterns and respiration rate were studied in copepods *Calanus euxinus* inhabiting the Black Sea and penetrating into the Marmara Sea, and mother species *Calanus helgolandicus* living in the Ionian Sea. Our laboratory and field data suggested more effective energy strategy of *C. euxinus* in the Black Sea due to metabolic effects of low salinity and temperature and ontogenetic phase shifts of metabolic rates in preadults and adults experienced recurrent hypoxia during diel vertical migrations.

Keywords: Copepoda, Physiology, Black Sea, Marmara Sea, Ionian Sea

In relatively warm, high-saline (38 psu) and oxygenated waters of the Mediterranean and Marmara Seas *Calanus* do not undertake diel vertical migrations [1, 2] whilst in cold brackish Black Sea late copepodite stages of *C. euxinus* migrate daily to deep oxygen minimum zone (OMZ) with constant temperature of 6–8°C [5] which results in nearly 8-fold decrease in their total metabolism [3]. Nevertheless, late copepodite stages of *C. euxinus* from the mesotrophic regions of the Black Sea are larger than those of the Mediterranean *C. helgolandicus* and can accumulate as high lipid reserves as *C .finmarchicus* from high-productive seas of the North Atlantic Ocean [4]. To explain this phenomenon, we conducted comparative studies of ontogenetic changes in body size, oil sac volume, molting patterns and respiration rate of *C. euxinus* collected in the Black Sea (BS), Marmara Sea (MS) and Ionian (IS) Sea, and also of the BS *C. euxinus* reared in the laboratory in the oxygenated water at high temperature (18°C) and salinity (38 psu). Morphological and physiological parameters were determined in *Calanus* individuals from all studied regions using the same methods described in [4]. Values are means ± SD.

It was shown that:

1) Diameter of eggs and body length of nauplii and earlier copepodites in *C. euxinus* and *C. helgolandicus* did not differ significantly. However, starting from copepodite stage IV, the divergence of prosome length began to increase in the individuals from different *Calanus* populations and resulted in 25 % increase of prosome length in females from the BS in comparison with the MS and IS.

2) Oil sac volume in *C. euxinus* preadults and adults from the BS was 6-8-fold higher than that in the same developmental stages from the MS and IS.

3) Intermolts dominated among copepodite stage V in the MS and IS whilst in the BS postmolts prevailed all year round indicating an increase in duration of this molting phase.

4) At the same experimental temperature (20°C) both total and basal metabolism in *C. euxinus* females collected in deep regions of the BS were 1.5-2 times lower than those in *C. euxinus* from warm (15°C), high-saline (38 psu) and oxygenated water of the MS, in *C. helgolandicus* from the IS and in the BS *C. euxinus* females reared in the laboratory from eggs at 18°C and 38 psu (Fig 1 A). Such metabolic shift was observed only in *Calanus* late development stages (Fig 1 B).

We hypothesize that due to the Black Sea environmental conditions (low salinity and temperature), *C. euxinus* can reduce energy losses and increase the duration of all developmental stages, whereas long-term recurrent hypoxia facilitates additional decrease in basal metabolic level and an increase in duration and efficiency of lipid accumulation in late copepodite stages migrating to OMZ.

Acknowledgements: This work was supported by the project PERSEUS (FP7-287600).

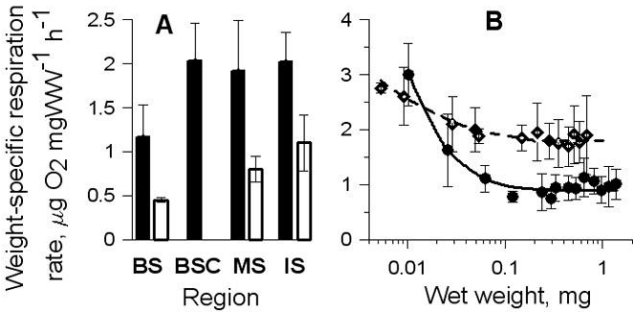

Fig. 1. Respiration rates of active and narcotized (white bars) females from the Black (BS), Marmara (MS), Ionian (IS) Seas and of the Black Sea females (BSC) reared in the laboratory at 18°C and 38 psu (A). Ontogenetic changes of respiration rate at 20°C in *Calanus euxinus* from the Black (•) and Marmara (◊) Seas (B).

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A MECHANISTIC CARBON INTAKE MODEL OF*OIKOPLEURA DIOICA*.

Maxime Vaugeois [1]*, François Carlotti [1] and Frédéric Diaz [1]
[1] Aix Marseille Université, CNRS/INSU, IRD, Mediterranean Institute of Oceanography (MIO), UM 110, 13288 Marseille ; Université de Toulon, CNRS/INSU, IRD, Mediterranean Institute of Oceanography (MIO), UM 110, 83957 La Garde - maxime.vaugeois@univ-amu.fr

Abstract
A mechanistic physiological model of the appendicularian *Oïkopleura dioïca* representing three feeding processes (filtration, ingestion and assimilation) has been built to better understand the ecology of these organisms. Specifically, the model is used to investigate the buffer abilities of the house and the gut. The mathematical formulations of the three feeding processes are based on laboratory experiment observations from the literature. The simulations evidence that environmental food depletion is not immediately experienced by the organism, but it occurs after a lag time due to the house and gut buffer abilities. The duration of those lag times depends on the environmental food concentration before the depletion period.

Keywords: Models, Zooplankton , Tunicata, North-Western Mediterranean

In pelagic ecosystems, appendicularians are thought to play a significant role both on the carbon cycle and on the ecosystem structuration [1]. Two features lead to such statement: first, appendicularians are circumglobal distributed organisms and among the dominant mesozooplankton group in many marine ecosystems [2] ; secondly, their specific biology allows them to occupy a unique ecological niche in the ecosystem food web. This specific biology is linked to their feeding process. Actually, appendicularians live inside a self-produced structure called "the house" within which the environmental particles are trapped by the filtration process [3]. This structure enables appendicularians to feed on a large prey size spectrum (from 0.2 to 30 µm [4]) but it often needs to be replaced (up to 27 houses per day at 23 °C [5]). This leads to the production of a large amount of detritic organic matter, besides an already high fecal pellet production (more than 700 per day [6]).

The model reproduces the physiological dynamics of the feeding processes of *Oikopleura dioica*, a main species in the north-western Mediterranean Sea. Other models of this organism exist but the model constructed here has many innovative aspects. It takes into account the house formation dynamics, the food storage capacity of the house and the gut throughput dynamics. Consequently, it is able to simulate the house and gut content dynamics (figure 1). At constant environmental food concentration and temperature, the house carbon content dynamic exhibits oscillations related to the house renewal process. During each cycle, the carbon content of the house rapidly increases up to a value that depends on the environmental food concentration. The fecal pellets production process also leads to observe an oscillating dynamic for the gut carbon content, with a frequency which depends on the environmental food concentration.

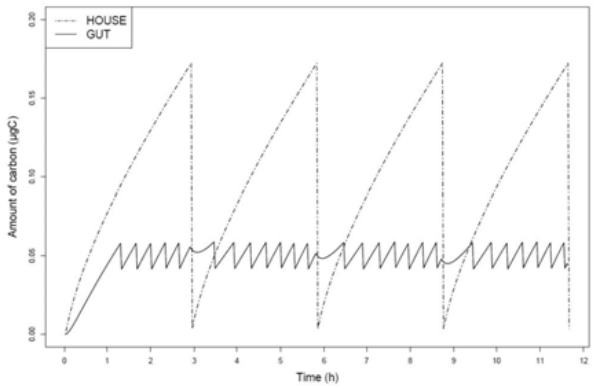

Fig. 1. House (dashed line) and gut (continous line) content dynamic during four house cycle with fixed environmental food concentration (100 µg of carbon per liter) and body weight of the organism (1 µg of carbon).

Different simulations with fluctuating food concentrations were run to highlight the food storage abilities of the house and the gut. The house and the gut allow appendicularians to survive short-term low food conditions, as their content do not immediatly drop to zero when a food depletion occurs. Thus, houses constitute a kind of external storage of non-assimilated food that can be seen as a substitute of a low level reserve inside the organism. When the house content is low, the gut content of the organism starts to be impacted as the assimilation process in consequence. We can estimate that the environmental food depletion is experienced by the organism only when its energy intake flux (here assimilation flux) is impacted. Thus, appendicularians experience environmental food depletion after a lag time duration that mainly depends on the environmental food concentration experienced before the food depletion. For one organism which experienced a food concentration condition of 100 µg C/l before the food depletion, this lag time is at least 30 minutes and can reach more than 2 hours, depending on when the food depletion occurs along the house lifespan.

In pelagic plankton models, the mesozooplankton group is most of time representative of copepods because they are the most abundant mesozooplankton organisms found along the year. Appendicularians are often second or third in terms of abundance [2] and are then not taken into account, whereas they present a different biology and ecology from the copepods. This individual-based model will be used, in future work, to constrain the processes and parameters of an appendicularian population module in a coupled biogeochemical-hydrodynamic model of the north-western Mediterranean Sea. It will allow the study of the appendicularian impact on the carbon export, and also on the structuration of the plankton community.

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Session

Gelatinous plankton distribution

Modérateur : **Davor Lucic**

JELLYFISH CONNECTIONS IN THE WESTERN MEDITERRANEAN SEA

L. Berline [1]*, M. Lilley [1], F. Lombard [1], B. Zakardjian [2] and N. Daly Yahia [3]
[1] Laboratoire d'Océanographie de Villefranche - berline@obs-vlfr.fr
[2] Mediterranean Institute of Oceanography
[3] Faculté des Sciences de Bizerte

Abstract

In the Mediterranean Sea, blooms of stinging jellyfish *Pelagia noctiluca* have occurred more frequently since 2000 (Bernard et al 2011), but their origins remain unclear. For this long-lived species, one persistent difficulty in understanding these blooms is to identify whether they are caused by local or regional processes. Here we try to understand the role of oceanic transport in redistributing existing jellyfish populations at regional and basin scale, using lagrangian particle tracking experiments mimicking jellyfish trajectories using high and medium resolution model velocity outputs.

Keywords: Cnidaria, North-Western Mediterranean, Models, Vertical migration

In the Ligurian Sea, presence of *P, noctiluca* onshore is erratic (Bernard et al 2011) while observations show a rather constant abundance offshore over a year (Ferraris et al 2012). Particle tracking simulation show that onshore presence is strongly influenced by coastline geometry, both upstream and downstream. During the year, onshore presence and therefore the probability of stranding is a function of the distance to the coast of the prominent alongshore Northern Current and of wind bursts to a lesser extent (Fig 1 and Berline et al 2013).

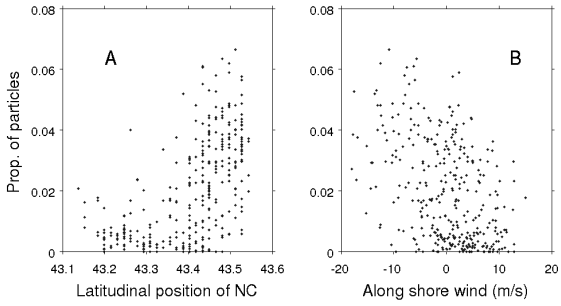

Fig. 1. Cross-shore connectivity for year 2001 as a function of (A) Northern Current latitude at longitude 7.23°E and (B) alongshore wind at location 7.5°E, 43.5°N (positive alongshore wind is blowing from the SW).

During bloom periods ('Pelagia years' sensu Goy et al 1989), reports suggest a widespread occurrence of *P. noctiluca* at a large spatial scale. Simulations including the Gulf of Lion suggest that the observed onshore distribution results from interactions between the Northern current and the diel migration behaviour (Fig. 2). The shelf of the Gulf of Lions is mostly avoided by *P. noctliuca* while Ligurian and Catalan coast are directly impacted.

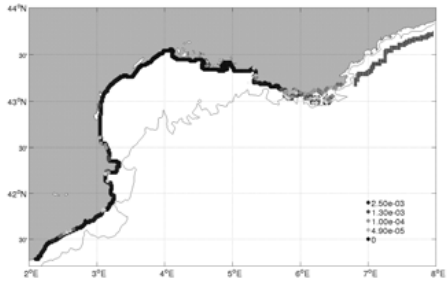

Fig. 2. Average abundance of jellyfish particle in the Littoral Zone simulated for July-August 2007, expressed as a ratio of total seeded particles.

At the scale of the Western Mediterranean basin, simulations allow quantifying transport time and mapping the most probable stranding zones. Coupled with progress in our knowledge of the biology of *P. noctiluca*, these results provide the basis for a better understanding of spatial and temporal fluctuations of jellyfish.

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DISTRIBUTION OF GELATINOUS MACROZOOPLANKTON IN THE BLACK SEA OF TURKEY (SINOP REGION)

Zekiye Birinci Ozdemir [1]*, Yakup Erdem [1] and Levent Bat [1]
[1] Sinop University, Fisheries Faculty - zekiyebirinci@hotmail.com

Abstract
The distribution, abundance and biomass of gelatinous macrozooplankton (*Aurelia aurita, Mnemiopsis leidyi, Beroe ovata* and *Pleubrachia pileus*) were determined between January 2008 and December 2008 in the southern Black Sea (Sinop Region). In the vertical, the amount of gelatinous organism was no significant statistically among stations (p> 0.05: Anova). Seasonal differences have been observed in biomass and abundance of species. Maximum gelatinous macrozooplankton abundance and biomass were calculated 44.17 n.m^{-2} (September) and 180.83 g.m^{-2} (April) respectively.

Keywords: Black Sea, Cnidaria, Ctenophora, Biomass

Intoduction Gelatinous macrozooplankton important effects on their pelagic ecosystems. They consume zooplankton groups and the eggs - larvae of fish considered in the ecosystem of Black Sea [1,2,3]. Gelatinous macrozooplankton is considered to be one of the effects in changes in the Black Sea fisheries. Therefore determined of its distribution, abundance and biomass is one of the most important points ascertain of role in ecosystem.

Material and methods

The present study was carried out to determine gelatinous macrozooplankton structure in the Sinop Region of Black Sea. Vertical sampling made using plankton nets (50 cm diameter mouth opening and 210 mm mesh size). Samples were collected monthly from three stations (St.A: 50 m, St.B: 65 m, St.C: 25 m) between January 2008-December 2008.

Result and Discussion

The maximum abundance and biomass of average gelatinous macrozooplankton was obtained 44.17 n.m^{-2} in September and 180.83 g.m^{-2} in April. Itsabundance increased in the summer and early autumn, however biomass values were increase at the beginning of winter and spring. Minimum abundance and biomass of average gelatinous zooplankton were found 5 n.m^{-2} and 5.67 n.m^{-2} in December (fig 1).

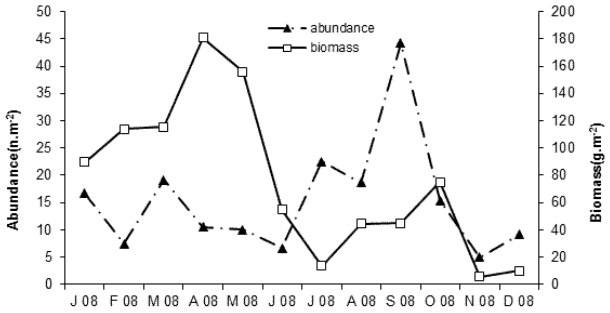

Fig. 1. Distribution of total gelatinous macrozooplankton of Sinop region, in 2008

In the study in the same region between 2002 and 2006, the most abundant and biomass of gelatinous macrozooplankton were obtained on May 2005 with 120 n.m^{-2} and March 2003 with 1073.5 g.m^{-2}. The high abundance values were determined as 42.5 n.m^{-2} on September 2002, as 91.25 n.m^{-2} on July 2003, as 108.33 n.m^{-2} on July 2004 and as 95 n.m^{-2} on May 2006. High biomass values were achieved at 230 g.m^{-2} on May 2002, 111.3 g.m^{-2} on March 2004, 447.75 g.m^{-2} on May 2005 and 393.33 g.m^{-2} on July 2006, respectively [4,5,6]. Gelatinous species composition showed varied by monthly. Growth A. aurita biomass was showed in spring and late winter. Its higest value was determined 16.67n.m^{-2} in March and 124.17g.m^{-2} in April. M. leidyi abundance was increased summer. Maximum value was in August as 51 n.m^{-2}, however maximum biomass was determined 82.5 g.m^{-2} in January. Higher P. pileus values were recorded in the winter and autumn months. Its maximum abundance and biomass was 11.67 n.m^{-2} in September and 7.14 g.m^{-2} in January. B. ovata was found just 3 months (October, November and December). Maximum abundance and biomass was 2.5 n.m^{-2} in December and 17.29 g.m^{-2} in September (fig 2).

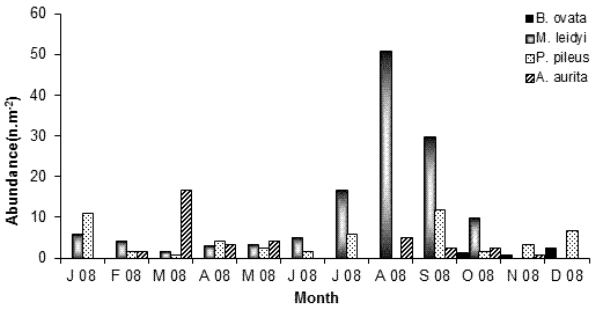

Fig. 2. Abundance and biomass of gelatinous macrozooplankton species of Sinop region in 2008

In terms of annual abundance, M. leidyi was the dominant group (52%) in 2008, then the following species was P. pileus with 27%. Analyzed the distribution of biomass of the species A. aurita had the highest share value of 53%, the next species was M. leidyi with 41%. In both abundance and biomass B. ovata was found to have a very low. Compared toprevious years, A. aurita was the dominant group in 2002, whereas P. pileus was the highest abundance group in 2004, 2005 and 2006 [4,5,6]. The percentage of M. leidyi decreased from 2002 to 2006, whereas it was increased in this study.

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POPULATION DYNAMIC OF *AURELIA AURITA* IN BIZERTE COASTAL AREA (SOUTH-WESTERN MEDITERRANEAN) BETWEEN 2012 AND 2013

Sonia K. M. Gueroun [1]*, Rihab Saidi [1] and Mohamed N. Daly Yahia [1]
[1] Faculté des Sciences de Bizerte - sgueroun@yahoo.fr

Abstract
Abundance and growth of *Aurelia aurita* were studied from February 2012 to March 2013 in Bizerte area. In 2013, *A.aurita* population displayed recorded the highest abundance with a mean of 1.2 ± 0.7 ind.³ while in 2012 it exhibited the highest bell diameters with a mean of 9.1 ± 0.4 cm. The specific growth rate was higher in 2013 (k = 1.04 d^{-1}) than in 2012 (k = 0.01 d^{-1}) due to the smaller initial size of medusae population.

Keywords: Medusae, Population Dynamics, Growth, South-Western Mediterranean

Introduction
The jelly moon, *Aurelia aurita*, is undoubtedly the most studied medusae in the world probably due to its worldwide distribution and high abundance. Dynamic occurrence of this scyphozoan has been reported from many parts of the world [1, 2]; however it remains scarce in western Mediterranean where only two publications referred to *A.aurita* population dynamic [3,4].

Material and methods
The occurrences of *Aurelia aurita* was investigated with a bimonthly frequency from February 2012 to March 2013 in Bizerte area (Tunisia, South-Western Mediterranean): bay (37°17'09.23"N, 09°53'91,1"E) channel (37°16'10.8"N, 09°52'42,7"E) and lagoon (37°12'20.15"N, 09° 50'53,56"E). *A. aurita* abundances were calculated from *in situ* counting, oblique macroplankton net hauls (700µm mesh size) and vertical WP2 net hauls (200µm mesh size). In order to characterize the size structure of *A. Aurita* population , specimens were collected with a scoop net from the surface and the bells diameter were then measured. The average specific growth rate (k, d^{-1}), for February-March 2012 and 2013 periods, was calculated according to the folloxing equation: $K = 1/T \times (W_{March}/W_{February})$, (W: wet weigh, T: time in days) [1]. Medusae dry weight (W) were calculated from the equation: $W = 0.00173D^{2.82}$ (D: bell diameter)[2].

Results
In 2012, *A. aurita* abundance averaged 0.5 ± 0.3 ind.m^{-3} whereas in 2013, it averaged 1.2 ± 0.7 ind.m^{-3}. The medusae were more abundant in the lagoon than in the channel and the bay (Fig 1-A).

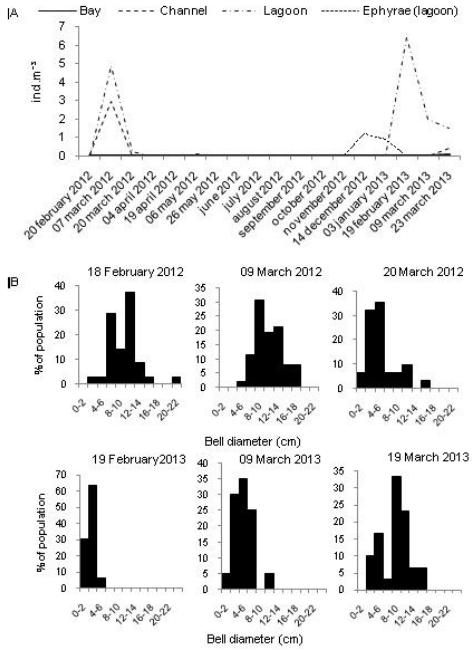

Fig. 1. *A. aurita* abundance (A) and growth (B) in Bizerte area between 2012 and 2013.

The ephyrae were only recorded in the lagoon. Bell diameters of *A. aurita* populations averaged 9.1± 0.4 cm in 2012 and 5.3 ± 0.4 cm in 2013 (Fig 1-B), and exhibited an average specific growth rate of 0.01d^{-1} and 1.04 d^{-1}, respectively. *A. aurita* populations are constituted of a succession of five cohorts in 2012, and two cohorts in 2013.

Discussion
Early appearance, high abundance and ephyrae presence of *A. Aurita* in Bizerte lagoon suggest that it originates from the lagoon as in Thau. Polyps colonies probably find refuge, food and substratum necessary to its development [3]. For the population in 2013, ephyrae were released from benthic polyps between December 2012 and January 2013. Nevertheless, for the population in 2012, as more cohorts and medusae with a bigger size bells were observed, ephyrae release might have occured earlier than December 2011. Strobilation may be affected by many factors, such as temperature and food supply [5,6]. The growth rate was highest in 2013 because of the smaller initial size of medusae population in February compared to 2012. The increase of the growth rate over the period of rapid growth of the young medusae were reported in the literature nevertheless few is known about the rate growth limitation. The low growth rate in 2013 may be limited by the level or the type of the available food [1]. All observations,i.e. the bell diameter, the number of cohort composing the population, and the specific growth rate of medusae, suggest that the *A. aurita* population was younger in February-March 2013 than in 2012.

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MONITORING THE ABUNDANCE OF JELLYFISH OFF THE COAST OF VALENCIA (SPAIN) DURING THE SUMMER PERIOD (2009-2012)

Juan Eduardo Guillén Nieto [1]*, David Gras Olivares [1], Joaquín Martínez Vidal [1] and Alejandro Triviño Pérez [1]
[1] Instituto de Ecología Litoral - j.guillen@ecologialitoral.com

Abstract
The present work studies the abundance and species composition of jellyfish on the beaches of Valencia (Spain), comparing surface seawater temperature, chlorophyll *a* production, and wind conditions in the summer seasons of 2009-2012. Although the causes that can motivate jellyfish abundance are many and difficult to establish, we have detected two different periods: 2009-10 and 2011-12. In the first period, we observe high abundances of jellyfish, coinciding with periods of low seawater temperatures in spring, high levels of chlorophyll a, and a limited role of calm winds. By contrast, in 2011-12, the temperature in spring months was higher, the concentration of chlorophyll a lower, the percentage of calms higher, and finally jellyfish abundances were lower than those observed in the period 2009-10.

Keywords: Coastal waters, South-Western Mediterranean, Medusae, Zooplankton

Introduction. The presence of jellyfish is a common phenomenon, and that sometimes can become massive. The main factors that may influence the amount of jellyfish along the coast, are: i) the frequency of certain winds and ocean currents ii) the water temperature and the number of hours of sunlight throughout the day (both essential to trigger reproductive phenomena in most planktonic species), and iii) the eutrophication, which can promote the growth of plankton biomass and, therefore, greater availability of food resources for jellyfish (Garcia-Comas *et al*., 2011; Sabatés *et al*., 2010). The purpose of this paper is to help understand the relationship between physical and chemical factors, and marine ecological and the presence of jellyfish off the coast of Valencia, trying to obtain long time series of results, in order to meet potential cycles in the arrival of these jellyfish.

Material and Methods. Since 2009 is carried out monitoring on the presence of jellyfish along the coast, based on observation from boat observer notices, and records of lifesaving services of the municipalities participating in the campaign. In parallel tracks on the surface temperature (taken by multiparameter probe), the concentration of chlorophyll *a* total in a total of 20 stations spread over the Valencian coast, and notes on the wind conditions obtained from the meteorological station network.

Results. Figure 1a shows the variations between the number of observations of jellyfish records between the summers of 2009-2012. This figure shows how the observed quantities of jellyfish in the summers of 2009 and 2010 (823 and 1048 records respectively) was higher than those of 2011 and 2012 (577 and 164 respectively). The largest number of records of jellyfish is between July and August, with the increased presence of species *Pelagia noctiluca*, and *Rhizostoma pulmo*. Subsequently, in September and October, the species dominates is *Cotylorhiza tuberculata*. Occasionally (2010), during the months of April and May, there are specimens of *Chrysaora hysoscella*, and less frequently, of *Physalia physalis*, associated currents from the Strait of Gibraltar. Other species have been observed, like *Olindas phosphorica* in relatively confined areas, and also, since 2008, *Carybdea marsupialis*. In the summer seasons with lower abundance of jellyfish (2011-12), the dominant specie was *C. tuberculata*. In the coast of the Valencian Region, the arrival of jellyfish off the coast, could be associate with winds from the E, which favors the presence of Pelagia noctiluca and *R. pulmo* while the presence of an uncommon jellyfish *P. physalis* and *C. hysoscella*, could be related to winds from the S, SW. The parameters studied lead us make a clear difference between the summers of 2009-10, when increase abundance jellyfish, and the subsequent period of 2011-12, with lower observed jellyfish records. Thus, the surface temperature of the seawater was colder in the months of May in 2009-10 (mean 20.02 +1.35° C) compared to the average observed in the next two years (22.33 +0, 45° C), with statistically significant differences ($p = 0.01$) (Fig. 1B). Chlorophyll *a* levels were higher in the case of the period 2009-10, along the lines of that cold winters can cause increased production planktonic (Estrada et al., 1989), also with significant differences (p=0,01; 2,51 µg/l in 2009-10, compared to 1,69 µg/ in and 2010-11). In relation to wind regimes, differences were also observed between the two periods, in the summer seasons of 2011-12 calm prevailed (27.42% of days, compared with 9.45% in 2009-10).

Conclusions. In the present work it has been found a period of great abundance of jellyfish in 2009-10, when surface temperature seawater observed is lower in spring and the concentrations of chlorophyll a are higher, which could result in increased plankton production. The predominance of calm winds, can also be a relevant factor in the number of observations of jellyfish in the area. This study highlights the potential role of seawater temperature, concentration of chlorophyll *a*, and wind conditions, as factors that may influence the unequal abundance jellyfish off the coast ofValencia. Without detriment to ocean currents, climate change, changes in the food chain, overfishing, etc.

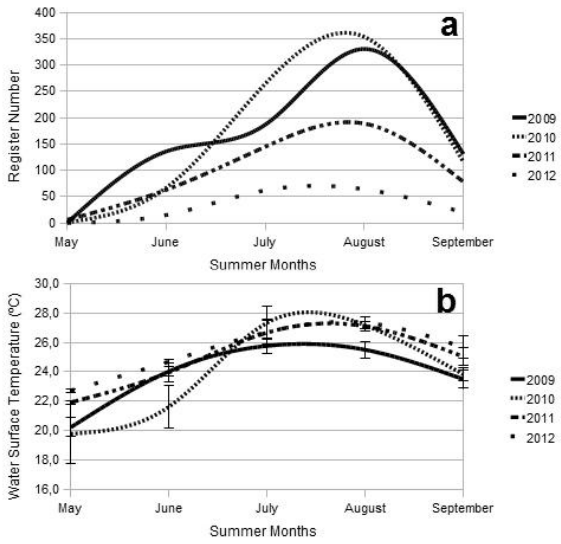

Fig. 1. Summer periods comparison (2009-12): a) Number of records of jellyfish; b) Seawater surface temperatures.

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SEASONAL DISTRIBUTION OF SCYPHOZOA (CNIDARIA) AND CTENOPHORA SPECIES IN GÖKOVA BAY, MUGLA, TURKEY

Nurçin Gülsahin [1]* and Ahmet N. Tarkan [1]
[1] Mugla Sitki Kocman University, Faculty of Fisheries - ngulsahin@mu.edu.tr

Abstract
In this study, seasonal distribution of the gelatinous organisms Scyphozoa (Cnidaria) and Ctenophora species was determined in Gökova Bay which has been one of the most important fishing area in Turkey. Sampling of the study was done between September 2011-October 2012 at 10 stations in the bay. Two Scyphozoa species- *Aurelia aurita, Cotylorhiza tuberculata* and three Ctenophora species- *Mnemiopsis leidyi, Beroe ovata, Cestum veneris* were observed in Gökova Bay. Especially, it was found that *C.tuberculata* reached high abundances in summer and autumn months. *M.leidyi* and *B.ovata* were showed high abundances on stated months.

Keywords: Ctenophora, Medusae, Gokova Bay

Gelatinous organisms are important ecologically because they are consume on zooplankton, have wide distribution and also complex life cycle [1]. The seasonal bloom of jellyfish medusae is a characteristic of many marine environments, but there is also a great interannual variability in the abundance of medusae [2]. In this study, seasonal distribution of Scyphozoa and Ctenophora species was determined in Gökova Bay, Mugla, Turkey. Gökova Bay, whose total area of 52000 hectares, is located in the connection zone of Aegean Sea and the Mediterranean and has been declared as "private environment protection zone-PEPZ" since 1989. It is one of the protected eight marine areas in Turkey [3]. Previously, there was not done a comprehensive study about gelatinous organisms in the area. This study was done between September 2011-October 2012 monthly at 10 stations in Gökova Bay. Regular shoreline surveys were carried out in the study area with a boat during each month for sampling Scyphozoa species. All observations were made from the front part of the boat and jellyfish were counted in 2 m width and 2 m depth from both sides of the boat. Ctenophora was sampled horizontally at all stations by a 200µm WP-2 net. Also, scuba diving was used for counting and sampling of Scyphozoa and Ctenophora species. Data were additionally converted to numbers of individuals per 100 m^3. Only *C. andromeda* which lives upside-down on the sea floor was counted and calculated to numbers of individuals per 100 m^2. Moreover, temperature, salinity and dissolved oxygen values of all stations were measured monthly by YSI multiprobe system.

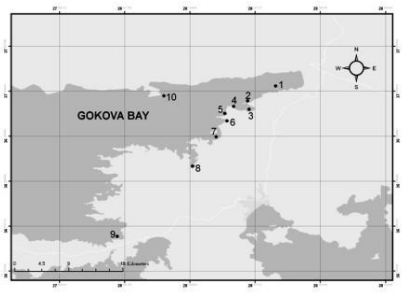

Fig. 1. Gökova Bay and sampling stations.

During the study period minimum surface water temperature was 15ºC in January at station 8; maximum temperature was 29,06ºC in July at station 4. Mean temperature value of the study period was 21,12 ºC, mean meaured salinity was 37,96 ‰. Minimum water salinity was 27,13‰ in October at station 10, maximum salinity was 39,78 ‰ in June at station 3. The mean value of the dissolved oxygen (DO) of the study period was measured 7,35 mg/l and minimum DO was 5,25 mg/l (at station 10) in September, maximum DO was 9,43 mg/l (at station 8) in April. *Aurelia aurita* was observed only in May and September at station 6 and had low abundance. Medusae *Cotylorhiza tuberculata* was found all the months of the study except December, January, February, March, April and May. *M. leidyi* and *B. ovata* also showed high amounts and aggregated in stations2,5,6,7,8 and 10. Also, *Cassiopea andromeda* was found in the bay from April to December and had mean abundance 33,5 ind./100m².

Tab. 1. Monthly abundance values (individual/100m^3) of the Scyphozoa and Ctenophora species in Gökova Bay.

	Aurelia aurita	*Cotylorhiza tuberculata*	*Mnemiopsis leidyi*	*Beroe ovata*	*Cestum veneris*
Sep.11	-	1055	69	7	5
Oct.11	-	1082	33	4	2
Nov.11	-	12	41	34	7
Dec.11	-	-	235	282	350
Jan.12	-	-	-	-	-
Feb.12	-	-	-	-	-
Mar.12	-	-	1	-	-
Apr.12	-	-	390	58	10
May.12	1	-	389	248	28
Jun.12	-	201	422	87	25
Jul.12	-	24	412	4	-
Aug.12	-	130	91	52	-
Sep.12	2	93	140	117	17
Oct.12	-	45	526	67	4

It was found that *C.tuberculata* which is native spacies of Gökova Bay reached high abundances in summer and autumn months. *M.leidyi* and *B.ovata* were showed high abundances in certain months (Table 1). The enter of Gökova Bay is quite wide so the bay is effected from Aegean open water system and has high potential of waves and currents. The current coming from the open water enters to Gökova Bay from the north, turns and gets out through mid-line of the bay [4]. The species coming from the open water could settle in the bay under optimum conditions. Also, there are many small bays in Gökova Bay which show oligotrophic character. Jellyfish were drifted to the small bays and increased their numbers in there. Sea water temperature of Gökova Bay showed typical Mediterranean Sea characteristic that mean value of temperature was not below 15°C in the bay. Therefore, the bay is suitable environment for Scyphozoa and Ctenophora species for the purposes of temperature.

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RECENT CHANGES IN THE NORTHERN ADRIATIC HYDROMEDUSAN FAUNA

D. Lucic [1]*, M. Miloslavic [1], B. Gangai [1], I. Onofri [1] and I. Ivancic [2]
[1] University of Dubrovnik Institute for Marine and Coastal Research - davor.lucic@unidu.hr
[2] Center for Marine Research, Ruder Boškovic Institute

Abstract
Previous investigations of the northern Adriatic observed the changes in the hydromedusan fauna that demonstrate one aspect of the long-term consequences in marine ecosystem: decreased biodiversity. Following concern about substantial changes in these area, in this study we present the comparative results of the composition and abundance of hydromedusan fauna of northern Adriatic, pointing to the possibility of species repopulating recent years. During 2009-2011 we found considerably higher number of species and higher abundances in comparison with the results for the last 5 decades.

Keywords: Biodiversity, Cnidaria, North Adriatic Sea

Introduction
There is long tradition of marine plankton research of the northern Adriatic and its ecosystem is regarded as typically neritic. During the last 50 years ecological changes were already noted in the northern Adriatic, and many species disappeared from this zone [1]. Among the first described plankton species of the northern Adriatic were hydromedusae that at the beginning of 20th centaury they were rated to 42 species: 35 meroplanktonic and 7 holoplanktonic [2]. Low oxygen saturation near bottom and hypersaturation near the surface demonstrated new established trend from 1955 onwards, and it has been hypothesized that meroplanktonic hydromedusae could indicate early phase of hypoxic events [3]. The changes observed in the hydromedusan fauna demonstrate one aspect of the long-term consequences in marine ecosystem: decreased biodiversity [4]. Following concern about substantial changes in the northern Adriatic, in this study we present the comparative results of the composition and abundance of hydromedusan fauna of northern Adriatic, pointing to the possibility of species repopulating recent years.

Methods
Plankton was sampled monthly by bottom-to-surface vertical tows with 0.20 mm (WP2) Nansen mesh plankton net at four stations: two in the western part of the northern Adriatic (44,9^{0}N, 12,8'E; 44,7^{0}N, 12,7'E), and two in the eastern part (45,0^{0}N, 13,3'E; 45,4^{0}N, 13,4'E). Presented data are results of investigations during three study periods: the first from 1999-2002, second from 2003-2007 and the third from 2009-2011.

Tab. 1. Composition of medusa species in the northern Adriatic (1999-2011) with their mean (mean ± SD, ind. m^{-3}) and maximum (max, ind. m^{-3}) abundance.

Periods of investigations	1999-2002		2003-2007		2009-2011	
	mean ± SD	max	mean ± SD	max	mean ± SD	max
Anthomedusae						
Bougainvillia muscus					0.05±0.27	2
Lizzia blondina						<1
Lizzia fulgurans						<1
Thamnostoma dibalia				<1	0.11±0.90	8
Hydractinia minima	0.95±2.85	17	0.42±1.35	9	7.91±34.90	279
Hydractinia minuta	1.34±5.83	44	0.75±2.79	23	15.88±44.02	293
Hydractinia carnea						<1
Amphinema dinema					0.01±0.07	1
Corymorpha nutans	0.03±0.14	1	0.06±0.68	8	0.29±1.44	9
Coryne eximia						<1
Dipurena gemmifera			0.49±3.00	32	0.12±0.90	8
Sarsia tubulosa					0.11±0.89	8
Euphysa aurata					0.18±0.0.62	5
Ectopleura dumortieri						<1
Rhabdon singulare					0.01±0.07	1
Zanclea costata						<1
Leptomedusae						
Aequorea forskalea						<1
Eirene viridula	0.09±0.36	2	0.02±0.12	1	0.01±0.07	1
Eutima gracilis	0.04±0.17	1	0.05±0.27	2.29	0.02±0.08	1
Helgicirrha shultzei	0.05±0.21	1	0.03±0.17	9	0.16±0.56	5
Laodicea undulata						<1
Orchistomella graffei						<1
Clytya spp.	10.93±23.68	154	2.93±8.31	46	67.48±183.17	1024
Obellia spp.	0.45±1.44	8	0.55±1.66	9	1.61±7.27	55
Trachymedusae						
Liriope tetraphylla	0.04±0.21	1	0.06±0.68	8	0.03±0.22	2
Aglaura hemistoma	1.38±3.41	20	0.84±2.89	23	2.81±8.97	73
Persa incolorata					0.14±0.92	8
Rhopelonema velatum	1.47±3.58	18	0.64±2.56	23	0.53±4.22	37
Nacromedusae						
Cunina spp.					0.12±1.06	9
Solmaris spp.	3.85±20.76	157	0.86±2.64	18	21.83±76.99	622

Results and Discussion
Our results clearly showed that the number of species and their abundance increase from the first to the third investigated period (Table 1). Thus, during 2009-2011 we found 16 anthomedusa and 8 leptomedusa that is considerably higher number of species than the findings of Benovic et al. ([3], [4]). We assume that some species were introduced by input currents in the northern Adriatic, which is confirmed by the increasing density of trachymedusa, but abundances of some species were several times higher than in previous records ([3], [4]). Although the abundance of hydrozoan species vary during their life cycles [5], our high mean and maximum values of this metagenetic specimens could indicate the possibility of establishing stable populations in the area. These changes are consistent with the recent changes in the plankton composition and abundance, probably caused by a climatic forcing and recognized oligotrophication of the entire northern Adriatic ([6], [7]). Our results confirm previous suggestions of Benovic et al. ([3], [4]) that hydromedusae may be used as indicators of changes in marine shallow ecosystems.

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GELATINOUS MACROZOOPLANKTON'S BLOOMS AND THEIR WELFARE IMPACTS IN THE MEDITERRANEAN REGION

Maria Giovanna Palmieri [1]*, Tiziana Luisetti [2], Alberto Barausse [3] and Kerry Turner [1]
[1] University of East Anglia - m.g.palmieri@uea.ac.uk
[2] CEFAS
[3] University of Padua

Abstract
Extensive blooms of gelatinous macrozooplankton species have occurred in recent decades in Mediterranean waters. We conducted a literature review of the impacts of blooms on the ecosystem services provided by the Mediterranean Sea and on the consequent welfare losses and highlight gaps and further research needs. The results of a case study focused on the estimation of the economic losses suffered by Northern Adriatic fishermen are also summarized and explained.

Keywords: Blooms, Ecosystem services, Economic valuation, Fisheries, North Adriatic Sea

1. Introduction
Extensive blooms of gelatinous macrozooplankton species have occurred in recent decades in Mediterranean waters [1]; [2]; [3]; [4]. We conducted a literature review of the impacts of blooms on the ecosystem services provided by the Mediterranean Sea and on the consequent welfare losses and highlight gaps and further research needs. The results of a case study focused on the estimation of the economic losses suffered by Northern Adriatic (NA) fishermen are also summarized and explained.

2. The impacts of blooms on the ecosystem services of the Mediterranean Sea: A review
According to the literature reviewed, blooms affect a number of the ecosystem services provided by the Mediterranean Sea. These include provisioning services (e.g. biomass production; provision of seawater for cooling systems of coastal power plants) and regulating services (e.g. maintenance of food webs' structure and function). The impairment of ecosystem services by blooms leads to the loss of welfare benefits. Very few estimates of the welfare losses due to blooms were retrieved, suggesting the need for more economic valuation studies in the Mediterranean region.

Tab. 1. Welfare benefits affected by jellyfish blooms by species.

Benefit affected	Energy production	Catch/production of marine living resources	Recreation	Human health
Species				
Aurelia aurita		√		
Cotylorhiza tuberculata			√	
Pelagia noctiluca		√	√	√
Rhizostoma pulmo		√		
Ropilema nomadica	√	√	√	√
Mnemiopsis leidyi		√		

3. Gaps and further research needs
Based on the results of the literature review, we suggest a number of different economic techniques, which can be used for the economic valuation of the welfare losses caused by blooms. They range from market analysis to revealed and stated preference techniques [5]. An example of the use of economic techniques is presented in Section 4 below.

4. Northern Adriatic fisheries' losses: A case study
We conducted a survey of fishermen in the city of Chioggia (Italy), focusing on fishermen's perceptions about jellyfish blooms in the NA Sea and investigating how blooms interfere with with fishing operations. The study provides evidence that jellyfish blooms interfere with fishing operations in several ways and affect different fishing segments.

Tab. 2. Frequency of reports of interferences of jellyfish with fishing operations by fishing system practiced.

	Mid-water trawling (%)	Otter trawling (%)	Small scale fishing (%)
Return to port	0.0	37.5	0.0
Change of fishing grounds	100.0	93.8	0.0
Clogging of fishing gear	100.0	93.8	57.1
Breakage of fishing gear	100.0	75.0	42.9
Additional catch sorting time	100.0	87.5	85.7
Reduction in fish catches	100.0	93.8	71.4
Jellyfish stings	50.0	43.8	42.9

The study also provides evidence that NA fishermen suffer considerable economic damage because of jellyfish interferences. We estimated economic losses deriving from reduction in catches and from additional fuel costs due to changes of fishing grounds. The former could amount to as much as € 8.2 per year for the mid-water- and otter trawling segments, if no additional hauls were performed to mitigate losses. Additional fuel costs were conservatively estimated and could represent an annual increase in fuel costs of 3% per vessel for the same fishing segments mentioned above.

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SPATIAL-TEMPORAL DIRECTED GRAPHS FOR MODELING THE DISPERSION OF PLANKTON IN THE MEDITERRANEAN SEA

B. Petelin [1]*, I. Kononenko [2], M. Kukar [2], V. Malacic [1] and A. Malej [1]
[1] National Institute of Biology Marine Biology Station Piran - petelin@mbss.org
[2] University of Ljubljana, Faculty of Computer and Information Science

Abstract
In this work a new methodology is proposed for predicting dispersion of biological species. The methodology uses multi-level spatial-temporal association rules and directed graphs. The latter are the basis of Markov models which help us predict the spatial distribution of species, depending on previous observations. We applied the methodology on results of the Mediterranean Ocean Forecasting System (MFS) model and available observations of the jellyfish *Pelagia noctiluca* (Cnidaria: Scyphozoa). The model results are promising for further prediction of plankton dispersal.

Keywords: Cnidaria, Population Dynamics, Circulation models, South-Western Mediterranean

We developed a new methodology [1] which upgrades the Lagrangian tracking of fluid parcels analysis and consists of several phases. First we calculate a vast number of Lagrangian trajectories within velocity fields of a numerical model. Second, we subdivide the model domain into smaller sea areas and search for spatial-temporal association rules that denote the probability of the transition of parcels from one area to another in a specified time interval (see Fig. 1). Third, from the resulting association rules we construct multi-level directed graphs which cover the whole domain and represent a basis for modeling the dispersion of biological species using the Markov processes. The above methodology is described in detail in [1].

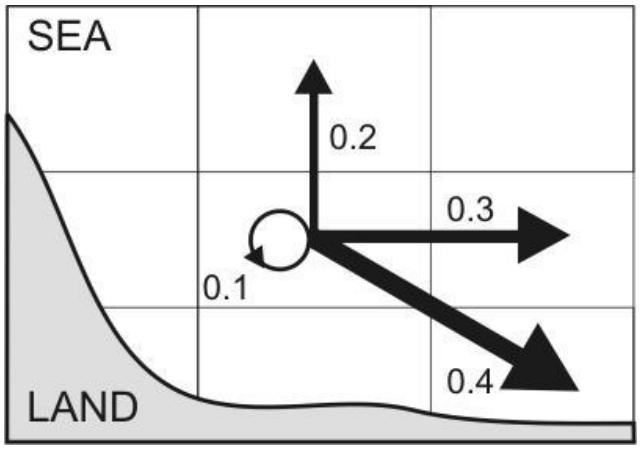

Fig. 1. Spatial–temporal association rules used in the proposed methodology. The arrows show the transitions of particles from the selected area to the surrounding areas.

The methodology was applied on the surface velocity fields of the numerical model Mediterranean Ocean Forecasting System (MFS) [2]. We generated 156 directed graphs that cover monthly transitions of parcels in the period 1999-2011. Each directed graph has an associated transition matrix of a non-homogenous Markov process. Graph nodes (sea areas) represent the states, and the elements of the matrix denote the probabilities of movements of particles (biological species) between the areas. We can obtain the long term probabilities of movements by multiplying the matrices sequentially in time. For modeling the spread of biological species, we have chosen the jellyfish mauve stinger (*Pelagia noctiluca*, Scyphozoa). This jellyfish forms recurrent blooms in the Mediterranean and eastern Atlantic [3] with considerable effects on tourism and coastal industry. Its life cycle is characterized by the absence of benthic polyp and its holoplanktonic life cycle enables mauve stinger to occupy offshore water niches in addition to coastal environments. Our past study showed low genetic differentiation of *Pelagia noctiluca* over a large spatial scale (Mediterranean Sea and Eastern Atlantic) indicating that its populations are demographically open and have considerable dispersal capabilities [4]. As an example for the spread of mauve stinger in the Mediterranean Fig. 2 shows, after six months of dispersal, the hypothetical distribution (in %) of *Pelagia noctiluca (Scyphozoa)*, which was observed in the Alboran Sea in April 2008. A further upgrade of this application with new observations will improve the predictability of jellyfish spread with the model.

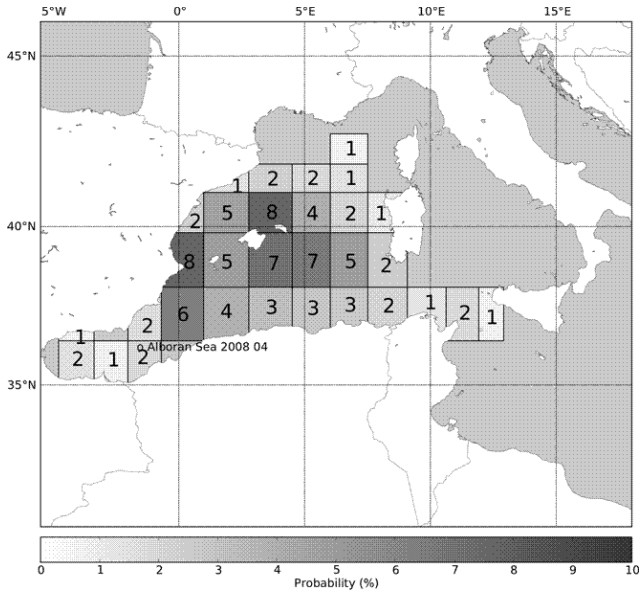

Fig. 2. The hypothetical distribution (in %) of *Pelagia noctiluca*, which was initially observed in the Alboran Sea in April 2008, after six months. The rectangles represent the nodes of the multilevel directed graph. The small circle represents the location of the observation of jellyfish in the Alboran Sea in April 2008, the color saturation and the numbers in the nodes show the percentage of jellyfish which are distributed in different areas after six months.

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MODELING *PHYSALIA PHYSALIS* SWARMS NEARBY THE STRAIT OF GIBRALTAR

Laura Prieto [1]*, Diego Macías [2], Alvaro Peliz [3] and Javier Ruiz [1]
[1] Instituto de Ciencias Marinas de Andalucia (ICMAN) CSIC - laura.prieto@icman.csic.es
[2] European Commission, Joint Research Center, Institute for Environment and Sustainability, Water Research Unit, Via E. Fermi 2749, 21027 Ispra, Italy
[3] Centro de Oceanografia, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Abstract
A comprehensive analysis of the facts associated to the Portuguese Man-of-War swarms events in year 2010 was performed. All the *Physalia* sightings during several years and the climatic/oceanographic conditions have been analyzed. Finally, a virtual experiment of the drifting of the individuals using a hydrodynamical model, consisting of a ROMS based numerical simulation forced with realistic winds (ASCAT) and heat fluxes from ERA-Iterim, together with an Individual Based Model (IBM) simulations was performed. The results showed small differences in the overall estimated arrival of *Physalia* between the model experiment and the real observations.

Keywords: Alboran Sea, Gulf of Cadiz, Gibraltar Strait, Medusae

The Portuguese Man-of-War, *Physalia physalis*, is armed with a singularly potent toxin [1] [2]. The major protein of the venom is *physalitoxin*, which is a hemolysin [3]. This is contained in nematocyst, which chemical characterization [4], collagenase activity [5] and cloning and functional expression of the cnidocytes [6] had been described. The nematocysts venom of *P. physalis* is lethal to animals and humans [2]. The envenomation syndromes on humans of *P. physalis* are extent [1]. As fatal reactions: toxin-induced immediate cardiac arrest and delayed renal failure; as systematic reactions: toxin-induced, Irukandji reaction and respiratory acidosis; as local reactions: toxin-induced to skin, mucosa and cornea, recurrent reactions up to tour episodes, distant site reactions and local lymphadenopathy; as chronic reactions: contractions, vascular spasm and mononeuritis; as post-epidode dermatitis: granuloma annulare. In this study, the occurrence of the Portuguese Man-of-War in the NE Atlantic and Mediterranean Sea have been compiled from 2005 to 2011 from different sources: media, national and regional agencies and Jellywatch Program data base (http://jellywatch.org/) (Fig. 1).

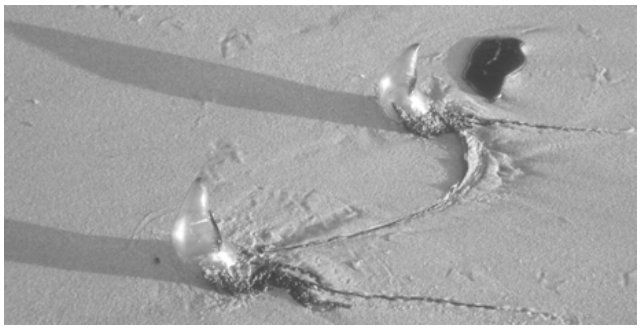

Fig. 1. Two stranded colonies of *Physalia physalis* in the beach of Camposoto (Gulf of Cadiz) on February 5th 2009.

The year 2010 registered an unusual record of *Physalia* sightings along the Mediterranean Sea and (at Atlantic and Mediterranean coastlines) and Canary Islands (North East Atlantic). This was an outstanding year in the frequency of occurrences, but also in the total number of colonies arrived (> 100,000 colonies), compared to 2009 and 2011 that they were less than 60 colonies (Fig. 2). Therefore, the climatic/oceanographic conditions have been analyzed of that particularly year, which pointed out to be one year of stronger westerlies winds in the NE Atlantic basin compared to the time series from 1979. Also, the winter 2009-2010 had one of the most negative North Atlantic Oscillation index (-4.64) measured during the almost 150-year record. A virtual experiment of the drifting of the individuals was performed using a hydrodynamical model. This consisted of a ROMS based numerical simulation forced with realistic winds (ASCAT) and heat fluxes from ERA-Iterim, together with an Individual Based Model (IBM) simulations. The oceanic population of *P. physalis* started to appear stranded on the beach on February 22nd 2010. Then the observations on the coast occurred from West to East advancing towards the Mediterranean, passing the Strait of Gibraltar and to the far East of the Alboran Sea. The beaching timing observed is highly correlated to the simulated ($r=0.81$, $p<0.001$, $n= 18$). The results showed small differences in the overall estimated arrival of *Physalia* between the model experiment and the real observations.

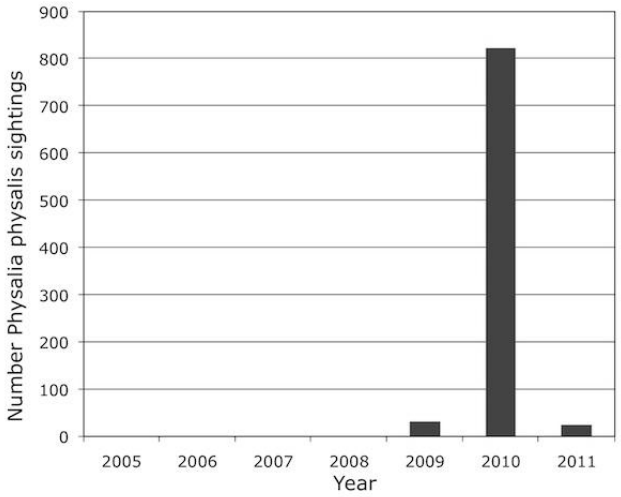

Fig. 2. Total number of *Physalia physalis* sightings at both adjacent basins of the Gibraltar Strait during seven consecutive years (2005-2011).

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Session

Gelatinous plankton ecology

Modérateur : **Tamara Shiganova**

REVIEW OF APPENDICULARIAN BIODIVERSITY IN THE ADRIATIC

Rade Garic [1]* and Mirna Batistic [1]
[1] Institute for Marine and Coastal Research University of Dubrovnik - rade.garic@unidu.hr

Abstract
Until 2007 continuous monitoring of appendicularians in the Adriatic was not conducted except few isolated annual series. Since 2007 eleven appendicularian species were recorded in the Adriatic for the first time while three species recorded in previous investigations were not found. Due to infrequent sampling of appendicularians it is hard to determine if this sudden increase of species number is the result of prior inadequate samplings or if it is related to hydroclimatic changes. Here we try to assess status of newly recorded appendicularian species in the Adriatic by using their population dynamics and by revising historical samples.

Keywords: Biodiversity, South Adriatic Sea, Zooplankton , Tunicata

Introduction

In the last 20 years an increase of biodiversity is recorded in many gelatinous zooplankton groups in the Adriatic [1] while appendicularians were not investigated. The last basin-scale investigation of appendicularians was conducted from 1974 to 1976, more than 30 years ago [2], while yearly cycles were investigated in 1989/1990 and 1996/1997 in coastal South Adriatic [3,4] and from 1999 to 2002 in the North Adriatic.

In 2009 species *F. aequatorialis* was recorded in open waters off Albania [5] and a new species to science *Fritillaria ragusina* [6] was described from samples collected in the open Adriatic waters in 2008. Here we present a review of the status of Adriatic appendicularian biodiversity with nine new appendicularian records for the Adriatic. We also try to assess which species were possibly overlooked in previous investigations and which could be promising candidates for indicator species of different water masses.

Materials and methods

From 2007 onwards appendicularians were sampled bimonthly on 4 stations from the coast to the open sea along transect from 42°38'N, 18°02'E to 42° 20'N, 17°43'E. A 100 m deep costal station off Dubrovnik was sampled twice per month. All stations were sampled using Nansen closing nets with 53-µm, 200-µm and 250-µm mesh. A limited number of historical samples from 1974-1976, 1987 and 1996 was examined for possibly overlooked species.

Results and discussion

From 2007 onwards we recorded nine more species in addition to *F. aequatorialis* and *F. ragusina* in the Adriatric for the first time: *Oikopleura villafrancae, Folia gracilis, Appendicularia tregouboffi, Fritillaria formica tuberculata, F. formica digitata, F. charybdae, F. lucifer, Tectillaria fertilis* and *Kowalevskia oceanica*.

Based on presence of species in historical samples and their abundance patterns in recent samples six species were overlooked in previous investigations: *Oikopleura villafrancae, Folia gracilis, Fritillaria ragusina, F. formica digitata, Appendicularia tregouboffi* and *Kowalevskia oceanica*. During the revision of historical samples from 1970s, *O. villafrancae* was regularly found in deep sea samples. This species was probably overlooked in earlier investigations due to its poor preservation in net tows and typical depth of occurence of more than 300 m.Species *Folia gracilis, Fritillaria ragusina, Appendicularia tregouboffi* are open sea species which are found in 53-µm mesh net, but rarely in 200/250-µm mesh nets. These species were also found in historical open sea samples taken with 53-µm mesh net in 1980s suggesting that they were probably overlooked due to inadequate sampling techniques. Species *Fritillaria formica digitata* and *Kowalevskia oceanica* were found in samples from 1990s. Species *K. oceanica* was probably overlooked because of its similarity to *K. tenuis* while species of *F. formica* group were never determined to the *formica* or *tuberculata* species level in previous investigations. The declining abundance pattern is registered in species *K. oceanica* and *F. formica digitata* from 2007 onwards suggesting that they migh have interrmittent occurence in the Adriatic, possibly related to entering currents. Similar declining patttern from 2007 onwards is also found in species *F. aequatorialis* and *O. intermedia*. Species *F. aequatorialis* hasn't been found in examined samples from years prior to 2007, while species *O. intermedia* is regarded as accidental Adriatic species [2]. Species *O. intermedia* was recorded in late 1970s but never afterwards, until 2007. This species likely also belongs to species with intermittent occurence in the Adriatic and future investigations might confirm the same for species *F. aequatorialis*. Species *Fritillaria formica tuberculata* was found in many samples throughout the years and should be regarded as common member of Adriatic appendicularian fauna.

Species *T. fertilis* and *F. charybdae* are rare species even in the Mediterranean and their presence might indicate influence of Atlantic waters on deep layers. In September 2011 a single specimen of recently described *Fritillaria lucifer* [7] was found in the tow from 300 m to the surface. This is first finding of this species since its description from Monterey Bay (Pacific Ocean). The pecularity of this isolated specimen was presence of two ovaries while holotipic individuals caught in pristine condition had only one ovary (Fig. 1).

Three appendicularian species have not been found since 1970s in the Adriatic: *Oikopleura rufescens*, *Megalocercus abyssorum* and *Fritillaria fagei*. These species are probably extinct from the Adriatic.

Even though the majority of newly recorded species were overlooked in previous investigations, there are notable changes in appendicularian species composition in the Adriatic. This corrensponds to recorded changes in other gelatinous zooplankton groups [1]. Future investigations will determine the value of species with intermittent occurence as indicator species of different circulation regimes in the Adriatic.

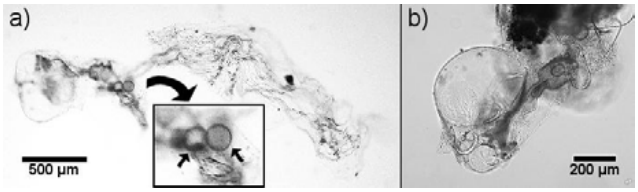

Fig. 1. *Fritillaria lucifer*. a) The whole animal with enlarged detail showing two ovaries; b) lateral view of the anterior part of trunk.

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IMPACTS OF *MNEMIOPSIS LEIDYI* ON PHYTOPLANKTON COMMUNITIES IN A MEDITERRANEAN LAGOON: PRELIMINARY OBSERVATIONS.

A. Gavini [1]*, M. Garrido [1], P. Cecchi [2], S. Etourneau [3], B. Bec [4], V. Orsoni [5], N. Malet [5] and V. Pasqualini [1]
[1] UMR 6134 CNRS SPE, UMS 3514 CNRS Stella Mare - gavini@univ-corse.fr
[2] IRD UMR G-eau
[3] CG2B
[4] Laboratoire Ecosystèmes Lagunaires, UMR 5119 CNRS-Université Montpellier II-Ifremer
[5] IFREMER

Abstract
Phytoplankton communities were studied in the Biguglia lagoon between May 2012 and March 2013. A massive invasion of *Mnemiopsis leidyi* occurred during the same period. We discuss the potential interactions between ctenophores and phytoplankton.

Keywords: Blooms, Chlorophyll-A, Ctenophora, Lagoons, Corsica Trough

Mnemiopsis leidyi (Agassiz, 1865; Ctenophora) is a species accidentally introduced in the Mediterranean Sea since 1990 [1]. It was found in a lagoon environment for the first time in 2005 (Berre lagoon, France; Bonnet, Com. Pers.). *M. leidyi* is not strictly carnivorous, but it may also eat the micro- and nanoplankton, which constitute important sources of nitrogen for its growth [2].

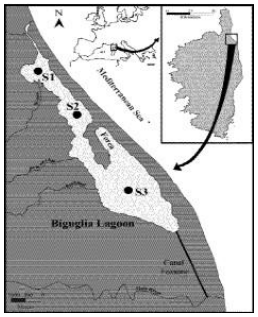

Fig. 1. Biguglia lagoon and sampling stations

M. leidyi appeared sporadically in August 2011 within Biguglia lagoon (Corsica, France,Fig.1). This brackish and shallow lagoon (average depth 1.5 m) is a confined ecosystem disturbed by a growing eutrophication since the eighties [3]. Phytoplankton communities were studied in three stations of the Biguglia lagoon between May 2012 and March 2013. A massive invasion of *Mnemiopsis leidyi* occurred during the same period. This study aims at pointing out the interactions between *M. leidyi* and phytoplankton communities. *M. leidyi* developed from August 2012 to February 2013 in the Biguglia lagoon with a maximum biomass in November 2012. During this period, salinity and temperature varied between 7-25 psu and 7-28°C, respectively. Subsurface Chl *a* concentrations measured with a FluoroProbe (BBE) ranged from 1.4 to 25.5 µg.L-1. Highest Chl *a* values were observed in November 2012 in all stations (Fig.2). Dinoflagellates were abundant all year round but a shift between Chlorophytes and Cryptophytes occurred in Oct-Nov. 2012 (Fig.2). Microscopic observations of phytoplankton communities revealed a codominance of *Gymnodinium sanguineum* and *Prorocentrum minimum* at that time. Both species are essential for the development of the larval stage of *M. leidyi* [4] and may have contributed to their expansion in the Biguglia lagoon in 2012.Conversely, this expansion also disturbed the phytoplankton communities'structure. In particular, the classical pico-nanoplankton summer bloom [4] has not been observed, in phase with literature indications [5]. However, there was an increase in biomass at each station (Oct-Nov.). Documenting key processes that influence ctenophore survival during early developmental stages may provide relevant insights to better understand the initiation and maintenance conditions of the *M. leidyi* adults' blooms commonly observed in coastal waters [4].

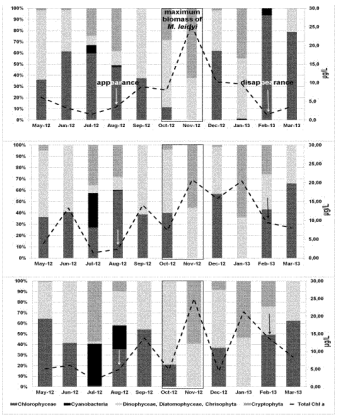

Fig. 2. Monthly fluctuations of the main phytoplankton groups and Chl. *a* with BBE FluoroProbefor each station.

In particular, it is important to improve our knowledge on the different growth stages of *M. leidyi*, their sizes and trophic behaviors. In the Biguglia lagoon and elsewhere, the study of this invasive species becomes essential to better understand the impacts of *M. leidyi* blooms on phytoplankton communities.

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PEUPLEMENTS MACROZOOPLANCTONIQUES DES ÎLES HABIBAS (MER ALBORAN): BIODIVERSITÉ ET COMPOSITION

Aziz Hafferssas [1]* and Yacine G. E. Khames [1]
[1] Faculté des Sciences Biologiques, USTHB, Algérie - ahafferssas@usthb.dz

Abstract
Le zooplancton des cents premiers mètres de l'archipel des Habibas a été échantillonné pendant le printemps 2012. Quatre radiales représentatifs des différentes structures hydrologiques (système oligotrophe côtier d'origine Atlantique et zone productive de type frontale) ont été étudiées. Une trentaine d'espèces macrozooplanctoniques ont été dénombrées. La distribution des peuplements montre d'étroites liaisons avec les structures hydrologiques. Les fortes abondances et biomasses sont localisées au sein de la zone frontale. Les espèces peuvent rencontrer des conditions trophiques favorables à leur développement. Au contraire, les peuplements sont faiblement concentrés au niveau de l'écosystème oligotrophe où la couche superficielle y concentre de faibles biomasses phytoplanctoniques (moins de 1 mg.m^{-3}).

Keywords: Biodiversity, Alboran Sea, Zooplankton

Matériel et méthodes
L'échantillonnage a été fait autour des îles Habibas. Cette île est située à proximité d'un front géostrophique dénommé Alméria- Oran. Celui ci est une conséquence du passage du courant atlantique et son affrontement avec les eaux méditerranéennes (Davies & al., 1993). Pour cette étude, douze stations de prélèvements ont été choisies (Figure 1).
Les échantillons zooplanctoniques ont été prélevés sur la couche d'eau épipélagique (0-200 mètres). Six stations (1.1, 1.2, 1.2, 2.1, 2.2, 2.3) sont situées au sein de l'écosystème oligotrophe côtier (R3 et R4) d'origine atlantique (Chl a surface < 1 mg.m^{-3}) et six stations (3.1, 3.2, 3.3, 4.1, 4.2, 4.3) sont localisées dans la zone de forte productivité biologique de type frontale (Chl *a* surface > 1 mg.m^{-3}) (R3 et R4). Le zooplancton a été échantillonné par des traits verticaux. Le filet utilisé est le Working Party 2 dont le tissu filtrant est en Nylon-Nytal de 200 µm de vide de maille.

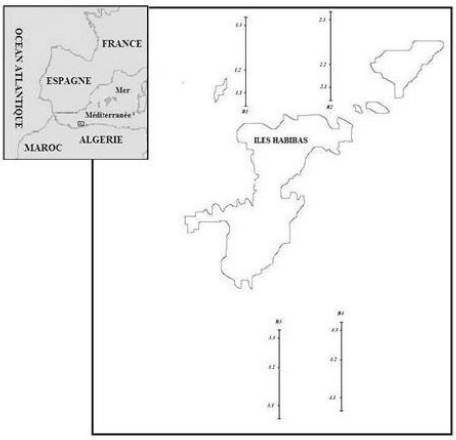

Fig. 1. Stations de prélèvements zooplanctoniques autours des îles Habibas.

Résultats.
La zone étudiée, héberge 26 taxons macrozooplanctoniques (Tableau 1). La faune appartient à divers phylums. Au sein des stations proches de la zone productive, de type frontale, les abondances totales sont supérieures à 100 individus.m^{-3}. Néanmoins au sein de l'écosystème oligotrophe côtier, les abondances totales sont nettement au dessous de 50 individus.m^{-3}.L'organisation trophique au sein de la zone frontale, est nettement dominée par les prédateurs: Ils représentent plus de 60 % de l'abondance totale. Au contraire, les filtreurs ne représentent qu'un faible pourcentage (moins de 40 %). En revanche, ce comportement trophique est dominant au niveau de la zone productive (plus de 70 %). Au sein de la zone oligotrophe, les valeurs pondérales sont faibles. Elles oscillent entre un minima de 1.60 mg.m^{-3} à un maxima de 3.52 mg.m^{-3}. Sur le front, les valeurs sont supérieures à 5 mg.m^{-3}. Une très faible variabilité est notée entre les six stations liées aux radiales 3 et 4. La faune macrozooplanctonique hébergée par les deux écosystèmes liés à l'archipel des habibas de est composée de 26 taxons. Celles-ci se répartissent sur trois phylums (Tunicata, Cnidaria et Chaetognatha), 17 genres et 11 familles. Ceux-ci ont été déjà collectés dans d'autres régions du bassin méditerranéen (Daly Yahia & *al.*, 2004). Les niveaux des abondances et des biomasses macrozooplanctoniques varient en relation avec les structures hydrologiques. Les fortes concentrations ont été localisées au asein de la zone productive. Le caractère oligotrophe de la faune est surtout signalé au sein de la zone oligotrophe côtière; les peuplements caractérisent des eaux faiblement productives (Chl *a* < 1 mg.m^{-3}). La zone d'influence du front Alméria - Oran semblerait réduite. Contrairement au front liguro-provençal, aucune incidence n'a été relevée sur les radiales côtières la zone étudiée. L'écosystème frontal représente une particularité au sein des côtes algériennes. Celle ci est corroborée par les données physiques et biologiques (Raimbault & *al.*, 1993). La forte productivité biologique (Chl *a* au niveau de la subsurface > 1 mg.m^{-3}) favorise l'accroissement des abondances zooplanctoniques où les filtreurs sont dominants.

Tab. 1. Biodiversité taxonomique de la faune macrozooplanctonique.

Phylum	Classe	Sous classe	Ordre	Famille	Genre et espèce
Tunicata	Thaliacea			Salpidae	*Thalia democratica*
				Doliolidae	*Dolilum denticulum*
					Doliolum mulleri
	Appendiculaires			Oikopleuridae	*Oikopleura albicans*
					Oikopleura dioica
					Stegosoma magnum
Cnidaria		Siphonophora	Calycophorae	Abylidae	*Abylopsis tetragona*
					Abylopsis eschscholtzi
					Bassia bassensis
				Diphyidae	*Diphyes dispar*
					Sulcolaria biloba
					Eudoxoides spiralis
					Lensia conoidea
					Lensia subtilis
					Muggiaea atlantica
	Hydrozoa		Filifera	Bougainvilliidae	*Bougainvillea muscus*
			Leptomedusae	Eucheilotidae	*Hyyocrophus quadratus*
				Aequoreidae	*Octocanna funeraria*
			Proboscoida	Camparulariidae	*Phialidium hemisphaericum*
			Limnopolypae	Olindiasidae	*Olindias phosphorica*
Chaetognatha			Aphragmophora	Sagittidae	*Sagitta elegans*
					Sagitta enflata
					Sagitta lyra
					Sagitta sp.
					Sagitta minima

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ABUNDANCE VARIABILITY OF GELATINOUS PLANKTON ON THE MEDITERRANEAN SPANISH COASTS: A COMBINED ANALYSIS AT REGIONAL AND LOCAL SCALES

Laura Prieto [1]*, Ana Genua [1], Nuria Sanz [2] and Gabriel Navarro [1]
[1] Instituto de Ciencias Marinas de Andalucia (ICMAN) CSIC - laura.prieto@icman.csic.es
[2] CUDOMAR SL,c/ Drassanes s/n, El Campello, 03560, Alicante, Spain

Abstract
The massive outburst of jelly organisms on the Spanish coast is a phenomenon with relevant implications at the socio-economic level. The aim of this study is to combine the abundance variability of these organisms with the physical and oceanographic forcing. The interannual variations of gelatinous plankton by different sources of data at regional scale (Alboran and Balearic Sea) are analyzed since 2007. Also, at local scale daily observations of abundance of jellyfish were estimated since 2011 in a fixed station offshore the Alicante coast. Remote sensing data are analyzed to characterize which are the time windows of increased proliferation of gelatinous plankton and their connection with the physical environment.

Keywords: Alboran Sea, North-Western Mediterranean, South-Western Mediterranean, Medusae

The worldwide concern about the massive proliferation of marine gelatinous zooplankton in the last decades has resulted in extensive recent work [1]. However, there is still no agreement about the underlying cause for their occurrence. Several hypotheses have been tested, thus the processes involved are not always mutually exclusive. Eutrophication, over-fishing, species introduction and climate change, are some of the proposed explanations [2].

Given the magnitude of ecological and socio-economic consequences of jellyfish outbreaks in the Mediterranean Sea, the understanding of mechanisms driving them is of great importance for the prediction of future scenarios. The identification and location of the target species as well as the gathering of relevant data seems a first valuable step through population dynamics and ecological modelling.

The aim of this study is to combine the abundance variability of these organisms with the physical and oceanographic forcing. The interannual variations of gelatinous plankton by different sources of data at regional scale (Alboran and Balearic Sea) are analyzed since 2007 (fig. 1).

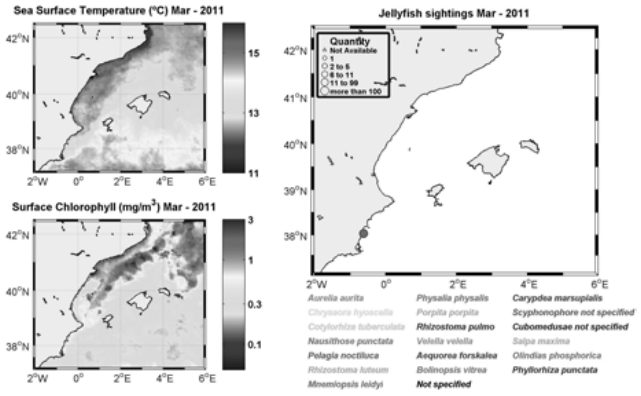

Fig. 1. Mean remote sensing sea surface temperature and surface chlorophyll and jellyfish sightings during March 2011 in the Balearic Sea.

Also, at local scale daily observations of abundance of jellyfish were estimated since 2011 in a fixed station (38º 25.200' N, 00º 20.850' W) sited near by a marine culture of fish floating cages, 1.87 miles offshore the Alicante coast (fig. 2). The number of species identified in this station was a four: *Chrysaora hyoscella*, *Cotylorhiza tuberculata*, *Pelagia noctiluca* and *Physalia physalis*. The specie most frequent and also most abundant was, in both years sampled, *Pelagia noctiluca*.

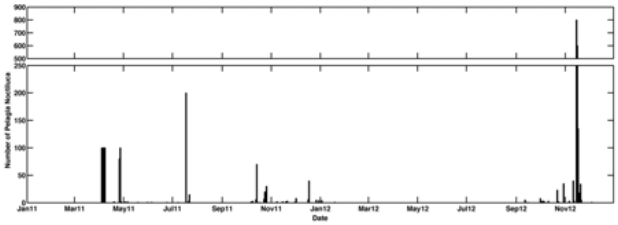

Fig. 2. Daily abundance variability of *Pelagia noctiluca* 1.87 miles offshore the Alicante coast, Spain, during 2001 and 2012. The exact location is observed in the map of fig.1 with a dot.

Remote sensing data are analyzed to characterize which are the time windows of increased proliferation of gelatinous plankton and their connection with the physical environment.

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ADAPTIVE STRATEGIES OF THE INVADER *MNEMIOPSIS LEIDYI* IN THE EURASIAN SEAS

T. Shiganova [1]*, U. Sommer [2], J. Molinero [2], J. Javidpour [2], A. Malej [3], E. Christou [4], M. Marambio [5], V. Fuentes [5] and D. L. Angel [6]

[1] Shirshov Institute of oceanology RAS - shiganov@ocean.ru
[2] Leibniz-Institut f. Meereswissenschaften Düsternbrooker Weg
[3] Morska biološka postaja
[4] Institute of Oceanography Hellenic Centre for Marine Research
[5] Institute de Ciencies del Mar CMIMA
[6] Charney School for Marine Science, University of Haifa, Haifa, Israel

Abstract

The predator ctenophore *Mnemiopsis leidyi* is a globally invasive species that was introduced in the seas around Europe and its expansion in new areas continue. *M.leidyi* has a wide environmental tolerance and could establish in contrasting ecosystems. We analyze variability of its morpho- physiological features, genetic diversity, patterns of spatial and temporal population dynamics in the Black, Azov, Caspian, Baltic, several areas of the Mediterranean seas as a response on different conditions (salinity, temperature, prey concentration). We conclude that environmental conditions determined its morpho-physiological features in its phenological variability range. This study may provide understanding evolutionary processes of invasive species in contrasting ecosystems.

Keywords: Alien species, Ctenophora, Black Sea, North-Eastern Mediterranean, North-Western Mediterranean

The predatory ctenophore *Mnemiopsis leidyi*(A.Agassiz, 1865) is a globally invasive species, "super" invader, native for the northern and southern America. It was first introduced into the Black Sea in early 1980s. From the Black Sea, it spread north to the Sea of Azov, south to the Sea of Marmara and to the Aegean Sea (Shiganova et al., 2001). It was brought in the Caspian Sea in 1999 (Shiganova et al., 2004).In 2009 it was recorded along the coastal areas of eastern and western Mediterranean (Galil et al., 2009; Boero et al., 2009; Fuentes et al., 2009 ; Shiganova & Malej, 2009). In 2006 its outbreak was recorded along the north-western European coast (Javidpour et al., 2006). In 2009 it was found in the coastal area of Australia and in the Indian Ocean (Costello et al., 2012). *M.leidyi* expansions in new areas still continue. Therefore this invader need to be detailed studied in comparative aspects in all recipient areas. *M.leidyi* has a wide environmental tolerance and high ecological plasticity and could establish in contrasting environmental conditions both marine and brackish ecosystems. The goal of the review is a comparative analysis of the variability of *M. leidyi* morphological, ecophysiological features, genetic population diversity ; patterns of spatial and temporal population dynamics in the Black, Azov, Caspian, Baltic seas, several areas of the Mediterranean as a response on different environmental conditions (salinity, temperature, productivity, prey concentration), anthropogenic factors and climate change effect; assessment of *M. leidyi* impact on trophic web of brackish and marine ecosystems in the seas of Eurasia; sensitivity assessment of ecosystems for invasion of *M.leidyi* and for invaders in general. We analyze the variability of morphological features of *M.leidyi* in different environments and conclude that environmental conditions determined its morphological features in its possible range of phenological variability. Earlier three species of genus Mnemiopsis were described on the base of these features (Mayer, 1912). We use data of genetic analysis based on analyses of investigated sequence variation in the nuclear ribosomal Internal Transcribed Spacer (ITS) region of the ctenophore *M. leidyi* that has provided understanding of its invasion history including dynamics of new areas' colonization and population sources (Ghabooli et al., 2011). We analyse *M.leidyi* physiological features in different environments that determine life cycle, which include metabolic and feeding rates, reproduction time and duration, fecundity, growth and size, pattern of distribution and finally predation rates on zooplankton. We analyze the interannual variability, individual and population *M.leidyi* size, spatial distribution and seasonal time of its spreading from the main area of distribution to adjacent areas and seas: from the Black Sea to the adjacent seas, from the Southern Caspian to the North that are controled by surface water temperature, especially by minimal winter and spring SST, and wind direction, which are modified mostly by global scale atmospheric patterns. *M.leidyi* effects on the European seas ecosystems are different. The strongest impact was recorded in the productive and disturbed Black, Azov and Caspian Seas, where it had cascading effect at all levels of ecosystems both bottom up and top down. During last years some temporal effect was observed in the Baltic Sea and coastal areas of the eastern and western Mediterranean. But effects depend on population size, which is controled by current environmental and biotic conditions and climate forcing. The comprehensive assessment of this globally invasive species may provide understanding evolutionary processes of invasive species, patterns of population dynamics of invaders in different contrasting ecosystems and their sensitivity for invasions.

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GELATINOUS ZOOPLANKTON IN THE BAY OF MARSEILLES - POTENTIAL CONTROL OF THE FISH POPULATION OVER THE ARTIFICIAL REEFS?

Delphine Thibault-Botha [1]*, Melanie Santo [1] and Megane Neauport [1]
[1] Aix-Marseille Universite Institut Mediterraneen d'Oceanologie - delphine.botha@univ-amu.fr

Abstract
Gelatinous zooplankton play important roles in coastal seas, competing with fish for food items and eating fish eggs and larvae. Despite this, they have been understudied in many ecosystem, especially in coastal marine ecosystems. In the framework of the colonization of the artificial reef, strong population of gelatinous zooplankton could limit the extension of the recruitment of fish over the reef, due to their strong feeding capacities. Gelatinous zooplankton both the carnivorous (siphonophores and jellyfish) and the filter feeders (salps, doliolids, appendicularians) have been collected over the Artifical reef area since 2010 on a bi-weekly base and show large seasonal variations.

Keywords: Biodiversity, Coastal systems, Zooplankton , Gulf of Lyon

Introduction Gelatinous zooplankton has been observed for a very long time along the coast of the Northwestern Mediterranean Sea. Nevertheless information are lacking on this group of organisms which play important roles in the structuring and functioning of the pelagic ecosystem The Northwestern Mediterranean Sea hydrodynamics is largely dominated by the North Current but also through strong southwards winds and inputs of freshwater through several small rivers and a larger contribution from the Rhone River. Artificial reef structures were placed in the Bay of Marseilles in 2008 and colonization by encrusting, benthic and pelagic species has been followed since then. Gelatinous zooplankton are part of the pelagic ecosystem and could regulate the population of fish around the reefs.

Material and methods Bi-weekly sampling has been conducted since 2010 in order to study the plankton composition found over the artificial reef. CTD cast were performed at a station located roughly in the mid-section of the reef area. Chlorophyll was measured at the surface and bottom of the water column. Mesozooplankton was collecting using vertical WP2 net. Nansen Net for gelatinous zooplankton mounted with 700um mesh size was towed from the bottom (~30m) and the surface, as well as horizontally at the surface at ~1 knot. Zooplankton collected was then preserved in formalin buffered solution until further taxonomic analysis. Gelatinous zooplankton were identified down to species when possible. Fish egg and larvae were also counted.

Results and discussion Over the 3 year period, temperature (figure 1) and salinity (not shown) displayed large inter-annual variations

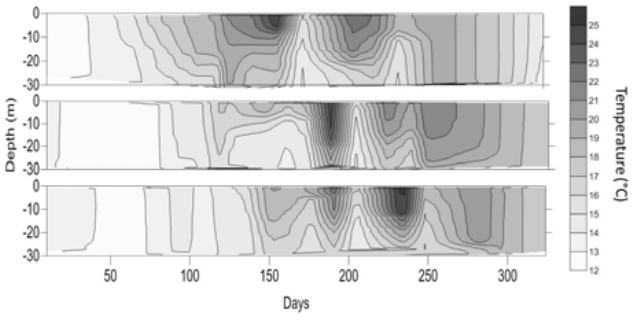

Fig. 1. In situ temperature profiles in 2010 (top), 2011 (middle) and 2012 (bottom) over the artificial reef

with a lag in the beginning of the warming season from 2010 to 2012 of about 2 months. Clear upwelling events as well as seasonal stratification are reported in all three years during the summertime. 2012 was also characterized by warmer waters in autumn. Fluorescence signal (Figure 2) displayed also strong inter-annual variation with spring 2012 displaying highest values. Low and rather homogenous values are reported through the rest of the year.

Gelatinous zooplankton as well as fish eggs/larvae were more abundant in surface nets than in vertical nets. This is partly due to the larger volume of water sampled but as well as by the aggregation of these pelagic organisms in the surface layer (hyponeuston; Della Croce, 1962). Gelatinous zooplankton both the predatory type and the filter feeders were observed through the year in variable abundance over the artificial reef area.

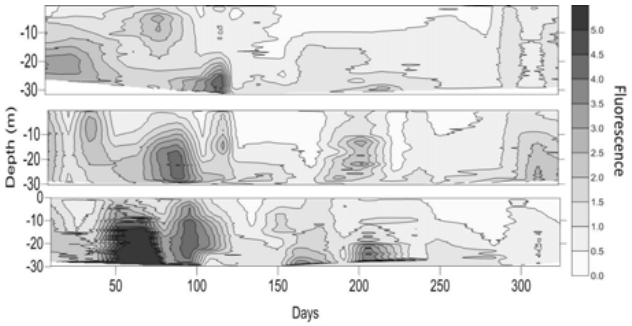

Fig. 2. *In situ* fluorescence profiles in 2010 (top), 2011 (middle) and 2012 (bottom) over the artificial reef

Predatory organisms were represented by siphonophores, medusa and chaetognathes. Salps, doliolids and appendicularians were the most abundant gelatinous filter feeders. Siphonophores were overall the most abundant type, contributing up to 100% of the gelatinous population and were presented by the following species : *Chelophyes appendiculata, Eudoxoïdes spiralis, Muggiaea atlantica, Muggiaea kochi, Lensia subtilis, Lensia fowleri, Lensia conoidea, Lensia subtiloides, Lensia subtilis, Lensia multicristata, Abylopsis tetragona,* and *Abylopsis eschscholtzi*. Both polygastric and eudoxid forms were found. Medusae were at time abundant and presented by *Obelia* sp., *Eutonina scintillans, Echoeilota ventricularis, Rhopalonema velatum, Eutima gracilis, Podocoryne borealis, Sminthea erygaster, Solmundella bitentaculata, Persa incolorata* and *Arctopodema ampla*. No clear pattern have been observed. Filter feeders showed large aggregates in spring and autumn. Salps were represented by both blastozooid and oozoids individuals of *Thalia democratica*. *Doliolum denticulatum* and *Doliolum nationalis* were the two species of doliolid reported. Appendicularian were mainly members of *Oïkopleura fusiformis, Oïkopleura longicauda* and *Oïkopleura dioïca*. Large jellyfish such as *Velella velella* and *Pelagia noctiluca* were seldom sampled by our net. Little information being available on the population of gelatinous zooplankton of the Bay of Marseille (Arfi et al., 1982), impact of the artificial reef structure and mainly on the establishment of several fish population remains unknown. Comparison with the SOMLIT station slightly off shore located at the entrance of the bay of Marseille allowed some spatial comparison. Gelatinous zooplankton assemblage appeared similar with matching temporal variations. Nevertheless fish eggs and larvae were more important over the reef area.

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THE ROLE OF NEWLY FOUND MUCIN (Q-MUCIN) OF JELLYFISHES IN THEIR PHYSIOLOGY AND ECOLOGY.

K. Ushida [1]*, M. Kawashima [1], M. Sugiyama [1], H. Miyake [2] and C. Numako [3]
[1] School of Science, Kitasato University, - ushidak@kitasato-u.ac.jp
[2] School of Marine Bioscience, Kitasato University
[3] Faculty of Science, Chiba University

Abstract
The role of novel mucin (Q-mucin) recently found in jellyfish bodies are investigated based on the physiology and ecology of jellyfishes. Although no direct evidence has been obtained, we speculate that Q-mucin are used as a mediating molecule in its biomineralization process, that is, collecting calcium to be used in the nervous and muscle systems from sea water. With this consideration, "Jellyfish explosion" can partly be understood by the change in the mineral environment of oceans.

Keywords: Calcium, Chemical analysis, Medusae, Biotechnologies, Extra-Mediterranean regions

In 2005, we discovered a novel mucin (qniumucin: Q-mucin)[1,2] from many kinds of jellyfishes, which is a group of highly polymerized glycoproteins composed of a single peptide main chain and blanched random glycochains connected to the peptide via an *O*-glycoside bond. Generally, mucins are involved in mucus of various animals, however, Q-mucins is not found in the mucus of jellyfishes but seems to be a content of extracellular matrices (ECMs) of their body. The chemical structure of Q-mucin is extremely simple as solved our series of studies[1-4] which shows a sharp contrast to conventional mucins extracted from various domestic animals.

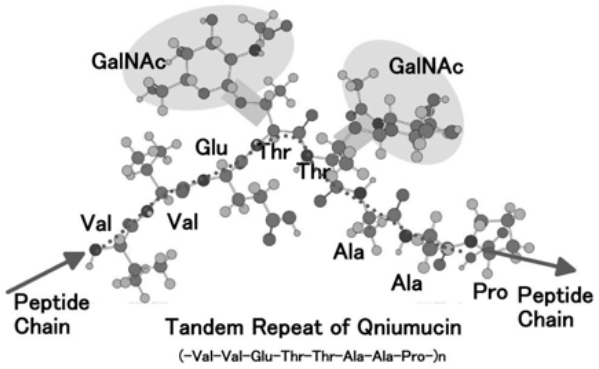

Fig. 1. Possible structure of a single tandem repeat part of jellyfish mucin (qniumucin: Q-mucin). The main peptide chain has a sequence of 8 amino acids -Val-Val-Glu-Thr-Thr-Ala-Ala-Pro-. Two monosaccharides (N-acetyl galactosamine: GalNAc or its derivatives) are connected to two the central Thrs. This sequence repeats several tens times to form a high polymer. Since GalNAc also has various anionic groups, (phosphate, phosphonate, and sulfate) Q-mucin has a function of ion exchange resins.

Fig. 1 shows a possible structure of Q-mucin of its single repeating part. The long peptide part has a simple repeating structure with a unit sequence of 8 amino acids, -Val-Val-Glu-Thr-Thr-Ala-Ala-Pro- and glycochains a simple monosaccharide which is GalNAc, or its derivatives having anionic groups such as phosphonate ($-O-PO_2^--CH_2-CH_2-NH_2$), phosphate ($-O-PO_2^{2-}$), and sulfate ($-O-SO_3^-$) (this one is not confirmed yet). However, no sialic acids are involved in the glycan chains deferent from any higher animals. Since no mucins can be synthesized by any methods, Q-mucin has a chance to be a useful and well-defined material as a chemical substance. Jellyfish wastes accumulated on gulfs can be used as the source of Q-mucin.

Based on the consideration of its chemical structure, we recently studied the original function of Q-mucin in jellyfishes and obtained some knowledge about their physiology and ecology. Jellyfish seems to employ Q-mucin as a mediating material to capture useful minerals from sea water. The above-mentioned anionic groups in the glycan chains have a tendency to collect various doubly or more charged metal cations with a large binding equilibrium constant, e.g. with Mg^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, and Cd^{2+}. In other words, Q-mucin has a function of ion-exchange resins. This property is rather uncontrolled (random) but the mineral composition of sea water is stable in all over the oceans. Therefore, each jellyfish can safely collect calcium and other nessesary minerals with a very simple mechanism to maintain their life. For example, dilute (<5 ppm) Cu^{2+} and Cd^{2+} are toxic for jellyfish and without the stimmulation of Ca^{2+} it loses the motions. We suspect that a jellyfish moves its body to stir the surrounding sea water and capture the minerals effectively by Q-mucin, especially for calcium needed for its muscle and nervous systems, i.e. biomineralization process similar to other sea creatures.

In the long history of development, jellyfish is the first animal which acquired a sophisticated and dynamic muscle and nervous systems. It seems to want to use calcium dynamically but only has small gravity stones for the storage of calcium instead of the bone system in the higher animals. Although almost all the researches on biomineralization of jellyfishes published previously only investigate the final production of gravity stones, now we focus on the mediating materials, Q-mucin, and would like to discuss their chemical knietics that collect mineral cations from sea water where they are involved with relatively low concentrations.

We suppose that the causes of "Jellyfish Explosion" can be related to the change in mineral environment of our oceans especially for calcium concentrations. For example, concrete structures affect the near-coast environment and similar mass occurrence of shells is frequency found. In our study, now we have indirect evidence only, but some discussion about ecology of jellyfish may be possible.

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Session

Good Environmental Status, assessment

Modérateur : **Slim Gana**

ISOTOPIC TISSUE FRACTIONATION AT BIVALVE *PINNA NOBILIS*, A NON-INVASIVE APPROACH

Carme Alomar [1]*, Salud Deudero [1] and Maite Vázquez-Luis [1]
[1] Instituto Español de Oceanografía Centre Oceanogràfic de les Balears - c.alomar@ba.ieo.es

Abstract
Carbon and nitrogen isotopic values of muscle and mantle in Mediterranean endemic bivalve *Pinna nobilis* individuals have been analyzed to study tissue fractionation. Muscle tissue is enriched in both $\delta^{13}C$ and $\delta^{15}N$ compared to mantle on average 1.11 ‰ and 0.71 ‰, respectively. Analyses of mantle tissue do not involve sacrifice of individuals and are therefore proposed as a conservation tool in the study of *P. nobilis*.

Keywords: Bio-indicators, Bivalves, Conservation, Balearic Islands

Introduction- *Pinna nobilis* is one of the largest bivalves in the world [1] and endemic to the Mediterranean. Populations have been reduced due to direct and indirect impacts [2]. As a consequence, it has been listed as a Mediterranean endangered species (92/43/EEC). Previous studies have suggested muscle as the most appropriate for stable isotopes analyses [3]. The aim of this study was to analyze mantle and muscle tissues of *P. nobilis* at three different localities to i) study fractioning between tissues, ii) study isotopic differences among localities and iii) propose sampling of mantle instead of muscle to study the trophic ecology of the fan mussel. Results will allow comparison of muscle and mantle tissue in order to provide a non-invasive technique for sampling vulnerable fan mussel.

Materials and Methods-The study was carried out at 3 sampling sites: Cabrera, Es Freus and Andratx, Balearic Islands (Western Mediterranean). Individuals of *P. nobilis* were collected under licence from the Government for research purposes by experienced scuba divers in February 2013. For each *P. nobilis* individual, muscle and mantle tissues were obtained. Stable isotopes of $\delta^{13}C$ and $\delta^{15}N$ were analyzed following standard procedures [4]. A multivariate analyses of variance PERMANOVA tested significant spatial differences among sites and tissues.

Results- For all localities, muscle tissue were enriched in $\delta^{13}C$ and $\delta^{15}N$ compared to mantle tissue (Fig. 1). Values of $\delta^{13}C$ were highest at Andratx and lowest at Es Freus. Values of $\delta^{15}N$ were highest at Andratx and lowest at Cabrera (Fig. 1). Both $\delta^{13}C$ and $\delta^{15}N$ isotopic signatures of *P. nobilis* showed significant differences for locality (Lo) (PERMANOVA, Lo, $\delta^{13}C$, $p < 0.001$ and Lo, $\delta^{15}N$, $p < 0.001$, Fig 2.) and tissue (Ti) (PERMANOVA, Ti, $\delta^{13}C$, $p < 0.001$ and Ti, $\delta^{15}N$, $p < 0.001$, Fig 2). Only the interaction between tissue and locality for $\delta^{15}N$ showed significant differences (PERMANOVA, Lo x Ti, $\delta^{15}N$, $p < 0.05$, Fig 2).

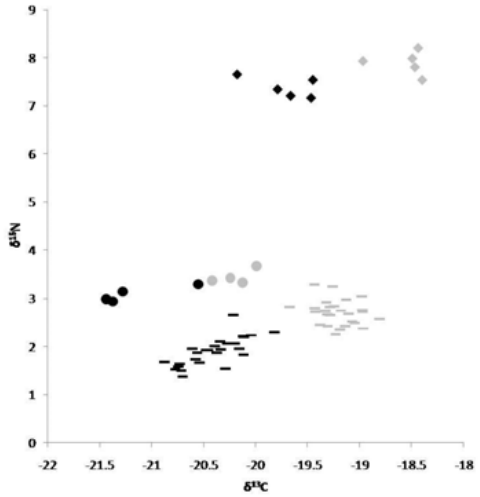

Fig. 1. Individual values of $\delta^{13}C$ and $\delta^{15}N$ for *P. nobilis* at Andratx ♦, Cabrera – and Es Freu •. Mantle is represented in black and muscle in grey.

Discussion-The present study shows significant differences between tissues and localities. Muscle is enriched compared to mantle of the same individual. Both tissues are nitrogen enriched in localities which receive higher anthropogenic pressure, Andratx. Mantle has shown to follow the same isotopic pattern as muscle. Studying mantle in place of muscle does not involve scarifying individuals and minimizes the sampling impact on the existing populations contributing to the conservation of this endangered specie.

Tab. 1. Results of multivariate analyses of variance PERMANOVA for $\delta^{13}C$ and $\delta^{15}N$ in *Pinna nobilis* and posterior pair wise test for factors locality and tissue. ** $p < 0.001$ * $p < 0.05$

	$\delta^{13}C$				$\delta^{15}N$			
Source of variation	**df**	**SS**	**MS**	**Pseudo-F**	**df**	**SS**	**MS**	**Pseudo-F**
Locality (Lo)	2	10.602	5.3012	87.446**	2	239.25	119.63	1737**
Tissue (Ti)	1	11.283	11.283	186.12**	1	2.8349	2.8349	41.16**
Locality x Tissue	2	0.091	0.046	0.75293	2	0.4587	0.22935	3.33*
Residual	64	3.8799	0.06		64	4.4075	0.069	
Total	69	38.274			69	252.88		
Pair wise within level of factor Locality	Andratx ≠ Cabrera ≠ Es freus				Andratx ≠ Cabrera ≠ Es freus			
Pair wise within level of factor Tissue	Muscle ≠ Mantle *Pair wise test*				Muscle ≠ Mantle			
					Lo x Ti Andrtax: muscle > mantle Cabrera: muscle > mantle Es freus: muscle > mantle			

Acknowledgments- The study was financed by Organismo Autónomo de Parques Nacionales, MAAA project: ¨Estado de conservación del bivalvo amenazado *Pinna nobilis* en el Parque Nacional de Cabrera (024/210).”

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ANNUAL CYCLE OF ^{13}C AND ^{15}N STABLE ISOTOPE SIGNATURES OF ADDUCTOR MUSCLE AT THE BIVALVE *PINNA NOBILIS*

Carme Alomar [1]*, Salud Deudero [1] and Maite Vázquez-Luis [1]
[1] Instituto Español de Oceanografía Centre Oceanogràfic de les Balears - c.alomar@ba.ieo.es

Abstract
Pinna nobilis are efficient filter feeders bivalves and provide evidence of surrounding conditions. Individuals of a Marine Protected Area (MPA) have been sampled and isotopic values of $\delta^{13}C$ and $\delta^{15}N$ have been analyzed to study the annual cycle of the fan mussel in non-eutrophic waters. Values obtained in summer months are higher indicating the need to consider temporal shifts in stable isotope linked with trophic resources availability.

Keywords: Bivalves, Coastal systems, Trophic relations, Balearic Islands

Introduction-Organism assimilate both carbon and nitrogen derived compounds from their food sources [1] giving isotopic signals which reflect surrounding water conditions. Isotopic values of $\delta^{15}N$ quantitatively asses trophic level, whereas values of $\delta^{13}C$ indicate relative contributions to the diet of different potential primary sources, giving evidence of inshore versus offshore food intake [2].Environmental differences such as light intensity and nutrient concentrations, species composition and geographic variability affect $\delta^{13}C$ and $\delta^{15}N$ values of primary producers in a region [3].Therefore, isotopic analysis is an effective method to study food webs [4].The aim was to study the annual cycle of the filter feeder *P. nobilis* at a MPA with stable isotope analyses of $\delta^{13}C$ and $\delta^{15}N$ and to contribute with new isotopic values to the existing library of such data.

Materials and Methods-The study was carried out at Cabrera, a MPA in the Balearic Islands (Western Mediterranean). Between five and ten individuals were monthly collected under licence from the Government for research purpose by experienced scuba divers from April 2011 to March 2012. Stable isotopes of $\delta^{13}C$ and $\delta^{15}N$ in muscle tissue of *P. nobilis* were analyzed following standard procedures [5]. A multivariate analyses of variance PERMANOVA tested significant spatial differences among months and season.

Results-Values of $\delta^{13}C$ were highest in August (-18.83 ± 0.00 ‰) and lowest in April and March (-19.81 ± 0.02 ‰ and -19.81 ± 0.00 ‰) (Fig.1). Values of $\delta^{15}N$ were highest in May (3.37 ± 0.00 ‰) and lowest in March (2.54 ± 0.00 ‰) (Fig. 2). Both isotopes showed significant differences between months (PERMANOVA, $P < 0.001$). Values of $\delta^{13}C$ and $\delta^{15}N$ were highest in summer, -19.16 ± 0.00 ‰ and 3.11 ± 0.00 ‰, respectively, and there were significant differences between seasons (PERMANOVA, $P < 0.001$).

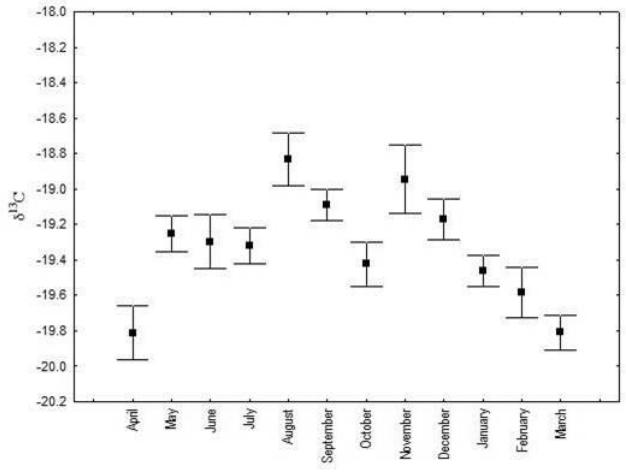

Fig. 1. Monthly mean ± Standard Error of isotopic signatures of $\delta^{13}C$ at muscle of *Pinna nobilis* in Cabrera.

Discussion-The fan mussel shows variation in isotopic composition of muscle among months and summer months are enriched in carbon and nitrogen. This variation suggests a change in inhabiting conditions and diet. The study contributes with new data and obtained results agree with available data from the literature for the same specie and sampling area.

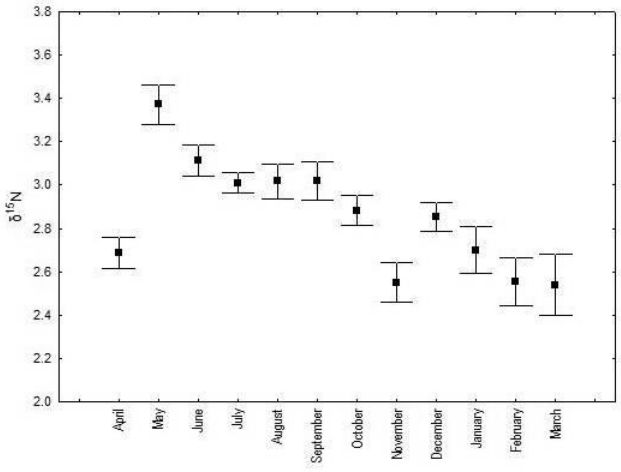

Fig. 2. Monthly mean ± Standard Error of isotopic signatures of $\delta^{15}N$ at muscle of *Pinna nobilis* in Cabrera.

Acknowledgments-The study was financed by Organismo Autónomo de Parques Nacionales, MAAA project: ¨Estado de conservación del bivalvo amenazado *Pinna nobilis* en el Parque Nacional de Cabrera (024/210).”

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VULNERABLE MARINE ECOSYSTEMS IN FRENCH CONTINENTAL MEDITERRANEAN SUBMARINE CANYONS: SPATIAL DISTRIBUTION AND ANTHROPOGENIC IMPACTS

M. Fabri [1]*, L. Pedel [1], L. Beuck [2], F. Galgani [1], D. Hebbeln [3] and A. Freiwald [2]
[1] Ifremer ODE / LER-PAC - Marie.Claire.Fabri@ifremer.fr
[2] Senckenberg am Meer
[3] MARUM

Abstract
Vulnerable Marine Ecosystems (VME) in the deep Mediterranean Sea have been identified as consisting of communities of Scleractinia (*Lophelia pertusa* and *Madrepora oculata)*, Pennatulacea (*Funiculina quadrangularis)* and Alcyonacea (*Isidella elongata*). This study deals with video data recorded in the heads of French Mediterranean continental canyons.

Keywords: Biodiversity, Bathyal, Canyons, North-Western Mediterranean

Introduction
Adverse impacts to Vulnerable Marine Ecosystems (VME) in the deep sea have now become an international concern since the United Nation called on governments and Regional Fishery Management Organisations to prevent them. The biggest constraint in protecting VMEs are the uncertainties in the distribution and abundance of VME indicator species, and similar uncertainties in the link between fishing intensity and significant adverse impacts. The pressures on natural marine resources and the demand for marine ecological services are considered excessive and have led to the establishment of the European Marine Strategy Framework Directive (MSFD). This study was performed in the framework of the initial assessment of the bathyal benthic ecosystems in the French continental canyons of the Mediterranean Sea.

Method
Quantitative observations were extracted from 101 video films recorded during the MEDSEACAN cruise in 2009 (Aamp/Comex) [1]. Qualitative information was extracted from four other cruises (two Marum/Comex cruises in 2009 and 2011 and two Ifremer cruises in 1995 and 2010) to support the previous observations in the Cassidaigne and Lacaze-Duthiers canyons. All the species, fishing impacts and litter recognized in the video films recorded from 180 to 700 m depth were mapped by GIS. Abundances and distributions of benthic fishing resources (marketable fishes, Aristeidae, Octopodidae), Vulnerable Marine Species, trawling scars and litter were calculated and compared between 17 canyons and the open slope between the Stoechades and Toulon canyons.

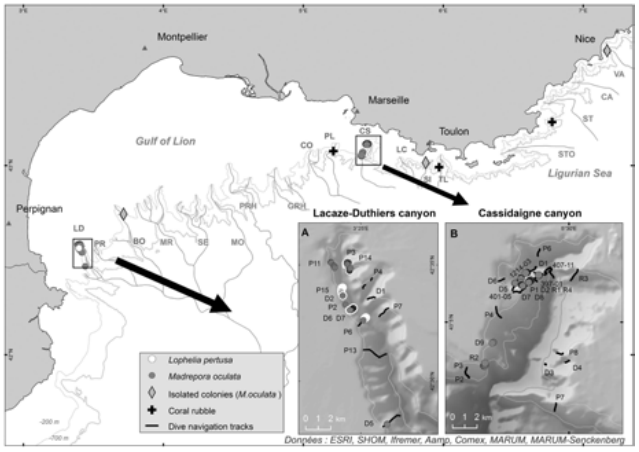

Fig. 1. Distribution map of frame-building scleractinian cold-water coral communities. **A**: Zoom in the Lacaze-Duthiers canyon. **B**: Zoom in the Cassidaigne canyon.

Results and discussion
Lacaze-Duthiers and Cassidaigne canyons revealed the highest density and largest colony sizes of scleractinian cold-water corals, which distribution was mapped in detail (Fig. 1). Funiculina quadrangularis was rarely observed, essentially in the Marti canyon and, I. elongata was abundant in three canyons (Bourcart, Marti, Petit-Rhône). The alcyonacean Callogorgia verticillata, observed in high abundance in the Bourcart canyon and in less abundance in several other canyons, is proposed as a Vulnerable Marine Species. Our studies on anthropogenic impacts show that litter was present in all of the canyons, however, higher abundances were found in the Ligurian Sea, where the heads of the canyons are closer to the coast. Seafloor disturbance due to benthic fishing was observed to be mainly due to trawling in the Gulf of Lion and to long lines in the Ligurian Sea where rocky substrates are present. The bauxite red mud residue expelled in the Cassidaigne canyon was seen to prevent fauna from settling at the bottom of the canyon and it covered much of the flanks [2].

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QUANTIFICATION OF ANTHROPOGENIC PRESSURES ON MARINE ECOSYSTEMS OF THE GULF OF TUNIS

Slim Gana [1]* and Khaoula Souissi [1]
[1] SAROST Marine Engineering and Geosciences Division - slim.GANA@sarost-group.com

Abstract
In the framework of the EU-funded PERSEUS[1] project, we quantify the impacts of anthropogenic pressures on Gulf of Tunis marine ecosystems. The first step of the methodology required by the MSFD's [2] principles is "the initial assessment of the environmental state", with the view to achieve the main objective "Good Environmental Status (GES)" by 2020. Practically, we used a standard methodology developed by Halpern et *al*. [1]; [2] based on expert survey to determine the cumulative impact index of anthropogenic pressures on marine ecosystems in the Gulf of Tunis.

Keywords: Mapping, Gulf of Tunis, Coastal management

Introduction
In order to achieve the Good Environmental Status in a given area, it is first necessary to identify threats on marine ecosystems. The Gulf of Tunis is chosen as one of the study areas in the case of the European project "PERSEUS" to implement the MSFD's principles. This Gulf is concerned by different anthropogenic pressures threatening its ecosystems. The quantification of threats impact on marine ecosystems is important for coastal management and for determination of remedial measures. In this work, we are focusing on the first step of the MSFD's methodology which is "the initial assessment of the environmental state"

Methods
First, a geo-database describing the different threats and the most important coastal ecosystems in the Gulf of Tunis was prepared. Second, we determined the weighted average vulnerability score through an expert survey by considering 5 vulnerability ranks: spatial scale, frequency, functional impacts, resistance and resilience [1]. We included another rank that determines the level of "certainty" in the survey response. The weighted average vulnerability score was calculated following the following steps: for each threat-ecosystem combination, we rescaled "scale" and "resistance" (multiplied by 4/6 and 4/3, respectively); each weighted value of 5 vulnerability ranks was multiplied by the certainty value; the sum of these weighted values for each vulnerability measure was divided by the sum of the certainty values to obtain the weighted-average vulnerability score for each threat-ecosystem. Then, cumulative impact index is calculated using the following formula for each cell :

$$I_c = \sum_{i=1}^{n} \sum_{j=1}^{m} D_i \times \mu_{ij} \times E_j$$

Where: $\mathbf{D_i}$: log transformed and normalized value of an anthropogenic pressure at location "i", $\mathbf{E_j}$: is the absence or the presence of an ecosystem "j" in each cell ((0=absence) or (1=presence)), $\boldsymbol{\mu_{ij}}$: is the weighted vulnerability score (0 to 4), **n**: number of anthropogenic pressures identified in the Gulf of Tunis, **m**: number of ecosystems identified in the Gulf of Tunis. Finally we implemented the database using a GIS for mapping the cumulative impact index.

Results
The Gulf of Tunis is threatened by several pressure types (Rivers discharges, wastewater discharges, maritime traffic, industries and tourism) which threaten its marine ecosystems by inducing different impact levels. The most important pressure loads is located around the Bay of Tunis (Fig 1).

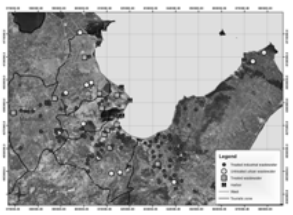

Fig. 1. Anthropogenic pressures in the Gulf of Tunis

The cumulative impact index of these pressures allows the quantification of threats to determine the environmental state in the area and help decision-making for a sustainable management of the marine environment to achieve "the Good Environmental State (GES)". Anthropogenic pressures in the Gulf of Tunis induce different cumulative impact levels depending to the considered ecosystems. The Bay of Tunis is the most threatened area of the Gulf because it is the recipient of the most important pressure loads (Fig 2).

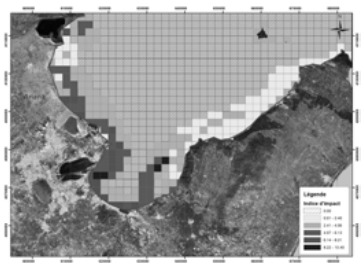

Fig. 2. Cumulative Impact Index in the Gulf of Tunis

The eastern part of the Gulf is less impacted than the western one because of the low volume of existing pressures in this area (from Korbous to Ras At Tib). The determination of the weighted average vulnerability score shows that the most important vulnerability scores are assigned to the seagrass (*Posidonia oceanica*, *Caulerpa prolifera* and *Cymodocea nodosa* meadows) against trawling, dredging and disposal of dredge spoil. In addition, the result can be different in dependence to the ecosystems considered in the study.

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[1] This work was undertaken within the European project "PERSEUS" funded by the EU under FP7 Theme "Ocean of Tomorrow" OCEAN.2011-3 Grant Agreement No.287600.
[2] Marine Strategy Framework Directive

BOTTOM TRAWL DISCARDING PRACTICES IN THERMAIKOS GULF (NORTH AEGEAN SEA): PRELIMINARY RESULTS

Xaralambos Apostolidis [1], Paraskevi K Karachle [2]* and Christos D Maravelias [2]
[1] Aristotle University of Thessaloniki, School of Biology, Department of Zoology, Laboratory of Ichthyology, Box 134, 54124, Thessaloniki, Greece
[2] Hellenic Centre for Marine Research, 46.7 km Athens Sounio ave., P.O. Box 712, 19013 Anavyssos Attiki, Greece - pkarachle@hcmr.gr

Abstract
Preliminary results on the discards of trawlers in Thermaikos Gulf are presented. Higher rates of discarding (52.3% on average) than previously reported in Greek waters were recorded. The percentage of individuals under the minimum landing size of the most prevalent commercial and discarded species ranged between 6.7% (*Citharus linguatula*) and 93.6% (*Trachurus mediterraneus*). Results indicated depletion of fish stocks due to high fishing effort and an increase of more resilient and less vulnerable to overfishing species, mainly Cephalopoda and Crustacea.

Keywords: Aegean Sea, Trawl surveys

Introduction Discarding, a common practice in most fisheries, has important implications for the ecosystem and fisheries economy [1, 2]. The process of discarding is very variable in nature, especially in the Mediterranean multispecies fisheries context [3]. Among different fishing methods, bottom trawling produces proportionally more discards [4]. Herein we describe and analyze discards in relation to landings of bottom trawl fishing in Thermaikos Gulf, NW Aegean Sea. These data are important information, since catch data are not available after 2008 in Greece.

Materials and methods Sampling was conducted on a monthly basis (November 2012 - March 2013), in Thermaikos Gulf. Four commercial trawlers, of approximately the same horsepower and length, were used (40mm squared mesh size cod end). Catches, after sorting by crew members into landings and discards, were identified to the lowest possible taxonomic level (hereafter species) and weighed. Additionally, the number of discarded individuals per species was recorded. Random subsamples of 30 individuals of discarded commercial species were measured to the nearest millimeter (mm) of total, carapace and mantle length for fish, Decapoda and Cephalopoda, respectively.

Results and Discussion In total, catches of 27 hauls were sampled during 12 one-day fishing trips. Overall, 96 species were recorded in the catches (60 fishes, 9 decapods, 6 cephalopods and 21 other invertebrate species). Landings composed mainly of *Mullus barbatus* (22.4%), *Sepia* spp. (10.0%), *Squilla mantis* (8.2%), *Melicertus kerathurus* (7.7%), *Parapenaeus longirostris* (7.45%), *Eledone* spp. (6.9%) and *Lophius* spp. (6.1%). Discards were dominated by the blue-leg swim crab *Liocarcinus depurator* both in terms of weight and number of individuals (Fig. 1a, b).

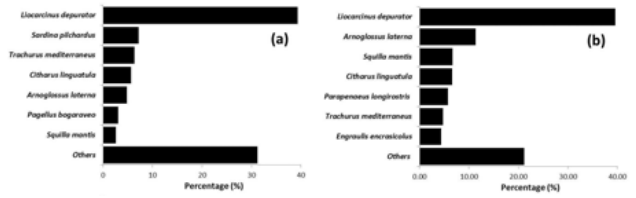

Fig. 1. Most prevalent discarded species in terms of biomass (a) and number of individuals (b).

With respect to commercial species that were discarded, *Citharus linguatula*, *P. longirostris*, *S. mantis*, *Trachurus mediterraneus*, *Engraulis encrasicolus* and *Sardina pilchardus* were the most abundant. Length frequency distributions of the four first species were skewed toward small sizes (Fig. 2). In the contrary, length frequency distributions of *E. encrasicolus* and *S. pilchardus* presented a bimodal pattern (Fig. 2). The latter is most probably a result of the fact that these species were totally discarded and thus not sorted. The positive skewed distributions of the rest of the species are indicative of size based selection during sorting by the crew. The number of individuals discarded and under the minimum landing size (MLS) differed between these species. In particular, 6.7%, 34.7%, 93.6%, 42.7% and 34.7% of the individuals discarded were below the MLS for *C. linguatula* (MLS = 80mm), *P. longirostris* (MLS = 20mm), *T. mediterraneus* (MLS = 150mm), *E. encrasicolus* (MLS = 90mm) and *S. pilchardus* (MLS = 110mm) respectively. No MLS has been set for *S. mantis*.

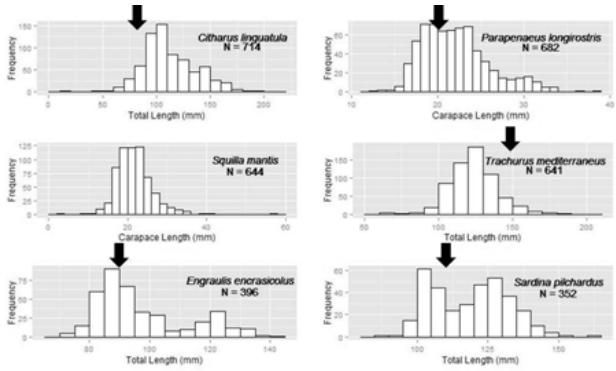

Fig. 2. Length frequency distributions of the six more abundant commercial and discarded species. Black arrows indicate minimum landing size.

Invertebrates' biomass in both landings and discards (52.5% and 53.5% respectively) was higher compared to fish. Haul specific discarding ratio (discards/landings) was on average 52.3%, while discarded fish were on average 23.5% of catches. These values are higher compared to results of similar studies performed in Greek waters [2, 5]. All above facts indicate depletion of fish stocks due to high unselective fishing effort and an increase of more resilient and less vulnerable to overfishing species.

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no 289192.

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RADIOACTIVITY CONCENTRATIONS IN INDIGENOUS AND TRANSPLANTED MUSSEL (*MYTILUS GALLOPROVINCIALIS*) OF TURKISH SEA COAST

Ö. Kiliç [1]*, M. Belivermis [1], F. Gözel [1], Y. Çotuk [1] and S. Topçuoglu [1]
[1] Istanbul University Faculty of Science, Department of Biology - kilic_onder@yahoo.com

Abstract
In the present study, radioactivity concentrations (^{137}Cs, ^{40}K, ^{226}Ra, ^{228}Ra, ^{210}Po and ^{210}Pb) were determined in indigenous mussels (*Mytilus galloprovincialis)* collected in Bosphorus, Black Sea, Marmara Sea and Aegean Sea coast of Turkey. Since *M. galloprovincialis* is not available, mussel cages were employed in Levantine Sea coast . The average activity concentrations of ^{137}Cs, ^{40}K, ^{226}Ra, ^{228}Ra, ^{210}Po and ^{210}Pb were found to be 0.71 ± 0.13, 469 ± 24, 0.94 ± 0.07, 1.0 ± 0.11, 121.9 ± 4.2 and 10.9 ± 0.9 Bq kg^{-1} in dry weight (d.w.), respectively. The average of ^{210}Po/^{210}Pb ratio was found to be 13.9. All found activity concentrations were compared with levels of similar studies carried out in Mediterranean coast.

Keywords: Radionuclides, Monitoring, Aegean Sea, Black Sea, Marmara Sea

Introduction
Mytilus galloprovincialis is commonly used for determination of contaminant levels such as radionuclides, trace metals and organic contaminants in marine environment [1-4]. Natural radionuclides are the main source of radioactivity in the marine environment. In addition, artificial radionuclides which released into atmosphere due to nuclear weapon tests and nuclear power plants (NPP) accident such as Chernobyl NPP accident, contribute to existing radioactivity in the marine environment. Some studies were locally carried out for determination of radioactivity concentrations by using various samples in Turkish Sea coast [1,2,4], however, radionuclide levels were not determined in all coast of Turkey in the same period of year by using same bioindicator species. Therefore, this is the first comprehensive study related with determination of radionuclide levels in Turkish coast.

Materials and Methods
The mussel samples (*M. galloprovincialis*) were collected at 20 stations in May 2012 from Turkish coast (8.333 km) (Figure). Due to high seawater temperature *M. galloprovincialis* is not available in Levantine Sea and south coasts of Aegean Sea. Therefore, mussel cages were employed in this area for 4 stations during 6 months (from October to May 2012). After all collected mussel samples were transported to laboratory, the samples with a shell length 4-6 cm were cleaned any external material, their soft tissues were dissected and then dried at 85 ^{0}C to constant weight and homogenized. Activity concentrations of ^{210}Po and ^{210}Pb in soft tissue of mussels were measured using silicon surface barrier detectors connected to multi-channel analyzer alpha spectrometer. Activity concentrations of ^{137}Cs, ^{40}K, ^{226}Ra and ^{228}Ra were measured by using gamma ray spectrometer with HPGe detector.

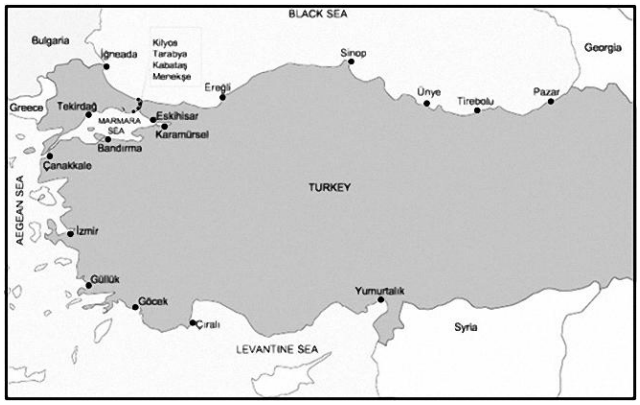

Fig. 1. Passive and active biomonitoring locations

Results and Discussion
It is seen that the activity concentrations of ^{137}Cs were found in very low levels (MDA< - 1.37 Bq kg^{-1} d.w.) in all stations. These results are consistent with levels (0.3-1.9 and 0.86–2.43 Bq kg^{-1}) of previous studies [3,4]. Thebault et al. (2008) determined activity concentrations of ^{137}Cs in the range of 0.01-1.50 Bq kg^{-1} w.w. (wet weight) by using *M. galloprovincialis* in Mediterranean Sea including Turkish coast [5]. In the current study, activity concentrations of ^{137}Cs (0.09-0.31 Bq kg^{-1} w.w.) were found at lower levels, when it was compared with those of aforementioned study [5]. Although ^{40}K was found to be high activity concentrations (391-592 Bq kg^{-1}), ^{226}Ra and ^{228}Ra activities (MDA< - 1.26 and MDA< - 1.68) were found to be low since both of radionuclides are not accumulated in the soft tissues. Activity concentrations of ^{210}Po (26.3-279.6) were found much higher than those of ^{210}Pb (4-23) since ^{210}Pb is not accumulated in soft tissues. The average of ^{210}Po/^{210}Pb ratio (13.9) was found to be similar those of ^{210}Po/^{210}Pb ratio (12.1) which was has been found by some authors [2]. The activity ranges of ^{210}Po and ^{210}Pb were lower than the levels (52-1344, 6-167; 518-2254, 21.5-258.8; 53-1960, 5-135, respectively) of previous studies [2,6,7]. When activity concentrations of studied radionuclides compared with levels of literature, it is seen that radioactivity concentrations are consistent with levels in the present study.

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NUTRIENT CHANGES IN SURFACE WATERS OF THE IZMIT BAY (THE MARMARA SEA) IN 2010-2011

Halim A. Ergül [1] and Ahmet Küçük [2]*
[1] Kocaeli UNiversity, Science and Arts Faculty,Department of Biology, Kocaeli
[2] Çanakkale Onsekiz Mart University, Faculty of Marine Sciences and Technology, Çanakkale - ahmetkucuk55@hotmail.com

Abstract
In this study, it was aimed to examine the relationship among chl-*a*, oceanographic parameters such as temperature, salinity (ppt), pH, dissolved oxygen (DO), electrical conductivity (mS/cm) and Total nitrogen (TN), Total Phosporus (TP), Ammonia-nitrogen (NH_4) and Silicate (SiO_2) between October 2010 and December 2011 in Izmit Bay. Samples were taken once per a month (October 2010- December 2011) in the surface waters (inner and outer bay of the Izmit- Marmara Sea). NO_2, NO_3, NH_3, PO_4 and SiO_2 concentrations were determined spectrophotometrically. The lowest and highest concentrations TN, PO_4-P, SiO_4-Si and chl-*a* were 0.01-0.79 mg/L, 0.03- 0.21 mg/L and 0.72- 14.82 mg/L, respectively. Mean atomic ratio of N/P was lower than the Redfield ratio of 16 for ocean phytoplankton expect July and August 2011, and N was the limiting nutrient.

Keywords: Marmara Sea, Nutrients, Phytoplankton, Chlorophyll-A

Nutrients are essential components of marine life. The most important inorganic nutrients, with respect to euthrophication, are phosphate, total of nitrite, nitrate and slicon. Although most of the nutrients are present in sufficient concentration, lack of them limit growth of phytoplankton. On the other hand their abundance can be cause bloom condition. Izmit Bay is located at the eastern end of the Marmara Sea. It has approximately 45 km long and 1.8-9 km width. The bay is separated into three sections which are known as western, central and eastern. These sections are connected each other with shallow and narrow passages (Balkis 2003). Sea water quality of Izmit Bay is under pressure of heavy industrial and domestic discharges. Treated or untreated industrial and domestic wastes discharges into the Izmit bay and it is necessary to monitor nutrient concentrations in the region. Thus, in this study it is aimed to examine monthly nutrients changes with oceanographic conditions in the surface waters of the Izmit Bay (Fig. 1).

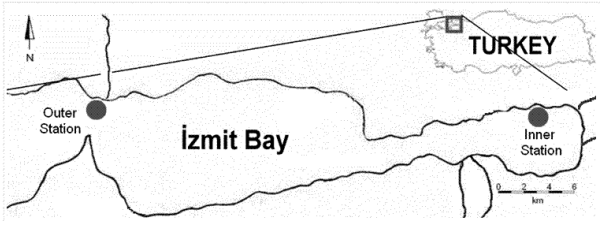

Fig. 1. Sampling stations in the Izmit Bay

Samples were taken once a month (from October 2010 to December 2011) in the surface waters (inner and Outer Bay) of the Izmit Bay (Fig. 1). Nitrite (NO_2), nitrate (NO_3), ammonium (NH_3) phosphate (PO_4) and silica (SiO_2) concentrations were determined spectrophotometrically. Also spectrophotometric techniques were used for determination of Chl-*a* (µg/L). Dissolved Oxygen (mg/L), Temperature (°C), pH, Electrical Conductivity (mS/cm) and Salinity (ppt) were determined by Hydrolab DS-5 Data Sonda. These data were given as average value in the table 1. The ratio between nitrogen and phosphorus varied between 0.15-61.46. Based on the present results, N/P ratio has reached its maximum levels in summer months (i.e. June 2011 and July 2011). Mean atomic ratio of N/P was lower than the Redfield ratio(i.e.16:1) for ocean phytoplankton (except July and August 2011) and nitrogen is assumed the limiting factor. The best N/Si/P ratio for phytoplankton health is about 15/15/1 (Friligos 1981). Thus, lower level Si/P ratio were observed during the sampling period. Maximum concentrations of nitrate + nitrite, phosphate and silicate were determined during winter season because of the low consumption by phytoplankton. The highest Chl-a concentration was measured in winter season in the inner bay possibly related with the nutrient abundance dependent phytoplankton increase. However it is known that Chl-a distribution is depends on other hydro-chemical conditions (e.i. temperature, light conditions, salinity).

Tab. 1. Oceanographich average values and nutrient measurement

		Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar.11	Apr-11	May.11	June-11	July-11	Aug-11	Sep-11	Oct-11	Dec-11	Average
mg/L																
PO^{-3}_4	1	0,04	0,11	0,06	0,06	0,07	0,09	0,05	0,10	0,05	0,05	0,04	0,16	0,09	0,13	**0,08**
	2	0,03	0,05	0,21	0,14	0,18	0,12	0,09	0,16	0,17	0,06	0,04	0,21	0,10	0,21	**0,13**
NO_2	1	0,00	0,00	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00	0,01	0,00	0,00	0,01	**0,01**
	2	0,00	0,00	0,03	0,02	0,02	0,01	0,01	0,04	0,01	0,01	0,01	0,01	0,00	0,01	**0,01**
NO_3	1	-	-	-	0,03	0,11	0,06	0,12	0,03	0,13	2,31	2,36	0,03	0,05	0,02	**0,48**
	2	-	-	-	0,15	0,08	0,05	0,03	0,12	0,09	1,82	0,89	0,03	0,02	0,09	**0,31**
NH^-_4	1	-	-	-	0,08	0,08	0,11	0,07	0,03	0,02	0,05	0,02	0,03	0,04	0,08	**0,06**
	2	-	-	-	0,82	0,16	0,15	0,01	0,12	0,03	0,13	0,02	0,04	0,11	0,23	**0,17**
SiO_4	1	-	-	-	-	-	0,41	0,32	0,21	0,23	0,36	0,38	0,42	0,19	0,47	**0,33**
	2	-	-	-	-	-	0,91	0,45	1,11	0,38	0,27	0,14	0,21	0,15	0,73	**0,48**
N/P	1	-	-	-	0,62	1,57	0,71	2,71	0,46	2,6	47,46	61,46	0,21	0,62	0,18	**10,78**
	2	-	-	-	1,3	0,54	0,49	0,35	0,95	0,55	29,44	24,39	0,15	0,28	0,47	**5,36**
Si/P	1	-	-	-	-	-	4,42	6,88	2,14	4,36	7,50	9,87	2,54	2,05	3,55	**4,81**
	2	-	-	-	-	-	7,62	4,75	6,79	2,28	4,42	3,95	0,99	1,54	3,58	**3,99**
TN	1	-	-	-	0,04	0,06	0,06	0,07	0,03	0,05	0,79	0,79	0,02	0,03	0,03	**0,18**
	2	-	-	-	0,33	0,08	0,07	0,01	0,09	0,04	0,65	0,31	0,02	0,05	0,11	**0,16**
D O (mg/L)	1	7,89	8,94	9,13	8,55	-	9,23	8,83	8,69	8,07	6,69	6,63	6,38	7,91	8,36	**8,08**
	2	7,68	9,96	7,58	9,71	6,96	8,84	9,27	10,31	10,17	6,54	7,70	7,65	7,96	8,30	**8,47**
E C (mS/cm `	1	32,40	33,84	35,09	37,07	-	35,84	35,12	32,89	31,20	33,72	35,84	37,33	40,62	38,61	**35,35**
	2	32,85	31,13	33,26	30,47	38,31	34,47	33,06	30,95	31,23	31,60	32,89	32,89	39,71	34,90	**33,41**
chl-a	1	2,03	4,24	14,82	3,40	-	3,44	4,39	2,32	2,95	1,55	1,97	1,66	3,09	2,90	**3,75**
	2	6,28	7,71	3,24	4,26	0,91	0,72	11,32	9,57	9,02	3,87	3,24	4,28	1,98	0,98	**4,81**
pH	1	8,61	8,81	8,70	8,38	-	8,09	8,28	8,23	8,13	8,41	8,50	8,48	8,28	8,15	**8,39**
	2	8,53	8,76	8,57	8,24	7,96	7,99	8,32	8,24	8,21	8,32	8,48	8,58	8,27	8,15	**8,33**
T (°C)	1	17,53	15,77	13,26	11,67	-	9,90	10,22	14,21	17,87	18,91	19,44	18,32	15,49	11,54	**14,93**
	2	17,02	15,29	12,76	9,66	11,10	8,66	11,18	18,11	21,82	21,00	21,58	19,29	14,39	10,28	**15,15**
Salinity (ppt)	1	20,21	21,24	22,09	23,48	-	22,62	22,12	20,55	19,39	21,14	22,65	23,70	26,01	24,58	**22,29**
	2	20,54	19,33	20,85	18,99	24,36	21,66	20,68	19,22	19,41	19,66	20,57	20,56	25,36	21,96	**20,94**

1: outer bay, 2: inner bay

Since 1950's increasing industry and a growth of human population resulted in a dramatic increase of contaminant discharge to the Izmit Bay. Although treatment plants established in the region substantial level of discharges remain untreated and presents results reveal that nutrient input to the surface waters of the bay is still effective on the conditions that can be stimulate plankton bloom. Following experiments should be composed to understand ecosystem structure and determine recent changes . Long-term monitoring studies in the Izmit Bay are necessary for better understanding in nutrient cycle and plankton distributions.

Acknowledgment: This study was funded by Kocaeli University Scientific Research Unit (BAPB 2009/40).

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CLIMATE CHANGE IMPACTS ON PRIMARY PRODUCTION AND ECONOMICALLY IMPORTANT FISH STOCKS IN THE BLACK SEA

Selin Kucukavsar [1]*, Aysen Yilmaz [2] and Hakan Ercan [3]
[1] Middle East Technical University (METU), Earth System Science (ESS) Program, Ankara, 06800, TURKEY - selin.kavsar@gmail.com
[2] METU-ESS, Ankara/Institute of Marine Sciences, Erdemli- TURKEY
[3] METU-ESS/Deparment of Economics, Ankara-TURKEY

Abstract
Present study deals with the determination of the relationship between climate change and primary production and to understand how economically important fish stocks have been influenced by the variations in primary production in the Black Sea for 1970-2010 period.

Keywords: Primary production, Fisheries, Economic valuation, Global change, Black Sea

Introduction
The Black Sea is very sensitive to environmental changes, anthropogenic impact, and climate forcing. Hydro-meteorological and biochemical data records showed that robust climatic signature at inter-annual to inter-decadal time scales is evident. A general warming trend was observed in the annual mean Sea Surface Temperature (SST) by a continuous rise at the rate of 0.25 ^{o}C with in the last 100 years even though a strong cooling phase in 1992–1993 years were observed [1]. Unfavorable phytoplankton growth is especially reflected at higher trophic levels in the form of their reduced stocks after 1995 since the warming trends were more drastic. SST increase was recorded as 0.96 ^{o}C in the Black Sea for the 1982-2008 period [2]. Similarly, SST data examined for the period of 1958 and 2005 in the North Sea showed shifts in the ecosystem such as unfavorable primary production and decreased cod recruitment during the 1980's due to increased SST [3]. Strong relationship between NAO and SST is clearly evident and these climatic driven changes in the Black Sea are also related with the NAO index [1].

Methodology
Long term (40 years) data available through in situ measurements of lower trophic level ecosystem parameters (METU-Institute of Marine Sciences) and satellite data provided by Goddard Earth Sciences Data and Information Services Center-NASA are evaluated, whereas the data on meteorological parameters and biodiversity change/fish stocks are collected from Turkish State Meteorological Service and Ministry of Food, Agriculture and Livestock respectively. Regression analysis was performed to investigate the relationship between the above parameters and to propose sustainable management strategies, economic and policy tools for Turkish fishery sector for the coming 20 years.

Results and Discussion
One of the main concerns regarding the marine environment is reduced primary productivity and consequently decreased fisheries production due to global warming. The general trends in SST and the Total Catch in the Western Black Sea for the last 40 years has been presented in Figure 1.

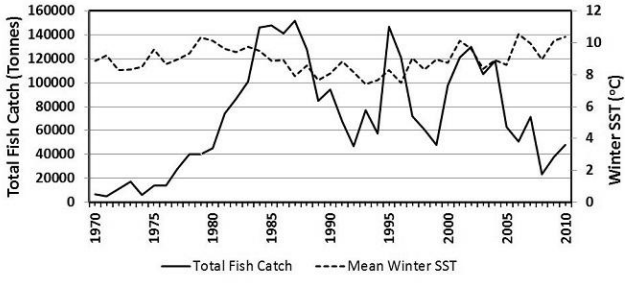

Fig. 1. Total Fish Catch and Sea Surface Temperature (SST) in the Western Black Sea

The eutrophication period after 1970 (intensified after 1980) caused increase in primary production and the related higher trophic level production including fish production. The sharp decrease in the fish catch in the late 1980s was due to the invasion test of a ctenophore, *M. leidyi* which reached very high biomass level (> 1 kg/m2) in 1989. This caused devastation in the regular food chain of the entire Black sea and a sharp decline in the total catch (especially the anchovy catch) observed in 1990s and the introduction of *B. ovata* in 1997, a predator of *M. leidyi*, helped the ecosystem to recover till the beginning of 2000 [4]. The increasing trend in the total fish catch just after irregular cooling period (1992-1993) was separately and clearly defined within this catastrophic ecosystem change. Total fish catch in the Black Sea has declined intensively after 2000 due to increase in the SST which was proved by Mann-Kendall trend (p value=0.0001; α=0.05). Potential consequences of SST increase on the bottom up nutrient flux processes were the main cause for the decrease in the primary production and ultimate fish catch. Figure 2. shows the changes in chlorophyll-a concentrations with respect to changes in SST. Finally, decrease in the profits of fisheries sector was shown using the present data and appropriate models/projections were performed for the coming two decades.

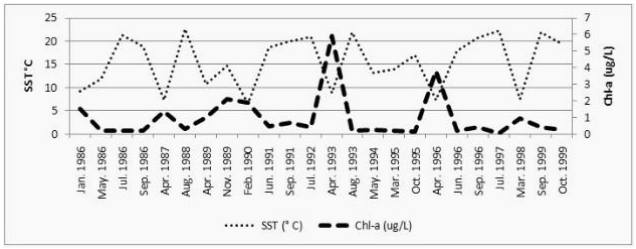

Fig. 2. Western Black Sea Chlorophyll-a in situ measurements and corresponding Sea Surface Temperatures

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EVIDENCE OF ^{210}PO BIOMAGNIFICATION IN SARDINE AND ANCHOVY FOODWEBS FROM STABLE NITROGEN ISOTOPE RATIO IN THE GULF OF LION, NORTH WESTERN MEDITERRANEAN SEA

Emilie Strady [1]*, Mireille Harmelin-Vivien [2], Jean-François Chiffoleau [3] and Olivier Radakovitch [4]
[1] LTHE-IRD, Grenoble, France - emilie.strady@ujf-grenoble.fr
[2] MIOS- Marseille, France
[3] IFREMER, Nantes, France
[4] CEREGE, Univ Aix-Marseille, France

Abstract
In the Gulf of Lion, a pluridisciplinary project (COSTAS) combining ecology and biogeochemistry of contaminant aims at understanding the trophic transfer of contaminant, including ^{210}Po, a natural radionuclide which induces the highest internal radioactive dose in fishes. Based on ^{210}Po concentrations and δ^{15}N measurement on seawater, SPM, five size classes of plankton, anchovy and sardine, we demonstrated for the first time the biomagnification of ^{210}Po among sardine and anchovy foodweb.

Keywords: Gulf of Lyon, Food webs, Bio-accumulation, Radionuclides, Plankton

Introduction The COSTAS project aims at understanding the trophic transfer of metallic and organic contaminants through seawater, phytoplankton, zooplankton, sardine and anchovy populations in the Gulf of Lion (NW Mediterranean Sea). Its originality is to combine the ecology of the trophic web with the biogeochemistry of organic and metallic contaminants. Here we present the evidence of ^{210}Po (natural radionuclide from ^{238}U decay chain) trophic transfer in the foodweb of these fishes in the Gulf of Lion.

Material and method Seawater, SPM and plankton were sampled in May 2010 and February 2011 in the Gulf of Lion at different sampling sites from east to west. Seawater was pumped at the Chl-*a* maximum and filtered through a 0.45µm filter for SPM analysis. Small plankton organisms were sampled by pumping seawater at the Chl-a maximum followed by onboard filtration through 200µm, 60µm and 6µm mesh size plankton nets. Two small plankton size fractions were retained [6-60µm] and [60-200µm]. A trawling system (200µm mesh) was used to get larger plankton organisms. Plankton was collected during 30 min and sieved onboard through three different meshes: 2000µm, 1000µm, 500µm and 200µm to get four large plankton fractions: [200-500µm], [500-1000µm], [1000-2000µm] and [>2000µm]. ^{210}Po and δ^{15}N analysis and measurement were performed at the CEREGE and MIO laboratories.

Results and discussion A strong spatial structuring of sites based on ^{210}Po concentrations was evidenced by hierarchical clustering, both in spring (May 2010) and winter (February 2011). In May, ^{210}Po concentrations presented values significantly different according to size : the highest concentrations were recorded in SPM and the [6-60µm] fraction, and the lowest value in the dissolved phase and the largest size fraction [>2000µm], while ^{210}Po concentrations did not differ significantly among plankton fractions from [60-200µm] to [1000-2000µm]. In February, 210Po concentrations presented homogenous values in particulate matter and plankton fractions in the Gulf of Lion. However, higher ^{210}Po concentrations were observed for each period in the eastern part (Figure 1).

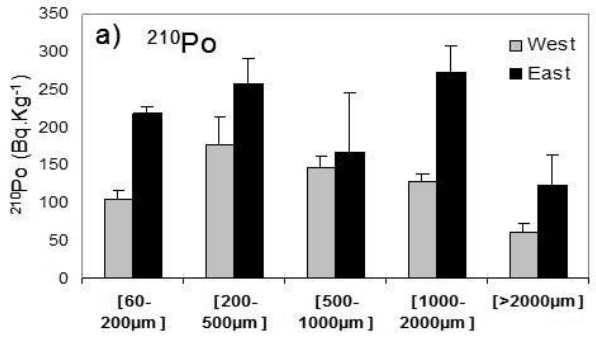

Fig. 1. Figure 1: Mean (+ SE) concentrations of ^{210}Po in the different size fractions of plankton in the East and West parts of the Gulf of Lions

^{210}Po concentrations in both species decreased in the following order: liver~gonads>fish remains>muscles. Concentrations were significantly different between species, with higher concentrations measured in anchovy (tissues and whole fishes, t-tests, $P<0.01$ for all tissues). In May, δ^{15}N was significantly lower in the largest size class [>2000µm], while in February, highest δ^{15}N was measured in the [1000-2000µm] fraction and the lowest in the [60-200µm] fraction. Like ^{210}Po, δ^{15}N was higher in the East than in the West part of the Gulf of Lion for each period Significant positive linear relationships were observed between Log^{210}Po (y) and Logδ^{15}N (x) in plankton size fractions in May ($y = 1.809x + 1.192$, $R^2 = 0.85$, $P<0.001$) and February ($y = 0.636x + 2.147$, $R^2 = 0.59$, $P<0.01$). However, the slope and accuracy of the relationships were higher in spring than in winter. For investigating a possible biomagnification of ^{210}Po in the food webs of sardine and anchovy, ^{210}Po and δ^{15}N values in a whole fish were used[1], along with mean concentrations in plankton fractions from the two sampling dates. Then, a similar significant positive linear relationship between Log^{210}Po and Logδ^{15}N was observed from plankton to the two zooplanktivorous fish species (Figure 2). This relationship demonstrates the biomagnification of ^{210}Po along the food webs of these zooplanktivorous fishes, related to the trophic level (δ^{15}N) of organisms. Such relation is shown here for the first time along the complete foodweb structure.

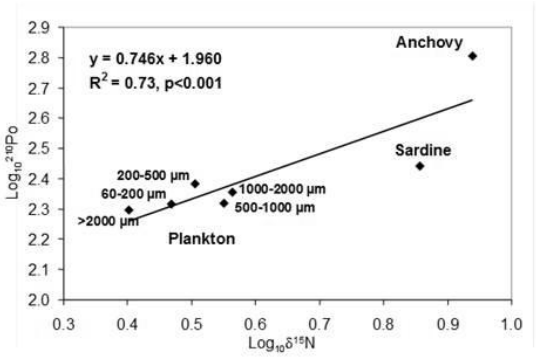

Fig. 2. Figure 2: Biomagnification of ^{210}Po in the food webs of two small pelagic zooplanktivorous fishes, *Sardina pilchardus* (sardine) and *Engraulis encrasicolus* (anchovy) in the Gulf of Lions.

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Session

Good Environmental Status, indicators

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POPULATION DYNAMICS, BIOLOGY AND STATE OF EXPLOITATION OF THE NORWAY LOBSTER (*NEPHROPS NORVEGICUS*) IN THE BALEARIC ISLANDS

Beatriz Guijarro [1]*, Natalia González [1], Vanessa Rubio [1] and Enric Massutí [1]
[1] Instituto Español de Oceanografía. C.O. Baleares - beatriz@ba.ieo.es

Abstract
The Norway lobster (*Nephrops norvegicus*) is the target species of the deep-water bottom trawl fishery carried out in the upper slope (250-500 m) off Mallorca (Balearic Islands). This study aims to analyse the trends in its catches per unit of effort, as well as its population dynamics and biological parameters, and to assess its state of exploitation. Biological information has been calculated for this species in this area for the first time and used as input parameters for the stock assessment. The current fishing mortality is higher than the reference point $F_{0.1}$, which indicates that the stock is subjected to overfishing.

Keywords: Decapoda, Population Dynamics, Stock assessment, Growth, Balearic Islands

The Norway lobster (*Nephrops norvegicus*) is one of the main fishing resources of the deep-water bottom trawl fleet from the Balearic Islands, representing up to 7% in biomass and 10% in economic value from all the deep-water crustaceans landed [1]. Although landings from this species showed a negative trend between 1986 and 1995 [2], an improvement in its state of exploitation, using indicators, has been detected [3]. Even though it is the main target species from the upper slope, between 250 and 500 m depth, no previous studies have been carried out on its biology in the area, with a lack of information for parameters such as growth curve, length-weight relationship or maturity ogive.

The objectives of this study were: (i) to analyse the annual, seasonal and geographical trends of the catches per unit of effort of *N. norvegicus* from the bottom trawl fleet off Mallorca; (ii) to analyse the population dynamics of this species and calculate its growth parameters; (iii) to analyse the reproductive biology (spawning period, maturity ogive, fecundity) and other biological traits such as condition index and length-weight relationship and (iv) to assess the state of exploitation of the species using traditional assessment methods. Data were obtained from different sources: (i) official landings from the bottom trawl fleet; (ii) monthly sampling on-board trawlers; (iii) annual bottom-trawl surveys; and (iv) on-board and in-laboratory individual biological sampling. Annual, seasonal and geographical trends were analysed by Generalized Additive Models and the state of exploitation was analysed by Extended Survivor Analysis (XSA) and Yield per Recruit (Y/R) analysis.

Data analysed from the commercial fleet covered years between 2000 and 2011 and from the scientific surveys from 2001 to 2011. Biological sampling was performed seasonally between 2010 and 2012 and annually between 2001 and 2011. Annual landings from the bottom trawl fleet off Mallorca oscillate between 5 and 32 tons, with an average size of approximately 36 mm carapace length (CL, Figure 1). Length-weight relationship showed a positive allometry (b= 3.4) and length at first maturity for females was established at 37 mm CL. The Von Bertalanffy growth function parameters were estimated as L_∞= and k= 0.126, showing a slow-growth performance.

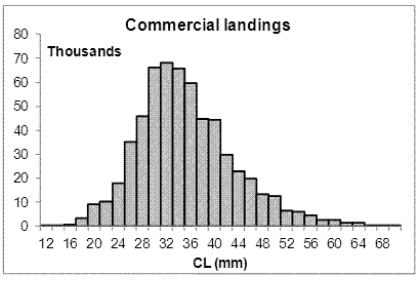

Fig. 1. Size frequency distribution of *N. norvegicus* from the bottom trawl commercial landings (average 2002-2011).

XSA showed a quite stable population during the years analysed (Figure 2a), with its total abundance around 10.5 million individuals, recruitment abundance around 5.5 million individuals, total biomass around 95 t and spawning stock biomass around 46 tons. Fishing mortality was estimated between 0.3 and 0.6, with a current value of 0.45 (average of the last three years). Y/R (Figure 2b) showed this current fishing mortality higher than the reference point $F_{0.1}$ (0.13), which indicates that the stock is subjected to overfishing.

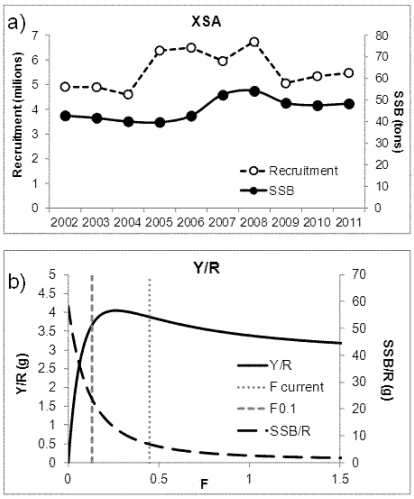

Fig. 2. Results from the Extended Survivor Analysis (XSA, a) for *N. norvegicus* showing the recruitment abundance and spawning stock biomass (SSB) and from the Yield per Recruit analysis (Y/R, b), showing the current F (0.45) and the reference $F_{0.1}$ (0.13).

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ETUDE PRELIMINAIRE DE LA STRUCTURE DES PEUPLEMENTS DE FORAMINIFERES DU GOLFE DE TUNIS

Samia Khabouchi [1]* and Atf Azzouna [1]
[1] université de Tunis El Manar: Fac. Sciences - khab.sami@yahoo.fr

Abstract
The structure of Foraminifera from the Gulf of Tunis revealed large differences between the various environmental factors between the stations studied. Water quality, dissolved oxygen, salinity and granulometry are limiting factors. The Foraminifera responded to different abiotic stess by a special change in their specific composition and the appearance of morphological abnormality of their tests, therefore they are used as bio-indicator of pollution. Keywords: Foraminifera, bio-indicator, diversity, Gulf of Tunis.

Keywords: Bio-indicators, Gulf of Tunis

Introduction
Le Golfe de Tunis, à cause de sa côte la plus urbanisée de la Tunisie, est le siège d'une forte pression anthropique. Ce qui nécessite un suivi et une attention particulière à sa biodiversité. Les Foraminifères sont de bons indicateurs des changements de l'environnement pour multiples raisons dont: (i) un cycle de vie trés court (1 à 3 mois en moyenne, 1an maximum, [4]), (ii) des préférendums écologiques spécifiques à chaque espèce [3], (iii) une grande diversité qui fait partie majoritairement de la méiofaune, (iv) une réaction rapide au stress environnemental comme les variations de l'oxygène dissous, du pH, de la température, de la salinité, de la granulométrie et de la qualité de l'eau. Dans le présent travail, et en se basant sur les facteurs cités ci-dessus, la structure des peuplemens des Foraminifères est comparée entre cinq stations du Golfe de Tunis afin d'évaluer la réponse de ces protistes au variations des différents paramètres et de tirer l'attention sur l'état actuel des stations prospectées.

Matériel et Méthodes
L'échantillonnage est réalisé entre janvier 2010 et juillet 2011, à partir des cinq stations suivantes du Golfe de Tunis: Sidi Rayes, BorjCedria, Radès, la Goulette et la Marsa. Deux types de carottes de 2cm de diamètre et de 6 et 10cm de hauteur sont enfoncées à un mètre de profondeur, retirées délicatement et bouchées des deux cotés. Au laboratoire, le tri des espèces s'est fait par des pinces trés fines et effilées. Les échantillons triés ont été conservés surtout à sec. Les différents mesures sont effectuées à l'aide d'un multiparamètre; la classification granulométrique est celle de Lansonneur, 1977. [2]

Résultats et Discussion
Les cinq stations prospectées sont toutes polluées sauf celle de Sidi Rayes. Cette dernière est la moins riche en espèces avec une richesse spécifique Rs=18. La fréquence (fi) est très variable oscillant entre: espèces rares (0.05< fi<1%) et très fréquentes (1< fi < 5%). Les facteurs abiotiques de cette station, mis à part la qualité des eaux, sont comparables à ceux de la station de Borj Cedria(tab 1) ; mais, la diversité spécifique est totalement différente entre les deux. Ce qui permet de suggérer que la qualité des eaux est un facteur majeur dans la vie des Foraminifères. La Goulette, qui est une station très polluée, à forte conductivité (36.04) et à faible teneur en oxygène dissous (71%) est la station la plus riche en espèces (34 espèces). Les espèces trés rares (0.05% < fi) -*Lagena sp*1 *et Lagena sp* 2- sont typiques de cette station. *Rosalina bradyi* est une espèce trés fréquente et spécifique des eaux polluées. La taille et la couleur du test d'une même espèce varie considérablement d'une station à une autre, du plus petit et souvent foncé en milieu pollué au plus grand et clair en milieu propre; il s'agit d'une adaptation aux conditions de stress: les Foraminifères réduisent leur taille pour s'adapter au type de sédiment où ils vivent et pour diminuer la consommation d'oxygène réduite en milieu pollué. L'étude granulométrique montrent que : (*)certaines espèces n'ont pas de préférence granulométrique comme *Qinqueloculina* et *Elphipium* qui se rencontrent du sable très grossier à très fin (les stades juvéniles), ainsi que les *Ammonia* avec une légère préférence pour le sable moyen à grossier, (*)la plupart des espèces préfèrent le sable moyen à fin particulièrement *Rosalina*, (*)le sable très fin ne contient que les stades juvéniles, (*)la granulométrie agit sur la croissance du test des espèces (tab 2).

Tab. 1. Données écologiques des stations étudiées

Station	Température (°C)	pH	Oxygène dissous (%)	Conductivité PPM	Salinité (g/l)	qualité des eaux
la Marsa	19.6	8.45	72.2	34.780	34.78	polluée
la Goulette	19.3	8.4	71	36.040	36.04	très polluée
Radès	20.3	8.29	74	35.360	35.360	très polluée
Borj Cedria	19	8.35	71	34.140	34.140	polluée
Sidi Errayès	23	8.35	71	34.100	34.1	propre

Tab. 2. Répartition des genres de Foraminifères selon le type de sédiment

	Sable trés grossier	Sable grossier	Sable moyen	Sable fin	Sable trés fin
LA MARSA	----	*Ammonia*	Reste des espèces	*Rosalina* *Ammonia*	Stade juvénile
LA GOULETTE	----	*Quinqueloculina sp* +++ *Ammonia*	*Ammonia* *Triloculina* *Elphidium*	*Quinqueloculina* *Ammonia* *Massilina*	Reste des espèces
RADES	*Elphidium*	*Ammonia* *Elphidium*	*Rosalina* *Ammonia* *Quinqueloculina*	*Globigerina* *Rosalina*	Espèces juvéniles : *Rosalina* *Globigérinides*
BORJ CEDRIA	-----	*Ammonia* *Elphidium* *Quinqueloculina*	*Quinqueloculina* *Elphidium* *Ammonia* *Triloculina*	*Quinqueloculina* *Ammonia*	*Ammonia*
SIDI RAYES	*Quinqueloculina*	*Ammonia* *Cornuloculina*	*Quinqueloculina* *Elphidium* *Massilina* *Ammonia*	La plupart des espèces	Stade juvénile

Conclusion
La réponse fonctionnelle des Foraminifères à des modifications soudaines du milieu est utilisée comme indicateur de pollution.

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ORGANOTIN LEVELS IN MARINE ORGANISMS FROM EASTERN AEGEAN COAST (TURKEY)

F. Kucuksezgin [1]*, S. Aydin-Onen [1], L. Gonul [1], I. Pazi [1] and F. Kocak [1]
[1] Dokuz Eylul University Institute of Marine Sciences and Technology - filiz.ksezgin@deu.edu.tr

Abstract
The average concentrations of TBT ngSng^{-1} were found as 235 in fish, 116 in mussels and 635 in barnacles. All mussels sampled showed values of TBT+DBT, which were below the "tolerable average residue level (TARL)" as currently accepted. Barnacles have high potential as biomonitors for the presence of organotin in the Aegean Sea.

Keywords: Aegean Sea, Fishes, Bio-accumulation

Introduction

Since the early 1960s organotin compounds (OTs) have been used for several purposes, such as polyvinyl chloride stabilizers, fungicides and as antifouling agents in ship paints [1]. Many countries worldwide have banned the application of TBT-based paints to small vessels (<25m) and butyltins have been identified as priority hazardous substances [2]. Due to the ongoing legislative restrictions, various studies worldwide have shown a slow decline on TBT contamination [3]. There have been a few studies on the distribution of OTs in Turkish coastal areas. This study aims firstly to create a baseline regarding organotin levels in mussel, barnacle and fish tissues; secondly to gather more information on the use of selected species as biomonitors and finally to evaluate potential risks for butyl tin species contamination in seafood along the Eastern Aegean coast as sampled in 2009.

Material and Methods

In the present study, different marine species were sampled for BTs analysis in terms of their different feeding strategies. Samples were collected from the Saros, Candarli and Izmir Gulfs along the Eastern Aegean coast, during 2009. Marine biota samples were analysed according to Cassi et al. [4]. Mussel (ERM-CE477) sample was used as a control for the analytical methods.

Results and Discussion

TBT concentrations ranged between 134-368, 186-275, 157-198, 181-260, 276-327 ng Sn g^{-1} ww for *M. barbatus, D. annularis, M. merluccius, S. vulgaris, P. erythrinus*, respectively. Total BTs concentrations, and in particular the TBT, in barnacles were generally higher (396-1163ng g^{-1}ww) than those monitored in the mussel and fish species sampled along the Eastern Aegean coast. MBT was the dominant species in mussels, fish and barnacles. This may indicate that MBT is derived not only from the dominant breakdown product of TBT degradation but also from other sources, such as city sewage, industrial wastewater etc. Based on average seafood consumption for Turkey, TARL was found to be 680 ng TBT g^{-1} (279 ng Sn g^{-1}). A comparison of the results of the present study with the TARL indicated that three samples for fishes were found to exceed the TARL when only TBT is considered. Only *Solea vulgaris* samples were below the TARL if both the sum of TBT+DBT and TBT were considered. For mussel samples, whole values were below the TARL, thus confirming that this group is the one posing no risk for consumers. But, in contrast all barnacle samples exceeded the approved TARL.

Conclusion

Tolerable Average Residue Levels of TBT+DBT based on the average weight of 60 kg exceeded in 50% of the fish sampled. The levels of organotin compounds derived seafood in the Eastern Aegean Coast of Turkey constitute “a risk to humans” as presently defined. Although bivalves are the most commonly used organisms as biomonitors, this study showed that barnacle *A. amphitrite* may be considered among the most sensitive organisms for biomonitoring programs due to their high accumulation capacity for absorbing BT compounds from their surroundings.

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PINNA NOBILIS AND EPIPHYTIC FORAMINIFERA AS POTENTIAL BIOINDICATORS OF HEAVY METAL POLLUTION IN BALEARIC ISLANDS (WESTERN MEDITERRANEAN)

M. Morató Trobat [1]*, A. Khokhlova [2], S. Deudero [1], G. Mateu-Vicens [2], M. Vázquez-Luis [1] and J. Campillo [3]
[1] Centro Oceanográfico de Baleares-IEO - merce.morato@ba.ieo.es
[2] Cátedra "Guillem Colom Casasnovas", Universidad de las Islas Baleares
[3] Centro Oceanográfico de Murcia-IEO

Abstract
Metal (Cd, Cu, Hg, Pb, and Zn) concentrations and percentage of deformed foraminifera were measured in soft tissues of *P. nobilis* and sediment samples, respectively, in order to assess pollution levels in Baleraric Islands.
Analyses of Cabrera and Mallorca indicated that heavy metal concentrations were generally higher in the majority of samples, specially in Santa Maria bay (Cabrera, MPA), where high percentages of deformed shells (up to 26 %) and high values of metal pollution index (38.171 mg/Kg) were found.

Keywords: Balearic Islands, Bio-indicators, Bivalves, Foraminifera, Metals

Introduction
Heavy metals are an special group of contaminants, being the most common environmental pollutants and can be either adsorbed onto sediments or accumulated in benthic organisms, sometimes to toxic levels [1].
Pinna nobilis L., 1758 is a fan mussel endemic to the Mediterranean Sea and is considered the biggest bivalve mollusc of this area. It is common within the seagrass meadows of *P. oceanica*,is a long-lived species, benthic filter and easy to find at the seabottom. Foraminifera are protozoans with an external skeleton (shell), forming one of the most conspicuous groups in the epiphytic community of the *P. oceanica*. Foraminifers are very abundant in all marine environments, they have relatively short life-cycles and they react quickly to environmental changes at global and a local scale, are highly adapted to well-defined ranges of environmental parameters and pollution. Analysis of soft tissues of endemic bivalve *Pinna nobilis* revealed high heavy metals levels. The analysis of foraminifera assemblages revealed considerable amounts of individuals with deformed shells. These organisms are known as being significant bioindicators for monitoring seagrass meadows ecosystems, therefore their specific response to environmental changes can indicate the presence of the pollutants [2].

Materials and methods
The study area comprehends four localities from the Balearic Islands, situated in Mallorca (Andratx and Magaluf) and Cabrera (Santa Maria bay and Els Estels - only foraminifera samples). Mallorca is the biggest island of the Balearic Islands, which is located in the Western Mediterranean. The study area is located in the southern part of the island, two stations, Magaluf and Andraxt, with different degrees of anthropic impact was investigated and the other stations, Santa Maria bay and Els Estels (only foraminifera samples) were observed in Cabrera island (9 km south-east of Mallorca) which is characterise by the excellent conditions with low anthropogenic impact, and has the maximum degree of protection since 1991(LAW 14/1991).
Fourteen *P. nobilis* samples were taken in October 2011 by scuba diving and samples of foraminifera were collected over soft bottoms colonized by *P. oceanica* from May to November 2012 in the same sites. Concentrations of Cd, Cu, Pb and Zn were determined by atomic absorption spectrometry (AAS), and Hg was determined by Advanced Mercury Analyzer (AMA 254). For comparison of total metals at the sampling sites, the metal pollution index (MPI) was applied ([3]; [4]).

Results and discussion
Species identification and morphometric analyses of benthic foraminifera revealed high percentages of deformed shells, from 7% in Andratx, to the highest value in Santa Maria Bay (up to 26%) where only 1% of deformed shells in natural population can by present. Metal Pollution Index (MPI) mean concentrations in soft tissues of *P. nobilis* samples (dry weight) range from 6.22 mg/Kg in Andratx, 34.45 mg/Kg in Magaluf, and 38.17 mg/Kg in Santa Maria bay.

Higher values of heavy metals agree the highest percentages of deformed foraminifera, thus MPI and percentage of deformed foraminifera reaches the maximal value in Santa Maria bay and the minimal value in Andratx. The metal pollution index reaches the maximal value for Santa Maria Bay can be explained by the fact that the highest concentrations of three metals (Cd, Pb and Zn) out of the five considered.

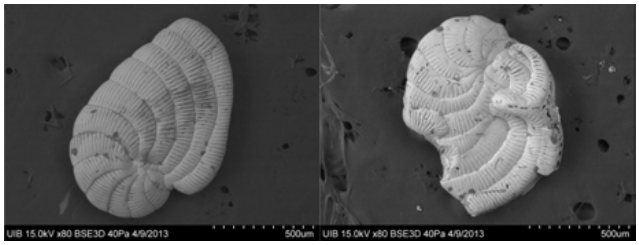

Fig. 1. Normal and deformed foraminifera *Peneroplis planatus* from Cabrera, Balearic Islands.

Conclusions
The high percentage of abnormal tests and metal pollution index indicates the presence of heavy metal pollution higher in Cabrera, marine protected area. Generally, the most effective bio-monitoring approach is to use several species representing differing trophic levels [5]. Therefore, the use of these organisms as bioindicators can be very useful in determining the health of seagrass meadows ecosystems in areas that have no obvious symptoms of degradation.
Assessing bioaccumulation is also a component of international efforts to identify and control chemicals of environmental concern, and there is a need to establish reliable procedures for estimating bioaccumulation potential from knowledge of properties of the substance.

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A CHEMOTAXONOMICAL APPROACH TOWARDS SYNTHETIC INDICATORS OF MAIN PHYTOPLANKTON GROUPS IN THE CONTEXT OF MSFD

R. Casotti [1], M. Saggiomo [1]*, O. Mangoni [2], F. Margiotta [1], V. Saggiomo [1] and I. Santarpia [1]
[1] Stazione Zoologica Anton Dohrn - m.saggio@szn.it
[2] Dip. di Biologia, Università di Napoli 'Federico II', Napoli, Italia

Abstract
Chemotaxonomy of algal liposoluble pigments is proposed as a synthetic indicator of phytoplankton group composition to be used in the assessment of chlorophyll concentrations and shifts in groups composition (diatoms to flagellates) as required by the MSFD.

Keywords: Phytoplankton, Eutrophication, Tyrrhenian Sea

Introduction
In order to pursue the Good Environmental Status (GES) with the aim to reduce the negative effects of anthropogenic eutrophication, the MSFD includes several criteria to be followed, among which, for Descriptor 5 (Eutrophication), total chlorophyll concentrations and the shift in the diatom-to-flagellate ratio. Within this Descriptor, the assessment is based on the nutrient concentrations in the water column and their direct and indirect effect on Chl *a* concentration and species shift in floristic composition (e.g. diatom to flagellate ratio) used as indicators. However, the tools to reach the described criteria are not clearly defined neither agreed upon. In recent years, the chemotaxonomical approach to phytoplankton community composition is spreading. This is based on the observation that some pigments can be mainly attributed to specific algal classes and/or types and are therefore used as taxonomical markers (Mangoni *et al*., 2008). This approach allows to map the main functional groups including smaller size groups usually underestimated by microscopical counts. This works aims at analyzing the temporal dynamics of main phytoplankton groups along the water column at a fixed station in the Gulf of Naples from 2003 to 2010 as related to macro-nutrients and water column dynamics.

Materials and methods
The sampling was carried out weekly from 2003 to 2010, at LTER Station MareChiara. Sea water samples were collected from 4 to 5 depths (0, 10, 20, 40, 60 m) for the determination of nutrient and chlorophyll concentrations and HPLC liposoluble pigments. The contribution of the various functional groups to the microalgal biomass (in terms of Chl *a*) was determined by using the ChemTax software (Latasa, 2007).

Results
The sampling period was characterized by cold winters (from 2003 to 2006) and hot summers except for the winter of 2007. This was the warmest winter in the recorder period and prevented the winter-mixing that usually drives the injection of new nutrients from deeper waters. The multi-year distribution of salinity showed a strong influence of anthropogenic inputs at surface, traced by lower salinity waters. Diatoms dominated phytoplankton, representing up to 53% of the total biomass, in terms of chlorophyll and also closely matched its variability in time, with two peaks, in spring and autumn. The other major algal groups showed a large interannual variability in contribution to total phytoplankton biomass (Fig. 1a). Principal component analysis (annual average values) of phytoplankton groups as related to environmental parameters shows a close correlation between total biomass, nutrients and diatoms (Fig. 1b). In the years from 2007 to 2010 there was less variability in the biotic and abiotic properties of the water column. The distribution of phytoplankton biomass in surface was usually significantly correlated to anthropogenic inputs in terms of less saline waters. Diatoms show higher contribution in the coldest winter (2004, 2005, 2006) as related to active vertical mixing and the consequent injection of nutrients from deeper waters. These years were also characterized by an increased presence of Pelagophyceae. Chlorophytes did not show any clear correlation with any environmental variable, with a constant contribution along the years.

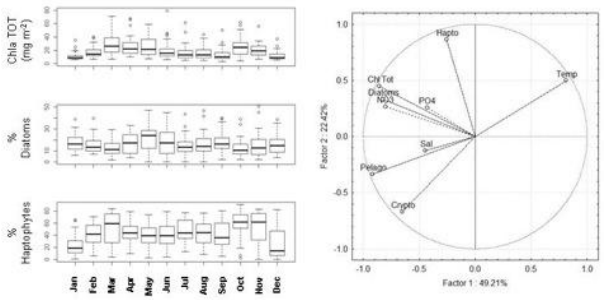

Fig. 1. Pluriannual and seasonal distribution of phytoplankton principal functional groups (a) in relation to environmental parameters (b)

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USING FISHERY INDICATORS FOR THE EVALUATION OF THE STATUS OF TWO COMMERCIALLY IMPORTANT DEMERSAL STOCKS IN THE CENTRAL AEGEAN

Andreas Palialexis [1] and Vassiliki Vassilopoulou [1]*
[1] Hellenic Centre for Marine Research - celia@hcmr.gr

Abstract
State and pressure indicators describing the status and the trends of two commercially important species (*Merluccius merluccius* and *Parapenaeus longirostris*) were estimated using both fishery-dependent and fishery independent data. Both species, targeted by trawl fishery in the Central Aegean Sea, account for the highest proportion of catch and annual gross income. Results revealed signs of deterioration of the two stocks for the study period (2003-2008).

Keywords: Fisheries, Aegean Sea, Demersal

The use of indicators as tools to identify changes, quantify problems and monitor the implementation of policies and regulations is developed rapidly in fisheries and ecosystem fields [1]. The importance of such indicators is highlighted through the Marine Strategy Framework Directive (MSFD 2008/56/EC) to achieve and maintain the Good Environmental Status in European Waters. In this study we quantified selected state and pressure indicators using trawl fisheries data, derived from the EU Data Collection Regulation programme, to assess the status, and study possible trends of two commercially important species – the hake (*Merluccius merluccius*) and the deep-water rose shrimp (*Parapenaeus longirostris*) - in the Central Aegean Sea.

State indicators describing key features of the populations of the two species, were quantified using data derived through fishery independent surveys (MEDITS surveys, in this case), and included: total stock biomass, and descriptors of length structure (i.e. 25% and 75% percentiles of the length distribution for small and large individuals respectively). Pressure indicators describing the intensity of fishing (i.e. the input to the fishing activity) were taken from official records and included: fleet size and effort expressed as Days-at-Sea. Pressure indicators describing catch & discards (i.e. the output of the fishing activity), were based on records made by observers on board commercial vessels, and included: catch and discards amount in weight and numbers per species, minimum, mean and maximum size of catch and discards. For comparative purposes data from both experimental and on-board surveys covered the same period i.e. 2003-2008 (except for 2007, when no data were available). All indicators were tested for significant trends by applying a simple linear regression and evaluating the significance of the slope.

The fleet size of trawlers in Greece presented a slight decline from 2003 to 2008 (336 to 323 respectively), with the majority of the vessels operating in the Aegean Sea (~90%). However, no change in Days-at-Sea has occurred across the time-series.

Deep-water rose shrimp, the top landed species in the Aegean Sea, was landed in lengths lower than the Minimum Landing Size (MLS). Regarding pressure indicators, the discard weight slightly increased over 2003-2008, with neither catch weight nor discarded fraction exhibiting any significant trend. Moreover, a significant decreasing trend appeared in the minimum catch sizes. Biomass state indicators showed also a significant decline during the study period.

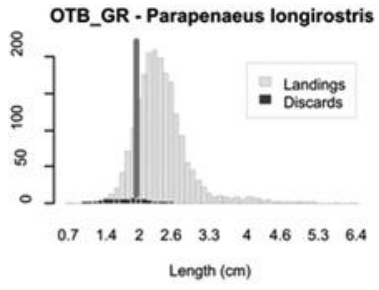

Fig. 1. Length composition of deep-water rose shrimp caught by the Greek trawlers in the Central Aegean Sea. Dark gray illustrates discards, light gray landings, and the Minimum Landing Size bar is at 2cm carapace length.

Hake was landed below the MLS and the discarded proportion consisted of the very small sized individuals. Discard weight and discard ratio of the species increased in the Aegean Sea over the 2003-2008 period. As for state indicators, the high percentile (95%) of population length distribution exhibited a significant decline, suggesting the existence of a decreasing trend in the size of larger individuals during the study period in the central Aegean Sea.

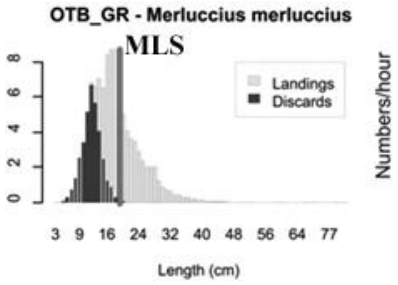

Fig. 2. Length composition of hake caught by Greek trawlers in the Central Aegean Sea. Dark gray illustrates discards, light gray landings and the Minimum Landing Size bar is at 20cm total length.

Our findings highlight the existence of signs of deterioration of the status of the two stocks over the period under study. However, the recent implementation of the EC Regulation 1967/2006 imposing a modification to the cod-end mesh opening to either 40 mm square or 50 mm diamond, as well as the banning of the operation of trawl vessels within 1.5 NM off the coast may have contributed towards improving the status of fishery resources, but this could not be confirmed due to the lack of data since 2008. Furthermore, it should be pointed out that the weak compliance of Greek fishermen to the national and EU regulations, particularly regarding the MLS [2], resulted in less discards of the two species, in cases when individuals smaller than the MLS had a market demand.

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Session

Good Environmental Status, tools & methods

Modérateur : **Marc Bouchoucha**

TO THE COMPLEX ESTIMATION OF BIOLOGICAL SIGNIFICANCE OF MARINE AREAS

Borys Aleksandrov [1]*, Gaina Minicheva [1] and Yuvenaliy Zaitsev [1]
[1] Institute of Biology of Southern Seas Odessa Branch, NASU - alexandrov@paco.net

Abstract
One of the key tasks of EC Water Frame Directive (2000) is the warning of degradation of aquatic ecosystems. The concept «good environment status» is offered for the determination of the grade of deviation between analyzing aquatic ecosystem and the desirable level, for this purpose 11 descriptors have been worked out. The index of biological significance of aquatic area (K_f) has similar aim. It combines the characteristics of biodiversity, water quality and anthropogenic effects in investigating area. The possibilities of this new index have been illustrated on the example of off-shore aquatic areas of the Black and Azov Seas within the limits of Ukraine.

Keywords: Conservation, Biodiversity, Black Sea

Introduction
Ukraine has the biggest coast line (1628 km, or 37%) and the largest shelf area (55750 km^2, or 57%) among all Black Sea countries. It is explained by the fact that from 33 of the wetlands of internationally importance the 19 Ramsar's sites are located in Ukraine. The largest part of marine protected areas is situated on the coastal zone of Ukraine in the Black Sea and the Sea of Azov. All of 5 marine coastal ecotones, registered in European seas, are located in the Black sea as well. Among 37 benthic biocenoses - 35 are found in Ukraine. The aim of this study is to work out the methodology of a quantitative appraisal of biological value determination of marine aquatic bodies and settings (lagoons, bays etc.) for creation of new, or expansions of existent marine protected areas.

Methodology
The complex (integrated) index of biological significance of aquatic object (K_f) has been worked out for creation of new or widening the existence of marine protected areas. It was tested on 34 aquatic areas in Ukrainian part of the Black Sea and the Sea of Azov: 13 – bays, 13 – limans (estuaries), 2 – lagoons, 2 – lakes, 1 – Delta (Danube), 1 – Island (Zmeiny), 1 – exposed shelf area (Zernov's Phyllophora Field), 1 – strait (Kerch).The ecological state of analyzing aquatic bodies and settings of Ukraine has been described from accessible literatures data from more than 100 references.

Result and Discussion
Three direct characteristics of biological significance were used in K_f: total number of Red Data Book species, total number of macrozoobentic species; total number of benthic biocoenoses. Besides, for calculation of the K_f value three characteristics of aquatic productivity that reflected the water quality in the whole have been considered: primary production of phytoplankton; primary production of benthos, that has been calculated as average value of specific surface of three dominant species of macrophytobenthos [2]; ratio of total biomass of plankton and macrozoobenthos under the square meter of sea surface. The last (seventhes) characteristic including in the equation for determination of K_f was anthropogenic effect factor (K_{AI}). The given characteristic was calculated for each investigating area by the generalized matrix of expert assessments of ecological processes in the Black Sea coastal zone. K_{AI} includes 27 – stress factors and 15 types of their possible effect on ecosystem. There are 10 kinds of anthropogenic effects with different influence on biological characteristics of aquatic ecosystems (positive or negative): 1) industry, 2) agriculture, 3) pisciculture, 4) sea transport, 5) municipal economy, 6) coast protection, 7) hydro-power engineering, 8) tourism and resorts, 9) nature conservation, 10) environmental education and environmental ethics [3]. Average significance of the K_{AI}-index reflected the influence of different types of anthropogenic effects (starting from negative effects, for example agricultural runoff and industrial wastes, up to positive one – the activity of the environmental inspections). The map "Recommendations for the establishment of new and the expansion of existing protected areas in the coastal waters of the Black and Azov Seas" has been prepared on the bases of carried out K_f value calculations [1].This work has been carried out under the financial support from the side of "Towards Coast to Coast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential" Project.

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REMOTE HIGH-DEFINITION ROTATING VIDEO FOR FAST SPATIAL SURVEY OF COSTAL MEDITERRANEAN MARINE UNDERWATER MACROFAUNA AND HABITATS

Marc Bouchoucha [1]*, Gilles Hervé [1] and Dominique Pelletier [2]
[1] Ifremer, LER/PAC - marc.bouchoucha@ifremer.fr
[2] Ifremer, LEADNC

Abstract
This paper presents an innovative remote high-definition rotating unbaited video system developed by Ifremer, IRD and ADECAL (New Caledonia Economic Development Agency). This system has many advantages for observing variation of biodiversity of macrofauna and habitats under human pressure in the context of global change. It has been used to evaluate the impact of "Cap Sicié" outfall (France, Var).

Keywords: Biodiversity, Fishes, Monitoring, Coastal waters, North-Western Mediterranean

Introduction
Functional organisation and biogeography of coastal fish communities of the French Mediterranean Sea are paradoxically poorly known. Studies are essentially concentrated on Marine Protected Areas and data are rarely comparable. However observing spatial and temporal variations of marine biodiversity through non-destructive techniques is a major stake for understanding patterns of variations facing anthropogenic pressures in a context of global change. Underwater Visual Censuses (UVC) have been widely used for monitoring coastal ecosystems. Advantages and disadvantages of UVC for estimating fish abundance and diversity have been reported and discussed in many papers. Aside from UVC, different video techniques have been used for observing marine biodiversity (macrofauna and habitat) essentially during the last decade. This paper presents a remote high-definition unbaited rotating video system, called STAVIRO (for STAtion VIdéo ROtative in French), patented by Ifremer, IRD and ADECAL (New Caledonia Economic Development Agency). Advantages of STAVIRO are numerous. Non-destructive, it can be used whatever the juridical status of the study area is (in MPA for example). The presence and abundance of vagile species is less affected than by the presence of a diver. It doesn't require diver or expert staff. A large number of observations can be realized on the field within a short time. It can be implemented easily on site by technical staff following a repeatable protocol. This enables to cover large areas including many habitats, to obtain comparable data from several sites and then avoid on-site observer effects. Finally, data can be archived easily. Between 2010 and 2012, 500 observations by STAVIRO have been carried out along the French Mediterranean coast.

Materials and methods
Staviro system:

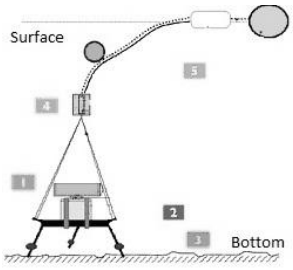

Fig. 1. Description of the Staviro system: 1) video camera housing; 2) engine housing; 3) weighted aluminium support; 4) landing camera insuring the flatness of the system 5) floating rope, intermediate buoy and surface buoy.

Figure 1 describes the STAVIRO system [1]. Rotations are programmed so that the camera housing rotates from 60° every 30 seconds. Images of three rotations are analysed by experts. Hence, six observation sectors are recorded per 360° rotation. In order to gather information about the variability of fish presence and abundance, the system are left in place 12 minutes.

Study area:
"Cap Sicié" is a cape located in the Var department in the south of France. Since the 40's, the site has been the largest waste water discharge of Toulon's urban area. In order to study the impact of the outfall on fish communities and habitats, 72 stations were randomly defined between 5 and 22m and divided into three areas: "Z1" West outfall (moderately impacted), "Z2" outfall (impacted), "Z3" East outfall (reference zone). Three campaigns have been carried out, respectively in spring, summer and autumn 2012. For each station, all fishes were identified at species level. For each species and each station, the maximum and mean abundance observed over the three rotations were calculated. Frequency and abundance density of each taxonomic family in the data set were investigated. Overall density and species richness per station were computed as synthetic metrics of biodiversity. Each metrics was modelled with respect to area, season and habitat using General Linear Models.

Results and discussion
135 observations were collected over 13 days by two persons. Good weather conditions permits the realisation of 30 stations a day. The analysis time was 45 minutes per station. 86 837 fishes were counted. 99.7% were identified at species level. 16 families, 24 genus and 37 species were identified. Species richness was found to strongly depend upon habitat. In every habitat, species richness did not significantly differ between seasons and zones.

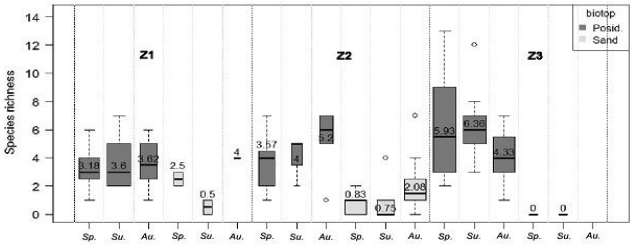

Fig. 2. Species richness per station as function of area, season and habitat. (Sp. = spring; Su. = summer; Au. = autumn).

This work has proved that STAVIRO systems are effective for observing variation of biodiversity over the time and are a good tool to design observatories of coastal macofauna and habitat variations under human pressure at the French Mediterranean coast scale. The implementation of such a monitoring network would support reporting on biodiversity status of fish communities and habitats in coastal areas for MSFD.

Ackwnowledgement
This work was supported by the Rhone-Mediterranean and Corsican Water Agency.

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A TOOL FOR GAP ANALYSIS OF THE MSFD ASSESSMENT ELEMENTS OF THE SOUTHERN EUROPEAN SEAS COUNTRIES, CARRIED OUT IN THE FRAMEWORK OF THE PERSEUS FP7 PROJECT

S. Laroche [1]*, B. Andral [1], M. Pantazi [2], C. Vasilopoulou Vassiliki [2], D. Gonzalez-Fernandez [3], G. Hanke [3], J. F. Cadiou [1], D. Secrieru [4], T. Begun [4] and M. T. Gomoiu [4]
[1] IFREMER - sophie.laroche@ifremer.fr
[2] HCMR
[3] JRC-IES
[4] GeoEcoMar

Abstract
In the framework of the MSFD implementation, a gap analysis of the methodological elements for environmental status assessment has been carried out within the PERSEUS FP7 project. It analyses and compares the kind of gaps reported for the eleven descriptors of Good Environmental Status by the Mediterranean Sea and Black Sea European countries.

Keywords: Biodiversity, Black Sea, North-Western Mediterranean, South-Eastern Mediterranean, Pollution

The research project PERSEUS has studied the experience of EU countries in the framework of the Marine Strategy Framework Directive (MSFD) environmental status assessment, with a view to share this knowledge with non-EU countries. Of the nine coastal EU Member States in the Mediterranean and Black Seas, information has been collected for five countries, which had published in 2012 their draft Initial Assessments and Good Environmental Status reports [1]: Cyprus, France, Greece, Romania and Spain. It has not been possible to include information from Italy, Malta and Bulgaria because their draft reports were not available. Slovenian information has not been included due to time constraints, but eventually it may be used in further steps.
Therefore, an analysis has been developed, considering all relevant information regarding the descriptors' scope, the methodologies and the data availability reported by each of the five countries at criteria and indicator level.
In order to provide a synthetic representation of the gaps underlined for each descriptor, a scoring system was introduced. Six PERSEUS partners were involved in a qualitative assessment of 8 semi-quantitative criteria, based on a matrix aiming to assess the methodological gaps per descriptor, taking into account the methodology developed by Van der Sluijs et al. (2001) [2].
The collected scores have been averaged among the six organisms and normalized (Fig. 1). They have then been aggregated to obtain a single score per descriptor (Fig. 2) and a single score per criterion. This process enables the visualization of the gap issues and aims to provide a broad comparison between descriptors. It is, however, based on expert judgment and, due to the diverse nature, content and importance of the MSFD descriptors, it should not be considered as exhaustive but rather as indicative, providing a general overview of the methodological gaps.

Gaps evaluated per descriptor

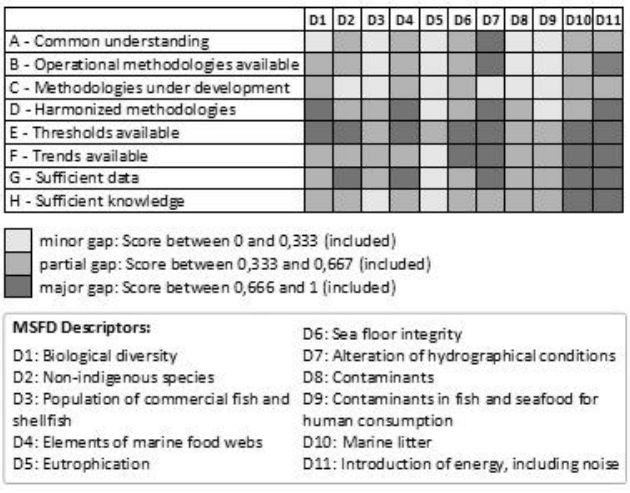

Fig. 1. Gap score composition for each descriptor

Comparison of the descriptors gap scores
The representation of the aggregated gap scores per descriptor is presented below, on the scale 0-1.

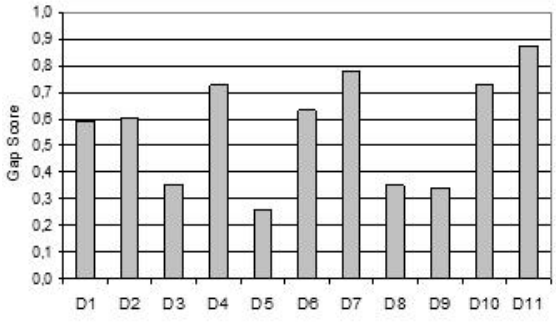

Fig. 2. Aggregated gap scores per descriptor

We notice on Fig. 2. that D11 (noise), D7 (hydrological condition) D10 (litter) and D4 (food webs) exhibit the highest gap values. D6 (seafloor integrity), D2 (NIS) and D1 (biological diversity) present also important gap scores. D3 (fisheries), D5 (eutrophication), D8 (contaminants and environment) and D9 (contaminants and human health) have lower gap scores. However, it should be noticed that even these "low gap score descriptors" still need harmonization efforts, further development and establishment of consistent regional thresholds/reference values.

Analysis of the most reported gaps
The analysis of the most reported gap, when outcomes from all descriptor were pooled together, has been produced by comparing the aggregated gap scores per criterion. The most important gap identified is the general lack of thresholds. The lack of data, the lack of harmonized methodologies, the lack of information on trends, as well as the insufficient knowledge present also high gap scores. Finally, the lack of operational methodologies, the lack of further methodological development and the lack of common understanding present lower scores.

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ASSESSING THE ECOLOGICAL STATUS OF THE MEDITERRANEAN AND BLACK SEA. STEPS TOWARD OPERATIONAL APPLICATIONS OF END-TO-END MODELLING

S. Libralato [1]*, C. Solidoro [1], E. Akoglu [2], T. Ballerini [3], D. Banaru [3], A. Capet [4], G. Daskalov [5], M. Gregoire [4], R. Kandilarov [6], P. Lazzari [1], B. Salihoglu [2], J. Staneva [6] and K. Tsagarakis [7]

[1] OGS (Istituto nazionale di Oceanografia e di Geofisica Sperimentale) - slibralato@ogs.trieste.it

[2] Middle East Technical University, Institute of Marine Sciences, P.O. Box 28, 33731, Erdemli, Mersin, Turkey

[3] CNRS/INSU, MIO, UMR 7294 , Campus de Luminy - Case 901, 13288 Marseille Cedex 09 – France

[4] University of Liège, Laboratory of Oceanology (B6c) , Allée de la Chimie 17, B-4000 Liège , Belgium

[5] Institute of Biodiversity and Ecosystem Research, Laboratory of Marine Ecology, Bulgarian Academy of Sciences, Bulgaria

[6] Department of meteorology and geophysics, Faculty of Physics, Sofia University "Sv. Kliment Ohridski", Bulgaria

[7] Hellenic Centre for Marine Research, Ag. Kosmas, 166 04 Hellinikon, Athens, Greece

Abstract

End-to-End (E2E) models attempt to describe in a common framework the ecosystem covering from hydrodynamics and biogeochemistry to fish and fisheries dynamics for the evaluation of the possible impacts of antropogenic and natural changes on ecosystem structure and functioning. A E2E approach has been set up for the Mediterranean and Black Sea linking biogeochemical LTL model with HTL food web models to evaluate the effectiveness of policy scenarios and to assess space variability and trends in terms of ecological indicators such as ecosystem vigor, organization and resilience.

Keywords: Ecosystem services, North-Central Mediterranean, North-Eastern Mediterranean, North-Western Mediterranean, Black Sea

Methods and approaches for assessing marine ecosystem state are increasingly requested for the evaluation of the possible impacts of antropogenic and natural changes on ecosystem structure and functions and for the evaluation of the effectivness of conservation policies. This implies the possibility of using integrated assessments tools capable of considering the cumulative effects of all major factors influencing marine ecosystem dynamics. End-to-End (E2E) models attempt to describe the ecosystem responses to main drivers (climate change, nutrient enrichment, fisheries) in a common framework, which covers from hydrodynamics and biogeochemistry to fish and fisheries dynamics [1]. The development of E2E applications in the Mediterranean Sea represents an important opportunity for setting a common framework useful for harmonization, intercomparison and generalization of results achieved at sub-basin scales, and towards the development of a pan-Mediterranean framework. This will allow to compare Mediterranean sub-regions, to evaluate the effectiveness of policy scenarios and to assess space variability and trends in terms of ecological indicators such as ecosystem vigor, organization and resilience [2], and more.

In the PERSEUS-FP7 project we focused on several regional sub-basins such as the Gulf of Lion, the Adriatic Sea, the North Aegean Sea, the Western and Eastern Black Sea, as a first step but other sub-regions (Ionian, Catalan, Tyrrenian, Sicily channel) can be easily integrated [3].

The E2E modelling approach we implemented capitalizes on already existing and state-of-the-art tools in hydrodynamic and biogeochemistry (LTL model), as well as food web models (HTL), which are linked through a methodology which enables integration of LTL and HTL sub-models with no, or minor, re-parameterization of their closure terms [4].

The integrated approach followed the processes of a) standardization of the structure of the HTL models; b) aggregation of the information of the LTL model for coupling; c) extension of HTL models to represent also the LTL processes and building the E2E model; d) correction of the trajectory of E2E model to account for different biological, temporal and spatial resolution of the integrated E2E model.

a) the standardization of the structure of the HTL models is needed because several ecological indicators are sensitive to the number and composition of functional groups used to describe a system. After considering several possibilities, including the use of the least complex structure embedding each and every subregional structure, the most complex substructure common to all regions, the use of variable structure and of dual representation of the same region, we ended up with an intermediate complexity structure specific for the Mediterranean Sea, also able to account for fisheries impacts. The aggregated structure for the HTL models includes 9 invertebrates, 12 fish and elasmobranches, seabirds and marine mammals.

b) The LTL part of the E2E models has been achieved by using a common biogeochemical plankton functional type model (OPATM-BFM, [5]) for the whole Mediteranean region. The results of the BFM model were aggregated in order to be used efficiently in the E2E modelling scheme. For example, the BFM results for different copepods (Z3 and Z4) were pooled into a single functional group (Zoo2), and microzooplankton groups (Z5 and Z6) were lumped together under another functional group. Diatoms, dinoflagellates and nanoflagellates (P1, P2 and P4) in BFM were grouped together into Phy2. Picoplankton (Phy1) and Bacteria (Bact) were represented as separate functional groups.

c) Furthermore given the current knowledge and models results, phosphorous was defined as the single limiting nutrient for the Mediterranean Sea whereas nitrogen was considered more appropriate for the Black sea (see Black Sea State of the Environment Report 2001-2006/7). The E2E model implemented in Ecopath with Ecosim (EwE) (www.ecopath.org) extended to represent LTL, was built using the information from the standardized HTL structure previously defined plus estimates of average annual fluxes between LTL compartments (including diet, nutrient consumptions, flows to and between non-living compartments) calculated by BFM for the parameterization of the lumped LTL functional groups (5 living and PO4, POP, DOP and Input PO4 non-living functional groups). Therefore, the extended E2E model, thus comprise of 37 functional groups covering 5 trophic levels, from nutrients and detritus to plankton, small, medium and large pelagics, jellyfish, marine mammals and seabirds and includes fisheries dynamics, all embedded in a 3D description of hydrodynamics and physical properties. Results of the E2E model provided the first estimates of vigor and resilience at the Mediterranean scale.

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SPATIAL MODELLING OF MULTIPLE PRESSURES TO SUPPORT THE IMPLEMENTATION OF THE MARINE STRATEGY FRAMEWORK DIRECTIVE AND MARITIME SPATIAL PLANNING

D. March [1]*, C. Murciano [2], J. Albaigés [3], R. Sardà [4] and J. Tintoré [5]
[1] Mediterranean Institute of Advanced Studies (UIB-CSIC). Illes Balears, Spain - david@imedea.uib-csic.es
[2] Plan Bleu. Marseille, France
[3] Centre d'Investigació I Desenvolupament, (CID-CSIC). Catalunya, Spain
[4] Centre d'Estudis Avançats de Blanes (CEAB-CSIC). Catalunya, Spain.
[5] IMEDEA, SOCIB, Spain

Abstract
We present two different approaches to study human pressures within the context of the Marine Strategy Framework Directive (MSFD) and further developments on Maritime Spatial Planning (MSP). The first approach considers a single driver or sector (ie., maritime transport) and its relation to multiple pressures and their relationship with descriptors from MSFD. We use data of automated identification systems (AIS) and highlight the potential applications of this new source of data. The second approach integrates multiple drivers, which results in multiple pressures, into an integrative cumulative index. The study area is the Gulf of Lyon (NW Mediterranean), as a trans-boundary case study developed in the FP7 project KnowSeas. The results obtained highlight the potential of both approaches to be used in different steps of the MSFD.

Keywords: Mapping, Conservation, Gulf of Lyon

From one driver to multiple pressures: Maritime transport plays an important role in the world trade and its economic developments. In Europe the "motorways on the sea" concept has been an important issue since the launch of the EU Transport white paper (EC 2001). An enclosed sea such as the Mediterranean is particularly vulnerable to ship-associated pressures due to a high-volume of shipping routes, long history of use, and sensitive shallow and deep-sea habitats [1]. Maritime transport is related to most of the descriptors targeted by the MSFD and associated negative pressures are more specifically related to biodiversity loss, introduction of alien species, pollution, marine litter and underwater noise [1,2,3]. We developed a system to store, manage, analyse and visualize AIS data based on open-source components (PostGIS, R). Using this information, different products may be generated [2]. We illustrate these products in the Gulf of Lyon area using an AIS dataset for the year 2012 (Figure 1).

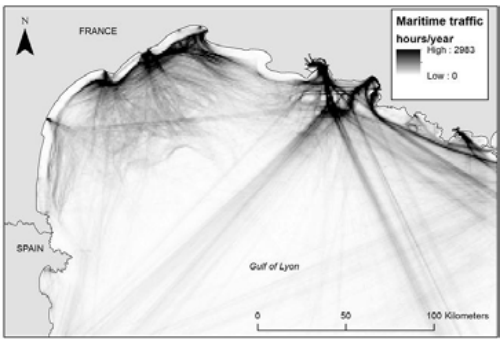

Fig. 1. Marine traffic density in the Gulf of Lions derived from AIS data

From multiple drivers to a single pressure index : The good environmental status of marine environments is conditioned by a wide set of pressures exerted by human activities. Therefore, long-term economic, environmental and social aspects have to be considered simultaneously to understand the complex network linking sea uses and environmental pressures and impacts. The acquisition of a holistic approach is essential for the management of marine areas: the identification, comparison and quantification of cumulative pressures are critical in order to understand effects on marine ecosystems [4]. We conducted a high-resolution cumulative pressure analysis based on [4]. We generated 35 pressure maps, and included 16 ecosystem types. Due to the absence of a current vulnerability matrix for the Mediterranean we used the same matrix developed at global scale [4]. The final map of the cumulative pressure index in the Gulf of Lions is presented in Figure 2.

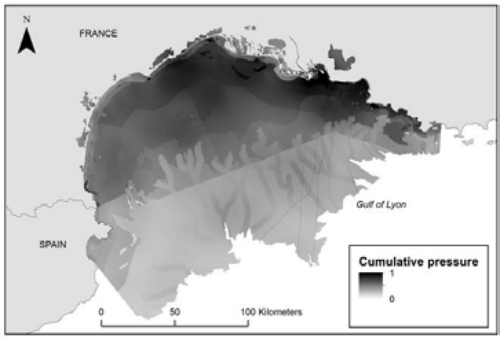

Fig. 2. Cumulative pressure index

Implications for the MSFD : Both approaches are suitable for supporting the Initial Assessment by providing quantitative data on different pressures considered in the MSFD [2]. In addition, the example of generating soundscapes from marine traffic data highlights it potential for modelling indicators of good environmental status. Finally, the information provided in this study can also be incorporated into Decision Support Systems for supporting the design of further monitoring programs and assessing plans of mitigation measures considered in the MSFD.

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A METHOD BASED ON SATELLITE IMAGERY TO EVALUATE THE EUTROPHICATION AT MSFD SCALE IN THE ALBORAN SEA

J. M. Mercado [1]*, D. Cortés [1], F. Gómez [1], P. León [1], S. Putzeys [1], S. Sallés [1] and L. Yebra [1]
[1] Instituto Español de Oceanografía Centro oceanográfico de Málaga - jesus.mercado@ma.ieo.es

Abstract
A time series of chlorophyll *a* daily images provided by MODIS-Aqua from 2002 to 2010 was analysed by means of *k-means* clustering analysis in order to identify the main spatial variability patterns of nutrients and chlorophyll a in the northern Alboran Sea. Based on the output of this analysis, six areas were identified whose chlorophyll a annual cycle presented distinguishing features. Baselines of nutrients and *in situ* chlorophyll were calculated for each area and afterwards used to define the good ecological state (GES) and to evaluate their actual state.

Keywords: Eutrophication, Nutrients, Time series, Chlorophyll-A, Alboran Sea

Introduction. The eutrophication is a process driven by enrichment of water by nutrients, that could be natural, human-induced or both [1]. The anthropogenic eutrophication in the Mediterranean Sea is usually a local process that affects coastal waters; therefore its assessment at the scale of the MSFD requires identifying the hot-spots where the nutrient charge can be not explained from natural sources. This task is complicated in some marine regions because the time and spatial distribution of nutrients is inherently (i.e. naturally) patched. This is the case of the Alboran Sea where the Atlantic jet that penetrates through the Gibraltar Strait feeds two quasi permanent anticyclonic gyres which occupy the entire central part of the basin. Intensive geostrophic fronts are located at the edges of the western and eastern Alboran anticyclonic gyres. Furthermore, favourable winds induce episodically enriched water upwelling [2]. Consequently, the permanent presence of conspicuous latitudinal and longitudinal hydro-geochemical gradients is a typical feature of the Alboran Sea. In the present work, an objective method based on statistical analysis of chlorophyll *a* satellite image time series is described allowing to delimit homogenous areas with respect to their annual productivity cycle. The analysis facilitates the definition of practical baselines to the assessment of the good ecological state (GES).

Materials and Methods. The chlorophyll *a* daily images provided by MODIS-Aqua (1.1x1.1 km resolution) from 2002 to 2010 were gathered. Monthly means for each pixel were calculated (questionable pixels as indicated by L2 processing flags were excluded). A *K-means* clustering analysis was performed with the monthly means in order to group the pixels according to both relative concentration and annual cycle of satellite chlorophyll *a*. The number of groups pre-chosen was six. In parallel, a database of chlorophyll *a* and nutrients generated during multiple research surveys performed in the northern Alboran Sea was built. Data collection included registers from 1992 to 2011.

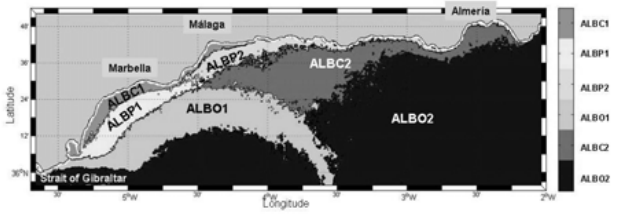

Fig. 1. Output of the *K-means* clustering analysis. The six areas identified according to their annual productivity cycles are shown.

Results and Discussion. Six homogenous productivity areas were identified (Fig. 1) which matched with the main hydrological structures: the cores of the anticiclonic gyres (ALBO2), the edges located at the north of them (ALBO1 and ALBOC2) and the upwelling coastal areas (ALBC1 and ALBP1). Baselines of nutrients and *in situ* chlorophyll *a* for each pixel group were calculated by aggregating the data according to the position of the sampling station. The assessment of the actual state in each area was performed by comparing the concentrations in the recent period (2006-2011) with the corresponding baseline (Table 1). Nitrate remained stable in 2006-2011 in comparison to the whole time series in all the areas. However, increasing trends of phosphate were obtained in ALBC1, ALBP1 and ALBP2. In contrast, there were not significant differences in chlorophyll *a* for the two periods. Consequently, primary symptoms of eutrophication were not detected in the Alboran Sea [3]. In performing the described procedure to assess the eutrophication state, it was implicitly assumed that the good ecological state (GES) was reached when there were not increasing time trends of nutrients and/or chlorophyll *a* beyond the shifts attributable to hydrological variability.

Tab. 1. Description of the data base of nitrate and in situ chlorophyll a concentrations used for determining baselines in each area delimited by the cluster analysis

Nitrate (µM)					
	n	Median	Mean	Standard deviation	Percentile 90
ALBC1	480	0.35	0.97	1.28	2.84
ALBC2	470	0.09	0.42	0.89	1.34
ALBP1	337	0.35	1.10	1.43	3.58
ALBP2	1148	0.15	0.70	1.14	2.14
ALB01	371	0.32	1.03	1.30	2.76
ALB02	288	0.12	0.37	0.12	1.28
Chlorophyll *a* (µg L^{-1})					
	n	Median	Mean	Standard deviation	Percentile 90
ALBC1	480	0.88	1.19	1.03	2.47
ALBC2	480	0.29	0.66	0.86	1.65
ALBP1	297	0.84	1.23	1.17	2.89
ALBP2	1209	0.51	0.88	1.15	2.03
ALB01	326	0.62	0.97	1.01	1.99
ALB02	151	0.18	0.29	0.26	0.68

Acknowledgements This research was supported by a grant from the Spanish Ministry of Agriculture, Food and Environment. The present work is a contribution to the EU 7th Framework project "Policy-oriented marine environmental research for the Southern European Seas (PERSEUS, 287600).

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NEW METHODOLOGICAL APROACH IN ESTIMATION OF THE NORTHWESTERN BLACK SEA WATER BODIES' ENVIROMENTAL STATUS

Galina Minicheva [1]*, Andrey Zotov [1] and Eugeniy Sokolov [1]
[1] Institute of Biology of Southern Seas Odessa Branch, NASU - minicheva@ukr.net

Abstract
The central concept of the EU Water Framework Directive - Environmental Status (ES) reflects both the degree to which people use the water environment and the peculiarities of nature conditions in different types of marine ecosystems. It has been proposed to assess ratio between nature ecosystem capacities and artificial force using Artificial Force Index (AFI). The AFI is determined from the difference between 5 WFD's classes as the result of comparison of ES assessed on morphofunctional indicators of Macroalgae and Phytoplankton with the categories of Nature Resistance Index. Negative, zero and positive AFI values have been presented for 12 water bodies of the northwestern part of the Black Sea. Reasons, under which the ES could be lower, identical or higher than the nature capacities of an ecosystem, have been discussed.

Keywords: Phytobenthos, Phytoplankton, Black Sea

Introduction
Implementation on the National level of the EU Water Framework Directive (WFD, 2000/60/EC) and the Marine Strategy Framework Directive (MSFD,2008/56/EC) requirements and standards in all the countries of the Mediterranean-Black Seas Basin is an important condition of trans-boundary monitoring and water resources management. Ukraine has started the work to adapt the National marine ecosystems monitoring methods to the WFD key principles. It has been proposed in the paper to apply the developed in Ukraine morphofunctional indicators for macrophytes and phytoplankton, as well as Nature Resistance Index (NRI) to make expert judgement on the two constituents of Environmental Status (ES) – the nature capacity of an ecosystem and the artificial force impacting it.

Methodology
ES is the central notion on the WFD. It is used as a universal indicator to assess the «degree to which human uses of the water environment». If we use both historical and current data to assess the ES of the same ecosystem, the «altered the structure and functioning of aquatic plant and animal communities» would give us objective picture of temporal dynamics of human impact, as the nature conditions in this case will constitute relatively constant values. When we assess the ES of different types of aquatic ecosystems (coastal, shelf, estuary, bay, gulf, delta front and so on) the Biological Quality Elements (BQE) indicators contain double information: on nature capacities of the ecosystem and on the level of human impact. In this case comparison between the ES of aquatic ecosystems belonging to different types will not always unambiguously reflect human impact only. There is, for example, high probability that the state of the Black Sea Danube Delta Front will show lower ES compared to the state of the Black Sea Crimean Coast because of natural eutrophication due to river discharge and, as the result, simplification of communities and poorer biological diversity. In order to single out non-natural impact from the ES of an ecosystem we propose to use Artificial Force Index (AFI). The AFI characterizes the difference between the level of environmental processes observed in a real ecosystem including human impact and the potential level of environmental processes that could form in water bodies exceptionally under the influence of an ecosystem's natural properties. The AFI should be determined using comparative method from the difference between the WFD classes ES and NRI. For the ESC assessment we propose morphofunctional parameter as a new indicator for Macroalgae and Phytoplankton - specific surface (S/W), which is calculated according to special algorithms [1]. The S/W value is connected with the morphological structure of different aquatic vegetation life forms and reflects their environmental activity in production process. Based on the S/W, a number of new indicators are proposed to assess the ESC of benthic vegetation [2]. Use of the NRI is proposed to assess the ecosystems capacity to resist artificial force based on their natural properties. NRI is calculated as an integral value of hydrological & morphological parameters of water body bed, catchment area, geographical & climatic conditions with further reference to the WFD classification scale [3].

Result and Discussion
The first attempt of the AFI determination has been made for 12 water bodies of the northwestern part of the Black Sea. More than half of the water bodies (7) have negative AFI values, which mean that their ES is worse than nature features as the result of human pressure. The maximum negative values of the AFI (-2) were demonstrated by the Hadzhibeyskiy Liman (located within the city boundaries; sink for domestic discharges from the city with million population) and the Sukhoy Liman (with commercial port in its water area having annual cargo turnover 15 million tons). ES of the 3 water bodies correspond to the nature features of their ecosystems (AFI=0). Only 2 of the 12 Limans have demonstrated positive AFI values: the Tiligul Liman (AFI =+1) with two protected areas of regional significance along its banks and the Dofinovskiy Liman, with the lowest SC NRI category (area - 5.5 km2; average depth – 0.6 m; used to have no natural connection with the sea). At that, the highest AFI value happened to be demonstrated by the Dofinovskiy Liman (AFI = +2) as the result of successful environmental management (there is a fish farm, which has built hydro-engineering facilities and is managing water exchange with the sea). The results received entitle us to continue development of methodological approaches in assessment and comparative interpretation of ES categories of aquatic ecosystems having different natural properties. Work is executed at support Project "Towards COast to COast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential".

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AN ECOSYSTEM-BASED APPROACH TO EVALUATE THE STATUS OF MEDITERRANEAN ECOSYSTEMS HABITATS

S. Ruitton [1]*, C. Boudouresque [1], S. Personnic [1], R. David [2], -. 61 Mediterranean Marine Scientists [3] and F. Renaud [4]
[1] Institut Méditerranéen d'Océanographie - sandrine.ruitton@univ-amu.fr
[2] UMR CNRS-IRD 7263 IMBE Institut Méditerranéen de Biodiversité et d'Ecologie
[3] See authors' list in the text
[4] CNRS INEE

Abstract
The background and the guidelines of the new marine environmental policies (e.g. MSFD) is the ecosystem global approach. Previous indicator-based strategies for ecosystems evaluation was focused on specific elements. Here we propose a global approach, based on conceptual models, to evaluate the status of 24 geolocalized pelagic and benthic marine habitats (*e.g. Posidonia oceanica* beds).

Keywords: Monitoring, North-Western Mediterranean

The EU Marine Strategy Framework Directive (MSFD 2008/56/EC) established a framework for community action in the field of marine environmental policy. The French marine environment action plan (PAMM) has crystallized the French scientific community and all stakeholders involved in marine management towards a common goal and possible improvements have been identified to optimize the next PAMM (2018-2024). The North West Mediterranean region was divided into 24 habitats, for which conceptual models were developped. As an example, the *Posidonia oceanica* ecosystem conceptual model is presented in figure 1.

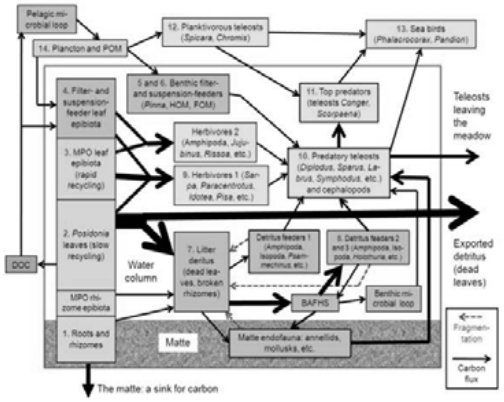

Fig. 1. Conceptual model of the functioning of the *Posidonia oceanica* ecosystem in the North Western Mediterranean Sea (C.F. Boudouresque, original figure; modified from [1])

The rationale and principle governing our ecosystem-based approach are to quantify and evaluate each compartment (functional group) of the conceptual model by means of a set of parameters, to balance their relative weight and therefore to calculate a rank for the ecological status within a given area in relation with surrounding pressures. Each parameter was evaluated by means of a semi-quantitative scale (4 through 0), from very good (4) to very low (0). Compartments were balanced, according to their relative weight in the ecosystem functioning, from 5 (higher weight) to 1 (lower weight). A final rating from 0 to 20 is calculated (highest rating for the highest ecological status). For each compartment, each value of the compartment status and each site, a Confidence Index (CI) has been proposed. The reason for the CI is (i) that data for one or several compartments may be missing or of poor quality in some sites (ii) the reliability of available data may be different between compartments and sites and (iii) it is worth driving the attention of managers and scientists on those compartments that are poorly known and which deserve further field studies. This method was applied to a variety of sites, including continental France, Corsica, Balearic Islands and Catalonia (Italie will be included), that are representative of the North Western Mediterranean subregions, as defined in the MSFD (Figure 2).

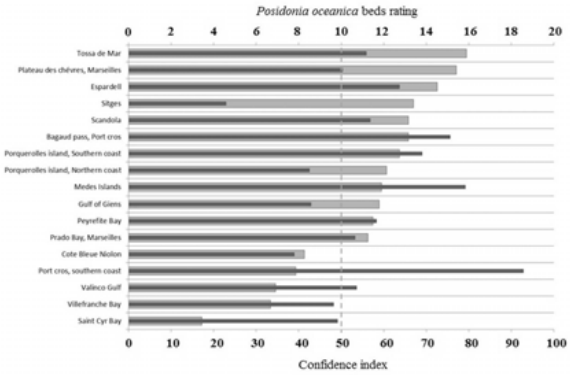

Fig. 2. Evaluation of *Posidonia oceanica* beds from 17 stations based on state rating (mark : 0-20; dark grey) and confident index (mark : 0-100; light grey)

This method allows identifying 3 situations: (1) CI < 50% and whatever the ecological rating is, we expect that knowledge or data are not sufficient enough to allow evaluating the station and we propose to strengthen research and monitoring programs on the area. (2) CI > 50% and ecological rating > 10/20, we expect that the station is in relative good status and does not need particular management measures or to undergo enhanced monitoring. (3) CI > 50% and ecological rating < 10/20, we expect that the ecosystem is not in good status and present a risk of disequilibrium. Further management and monitoring are required.

Coauthors list P Astruch, S Ayata, K Ballesteros, D Banaru, C Barras, G Bellan, D Bellan-Santini, CN Bianchi, J Blanchot, S Blouet, P Bodilis, P Bonhomme, S Bonhommeau, T Bouvier, S Bussoti, F Charles, P Chevaldonné, B Daniel, R DeWitt, A DiFranco, JP Féral, E Feunteun, P Francour, S Gasparini, P Guidetti, J Harmelin, M Harmelin-Vivien, JO Irisson, D Jamet, JL Jamet, P Koubbi, C Labrune, S Lamare, L LeDireach, F LeLoc'h, P Lenfant, M Montefalcone, C Morri, B Mostajir, L Mousseau, N Niquil, D Ody, M Pagano, J Pastor, M Pedrotti, C Pelaprat, G Pergent, C Pergent-Martini, T Perez, B Quéguiner, P Raimbault, PA Rastorgueff, F Rossi, E Rouanet, S Ruitton, S Sartoretto, L Stemmann, D Thibault-Botha, T Thibaut, J Vacelet, M Verlaque.

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ARE OPERATIONAL BIOGEOCHEMICAL AND ECOLOGICAL MODELS RELIABLE AND WILL THEY BE PART OF NEXT GENERATION MARINE SERVICES?

C. Solidoro [1]*, L. Aveytua [1], G. Cossarini [1], A. Crise [1], P. Lazzari [1], S. Salon [1] and A. Teruzzi [1]
[1] OGS - csolidoro@ogs.trieste.it

Abstract
Projections of operational biogeochemical modelling for the Mediterranean Sea are fully available within the MyOcean infrastructure and they might be a not replaceable tool for the estimate of the environmental status of a marine system, also sensu European MSFD. Still, there is an urgent need of suitable and efficient methodologies to assess models skills and reliability of the forecast products. In fact, since the specificity of biogeochemical properties, ad-hoc tools have to be developed and implemented (e.g. Relative Operating Curve, non-parametric statistics). In this work the application of different validation tools to the results of the biogeochemistry component of the Mediterranean Monitoring and Forecast Centre is presented and discussed.

Keywords: Ecosystem services, North-Western Mediterranean, Models, Monitoring

Reliable model estimates of biogeochemical and ecological properties are an urgent need for the estimate of the environmental status and the assessment of efficacy of conservation and environmental policies, also with reference to the enforcement of the European MSFD. Indeed, models can provide space interpolation, time extrapolation and estimates of hardly measurable indicators. Consequently, the assimilation of biogeochemical and ecological data in oceanographic models have been gaining increasing attention, up to the implementation of operational ecological models in GMES (now Copernicus) related services. However, assessing the validity of model results is a complex process that requires the definition of appropriate indicators, metrics, methodologies and faces with the scarcity of real-time in-situ biogeochemical data. Furthermore, biogeochemical models typically consider dozens of variables which are heavily undersampled. Biogeochemical operational forecasts of the Mediterranean Sea are available for users through the MyOcean portal [1]. The biogeochemical forecasts are provided by OPATM-BFM model [2] which is off-line coupled with the MFS general circulation model [3] and includes a 3DVAR assimilation scheme [4] of satellite chlorophyll concentrations [5]. The system runs biweekly and provides 7 days of reanalysis and 10 days of forecast of many variables (primary producers, chlorophyll, nutrients, oxygen and primary production). The set of reanalysis gives an assessment of the near past conditions of the Mediterranean marine ecosystem. Decadal reanalysis might be used for optimal analysis of long term dynamics.
The present stage of validation compares model results with daily satellite data of surface chlorophyll concentration, and with climatological seasonal in-situ profiles of chlorophyll, nutrients (nitrate, ammonium, phosphate and silicate) and oxygen. The comparison with satellite data uses both parametric statistics (as standard indicators and Taylor diagram) and non-parametric statistics (as percentiles comparison, contingency table and Relative Operating Curve -ROC-) and it is aimed to assess the skill of the forecasts in capturing the short term, mesoscale patterns of the surface chlorophyll field which are triggered by the physical processes.

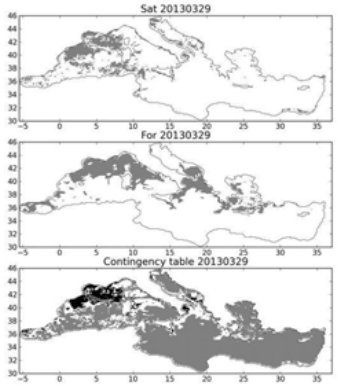

Fig. 1. Satellite (upper panel) and forecast (central panel) maps of chlorophyll concentration higher than 0.4 mg/m3 (gray) for 29/03/2013. Map of the table of contingency (lower panel): true positive predictions (black), true negative predictions (gray) and misses (white).

An example of the contingency table (from which the ROC index is estimated) is shown in Figure 1 which reports the model forecast and satellite observations for a day at the end of March 2013 and highlights the capability of the model system to reproduce the phytoplankton blooms in the North Western Mediterranean (NWM). Such blooms are trigged by vertical mixing and are vital for the productivity of the entire water column ecosystem.

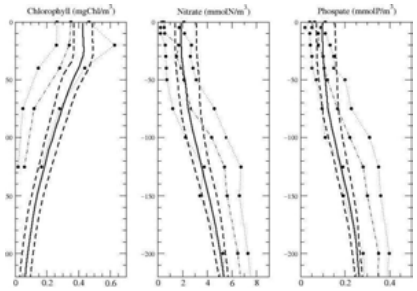

Fig. 2. Comparison of seasonal (winter) profiles of chlorophyll, nitrate and phosphate for Northern Western Mediterranean. Median and range interquartile are shown for model results (black lines) and climatological observations (dots and thin lines).

The system also reproduces fairly well the mean biogeochemical vertical structure of the column. Figure 2 shows the comparison of non-parametric statistics between modelled and seasonal climatological chlorophyll, nitrate and phosphate for the upper layer in NWM. In this case the difference between the medians of model and observation is smaller than the variability of observations, and the shape of vertical profiles are similar. however, a proper assessment of the full model output remains a challenge.

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MODELLING REFERENCE CONDITIONS FOR THE UPPER LIMIT OF *POSIDONIA OCEANICA* MEADOWS

M. Vacchi [1]*, G. Misson [2], M. Montefalcone [2], R. Archetti [3], C. N. Bianchi [2] and M. Ferrari [2]
[1] OT-Med Labex, Université Aix-Marseille - matteo.vacchi@gmail.com
[2] DISTAV, University of Genova
[3] DICAM, University of Bologna

Abstract
Anthropogenic pressures are known to cause regression of the upper portion of the most important underwater coastal seascape of the Mediterranean: the *Posidonia oceanica* meadow. Evaluation of its status is part of monitoring programs, but lack of definite reference conditions hampers proper conclusions. We elaborated an innovative model to locate the region of the seafloor where the meadow upper limit should lie in natural conditions (i.e. those governed only by hydrodynamics, in absence of significant anthropogenic impact). This model was validated along the Ligurian coastline and is currently tested at Mediterranean scale.

Keywords: Coastal systems, Posidonia, North-Western Mediterranean

Introduction
The problem of sliding baselines represents a major concern for the evaluation of global change impacts on ecosystems [1]. Lack of information on pristine (or at least historical) conditions to be used as references impairs our understanding of the effects of global change on natural ecosystems and their consequences on the amount of resources a healthy ecosystem can provide. In general, reference conditions can be defined in three ways:
i) historical information, when available and reliable, which is not always the case [2];
ii) data collected in pristine areas, still scarce worldwide and often insufficiently enforced [3];
iii) modelling [4].
Here we present an innovative predictive cartographic approach able to identify the seafloor portion where the meadow upper limit should naturally lies (i.e. its reference conditions). The model was elaborated and validated along the Ligurian coastline and is currently tested in other Mediterranean areas.

Methods
The conceptual framework of this model is based on 3 essential components (Fig. 1):
i) Definition of the breaking limit position, which represents the major constrain for the landward meadow development [5]. We modelled the breaking limit (1 year return time) using the software Mike 21 SW (www.dhi-italia.it). Mike 21 SW is a spectral wind-wave model that simulates the growth, decay and transformation of wind-generated waves and swells in offshore and coastal areas.

ii) Definition of the morphodynamic domain of the beach using the surf scaling index ε [5]
In each site, the surf scaling index ε was calculated combining wave parameters with information derived from the specifically created bathymetric maps (Table 1). The following formula was employed

$$\varepsilon = a\omega^2/g \cdot tan^2\beta$$

where: a (breaker amplitude) = $H_0/2$; ω (incident wave radian energy) = $2\pi/T_0$: T_0 = period; g = acceleration of gravity; β = the slope of the beach in the surf–zone.

iii) Definition of the *P. oceanica* upper limit geometry. We coupled detailed aerial photo with thematic bionomic cartography.

Results and discussions
In GIS environment, we modelled the extent of the seafloor where the meadow should naturally lie (i.e. the reference condition), according to the breaking limit position and the morphodynamic domain of the beach. Then, we added the GIS layer over the meadow upper limit geometry. Therefore, the final output shows, on the same map, both the reference condition and the actual location of the upper limit, allowing to assess the status of the landward extent of a given *P. oceanica* meadow.

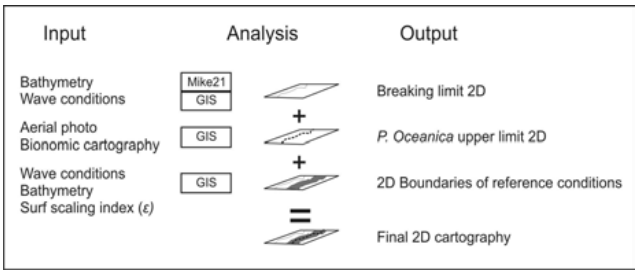

Fig. 1. Conceptual framework of the 2D model to predict the reference condition of *Posidonia oceanica* upper limit

Knowing where the upper limit of a specific meadow should naturally occur is fundamental to quantify any suspected or observed regression caused by anthropic factors. The predictive model presented in this paper allows quantifying the amount of seagrass meadow regression, thus providing the theoretical reference condition requested by the European Directives (MSFD and WFD). In conclusion, these result have important consequences for coastal zone management, as the status and the depth of the upper limit of *P. oceanica* meadows is part of current protocols for seagrass monitoring activities (Boudouresque et al. 2006; Montefalcone 2009), which need reference conditions to track their evolution under natural and anthropogenic influences.

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Session

Indo-Pacific aliens biology

Modérateur : **Bella Galil**

DÉTECTION DE LA MALADIE DE L'ANNEAU BRUN CHEZ *FULVIA FRAGILIS*

Mouna Rifi [1], Monia El Bour [2] and Jamila Ben Souissi [1]*
[1] Institut National Agronomique de Tunis - jbensouissi@yahoo.com
[2] Institut National des Sciences et Technologies de la Mer

Abstract
L'étude de la coque lessepsienne invasive *Fulvia fragilis*, en provenance de la baie de Tunis et la lagune de Bizerte, a révélé la présence des symptômes caractéristiques de la maladie de l'anneau brun. Les prévalences élevées de cette maladie expliqueraient en grande partie les épisodes de raréfaction et de mortalités de ce bivalve dans les 2 sites.

Keywords: Alien species, Bivalves, Diseases, Tunisian Plateau

Introduction
Fulvia fragilis (Froskal in Niehbur, 1775), un cardiidae originaire de l'Indo Pacifique et de la mer Rouge, a été signalé pour la première fois en Tunisie dans le golfe de gabès par Passamonti en 1996 [1] et a élargi son aire de répartition géographique aux côtes les plus septentrionales à savoir la lagune de Bizerte [2] et la baie de Tunis [3]. Lors de, l'étude écobiologique de l'espèce, nous avons détecté des malformations coquillières et des dépôts de matière organique à l'intérieur de l'animal, symptômes caractéristiques de la maladie de l'anneau brun.

Matériel et Méthodes
Des échantillonnages mensuels à bimensuels de *F. fragilis* dans la baie de Tunis et la lagune de Bizerte ont été effectués, entre avril 2006 et Octobre 2007. Dans le cadre d'une étude de la reproduction de ce bivalve, un total de 4534 specimens en provenance des 2 sites a été récolté et observé. Des coupes coquillères ont été examinées au microscope éléctronique à balayage et la prévalence de cette maladie a été calculée.

Résultats
L'examen des coquilles montre des anomalies et malformations avec des dépôts de matière organique (figure 1). L'ultrastructure coquillière révèle la présence de bactéries de type gram (-) (figure 2), et le germe responsable étant *Vibrio tapetis*. Tous les symptômes de la maladie de l'anneau brun décrits dans la littérature ont été observés [4]. La prévalence de cette maladie chez les spécimens récoltés dans la baie de Tunis oscille entre 10 et 100 % avec une moyenne de 74,33% et fluctue entre 0 et 100% dans la lagune de Bizerte avec une moyenne de 50,6%. Lors de notre suivi sur le terrain plusieurs épisodes de mortalité ont été enregistrés notamment durant les périodes chaudes de l'année. L'étude de la reproduction a montré une déficience chez les spécimens pêchés à la lagune de Bizerte. Par ailleurs, un suivi de l'Indice de condition, considéré comme un indice eco physiologique pour cette coque, a révélé une déterioration métabolique plus accentué chez les specimens de la lagune de Bizerte.

Fig. 1. Des coquilles de *Fulvia fragilis* présentant des symptômes de l'anneau brun.

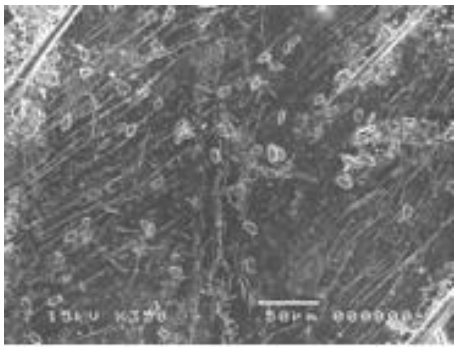

Fig. 2. Photo de la bactérie (bacille gram -) détectée au niveau de la coquille de *Fulvia fragilis.*

Discussion
La maladie de l'anneau brun a fait l'objet de plusieurs travaux de recherche [4 ; 5]. Les études ont montré que cette maladie, notamment chez *R. philippinarum*, induit un déséquilibre de la balance énergétique [5]. Certains auteurs [5] ont décrit de fortes mortalités de *R. philippinarum* suite à son infection par la maladie de l'anneau brun. En Tunisie, cette maladie a été détectée chez plusieurs espèces de bivalves. La présence de cette maladie chez *F. fragilis* expliquerait en partie les fortes mortalités estivales et la raréfaction de l'espèce. Le déséquilibre métabolique accentué observé chez les spécimens de la lagune de Bizerte serait probablement du à l'effet conjugué de la pollution intense du site et de l'infection de ce bivalve par la maladie de l'anneau brun. Les perturbations du cycle de reproduction ainsi que l'amaigrissement de l'animal ont été démontrés par l'étude histologique et le suivi de l'indice de condition que nous avons réalisés [6].

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DO INVASIVE MACROALGAE INFLUENCE ASSOCIATED MOLLUSC DIVERSITY IN THE MEDITERRANEAN SEA ?

Riccardo D'Agostaro [1]*, Marco Milazzo [1] and Renato Chemello [1]
[1] Dipartimento Scienze della Terra e del Mare, University of Palermo - riccardo_dagostaro@yahoo.it

Abstract
The benthic molluscs associated to the non-indigenous red algae *Asparagopsis taxiformis* invading the Mediterranean rocky subtidal were compared with those associated to a native brown alga. The results showed a marked difference in species richness and abundance between native and non-native algal species.

Keywords: Alien species, Biodiversity, Algae, Mollusca, Tyrrhenian Sea

Introduction
The introduction and spread of non-indigenous species represent one of the main threats to biodiversity, structure and functionality of ecosystems at various scales [1]. One of such potential threat may be currently represented by the invasive macroalga *Asparagopsis taxiformis*, a non-indigenous red alga widely distributed along the west coast of Sicily (Italy). Different seaweeds do not support benthic fauna in the same way, due to several factors such as algal architecture, life cycle or presence of chemical defenses [2]. This work compares the molluscan assemblages associated with *A. taxiformis*, with those associated with *Cystoseira brachycarpa*, a brown alga typical of the shallow rocky subtidal of the SW Mediterranean, trying to quantify the potential effects caused by the invasion of *A. taxiformis* on native benthic fauna.

Material and methods
The study was carried out within the Egadi Islands MPA (Western Sicily, Central Mediterranean) on a shallow rocky platform, where *A. taxiformis* and *C. brachycarpa* share the habitat. In order to estimate the abundance and composition of the associated molluscs, in June 2011, four different habitats' types were sampled: native habitat with *C. brachycarpa* (C), non-native habitat with *A. taxiformis* (A), invaded but dominated (covering ≥70%) by native *C. brachycarpa* (mixed native habitat, MC) or dominated (covering ≥70%) by non-native *A. taxiformis* (mixed not-native habitat, MA). Ten samples for each habitat's type, represented by a single algal stem, were collected by scuba-diving. Molluscs were then sorted out, identified to species level and counted, whilst the main physical attributes of algae were calculated and used for the estimation of the architecture, the interstitial volume and the biomass [3].

Results and discussion
A total of 79 mollusc species were identified. Fifty of them were on native habitat with *C. brachycarpa* (C), 52 species were found on mixed native habitat (MC), while 23 were on mixed non-native habitat (MA), but only 21 were found on habitat exclusively dominated by *A. taxiformis* (A) (Fig.1). PERMANOVA showed significant differences in molluscan assemblage among habitats and sites ($p<0.001$). The highest dissimilarity was found between molluscan assemblages associated to MC and A (88.4%; SIMPER) and C and A (89.16%; SIMPER). The correlation between biomass of macroalgae was significantly correlated to species richness ($r_s=0.53$; $p<0.01$) and total abundance ($r_s=0.53$; $p<0.01$) of associated molluscs.
These results showed a marked difference between the molluscan assemblages associated with native and non-native habitat, furthermore an overall reduction in the number of species and abundance was associated to *A. taxiformis* due to differences in the main structural index and in the algal biomasses.

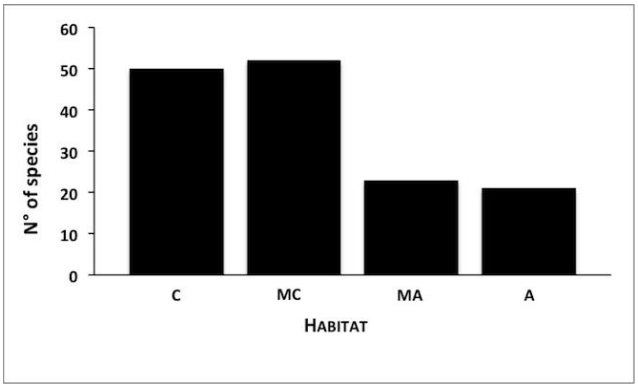

Fig. 1. Total number of species found on different habitat's types. C= Native Habitat, MC= mixed native habitat, MA= mixed non-native habitat, A= non-native habitat.

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A NEW FOOD WEB IN THE EASTERN MEDITERRANEAN AFTER LESSEPSIAN FISH INVASION: INSIGHTS FROM STABLE ISOTOPES ANALSYIS

Emanuela Fanelli [1]*, Ernesto Azzurro [2], Michel Bariche [3] and Francesc Maynou [4]
[1] Marine Environment Research Centre ENEA-S. Teresa (Italy) - emanuela.fanelli@enea.it
[2] National Institute for Environmental Protection and Research, Livorno (Italy)
[3] Department of Biology, Faculty of Arts and Sciences, American University of Beirut (Lebanon)
[4] Institut de Ciències del Mar (CSIC), Barcelona (Spain)

Abstract
The isotopic composition of 30 Lessepsian and 19 native fish inhabiting the littoral rocky shores of Lebanon (Eastern Mediterranean) was analysed. Wider $\delta^{15}N$ and narrower $\delta^{13}C$ ranges were identified for LES than for native species and both Multivariate and population metrics pointed to a narrower trophic niche width of these formers with respect to their native counterpart.

Keywords: Lessepsian migration, Stable isotopes, Food webs, Levantine Basin

Introduction
Stable isotope analyses (SIA) are powerful tools to investigate the ecological consequences of non-indigenous fishes on receiving ecosystems [1, 2]. They allow to estimate niche width and can be used to quantify the potential ecological effects of non-indigenous species on recipient food webs [2]. Here we use SIA, to investigate the food web of the eastern Mediterranean rocky-reef fish assemblage, after the establishment of Lessepsian immigrants (LES). Our aims were to: 1) describe the structure of the new food web and 2) compare the trophic niche of LES *vs*. native fish species, according to both the whole assemblage and the different trophic guilds established a priori.

Materials and methods
Common native fish species, together with a representative pool of Lessepsian fishes were collected in 2012 along the littoral zone of Beirut (Lebanon, Eastern Mediterranean). Portions of tissues were prepared and analysed according to standard protocol for SIA. Multivariate techniques (nMDS, PERMANOVA, PERMDISP) and standard population metrics [2] were used to compare isotopic ratios of LES and native species at community level and on trophic guilds (TG) defined a priori (benthic carnivores=BC, generalized carnivores=GC, planktivores=PL, piscivores=PI and herbivores=H).

Results
A total of 49 fish species (19 natives and 30 LES) were analysed. The nMDS plot showed the relative position of samples according to their isotopic ratios (Figure 1).

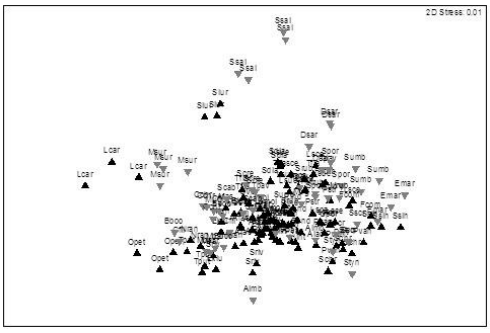

Fig. 1. NMDS plot of the isotopic ratios of C and N of LES (black) and native fish (grey).

PERMANOVA analysis revealed a significant separation between the isotopic ratios of LES *vs*. natives at both the level of the entire assemblage ($F_{1,160}$= 7.38, p<0.01) and of single trophic guilds ($F_{5,160}$= 11.28, p<0.001). In addition, PERMDISP showed significantly higher dispersion (i.e. more generalized diet) in isotopic values of natives *vs*. LES ($F_{1,159}$=15.40, p=0.002). In general, LES species showed greater $\delta^{15}N$ (higher trophic levels, NR in Table 1) and narrower $\delta^{13}C$ range (limited range of exploited resources, CR) than natives. The other population metrics (CD, SEAc, Table 1) pointed to a narrower niche width and low trophic diversity of LES compared to natives.

Tab. 1. Population metrics of LES and native species according to both the whole assemblage (All) and trophic guilds established a priori. For population metrics see details in [2].

	All		GC		BC		H		PL		PI	
metrics	nat	LES	nat	LES	nat	LES	nat	LES	nat	LES	nat	LES
NR	7.07	8.36	3.87	2.34	7.07	5.78	2.95	4.47	3.56	3.72	2.17	2.13
CR	7.30	6.21	4.03	4.44	5.69	6.21	4.51	3.83	3.40	2.25	1.84	2.24
CD	2.45	1.69	1.65	1.29	2.58	1.71	2.19	2.08	1.50	0.99	1.07	1.04
SEAc	11.38	5.82	5.9	2.38	10.07	4.91	4.75	5.24	4.21	1.18	1.47	2.31

Discussion
Here we provided the first comprehensive dataset on the isotopic composition of the most successful Lessepsian immigrants. Competition for trophic niche has been indicated as a primary force in ruling the coexistence of species of native and Lessepsian origin, often resulting in strong ecological segregation or displacement. Present findings do not support the idea of invaders as opportunistic species [3]. On the contrary, our results showed a greater trophic specialization of LES compared to natives. This pattern could be generated by some new capabilities of LES to exploit available resources with respect to native species. The particular situation of the Mediterranean, with several empty niches and lower competition among fish than in tropical reefs may favour this behavior. Further isotopic studies, targeting changes in stable isotope values along the spatial and temporal scales, will be promising to understand the applied and theoretical aspects associated with the Lessepsian bio-invasion.

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LIFE HISTORY STRATEGIES OF NON-INDIGENOUS *UPENEUS PORI* AND CONFAMILIAL *MULLUS BARBATUS* IN THE NORTHEASTERN (NE) MEDITERRANEAN

Meltem Ok [1]* and Ali C. Gücü [1]
[1] Middle East Technical University, Institute of Marine Sciences, Turkey - monkseals@gmail.com

Abstract
In this study, allocation of energy and time for growth and reproduction of *M. barbatus* and *U. pori* were investigated to understand life history strategies adapted by a native and non-indigenous confamilial species based on multidisciplinary survey data collected in three successive years in the NE Mediterranean. The results indicated that the species seem to fulfill their biological activities within a short period of time when the highest productivity is reached in the area. The native fish exhibits fast growth, early maturation and short reproduction season while its counterpart spawns during two different time period (dual spawning) on the bathymetric slot (upper thermocline) that *M. barbatus* abandons during summer.

Keywords: Demersal, North-Eastern Mediterranean, Fishes, Lessepsian migration, Life cycles

Introduction
The Mediterranean Sea is in a metaphoric change mainly due to anthropogenic interferences and natural perturbations. The life history traits adopted by the native components and those successfully established are among the most important weapons in the modern Mediterranean arena. In this study, patterns in life history strategies (timing and energy allocation for growth and reproduction) of *M. barbatus* (Red mullet) and lessepsian *U. pori* (Por's goatfish) were investigated to improve ecological understanding of demersal fish assemblages of the Northeastern Mediterranean Sea.

Material and Method
The data used in the study were collected during the monthly fisheries surveys between May 2007 and May 2010 at six different depths (Figure 1) where temperature and salinity profiles at each station were measured.
The energy allocation is evaluated by i) the parameters of seasonally oscillating von Bertalanffy Growth function, ii) length at first maturity, iii) sex-ratio and size differences by sex and iv) biological indices, namely GSI, HSI and Somatic K.

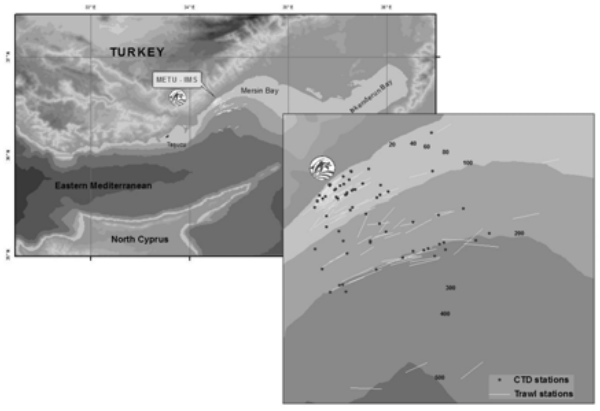

Fig. 1. The study area including bathymetry of the region as well as the position of the trawl hauls and CTD profiler. Lines show the trawl hauls while points show the CTD sampling cast performed during the study period.

Results
The parameters of seasonalized vBGF approximated based on monthly length frequencies of *M. barbatus* (n=18894) and *U. pori* (n=3577) indicated that the both species displays strong seasonality in growth (C = 0.40) while former grows faster (K = 0.56) and larger (L∞ = 26 cm) with early-summer deceleration in growth (WP=30). The latter species is smaller in size (L∞ = 20.0, K = 0.45) and slow growth state is displayed earlier than the former. The analyses indicated that both species reaches sexual maturity in the first year of life when male red mullets reaches to 11.6 cm and females reaches 12.6 cm total length on average. The length at first maturity for *U. pori* is reached at smaller total length (9.5 cm and 10.0 cm for males and females respectively). A significant difference was observed in the spawning season of *M. barbatus* and *U. pori* (Figure 2).

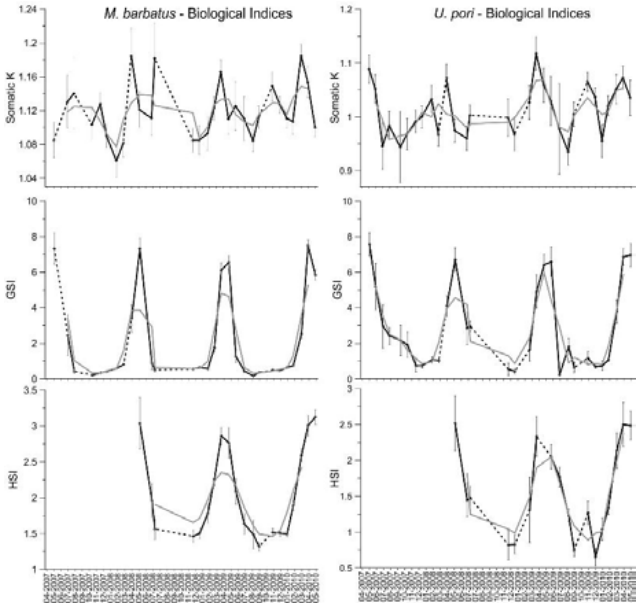

Fig. 2. Time series of calculated biological indices of *M. barbatus* and *U. pori*. Continuous grey lines are the 3x running averages.

The red mullet develops its gonads fast and spawns within a month between May and June. The data clearly showed that gonad development in *U. pori* occurs two times a year starting from late February - early July and early July to late December indicating the existence of secondary spawners within the population. As for bathymetric preference, *U. pori* almost exclusively occupied the depths shallower than 20 m depth while the native confamilial occupied deeper waters down to 220 meters. The very warm (> 27 °C) waters of the upper summer thermocline seem to limit the distribution of *M. barbatus* on the shallow littorals. *U. pori* successfully occupies this area left by the *M. barbatus* and gets the most benefits by high seasonality in growth, fast and multiple gonadal development and smaller maturation size. Golani (1994) has already reported similar niche partitioning on the bathymetric distribution axis.

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VERRUCAE ON SEA-FANS: UNEXPECTED ABUNDANCE OF THE BARNACLE *CONOPEA CALCEOLA* (ELLIS) ON THE GORGONIAN *EUNICELLA SINGULARIS* (ESPER) IN THE MEDITERRANEAN SEA

Andrea Peirano [1]*, Chiara Lombardi [1], Nicolò Ponzè [2] and Silvia Cocito [1]
[1] ENEA, Marine Environment Research Centre, La Spezia, Italy - andrea.peirano@enea.it
[2] Area Marina Protetta Isole Egadi, Favignana (TP), Italy

Abstract
Colonies of the symbiotic Mediterrean gorgonian *Eunicella singularis* were found to host the warm-tropical barnacle C*onopea calceola* on rocky bottoms in the Sicily Channel. Barnacle' presence and abundance (some tens individuals per colony) is probably due to increasing seawater temperatures, this 'co-habitation' supposedly representing a strategy for *C. calceola* species' survival and a further threat for *E. singularis* in an increasingly warming Mediterranean Sea.

Keywords: Crustacea, Sicily Channel, Cnidaria, Global change, Alien species

Introduction
The barnacle *Conopea calceola* (Ellis), living on gorgonians, has been reported present, yet rare in Southern Italian coasts ([1], [2]). Records are given here on monospecific, dense stands of candelabra-like *Eunicella singularis* (Esper) hosting the barnacle, found in the Sicily Channel.

Material and methods
A biodiversity survey was carried out in May 2012 at Favignana Island (Marine Protected Area of Egadi Islands, Sicily Channel, Italy). In 13 localities, rocky bottom communities were video-surveyed along transects spanning on the whole a 0 to 60 m depth range. Video sampling (30 min per transect) was performed with a full-HD camera equipped with a wide-angle lens recording nearly 0.75 m^2 at a distance of approximately 50 cm.

Results and Discussion
A total of 570 *E. singularis* colonies were surveyed, of which 24.6 % were seen to host *C. calceola* (Tab. 1). The majority of *E. singularis* colonies living on bottoms between 15 and 30 m were characterized by tens of 'verrucae' barnacle housings (Fig. 1).

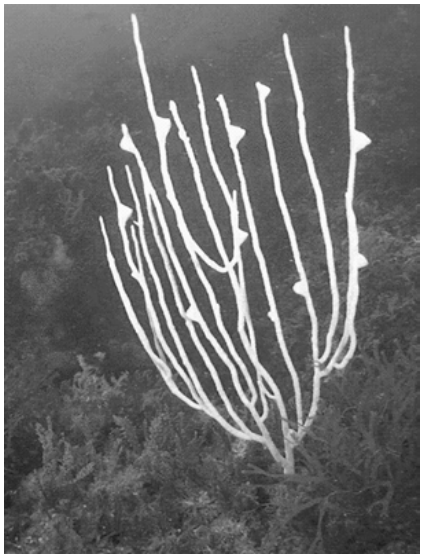

Fig. 1. Colony of *Eunicella singularis* on a flat rocky bottom at Favignana, Egadi Island, Sicily Channel (South Western Mediterranean) colonized by more than 12 individuals of the barnacle *Conopea calceola* that form visible verrucae.

By sampling a few *E. singularis* colonies, gorgonian tissue was observed to wrap *C. calceola* shell with the exception of a small opening which ensure barnacle feeding. The presence of alive individual within the shell suggested that the white gorgonian is a suitable substrate for the barnacle. Warm-tropical *C. calceola* has a wide distribution extending from the eastern Atlantic coast to the Indian Ocean, and further to the seas bordering S.E. Asia ([3]). Present occurrence and abundance of this barnacle may be compared with those of other warm-water species such as *Solidobalanus fallax* (Broch), which is found inhabiting the British sea-fan *Eunicella verrucosa* ([4]). As for *S. fallax, C. calceola* ubiquitous presence observed in the last few years is probably due to increasing seawater temperatures, favoring species widespread and making it more detectable. In light of serious threats affecting the Mediterranean white gorgonian *E. singularis* such as the extensive mortalities that occurred in the past decade ([5]), the increase in *C. calceola* abundance could signify a further problem for *E. singularis*. This 'co-habitation' may represent a strategy for *C. calceola* survival in the changing Mediterranean Sea.

Tab. 1. Localities, depth range, number of *E. singularis* colonies and number of colonies (%) with *C. calceola.*

Localities	Depth (m)	colonies (n)	n. colonies with *C. calceola* (%)
Secca Fondale	15-31	136	1.5
Secca del Toro	7-33	132	12.9
Punta Longa	19-32	63	65.1
Manuzza	19-34	42	61.9
Nonna Venus	19-32	18	66.7
Galeotta	3-30	40	35
Palo Spirografi	15-32	37	13.5
Scoglio Corrente	5-30	52	3.8
Grotta Cala Rotonda	0-8	0	0
Costiera di Ponente	0-10	0	0
Punta Sottile	12-30	44	47.7
Faraglioni	8-20	1	0
Atlantide	30-60	5	0

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FEEDING BEHAVIOUR OF INVASIVE WHELK, *RAPANA VENOSA* VALENCIENNES, 1846 FROM THE SOUTH-EASTERN BLACK SEA, TURKEY

Hacer Saglam [1]* and Ertug Düzgünes [1]
[1] Karadeniz Technical University - hacersaglam@yahoo.com

Abstract
In present study the effects of predator size, prey size, temperature and prey type on the time spent on feeding by *Rapana venosa* were studied in the laboratory conditions in the south eastern Black sea.

Keywords: Black Sea, Alien species

Introduction

The Rapa whelk is not a native species of the Black Sea and introduced from Asian waters in the 1940's and it's first reported in Turkey waters in 1960s [1]. Rapa whelk, *Rapana venosa*, characterized by strong ecological fitness due to its high fecundity, generalist feeding strategy, early sexual maturity, longevity, fast growth rate and broad tolerance to salinity, temperatures, water pollution and oxygen deficiency (Figure 1). All these factors are characteristics of a successful invader. There are no major predators of invasive adult whelk in this region and an intensive predatory impact on the mussels by Rapa whelks [2].

Fig. 1. Rapa whelk morphology

Rapa whelks are the most important component of the demersal fauna in the coastal waters of south eastern Black Sea. Rapa whelks play an important role in the food web. The results of this study are a contribution to the understanding of the role of this species within the ecosystem.
The diel feeding periodicity, gastric emptying, food consumption [3] daily consumption rates, prey preferences [4, 5] were studied on feeding of Rapa whelk up to date. The present study aims to determine feeding behaviour of *R. venosa* based on the time spent on feeding in the Black Sea, Turkey.

Material and Methods

Rapa whelk was collected using dredge on the South-eastern Black Sea at 20 m depth. Whelks were maintained in fiberglass tanks supplied with continuously flowing seawater. Adult whelks were placed in the aquaria, 30x30x30 cm, with water circulation and were fed mussel tissue or live mussels, *Mytilus galloprovincialis*. The ten experiments were conducted between July and October 1998. Feeding behaviour of whelks ranging from 61 to 89 mm in shell length was observed for 24 h for each experiment. In each experiment, each of the whelks was starved for 48 h and then presented a single meal of fresh mussel tissue (approximately 1 g). The total time spent on feeding from the start until the end of feeding on mussel tissue or live mussels was recorded for each individual. Effects of predator (Rapa whelk) size (71, 78 and 82 mm), prey size (0.97, 1.35 and 1.70 and 2.46 g), temperature (20, 23 and 26ºC) and prey type (mussel tissue and living mussel) on the time spent feeding were studied.

Results and Discussion

Rapa whelk was consumed mussels without damaging the shell of its prey in our study. The time spent on feeding by Rapa whelk decreased with increasing its size and increased with increasing prey (mussel tissue) ($P<0.05$). The time spent on feeding by predator Rapana varied with the temperature. Approximately 1 g mussel tissue was consumed in 70.6, 49.2 and 18.5 minutes at 20, 23, 26°C by adult whelks respectively. The Rapa whelk consume 14.3 g living mussel (2.42 g mussel tissue) in about 310 minutes while it consume 2.46 g mussel tissue in 160 minutes at 27-28°C. The estimated average food requirement for Rapa whelk was 1.2 (Northern Adriatic), 0.68 (South Western Atlantic) and 0.2-03 (South Eastern Black Sea) g mussel tissue per day [3, 4, 5]. These differences between studies may be due to different whelk size, temperature and prey types. The approximately 1 g mussel tissue used in our experiments is higher than daily food requirement for Rapana.

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ALIEN SPECIES IN THE NORTHERN ADRIATIC LAGOONS: *PARACERCEIS SCULPTA* (ISOPODA: SPHAEROMATIDAE)

C. Vincenzi [1]*, C. Lanzafame [2], M. Colombo [2], M. G. Caccia [2], M. Abbiati [2] and M. Ponti [2]
[1] Corso di Laurea Magistrale in Biologia Marina Alma Mater Studiorum Università di Bologna - carolina.vincenzi@studio.unibo.it
[2] Dipartimento di Scienze Biologiche, Geologiche ed Ambientali, Alma Mater Studiorum Università di Bologna

Abstract
Invasions by alien species is one of the most alarming threats that reduces biodiversity and leads to direct or indirect ecological effects on marine ecosystems. Northern Adriatic lagoons are affected by high anthropogenic impacts, which may facilitate the introduction and spreading of alien species. The sphaeromatid isopods *Paracerceis sculpta*, native to the northeast Pacific, has been found for the first time Pialassa Baiona, a brackish lagoon connected to Ravenna harbour, in 2012. Field data suggest that *P. sculpta* became a pest species, being more competitive compare to the two native sphaeromatid species inhabiting the lagoon.

Keywords: Lagoons, Alien species, Brackish water, Crustacea, North Adriatic Sea

Introduction Northern Adriatic coastal lagoons show a high rate of introduction of alien species compared with other coastal regions, becoming one of the major hot spot of invasion in the Mediterranean basin ([1], [2]). Human disturbance and the increase of vessel traffic countries is an important pathway of spreading of alien species in stressed environments ([2]). *Paracerceis sculpta* (Holmes, 1904) is one interesting examples of alien species introduced to costal lagoons. It is a sexually dimorphic sphaeromatid isopod native to the NE Pacific, from southern California to Mexico. This species has been introduced to many areas and has a world wide distribution. Maritime traffic has been assumed to be the most probable vector of spread for *P. sculpta*, which could be transported among fouling, in ballast water or associated to species of interest for aquaculture ([2]). **Material and methods** The abundance of sphaeromatid isopods was investigated in 4 areas of the Pialassa Baiona, a lagoon connected to the Ravenna harbour and located 60 nm south to Venice. Area 1 is landward and close to main human disturbance sources (sewage, thermal plants, etc.), area 2 seaward and also affected by disturbances, area 3 seaward but less subjected to disturbance and area 4 landward and far from disturbances ([3]). Specimens were collected both in the soft bottoms, by box corer in May 2012, and associated to recruitment panels, recovered every two weeks between March and October 2012. Data from previous soft bottoms surveys were also reported.

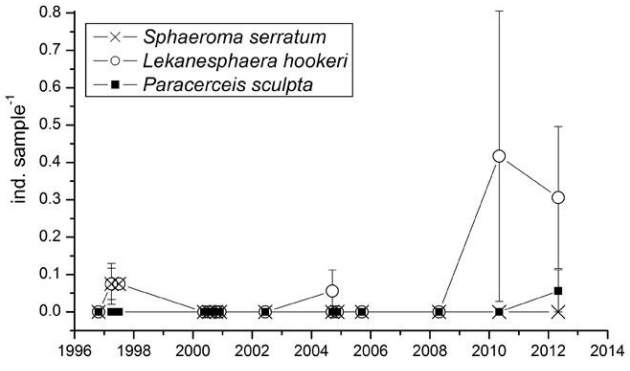

Fig. 1. Mean densities (± s.e.) of sphaeromatid isopods in benthic samples collected in the coastal lagoon Pialassa Baiona since 1996 to 2012.

Results The first record of *P. sculpta* in the northern Adriatic Sea dates back to April 1981, in the Venice lagoon ([4]), but it has never been observed in the soft bottoms of Pialassa Baiona lagoon, until May 2012 (Fig. 1).The native sphaeromatid species inhabiting the Pialassa Baiona are *Lekanesphaera hookeri* (Leach, 1814) and *Sphaeroma serratum* Fabricius, 1787. Few individuals of *P. sculpta* were found in area 2, in May, thereafter the species became more abundant, reaching 9.2 (±2.67 s.e.) ind. sample^{-1} in September in area 2, and colonising the area 3 (Fig. 2). *L. hookeri* was the most abundant species in the lagoon, even if during the investigated period its populations seem to move progressively from area 1 to 2 and then 3. **Discussion** *P. sculpta* was found in area 2, and 3, both areas are close to the sea and to the harbour entrance. This distribution suggests a recent introduction of the species into the lagoon, facilitated by maritime traffic and local human disturbances. The gradual enlargement of the colonised area and the increase in population size of this alien species suggest that it may be threatening native species. Further studies are needed to confirm that *P. sculpta* is more competitive than the native species and it has a true impact in term of loss of ecological functions.

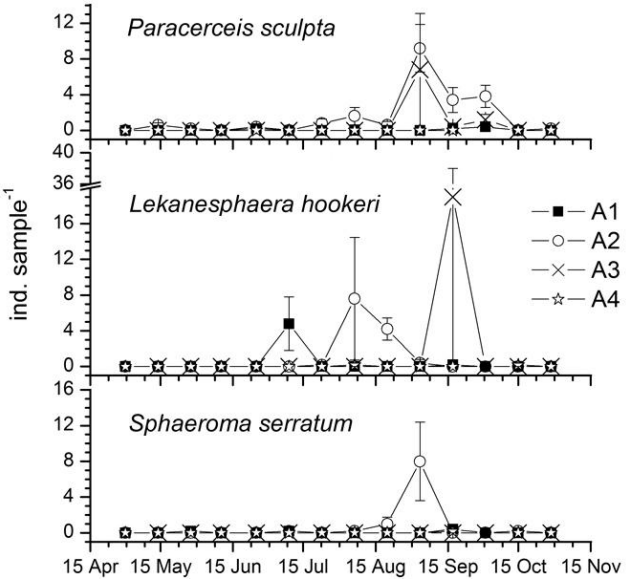

Fig. 2. Mean densities (± s.e.) of sphaeromatid isopods in recruitment panel samples in four inner areas in the Pialassa Baiona in 2012.

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Session

Indo-Pacific aliens impacts

Modérateur : **Jamila Ben Souissi**

TRACKING CHANGES IN FISH ABUNDANCE ACROSS THE COAST OF LEBANON: A LOCAL ECOLOGICAL KNOWLEDGE STUDY

Safia Alajlan [1]*, Ernesto Azzurro [2] and Michel Bariche [1]
[1] American University of Beirut - sha55@aub.edu.lb
[2] ISPRA,Italy

Abstract
The current work aims at detecting changes encountered in fishery landings along the Lebanese coast using an LEK approach. Preliminary results mainly indicate a decrease in the abundance of native as well as invasive species having commercial importance. Furthermore, we found an increase in a number of invasive species that are considered as pests to fishermen, while others were found in high abundance despite fishing pressure.

Keywords: Alien species, Levantine Basin, Global change, Fisheries

Introduction

The eastern part of the Mediterranean Sea has been severely impacted by anthropogenic activities, such as coastal degradation, overfishing, species invasions and seawater warming (1). Local Ecological Knowledge (LEK) can be defined as the information accumulated over time by a group of local people through observation and interaction with the natural environment. LEK is emerging as a powerful, low cost, information source on natural ecosystems, complementing "traditional" scientific research (2). Gathering information from local fishermen can improve our understanding of the temporal changes occurring within the marine ecosystem, as has been shown recently for Mediterranean fish (3). Here we apply this methodology with the aim to reconstruct recent changes in fishery landings along the Lebanese coast.

Materials and Methods

Regular visits to fishing ports spread along the entire coast of Lebanon are being undertaken to interview fishermen, which were selected based on seniority (≥10 years of experience). A total of 32 fishermen from various parts of the country have been interviewed so far following a survey questionnaire. This questionnaire has been adopted from the CIESM Tropical Signals Program (http://www.ciesm.org/marine/programs), and slightly modified to accommodate the specific requirements of the Eastern Mediterranean region.

Results and Discussion

Preliminary results showed that several native fish species, such as *Mycteroperca rubra*, have decreased dramatically in size and abundance as they have been overexploited by the local fishery. Exotic species showed different patterns of abundance in the landings: The populations of some invasive species have considerably increased and this correlated with their date of invasion, especially for those of non-commercial importance (*e.g. Lagocephalus sceleratus*). However, other species (*e.g. Upeneus moluccensis*) have declined significantly, after having an initial stage of population expansion. The latter have been highly targeted because of their market value. In contrast, other species have displayed a high abundance despite significant fishing pressure (*e.g. Siganus rivulatus*). Surveying LEK from the coastal waters of Lebanon has shown encouraging preliminary results. This simple and innovative approach has open up new opportunities to detect temporal changes in fish diversity and abundance in the Levant.

Acknowledgements

This study has been conducted within the framework of the CIESM tropical signals program. We kindly acknowledge all the Lebanese fishermen who participated in the survey.

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SIGANUS SPECIES IN AN ARTISANAL FISHERY IN THE EASTERN AEGEAN

A. Pennington [1], J. Shepperson [1], A. Jeffery [1], A. Miliou [1] and V. Anagnostou [1]*
[1] Archipelagos Institute of Marine Conservation - b.anagnostou1@gmail.com

Abstract
Underwater visual census (UVC) surveys, fishery landings surveys and interviews were used to assess the level of Siganus spp. invasion in Fourni island complex, NE Aegean Sea, Greece. Results showed that despite a high abundance of Siganus spp. being observed in UVC surveys, this was not translated into fisheries landings. Interview surveys identified avoidance behaviour and discarding activities by local fishermen, due to the low economic value of Siganus spp. fish in the specific region. This study provides evidence that changing public perceptions could bring both economic and ecological benefits to the local area.

Keywords: Lessepsian migration, Aegean Sea, Fisheries

Introduction
Siganus spp, are considered to be amongst the 100 worst invasive species in the Mediterranean [1], and have been shown to cause a significant impact on local ecosystems [2]. They have become established in a relatively unsaturated niche, due to a scarce number of indigenous herbivorous fish and now pose serious competition for food and habitat, to native herbivores, which are economically important species [4]. This study comments on the extent of the *Siganus* invasion, the fishermen's perceptions, and the implications for the fishery in the region of Fourni island complex, NE Aegean Sea, Greece.

Methods
Three parallel studies were conducted to obtain the relevant information:
1. Fish populations were surveyed between 31st August and 26th September 2012 over *Posidonia oceanica* meadows and rocky algal habitats using standard underwater visual census (UVC) as described by Sala *et al* [2].
2. Daily port landing surveys of the artisanal fishing fleet were conducted at the main port on Fourni, recording species and total length (cm) throughout 2012.
3. Interview based surveys of local fishermen were conducted in order to gauge perceptions of the *Siganus* spp. catch.

Results
The composition of herbivorous fish recorded in UVC surveys differed to that of the fishery landings surveys. In the UVC data, *S. luridus* accounted for 67% of all herbivorous fish observed, but it only accounted for 15% of herbivorous fish landed. In contrast, in the UVC data *Sparisoma cretense* only accounted for 24% of the herbivorous fish observed, but accounted for 83% of all herbivorous fish landed. *S. luridus* has clearly replaced the native *S. salpa* in Fournoi, as evident in both the UVC and fisheries surveys (fig 1). *S. luridus* can now be considered established on Fournoi, this is verified by the presence of both juveniles and adults at all sites (mean of 31 individuals at each site) and by the dominance in terms of biomass of *S. luridus* at three out of four sites surveyed.

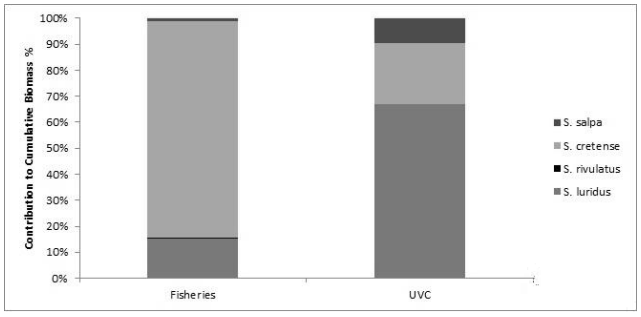

Fig. 1. The composition of herbivorous fish in UVC and fisheries surveys

The results indicate that *Siganus* luridus is the most abundant herbivorous fish species in shallow water ecosystems in Fourni, however they have not replaced *S. cretense* as the dominant herbivorous species in fishery landings. One possible explanation may be due to discarding of *Siganus* at sea, which was evident from interviews and on-board observations, due to its low commercial value in this region. Another possibility identified by the results from our surveys was that local fishermen actively avoided areas which were likely to yield high catches of *Siganus*, due to the increased labour involved in removing fish of poor value from their nets. In some areas in the Mediterranean, *S. luridus* has been successfully introduced into the market, which has shown a positive effect on the fishery [5]. In Fourni there is currently no market for the species, and fishermen doubt it would ever be profitable. However, it is worth noting that perceptions of the Fourni community have changed previously, for example, *Mullus surmullettus*, a fish now of high economic importance, was also once unpopular. Considering the abundance of *Siganus*, if consumer neophobia could be overcome, and a market established for *Siganus* in Fourni, it would have the potential to bring economic benefits to the fishery as well as ecological benefits to the ecosystem [2].

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SUR LA PRESENCE DES POISSONS EXOTIQUES NOUVEAUX DE LA COTE LIBANAISE (MEDITERRANEE ORIENTALE)

Ghazi Bitar [1]*
[1] Lebanese University - Faculty of Sciences - ghbitar@ul.edu.lb

Abstract
Les poissons exotiques répertoriés de la côte libanaise comptent 42 espèces. Nous y ajoutons six espèces dont trois, sont mal connues (*Enchelycore anatina, Lagocephalus sceleratus, Torquigener flavimaculosus*) et trois sont nouvelles pour la côte libanaise (*Plotosus lineatus, Abudefduf vaigiensis, Pseudanthias squamipinnis*). Cette dernière espèce n'a jamais été encore signalée en Méditerranée.

Keywords: Alien species, Levantine Basin

Introduction Depuis l'ouverture du canal de Suez en 1869 et avec le réchauffement global, des centaines d'espèces marines ont migré de la mer Rouge vers la Méditerranée orientale, en modifiant la composition et la structure des habitats marins dans cette région et en particulier au Liban [1,2,3,4]. Dans un atlas des poissons exotiques [5], 59 espèces de poissons Indo-Pacifiques sont enregistrées dans la région méditerranéenne, mais ce nombre ne cesse d'augmenter [6].

Matériel et méthodes Depuis 1991, dans le cadre des études des communautés benthiques et ichtyologiques, nous avons prospecté systématiquement la côte libanaise en plongée. Pour faire progresser l'inventaire de la biodiversité ichtyologique et rechercher les espèces exotiques en relation avec le changement global, la reconnaissance visuelle des poissons en plongée a été complétée par des photographies sous-marines.

Etat des lieux D'après les travaux bionomiques et ichtyologiques effectués sur la côte libanaise , 42 espèces de poissons exotiques sont signalées : *Himantura uarnak, Dussumieria elopsoides, Etrumeus teres, Herklotsichthys punctatus, Saurida undosquamis, Parexocoetus mento, Tylosurus choram, Hemiramphus far, Hyporhamphus affinis, Fistularia commersonii, Atherinomorus lacunosus, Sargocentron rubrum, Platycephalus indicus, Epinephelus fasciatus, Pelates quadrilineatus, Terapon puta, Apogon nigripinnis, Sillago sihama, Alepes djedaba, Leiognathus klunzingeri, Lutjanus argentimaculatus, Upeneus moluccensis, Upeneus pori, Pomadasys stridens, Pempheris vanicolensis, Heniochus intermedius, Pomacanthus maculosus, Sphyraena chrysotaenia, Pteragogus pelycus, Oxyurichthys papuensis, Scarus ghobban, Callionymus filamentosus, Siganus luridus, Siganus rivulatus, Scomberomorus commerson, Cynoglossus sinusarabici, Stephanolepis diaspros, Ostracion cubicus, Lagocephalus lagocephalus, Lagocephalus spadiceus, Lagocephalus suezensis, Champsodon vorax.* Ici nous rapportons la présence de six espèces dont trois, signalées dans un rapport national personnel [7], mais mal connues par la communauté scientifique (*Enchelycore anatina, Lagocephalus sceleratus, Torquigener flavimaculosus*) et 3 autres nouvelles pour la côte libanaise (*Plotosus lineatus, Abudefduf vaigiensis, Pseudanthias squamipinnis*). La dernière n'est jamais signalée en Méditerranée.

Enchelycore anatina : un seul individu rencontré et photographié (14/05/2008) à l'entrée de la grotte Chak El Hatab au nord de Selaata. Puis à Ramkine (29/05/2011) et à Batroun (18/06/2011).

Lagocephalus sceleratus : Un seul individu observé à Tyr (11/09/2010) et un autre photographié dans la même zone (6/04/2011).

Torquigener flavimaculosus : rencontré et photographié à Tyr (10/092009) puis à deux reprises ensuite (11/09/2010 et 17/04/2011). Nous l'avons trouvé dans deux autres localités à Beyrouth (30/09/2010 et 23/03/2011) et à Batroun (9/07/2011 et 14/10/2011). Il est toujours observé en groupe de quelques individus.

Plotosus lineatus : un très jeune spécimen rencontré et photographié pour la première fois à Tyr (15/09/ 2012). D'après un pêcheur, ce poisson se rencontre en petit banc dans la région de Tyr.

Abudefduf vaigiensis : Cette espèce nouvelle pour le Liban a été observée et photographiée dans deux localités sur fonds rocheux entre 2 et 5 m de profondeur. Quatre individus photographiés ensemble à Khaizaran (9/08/2012) et un seul à Tyr (15/09/2012).

Pseudanthias squamipinnis : identifié par Mireille Harmelin-Vivien, ce poisson, nouveau pour le Liban et la Méditerranée, a été observé et photographié à BIEL (au sud du port de Beyrouth) par le plongeur professionnel Albert ASSAL en Mai - Juin 2000. A chaque reprise un ou deux individus ont été rencontrés.

Conclusion et perspectives A part les deux espèces de Tetraodontidae *L. sceleratus* et *T. flavimaculosus,* le fait que la première observation de ces espèces ne concerne qu'un ou un petit nombre d'individus dans peu de localités, ne permet pas de dire si elles sont bien établies au Liban. En plus de ces six espèces, sept autres ont été enregistrées depuis 2007 : *Etrumeus teres, Scarus ghobban, Ostracion cubicus, Champsodon vorax, Epinephelus fasciatus, Heniochus intermedius, Pomacanthus maculosus.* Comme le réchauffement global et l'arrivée des espèces exotiques affectent tout particulièrement le bassin levantin, le Liban est un lieu privilégié pour l'étude de la biodiversité marine dans cette région, ainsi que ses évolutions récentes. En ce sens, l'élaboration des plans d'action nationaux et régionaux afin de bien contrôler et suivre la répartition de ces espèces en relation avec le réchauffement global est une nécessité.

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THE IMPACT OF INVASIVE FISH POPULATIONS ON THE EASTERN MEDITERRANEAN FOOD WEB

Menachem Goren [1]*, Bella S. Galil [2], Arik Diamant [3] and Ya'arit Levit [1]
[1] Tel Aviv University - gorenm@tauex.tau.ac.il
[2] National Institute of Oceanography
[3] National Center for Mariculture

Abstract
The food web in the eastern Mediterranean is heavily affected by alien fish populations. Recent studies comparing the trophic levels of soft bottom demersal alien and native fish, revealed that the weighted trophic level of the aliens is considerable higher than that of the native ones.

Keywords: Lessepsian migration, Levantine Basin, Food webs, Fishes

Introduction: The invasion of Indo-Pacific biota through the Suez Canal, combined with warming and unsustainable fisheries, have altered the biodiversity of the Eastern Mediterranean. About 100 alien tropical fish species were reported from the Levant basin, where they have been gradually replacing native species (Galil and Goren, in press).The invasion and replacement have greatly affected the infralittoral food web structure in the easternmost Mediterranean. In rocky habitats, the native herbivores are either small sized or of negligible biomass, while the two alien herbivores, *Siganus rivulatus* Forsskål, 1775 and *S. luridus* (Rüppell, 1829) comprise about one third of the fish biomass and, impacting the local macrophytes and food web (Goren and Galil 2001; Lundberg et al., 2004).
Material and Methods: The results presented in this talk are based on measurements and weights of ca. 500,000 fish collected by an otter trawl along the Israeli coast during 2008-2012.
Results and Discussion: Recent studies compared the trophic levels of alien and native fish populations on infralittoral (to depth of 40m) soft-bottom habitats along the Israeli coast. The results revealed that while the average trophic levels of native and alien fishes are similar (3.44 ± 0.55 and 3.65 ± 0.44 respectively) (data on trophic levels extracted from FISHBASE (Froese and Pauly 2013)), the weighted trophic levels are dissimilar. The native species dominated the lowest and the highest trophic levels (below 3 and above 4), whereas the aliens dominated the range of 3 to 4 (Figure 1).

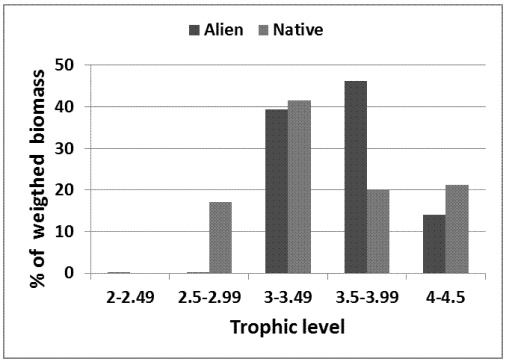

Fig. 1. A comparison of the weighed trophic levels' distribution between alien and native species (divided into five guilds).

Moreover, when the weighted fish biomass was grouped into two trophic guilds (2-3.49 and 3.5-5.0; Figure 2) the average trophic level of the alien fish was significantly higher than that of the native species. The ongoing replacement of the native species biomass by the alien fishes is expected to increase the overall weighted trophic level of the fishes and thus, may significantly affect the entire food web in the eastern Mediterranean.

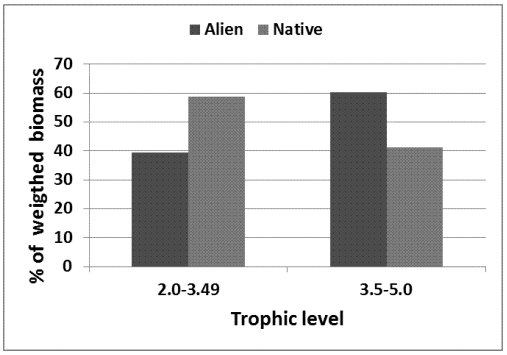

Fig. 2. A comparison of the weighed trophic levels' distribution between alien and native species (divided into two guilds).

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EAST IS EAST AND WEST IS WEST – IMPLICATIONS OF BIOINVASION PATTERNS IN THE MEDITERRANEAN SEA FOR IMPLEMENTATION OF THE MSFD

Bella Galil [1], Anna Occhipinti-Ambrogi [2]* and Agnese Marchini [2]
[1] National Institute of Oceanography, Israel Oceanographic and Limnological Research, 31080 Haifa, Israel
[2] Department of Earth and Environmental Sciences, University of Pavia, Via S. Epifanio 14, 27100 Pavia, Italy - occhipin@unipv.it

Abstract
About 700 non-indigenous marine multicellular species have been recorded in the Mediterranean Sea, with many establishing viable populations. So far more non-indigenous species (NIS) were documented in the Levantine Basin than in the better surveyed western Mediterranean, and whereas most of the NIS in the eastern Mediterranean have presumably entered through the Suez Canal, shipping and massive shellfish farming are the drivers in the western Mediterranean. The implications of regionally different vectors for the implementation of the Marine Strategy Framework Directive (MSFD) mandated good environmental status concerning NIS in the Mediterranean are briefly discussed.

Keywords: Alien species, Suez Canal, South-Eastern Mediterranean, North-Western Mediterranean

Introduction
The EU's ambitious MSFD (2008/56/EC) [1], aiming to achieve good environmental status by 2020 (http://ec.europa.eu/environment/water/marine/directive_en.htm), places great emphasis on the "trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species … in relation to the main vectors and pathways" (http://eur-lex. europa.eu/lexUriServ). With so much at stake for regulators, scientists, and stakeholders it is important that NIS datasets used for the implementation of MSFD policy decisions are scientifically verified. This contribution aims to report updated statistics on NIS introduced in the Mediterranean Sea, with focus on the different introduction pathways between its eastern and western regions.

Material & Methods
Data were extracted from AquaNIS, a European wide information system of aquatic NIS. AquaNIS is a flexible, easily extendible structure, where new data blocks and functional modules may be included as necessary. Data is organised in four interrelated data blocks: INTRODUCTION EVENTS, SPECIES, GEOGRAPHY and IMPACTS. Data within blocks are grouped according to attributes (Biological traits, Pathways and vectors, etc.). Introduction events were updated with records until year 2012.

Results & Discussion
AquaNIS records about 700 multicellular NIS in the Mediterranean Sea, of which a great many are invasive: 111 species were recorded in 5 or more countries, and 19 hyper-invasive species were recorded in 10 or more countries. Molluscs (31%), crustaceans (18%) and bony fish (16%) make the largest contributions to the number of documented NIS in the Mediterranean and comprise more than 60% of total NIS richness in the sea. Macrophytes (11%), annelid polychaetes (11%), bryozoans and cnidarians (6%), and all other taxa (7%) complete the number of species. There are considerable differences among the peri-Mediterranean countries in the number of NIS recorded. Far more NIS have been documented in the Levantine Basin than the entire western Mediterranean: 352 multicellular NIS were reported along the 180 km long coast of Israel, whereas only 62 NIS were reported off the 1660 km long Mediterranean coast of peninsular Spain. Most of the NIS in the eastern Mediterranean have presumably entered through the Suez Canal, but are increasingly spreading to the central Mediterranean: they comprise 39%, 30% and 23% of the NIS in the Tunisia, Malta and southern Sicily, respectively. Shipping and massive shellfish farming are the main drivers in the western Mediterranean. Propagule pressure [2] is recognized as the most important factor for the invasion success of species causing impacts on biodiversity and disturbance on community structure and functions. A meta-analysis of invasiveness of species and invasibility of habitats found that propagule pressure (defined as a composite measure of the number of viable NIS individuals, genotypes and taxa, the number of discrete introduction events, their frequency and duration) was a significant predictor of both [3]. Of the three high propagule conveyances into the Mediterranean –shipping, mariculture, Suez Canal– the latter supplies the largest number of successfully established NIS in the eastern Mediterranean Sea by virtue of the magnitude, frequency, and duration of the trans-isthmian corridor invasion and the common evolutionary history of its components. Such high propagule pressure of co-evolved invaders greatly increases the risk of further invasions. The implications of enlarging the Suez Canal without erecting a barrier to the Erythraean biota is all too clear –increasing the delivery of multiple invaders, increasing the supply of deeper living taxa. The influx of thermophilic Erythraean NIS has recently invaded deeper waters, establishing an ever larger invasion bridgehead in the Mediterranean. At present only voluntary ballast water management is in effect in the Mediterranean, but the 'Ballast Water Management Convention' will enter into force within a few years. In 2011 IMO published 'Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species'. Institution of "zoosanitary precautions" by the mariculture industry have already contributed to a reduction in the numbers of mariculture-associated NIS in the past decade. When properly regulated and enforced, the number of shipping and mariculture introduced NIS will decline. However, the Mediterranean countries have yet to develop a comprehensive and effective response to the introduction of NIS through the Suez Canal. Key industry groups, governmental bodies, even regional environmental groups have poor appreciation of the magnitude of the problem. Scientific, administrative and political coordination at the regional level is urgently needed to attain the MSFD mandated good environmental status concerning NIS in the Mediterranean.

Acknowledgements Support for this research was provided by the European Community's Seventh Framework Programme (FP7/2007-2013) for the project *Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors* (VECTORS).

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A PRELIMINARY ANALYSIS INTO THE RELATIONSHIP BETWEEN *POSIDONIA OCEANICA* MORPHOLOGY AND CAULERPA RACEMOSA

J. Shepperson [1], A. Jeffery [1], L. Taylor [2], A. Miliou [1], H. Thornton [1]* and C. Acasuso-Rivero [1]
[1] Archipelagos, Institute of Marine Conservation, P.O. 42, Pythagorio, 83103, Samos, Greece - hazel@archipelago.gr
[2] Cardiff University, Main Building, Park Place, Cardiff, CF10 3AT, UK

Abstract
The present study investigates the interaction between the invasive algae *Caulerpa racemosa* and the endemic seagrass *Posidonia oceanica*, in the eastern Aegean Sea. When *C. racemosa* is present, *P.oceanica* exhibits a smaller morphology and a lower shoot density, which can be indicative of a more degraded seagrass ecosystem. This forms the preliminary analysis of a study concerning how *P.oceanica* and *C.racemosa* are impacted by their coexistence.

Keywords: Alien species, Aegean Sea, Posidonia

Introduction
The invasive species *C. racemosa var. cylindracea* can have a significant impact on its surrounding ecosystems, therefore its rapid spread in the Mediterranean gives cause for concern [1,2]. It can be found within the Mediterranean's endemic and protected *Posidonia oceanica* beds, which are regarded as one of the most valued and highly productive shallow-water ecosystems [3]. The interaction between the two species in the eastern Aegean offers the opportunity to investigate how the morphology and level of degradation of *P. oceanica* influence *C. racemosa* presence.

Methods
Three bays around the Greek Island of Fourni Korseon (eastern Aegean) were sampled between July and September 2012. All three bays are characterised by extensive Posidonia beds that suffer differing levels of C.racemosa invasion within each site. Ten metre transects were randomly placed in the P.oceania meadows, with 20 by 20cm quadrats placed randomly along the transects at pre-determined points.

A total of 110 quadrats were sampled, between depths of 1.5 – 5m. Through snorkel surveys, Posidonia meadow characteristics such as shoot density and canopy height were measured. Canopy height was determined using methods described by Short and Coles (2001) [4], where random handful of shoots were fully extended and 80% of the full height of the leaves were measured, using the sediment as the base. From each quadrat, 10% of the P.oceanica shoots were removed for morphometric analysis, to obtain measurements of shoot height, blade area, and blade density.

In addition, all C.racemosa was extracted, to determine the mass in each quadrat. A wet to dry conversion ratio was determined by drying samples of C.racemosa for 48 hours at 200°C (ratio 29:3, r-sq = 0.02). All C.racemosa samples were subjected to a constant treatment, and processed within 24 hours of extraction. A Mann-Whitney test was used to test individual P.oceanica morphology variables for differences when C.racemosa was present or absent, and a Kruskal-Wallis test used to look for differences in C.racemosa abundance between sites.

Results and Discussion
P. oceanica beds showed a significant positive correlation between canopy height and shoot density, $r(108) = 0.669$, $p<0.001$, with *C. racemosa* presence being related to this trend. When *C. racemosa* is present, *P. oceanica* exhibits a trend towards a lower shoot density and a smaller morphology (Tab. 1), which can be indicative of a degraded or stressed seagrass ecosystem [4]. *P. oceanica* shoot morphology did not differ between the three study sites, however, the abundance of *C. racemosa* was not the same at all three sites (Kruskal-Wallis, $p<0.001$). This suggests that there may be additional factors influencing the level of *C. racemosa* invasion in *P.oceanica* beds, in addition to shoot morphology.

Tab. 1. Results of Mann-Whitney test. Values from each measurement indicate mean ± standard error.

Variable	*C.racemosa* present	*C.racemosa* absent	p
Shoot Density (shoots/0.2m^2)	22.156 ±1.320	42.947 ±3.564	<0.001
Canopy height (cm)	19.264 ±0.792	30.751 ±2.219	<0.001
Number of blades per shoot	5.111 ±0.120	5.082 ±0.195	n.s.
Blade height* (cm)	11.673 ±0.428	16.766 ±1.070	p<0.001
Blade width (mm)	0.689 ±0.0103	0.722 ±0.0199	n.s.
Blade area* (cm^2)	8.245 ±0.372	12.276 ±0.920	p<0.001

This study supports findings that when *P. oceanica* is degraded, the opportunistic *C. racemosa* is able to invade more successfully, which could have further consequences on an important and already threatened ecosystem. These findings will contribute to an on-going analysis into how *C. racemosa* and *P. oceanica* growth rates are impacted by their coexistence.

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ABOUT TWELVE YEARS OF PRESENCE OF THE ALIEN SPECIES *HYPNEA CORNUTA* (RHODOPHYTA, GIGARTINALES) IN THE MAR PICCOLO OF TARANTO (IONIAN SEA, SOUTHERN ITALY

Antonella Petrocelli [1], Marc Verlaque [2]*, Giuseppe Portacci [1] and Ester Cecere [1]
[1] IAMC-CNR, Taranto, Italy
[2] Mediterranean Institute of Oceanography, Marseille, France - marc.verlaque@univ-amu.fr

Abstract
Populations of the alien seaweed *Hypnea cornuta* were followed on a twelve-years period in the Mar Piccolo of Taranto. On the 13 alien macrophytes identified in the basin since the eighties, it is the only established species that showed an invasive behaviour, even though without any clear negative effect on environment, human health or socio-economical activities.

Keywords: Algae, Alien species, Lagoons, Phytobenthos, Ionian Sea

Introduction
The Mar Piccolo of Taranto, which is a Transitional Water System (TWS) under strong pressures of aquaculture and importation of seafood, is the third Mediterranean hot spot for the introduction of alien macrophytes. Most of aliens recorded in the basin come from the cold-temperate Pacific Ocean [e.g. *Undaria pinnatifida* (Harvey) Suringar, *Grateloupia turuturu* Yamada, *Codium fragile* (Suringar) Hariot subsp. *fragile*] and did not succeed to establish. Conversely the Lessepsian species *Hypnea cornuta* (Kützing) J. Agardh, which was first recorded along the Italian coasts in the Mar Piccolo in December 2000 [1], formed permanent both attached and unattached populations. Here we report the results of a twelve year monitoring of this species in the Mar Piccolo.

Materials and Methods
During a twelve-years period, *H. cornuta* was qualitatively and quantitatively monitored in two sites of the Mar Piccolo (Fig. 1). From 2000 to 2006 its occurrence and spread were qualitatively followed at the station of first observation (Battendieri). Then, from 2007 to 2010, monthly quantitative campaigns were carried out also at Cimino, where the species was first observed in October 2007. In 2011 and 2012, quantitative observations were carried out in early summer and autumn.

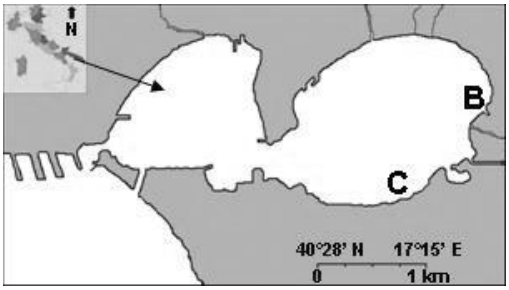

Fig. 1. Map of the Mar Piccolo of Taranto. (B) Battendieri; (C) Cimino.

Results and Discussion
From 2000-2006, the qualitative monitoring showed that *Hypnea cornuta*, firstly found as sparse thalli attached on pebbles, spread out, year after year, at Battendieri, also colonising the soft bottoms under free-living thalli. No fertile gametophyte was ever found but, both attached and free-living thalli produced stellate propagules that were observed detached on the surrounding substrates. From 2007 to 2010, quantitative observations carried out on macrophyte assemblages highlighted that *H. cornuta* was becoming a dominant species in summer-autumn, with a steady annual increase of biomass in both stations. The maximum biomass was registered at Battendieri in August 2010 (m ± sd : 971 g wet weight 0.25 m^{-2} ± 15.43). In this station, first fertile tetrasporophytes were observed in summer 2008. In the absence of fertile gametophytes, it was supposed that tetraspores were apomeiotic and give birth directly to new tetrasporophytes. In 2011 and 2012, seasonal monitoring showed a slight decrease of biomass during the two sampled months (July and November) with respect to 2010 but, in the absence of sampling in August, we cannot conclude on a possible decreasing trend of populations. On the 13 alien macrophytes listed in the Mar Piccolo since the eighties, *H. cornuta* is the only established species that showed an invasive behaviour, even though without any clear negative effect on environment, human health or socio-economical activities. Its success in this southern Mediterranean TWS agrees with its natural worldwide distribution in the warm seas.

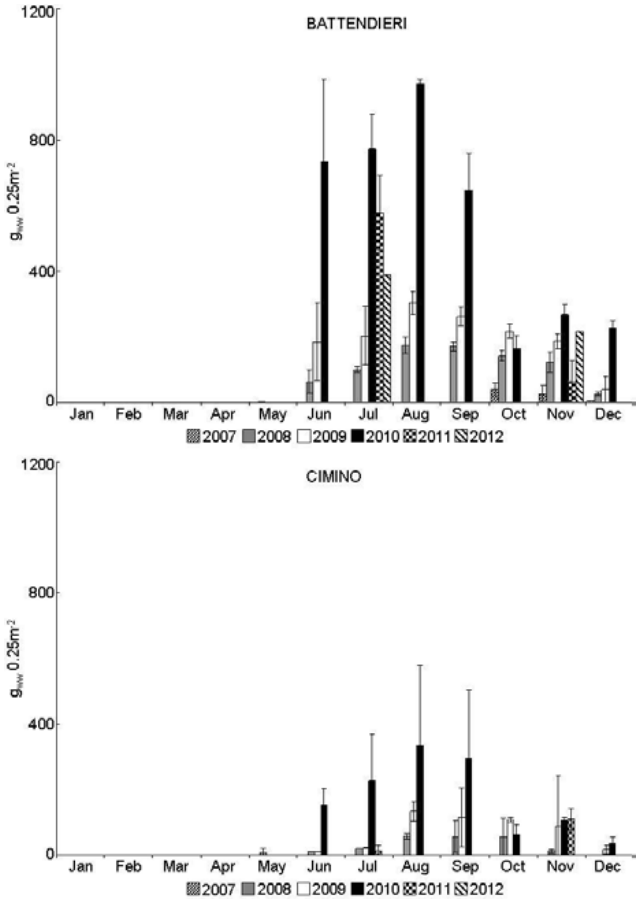

Fig. 2. Biomass of *Hypnea cornuta* from the Mar Piccolo of Taranto in 2007-2012.

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Session

Indo-Pacific aliens records

Modérateur : **Tarek Temraz**

EXOTIC FISH SPECIES IN THE MEDITERRANEAN SEA: ANALYSIS OF OCCURRENCE RECORDS

E. Azzurro [1]*, S. Soto [2], M. Bariche [3], E. Fanelli [4] and F. Maynou [2]
[1] ISPRA - eazzurr@gmail.com
[2] ICM-CSIC, Passeig Maritim de la Barceloneta 37-49, 08003 Barcelona, SPAIN
[3] American University of Beirut, PO Box 11-0236, Beirut, LEBANON
[4] Marine Environment Research Centre ENEA - Santa Teresa, Pozzuolo di Lerici 19100 - La Spezia, ITALY

Abstract
Here we provide a dynamic reconstruction of exotic fish occurrences in the Mediterranean Sea and report on the means in which we are tracking this phenomenon. Data were mainly extracted from published sources, resulting in a total of 2456 geo-referenced observations, from 1896 to March 2013. The database currently includes 85 Lessepsian species, 20 human mediated introductions and 44 recent immigrants from the Atlantic, holds a number of 172 fish taxa, including questionable and cryptogenic species.

Keywords: Species introduction, Fishes, North-Central Mediterranean

Introduction
The current change in the species geographical ranges is one of the most apparent signals of a changing biodiversity worldwide [1]. A spectacular example of this phenomenon is provided by the recent alterations of the Mediterranean marine biota due to the ongoing incoming of species of extra-Mediterranean origin. A major convenient division of these immigrants separates '"true"' exotic species, introduced outside their dispersal potential, from non-native organisms which have extended their distribution by natural means [2]. The former classification would include Lessepsian species entering through the Suez Canal and other human mediated introductions (for example, ballast water or aquarium escapes). The second type of immigrants is basically represented in the Mediterranean by Atlantic species, entering the Mediterranean through the Straits of Gibraltar. Here we present 'ORMEF', a new geo-referenced database, with the aim to provide 1) a dynamic reconstruction of exotic fish occurrences in the Mediterranean Sea, and 2) insights on the methods we have used to detect these species thus far.

Materials and Methods
Data were extracted from a total of 457 published sources, spanning from 1896 to 2013. Presence records were geo-referenced using ArcGIS 9.3 as Geographical Information System (GIS) (Fig. 1). Documentation of biological, ecological, taxonomic information, introduction pathways, bibliographic references and other relevant data for each species was also compiled. The database was here explored to provide synthetic information on the chronology of these sightings and on species spatial dynamics. For insights on how exotic fishes are being monitored in the Mediterranean Sea, we analyzed the whole set of records according to the country and means of detection.

Results and Discussion
The ORMEF database currently includes 2456 geo-referenced observations. Out of these, 2019 were extracted from published presence records; 377 from checklists and 60 from grey literature. Initial analyses consisted of calculations of linear rates of spread for both single species and major pathways of arrival. Spatial patterns are shown for i) Lessepsian species, ii) human mediated introductions other than Lessepsian, and iii) Atlantic species entering through Gibraltar. Professional fishing gears such as trawls and nets have traditionally been important means of recording exotic species, but the recent increasing use of underwater photographs and videos has emerged in the last few years. The uneven geographical allocation of species sightings along the various Mediterranean sectors reflects the unbalanced publishing efforts among different Mediterranean countries, with the greatest gap corresponding to some southern countries, where little published information exists.

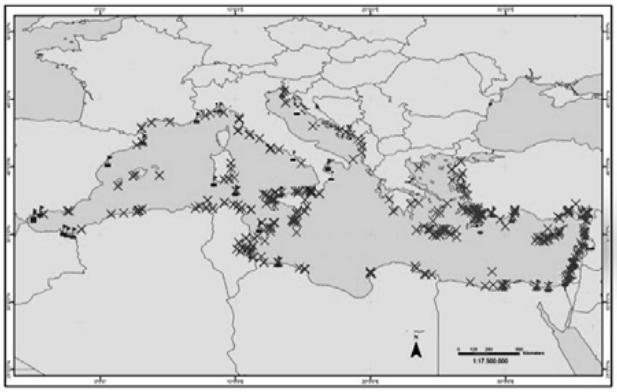

Fig. 1. ORMEF (Occurrence Records of Mediterranean Exotic Fishes) Database: Geographical distributions of documented records. First records in the Mediterranean are reported with flags, subsequent records with crosses.

Acknowledgments
We acknowledge the contribution of the VECTORS project, funded by European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement No. 266445.

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SEAWATCHERS: AN INTERACTIVE WEBSITE TO MONITOR THE OCCURRENCES OF EXOTIC FISHES IN THE MEDITERRANEAN SEA

Ernesto Azzurro [1]*, Michel Bariche [2], Elisabetta Broglio [3] and Francesc Maynou [3]
[1] ISPRA - eazzurr@gmail.com
[2] American University of Beirut, PO Box 11-0236, Beirut, LEBANON
[3] ICM-CSIC, Passeig Maritim de la Barceloneta 37-49, 08003 Barcelona, SPAIN

Abstract
Public participation in programs aimed at biodiversity monitoring, is rapidly expanding in the Internet Era. Here we present SEAWATCHERS, a new interactive website aimed to acquire geo-referenced observations of exotic fish species at the Mediterranean scale. The system is open to volunteer-based collaborations who are passionate observers of marine life. A first phase of testing generated 47 records (in a period of 10 months), including the observation in Catalonia of Abudefduf saxatilis, a new species for the Mediterranean Sea.

Keywords: North-Central Mediterranean, Fishes

Introduction
The Mediterranean Sea is undergoing rapid biodiversity alterations and new research approaches are needed to track these changes at the basin scale. Among the reliable solutions to overcome practical difficulties in surveying large geographical ranges, community-based actions have rapidly gained scientific consensus [1]. The engagement of volunteers is also expected to have a role for Mediterranean research [2] but specific procedures for the detection of exotic species were thus far limited to the local level.

Materials and Methods
SEAWATCHERS is an interactive web site aimed to collect sightings that enthusiasts of marine life make through their activities, whether professional or recreational. In May 2012, a new specific action (at http://www.observadoresdelmar.es/projecte-9.phpto) was developed with the double aim to receive referenced observations of exotic fish species and to generate awareness on the issue of Mediterranean fish invasions. Users post their observations, usually sending a photograph, and then a team of scientific editors validate these sightings (Fig. 1). Finally, the overall occurrences are projected in an interactive map (Fig 2c). Here we report the preliminary results of a testing phase, which was concluded in March 2013.

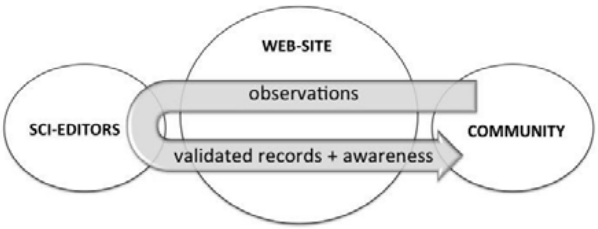

Fig. 1. SEAWATCHERS/exotic fish: Basic conceptual scheme.

Results and discussion
Overall, 47 sightings (Fig. 2c) were received during the phase of testing, for a total of 16 recorded species. Some of these observations were particularly significant, such as 3 new sightings of *Fistularia commersonii* from the Western Mediterranean and the observation of *Abudefduf saxatilis*, spotted on August 2009 along the coast of Tarragona, Spain (Lat. 41.1210º, Long. 1.3704º) at 3 m depth. This observation represents the first documented record of this Atlantic species in the Mediterranean Sea, providing a new and scientifically validated record of an exotic species in the Mediterranean. These preliminary results encouraged us to promote this system at the Mediterranean scale. Information gained through this participatory action would provide an additional, low cost resource to professional monitoring activities, while promoting awareness among its participants.

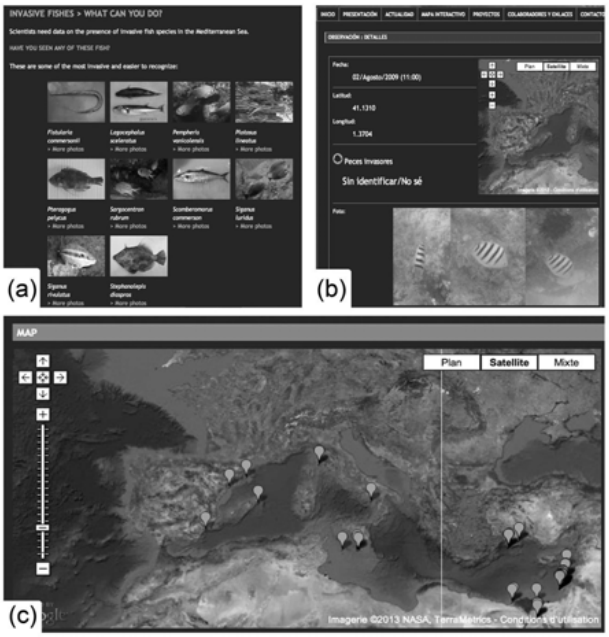

Fig. 2. Screenshots from SEAWATCHERS /exotic fish: a) Main target species; b) Submitted sighting of Abudefduf saxatilis fron the Catalan Sea; c) Geographical distribution of 47 records posted during the preliminary test phase (May 2012 - March 2013)

Acknowledgments This project has been funded by FECYT in collaboration with CLIMCARES, VECTORS, CUBOMED, EN CHANGES. We thank Joseba Santiago, who developed the web site platform and all the volunteer observers.

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FIRST REPORT OF *CAULERPA TAXIFOLIA* VAR. *DISTICHOPHYLLA* (SONDER) VERLAQUE, HUISMAN & PROCACINI (CAULERPACEAE, CHLOROPHYTA) FROM NORTHERN CYPRUS

Burak Ali Çiçek [1]*, Oguz Kurt [2], Ergün Taskin [2] and Mehmet Öztürk [2]
[1] Eastern Mediterranean University - burak.cicek@emu.edu.tr
[2] Celal Bayar University

Abstract
Caulerpa taxifolia var. *distichophylla* is an Australian species which was introduced into the Mediterranean Sea. Finally it was reported from the Levantine coast in 2007 (Gulf of Iskenderun, SE Turkey). Since then it has expanded, covering large areas of the eastern Mediterranean. *C. taxifolia* var. *distichophylla* has not been reported in any earlier marine floras of Cyprus. We report for the first time observing *C. taxifolia* var. *distichophylla* presence on the northern Cypriot coast describing its ecological and morphological features.

Keywords: Alien species, Algae, Cyprus Basin

Introduction
The marine alga *Caulerpa taxifolia* (Vahl) C. Agardh is native to several tropical and subtropical regions of the world (Phillips and Price 2002). Seaweed invasions are a growing concern around the world (Ribera and Boudouresque 1995). One of the most famous, or infamous, of these in the past decade was the establishment of an aquarium strain of tropical green seaweed, *Caulerpa taxifolia* (Komatsu et al. 2003). Accidentally introduced into the Mediterranean Sea in 1984, the tropical alga *Caulerpa taxifolia* has spread since then, reaching the Mediterranean coast. Invasive populations of *C. taxifolia* now occur at more than 100 sites where more than 13,000 hectares have been colonized (Meinesz et al. 2001; Galil 2008). *Caulerpa taxifolia* var. *distichophylla* (Sonder) Verlaque, Huisman & Procacini was reported only from the Iskenderun Bay (Mediterranean coast of Turkey) by Cevik et al. (2007 as *Caulerpa taxifolia*) and Sicily by Jongma et al. (2013). But it has not yet been reported from the Cyprus coast since then. In the present study, we carried out morphological analyses to identify the taxon and compared with the materials obtained from Iskenderun Bay (Cevik et al. 2007).

Material and method
Specimens with stolons were hand-collected with SCUBA diving in June 2009 in the northeast coast of Northern Cyprus. The physico-chemical characteristics of the colonized area were registered during the field study by using DKK-TOA WQC 24 Instruments, Multiparameter Water Quality Checker.

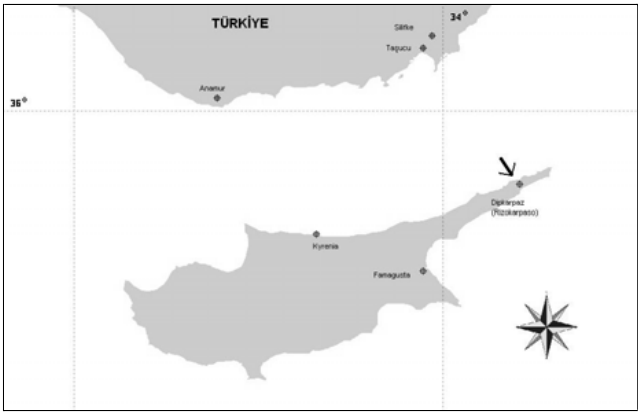

Fig. 1.
Cyprus coast-line and the sampling locality (arrowhead).

Results and Discussion
Current distribution, substratum structure and morphological variations; The colonies of *Caulerpa taxifolia* var. *distichophylla* were found at two regions in Ayios Philon Church Bay, Dip Karpaz, Northern Cyprus (35º 38' 12.52" N; 34º 22' 30.71" E). The general biotope structure (mainly depending on depth, substrata and flora communities) of the site shows a dense *Cystoseria* spp. on the rocky substrata with a very small part covered with *Posidonia oceanica* (L.) Delile. The measurements at two points showed that *C. taxifolia* var. *distichophylla* spread within the depth limits of 6-8 m. *Morphological variations and comparison of Cypriot and Iskenderun specimens;* The specimens of Caulerpa collected in the Northern Cyprus do not exhibit the usual morphology of the species. It resembles the specimens collected in Iskenderun (Cevik et al. 2007). Compared with specimens of Iskenderun and Cyprus; the Cyprus stolons are less elongated in shape and its stolons, fronds and pinnules are more or less elongate and long then the Iskenderun material. *Conclusions;* In conclusion, *C. taxifolia* has been studied extensively in the western Mediterranean, as its impact on the marine ecosystem is well admitted. It colonizes all types of sea bottoms such as; rock, sand, mud and dead *P. oceanica* meadows, and invades indigenous biocenoses, modifying the biodiversity and the ecodiversity. The present study constitutes the first report of *Caulerpa taxifolia* var. *distichophylla* along the Northern Cyprus coast. It is spreading in two different regions which are close to each other. At the site, it is found that *P. oceanica* meadows are located 100 m away, but brown algae are present in nested appearance with *C. taxifolia* var. *distichophylla*. At both regions under *C. taxifolia* var. *distichophylla* invasion, it is observed that presence of molluscs, fishes and other species continues in usual manner.

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ACCELERATION OF FISH INVASIONS IN THE MEDITERRANEAN - A FUTURE "SEA CHANGE"?

D. Golani [1]*, L. Orsi-Relini [2], E. Massuti [3], J. P. Quignard [4], J. Dulcic [5] and E. Azzurro [6]
[1] Hebrew University of Jerusalem - dani.golani@mail.huji.ac.il
[2] University of Genova
[3] IEO, Palma de Mallorca
[4] Universite Montpellier II
[5] Institute of Oceanography and Fisheries, Split
[6] ISPRA Livorno

Abstract
In the last decade no less than 33 Red Sea (Lessepsian) fish species have invaded the Mediterranean, including coral-associated species; there are 19 Atlantic species and aquarium/mariculture escapees; numerous indigenous species have extended their range northwesterly in the Mediterranean. All these indicate a profound "sea change" faunal shift in the Mediterranean, due to either temperature rise or the wider, deeper Suez Canal. These processes must be monitored to study their possible impact on the future of marine biodiversity in the Mediterranean.

Keywords: Alien species, Lessepsian migration, Fishes, Mediterranean Ridge

The last decade has seen a tremendous acceleration of fish invasions into the Mediterranean. Since 2000 no less than 33 Red Sea (Lessepsian) fish species have invaded the Mediterranean (Fig 1), among them 2 species of commercial value (*Nemipterus randalli* and *Decapterus russelli*) and 5 non-commercial species (*Fistularia commersonii*, *Plotosus lineatus*, *Jaydia smithi*, *Ostorhinchus fasciatus* and *Lagocephalus sceleratus*) [1] that established large populations almost immediately upon arrival. A number of coral-associated species have migrated as well (*Pomacanthus imperator*, *P. maculatus*, *Chaetodon austriacus* and *C. larvatus*). Numerous indigenous species have extended their range north-westerly in the Mediterranean. All these indicate a profound "sea change" faunal shift in the Mediterranean. Figure 1 reveals two different species accumulation trends. Despite the growing ichthyologic study effort, the number of new Lessepsian species records per decade remained constant (6-11) from the 1950's to the end of the 20 century. The dramatic increase in Lessepsian migrant species in the last appear to be due mainly to the widening and deepening of the Suez Canal, which led to an increase in water flux in the Canal, thus allowing *propaguli* distribution and adult fish swimming freely into the Mediterranean. In the framework of Marine Strategy, the Atlantic species newly recorded in the Mediterranean have been in part recognized as a natural phenomenon; however the problem of Atlanto-Mediterranean fish species is very complex in terms of genetic units and their geographical limits. Members of CIESM exotic fish team agreed about the necessity to maintain the study of these fishes in the original CIESM approach, because a) Atlantic successful species show by their spatial and temporal distribution very clear links with ecological factors (3, 4, 5, 6); b) an oscillating balance (see below) between Lessepsian and Atlantic migrants in some critical areas such as the Sicily Strait has been observed. c) Its monitoring could open windows for the studies concerning the maintenance of Mediterranean biodiversity. The ratio of Lessepsian/Atlantic invaders shows a geographical West-East gradient, with only one Lessepsian species in the Alboran Sea and a maximum in the Levantine Sea. The shift to a prevalence of Lessepsian species occurs in the Central Mediterranean, in Greek waters, while in Italian waters the overall ratio during the last twenty years has been 4/7. In the 2013 updating of CIESM exotic fish Atlas, Atlantic species are 9 and Lessepsian 21; in Marseille, 91 Lessepsian species and a large sample of Atlantic species observed in Italian waters were figured in five categories (1), “very rare”, "rare", "prevalent", “common” and “very common” and related to the time of their appearance: among Lessepsians the latter two categories were about 1/3 of the total and appeared both a century ago and in the years 2000-2005. In Italian waters three numerical categories (5) of Atlantic successful species were found in seven cases: *Kyphosus* spp., *Sphoeroides pachygaster*, *Beryx splendens*, *Seriola fasciata*, *Psenes pellucidus*, *Seriola carpenteri*, and *Pisodonophis semicinctus*; all but the first were observed in coincidence with the twenty year period (1980-2000) characterized by high Winter NAO indexes (http://www.LFEO.COLUMBIA.EDU/NAO) (see also fig. 1). *Enchelycore anatina*, established from the Aegean to the Levantine Sea, was recently found also in the Eastern Adriatic (7) and in Italian waters, in the Ionian Sea.

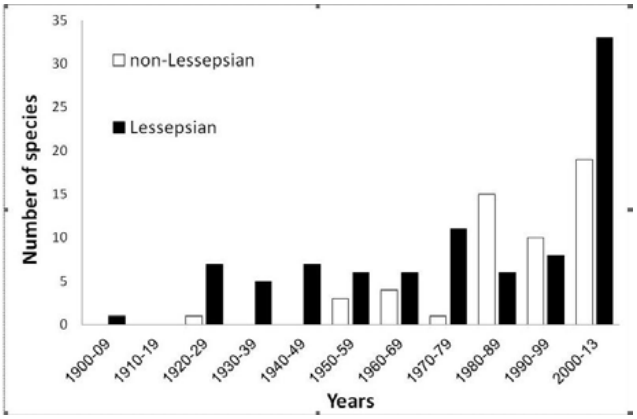

Fig. 1. Number of Lessepsian and non-Lessepsian fish species recorded in the Mediterranean by decade

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FACILITATING ASSESSMENTS OF ALIEN INVASIONS IN THE MEDITERRANEAN: THE EUROPEAN ALIEN SPECIES INFORMATION NETWORK (EASIN)

S. Katsanevakis [1]*, A. L. Nunes [1], M. Trombetti [1], I. Deriu [1] and A. Cardoso [1]
[1] Joint Research Centre, Institute for Environment and Sustainability, Water Resources Unit - stelios.katsanevakis@jrc.ec.europa.eu

Abstract
The European Alien Species Information Network (EASIN) provides tools and services for the exploration of alien species information in Europe. Efficient widgets can be used for the easy creation of distribution maps of any aggregation of alien species. Herein, we investigated distribution patterns of marine alien species in the Mediterranean Sea, using EASIN tools and data from various sources. These patterns differ depending on the pathway of introduction, indicating that human activities shape alien species richness patterns and overall biodiversity patterns in a changing Mediterranean Sea.

Keywords: Alien species, Biodiversity, Lessepsian migration, Mapping, Levantine Basin

Mediterranean countries are severely affected by biological invasions, which are considered as one of the most important direct drivers of biodiversity loss [1]. A stepping stone for the assessment of biological invasions in the Mediterranean is the collection of basic information on the occurrence and spatial distribution of alien species, pathways of introduction, spread rates, life histories, biological and ecological traits. Such information is a prerequisite for the efficient prevention, early detection, rapid response, and management of biological invasions.

In the framework of CIESM, pioneering work has been conducted for alien fish, molluscs, crustaceans and macrophytes through the 'Atlas of Exotic Species in the Mediterranean' (http://www.ciesm.org/online/atlas/index.htm). Information on marine alien species in the Mediterranean can be also retrieved from a large number of other online global, European, regional, or national databases [2]. Furthermore, there is a large amount of occurrence records in the literature that is not included in any online information system.

In September 2012, the European Commission's Joint Research Centre (JRC) launched the European Alien Species Information Network (EASIN) to facilitate the exploration of existing alien species information from distributed sources and to assist the implementation of European policies on biological invasions [2, 3]. EASIN integrates and harmonizes alien species data from all available sources, and functions as a one-stop shop for such information in Europe. It provides web services and tools that allow easy exploration, visualization, and best use of alien species data [2].

Herein, as an example of the use of EASIN, we analysed the distribution patterns of marine aliens in the Mediterranean according to the pathways of introduction. Currently EASIN includes data from GBIF (Global Biodiversity Information Facility; http://www.gbif.org), GISIN (Global Invasive Species Information Network; http://www.gisin.org), REABIC (Regional Euro-Asian Biological Invasions Centre; http://www.reabic), CIESM (Mediterranean Science Commission; http://www.ciesm.org/online/atlas/index.htm), ELNAIS (Hellenic Network on Aquatic Invasive Species; https://services.ath.hcmr.gr/), and selected literature (EASIN-LIT; http://easin.jrc.ec.europa.eu/About/EASIN-Lit).

Richness of alien species introduced through the Suez Canal was higher in the eastern coastline of the Mediterranean basin and progressively decreased along the southern Turkey and Greek coastlines, while it was much lower in the western basin and the Adriatic Sea (Fig. 1). The richness distribution patterns for alien species introduced by shipping were very different, with no apparent east-west gradient; hotspot areas included the eastern Mediterranean coastline, many sites in the Aegean, northern Adriatic, the Sicily strait, and the French coast (Fig. 2). For species introduced by aquaculture (not shown here), hotspot areas included the northern Adriatic, Sicily and the French coastline. Apparently, human activities shape the distribution patterns of alien species and affect the overall biodiversity patterns in a changing Mediterranean Sea.

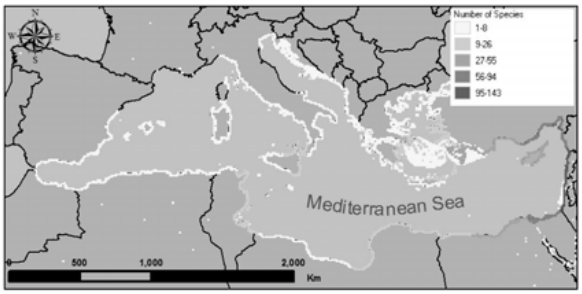

Fig. 1. Distribution map of marine alien species that were introduced in the Mediterranean through the Suez Canal (Lessepsian immigrants)

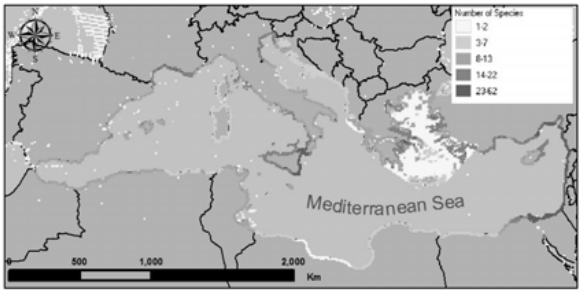

Fig. 2. Distribution map of marine alien species that were introduced in the Mediterranean by shipping

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PATTERN OF *OCULINA PATAGONICA* OCCURRENCE ALONG THE IBERIAN PENINSULA COASTLINE: A FIRST STEP TO UNDERSTAND THE FACTORS AFFECTING ITS INVASION DYNAMICS

Eduard Serrano [1]*, Rafel Coma [1] and Ribes Marta [2]
[1] Centre d'Estudis Avançats de Blanes (CEAB-CSIC) Institut de Ciències del Mar (ICM-CSIC) - eserrano@ceab.csic.es
[2] Institut de Ciències del Mar (ICM-CSIC)

Abstract
The zooxanthellate coral *Oculina patagonica* can drive a compositional shift in Mediterranean shallow water benthic communities. We examined occurrence of the species on natural rocky reefs along the Iberian Peninsula coastline. Although the species was found on 70% of the explored locations, the distribution of the species exhibited a core area in the SE Iberian Peninsula, and progressively decreased to the northeast and to the southwest. This marked pattern of occurence in a coastline encompassing a 3°C temperature gradient provides an opportunity to determine the main factors that affect the *O. patagonica* invasive dynamics in the Mediterranean Sea.

Keywords: Alien species, South-Western Mediterranean, North-Western Mediterranean, Biogeography, Temperature

Macroalgae dominate Mediterranean shallow water assemblages, whilst corals are extremely rare. However, climate change and the introduction of alien species are currently affecting the structure and dynamics of marine ecosystems worldwide. In this sense, a persistent phase shift from macroalgal to alien coral dominance has already been reported at a particular location in the Mediterranean Sea [1]. *Oculina patagonica* is an alien, non-lessepsian scleractinian zooxanthellate coral that presumably originated from the southwest Atlantic and was first recorded in the Mediterranean Sea in 1966 (Gulf of Genoa, [2]). The most abundant populations of this coral in the Mediterranean have been recorded in the coast of the Iberian Peninsula ([3], [4], [1]), where the species was already found to occur in the 1970s (along ~300 km of the southeast region of the Iberian Peninsula, [5]). Over the last decade, a large increase in abundance of the species has been documented in several locations in this area ([4], [1]). In parallel, the coral has been found in several new areas throughout the Mediterranean, suggesting that *O. patagonica* is spreading geographically ([6]). This spreading has been demonstrated in the northern Iberian Peninsula and in the Aegean Sea ([7], [8]). In this study, we examined occurrence of the species on natural rocky reefs along the Mediterranean coast of the Iberian Peninsula. Five regions, each encompassing ~200 km of coastline, were sampled along the Iberian Peninsula from southeast to northeast over the period 2008-2010. Occurrence of the coral was examined on 12 to 29 natural rocky reefs within each region (Fig. 1). Occurrence of the species on each location was determined by means of the detailed exploration of 1500 m^2 of the sea floor using SCUBA, between 0 and 10 m depth. A total of 90 randomly selected rocky reefs were examined for the presence of the scleractinian coral *O. patagonica*.

The species was observed to occur in about 70% of the explored locations (n = 64). However, occurrence of the species exhibited a marked pattern of variation along the Iberian coastline (Fig. 2, Chi-square, $p<0,05$). The species was present on most of the locations in zones 2, 3 and 4 (presence in 100, 95 and 83% of the locations, respectively) and, in contrast, the species was present in about half of the examined locations in zones 1 and 5 (presence in 50 and 45% of the locations, respectively). Recent data on occurrence of the species on the northernmost part of this coastline (zone 6 from [7]) has been included in Figure 2 to provide a complete view of the occurrence of the species along the Mediterranean coast of the Iberian Peninsula. The northward spread of the species in Zone 6 has been related to the availability of open space, sea warming and its effect on extending the growth period of the species, and the particular biological features of the coral *O. patagonica* [7]. The regions examined in this study encompasses a temperature gradient of 3 ºC, which corresponds to the range of predicted increases in ocean temperature for the Mediterranean by 2070-2099, [9]). Therefore, the marked pattern of variation in occurrence of the coral *O. patagonica* along the Iberian coastline provides a good opportunity to determine the effect of the main factors that contribute to the population dynamics of the alien coral *O. patagonica* in the Mediterranean Sea.

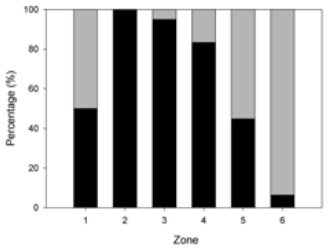

Fig. 1. Proportion of locations with *Oculina patagonica* occurrence for the six regions distinguished along the coastline of the Mediterranean Iberian peninsula **.** The proportion of locations in which *O. patagonica* was found are represented by black bars. The proportion of locations in which *O. patagonica* was not found are represented by grey bars. Data from zone 6 was obtained from [7].

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FIRST RECORD OF STRIPED EEL CATFISH *PLOTOSUS LINEATUS* (THUNBERG, 1787) FROM EGYPTIAN WATERS OF THE MEDITERRANEAN

Tarek Temraz [1]* and Jamila Ben Souissi [2]
[1] Marine Science Department- Suez Canal University - ttemraz@yahoo.com
[2] National Institute of agronomy Tunisia

Abstract
On October 2012, the lessepsian migrant *Plotosus lineatus* was captured offshore Damietta coast (Egypt, Eastern Mediterranean sea). This represents the first record of this species along the Egyptian waters.

Keywords: Lessepsian migration, South-Eastern Mediterranean, Suez Canal

Introduction: The Suez Canal is an artificial sea-level water way running south to north across the Suez Isthmus to connect the Red Sea with the Mediterranean. The canal was opened for navigation on 17th of November 1869 and was closed five times; the last time was the longest one as it lasted for eight years. The canal was reopened on 5th of June 1975. The canal encompasses various benthic habitats. At Port Said and surroundings the soil is mainly of silt and clay (drifted from the Nile estuary this formation extend bout 40km south wards to Kantara. The middle part between Kantara and Kabrit consists of fine and coarse sand, while the southern region composed of dispersed rocky layers entrapping soft sediment and sea grass beds in between [1]. Science the opening of the Suez Canal the migration of species between the two ends was questioned and the Northward migration process named "Lessepsian migration" [2] The striped eel catfish *Plotosus lineatus* was first recorded in the Mediterranean [3]. Since then it was rapidly becoming a dominant component of the benthic biota of the Levant [4]. During annual environmental monitoring program off Damietta coast at (N 31° 30.50' 20" E 31° 43' 43.20") (Figure, 1).

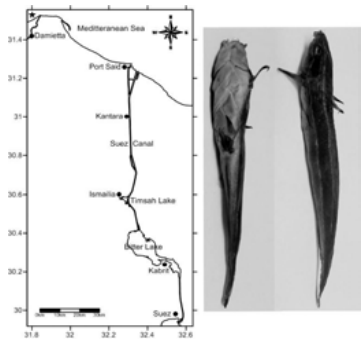

Fig. 1. Sampling location and specimen photo

Sampling of benthic habitat resulted in catching 7 specimens of *Plotosus lineatus*. The survey was conducted on muddy substrate. The stinging catfish was newly introduced to the Egyptian Mediterranean waters were local fishermen name it (Shelan) similar to the name of small Nile catfish.

Description of the specimens: The specimens' dorsal color was dark brown with 2 whitish lateral strips originating from the snout, the ventral surface whitish to creamy with pale brown dendritic organ. The fins have darker borderline. Four pairs of barbels; one nasal and one maxillary barbels extend slightly beyond the posterior borders of eye. The inner pair of mental barbels is shorter than the outer pair. The upper jaw overhanging with pointed teeth while the lower jaw has conical ones anteriorly and molar like posteriorly. Smooth (no scales) elongated body with broad head and laterally compressed after anus. The specimens weight varied from 4.836 - 6.983 g, total length 112 to137 mm, head length 22-26,snout length 4.2- 4.4, eye diameter 4.5-4.7, caudal fin 4.4 -4.7, first dorsal fin height 12.5 -13.1, first dorsal fin base 7.6 -7.9, second dorsal fin height 3.1-3.3, second dorsal fin length71-75, pectoral fin length 7.9 -8.2, pectoral fin base 3.9- 4.1, anal fin height 2.4-2.6, anal fin length 65.3 – 69.1. The count of spines and rays; first dorsal fin with one serrate spine and four rays, second dorsal fin with 78- 86 rays, pectoral rays 10-11, pelvic rays11-12, and anal rays 63-68.

Discussion: *Plotosus lineatus* widespread over the coral reef ecosystems in Indian Ocean, Western Pacific and East Africa [5]. Recently in 2006 it was recorded among the 100 worst invasive species in the Mediterranean [6] and recorded in the seventy nine Lessepsian migrant fish species up to 2010 [7]. As a migrant species it was recorded in the Red Sea and represents the only member of the family plotosidae [8], very early record in late 1800s took place in Gulf of Suez [9]. While it was recorded in southern Suez Canal in the early 1930s [10] no range of extension along the canal was recorded. The majority of the Red Sea migrants spread along the Israeli coast and consequently among the Levant littoral as a result of the permanent alongshore anti-clockwise current. As this species showed euryhaline capacities [1] the Bitter lakes didn't pose a barrier for migration across the Suez Canal and it was reported to cause injury to swimmers and beach users at Kabrit (personal communications). The abundance of the striped catfish along the northern region of the Suez Canal was relatively recent 4 to 5 years ago. On the other hand the migration is more likely related to availability of suitable food source, substrate composition and environmental conditions as well as lack of predators and competitors for space and food. Further studies are needed to indicate the reasons for the *Plototus lineatus* delay in migration to the Mediterranean (140 Years) and to indicate whether the proliferation along Damietta coast is as a result of the spreading along the Israeli coast or from recent dominance along the Northern region of the Suez Canal. Furthermore, this may suggest a role for Suez canal as earlier monitoring stations for potential migrants to the Mediterranean.

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UPDATING OF THE CIESM WEBSITE - ATLAS OF EXOTIC SPECIES IN THE MEDITERRANEAN: MACROPHYTES

Marc Verlaque [1]* and Charles F. Boudouresque [2]
[1] Mediterranean Institute of Oceanography (MIO), Aix-Marseille Université, France - marc.verlaque@univ-amu.fr
[2] Mediterranean Institute of Oceanography (MIO), Aix-Marseille Université, France

Abstract
An update of the CIESM website of exotic macrophytes introduced into the Mediterranean Sea is proposed. A list of 19 new exotic taxa has been drawn up, and among them 7 invasive or potentially invasive taxa. Overall, 129 taxa of exotic macrophytes have been recorded in the Mediterranean Sea.

Keywords: Alien species, Algae, Ionian Sea, North-Eastern Mediterranean, North Adriatic Sea

Introduction
The Mediterranean distribution of 110 exotic marine macrophytes is presented on the CIESM website (1). To highlight any recent change in the flow of species introductions and to identify any exotic macrophyte likely to significantly change the composition and functioning of Mediterranean assemblages, we analysed the inventories of exotic species and publications on this subject available since 2009 (2-5).

Materials and Methods
For each species, we considered: D: the date of introduction (ante- or post-2009), R: the native region, Distr.: the Mediterranean distribution, V: the putative vector(s)/pathway(s) of introduction and S: the status in the recipient area(s), i.e. Casual if only one record, or Established, if several records in space and/or in time. A given species can have several putative vectors/pathways of introduction.

Tab. 1. Addition to the CIESM website (1). Abbreviations: <: ante-2009, >: post-2009; Atl.: Atlantic; IndoPac.: Indo-Pacific; C: Casual; E : Established.

Species	Date	Region	Distribution	Vector/Pathway	Status
OCHROBIONTA					
Ascophyllum nodosum	>	Atl.	Central Basin	Shellfish	C
Chrysonephos lewisii	<	Atl.	Western Basin	Shipping	E
Microspongium globosum	<	Atl.	Eastern Basin	Shipping	C
Microspongium tenuissimum	<	Atl.	Western Basin	Shellfish	C
Padina antillarum	<	IndoPac.	Eastern Basin	Suez Canal	C
RHODOBIONTA					
Gracilaria vermiculophylla	<	IndoPac.	Adriatic Sea	Shellfish	E
Grateloupia minima	<	Atl.	Western/Central Basins	Shellfish	E
Hypnea anastomosans	<	IndoPac.	Eastern Basin-Israel	Suez Canal	E
Hypnea flexicaulis	>	IndoPac.	Adriatic Sea	Shellfish	E
Lomentaria flaccida	<	IndoPac.	Western Basin	Shellfish	C
Palisada maris-rubri	<	IndoPac.	Western/Central Basins	Suez Canal	E
Solieria sp.	>	IndoPac.	Western Basin	Shellfish	E
CHLOROBIONTA					
Batophora sp.	<	Atl.	Central Basin	Shipping	E
Cladophora hutchinsioides	<	IndoPac.	Western Basin	Shellfish	C
Caulerpa taxifolia var *distichophylla*	<	IndoPac.	Eastern/Central Basins	Aquarium	E
Codium arabicum	<	IndoPac.	Eastern Basin	Suez Canal	E
Codium parvulum	<	IndoPac.	Eastern Basin	Suez Canal	E
Ulva californica	>	IndoPac.	Adriatic Sea	Shipping	C
Uronema marinum	<	IndoPac.	Western basin /Adriatic	Shipping	E

Results and Discussion
A total of 19 taxa (7 Chlorobionta, 7 Rhodobionta and 5 Ochrobionta) have been listed (Table I) but only 4 of them, namely *Ascophyllum nodosum*, *Hypnea flexicaulis*, *Solieria* sp. and *Ulva californica*, were reported after 2009, attesting the apparent absence of recent increase in the rate of species introduction. The major putative vector/pathway of recent introductions is shellfish transfer (9 taxa), mainly in the aquaculture sites of the North-Western Basin and the Northern Adriatic Sea, followed by the Suez Canal (5 taxa), mainly in the Eastern and Central Basins, shipping (5 taxa), and the aquarium trade (1 taxa). The major donor region is the Indo-Pacific Ocean (13 taxa), in relation with the two major vectors/pathways of introduction, followed by the Atlantic Ocean (6 taxa). The majority of taxa are established (12 established versus 7 casual), and 7 are invasive, namely *Caulerpa taxifolia* var. *distichophylla*, *Chrysonephos lewisii*, *Codium arabicum*, *C. parvulum* and *Gracilaria vermiculophylla*, or potentially invasive, namely *Solieria* sp. and *Ulva californica*. However, we must not forget that the apparent absence of recent increase in the introduction rate can be merely an artefact due to the weakness or the unbalanced effort of investigations in certain regions. The species introductions through shellfish transfers have been thoroughly studied in the North-Western Basin and the Adriatic Sea but the small Lessepsian migrants remain poorly known. It is the same situation for the exotic marine flora of the southern Mediterranean coasts. An in-depth study of the marine flora of the Middle-East and the North Africa would probably increase the number of exotic macrophytes occurring in the Mediterranean Sea and the proportion of Indo-Pacific species arriving in the Mediterranean Sea through the Suez Canal. However, the possibility that the number of introduced macrophytes is reaching a plateau cannot be excluded as suggested by (6). Overall 129 taxa of exotic macrophytes were recorded in the Mediterranean Sea.

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ACTIVITÉS AQUACOLES ET INSTALLATIONS D'ESPÈCES INVASIVES (TUNISIE)

jeanne Zaouali [1]* and Jamila Ben Souissi [1]
[1] INAT Institut National Agronomique de Tunisie - jeanne.zaouali@planet.tn

Abstract
La récente accélération des activités aquacoles offshore en Tunisie avec la présence de cages flottantes disséminées tout au long du littoral oriental ne s'est pas faite sans de rapides retentissements sur les biocénoses autochtones marquées par l'installation d'un nombre important de NIS d'origine érythréenne.

Keywords: Biogeography, Gulf of Gabes

Matériel et méthodes
L'étude du fouling des filets et des infrastructures des cages d'élevage de loups et daurades royales (23 sociétés actives en 2012) et de grossissement du thon rouge (5 sociétés) installées depuis la région de Beni Khiar (cap Bon- Tunisie septentrionale) jusqu'à Zarzis (frontière tuniso -libyenne), a permis de mettre en évidence, d'une part, la présence d' espèces érythréennes jusqu'alors non répertoriées en Méditerranée et, d'autre part, de mesurer la progression spatio temporelle d'espèces invasives déjà acclimatées dans les eaux du sud du bassin oriental (notamment dans les eaux libyennes).

Résultats
Les observations faites tout au long de la côte ont ainsi montré l'installation d'espèces nouvelles jusqu'alors non répertoriées dans les eaux méditerranéennes.
Des mollusques gastéropodes typiquement représentatifs des biocénoses de mer Rouge tels :
Neritea sanguinolenta Menke,1829 avec 2 morphotypes distincts, Zenetos et all., 2003 (1) - bicolore blanc et noir à la Chebba (zone nord du golfe de Gabès - fouling des infrastructures des cages, 6 individus juvéniles, taille moyenne dans la plus grande largeur= 12 mm et rouge vif à Hergla -Sahel soussien – fouling des cages, 3 juvéniles de taille moyenne de 8 mm).

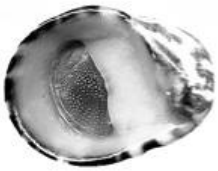

Fig. 1. *Neritea sanguinolenta*- Mencke, 1829 -morphototype noir et blanc - la Chebba (Tunisie)

Morula (Morula) aspera (Lamarck, 1816) Mastaller, 1978 (2), Clarmont et all., 2013 (3) zone sud du golfe de Gabès, fouling des infrastructures des cages, 2 juvéniles de taille moyenne de 8 mm. *Gibberulus gibberulus albus* Linnaeus, 1758- la Chebba, prairie d'*Halophila stipulacea*, un individu de 39 mm de hauteur - (Gab Alla, 2001 (3).

Fig. 2. *Morula (Morula) aspera* (Lamarck, 1816)- Zarzis (Tunisie)

La remontée d'espèces, identifiées en 2007 au niveau de la grande Syrte, Tripoli, Zaouali et all., 2007 (5 et 6). apu par ailleurs être mise en évidence. Ces espèces, elles aussi représentatives de biocénoses érythréennes sont le décapode *Grapsus granulosus* H. Milne Edwards, 1853 (omniprésence au niveau des cages jusqu'à la péninsule du Cap Bon) et le polyplacophore *Acanthopleura gemmata* (Blainville, 1825) - 1 individu de 35 mm de longueur - fouling des infrastructures des cages proches du port de Zarzis.

Discussion
Pour conclure, la présence d'espèces érythréennes non signalées dans la partie septentrionale du bassin oriental méditerranéen peut être considérée comme caractéristique de ses côtes méridionales. Ces néo peuplements montreraient, qu'en dehors de l'injection de propagules allochtones liées à l'introduction volontaire d'espèces malacologiques non indigènes qui ne peuvent, a priori, être retenus dans le cas présent, il peut exister un autre effet pervers des activités de l'aquaculture marine. C'est ainsi, que dans le cas des espèces citées, les colonisations observées ne sont pas à imputer directement à des transferts volontaires de mollusques. Elles pourraient, par contre, être mises en relation avec les installations de centaines de cages flottantes ayant nécessité le transport, notamment par mer, d'une importante quantité de matériel (infrastructures des cages, gros engins de manutention et filets en tous genres, souvent de 2ème main et d'origine les plus variées). L'efficacité de ces installations de biocénoses originales puisqu'elles n'ont, actuellement, pas d'équivalents en Méditerranée orientale septentrionale est, par ailleurs, potentialisée par le corollaire en zone sèche, des effets du réchauffement climatique global, qui est une forte augmentation de la salinité des eaux côtières caractérisant la portion sud du bassin oriental.

Remerciements: Avec tous nos remerciements à Mr Roland Houart (Institut royal des sciences naturelles de Belgique) pour ses précieuses indications concernant la faune malacologique.

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Session

Marine mammals, Turtles and sea Birds

Modérateur : **Adriana Vella**

HABITAT USE, MOVEMENT AND SIGHTINGS OF MONK SEALS IN CROATIA BETWEEN 2010 AND 2012-2013

L. Bundone [1]*, J. Antolovic [2], E. Coppola [3], S. Zalac [2], M. Hervat [2], N. Antolovic [2] and E. Molinaroli [1]
[1] Ca' Foscari University, Dip DAIS, Venice - luigibundone@tiscali.it
[2] Grupa Sredozemna Medvjedica, Zagreb
[3] Gruppo Foca Monaca, Rome

Abstract
Sightings of Mediterranean monk seal (*Monachus monachus*) have been recorded and verified from the whole Croatia since 2000. This paper reviews some of the activities carried out *in situ* and seals sightings between 2010 and the first month of 2013. The preliminary results clearly show the importance to conduct further investigations in the Istrian region and Cres Island, to be extended as well to the entire Croatian coastline, in order to understand the actual population consistency.

Keywords: Conservation, Monitoring, North Adriatic Sea, Central Adriatic Sea

Introduction
Scattered sightings of the Critically Endangered Mediterranean monk seal (*Monachus monachus*) have been reported along the entire Croatian coastline in the last two decades. About 180 sightings were gathered and verified by the Grupa Sredozemna Medvjedica-GSM (Croatia), in collaboration with the Gruppo Foca Monaca-GFM (Italy), during the years 2000-2009. Since 2005, a considerable amount of these encounters have been recorded, with a certain frequency, along the Istrian Peninsula (North-Western Croatia). Following these encounters, the GSM and the GFM have started a series of activities in 2008 to monitor the area concerned and to organize local and national sensitization campaigns for the protection of the monk seal. Thanks to the positive effects of increased public awareness on this matter, from 2009 a more consistent record of data collection has become attainable, including a great number of images taken in the Istrian region and Cres Island areas. Apart from collecting and verifying sightings data and direct monitoring, short surveys were carried out with the intent to comprehend the species habitat availability and use of the region.

Materials and Methods
A total of 130 verified encounters were reported, directly recorded, stored and analyzed from 2010 to 2012 including the first couple of months of 2013. The data were classified into 3 categories according to the information that can be deduced from them:
1-Sightings with photos or videos that allow photoidentification of specimen/s;
2-Sightings with photos or videos that do not allow photoidentification of specimen/s;
3-Sightings with no photos or videos but with reliable evalution (through direct interviews).
All the images collected came from the area of Cres Island and the Istrian Peninsula. The first category of sightings yielded the photoidentification of an adult female, following the methodology of Samaranch & González [1] and Forcada & Aguilar [2]. Although these analyses do not enable any other specimens clear detection, nevertheless they have made it possible to determine the home range extents of the aforementioned female: spreading from the Eastern Cres coast to Pula (about 130-150 km of coastline). This statement is in accordance with the data on the movement of the species [3] and habitat use [4] from other areas of the Mediterranean. In January 2011, after prior experimental pilot projects, a video-monitoring system (Vivotek IP 8332) was installed by GFM-GSM in the cave of Mala Kolombarica (southern part of the Kamenjak peninsula, Istria), allowing a continuative screening coverage of the internal beach. This is an active cave frequently used by the specimen that we were able to identify; the interior of the cave is easily accessible from the water and might not display ideal conditions for active use by seals during the summer months, due to anthropic presence in the highest tourist periods.
Even though, a large amount of collected images depicts the same specimen, a minor number of these, particularly the ones belonging to relatively more remote areas, were not clear enough to conduct any further identification. In addition, some of the overall sightings cannot be ascribed to a single individual, when taking into account the position and the time of the records. Particularly the ones coming from Southern Croatia, since distances and time to cover them far exceeded the natural known ability of the species of about 12-40 km/day [3].

Discussion and Conclusion
This work reviews data from occasional encounters of monk seal specimens and short self funded monitoring campaigns. Thus the results cannot be considered exhaustive of the monk seal actual population status in Croatia but represent a preliminary enquiry of a more consistent reasonable reality. The sightings reflect the position of the witness and its/their behaviour rather than the seals. Apart from the direct monitoring surveys most of the data belongs from tourists or people in recreational time, meanwhile few of them come outside the holiday seasons and or human settlement areas, rarely from places with scarce human presence and occurrence. Taking a look back at the images, from 2005 onwards, it is evident that at least an adult female has been frequenting the Istrian region since then. Moreover, comparing directly the data from Southern Croatia and the Istrian-Cres ones, it is evident that they cannot be ascribed to the same specimen with the current knowledge on the species movements. From our study it appears that the country coastline might hold two different nuclei of seals from the northern and southern coast, but the information is unsubstantial to define the real numbers of individuals and the eventual specimens inter-exchange. The adult female identified in the area between Pula and Cres has shown a pattern of coastal use that reflects habitat utilization and preferences explainable as an actual home range. This behaviour is a sufficient forethought to support a more thorough study of the region in order to ascertain the presence of other specimens, breeding caves and eventual births. Further investigations and a more detailed and systematic analysis of habitat availability is required in order to have a much better understanding of the real consistency of monk seal population along the entire Croatian coastline.

Acknowledgments
This research has been possible thanks to the instrumentations provided by Panda Film. A special appreciation goes to Clara Piazza for the editing work.

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MEETING THE NEEDS FOR CONSERVATION: A NETWORK OF CETACEAN MONITORING IN THE MEDITERRANEAN SEA

A. Arcangeli [1], L. David [2]*, N. Di-Meglio [2], A. Moulins [3], P. Mayol [4], L. Marini [5], M. Rosso [3], P. Tepsich [3], A. Castelli [6], B. Paliaga [7] and M. Tringali [8]
[1] ISPRA, Italy
[2] EcoOcéan Institut, France - lea.david2@wanadoo.fr
[3] CIMA Foundation, Italy
[4] Souffleurs d'Ecume, France
[5] Accademia del Leviatano, Italy
[6] Biology Dept., University of Pisa, Italy
[7] MPA Capo Carbonara, Italy
[8] Ketos, Italy

Abstract
A collaborative programme for monitoring cetacean has been established in the Mediterranean Sea based on ferries as platform. Outputs of the programme are a baseline for long term – large scale data on cetacean distribution and relative abundance. Results from data collected in the PELAGOS Sanctuary show how this work can help to manage these species.

Keywords: Monitoring, Cetacea, North-Western Mediterranean, Conservation

Introduction
Because threats can have impacts on cetacean population size or distribution, long term population monitoring is needed to early detection of any significant change that require a (re)definition of conservation efforts. The characteristics of the species and their habitats, the costs (affecting the repeatability and spatial extent of the surveys) and standardized protocol are the main parameters affecting the success of monitoring programmes. A collaborative programme for monitoring cetacean has been established in the Mediterranean Sea since 2007. More than 10 scientific bodies work along sampled routes using ferries as platform of research. Within the programme, a synoptic large-scale cetacean systematic monitoring program has been realized within the PELAGOS Sanctuary in 2010, funded by PELAGOS France through the GIS3M.

Materials and Methods
In 2011 /2012 MMO embarked on 4 lines covering the PELAGOS Sanctuary. To collect data the standardized line transect method were applied along fixed routes from the command deck of the ferry. The frequency of sampling was based on a regular design throughout the year (February 2011-April 2012) on lines Toulon-Ajaccio (TA) and Livorno-Bastia (LB) and weekly from June to September on the two other lines, Nice-Calvi (NC) and Savona-Bastia (SB). Spatial analysis were execute on a 10x10Km grid cell using ArcGIS 9.1.

Results
Results showed a spatio-temporal heterogeneity on species composition, distribution and sighting rates between the summer (June to September 2011) and the two other periods of the year (March to May 2011, October to April 2011-2012). On the two lines monitored yearly round (TA and LB), the sighting rates on TA were always higher (1.88 to 3.62 sightings of cetacean per 100km) than those on LB (0.77 to 1.23 s.100km^{-1}). Seasonally, the highest sighting rate was recorded during summer on TA and from October to April on LB. Comparing data along 4 lines during summer, the highest sighting rate were recorded in the western part of the Sanctuary along the NC (6.3 s.100km^{-1}) and the TA (3.6 s.100km^{-1}). During the all study period the richest areas both in terms of sighting rates and species richness were located in the south of Toulon, in the middle of the abyssal plain: between Toulon and Ajaccio in spring, north of Corsica (on NC and SB) in summer and offshore Ajaccio during the all study periods. The four frequently sighted species were *S.coeruleoalba, B.physalus, T.truncatus* and *P.macrocephalus*. Species distributions reflect respective habitat preferences: the highest sighting rate of striped dolphin was recorded during summer on NC, an offshore area, while bottlenose dolphin was mainly sighted on LB along the widespread continental shelf. Sighting rate of fin whale showed inverse seasonal line-trends on the two borders of the PELAGOS Sanctuary, according to its migratory pattern. Sperm whale showed a clear preference for the western area (TA) during summer season.*G.griseus, D.delphis, G. melas* and *Z.cavirostris* where mainly sighted on the central routes (NC and SB).

Discussion
Data confirm that the species are highly mobile and that the home range is larger than the Pelagos Sanctuary. Within the Sanctuary, results shows that a high spatio-temporal variability occurs.Some species are present all year round but the area is mostly used by cetacean during summer. Moreover, not all the Sanctuary is used on the same way and different seasons and areas differ in importance in term of species diversity, relative abundance and habitat use. Consequently, to conserve the species, a large scale programme is needed at a Mediterranean scale both, to collect data on species and to manage pressure at an adequate scale. As well at the Pelagos scale, management actions can be maximized by using a multi-scale and multi-temporal approach to take into account seasonality, spatial heterogeneity and species specific characteristics.

Conclusion
The use of ferries as a platform for the collection of data was found to be a valuable, sustainable and cost effective method for monitoring programs on cetacean on a wide temporal and spatial scale, including high sea and international sea areas.

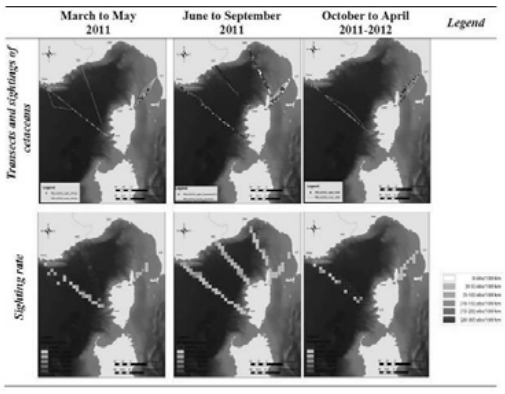

Fig. 1. Distribution of the sightings of cetaceans (upper) and sighting rates per cell of 10kmx10km (bottom).

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PREDICTING THE RESPONSE OF A SEA-TURTLE NESTING BEACH IN SEA-LEVEL RISE, GERAKAS, ZAKYNTHOS ISL., GREECE

F. Psarros [1], I. Monioudi [1], E. Manoutsoglou [1], O. Andreadis [1], P. Tziourrou [1], T. Hasiotis [1]*, A. Velegrakis [1], C. Dimitriadis [2], L. Sourbes [2] and D. Koutsoubas [2]

[1] Dept. of Marine Sciences, University of the Aegean, Mytilene, Lesvos isl., Greece - hasiotis@marine.aegean.gr

[2] National Marine Park of Zakynthos, Zakynthos, Greece

Abstract

This study evaluates the effect of sea level rise on the Gerakas sea turtle nesting beach in the Marine Protected area (MPA) of the National Marine Park of Zakynthos. Spatial, meteorological and grain-size data of the coastal area were collected and introduced to the Leont'yev's morphodynamic model in order to estimate the potential retreat of the beach under 4 scenarios of sea level change. The results have shown that the beach is projected to suffer a considerable retreat/inundation that will directly diminish the available nesting space and consequently pose constrains in the nesting success of the endangered species *caretta caretta*.

Keywords: Ionian Islands, Coastal models, Marine parks, Sea level, Turtles

Introduction

The sea level rise (SLR) is considered as one of the major impacts of climate change that will unavoidably produce significant beach recession [1]. This will affect, among other issues, areas of considerable ecological importance such as sea turtle nesting beaches. This study focuses on the response of Gerakas nesting beach (Gulf of Laganas, Zakyntos, Ionian Sea) on the expected SLR. The Gulf of Laganas is considered as one of the most important nesting areas of the loggerhead sea turtle (*Caretta caretta*) in the Mediterranean since it hosts almost 25% of the total nesting activity [2]. Gerakas is the easternmost beach of the gulf, being 930m in total length, 610m of which formed on fine sand and the remainder (320m) on coarse gravelly material (from East to West). The greater part of the beach is backed by eroding clay cliffs with a small sand dune occurring at the widest section of the beach. The mean nesting density of the beach is about 80 nests per year [2] with an average distance and elevation from the sea ranging from 18.7 to 21.5m and 1m, correspondingly.

Methodology

An RTK GPS together with an echo-sounder was used for the coastal area topographic and the bathymetric surveys, respectively. 10 onshore and offshore bed (sand) samples were collected and analyzed with dry sieving. The wave regime was hindcasted from local wind data (by the National Meteorological Service). Future beach retreat was assessed through the 1-D Leont'yev's morphodynamic model that uses the energetic approach, with the cross-shore changes of the wave energy flux estimated by the wave energy dissipation due to breaking. Sediment transport rates are predicted separately for the refraction, surf and swash zones. Two types of sediment transport are distinguished: (i) the transport due to wave/current interaction and (ii) the run-up induced transport. Beach retreat was estimated for three sea level rises scenarios (0.2m, 0.5m and 1m) [1,3] and also for a storm surge event that produces 2m short-term sea level rise [4] (Fig. 1).

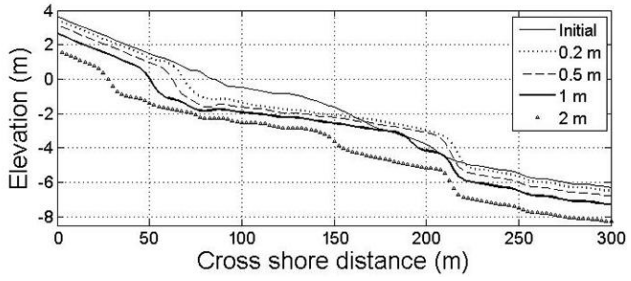

Fig. 1. Profiles of beach retreat under 4 scenarios of SLR.

Results and Discussion

The model outputs were compared with the width/elevations of Gerakas beach (Fig 2). It was found that the sea-level increases will have considerable impacts. In the case of a 0.2m rise the beach retreat was estimated as 13.95m, whereas for the 0.5m and 1.0m rises, 18.8m and 30.1m, respectively. For the worst case scenario (a 2.0m storm surge) beach recession was estimated as 50.75m. These estimates suggest that the beach will potentially lose 44-94% of its width for the first 3 SLR scenarios, whilst in the worst case of a 2.0m storm surge it will be entirely inundated. The beach cannot adapt to the SLR by transgression, as is backed by cliffs. This will promote coastal squeezing, which in return will dramatically reduce the available nesting space and increase conflict issues related to the recreational use of the beach. Ongoing research concerning all the nesting beaches of the MPA (6 in total) will further reveal the possible overall consequences of SLR on the nesting activity in the largest rookery of the endangered species *Caretta caretta* in the Mediterranean, thus allowing for the design and implementation of suitable management measures.

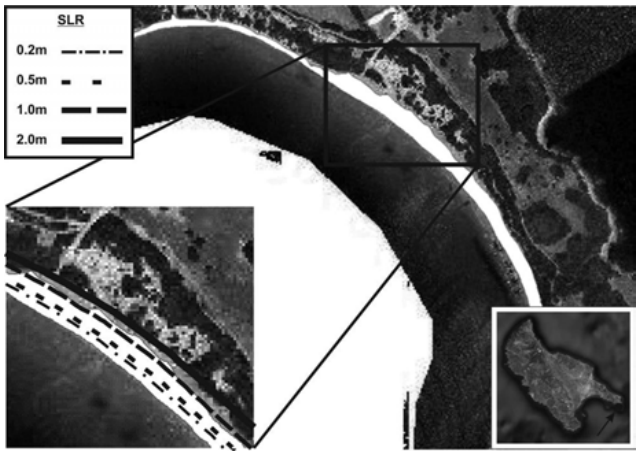

Fig. 2. Google image showing beach retreat at the central part of Gerakas beach under 4 scenarios of SLR.

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ETUDE DE LA NIDIFICATION D'OISEAUX D'EAU AU NIVEAU DE KALÂAT EL ANDALOUS

Feten Kanzari [1]*, Oum Kalthoum Ben Hassine [2] and Sabiha Zouari-Tlig [3]
[1] Doctorant - kanzari.feten@hotmail.fr
[2] professeur
[3] Maître de Conférences

Abstract

L'étude de la nidification au niveau de cinq stations de Kalâat El Andalous, a révélé la présence de sept espèces d'oiseaux d'eau migrateurs nichant au niveau des quatre stations suivantes : la dune littorale, des marais nord, les maris sud et la sebkha littorale. Deux espèces coloniales ont été marquées par un nombre important de nids à savoir la Sterne naine (*Sternula albifrons)* et la Glaréole à collier *(Glareola partincola)*. Ainsi, le complexe de Kalâat El Andalous, semble être un habitat de prédilection pour les oiseaux d'eau migrateurs, propice à la nidification.

Keywords: Birds, Gulf of Tunis, Coastal systems, Lagoons

Introduction

Les oiseaux d'eau sont considérés comme des excellents indicateurs écologiques de l'état des habitats. En raison de leur importante sensibilité aux changements des paramètres environnementaux, ces derniers sont contraints à s'adapter par le phénomène de migration [1]. En Tunisie, plusieurs auteurs se sont intéressés au phénomène de la nidification des oiseaux d'eau au niveau des zones humides ([2], [3]). Les études relatives à ce phénomène au niveau du complexe Kalâat El Andalous sont défaillantes. En effet, la complexité de ce milieu pourrait engendrer une grande diversité spécifique et pourrait être un lieu d'attraction pour les espèces aviaires migratrices et sédentaires. Pour cela, une étude sur la nidification des oiseaux d'eau au niveau des différentes entités du complexe a été appréhendée.

Matériel et Méthode

Le complexe de Kalâat El Andalous, situé au nord est de la Tunisie, abrite divers types d'entités géomorphologiques. Le recensement des espèces d'oiseaux nicheurs a été effectué au niveau de cinq stations de ce complexe, à savoir, les marais sud (KA1), la Sebkha littorale (KA2), la dune littorale (KA3), les marais nord (KA4), la lagune (KA5). Les prospections ont été réalisées au cours du de la saison printanière de l'année 2012 à raison d'une observation tous les quinze jours. De plus, selon le comportement des nicheurs inventoriés, plusieurs critères ont été considérés [4], tels que le nombre de nids occupés, le nombre d'adultes (mâles ou femelles) cantonnés dans des nids, nature du chant de l'oiseau nicheur, parade nuptiale, nombre d'œufs ou de poussins, activités alimentaires.

Résultats et Discussions

Au total 7 espèces nicheuses migratrices (Tab.1) ont été inventoriées au niveau de quatre stations de Kalâat El Andalous (KA1, KA2, KA3 et KA4) à savoir *Himantopus himantopus*, *Burhinus oedicnemus*, *Larus michaellis*, *Fulica atra*, *Charadrius alexandrinus*, *Glareola pratincola* et *Sternula albifrons.* Notons que l'absence des nicheurs au niveau de la station lagunaire (KA5) pourrait être liée à la fréquentation massive de cette zone par les estivants. A l'exception de *Himantopus himantopus*, Sternula albifrons et Glareola praatincola, les autres espèces ont été inféodées à une seule station (Tab.1). Un nid vide de *Himantopus himantopus* a été rencontré au niveau des marais sud (KA1) et des nids avec des œufs cassés et dévorés de *Himantopus himantopus* (KA1) et de *Larus michaellis* (KA4) ont été observés (Tab. 1). Bien qu'ils soient présents au niveau des marais (KA1 et KA4), *Sternula albifrons* et *Glareola pratincola* ne forment des colonies (plus de 10 individus) qu'au niveau de la dune littorale de Kalâat El Andalous.

Tab. 1. Les observations des oiseaux d'eaux nicheurs à Kalâat El Andalous; *: espèce coloniale.

Espèces	zones	observations
Himantopus himantopus (Linné 1758) Echasse blanche	La sebkha littorale (KA2)	-12 nids flottants abritant 12 femelles
	Les marais sud (KA1)	- 1 nid vide - 3 nids aux œufs cassés et dévorés - 1 nid à 3 œufs dont 2 cassés - 1 nid avec deux oeufs - 1 nid abritant 1 femelle
Burhinus oedicnemus Œdicnème criards	Les marais nord (KA4)	-3 couples sans nids
Larus michaellis Naumann, 1840 Goéland leucophée	Les marais nord (KA4)	- 2 nids à un seul œuf chacun - 1 nid avec 3 oeufs - 1 nid avec 2 oeufs détruits lors la 2ème prospection (debut mai).
Fulica atra Linné 1758 (Foulque macroule.)	La Sebkha littorale (KA2)	- Pas de nids, - 11 couples : 1 couple avec 3 jeunes, 6 couples avec 2 jeunes et 4 couples avec un seul jeune.
Charadrius alexandrinus (Linné 1758) (Gravelot à collier interrompu)	La dune littorale (KA3)	- 2 nids à 1 seul oeuf chacun - 4 adultes à comportement de nicheurs
Glareola praticola * (Glaréole à collier)	La dune littorale (KA3)	- 93 nids, ponte moyenne= 2,10 oeufs/ nids
	Les marais sud (KA1)	- 2 nids à 1 seul oeuf chacun
	Les marais nord (KA4)	- 3 nids à deux oeufs chacun
Sternula albifrons Pallas, 1764 * (Sterne naine)	Les marais nord (KA4)	- 2nids à 2 oeufs chacun - 1 seul nid à un oeuf - 30 individus à comportement de nicheur marqué par le transport de petits poissons pour nourrir les oisillons.
	La dune littorale (KA3)	- 54 nids occupés, ponte moyenne = 2,42 oeufs/nids.

Ces résultats semblent traduire que lecomplexe de Kalâat El Andalous, parait un habitat de prédilection pour les oiseaux d'eau migrateurs, propice à la nidification. Ce constat nous amène à suggérer la conservation de cet écosystème côtier, afin de le préserver l'impact des activités anthropiques qui semblent être néfastes pour la nidification.

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BIRTH AND POSTNATAL GROWTH OF THE FIN WHALE IN THE CENTRAL MEDITERRANEAN

Lidia Orsi Relini [1]* and Fulvio Garibaldi [1]
[1] DISTAV, C.so Europa, 26 - 16132 Genova - ITALY - largepel@unige.it

Abstract
The stranding data of 72 specimens of fin whale, *Balaenoptera physalus*, in the length range 5,05-16 m, were used to ascertain the calving season, the location of the calving grounds and the postnatal growth in the Central Mediterranean. Fin whales are born in a six month period (September-February), at a length of about 5,5 m, in a restricted latitudinal range: the calving area is situated in the northern part of the Western Mediterranean (Ligurian and Tyrrhenian Sea), close to the main summer feeding area. After one year the whale is about 12 m long and after two years about 14 m.

Keywords: Cetacea, Growth, Ligurian Sea

In non harvested populations of Cetacea, stranding studies and in particular length measures [1] are a very important source of information. Such is the case of the fin whale in Italian waters; in fact a whaling activity never existed in Italy, also if rare killings of whales were observed in the XIX century. In France stranding studies, after ancient work, were organized in regular form in the seventies. In Italy the Società Italiana di Scienze Naturali established a "Centro Studi Cetacei" in the eighties. The first comparative studies of strandings in the Mediterranean, showed larger numbers of whales on the French than on the Spanish coast, and an increasing gradient towards the Ligurian sector. Stranding data used for the present notes were obtained mainly (N= 52) from Italian and French national databases and in part (N=20) from papers appeared before 1970. Data were selected with the aim to deal with really measured specimens: three types were excluded a) measures with a notation of uncertainty (e.g. "about") b) measures assigned by observers on board to animals at sea c) animals whose length was less than 5 m, probably aborted. Retained data are listed below.
The calving season covers 6 months, September to February. The calving area was obtained mapping stranded neonates [2,3]. Data were first assembled per season and growing size and then in a continuous plot covering 3 years (Fig. 1).

Fig. 1. Plot of the length of stranded whales over a time interval of 38 months. In boxes data used to derive average lengths at age.

The plot shows a growth track, which can be considered the initial part of a Von Bertalanffy growth function; three groups of data positioned above the calving season represent birth, age 1 and age 2. The following average sizes at age of the fin whale can be calculated: ***at birth***: 5.6 m, st.d. 0.4 m, N = 16; ***at age 1***: 11.9 m, st.d. 1.1 m, N = 11; ***at age 2***: 14.0 m, st.d. 0.8 m, N = 11.

Present observations may shake old paradigms such as "weaning takes places when the calf is 6 months old and has reached a total length of about 12 m" and "information is lacking to suggest localized calving grounds" which unfortunately recur also in recent literature [4,5]. The former paradigm derives from whalers interest to minimize mother-calf links, but the calf remains with the mother at least one year; the latter from an improper definition of neonate (to 8 m). A whale of 8 m can be several months old. Recent genetic analyses [6] suggest to steer comparative studies of growth to N. Atlantic.

Data used (date, size, *place*): **1)** 29/11/1995 5.05m *Nonza* **2)** 24/02/1997 5.16m *Marseille* **3)** 30/11/1993 5.18m *Ajaccio* **4)** 28/11/1884 5.3m *Saint-Tropez* **5)** 11/12/1995 5.4m *Venzolasca H.C.* **6)** 13/12/1916 5.4m *Piombino* **7)** 11/11/1982 5.45m *Giglio* **8)** 07/11/1984 5.5m *Bouches du Rhone* **9**) 23/09/1909 5.5m *Cros de Cagnes* **10)** 18/09/1981 5.9m *Giglio* **11)** 22/11/1992 5.92m *Pisa* **12)** 17/01/1981 6m *Port Camargue* **13)** 14/02/1985 6m *Bouches du Rhone* **14)** 20/09/1986 6m *Ile du Levant* (Var) **15)** 12/12/1995 6m *Oristano* **16)** 17/10/1996 6m *Fos* **17)** 16/11/1953 6.5m *Ischia* **18)** 03/02/1996 6.6m *Reggio Calabria* **19)** 23/05/1986 7m *Comacchio* **20)** 24/11/1986 7.5m *Vibo Valentia* **21)** 14/07/1987 8m *Cagliari* **22)** 21/03/1996 8m *Meloria, Livorno* **23)** 15/07/1998 8m *Vescovato* **24)** 10/6/1871 9m *Antignano* **25)** 20/09/1986 9.31m *Pizzo Calabro* **26)** 21/07/1991 10m *Barcaggio* **27)** Summer 10m *Trieste* **28)** 28/03/1900 10.5m *Carloforte* **29)** 11/11/1984 11m *Grimaud (Var)* **30)** 08/11/2000 11m *Quinto* **31)** 03/08/1998 11m *Porto Vecchio* **32)** 19/06/1907 11.5m *San Vincenzo* **33)** 23/06/1986 11.5m *Livorno* **34)** 01/06/1984 12m *Linguizetta* **35)** 20/05/1989 12m *Olbia* **36)** 10/03/1990 12m *La Spezia* **37)** 01/01/1902 12m *Levanto* **38)** 10/11/1950 12m *Saintes-Maries* **39)** ?/1/1904 12m *Cape Bon* **40)** 07/10/1904 12.29m *Sete* **41)** 12/10/1997 12.7m *Genova* **42)** 23/09/1995 12.8m *Livorno* **43)** 01/01/1977 12.9m *Ferry to Genoa* **44)** 22/05/1987 12.95m *Ferry to Olbia* **45)** 15/02/1990 13m *Cosenza* **46)** 20/05/1870 13m *Marseille* **47)** 19/09/1982 13m *Villenueve Les Maguelone* **48)** 05/02/1949 13m *Kerkennah* **49)** 09/05/1990 13m *Palavas Les Flots* **50)** 20/05/1994 13m *Cagliari* **51)** 20/02/1991 13.7m *Ellouza* **52)** 21/12/1990 13.7m *Leucate* **53)** 07/02/1998 13.8m *Livorno* **54)** 12/7/1862 13.86m *Pago* **55)** 23/10/1896 14m *Framura* **56)** 11/12/1997 14m *Procida* **57)** 28/06/1986 14m *Gorgona* **58)** 26/07/1996 14m *Bastia* **59)** 10/02/1953 14m *Salerno* **60)** 16/07/1990 14.2m *Cesenatico* **61)** 18/08/1986 14.85m *Cartage* **62)** 30/12/1980 15m *Kelibia* **63)** 13/07/1990 15m *Reggio Calabria* **64)** 30/03/1993 15m *Porto Torres* **65)** 26/07/1997 15m *Gaeta* **66)** 25/09/1997 15m *Stintino* **67)** 25/05/1995 15.15m *Livorno* **68)** 21/11/1830 15.3m *Corsica* **69)** 31/8/1897 15.5m *La Maddalena* **70)** 28/04/1990 16m *Porto Torres* **71)** 03/08/1991 16m *Brindisi* **72)** 09/09/1993 16m *Tolone*.

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CETACEAN, TURTLE AND PELAGIC SPECIES AND ASSOCIATIONS IN THE CENTRAL-SOUTHERN MEDITERRANEAN SEA: IMPLICATIONS FOR CONSERVATION ACTION

Adriana Vella [1]*
[1] University of Malta - adriana.vella@um.edu.mt

Abstract

A research area of about 120,000km^2 around the Maltese Islands has been the subject of year-round marine research since 1997. Various species have been studied including cetaceans, turtles, elasmobranchs, bluefin tuna and sea birds. Aerial and marine survey techniques allowed for various aspects of species distribution and spatio-temporal associations to be analysed using the data mining (association rule learning) technique. Such results have applications in maritime and conservation management.

Keywords: Cetacea, Turtles, Birds, Conservation, South-Central Mediterranean

Introduction

The research project stationed around the Maltese Islands is a long-term and multi-species field research effort undertaken year-round [1,2]. Mobile species' habitats are typically heterogeneous in their biological and physical properties [3,4]. Understanding the spatio-temporal distributions and multi-species associations can provide insight into the multi-species preferences essential in the development of management and conservation initiatives [3,4].

Methods

A research area of about 120,000km^2 around the Maltese Islands has been the subject of conservation research since 1997. Aerial and marine field research surveys were undertaken to investigate species abundance and distribution using methods adopted by Vella [1,2]. This paper focuses on a pilot consideration of associations among species studied around the Maltese Islands by using a ten-year subset of the data collected. The Data Mining (association rule learning) technique [5] was adopted.

Results and Discussion

The most regular species found in the study area include the Bottlenose (*Tursiops truncatus*), Striped (*Stenella coeruleoalba*), Common (*Delphinus delphis*) and Risso's dolphins (*Grampus griseus*), Sperm (*Physeter macrocephalus*) and Fin (*Balaenoptera physalus*) whales, the Loggerhead turtle (*Caretta caretta*), elasmobranchs, such as, the Giant Devil ray (*Mobula mobular*), and seabirds such as, the Cory's Shearwater (*Calonectris diomedea*) and the Yelkouan Shearwater (*Puffinus yelkouan*). Figure 1 shows the bar graph indicating the extent of association between the turtles, seabirds, common dolphins, bottlenose dophins and fish scatter (different species) at the surface observed in specific areas and seasons, in the research area. With such sound data sets and effective support factor, the associations found are relevant for modelling and decision-making, such as planning spatio-temporal relevant and effective conservation management of mobile and wide-ranging species.

The use of the association rules proves to be effective in highlighting areas of interest for conservation area planning but more so for conservation management in various areas and at different times of the year. With highly mobile species it is becoming increasingly clear that with shifting favourable habitat conditions species will need to be managed for conservation through effectively mobile and adapting management rules. The extent of ecological plasticity of these species will need to be integrated through the considerations of buffer areas around such mobile management zones. To achieve high precision conservation management tools, long-term and year-round data sets are essential.

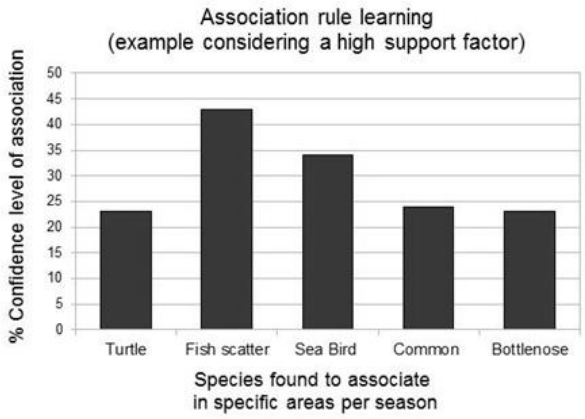

Fig. 1. Bar graph showing an example of a strong association rule learning outcome between multi-species distribution around the Maltese islands.

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Session

MPAs conservation and management

Modérateur : **Nataliya Milchakova**

SYSTEMATIC CONSERVATION PLANNING FOR ISRAEL'S MEDITERRANEAN SEA EXCLUSIVE ECONOMIC ZONE

Eran Brokovich [1]*, Noam Levin [2] and Salit Kark [1]
[1] The Biodiversity Research Group, Dept. of Ecology, Evolution and Behavior, The Hebrew University of Jerusalem, Israel - eran.brokovich@mail.huji.ac.il
[2] The Remote Sensing Lab, Dept. of Geography, The Hebrew University of Jerusalem, Mount Scopus, Israel

Abstract
Marine conservation planning is not as advanced as in terrestrial ecosystems. This is specifically true in the Mediterranean Sea (MS). Recent marine oil and gas discoveries and the process of declaring exclusive economic zones (EEZs) in the MS make systematic conservation planning especially important and timely. Large scale, EEZ, conservation planning, including the understudied deep seas, requires overcoming vast biodiversity data gaps and ongoing efforts for economic development. The eastern MS provides an interesting case study due to recent discoveries and existing efforts for territorial water conservation. Here, we apply the MARXAN decision support tool to prioritize conservation efforts for Israel's MS EEZ (yet to be declared), which will maximize conservation targets while minimizing the threats and the costs of conservation.

Keywords: Levantine Basin, Conservation, Deep waters, Mapping

While systematic conservation planning has substantially advanced in the past decade in terrestrial systems, much less work has been done in marine ecosystems. This is especially true for the Mediterranean Basin, where to date, systematic conservation plans are only beginning to be developed. Such plans are especially urgent in the Mediterranean Sea with the many threats to its nature and biological diversity (1). Located at the crossroads between Europe, Asia and Africa and shared by over twenty countries with over 250 million people, the Mediterranean Sea is an important biodiversity hotspot globally and has many endemic and threatened species. The Mediterranean Sea, unlike the oceans, due to its shape and size, is fully divided into exclusive economic zones and does not have "High Seas" (i.e. areas that do not belong to an EEZ of any country). This may make conservation planning in the region more practical if each Mediterranean country plans its EEZ, ideally coordinating its efforts with other Mediterranean countries.

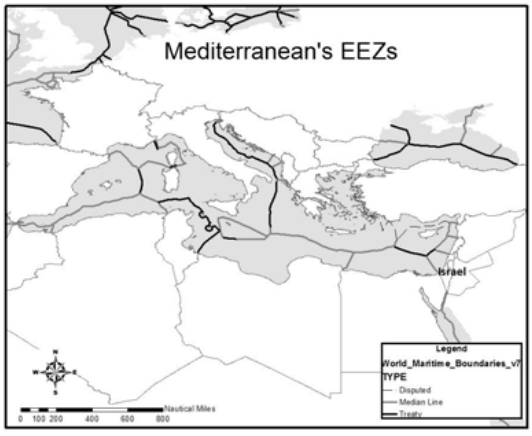

Fig. 1. Exclusive Economic Zones in the Mediterranean Sea. In most countries EEZ borders are yet to be declared (grey). For some there is an agreement in place (bold black) and for others, the exact borders` location is disputed (Thin black).

In Israel, there has been advancement in conservation efforts in the Mediterranean Sea in the past few years, led by Israel`s Nature and Parks Authority, and new efforts to propose a network of marine protected areas in Israel`s Mediterranean Sea territorial waters. These have been developed mainly based on bathymetry and habitat structure and will be discussed and determined in governmental planning committees in upcoming years. While these efforts are very important, they are limited to the territorial waters.

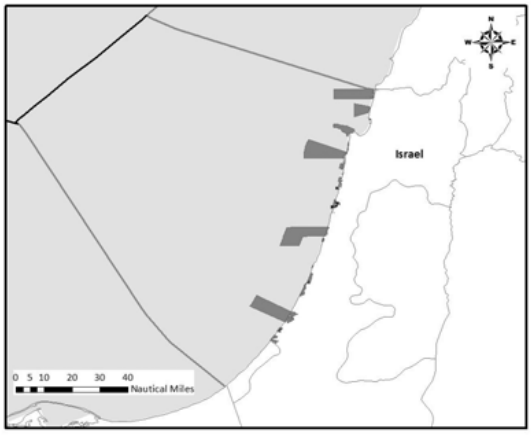

Fig. 2. Israel's EEZ with current and suggested Marine Protected Areas. The only agreed upon EEZ boarder is with Cyprus to the west (in black). MPAs Planned by the authorities are limited to the teritorial water.

While conservation planning has advanced slowly in the region, the threats to biodiversity and to its unique ecosystems are rapidly growing, along with the increase in resource extraction, shipping traffic, fishing efforts, population sizes along the coast, coastal development, invasive species, climate change and many other threats. The new discoveries of natural gas in the Mediterranean Sea within Israel`s EEZ have substantial future implications to both Israel`s energy market and potentially to the Mediterranean ecosystems. With the urgency in developing the ability to extract and transfer this energy resource, the need to develop a systematic conservation plan for Israel`s EEZ has become imperative. While data on biodiversity at the whole EEZ scale is limited, and the task is challenging, we developed the first systematic conservation plan for Israel`s Mediterranean EEZ. We used surrogates for the scarce biodiversity data (i.e. bathymetry, special substrate features, currents etc.) and used available data regarding the threats and the costs of biodiversity conservation. Our data will support the effort for integration of conservation considerations into the current and future planning in the region.

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IDENTIFICATION OF PREFERENTIAL SPAWNING AREAS FOR THE EUROPEAN SQUID

M. Calvo Manazza [1]*, M. Cabanellas Reboredo [1], M. Palmer [1], B. Morales Nin [1], J. Hernandez Urcera [2], M. E. Garci [2], Á. González [2] and Á. Guerra [2]
[1] Mediterranean Institute for Advanced Studies - denecochea54@gmail.com
[2] Institute of Marine Investigation

Abstract
According cephalopods short life cycle, population dynamics is mainly determined by between-year variability in reproductive success. Therefore, stock management may be improved after protecting the main spawning areas. The microsites where the European squid, *Loligo vulgaris* spawns within a Marine Protected Area have been identified by deploying an array of 30 artificial structures at diffrent depths. We belive that this species selects the spawning area searching for an optimal temperature range that maximizes egg survival. Our results sugest that adults migrate from off- to in-shore at winter, i.e.,when the water temperature near the cost is appropriate. Sandy bottoms seems to be preferred, which may be related with predator avoidance.

Keywords: Cephalopods, Spawning, Marine parks, North-Western Mediterranean

Introduction
The implementation of Marine Protected Areas (MPA) is one of the keys for the protection of marine species and could be used for fisheries management[1]. However, the high mobility of certain species, such as the European squid (*Loligo vulgaris*) [2], with a home range higher than MPA limits the usefulness of MPAs. Although, this species seems to aggregate at specific areas to spawn [2]. The identification of where and when these spawning aggregations occur may be very important for protecting the future recruits and for maximizing spawning success. The aim of this study is to identify the preferential spawning microsites of *L. vulgaris* within an MPA. The European squid is exploited by the trawling fleet, the small-scale fleet and the recreational fishery[3]. The study was carried out in Cabrera National Park (CNP) a small Archipelago south of Mallorca Island (Fig. 1).

Material and Methods
30 Artificial Spawning Attractors (ASA) were deployed over three main benthic habitats (sand, seagrass and rocky bottoms), and covering different depth ranges (Figure 1). The ASA were monthly sampled from june 2012 until june 2013. Number of egg clutches per ASA was modelled using a Generalised Linear Model (GLM). The model was fitted with the glm function of the R package (http://www.r-project.org/). A Poisson distribution of the response variable (monthly number of eggs clutches per ASA) was considered. The explanatory variables considered were; i) benthic habitat, ii) depth, iii) sea temperature, and iv) the interaction between depth and sea temperature.

Results
We found spawning activity all-year-round but with seasonal changes in the preferred depth for spawning. During colder months, spawning tend to be widespread, including shallow waters. Conversely, during the rest of the year, spawning is limited to deeper sites.

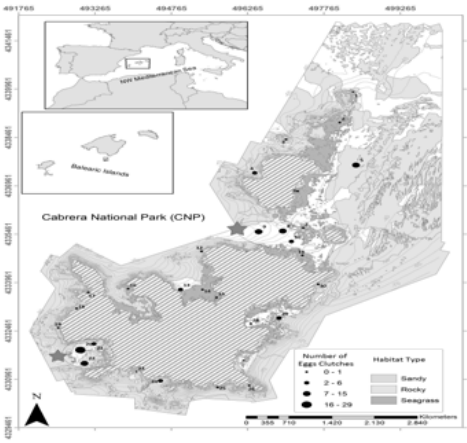

Fig. 1. Sampling area (CNP), distribution of the ASA (black circles). Size of circles indicates the number of the total eggs clutches. Stars indicate principal spawning area.

The GLM showed how the interaction between depth and sea temperature effects on squid spawning ($p<0.05$). In addition, sites with sandy bottoms were preferred as spawning habitat ($p<0.05$). Consequently, two main zones were determined as preferential spawning grounds: Canal and Ses Rates (Fig.1).

Discussion
The spawning at the park extends all-year-round. Our results agree with other studies performed for the same species, both in the Mediterranean and the Atlantic [4,5]. Despite the European squid spawned along all the depth range sampled, results suggests the existence of an optimal depth for spawning in function of the season. They spawned preferentially at shallow waters during cold months and at deeper water at warm months. This spatio-temporal spawning pattern may be linked with the optimal temperature range for maximizing the spawning success[6]. In addition, the spatio-temporal pattern described here is in accordance with the hypothesis of spawning migrations that has been suggested for the same specie and geographic area[7]. Sandy bottoms were preferred for *L. vulgaris* perhaps to avoid predators like *Epinephelus marginatus*[8]. We suggest to implement management measures that take into account the spatio-temporal pattern of spawning would maximize spawning success and would improve stock abundance.

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IMPACTS OF OFFSHORE WIND FARMS ON MARINE BIOTA: CHANGES IN BENTHIC AND FISH COMMUNITIES AT NORTHERN EUROPE, ARE THEY COMPARABLE TO MEDITERRANEAN ECOSYSTEMS?

Salud Deudero [1]*, Andrea Gari [1] and Cristina Gonzalez-Andres [1]
[1] Centro Oceanografico de Baleares. Instituto Español de Oceanografía - salud.deudero@ba.ieo.es

Abstract
Deployments of Offshore Wind Farms (OWF) are increasing throughout northern European seas. Few studies are dealing on impacts on marine biota. Revision of OWF monitoring on marine organisms reveals impacts as a result of substrate addition, indicating similar effects to those provided by artificial reefs and fish aggregation devices. Responses from ongoing projects at northern Europe will be discussed for expectation of further developments of OWF at the Mediterranean.

Keywords: Fishes, North-Western Mediterranean, Zoobenthos, Coastal management

Introduction
Marine renewable are increasing throughout northern European [1]. Effects of offshore wind farms on marine biota are diverse including addition of new substrate, creation of electromagnetic fields, noise, vibrations… [2]. Few studies have addressed such impacts. We hypothesized that OWF substrate addition is changing marine community structure; therefore we focus on discerning benthic and fish communities' changes to new substrate addition after OWF deployment. The expectation is that this data can serve as a baseline for establishing trends at Mediterranean ecosystems.

Material and methods
Review and analysis of 9 technical documents and scientific papers including biological data on OWF farms have been performed. OWF from Denmark, Holland, Belgium and England have been considered including temporal variation from 2001 to 2012. Two types of data have been addressed separately: benthic assemblages and fish communities. Permutational analysis of variance on log (x+1) transformed abundance data has been calculated at datasets from OWF, control areas, seasons and years.

Results and discussion

Benthic communities based on 17 taxonomic groups highlighted a dominance of Bivalvia and Nermertina at the OWF areas and a dominance of Amphipoda, Phoronida, Polychaeta at control areas. Benthic invertebrates are significatively differing among OWFs (Permanova, p>0,001). The sampling methodology is also modifying the observed benthic assemblages. Moreover, seasonality is influencing the faunal communities. (Table 1):

Tab. 1. Permanova for invertebrate species at OWF (Offshore Wind Farms) based on Bray-Curtis similarities. Fixed factors: Treatment: impact:OWF-control. Survey (sampling methodology: box-corer, trawl, triple-D dredge). Year (2005, 2007, 2008). Season (spring, autumn) . CV (Coefficient Variation) p<0,001

Source of variation	df	SS	MS	Ps-F	P(perm)	CV
OWF	2	67387	33694	49,78	0,001	27,97
Treatment(OWF)	3	1610,8	536,93	0,79	0,659	-2,40
Survey(OWF)	1	1,18E+05	1,18E+05	174,92	0,001	54,15
Year(Tr(OWF))	2	697,85	348,93	0,51	0,848	-5,51
Tr(OWF)xSu(OWF)	1	526,46	526,46	0,77	0,554	-2,73
Season(Ye(Tr(OWF)))	6	12063	2010,5	2,97	0,001	15,57
Res	195					26,01
Total	210					

Biomass increase in benthic communities can be highly relevant, although little is know about large-scale OWF consequences on marine biota (3). Temporal surveys determined an increase in organic matter, while abundance, species richness and invertebrate biomass was following a similar pattern at both OWF and control areas (4).

Tab. 2. Permanova for fish species at OWF (Offshore Wind Farms) based on Bray-Curtis similarities of log(x+1)-transformed data. Fixed factors: Treatment: impact:OWF- control. Year. Season (spring, autumn) . CV (Coefficient Variation) p<0,05

Source of variation	Df	SS	MS	Ps-F	P(perm)	CV
OWF	3	1,4E+05	48900	84,92	0,001	42,29
Tr(OWF)	4	3802,4	950,59	1,65	0,048	5,18
Ye(Tr(OWF))	3	9322,6	3107,5	5,39	0,001	16,96
Se(Ye(Tr(OWF)))	6	21141	3523,5	6,11	0,001	23,15
Res	97	55859	575,87			23,99
Total	113	2,4E+05				

Fish species
Several taxonomic groups from 5 OWF studies were quantified. The results highlight differences among offshore wind farms faunal assemblages. Fish species respond more clearly to OWF deployment exhibiting also temporal differences Permanova (Table 2):
Species mobility might explain the observed patterns linked to life cycle of each species. Seasonal variations are tight to environmental variability driving species responses. Time since deployment is also relevant for the observed communities around OWF. Previous studies on demersal assemblages showed a biomass increase of fishes surrounding the wind turbines (5). Future developments at Mediterranean coasts should include those aspects of variability within marine biota responses.

Acknowledgements This study was funded by a Spanish national research project CENIT-'AZIMUT: energia eólica offshore' and is a EU contribution Project 287844, COCONET, EU-FP7.

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STRIKING DIFFERENCES IN CARRYING CAPACITY VALUES OF FISH BIOMASS AMONG MEDITERRANEAN MPAS

Antoni Garcia Rubies [1]*, Josep Coll Montserrat [2], Mikel Zabala Limousin [3] and Bernat Hereu Fina [1]
[1] Centre d'Estudis Avançats de Blanes (CEAB-CSIC) - tonigr@ceab.csic.es
[2] Direcció General de Medi Rural i Mari - Govern de les illes Balears
[3] Dept. d'Ecologia, Universitat de Barcelona

Abstract
The carrying capacity of commercially interesting fish biomass was calculated in three Balearic MPAs. K values (1) differed among MPAs, and were reached at short times (< 5 yrs.). The differences were explained by environmental factors at small and medium spatial scales: exposure, "rugosity" and nearby abrupt changes in depth. By optimizing the effect of these factors we can get the "ideal MPA" for attaining maximum K values: a rocky outcrop in open sea, beaten by winds and currents, with a complex rocky bottom and pronounced slopes nearby. This case is close to the Medes Islands Marine Reserve, where a much higher value of K was observed, but attained at a far longer period of time (95% K at 25 yrs.). The results demonstrate that K values were regulated "bottom-up" and depend on the environmental factors prevailing in the area.

Keywords: Marine parks, Balearic Islands

Introduction
A population can be considered fully recovered when it reaches the carrying capacity of the system. This is one of the main aims of marine reserves, but has rarely been proven and there is no unanimity in the value of K nor the time necessary to achieve it. In this work we show that variations in K can be explained by the effect of different environmental factors acting at small and medium spatial scales. Knowing the effect of these factors, one can predict how it should be the "ideal MPA" to reach maximum values of K. This ideal environment is very similar to that found in the Medes Islands Marine Reserve, where, indeed, the value of K largely exceeds those observed in the Balearic MPAs, although the time required to achieve it was much longer.

Material and Methods
The study was carried out in three Balearic Islands Marine Reserves (from 2000 to 2011) (1) and the Medes Islands Marine Reserve (from 1991 to 2009). In both cases, visual censuses were conducted using transects (5 x 50m; from 5 to 10m, and 50 x 10m between 10 and 20m depth, respectively). All fish species of fishing interest were evaluated in the Balearic Is., and only 6 species (*Epinephelus marginatus*, *Dentex dentex*, *Dicentrarchus labrax*, *Diplodus cervinus*, *Sciaena umbra* and *Sparus aurata*) in the Medes Is.
The temporal evolution of the total biomass was adjusted to different asymptotic models of limited growth giving the value of K and the time required to achieve it. The K values obtained from Balearic MPAs were related to different environmental variables at small (bottom features, depth, slope and rugosity) and medium spatial scales (surrounding habitats, exposure, fishing effort and nearby abrupt slopes) by means of a generalized linear model analysis in order to ascertain which factors weighed more on conditioning the final value of K (2).

Results
The values of K vary widely, even in no-take zones within the same MPA (Palma MPA, K= 2656g; Freus MPA1, K= 6931g ; Freus MPA2, K= 4226g; Menorca MPA1= 4000g ; Menorca MPA2, K= 2394g 250m^{-2}) and they were reached in a short time period since protection (< 5yrs.). These differences were explained by the combined effect of several environmental factors (Exposure x Rugosity x Offshore slope). Optimizing those factors under this model could allow to reach higher K values, and that was the case of Medes Is. MPA (and other Mediterranean MPAs that can be considered as truly hot spots), where the carrying capacity stands at 12575g 250m^{-2} even though only six fish species of fishing interest have been taken into account. The 95% of that K value was reached after 25yrs of protection (Figure 1).

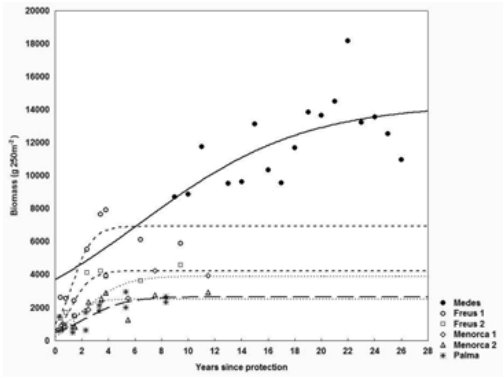

Fig. 1. The differences in carrying capacity and recovery time are evident between the Medes Is. and the Balearic MPAs (only 6 fish species were taken into account in the Medes Is. MPA)

Conclusions
Achieving the maximum biomass is regulated bottom-up by environmental conditions acting at small (Rugosity) and medium (Exposure, Offshore slope) spatial scales. The ideal combination of those factors allow the full development of the largest, long-lived, fish species. That's why the proces to reach the carrying capacity is longer in the "hot-spots", such as Medes Is. than in "normal' sites", although the final value of biomass is much higher (3). Prior knowledge of these factors, will allow us to design what would be ideal MPAs to achieve the highest biomass values of the most targetted, and therefore vulnerable, fish species in the Mediterranean Sea ?

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FROM COASTAL FISH SPECIES REPRESENTATION TO PHYLOGENETIC AND FUNCTIONAL DIVERSITY COVERAGE: NEW CHALLENGES FOR MEDITERRANEAN MARINE PROTECTED AREAS

F. Guilhaumon [1]*, C. Albouy [1], J. Claudet [2], L. Velez [1], F. Ben Rais Lasram [3], J. Tomasini [1], E. Douzery [4], C. Meynard [4], N. Mouquet [4], M. Araújo [5] and D. Mouillot [1]

[1] Laboratoire Écologie des Systèmes Marins Côtiers UMR 5119, CNRS, IRD, IFREMER, UM2, UM1, cc 093, Place E. Bataillon, 34095 Montpellier Cedex 05, France. - francois.guilhaumon@ird.fr

[2] Laboratoire d'Excellence "CORAIL" USR 3278, CNRS-EPHE CRIOBE, University of Perpignan, 66860 Perpignan cedex, France.

[3] Laboratoire Écosystèmes et Ressources Aquatiques UR03AGRO1, Institut National Agronomique de Tunisie, 43 avenue Charles Nicolle, 1082 Tunis, Tunisia.

[4] Institut des Sciences de l'Evolution, UMR 5554, CNRS, UM2, cc 065, Place E. Bataillon, 34095 Montpellier Cedex 05, France.

[5] Departamento de Biogeografía y Cambio Global, Museo Nacional de Ciencias Naturales, CSIC, C/José Gutiérrez Abascal, 2, 28006 Madrid, Spain.

Abstract

Here we assess gaps in the representation of taxonomic, phylognenetic and functional diversity components among coastal fishes in Mediterranean MPAs. We assessed gaps in the representation of coastal fishes and then asked whether MPAs protecteded phylogenetically and functionally more distinct species or whether there was a tendency for conserving more common ones and evaluated the overall conservation effectiveness for these two biodiversity components. We show that the Mediterranean MPA system fails short in achieving an effective conservation of coastal fish taxonomic, phylogenetic and functional diversity and does not provide better biodiversity coverage than random MPA systems. This study reveals multiple ongoing challenges for the extension of the Mediterranean MPA system in the context of the Convention on Biological Diversity.

Keywords: Conservation, Coastal systems, Fishes, Biodiversity, North-Central Mediterranean

The Mediterranean Sea is a remnant of the Tethys Ocean and has shown exceptional levels of marine biodiversity since the late Middle Eocene (42 to 39 Ma; 1). Most of this biodiversity is located on the continental shelf (2), an area that has been historically impacted by numerous anthropogenic threats (3). Amongst those threats, overfishing, often making use of destructive fishing gears is considered as the most prevalently affecting coastal fish populations (4). To counteract those threats about 100 coastal MPAs have been established in the Mediterranean Sea since the sixties (5). Despite their overlap with areas of high taxonomic fish diversity (6), recent investigations revealed that Mediterranean MPAs do not deliver on several important aspects (7).

Here we develop a gap analysis for Mediterranean coastal fishes and measure the MPAs ability to represent three key biodiversity components: taxonomic, phylognenetic and functional diversity. We first assessed gaps in the (taxonomic) representation of coastal fishes in Mediterranean MPAs, with targets being inversely proportional to species' range sizes. We then asked whether MPAs protecteded phylogenetically and functionally more distinct species or whether there was a tendency for conserving more common ones. We evaluated the overall conservation effectiveness of the MPAs using a metric that weights favorably MPA systems that maximize phylogenetic and functional diversity coverage as well as species representation. The effectiveness of the MPA system at protecting biodiversity was assessed by comparison with a null model defined by selecting MPAs at random over the study area. Among the 340 coastal fish species, 16 species were total gaps not covered by any MPA. All the remaining species only partially achieved their representation target. Current Mediterranean MPAs yield less total gap species than expected from locating MPAs at random. However, 30% of the species achieved significantly higher representation targets in random areas than in the current MPAs. Functional and phylogenetic distinctiveness were weakly correlated with target achievement. The observed coverage of functional and phylogenetic diversity was not different than for random systems.

The Mediterranean MPA system fails short in achieving an effective conservation of coastal fish taxonomic, phylogenetic and functional diversity and does not provide better biodiversity coverage than systems where current MPAs are sited randomly. The critical conservation status of the different components of Mediterranean coastal fish biodiversity highlighted here, as well as their spatial mismatches (6), demonstrate that the establishment of transnational conservation strategies would be of great benefit for biodiversity. Whether such pattern was verified for other taxa and habitats, it could have significant implications for the extension of the Mediterranean MPA system in the context of the Convention on Biological Diversity.

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CONSERVATION AND RESTORATION OF CYSTOSEIRA FORESTS IN THE MEDITERRANEAN SEA: THE ROLE OF MARINE PROTECTED AREAS

L. Mangialajo [1]*, F. Gianni [1], L. Airoldi [2], F. Bartolini [1], P. Francour [1], A. Meinesz [1], T. Thibaut [1] and E. Ballesteros [3]
[1] Universite Nice-Sophia Antipolis Laboratoire ECOMERS - luisa.mangialajo@unice.fr
[2] Dipartimento di Scienze Biologiche, Geologiche ed Ambientali BIGEA, University of Bologna, Ravenna, Italy
[3] Centre d'Estudis Avanc¸ats de Blanes-CSIC, Acc. Cala St Francesc 14, 17300 Blanes, Spain

Abstract
In the Mediterranean Sea *Cystoseira* forests are locally threatened due to several impacts. The low dispersal capacity of most *Cystoseira* species makes the natural recovery unlikely. The restoration of *Cystoseira* forests can represent a valuable solution and is recommended where the historical presence is recorded and the impacts that led to its loss are no longer acting (a reasoned forestation could be considered also where historical data are not available). MPAs may play a paramount role in the conservation of *Cystoseira* forests, guaranteeing protection from several impacts and representing the source of propagules for the restoration of lost or degraded forests outside their borders. MPAs where *Cystoseira* forests are lacking due to past impacts should be considered as priority experimental sites for artificial forestation.

Keywords: Marine parks, Phytobenthos, Conservation, Restoration, North-Western Mediterranean

Large brown seaweeds play the role of engineer species in shallow waters of temperate and cold waters. In the Mediterranean Sea, marine forests are mainly originated by Fucales of the genus *Cystoseira* that play an important functional role in sustaining complex food webs and maintaining a high biodiversity. As many other large brown seaweeds worldwide, *Cystoseira* forests are regressing due to several impacts, among which a decrease in water quality, coastline overbuilding and the proliferation of herbivores, sometimes an indirect effect of overfishing [1, 2]. Six Mediterranean species of *Cystoseira* are listed in the Annex I of the Bern Convention, and the Mediterranean Action Plan, adopted within the framework of the Barcelona Convention, identifies the conservation of all but one *Cystoseira* species as a priority.

The low dispersal capacity of most Cystoseira species makes the natural recovery unlikely, so that artificial reforestation can represent an extremely valuable solution for lost forests [3, 4]. Large brown seaweeds restoration has been already explored worldwide but only few studies have been carried out in the Mediterranean Sea on *Cystoseira* species (*C. amentacea var. stricta*, *C. barbata*, *C. compressa*). These experiments gave encouraging results, thanks to the highly-efficient reproductive strategy characteristic of the Fucales order. Negative effects of grazing have been observed in several cases, suggesting that, at least in a first phase of artificial reforestation, grazers should be controlled.

The restoration of *Cystoseira* forests is particularly recommended where the historical presence is recorded and the impacts that led to its loss are no longer acting in the area. Nevertheless, forestation could be considered also at sites where the previous distribution cannot be documented, but seems likely based on the local and regional environmental characteristics. Also existing man-made structures may be considered for forestation, whenever the biotic and abiotic environmental factors are compatible, as this would enhance the ecological value of these artificial substrata without compromising their engineering function.

Although pristine *Cystoseira* forests can be found in MPAs, this is not a general rule: several MPAs lack *Cystoseira* forests, while healthy dense forests can still be found in non-protected, but naturally isolated and lowly impacted sites [5]. MPAs can play a paramount role for the conservation of these forests, as they guarantee protection from various human impacts (e.g. overfishing, urbanization) and can reduce others through an integrated management with adjacent areas. Healthy forests in MPAs may represent also an important source of propagules for restoration of lost or degraded forests outside their borders. MPAs lacking *Cystoseira* forests may offer priority experimental sites to identify the factors facilitating the conservation and restoration of damaged forests.

The protection of existing forests should be coupled to regular monitoring programs in order to promptly highlight potential threats and early signs of regression. An ecosystem-based management applied to a network of MPAs with long-term monitoring programs and restoration actions, where necessary, is probably the best perspective for *Cystoseira* forests preservation in the Mediterranean Sea.

Acknowlegdments
The work was realized within the framework of the project MMMPA - Training Network for Monitoring Mediterranean Marine Protected Areas, that has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n°: 290056 (support of FG and FB) and of the project CoCoNet, under grant agreement N°287844. LA was supported by projects Theseus (EU - FP7 - ENV2009-1, grant 244104), MERMAID (EU FP7 – Ocean – 2011, grant 288710) and by a Fulbright Fellowship while writing the paper.

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DYNAMICS, CAUSES OF DEGRADATION AND THE PROGNOSIS OF RESTORATION ZERNOV *PHYLLOPHORA* FIELD (THE BLACK SEA)

Nataliya A. Milchakova [1]*, Nataliyia V. Mironova [1] and Vladimir V. Alexandrov [1]
[1] Institute of Biology of the Southern Seas, Sevastopol, Ukraine - milchakova@gmail.com

Abstract
The current status and causes of degradation of the Zernov *Phyllophora* Field (ZPF) over the last century are analyzed. The *Phyllophora* spp. population state is described, and the necessity of the conservation management plan of and restoration of ZPF as the largest Black Sea MPA are discussed.

Keywords: Phytobenthos, Black Sea, Conservation

Zernov *Phyllophora* Field (ZPF), discovered in 1908 in the north-western shelf of the Black Sea (NWBS), was the largest aggregation of unattached *Phyllophora* in the world with an area of about 11,000 km^2 [1]. Over the last century ZPF has nearly disappeared. *Phyllophora crispa* (= *Ph. nervosa*) dominated here earlier in the depth range from 20 to 50 m and consisted mainly in unattached form. Recently in many ZPF sites, it has been replaced with an attached form of *Coccotylus truncatus* (= *Ph. brodiaei*). *Phyllophora pseudoceranoïdes* which is less common has not been found [2,3]; this species is included in the Red Book of Ukraine (2009) as endangered.

Phyllophora spp. stocks decreased by at the least hundreds times of (Figure 1); sixfold since 1969 till 1978 and further by an order of magnitude since 1978 till 1990. At present, they are estimated to be less than 6–100 thousand tons (wet weight). In 2008 a botanical preserve comprising sufficient part of ZPF was established; now it is the largest MPA of the Black Sea with an area of 4,025 km^2. According to the IBSS R/V expedition data, *Ph. crispa* average biomass decreased by more than an order of magnitude since 1990 to 2011, and the biomass of *C. truncatus* was changed slightly; now their values amount to 2.22 and 12.01 g·m^{-2} respectively [2,3].

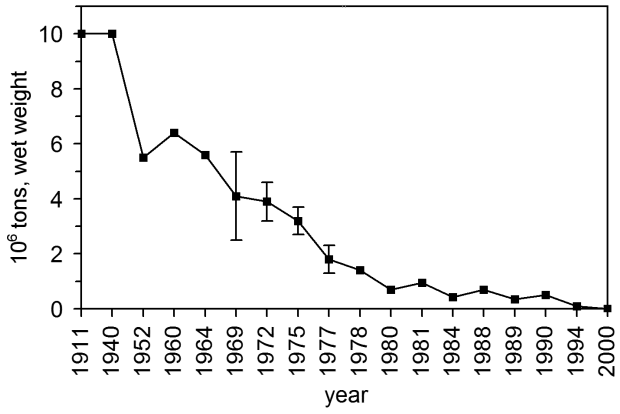

Fig. 1. Long-term dynamics of the *Phyllophora* spp. stock in the ZPF (the Black Sea).

The largest aggregations of both species are concentrated in the south-western part of ZPF; *C. truncatus* occurs throughout the entire area of the field and *Ph. crispa* grows mainly in its southern and central parts. In the population of *Ph. crispa* and *C. truncatus* young and small thalli are dominant. In 2011 in comparison with 1966 an increase in species diversity (32 and 25 species correspondingly) has been found; the Jaccard index of compositional similarity between these years reached to 70%.

Despite the eutrophication level decrease, increased water transparency of the NWBS shelf and putting a ban on commercial *Phyllophora* extraction into action since 1996 (catches ranged from 2,400 to 14,300 tons per year, see Figure 2), the ZPF recovery is not observed. In our opinion, the main causes of catastrophic ZPF degradation were not so much *Phyllophora* catching as sprat bottom trawling, which destroyed *Phyllophora* biocenoses, as well the eutrophication and the general unstable state of the NWBS ecosystem. The most important biological factors limiting the recovery of ZPF are an almost complete disappearance of the *Ph. crispa* unattached form (diploid sporophyte) which produced a significant biomass through vegetative propagation and increased expansion of the attached *C. truncatus* form (haploid gametophyte) characterized by a reduced sporophyte, low reproduction intensity and sensitivity to stress factors.

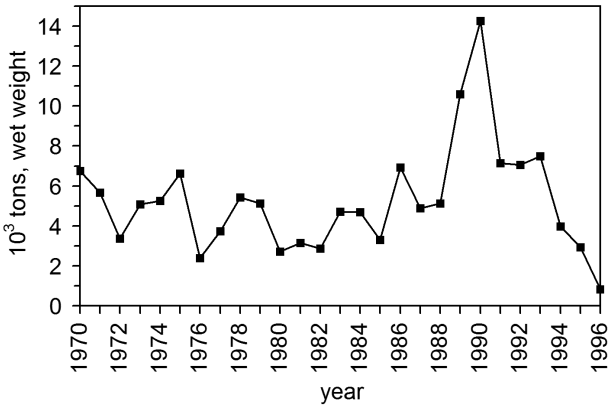

Fig. 2. Dynamics of *Phyllophora* spp. catching in the ZPF (the Black Sea).

Nevertheless, since the MPA was created, recovering of ZPF is unlikely because of the increase of vessel traffic and resource extraction in the NWBS and the entire Black Sea basin. There are several gas condensate fields close to the ZPF borders; their development is planned for the coming years. Taking all of this into account, the most urgent ZPF conservation goals in our opinion are: inclusion of key species and habitats into the European Red List and other documents, development management plan for the ZPF protection with the support of international organizations, and creation of the Black Sea MPA network. It is possible that implementing these goals will permit to change the nature protection paradigm from the protection of species to the protection of a ecosystem, taking into account the compensation principles of the correspondence in use of marine living resources by human to natural ecosystem dynamics.

Acknowledgements. The research has received funding from the EC (FP7/2007-2013) under Grant Agreement No. 287844 for the project CoCoNet ("Towards Coast to Coast NETworks of marine protected areas (from the shore to the high and deep sea), coupled with sea-based wind energy potential").

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IS THE PELAGOS SANCTUARY SUFFICIENTLY LARGE FOR THE CETACEAN POPULATIONS IT IS INTENDED TO PROTECT?

Giuseppe Notarbartolo di Sciara [1], Simone Panigada [1]* and Tundi Agardy [2]
[1] Tethys Research Institute - panigada@inwind.it
[2] Sound Seas, Inc.

Abstract
Critical habitats of cetacean populations regularly found in the Pelagos Sanctuary widely extend to the west and south of the Sanctuary's borders, in spite of its large size (87,000 km^2). A reconsideration of the Sanctuary's design to account for this shortcoming is proposed.

Keywords: Cetacea, North-Western Mediterranean, Marine parks

MPAs can provide effective protection to cetaceans [1], although the high mobility of many species presents a challenge to the applicability of MPAs to their conservation. The Pelagos Sanctuary for Mediterranean marine mammals was established in 1999 by a treaty among France, Italy and Monaco [2], to ensure the good conservation status of most of the cetacean species regularly occurring in the Mediterranean, attracted to the area by a particularly favourable feeding environment. However, in spite of its large size (87,000 km^2), the Pelagos Sanctuary includes only in part the critical habitats of the cetacean populations regularly found within its borders.

The fin whale, *Balaenoptera physalus*, a highly mobile, pelagic cetacean found at its highest regional concentrations in the northwestern Mediterranean and particularly within the Sanctuary's boundaries [3], is a case in point. During the last few years, evidence was provided that fin whales occur in important concentrations well beyond the Sanctuary's western boundary, i.e., south of the Gulf of Lion towards the Balearic Islands, where in fact models predicted the presence of fin whale feeding habitat [4, 5]. Tracks of eight fin whales, derived from a satellite tagging experiment we conducted in the area in Sept. 2012 (Fig. 1), while stressing the importance of the Pelagos Sanctuary for the whales, at the same time confirmed the propensity of several whales to spend time to the west of the Sanctuary, in a vast area comprised between the shelf drop in the Gulf of Lion, the west coast of Sardinia and Catalonia. Furthermore, the prediction by the same models of the existence of important fin whale habitat in the Tyrrhenian Sea, just south of the Sanctuary's eastern boundary, were confirmed by observations at sea [6, 7].

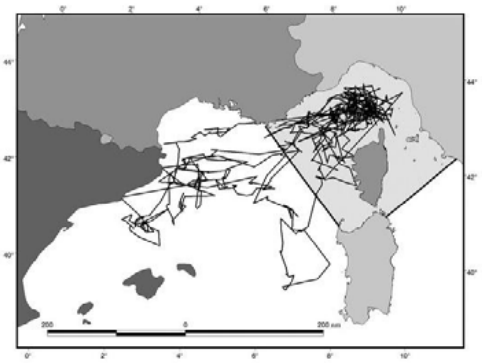

Fig. 1. Tracks of eight fin whales tagged with satellite transmitters in Sept. 2012. The shaded marine area is the Pelagos Sanctuary.

Since threats to cetaceans (e.g., maritime traffic [8], fishing, seismic exploration and effects of climate change) occur throughout the western Mediterranean, extending spatial protection to cover a larger portion of the species' critical habitat would provide a greater potential for addressing these threats. With the significant increase in ecological knowledge acquired in recent years, and with most of the concerned area now having become within national jurisdiction due to the establishment of an EEZ by France and an Ecological Protection Zone by Italy and Monaco, it would now be possible to design and manage a zoned system whereby areas containing cetacean critical habitats outside and within the Sanctuary boundaries are afforded protection. Such system would also contribute to strengthen the bases for the identification of CBD's Ecologically or Biologically Significant Areas (EBSA) in the region, and support the implementation of a Marine Spatial Planning scheme whereby human activities impacting on cetaceans can be made to coexist with environmental protection.

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COMPARISON OF THE SOCIOECONOMIC IMPACTS OF MEDITERRANEAN AND BLACK SEA MARINE PROTECTED AREAS: EVIDENCE, GAPS AND WAYS FORWARD.

Marta Pascual [1]*, Marisa Rossetto [2], Paco Meliá [2] and Elena Ojea [1]
[1] Basque Centre for Climate Change (BC3) - marta.pascual@bc3research.org
[2] Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Italy

Abstract
The increasing necessity of scientific evidence on the socioeconomic impacts of MPAs, as well as acknowledging them, is of relevance for marine policies. This is especially important at the regional level, such as for the Mediterranean and the Black Sea. However, since a previous work carried out in 2000, no study has analyzed the most recent findings, or performed a comparative review of the socioeconomic impacts of MPAs for the Mediterranean and the Black Sea. The present contribution aims to fill this gap by collecting evidences and analyzing MPAs' socioeconomic impacts, updating and expanding the analysis for the Black Sea. Preliminary results show that MPAs implications on tourism and fishing are important especially in the Mediterranean Sea, whereas in the Black Sea conflicts are likely to arise due to mineral extraction.

Keywords: Marine parks, Economic valuation, Black Sea, North-Central Mediterranean, North-Eastern Mediterranean

Marine Protected Areas (MPAs) have gained popularity worldwide as a management option for marine conservation, fisheries and other human uses of the oceans [1]. As a consequence, MPAs are increasingly common management tools for marine ecosystems and scientific evidence on the socioeconomic impacts of these reserves has gained relevance for marine policies, especially at the regional level, where common policies and regulations can be applied. It was in this line that current international targets, set by the Convention on Biological Diversity, promoted a network expansion of MPAs [2].However, more research is needed in order to understand the socioeconomic impacts of each MPAs, as well as the impacts of scaling marine reserves to regional networks, where many conflicts have been already observed to arise [3]. A work in 2004 estimated the costs and benefits of meeting global MPA network targets [4], however, studies looking at the impacts at a regional level are scarce. Two regions with abundant MPAs are the Mediterranean and the Black Sea, which provide a number of important marine ecosystem services to the wide range of countries that these regions encompass. These countries have the particularities of being geographically constrained by huge regulatory, economic and, even sometimes, geopolitical differences, which conflict with a more sustainable use of the resources. Understanding the socioeconomic impacts of MPAs in these two regions is therefore essential. Already in 2000, a review on the socioeconomic impacts of MPAs in the Mediterranean Sea was conducted [5], and since then, many other studies have tried to understand the various mechanisms in which MPAs can have socioeconomic impacts. However, since the latter review, no other study has analyzed the most recent findings from the literature, or performed a comparative review of the socioeconomic impacts of MPAs for the Mediterranean and the Black Sea. Acknowledging this gap, the present contribution aims to collect and analyze evidences from the Mediterranean, that would allow to update previous reviews [5], as well as performing the same analysis for the Black Sea. The main objectives of the present work are: (i) to conduct an up-to-date review on the state-of-the-art of socio-economic impacts of MPAs in the Mediterranean and Black Sea regions; (ii) to identify the implications of MPAs to the main existing marine activities and uses in the region´s countries; (iii) to derive implications, constrains, suggestions and conclusions for the creation of MPAs networks. In order to fulfill this aims, a review of the literature has been conducted by including studies on MPAs belonging to both EU and non-EU countries. The MPAs dataset was compiled based on the MEDPAN (www.medpan.org) and on the WDPA (World Database Protected Areas; http://www.wdpa.org/) databases and updated with scientific and management report that where found at the country level basis. An extensive bibliographic search was performed by reviewing peer-reviewed papers, gray literature, management plan reports, other scientific reports, books, book chapters, proceedings, policy briefings and personal and web communications that reported any information regarding socioeconomic impacts of MPAs, for each of the countries in the Mediterranean and the Black Sea regions. A set of 190 MPAs are included in the database, where special focus was placed on gathering information and analyzing the impacts per MPA on the different uses and economic activities performed in the area. Impacts of MPAs where identified for the following uses and activities: fisheries (commercial, artisanal, recreational); aquaculture/mariculture; maritime transport; military; extractive (oil and gas, sand, biological resources); renewables (wind, wave); recreational (diving, sailing, tourism, beach, etc); cultural heritage (archaeology) and education and science. The information gathered per use or activity was related to: presence / absence of impact; type of impact; management measures; effectiveness of the management measures; level of social impact; information source and reliability of the information. Based also on an intense bibliographic research, a complete compilation and weighting among the existing marine activities at the Mediterranean and Black Sea was performed followed by the analysis, per country, of the cultural and socioeconomic impacts of MPAs over those activities. With the final updated database, the expected significant differences of the impacts of MPAs, depending on the country and region, were corroborated by preliminary results which show that main relevant socioeconomic impacts of MPAs in the Mediterranean are to be more relevant for fisheries and tourism, whilst impacts on resource extraction are important for the Black Sea region. These regional differences have been further explored by focusing on two case studies, one at the Mediterranean (highlighting impacts of MPAs onto fisheries) and another one at the Black Sea (highlighting impacts of MPAs onto mineral extraction), regional differences as regards to MPAs socioeconomic impacts onto activities are discussed and MPAs networking steps are suggested as a mean to minimize MPAs socioeconomic impacts. A diagram of the steps that have been followed is shown here below:

Fig. 1. Description of the methodological approach for MPA socioeconomic impacts.

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EVALUATION ÉCOLOGIQUE DE L'ÎLE RACHGOUN EN VUE D'UN CLASSEMENT EN AIRE MARINE PROTÉGÉE (OUEST ALGÉRIEN)

Djillali Bouras [1] and Mohammed Ramdani [2]*
[1] Université d'Oran Département de Biologie
[2] Université Mohammed V Agdal Rabat, Institut Scientifique - mramdani@israbat.ac.ma

Abstract
L'île Rachgoun est un écosystème abritant d'importantes colonies d'invertébrés benthiques (Cnidaires, polychètes, Mollusques, échinodermes), pélagiques et terrestres. L'herbier est dominé par la posidonie, associée à des algues vertes et brunes. L'étude vise la détermination des potentialités en biodiversité. Il s'agit d'un site de nidification pour le faucon d'Eléonore et du faucon crécerelle. Les pressions anthropiques et climatiques ont contribué à une dégradation avancée du paysage. Ainsi, la nécessité d'engager des actions de sauvegarde de l'ile s'avère impérative. Ce site insulaire concrétise l'ensemble des caractéristiques d'une aire marine protégée pour préserver la biodiversité et le paysage, et intégrer cette région dans un développement durable en associant la population riveraine dans des activités respectant l'environnement.

Keywords: Biodiversity, Algerian Sea

Introduction
Les écosystèmes marins en Algérie subissent de fortes agressions menaçant le paysage et les composantes biologiques. L'ensemble de la façade maritime nationale dépasse 1600 km de long et ne compte aucune aire marine protégée reconnue à l'échelle internationale. Dans cette optique, la proposition de classement de l'Ile Rachgoun ne peut que signaler un des nombreux importants SIBEs de la zone marine dans la partie ouest algérienne. L'île Rachgoun est une brèche de maintien d'un site d'un grand intérêt écologique, représentant un patrimoine naturel soumis à de fortes pressions et reconfigurations (tourisme national accru en été et activités de pêche importantes toute l'année). Le classement de cet écosystème insulaire en aire marine protégée permettra de valoriser à la fois le paysage et les composantes biologiques.

Situation géographique
L'île Rachgoun, appelée aussi Layalla, se localise dans la baie de Beni Saf limitée par le Cap Acra à l'Ouest le Cap Oulhassa à l'Est, et étalée sur 14 km de long. Le site est matérialisé topographiquement par deux plages (plage du Puit ou Madrid et plage Rachgoun) séparées par des falaises rocheuses à l'embouchure de l'oued Tafna. Le secteur côtier et constitué d'une alternance de plages sableux et de rochers au voisinage de la ville de Beni Saf. L'ensemble du littoral est relativement moins peuplé et anthropisée ([1] in Khetib et Rezzoug, 1991).

Richesse paysagère et biodiversité
Les paysages marins algériens sont le théâtre d'une reconfiguration incessante, résultat d'une évolution permanente des compartiments marins et terrestres. Le site insulaire maritime offre un écosystème richement diversifié en flore: *Posidonia oceanica*, *Codium bursa*, *Cystoseira stricta*, *Sargassum* sp. et *Corallina elongata*). A des niveaux de profondeur encore moins importants et sur l'ensemble du pourtour immédiat de l'ile, se développent des ulvales: *Ulva rigida* et *Enteromorpha intestinalis*. La faune ornithologique remarquable est composée du Goéland d'Audouin *Larus audouinii* et du Faucon d'Eléonore *Falco eleonorae*. Nous avons observé également une importante colonie du grand cormoran, du balbuzard pêcheur et du Goéland leucophée *Larus cachinnans*. Nous avons noté une population importante de moules *Mytilus galloprovincialis*, de *Patella gigantea*, d'oursins (*Paracentrotus lividus* et l'oursin noir *Arbacia* sp) et de *Balanus* sp dans les crevasses rocheuses et dans les fissures et les creux du platier environnant. Les annélides polychètes, avec 110 espèces répertoriées, sont représentés principalement par *Stermaspis suctata*, *Nephtys hombergi*, *Lumbrineris latreilli*, *Lumbrineris gracilis*, *Chone filicaudata* et *Chone duneri*. Les arthropodes crustacés sont composés de: *Ampelisca corophium* et de nombreuses espèces de crabes. Les Tanaidacés comptent de nombreuses espèces. Les mollusques (34 espèces) sont largement représentés par les Tellinidés et les Nuculidés. Les Echinidés sont représentés par les oursins, les holothuries et les étoiles de mer. Les ressources halieutiques sont représentées par une vingtaine d'espèces de poisson d'importance économique, ainsi que par les crustacés *Natantia* (crevette rose du large *Parapenaeus longirostris*) et par les Mollusques céphalopodes dominés par le calmar *Loligo vulgaris*.

La zone insulaire est sous l'influence d'une alternance de périodes climatiques stables et instables ayant un impact négatif sur le site et ses composantes, auquel s'ajoutent les actions anthropiques qui aboutissent souvent à une érosion des espèces floristiques et faunistiques. Dans cette optique, trois questions majeures se posent :

Quelle évolution temporelle des sites insulaires en Algérie? Comment gérer cette zone maritime? Quels sont les outils efficaces pour protéger et préserver le paysage et ses composantes biologiques? Quel moyen efficace pour intégrer ce site dans le réseau CoCoNet?

La gouvernance et la protection de la biodiversité de l'Ile Rachgoun exige une évaluation pilotées par des équipes pluridisciplinaires avec la collaboration des décideurs et des gestionnaires. Le site, classé à l'échelle nationale en SIBE, se trouve dans le secteur côtier de Béni-Saf (importante zone portuaire à l'échelle nationale). Son classement en zone marine protégée limiterait amplement tous les types d'agression et de reconfiguration paysagère et préserve la richesse faunistique et floristique marine et terrestre [2-7].

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SOCIOECONOMICS OF MARINE PROTECTED AREAS: A REVIEW OF EMPIRICAL EVIDENCES

M. Rossetto [1]*, F. Micheli [2], G. A. De Leo [2], P. Melià [1] and M. Gatto [1]
[1] Politecnico di Milano - marisa.rossetto@nemo.unipr.it
[2] Hopkins Marine Station of Stanford University

Abstract
Recent trends in the science of marine protected areas (MPAs) highlight the need to strengthen the integration between socioeconomic and ecological aspects in the early stage of the planning process. So far, however, the magnitude and relevance of the socioeconomic consequences of MPA creation are still highly uncertain. Here, we present a synthetic review of the empirical evidences of benefits and costs (B/Cs) of MPAs, in order to inform the planning of future protected areas.

Keywords: Economic valuation, North-Central Mediterranean

Introduction. Marine environments offer extremely valuable resources in terms of extractive and non-extractive uses. The establishment of MPAs, partially or totally limiting human uses, raises important socioeconomic issues that should be included in the planning process at an early stage to increase compliance and general acceptance [1]. However, economic consequences of MPA establishment are often limited to collateral information evaluated *a posteriori* and are generally not integrated in the planning process [2]. Here, we review published empirical evidence of B/Cs of MPA establishment. Results are reported heraafter and summarized in Fig 1.

Fishery-related B/Cs of MPAs. We reviewed 95 ISI papers, focusing on 39 MPAs all over the world, that analyze B/Cs in terms of 1) spillover from MPAs toward fishing grounds; 2) change in market value of exported fishes; 3) effect of protection on catch variability; 4) effect on fishing effort; 5) effect on overall catches. Results show that spillover is a common benefit in well-established marine reserves, as it was detected in about 75% of the case studies. Worldwide, spillover from MPAs has been detected for a suite of different species, including finfish and invertebrates. Spillover of lobster has been observed in 6 Mediterranean MPAs. The increase in mean size of commercially important species in the surroundings of MPAs is another common benefit, detected in 28% of the MPAs under study. On the other hand, only four studies analyzed the effect of MPAs on catch variability. Even though theoretical studies suggest that MPAs could diminish catch variability, in 3 MPAs greater catch variability was detected after protection. Displacement of fishing effort associated with MPA creation was detected in almost 25% of analyzed cases studies that reported biomass export. Only 8 of the 39 empirical studies that analyzed spillover collected enough information to assess the effect of protection on overall catches. In 6 cases, MPAs resulted in a net advantage to local fishermen (fishing yields higher with MPA than without); in 2 cases, instead, a decrease in catches after MPA creation occurred due to excessive reduction of fishing grounds.

Non-consumptive B/Cs of MPAs. We reviewed 20 ISI papers analyzing the B/Cs of recreational use of 28 MPA in coral reef areas and in the Mediterranean. We focused on the effects of protection on 1) increase of touristic activities; 2) improvement of recreational use; 3) damage from increased visits. Attractiveness of protection on tourism and improvement of recreational use have been detected in 14 over the 28 MPAs, especially for divers, snorkelers and sailors. However, information about increased visits is often anecdotal and it is often impossible to distinguish how much of the revenues from touristic activities are due to the MPA presence itself. In 10 MPAs, contingent valuation and travel cost methods were used to estimate recreational users' willingness to pay (WTP) for enjoying the reserve or simply preserving the seascape. Such surveys are extremely useful for determining fees that can be introduced to sustain long-term financing [3]. In 3 MPAs, the estimated annual revenue from tourism could cover MPA's operating and management costs. Despite the importance of tourism as an income voice, 7 studies detected detrimental effects of recreational use on marine habitats [4]. In 2 MPAs, damages from increasing visists have been quantified in terms of decreased WTP for recreational use due to decline in reef quality [5] and crowding [6].

Review on MPAs management costs shows that acquisition, management, enforcement and transaction costs constitute an effective problem for effective management: in a surveys of 83 MPAs worldwide, it emerges that in only 15.7% of the cases current funding was sufficient for effective conservation [7]. The total annual running costs per unit area has been found to decrease with MPA size [7], meaning that MPAs cost more to run, per unit area, where they are small.

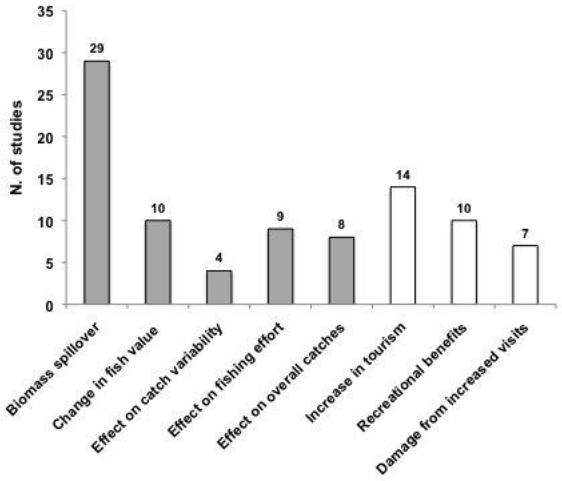

Fig. 1. Number of valuations of socioeconomic effects of MPAs found in the literature. Gray bars refer to consumptive B/Cs, white bars refer to non-consumptive B/Cs.

Conclusion. Our analysis revealed that consumptive users of marine resource can benefit from MPA establishment, as spillover of biomass from reserves is a common benefit in existing MPAs. Non-consumptive benefits are a crucial aspect in determining the degree of financial self-sustainment of MPAs, as long as no habitat damages from increased visits occurr. Information on MPAs management costs shows that economy of scale encourages the expansion of existing networks of MPAs to foster the recovery of marine ecosystems**.**

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ANALYSIS OF SHALLOW-WATER MARINE FISH COMMUNITIES OF CROATIA: THE INFLUENCE OF HABITAT AND GEOGRAPHIC VARIABLES ON BETA DIVERSITY

Stewart Schultz [1]* and Claudia Kruschel [1]
[1] University of Zadar - ss@stewartschultz.com

Abstract
We quantified shallow-water fish communities at 135 outer-coast sites throughout Croatia using non-destructive underwater visual-census transects. Species richness and diversity were significantly higher inside MPAs. Both habitat dissimilarity and geographic distance had significant and independent effects on beta-diversity, providing support for both niche- and dispersal models for species assembly. MPA design should target natural habitat mosaics rather than individual benthic habitats.

Keywords: Central Adriatic Sea, Fishes, Biodiversity, Marine parks, Posidonia

Introduction

Fish resources are highly depleted in the Adriatic Sea due to competitive commercial and artisanal fisheries (1). Recovery of these resources and their dependent economies requires both changes in the regulation of extraction activities through ecosystem-based management, and the design of a network of interconnected MPAs embedded within an interdisciplinary plan of integrated coastal-zone management in Croatia (2). The optimal design of an MPA network requires understanding of spatial connectivity patterns and the partitioning of biodiversity across habitat and geographic space (3). Here we report results of the first study to quantify shallow fish community assembly at the scale of the entire Croatian coast.

Methods

We performed a total of 13806 lure-assisted, visual-census field transects of fish communities at 135 outer coast sites in Croatia, for an average of 348 transects per site (minimum 12, maximum 377) (4). Sampling was performed in early and late summer of 2009, 2010, 2011, and 2012 with a mean of 3452 transects per year. These sites spanned the entire coastline from south to north, and included a total of 18 inner and outer islands. Sites were inside and outside 5 MPAs with differing enforcement. Sites differed in shoreline development, the presence and extent of urchin barrens, mean transect depth (1.4 m to 8.1 meters), and benthic habitat. Benthic habitats included rocky reefs, algal beds, bare sand, *Posidonia oceanica* and *Cymodocea nodosa* meadows, and many combinations of these in complex mosaics. The mean fish community was calculated for each site, and community differences among all 9045 pairs of sites were quantified using beta diversity measures. We performed permutational Mantel tests, PERMANOVA, and nonmetric multidimensional scaling to test and visualize relationships between beta diversity and predictor variables.

Results

Our predictor variables were able to explain a maximum of roughly 30% of the beta diversity variation. Variables associated with habitat, including anthropogenic influence and MPA status, generally explained approximately 5-10 times the variation in beta diversity that geographic distance explained. The overall effects of distance and habitat persisted when each was controlled for the other in statistical tests. A small number of key fish species explained a moderate but significant amount of the variation in beta diversity, for reasons currently unknown but perhaps related to stronger habitat preference or to competitive or predatory interactions.

Discussion

If beta diversity is a proxy for negative connectivity, then our results imply that 1) fish communities throughout Croatia are highly connected; 2) the majority of connectivity variation shows no discernable pattern, and 3) the portion that is explained is influenced primarily by habitat characteristics, including the quality of the habitat, e.g. the level of shoreline development and the degree of protection from fish-harvesting activities. The major benthic habitats, including seagrass, unconsolidated sediment, and rocky reefs, each harbor predictably different communities of fish with similar levels of species richness and diversity regardless of geographic location. However, diversity and richness were significantly higher within MPAs. In conclusion, there are no major discontinuities in composition of the fish communities we studied within Croatia; communities on the islands are similar to those on the mainland, and we found moderate differences between northern and southern sites. Most variation was unexplained, and a moderate amount was explained by habitat identity and degree of anthropogenic disturbance. MPA design within Croatia should place a high priority on maintaining a natural habitat mosaic rather than elevating any particular habitat type.

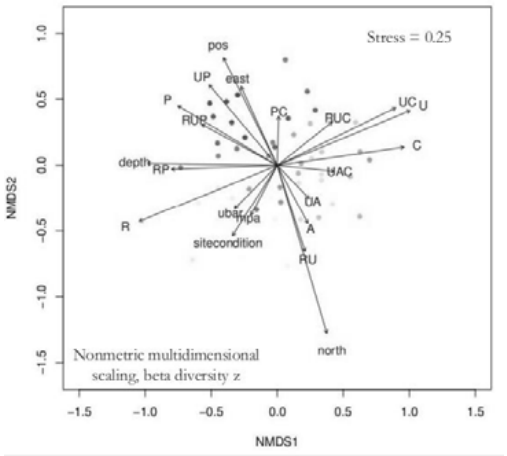

Fig. 1. NMDS ordination of fish communities in Croatia by beta diversity. R: rocky reef; P: *Posidonia*; C: *Cymodocea*, A: macroalgae; U: unconsolidated sediment; MPA: marine protected area; sitecondition: measure of lack of disturbance; ubar: urchin barrens. Points represent sampling sites, dark: southern; light: northern.

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ASSESMENT OF SOFT BOTTOM MUSSEL COMMUNITY STRUCTURE ON THE ROMANIAN BLACK SEA CONTINENTAL SHELF

Adrian Teaca [1]*, Tatiana Begun [1] and Marian-Traian Gomoiu [1]
[1] NIRD for Marine Geology and Geoecology - GeoEcoMar - adrianxteaca@yahoo.com

Abstract
Based on 83 quantitative samples collected between 2009 and 2012 within 20 - 65 m depth, the paper presents the structure of macrobenthic populations inhabiting the soft bottom mussel community from the Romanian Black Sea continental shelf. A total of 140 taxa were recorded, revealing that the community hold various species, annelids being the dominant group (80%) followed by mollusks. This baseline study of the shallow and deeper sedimentary habitats of the mussels bed will be used for the future MPA designation and for the implementation of projects regarding the wind farms settling in offshore area.

Keywords: Biodiversity, Zoobenthos, Black Sea

Introduction. The *Mytilus galloprovincialis* represents a mollusk mass species in shallow (rocky mussels') and in deep waters on the soft bottom. The typical deep mussel bed ranges between 30 - 50 m depth. However, it can occupy an area between 20 - 70 m depth. The total surface of mussels` community in front of the Romanian coast is about 7000 km$^2$, being the second largest community after those of *Modiolula* [1]. During eutrophication period (`70s-`90s) this community suffered major changes in terms of number of species and abundances of dominant species decreasing. This study, based on the results of researches performed in the last 5 years, comes to complete some gaps in the specialty literature concerning spatial distribution of mussel bed on the Romanian Black Sea shelf.

Material and Method. During several national and international cruises carried out in 2009, 2010, 2011 and 2012, 83 quantitative benthos samples were collected between 20 - 65 m depths using a Van Veen-type grab (0.14 m^{-2}), on board R/V „Mare Nigrum". The samples were washed using 1.0 and 0.5 mm sieves. The biomass of bivalves was weighted as wet visceral tissues.

Results and Discussion. A total of 140 taxa belonging to 21 systematic groups were found in the assemblages (Annelida - 36, Mollusca - 38, Crustacea - 26, others - 40). The mean abundance of the macrobenthic populations was 5,076 indv.m^{-2} and 85.4 g.m^{-2} as biomass. Polychaeta had the highest number of species (35) and individuals (Davg-3,200 ind.m^{-2}). The maximum biodiversity (128 species) occurred in the central part of mussels bed (Fig.1).

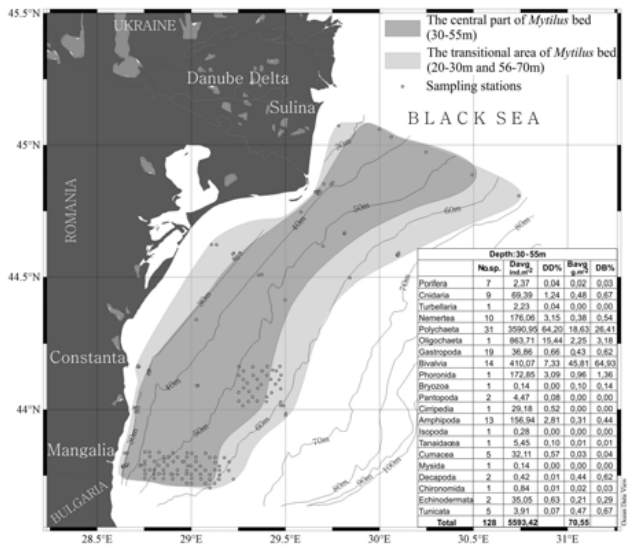

Fig. 1. Distribution of *Mytilus galloprovincialis* community and associated macrofauna along Romanian Black Sea shelf

According to the ecological indices the characteristic species throughout mussel community are: *Heteromastus filiformis* (F%-82), *Nephtys hombergii* (F%-81) and *Prionospio multibranchiata* (F%-52), *Phoronis euxinicola* (F% - 56) and oligochaets (F%-82). In the first 10 ranked species, only 2 crustacean species: *Phtisica marina* (F%-40) and *Iphinoe elisae* (F%-48) were found. The analysis of species distribution on geographic sectors indicated a clear demarcation between the northern sector (under the Danube influence) and the southern one. *Dipolydora quadrilobata* (DD%-21), with maximum densities of 15,000 ind.m^{-2} at 36 m on the Sulina transect, and *Melinna palmata* (DD%-19) with maximum densities of 8,300 ind.m^{-2} at 27 m on the Sf.Gheorghe transect are the species that form a new association in the northern area. The *D. quadrilobata*, recently introduced in the Black Sea (in 2000's), registered greatest development, living on various types of sedimentary substrata [2]. In the southern part, the polichaet *Aricidea claudiae* (max. 2700 ind.m^{-2}) is the characteristic species for the transition interval between littoral coenosis and the typical *Mytilus* one. The constant bivalvia species within the mussel beds are *Abra alba* (F% - 57) and *A. prismatica* (F% - 55). *M. galloprovincialis* as a weight dominant species has a patch distribution with average abundance of 56 ind.m^{-2} and 14 g.m^{-2} w.wt. In the northern part (Sulina - Cape Midia) the mussel is the third species as weight dominance after Mya *arenaria* (31 g.m^{-2} w.wt.) and *M.palmata* (15 g.m^{-2}), the latter forming a distinct association within the mussels` community. Analysis of the *Mytilus* community on bathymetric intervals reveals the importance of this coenotic unity as a biodiversity reservoir. The spatial distribution of the *Mytilus* presents 2 transition zones (20-30 m and 56-70 m), one situated at the limit with the littoral communities and the other with the deep ones, with the true mussels' community (30-55 m) in between (Fig. 1). Thus, within 20-30 m (77 species) the annelids dominate as density (*M.palmata*, oligochaeta, *H.filiformis*), while *M. arenaria*, as biomass, followed by *M.palmata* and *N.hombergii*. The most frequent crustaceans in this area are *I.elisae* (F%-50), *Perioculodes longimanus* (F%-45.5), *Ampelisca sarsi* (F%-40.9) and *Medicorophium runcicorne* (F%-36.4). The stripe between 56-70 m (52 species), marks the transition toward the *Modiolula phaseolina* community, resulting in a qualitative and quantitative impoverishing of macrobenthic populations. Here, the conductor species *M.phaseolina*, dominate numerically and as weight followed by oligochaets and *H.filiformis* (as density), *Mytilus* and *Terebellides stroemi* (as biomass). Only 6 crustacean species dominated in this area: *Eudorella truncatula*, *Stenosoma capito*, *Ph.marina*, *Microdeutopus versiculatus*, *Apherusa bispinosa* and *A.sarsi* (F%-37.5). The most constant at this depth are *Leptosynapta inhaerens* (F%-100) and *Amphiura stepanovi* (F%-87.5). In the central part of the *Mytilus* beds, between 30-55 m depth, numerical dominant are *D.quadrilobata* and *M.palmata*, while the oligochaets' contribution decreased. The mussels and *M. arenaria* reached 54% of total biomass, followed by *N.hombergii* and *M.palmata*. Along with the already mentioned crustacean species, other species like: *Actinothoe clavata*, *Obelia longissima*, *Micrura fasciolata*, *Eumida sanguinea*, *Exogone naidina*, *Oriopsis armandi*, *Phyllodoce mucosa*, *Pusillina lineolata*, *Megamphopus cornutus*, *Synchelidium maculatum and Apseudopsis ostroumovi* are the main cocoenotic species.

Acknowledgement. The author would like to thank the European Commission for their support as part of the FP7 program, CoCoNet, PERSEUS projects and DGEnv Program - MISIS project.

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MODELLING SPATIAL DISTRIBUTION OF THE ENDANGERED BIVALVE *PINNA NOBILIS* IN A MARINE PROTECTED AREA

Maite Vázquez-Luis [1]*, David March [2], Elvira Alvarez [3] and Salud Deudero [1]
[1] Instituto Español de Oceanografía Centre Oceanogràfic de les Balears - maite.vazquez@ba.ieo.es
[2] Instituto Mediterráneo de Estudios Avanzados, IMEDEA (UIB-CSIC)
[3] Govern de les Illes Balears. Direcció General de Medi Rural i Marí

Abstract
Pinna nobilis spatial distribution and densities have been analysed through a geostatiscal approach in Cabrera National Park. Model results indicate that benthic habitats play a key role in the spatial distribution of *P. nobilis*, with higher densities in seagrass meadows of *Posidonia oceanica*. The predict map shows some hotspots of density and provide valuable information for the spatial conservation management of this species.

Keywords: Bivalves, Balearic Islands, Coastal models, Density, Mapping

Introduction
Pinna nobilis is a Mediterranean endemic bivalve under strict protection [1]. Population of *P. nobilis* has been greatly reduced during the last decades [2] as a result of anthropogenic activities. MPAs can guarantee protection to this species. Knowledge on essential habitats and spatial distribution for this species is therefore fundamental to promote proper management strategies. Therefore, the aims of the present study are (i) to study density of *P. nobilis* across different habitats in the MPA, and (ii) create a spatial distribution model of *P. nobilis* densities within the MPA Cabrera National Park.

Materials and methods
The study was carried out at the marine protected area (MPA) of Cabrera National Park in the Balearic Islands (W Mediterranean), protected since 1991. A total of 378 visual census were conducted by scuba diving in line transects to survey *P. nobilis* density in all habitats at depths ranging from 4.2 to 50 meters. A total of 1456 *P. nobilis* individuals were censed. The field survey was carried out at the end of July 2011 and July 2012. We used regression kriging (RK) to predict the spatial distribution of *P. nobilis* densities within the MPA. This approach combines the results of a generalized linear model (GLM) with an autocorrelation map of the residuals calculated with ordinary kriging. The GLM was calculated using different environmental variables (ie., depth, slope, habitat, wave exposure and zoning protection) as explanatory variables and using the AIC criterion for model section.

Results and Discussion
P. nobilis maximum densities were found in *P. oceanica* meadows reaching values up to 37.3 ind/100m^2 in a no-take MPA sheltered site (Santa Maria bay at 8 m depth) (Fig. 1). The prediction map showed that the species is present in the whole MPA up to 50 meters depth, and highlights the presence of some hotspots within the MPA (Fig. 2). A map of the spatial distribution of *P. nobilis*, accompanied with knowledge of its population ecology, provides useful information for the management and monitoring of this endangered species in the MPA.

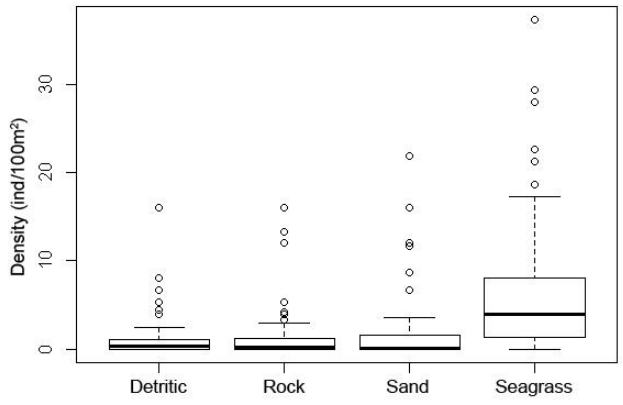

Fig. 1. Box plot of *P. nobilis* density (ind/100m^2) in Cabrera National Park for the different studied habitats. Whiskers: standard error; dots: outliers.

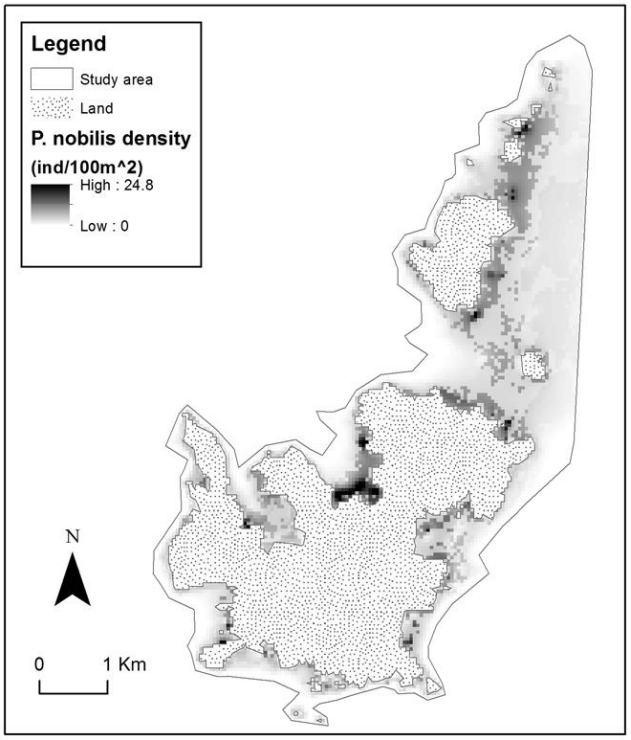

Fig. 2. Prediction map of *P. nobilis* densities within Cabrera National Park MPA.

Acknowledgements: This work was supported by research Project (024/2010), "Organismo Autónomo de Parques Nacionales, Ministerio de Medio Ambiente y Medio Rural y Marino".

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FEUILLE DE ROUTE POUR AMÉLIORER D'ICI 2020 LE RÉSEAU D'AIRES MARINES PROTÉGÉES EN MÉDITERRANÉE

Marie Romani [1] and Chloë Webster [1]*
[1] Mediterranean Protected Areas Network (MedPAN) - chloe.webster@medpan.org

Abstract
MedPAN, en collaboration avec le CAR/ASP, a développé une base de données des AMP en Méditerranée sur la base d'enquêtes auprès des gestionnaires des sites. Ainsi, une analyse de la distribution géographique des AMP, de leur représentativité, de leur connectivité et de leur niveau de gestion a été menée en 2012 pour identifier les points clés à améliorer au sein du réseau d'AMP dans les années à venir. Ces recommandations ont été détaillées sous forme d'une feuille de route d'ici 2020 élaborée lors du Forum des AMP de Méditerranée qui a rassemblé plus de 300 participants d'une trentaine de pays (scientifiques, gestionnaires, décideurs nationaux et méditerranéens, secteur privé, société civile…).

Keywords: Marine parks, North-Eastern Mediterranean, North-Western Mediterranean, South-Eastern Mediterranean, South-Western Mediterranean

L'inventaire des Aires Marines Protégées (AMP) méditerranéennes, dans la base de données MAPAMED développée par MedPAN et le CAR/ASP, a permis de recenser et de géolocaliser 677 AMP.

Fig. 1. Carte des AMP en Méditerranée

Parmi ces AMP, figurent 161 AMP de statut national, 9 AMP de statut uniquement international et 507 sites Natura 2000 marins. De plus, 55 AMP sont en projet. Ces AMP couvrent une surface totale de près de 114 600 km², soit environ 4,56% de la Méditerranée et 1,08% si l'on exclut le Sanctuaire Pelagos (87 500 km²). 96% des AMP sont localisées dans le Nord du bassin. Les AMP sont essentiellement côtières. Le « bassin algéro-provençal» et la « mer Tyrrhénienne » sont les écorégions les mieux représentées. L'analyse montre que les étages infralittoral et circalittoral sont les mieux représentés dans le système d'AMP qui par ailleurs n'est que très faiblement représentatif des habitats benthiques profonds. *Pinna nobilis, Posidonia oceanica, Tursiops truncatus, Caretta caretta* et *Epinephelus marginatus* sont les espèces les plus fréquemment mentionnées par les gestionnaires d'AMP comme présente dans leur site. La diversité de taille des AMP est grande, la plus petite couvre 0,003 km² et la plus grande (sans compter le sanctuaire Pelagos) couvre environ 4 000 km². 66% des AMP font moins de 50 km². Plus de la moitié des AMP ont plus de 10 ans. L'analyse a ensuite porté sur un panel de 80 AMP. Si plus de 90% des AMP de statut national ont un gestionnaire, 75% des sites Natura 2000 n'en ont pas et 56% d'AMP n'ont toujours pas de plan de gestion. En revanche 70% des AMP ont des états de référence écologique et 80% mènent des suivis réguliers. 84% des AMP indiquent avoir du personnel permanent. Si un quart des AMP a déclaré avoir du personnel assermenté, la plupart d'entre elles s'appuient pour la surveillance sur d'autres partenaires. La part d'autofinancement concerne 36% des AMP.

Lors du Forum organisé à Antalya (Turquie, 25-28 novembre 2012), les acteurs clés des AMP en Méditerranée ont analysé la situation des AMP méditerranéennes et ont identifié les actions nécessaires afin d'établir un réseau écologique d'AMP qui soit efficacement et durablement géré. Ils ont élaboré une feuille de route appelant à une action urgente et visant à atteindre, d'ici 2020, les objectifs établis dans le cadre des engagements internationaux. La vision commune adoptée par l'ensemble des participants est la suivante :
« Mettre en place en Méditerranée, d'ici 2020, un réseau d'aires marines protégées connectées, écologiquement représentatif, géré et suivi de manière efficace, pour assurer la conservation à long terme des éléments clés de la biodiversité marine et soutenir le développement durable de la région de manière significative. » 4 objectifs stratégiques ont été définis ainsi que des actions à mener au niveau local, national et méditerranéen :

1- Mettre en place un réseau écologique d'AMP représentatif et connecté
- les écosystèmes marins sous-représentés identifiés (dans les aires au-delà des juridictions nationales)
- améliorer la qualité et la couverture spatiale des inventaires et des suivis écologiques et des usages
- Une méthodologie devra clarifier à l'échelle régionale la définition de la connectivité, et de la représentativité
- maintenir des bases de données d'AMP nationales et régionales

2- Instaurer une gestion effective, efficace et durable ainsi qu'une bonne gouvernance dans les AMP
- Les systèmes de gestion (y compris les réserves de pêche), devraient être évalués
- une simplification des cadres institutionnels appliqués aux AMP et application des règlementations
- Les AMP de Méditerranée devront mettre en œuvre et actualiser des plans de gestion et d'affaires
- des programmes de sensibilisation, d'échange d'expérience et de renforcement des capacités

3- Développer une gouvernance des AMP Méditerranéenne qui soit intégrée sur le plan territorial et avec les autres secteurs tout en favorisant le partage des bénéfices environnementaux et socio-économiques
- meilleure intégration de l'AMP dans le territoire adjacent
- synergies avec d'autres secteurs (pêche, gestion des bassins versants, surveillance en mer, tourisme, …)
- valoriser les bénéfices pour les communautés locales
- Les approches de l'économie des écosystèmes et de la biodiversité (TEEB) doivent être développées
- tester des politiques « vertes » et des démarches d'« économie bleue »

4- Renforcer les ressources financières pour pérenniser le réseau d'AMP
- l'analyse des besoins financiers des AMP et l'évaluation des systèmes de financement
- renforcer les cadres institutionnels pour améliorer le financement des AMP
- De nouveaux mécanismes de financement durables devront être identifiés et testés

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Session

Physiology

Modérateur : **Nawzet Bouriga**

COMPOSITION EN OLIGO-ÉLÉMENTS ET ACIDES GRAS D'*HOLOTHURIA POLII* ET *HOLOTHURIA TUBULOSA* DES CÔTES TUNISIENNES

Hanen Ben Ismail [1]*, Jamila Ben Souissi [2], Salsabil Dridi [1] and Sami Fattouch [3]
[1] Institut National Agronomique de Tunisie (INAT), 43 Avenue Charles Nicolle, 1082 cité Mahrajène, Tunis, Tunisie - benismailhanen@yahoo.fr
[2] Laboratoire de Biodiversité, Biotechnologie et Changements climatiques, Faculté des Sciences de Tunis, Université Tunis El Manar, Tunis Tunisie
[3] Institut National des Sciences Appliquées et de Technologie (INSAT). Rue de la Terre, Centre Urbain Nord, BP676, 1080 Tunis Cedex. Tunisie.

Abstract
Dans le but de valoriser et diversifier les bio ressources exploitables des côtes tunisiennes, 2 espèces d'Holothuries *H. tubulosa* et *H. polii* récoltées dans les franges littorales de Bizerte, Nabeul et au golfe de Tunis ont servi à l'étude de la composition physico-chimique de ces échinodermes. Leur teneur en oligo-éléments a montré respectivement une quantité appréciable en oligo-éléments notamment le calcium. Quant à leur composition en acides gras, et bien que ces espèces ont présenté des teneurs faibles en lipides, elles présentent toutefois un intérêt nutritionnel non négligeable vu leurs teneurs intéressantes en oméga 3.

Keywords: Analytical methods, Calcium, Echinodermata, Tunisian Plateau

Introduction Face aux multiples menaces auxquelles font face les bio-ressources marines comme la surpêche, la pollution, l'érosion de la diversité biologique et le changement global, la valorisation et l'exploitation rationnelle de nouvelles ressources s'imposent. Ainsi, les campagnes de prospections réalisées suggèrent que les rendements horaires de rejets benthiques de la région septentrionale de la Tunisie comprennent jusqu'à 3,3 kg d'échinodermes, principalement des holothuries. Malgré cette richesse, et vu le peu de travaux traitant la qualité nutritionnelle de ces produits de rebus [1] nous nous sommes intéressé dans ce travail à l'analyse des teneurs en oligo-éléments et en acides gras essentiels. **Matériel et méthodes** Les Holothuries étudiées proviennent des régions côtières de Nabeul, Bizerte et du golfe de Tunis. Trois cent individus ont été prélevés vivants par plongée à une profondeur d'environ 7 mètres durant la période allant de septembre 2010 jusqu'à août 2011. Après identification [2] et [3], les Holothuries ont été éviscérées, puis les spécimens conservés à –20°C jusqu'à leur étude. Chaque analyse a été répétée trois fois. Le dosage des protéines a été réalisé selon la norme ISO 937 [4]. Le dosage des cendres a été réalisé selon la norme NFV04-404 [5] par incinération à 550°C. La matière sèche [6] a été déterminée à 103°C ± 2°C. Le dosage des minéraux a été effectué selon la norme NT 76.30. [7] par spectrophotométrie d'absorption atomique. L'extraction des lipides totaux a été réalisée selon la méthode de Bligh et Dyer [8] et l'analyse des acides gras par chromatographie en phase gazeuse (CPG). **Résultats et discussion** L'étude taxonomique a permis de montrer que les 300 individus récoltés appartiennent aux espèces *H. tubulosa (*20%) et *H. polii* (80%). Toutes les analyses statistiques ont montré une différence significative quant à la composition physico-chimique de ces deux espèces d'holothuries ($p<0,005$). En effet, elles sont riches en eau et présentent les teneurs respectives de 89,12±1,07 et 83,87±1,05%. Concernant les teneurs respectives en protéines elles correspondent à 10,56±0,54 et 9,1±0,37 g/100 g. Les teneurs en minéraux ont montré que le calcium est l'élément dominant (91,02±2,25 pour *H. polii* et 85,63±0,9 mg/100 g pour *H. tubulosa)* (tableau 1). En plus, elles présentent des teneurs très intéressantes en cuivre, fer et en zinc.

Tab. 1. Composition en minéraux de *H. polii et H. tubulosa* (mg/100 g).

	P	K	Na	Ca	Mg	Cu	Zn	Fe
Holothuria polii	112,87 ±0,23	224,70 ±0,53	47,44 ±0,62	91,28 ±0,25	32,39 ±0,54	38,98 ±0,2	36,37 ±0,6	6,66 ±0,1
Holothuria tubulosa	101,59 ±0,53	202,08 ±0,48	34,32 ±0,3	85,63 ±0,9	18,39 ±0,42	25,60 ±0,3	19,59 ±0,5	6,20 ±0,1

L'analyse des acides gras montre une richesse en AG saturés avec des pourcentages de 32,34% et 42,11% contre 14,49% et 23,29% pour les AG poly insaturés respectivement chez *H. tubulosa* et chez *H. polii* avec une prédominance de l'oméga 3 (figure1).

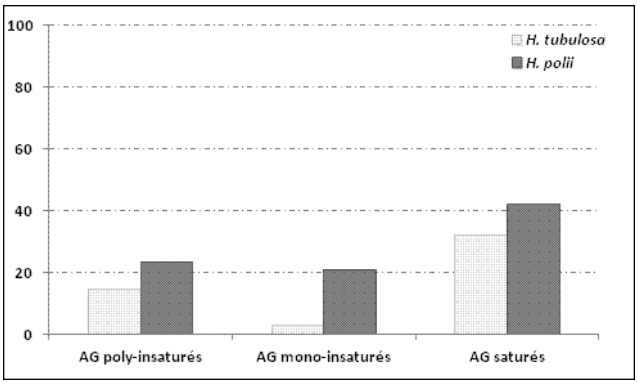

Fig. 1. Composition en acides gras (%) de *H. polii et H. tubulosa*

Conclusion : La caractérisation physico-chimique a révélé qu'*H. polii* et *H. tubulosa* sont riches en éléments minéraux caractéristiques en particulier le calcium et enacides gras intéressants en particulier l'oméga 3 à des teneurs appréciables. Malgré cette richesse nutritionnelle, les holothuries restent toutefois, jusqu'à nos jours, en Tunisie, comme des rejets benthiques non valorisés.

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ETUDE BIOCHIMIQUE COMPARÉE DE TROIS ESPÈCES DE SPARIDÉS DU GENRE *DIPLODUS* (D. *ANNULARIS*, D. *VULGARIS* ET D. *PUNTAZZO*) DU GOLFE DE TUNIS.

N. Bouriga [1]*, H. Ben Jemaa [1], S. Ghouaiel [1], E. Faure [2], J. Quignard [3] and M. Trabelsi [1]

[1] Université de Tunis El-Manar, Faculté des Sciences de Tunis, Unité de Biologie Marine, 2092 Campus Universitaire, Tunisie - hanounawsset@live.fr

[2] LATP, CNRS-UMR 6632, Evolution biologique et modélisation, case 5, Université de Provence, Place Victor Hugo, 1331 Marseille cedex 3 France.

[3] Laboratoire d'Icthyologie, Université Montpellier II, place Eugène Bataillon, case 102, 34095 Montpellier cedex 5 France.

Abstract

Le présent travail a pour but de caractériser, par l'approche biochimique trois espèces de sparidés (*Diplodus annularis, Diplodus vulgaris et Diplodus puntazzo*) provenant du Golfe de Tunis. Les résultats ont montré que la teneur en matière grasse de la chair de ces trois espèces de sparidés varie de 2,25±0,6329 *à* 2,6994±0,4115 g/100g matière fraîche (MF). Les différences entre les taux de lipides de ces 3 espèces restent non significatives ($p<0.001$). Les résultats ont montré aussi que ces poissons sont riches en acides gras polyinsaturés essentiellement pour *Diplodus annularis et Diplodus vulgaris*, avec 44.42 % et 39.37 % d'AGPI de la famille des ω3. Cette étude a permis d'affirmer qu'il ya un rapprochement dans les profils lipidiques *de Diplodus annularis et Diplodus vulgaris* par rapport au profil de *Diplodus puntazzo.*

Keywords: Fishes, Chemical analysis, Fisheries, Tunisian Plateau

Introduction

En Tunisie,la famille des Sparidés est considéréé parmi les ressources halieutiques qui présentent un potentiel économique considérable. Parmi les représentants de cette famille, on cite les espèces du genre *Diplodus* comme *Diplodus annularis*, *Diplodus vulgaris* et *Diplodus puntazzo* dont peu d'études ont ciblé leur composition lipidique.

Matériel et Méthodes

L'extraction des lipides a été réalisée selon la méthode de Folch *et al.,* (1957) modifiée par Bligh et Dyer (1959). La méthylation des acides gras a été effectuée selon la méthode de Cecchi *et al.,* (1985). les esters méthylique sont séparés par chromatographie en phase gazuse.

Résultats et Discussion

Dans la présente étude les trois lots de sparidés ont été échantillonnés à partir de même site (Golfe de Tunis) et à des dates qui sont hors de leurs périodes de reproduction. Les résultats montrent que la teneur en matière grasse des chairs de ces trois espèces de sparidés varie de 2,25±0,6329 chez *Diplodus puntazzo* (DP) à 2,6994±0,4115 exprimés en g/100g matière fraîche (MF) chez *Diplodus vulgaris* (DV) (tableau1).

Tab. 1. Variation de la composition en lipides dans la chair

ESP	LS (cm)	PV (g)	QUT.LIP.100g CH g
DA	10,41± 1,762	32,15±8,28	2,49±0,5718
DV	13,41±0,374	51,055±5,52	2,6994±0,4115
DP	10,35±0,4375	37,28±3,27	2,25±0,6329

Ces teneurs sont caractéristiques des poissons semi-gras (entre 2 et 10%) qui accumulent leurs graisses dans le foie mais aussi dans leurs muscles et dans d'autres tissus tels que le tissu adipeux péri viscéral [1], elles sont relativement basses à cause de la saison de capture (hors de la période de reproduction). D'une manière générale, la composition biochimique des poissons varie essentiellement en fonction de l'espèce, la saison, la période de ponte et l'alimentation [2], [3], [4]. Selon les analyses effectuées par la chromatographie en phase gazeuse, une vingtaine d'acides gras ont été identifiés dans les lipides totaux de la chair des sparidés. Les compositions en acides gras de ces extraits lipidiques sont en accord avec les compositions présentées dans d'autres études sur d'autre espèce de poissons [5], [6]. Le profil lipidique des AG de ces trois espèces de sparidés, révèle que la fraction des AG saturés (A.G.S.) est la plus dominante chez *Diplodus puntazzo* avec des proportions de 47.54 ±0.68%. L'acide gras le plus dominant des AGT est l'acide palmitique (C16:0) avec des proportions élevées chez *Diplodus puntazzo* de 32.97 ±0.42 %, et de façon moins importante chez *Diplodus annularis* et *Diplodus vulgaris* (14.28 ±0.10% et 16.95 ±0.01 %). Cependant, les acides gras polyinsaturés AGPI présentent les taux les plus dominants chez *Diplodus vulgaris* (*DV*) et *Diplodus annularis* (*DA*). Le taux d'AGPI est évalué à environ 47.36 ±0.01 % et 52.11 ±0.10 respectivement pour les deux espèces, tandis que le taux le plus bas est de l'ordre de 23.14 ±0.68 % pour *Diplodus puntazzo* (*DP*). Ce sont essentiellement des AG de la famille des omega 3 et omega 6. Il s'agit de l'acide docosahexaénoïque DHA C22:6 n-3, l'acide éicosapentaénoïque EPA C20:5 n-3 et l'acide linoléique C18:2 n-6. Le taux de l'acide éicosapentaénoique EPA C20:5 n-3 des sparidés *DA* et *DV* sont les plus élevés par rapport aux taux de l'espèce *DP* (respectivement 14. 77 ±0.01 %, 11.22 ±0.02 % et 6.83±0.12). Pour l'acide docosahexaénoique (DHA) C 22:6 n-3, on remarque son abondance chez les deux populations de sparidés. Le taux le plus élevé est pour *DA* et *DV* 26.51 ±0.08 % et 26.23 ±0.14 %. Toutefois, pour *DP* la proportion ne dépasse pas les 7.48± 0.37%. Les teneurs d'EPA et de DHA sont dues essentiellement à leur abondance dans la chaîne alimentaire marine. Toutefois, le rapport EPA/DHA est considéré parmi les meilleurs critères d'évaluation de la qualité des AG. L'étude du rapport A.G.P.I.-ω3/A.G.P.I.-ω6 révèle une teneur supérieure chez les *Diplodus annularis* (7.40) et *Diplodus vulgaris* (6.09).

La forte teneur en A.G.P.I.-ω3 des *DA* et *DV* du large peut être expliquée par l'accumulation des acides gras de la famille des ω3 et /ou une tendance à l'utilisation des acides gras ω6.

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THE EFFECTS OF SEASON AND GENDER ON THE PROXIMATE AND FATTY ACID PROFILE OF MALE AND FEMALE WARTY CRAB (*ERIPHIA VERRUCOSA*) FROM BLACK SEA

Y. Ozogul [1]*, M. Aydin [2], M. Durmus [1], U. Karadurmus [2], M. Öz [1], I. Yuvka [1], Y. Uçar [1], D. Ayas [3], E. Kuley [1] and A. Kösger [1]

[1] Cukurova University Faculty of Fisheries - yozogul@cu.edu.tr
[2] Fatsa Faculty of Marine Science, Ordu
[3] Mersin University, Faculty of Fisheries

Abstract

The effects of the seasonal on the proximate and fatty acid compositions of male and female warty crab from Black Sea were investigated. Important differences were found in proximate and fatty acid compositions for all seasons and gender. There were variations in protein and water content of meat of female and male crabs ($p<0.05$). The results of fatty acid analyses showed that the dominant SFAs were palmitic acid (C16:0) and stearic acid (C18:0). MUFAs in all samples consisted of C16:1, C18:1*n*9, C18:1*n*7, C20:1, C22:1n9. EPA (C20:5*n*3) and DHA (C22:6*n*3) were the main PUFAs in crab meat. The results obtained from the study showed that male and female crab meat is an important fatty acid and protein source.

Keywords: Crustacea, Black Sea

Introduction

Seafood, including crustacean shellfish, is recommended for human diet due to their health-promoting characteristics [1]. In terms of the amount of fat and the proportions of saturated, monounsaturated, and polyunsaturated fat, shellfish provide a healthful diet for humans [2]. Especially, seafood lipids have rich EPA and DHA. These fatty acids have a variety of health benefits, including prevention of sudden cardiac death [3] and chemo preventive effects of cancer [4]. *Eriphia verrucosa*, also called the warty crab, is found in the Black Sea, Mediterranean Sea and eastern Atlantic Ocean from Brittany to Mauritania and the Azores. *E. verrucosa* lives among stones and seaweeds in shallow water along rocky coastlines up to a depth of 15 metres. It is reported to feed on bivalves, gastropods and hermit crabs, or on molluscs and polychaetes. In the Black Sea, *E. verrucosa* is the only native species, capable of breaking into the shells of the invasive snail *Rapana venosa*. The objective of this study was to determine the effects of season and gender on the fatty acid and proximate compositions of warty crab from the Black Sea.

Materials and methods

The crabs were collected as discard products from artisanal fishery (gillnets and trammel nets) and by scuba divers, located in the coast of the Central Black sea of Turkey every season during January and Decembers in 2011 and transported immediately to the laboratory. Claw and body meat were separated manually and analysed in triplicate in terms of fatty acid and proximate composition. Lipid content was measured by the method of Bligh & Dyer [5]. Ash and moisture contents were determined as described by AOAC [6] and protein was determined by the Kjeldahl procedure using a Buchi Digestion System, Model K-424 (BÜCHI Labortechnic AG, Flawil, Switzerland) and a Kjeltec Distillation Unit B-324 (BÜCHI Labortechnic AG). Percent protein was calculated as % Nx6.25. Methyl esters were prepared by transmethylation using 2 M KOH in methanol and *n*-hexane according to the method described by Ichihara et al [7] with minor modification; 10 mg of extracted oil were dissolved in 2 ml hexane, followed by 4 ml of 2 M methanolic KOH. The tube was then vortexed for 2 min at room temperature. After centrifugation at 4000 rpm for 10 min, the hexane layer was taken for GC analyses.

Gas chromatographic conditions

The fatty acid composition was analysed by a GC Clarus 500 with autosampler (Perkin–Elmer, USA) equipped with a flame ionization detector and a fused silica capillary SGE column (30m×0.32mm ID×0.25µm BP20 0.25 UM, USA). The oven temperature was 140ºC, held 5 min, rose to 200ºC at the rate 4ºC/min and held at 220ºC at 1ºC/min, while the injector and the detector temperatures were set at 220 and 280ºC, respectively. The sample size was 1µl and the carrier gas was controlled at 16ps. The split used was 1:50. Fatty acids were identified by comparing the retention times of FAME with the standard 37 component FAME mixture. Two replicate GC analyses were performed and the results were expressed in GC area % as mean values±standard deviation.

Results and discussion

The fat and fatty acid compositions of seafood can vary depending on species, diet, gender, location and season of capture [8,9]. Tsai et al. [10] reported that the total lipid concentrations of blue crab were significantly correlated in gender. Akbar et al. [11] found that the protein content of body meat and claw meat in swim crabs vary, and protein is slightly higher in the edible portion of male crabs than female crabs. In this research, the dominant SFAs were palmitic acid (C16:0) and stearic acid (C18:0). MUFAs in all samples consisted of C16:1, C18:1*n*9, C18:1*n*7, C20:1, C22:1*n*9. EPA (C20:5*n*3) and DHA (C22:6*n*3) were the main PUFAs in crab meat. The results obtained from the study showed that male and female crab meat is an important fatty acid and protein source.

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BODY SIZE-WEIGHT RELATIONSHIP, LIPID AND DEFATTED DRY SUBSTANCE CONTENT OF HEPATOPANCREAS IN SQUID *TODARODES SAGITATUS* FROM THE EASTERN MEDITERRANEAN

A. E. Kideys [1], E. Mutlu [1], G. Abolmasova [2], G. Shulman [2], T. Yuneva [2], A. Shchepkina [2] and I. Öztürk [1]*
[1] Middle East Technical University Institute of Marine Sciences - destan@ims.metu.edu.tr
[2] Institute of Biology for the Southern Seas

Abstract
Some biological characteristics of the European flying squid (*Todarodes sagittatus)* that could be a potential source for the Turkish fishery were studied in the area between off Finike and Rhodes Island, in the northern Levantine Basin of the Mediterranean Sea in October 2000. The study focused mainly on nutritional condition and basic morphological measurements of the squid. Maximum mantle length and wet weight were measured as 40 cm and 2 kg. Stomach content analysis showed that the squid fed on euphausiids, young squids and different species of myctophid fish.

Keywords: North-Eastern Mediterranean, Fisheries, Population Dynamics

Introduction
Despite the fact that the European flying squid (*Todarodes sagittatus*) is the most abundant squid in the Mediterranean, surprisingly, until this study it was never reported from the Turkish waters (1). The region between Rhodes Island and south-western coast of Turkey may become the possible places of squid fishery as this region is known to have good nutritive base due to cyclonic gyre and banks (2) Therefore, the data regarding the biology and morphology of this squid could be of off great importance from the fishery perspective.

Materials and methods
The squid *Todarodes sagittatus* was sampled from a total of eight stations on board the R/V Bilim in October 2000 during the cruise to the eastern Mediterranean. These stations were mainly located around Rhodes cyclonic gyre and also in close distance to the southwestern Anatolia (Off Finike, Turkey). Squids were attracted by light and caught by the "Jiger" mainly during nighttime at these stations. A total of 73 squids caught were weighted to the nearest gram and then their mantle lengths were measured. Determination of sex and stage of gonad development was individually performed for each squid. Additionally, stomachs and hepatopancreases were weighed and stomach-somatic index (SSI) and hepato-somatic index (HSI) were calculated. Subsamples of hepatopancreases were used for determining of dry weight, lipid and defatted dry weight content later at the laboratory (3).

Results
Most squids were caught at stations near to Finike. The maximal length of the squid mantle was about 40 cm weighing 2 kg. These parameters have sex differences: the most of females were bigger than males. Size-weight relations for all examined squids, males and females show a high correlation between length and weight (r^2=0.90-0.98). All individuals were immature males and females (second stage of maturity). There are also close relationships between body (mantle) size of all squids and hepatopancreas weight, their lipid and defatted dry matter content. Positive relationship between hepatopancreas dry weight (% per wet weight) from one side, lipid and defatted dry weight of this organ (%, per wet weight) from another are revealed. Stomach somatic (SSI) and hepato somatic (HIS) indexes were unrelated with size of squids. With two exceptions, the SSI did not exceed 2%; but HIS presented a higher variation with a mean of 2.87±0.88 and CV=35%. All animals fed well and residues of euphausiids, young squids of the same and another species, different species of myctophids etc were founded in stomach content.

Discussion
We did not observed these squids during the cruise all the way from Dardanelles to the Rhodes in the Aegean Sea. However, all stations located in the region between the south of Rhodes and Finike had *T. sagittatus*. According to number of squids caught by "Jigers" the most abundant region for squids in our cruise was the area off Finike, southwestern Turkey. The size and weight of animals in this region were higher than in neighbouring regions. Unfortunately we have no data to allow the estimation of the condition of squids in different regions and their relation with fodder base but further investigations may give positive results for such estimations. Lordan et al (4) found a length-weight relationship of $w = 1.5E\text{-}06L^{3.4721}$ for the same squid where w is wet weight in g and L is dorsal mantle length (mm). They also showed that stomach content of the squid contained 82.1% of fishes including Myctophids, 12.96% of Cephalopoda composed of squids including small specimens of *T. sagittatus*, 4.94% of Crustacea (euphausids). This show that despite the great distance in areas studied by Lordan et al. and us, the food composition are similar in both regions (i.e. northeastern Atlantic and eastern Mediterranean). Results from this preliminary study show that the European flying squid could have a significant potential for fishery and therefore, its stock characteristics need to be evaluated with further studies.

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ACCLIMATION OF *CHELON.LABROSUS* TO LOW SALINITY ALTERS ENERGY METABOLISM OF OSMOREGULATORY AND NONOSMOREGULATORY

Imèn Rabeh [1]*, Khaoula Telahigue [1], Tarek Hajji [2] and Raouf Besbes [3]
[1] Faculté des Sciences de Tunis - rabehimen@yahoo.fr
[2] Université de la Manouba, Institut supérieur de Biotechnologie de Sidi Thabet, Biotechpôle Sidi Thabet, 2020 Ariana, Tunisie.
[3] Institut National des Sciences et Technologies de la Mer (INSTM Centre de Monastir), BP 59, 5000 Monastir, Tunisie

Abstract
The impact of the acclimation to freshwater on the energy metabolism of gills, kidney, liver, and muscle was assessed in *Chelon labrosus*. We found that the exposure to low salinity during 30 days induces significant changes in the fatty acids profiles of all studied organs. However, we noticed that these variations depend on organs and fatty acid types. In the gill and the liver, saturated and monounsaturated fatty acids increased nevertheless polyunsaturated fatty acids remained invariable. Antagonist tendency were recorded in the kidney and the muscle.

Keywords: Aquaculture, South-Western Mediterranean

Introduction
Euryhaline fish shows several metabolic changes and mobilizes large amounts of energy to compensate environmental salinity changes [1]**.** The thick lipped grey mullet *Chelon labrosus* is euryhaline and eurytherme species that can live in environments of different salinities and temperatures: coastal waters, estuaries [2]. In Tunisia, this fish is commonly captured and consumed by the local population. According to [3], the thick lipped grey mullet (*Chelon labrosus*) is useful for semi intensive aquaculture.The purpose of the present study is to assess the impact of acclimation of *C.labrosus* to hypo-osmotic environments on the lipid metabolism of different tissues simultaneously.

Materials and methods
Immature thick lipped grey mullet (*Chelon labrosus*) (30–40g body mass) were provided by an experimental fish culturing centre (INSTM- Centre de Monastir- Tunisia) and transferred to the laboratory at the faculty of sciences of Tunis (El Manar- Tunis). They were acclimated during 30 days in freshwater (5 ppt). Total lipids were extracted with chloroform: methanol (2:1, v/v)) using the method of Folch [4]. Fatty acids were methylated according to the method of Cecchi [5]. Fatty acid methyl esters (FAMEs) were then analyzed by capillary gas chromatography. Data were analysed for significant difference of means, ANOVA, and inspected by Duncan test at level of $p < 0.05$.

Results and discussion
Results showed that low salinity induces the mobilization of lipids in the different studied organs. At fatty acid scale, a total of 29 fatty acids ranged from C14:0 to C22:6ω3 was identified. Results showed that qualitatively, the fatty acid composition were similar in gill, kidney, liver and muscle. However, we observed a differentiated mobilization of fatty acids groups across tissues. In fact, under hyposmotic stress, saturated fatty acids (SFAs) and monounsaturated fatty acid (MUFAs) increased nevertheless polyunsaturated fatty acids (PUFAs) remained invariable in the gill and the liver. In the kidney and the muscle, we noticed that PUFAs increase while the SFAs and MUFAs tend to decrease. *Chelon.labrosus* organs acclimated in freshwater were dominated by the fatty acids C16:0, C16:1, C18:0, C18:1, C18:2n-6, C22:6n-3 and C20: 5n-3. These fatty acids are typically the most quantitatively important fatty acids present in fish although there are slight differences in their order of abundance. The increase in saturated fatty acids (SFAs) and monounsaturated fatty acid (MUFAs) fatty acids in liver and gill could be related with their importance as energy source. Meanwhile the increase of PUFA in kidney and muscle transferred in freshwater particulary DHA and EPA may show that *C .labrosus* tended to mobilize these fatty acids to increase the fluidity of the membrane.

Tab. 1. Organs fatty acid composition (% total lipids) of *C. labrosus* during acclimation to freshwater (5‰) and after a period of 30 days at this salinity.

Fatty acids	Gill	Kidney	Muscle	liver
SFA	37.41± 0.37^a	25.34±0.12^b	30.68±0.37^c	38.83±0.10^a
MUFA	34.61± 0.14^a	26.97±0.57^b	18.93±0.36^c	35.52±0.24^a
PUFA	27.97± 0.29^a	47.65±0.53^b	50.13±0.38^c	25.61±0.28^a
C14 :0	7.05± 0.24^a	2.74±0.05^b	2.13±0.09^b	5.19±0.03^c
C15 :0	0.22± 0.04^a	0.05±0.01^b	0.29±0.08^c	0.66±0.02^d
C16 :0	25.19± 0.25^a	16.49±0.22^b	14.66±0.46^c	27.43±0.37^d
C17 :0	0.68± 0.02^a	0.39±0.01^b	0.52±0.06^c	0.66±0.02^a
C18 :0	3.80± 0.21^a	5.45±0.15^b	12.11±0.05^c	4.36±0.11^a
C20 :0	0.03± 0.01^a	0.02±0.00^a	0.22±0.01^b	0.02±0.01^c
C22 :0	0.44± 0.03^a	0.20±0.03^b	0.75±0.03^c	0.53±0.09^d
C15 :1	0.97± 0.06^a	0.45±0.01^b	0.34±0.03^c	0.80±0.02^d
C16 :1	9.56± 0.12^a	4.91±0.10^b	2.85±0.14^c	8.41±0.01^a
C18 :1	22.57± 0.24^a	19.32±0.45^b	12.75±0.59^c	26.23±0.26^d
C20 :1	1.48± 0.06^a	1.25±0.01^b	1.62±0.34^c	0.02±0.01^d
C22 :1	0.03± 0.00^a	1.05±0.03^b	1.37±0.07^c	0.06±0.01^d
C18 :2n-6	10.47± 0.22^a	10.83±0.23^a	7.56±0.11^b	10.90±0.12^a
C18 :3n-6	0.24± 0.01^a	0.32±0.02^b	0.23±0.02^a	0.17±0.01^c
C20 :2n-6	0.24± 0.05^a	2.68±0.03^b	0.65±0.01^c	0.33±0.01^d
C20 :3n-6	0.06± 0.01^a	0.25±0.04^b	0.90±0.08^c	0.05±0.02^a
C20 :4n-6	0.55± 0.02^a	1.55±0.03^b	2.16±0.10^c	0.70±0.02^a
C22 :5n-6	0.17± 0.03^a	3.46±0.19^b	2.41±0.51^c	0.50±0.05^d
C18 :3n-3	2.35± 0.10^a	0.30±0.01^b	3.56±0.39^c	1.99±0.03^d
C18 :4n-3	1.22± 0.05^a	2.05±0.04^b	1.30±0.08^a	0.73±0.01^d
C20 :3n-3	0.09± 0.01^a	0.25±0.04^b	0.54±0.05^c	0.10±0.01^a
C20 :4n-3	0.35± 0.02^a	0.57±0.05^b	0.98±0.07^c	0.32±0.01^a
C20 :5n-3	3.96± 0.14^a	7.38±0.12^b	8.23±0.20^b	2.96±0.07^c
C22 :5n-3	0.93± 0.14^a	3.76±0.20^b	3.20±0.03^c	1.10±0.38^a
C22 :6n-3	4.56± 0.03^a	10.53±0.45^b	14.54±0.18^c	3.93±0.24^a
C16 :2	1.22± 0.05^a	0.75±0.02^b	0.65±0.04^b	0.99±0.00^a
C16 :3	0.77± 0.07^a	0.73±0.05^b	0.49±0.06^c	0.27±0.01^c
C16 :4	0.57± 0.01^a	0.44±0.01^b	0.27±0.04^c	0.25±0.01^c
C21 :5	0.25± 0.04^a	1.80±0.37^b	2.46±0.37^c	0.32±0.01^d

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EFFETS DU SEXE ET DE LA SAISON SUR LA COMPOSITION EN ACIDES GRAS CHEZ *SEPIA OFFICINALIS* DE LA CÔTE NORD DE TUNIS (RADÈS)

M. Tir [1], I. Rabeh [1]*, K. Telahigue [1], T. Hajji [1], I. Chetoui [1] and M. Elcafsi [1]
[1] Unité de Recherche : Physiologie et Ecophysiologie des Organismes Aquatiques, Faculté des Sciences de Tunis,Université Tunis El Manar, 2092 Tunis, Tunisie. - rabehimen@yahoo.fr

Abstract
Dans le présent travail, nous avons étudié la variation saisonnière de la composition en acides gras de la seiche commune *Sepia officinalis* appartenant à la famille des Sepiidae et qui fréquente les côtes tunisiennes. Les analyses des acides gras totaux nous ont permis d'identifier pour les deux sexes et durant les quatre saisons, des acides gras saturés, monoinsaturés et polyinsaturés qui varient respectivement entre35,6- 56,68%, 9,03-13,29% et 33,1-54,5%.Les concentrations des acides gras polyinsaturés sont significativement élevées en automne par rapport a l'été, le cas contraire est observé pour les acides saturés.

Keywords: Cephalopods, Gulf of Tunis

Introduction
Les produits de la mer jouent un rôle important dans la nutrition humaine. La baisse enregistrée dans les ressources mondiales halieutiques a favorisé le recours aux céphalopodes ; consommés principalement dans les pays méditerranéens et asiatiques vue leur abondance dans ces régions [1]. En Tunisie, la production des céphalopodes est destinée en grande partie à l'exportation avec 9800 Tonnes en 2011 (65 % de la production est représentée par la seiche commune *Sepia officinalis*) [2]. Comme les autres produits de mer, la qualité nutritionnelle des seiches varie selon les caractéristiques du milieu environnant. Ces dernières présentent des fluctuations saisonnières qui sont à l'origine des changements dans la composition biochimique des organismes marins. Dans ce contexte, nous nous sommes intéressés à l'étude de la qualité lipidique de *Sepia officinalis* en fonction des saisons afin de déterminer la période optimale de consommation et de prélèvement pour une meilleure conservation.

Matériel et méthodes
Les analyses ont été effectuées sur des spécimens récoltés par prise côtière artisanale, avec 12 échantillons (6 mâles et 6 femelles) durant chaque saison. Les lipides totaux ont été extraits par un mélange de solvants chloroforme méthanol (2/1) selon la méthode de Folch et al. [3], après méthylation, les esters méthyliques ont été analysés par chromatographie en phase gazeuse (HP 6890). Pour les analyses statistiques nous avons utilisé un logiciel : Statistica 6.0 (ANOVA- MANOVA).

Résultats et discussion
L'analyse statistique de la teneur en lipides totaux révèle que les variations saisonnières sont non significatives ($p<0,05$). L'analyse des acides gras révèlent que les pourcentages des AGS, des AGMI et des AGPI varient, respectivement, entre 34,7 - 56,7 %, 9,03 - 13,3 % et 33,1 - 54,5 %. Les AGS ont présenté des teneurs faibles en automne et en hiver. Cela est dû probablement au catabolisme de ces derniers afin de compenser l'énergie métabolique perdue. La teneur en AGPI contrairement à celle des AGS a présenté une élévation en automne et une baisse en été. En effet, Les variations saisonnières en AG sont dues à plusieurs facteurs ; la diminution de la température induit une diminution de la teneur en AGS et une augmentation de la teneur en AGPI pour assurer la fluidité de la membrane cellulaire [4] ; le régime alimentaire qui est basé principalement sur des poissons durant la migration vers les profondeurs en automneet le cycle reproducteur[5]. Les principaux acides gras révélèssont : l'acide palmitique (16:0), l'acide stéarique (18:0), l'acide eicosapentaénoïque (EPA 20:5n-3) et l'acide docosahexaénoïque (DHA 22:6n-3) avec des variations selon le sexe et particulièrement des teneurs plus élevées chez la femelle durant toutes les saisons.

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FATTY ACID COMPOSITION AND FLESH LIPID QUALITY OF THE FARMED SEA BREAM *SPARUS AURATA* IN TUNISIAN COASTS

Khaoula Telahigue [1]*, Imen Rabeh [1], Tarek Hajji [2] and M'hamed El Cafsi [1]
[1] Université Tunis EL Manar, Faculté des Sciences de Tunis, UR de Physiologie et Environnement Aquatique, 2092 Tunis, Tunisie. - k_telahigue@yahoo.fr
[2] Université de la Manouba, Institut supérieur de Biotechnologie de Sidi Thabet, Biotechpôle Sidi Thabet, 2020 Ariana, Tunisie.

Abstract
This study provide the assessment of the nutritional value of the fatty acids components and their health-related lipid indices in the fillet of the wild, the inshore and the offshore farmed sea bream *Sparus aurata* from Tunisian costs. The docosahexaenoic acid (DHA) content and the values of some indicators of the nutritional quality of lipids as the n-3/n-6 ratio, the thrombogenicity (TI) and the Atherogenicity (AI) indices show slightly higher nutritional value of farmed (mainly the inshore reared specimens) vs. wild gilthead.

Keywords: Aquaculture, Tunisian Plateau, Fishes, Physiology

Introduction
Fish constitute an excellent source of highly unsaturated fatty acids considered beneficial for human health [1]. In the Mediterranean countries, marine fish represent an important part of the diet. The gilthead sea bream (*Sparus aurata*) is among the most commonly farmed marine species in the Mediterranean Sea. This species is produced using a large variety of aquaculture facilities and techniques. This study seeks to establish a comparative analysis of the fatty acid profiles and flesh lipid quality in wild, inshore and offshore breeding of the fillet of the sea bream *S. aurata*.

Material and methods
Wild and farmed (N=60) sea bream *S. aurata* of average weight of 61.9 ± 2.5 g and total length of 15.6 ± 1.1 cm were analyzed. Wild specimens were picked up from a local market in Monastir region. The offshore farmed gilthead sea bream came from the intensive culture in floating cages from "The RESPUNA FISH" Company in Monastir and the inshore reared individuals were obtained from "The Station of Tunisian Aquaculture" located in Hergla (Sousse, Tunisia). Total lipids were extracted according to the method of Folch [2]. Lipid extracts were trans-esterified according to [3]. The fatty acid methyl esters were analyzed by capillary gas chromatography. Data was analyzed using the software R Version 2.1.2.1. according to the One Way Analysis of Variance method (ANOVA). Duncan test was applied and differences were considered significant when $p<0.05$.

Results and discussion
The fatty acid composition of the fillet of the wild, the offshore and the inshore farmed *S. aurata* are represented in table 1. Data revels that within the group of main fatty acids identified, the total content of saturated fatty acid (SFA), monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) was alike in the three studied groups ($p>0.05$). However, lipids of the inshore farmed *S. aurata* were characterized by slightly high percentage ($p>0.05$) of PUFAs with 46.28%. Within this fatty acid group, farmed specimens (mainly the inshore reared specimens) are characterized by a higher levels of n-3 series and mainly the DHA ($p<0.05$). Results revealed that farmed specimens exhibit a higher n-3/n-6 ratio as a consequence of their lower content of n-6 fatty acids. As to PUFA/SFA ratio, we noted that all studied *S. aurata* groups show similar values ranging from 1.4 to 1.8. The recorded values were much higher than the minimum recommended value of 0.45, which is considered as appropriate for human diet [4].Concerning the AI and the TI indices, we noted that all studied *S. aurata* groups show similar values ($p>0.05$). The low values of AI and the very low TI reveal a very interesting nutritional quality as well of reared gilthead as compared to the wild ones.

Tab. 1. Comparison of the fatty acids compositions (% of total fatty acids) and the lipid quality indices in the fillet of wild and reared *Sparus aurata* (n=6). SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids; DHA: Docosahexaenoic acid; EPA: Eicosapentaenoic acid, AI: Index of Atherogenicity; TI: Index of Thrombogenicity.

	Wild	Farmed	
		Offshore	Inshore
SFA	30.9±2.7	28.2±3.1	25.6±3.3
MUFA	26.2±1.4	29.4±1.1	28.1±2.7
PUFA	42.9±4.2	42.4±2.1	46.3±2.2
n-3	25.5±3.5	27.7±3.4	33.4±1.5
n-6	14.8±1.9	12.1±1.6	10.0±1.1
EPA	6.3±0.4	4.6±0.5	8.0±0.9
DHA	9.4±0.9	15.5±0.6	20.5±2.1
n-3/n-6	1.7±0.2	2.3±0.5	3.3±1.1
PUFA/SFA	1.4±0.1	1.5±0.3	1.8±0.8
AI	0.4±0.0	0.5±0.1	0.5±0.2
TI	0.3±0.1	0.2±0.1	0.2±0.0

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Session

Population dynamics

Modérateur : **Cemal Turan**

DISTRIBUTION AND POPULATION STRUCTURE OF NORWAY LOBSTER (*NEPHROPS NORVEGICUS* LINNAEUS, 1758) IN SAROS BAY (NORTH AEGEAN SEA, TURKEY)

Ali Ismen [1], Hasim Inceoglu [2], Mukadder Arslan [1]* and Cigdem C. Yigin [1]
[1] Çanakkale Onsekiz Mart University, Marine Science and Technology Faculty, Çanakkale, Turkey - mukadderarslan@gmail.com
[2] Republic of Turkey of Food, Agriculture and Livestock, General Directorate of Agriculture Research and Policy, Bandirma-Balikesir, Turkey.

Abstract
Distribution, length composition, CPUE (kg/h), biomass (kg/km^2) indices and growth parameters of *Nephrops norvegicus* from Saros Bay (North Aegean Sea) were determined. Monthly samples were collected (2554 specimens) by bottom trawl from the depth interval 20-500 m, in the period of June 2005-July 2008. Minimum carapace length 21 mm in females, 23 mm in males and maximum carapace length 59 mm in females, 72 mm in males were detected. The mean CPUE, biomass and catch rate were calculated 10.58 kg/h, 186.65 kg/km^2 and 3.8% respectively. Growth parameters estimated using the ELEFAN program as L_∞=81.9 mm (CL), K=0.07 year^{-1}. Length-weight relationship was determined W=0.0004*L$^{3.13}$

Keywords: Biomass, Saros Bay, Crustacea, Growth, Population Dynamics

Introduction
The Norway lobster, *Nephrops norvegicus* is one of the main target species of the commercial fisheries in the Mediterranean continental shelf and have been the subject of important biological and fishery studies [1], [2]. *Nephrops norvegicus* is a sedentary lobster which inhabits burrows constructed in muddy subtrates throughout the continental shelf of the north-eastern Atlantic and Mediterranean [2].

Material and 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 June 2005 to July 2008 at the range of 20-500 m depths, and there were 184 sampling station (Figure 1). Though, *Nephrops norvegicus* specimens were caught from the depth range of 200-500 m, trawl duration was restricted to 30 min and the vessel speed was kept constant at 2.5 knots during hauling. CPUE was calculated for 1 hour, biomass was estimated using the swept area method [3]. Total and carapace lengths were measured to the nearest 0.01 mm with a caliper. Total weight was measured to the nearest 0.01 g. Length – weight relationship were calculated W=0.0004*L$^{3.13}$.The length data were also used for the direct estimation of growth parameters, applying ELEFAN I [4] implemented by the FISAT package [5].

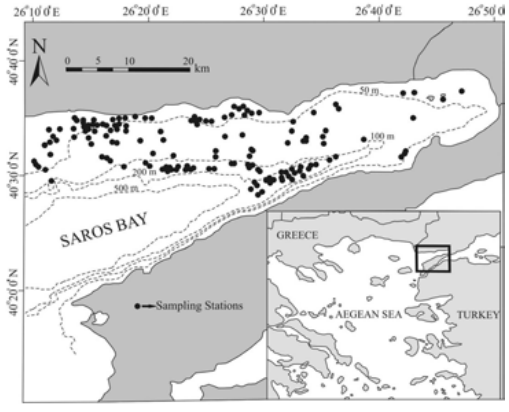

Fig. 1. Sampling stations of Norway lobster in the Saros Bay.

Result and Discussion
In this study, a total of 2554 Norway lobster were sampled. Minimum carapace length 21 mm in females, 23 mm in males and maximum carapace length 59 mm in females, 72 mm in males were determined. The mean CL of females were measured 38 (±0.18) mm and 42 (±0.26) mm for males. Significant differences in the mean carapace length and total length were identified between seasons ($p<0,05$). Von Bertalanffy growth parameters estimated using the ELEFAN program and calculated L_∞=81.9 mm (CL), K=0.07 year^{-1}. That was similar to the other studies [5]. The CPUE, biomass values and frequency of individuals were calculated in all seasons in Saros Bay (Table 1). The specimens were located only in the 200-500 m, and highly CPUE and biomass values between spring and summer period of the years. The reason for this might be the molting period of the Norway lobster which occur autumn and winter seasons of the year [6], and after the molting period the specimens were mostly caught. However, the highest values of abundance, both in number of individuals and in biomass, were located in the 200-500 m depth stratum in the N Aegean Sea [2].

Tab. 1. The seasonal CPUE (kg/h), biomass (kg/km^2) values, catch ratio (%) and female-male ratio of *Nephrops norvegicus* in Saros Bay.

Seasons	CPUE (kg/h)	Biomass (kg/km^2)	Catch rate (%)	F:M
Summer 2005	17.82	311.36	4.7	1:0.8
Autumn 2005	11.72	205.71	3.4	1:1.2
Winter 2006	6.70	117.89	3.1	1:1.6
Spring 2006	16.30	286.41	8.8	1:0.5
Summer 2006	12.35	222.00	4.1	1:1.7
Autumn 2006	4.79	84.08	1.9	1:0.9
Winter 2007	4.45	77.68	0.8	1:1.4
Spring 2007	24.68	433.22	7.9	1:0.8
Summer 2007	10.47	184.55	3.3	01:01
Autumn 2007	7.57	132.78	2.3	1:1.3
Winter 2008	5.57	97.75	1.3	1:0.7
Spring 2008	8.23	144.39	6.1	1:0.7
Summer 2008	6.97	128.75	1.2	1:0.5
MEAN	**10.58**	**186.65**	**3.8**	**1:0.9**

Acknowledgements
This study was financially supported by TUBITAK 106Y035 and COMU BAP PROJECT No: 2006/03.

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LA SÉLECTIVITÉ CHEZ *HOLOTHURIA POLI*

Nor-Eddine Belbachir [1]* and Karim Mezali [1]
[1] Université Abdel Hamid Ibn Badis de Mostaganem - belbachirnoreddine@hotmail.fr

Abstract
Une analyse granulométrique des sédiments ingérés par *H. poli* et de celui de son biotope, ont été réalisé. La sélectivité de cette espèce a été étudiée à travers l'indice d'électivité. Cette espèce sélectionne préférentiellement les fractions fines et très fines, ce qui démontre qu'elle reconnait les particules riches en matière organique.

Keywords: Echinodermata, Algerian Sea, Behaviour, Sediments

Introduction Les holothuries aspidochirotes joue un rôle important dans le "detritus food web" [1]. La sélectivité chez ces espèces, pourrait être un moyen de partition de la niche écologique et un moyen d'obtenir des aliments avec une grande valeur nutritionnelle.

Matériels et méthodes

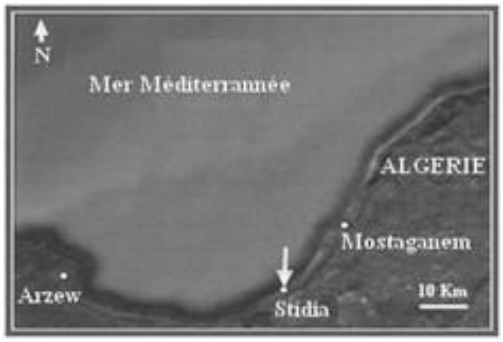

Fig. 1. Situation géographique du site étudié (petite flèche)

Vingt individus d'*H. poli* et le Sédiment du Biotope (SB) ont été prélevés à -3 m de profondeur. Le contenu digestif de chaque individu est isolé et le (%) des différentes fractions granulométriques est déterminé selon le protocole de [2]. La sélectivité dans le choix de la taille des grains, a été étudiée à travers le calcul de l'Indice d'électivité (*E'*) d'Ivlev [3].

Résultats et discussion
H. poli sélectionne préférentiellement la fraction fine (Fig. 2A). Toutefois, c'est la fraction très fine qui est la plus préférée, du moment qu'elle présente le plus haut indice d'électivité (Fig. 2B). Cela s'explique par le faite que les teneurs en matière organique augmentent avec les fractions fines. En effet, les holothuries ont le pouvoir de reconnaître et de sélectionner les particules sédimentaires les plus riches en matière organique [4]. On suppose que nos résultats cohérent avec le model du comportement alimentaire des déposivores marins; ce model cohére avec la théorie de l'"Optimal Foraging" [5].

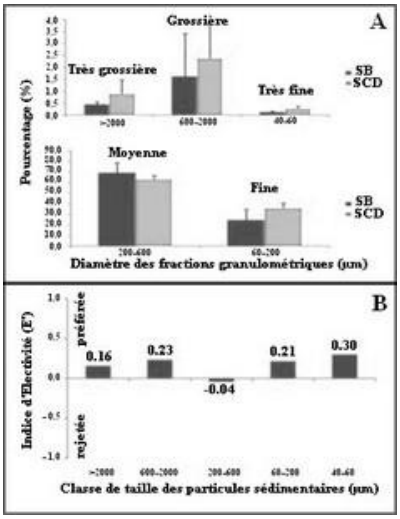

Fig. 2. % des fractions granulométriques du Sediment du Contenu Digestif (SCD) et de celui du biotope (SB) de *H. poli* **(A)**. Indice d'Electivité *E'* **(B)**

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A PRELIMINARY STUDY ON THE BIOLOGY OF THE ROUND SARDINELIA *SARDINELLA AURITA* VALENCIENNES, 1847 IN IZMIR BAY (CENTRAL AEGEAN SEA OF TURKEY)

B. Bayhan [1], M. Kaya [1], T. M. Sever [1], A. Kara [2], B. Taylan [1], O. Heral [1], H. Saygi [3] and M. A. Canyurt [3]*
[1] Ege University Faculty of Fisheries, Department of Hydrobiology, 35100 Izmir, TURKEY.
[2] Ege University Faculty of Fisheries, Department of Fish Capture and Processing Technology, 35100 Izmir, TURKEY.
[3] Ege University Faculty of Fisheries, Department of Aquaculture, 35100 Izmir, TURKEY. - m.ali.canyurt@ege.edu.tr

Abstract
This study describes the length and weight frequency distributions, condition factor and length-weight relationships of round sardinella *Sardinella aurita* Valenciennes, 1847 from Izmir Bay, Turkey. Fish samples were collected monthly (October 2010 - September 2011) during commercial fishing trials using gillnet from Izmir Bay. A total of 707 specimen of *S. aurita* were used for this study. Fish total lengths ranged from 12.1 to 27.1 cm The condition factors were calculated for seasonally with minimum and maximum values as 0.740 (Winter snd Spring) and 0.940 (Summer) for all individuals respectively.

Keywords: Population Dynamics, Aegean Sea, Izmir Bay, Pelagic

Material and Methods
Fish samples were collected monthly (October 2010 - September 2011) during commercial fishing trials using gillnet from Izmir Bay. A total of 707 specimen of *S. aurita* were used for this study [4]. The length–weight relationship was determined for males and females according to the equation $W = a L^b$, where W is total weight (g), L the total length (cm), The parameters a and b were calculated by functional regression, as was the coefficient of determination (r^2). The b value for each species was tested by t-test at the 0.05 significance level to verify that it was significantly different from the isometric growth (b=3). a the intercept and b the coefficient of the functional regression between W and L [3]. condition factor estimated by K=W *100/L3 [1].

Results and Discussion
Fish total lengths ranged from 12.1 to 27.1 cm (Fig. 1).

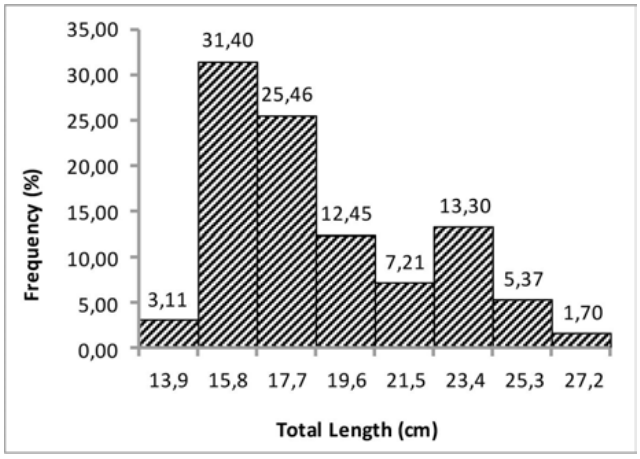

Fig. 1. Length frequency distribution of all individuals (female+male).

The parameters 'a' and 'b' of the length-weight relationships (LWRs) were calculated as $W=aL^b$ and LWRs for males, females and the total sample population determined to be $W=0.0056L^{3.126}$, $W=0.0069L^{3.063}$ and $W=0.0032L^{3.304}$ respectively. The values for allometric coefficient b of the length-weight relationships showed positive allometric growths in the both sexes. All allometric coefficients (b) estimated in this study were within the expected range 2.1-3.7, and according Benegal and Tesch [1978] allometric coefficients may range from 2 to 4. The condition factors were calculated for seasonally with minimum and maximum values as 0.740 (Winter snd Spring) and 0.940 (Summer) for all individuals respectively (Fig. 2).

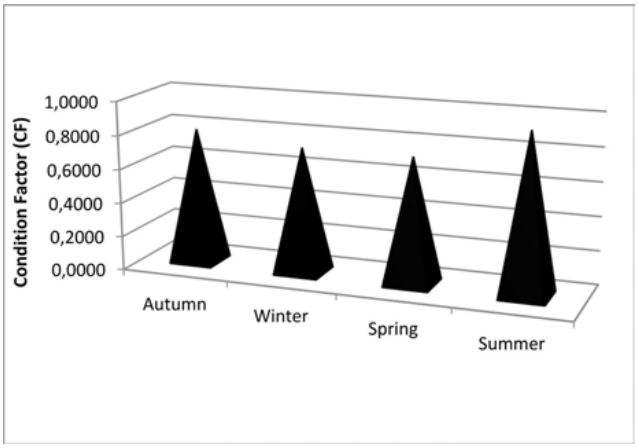

Fig. 2. Seasonal condition factor (CF) for *Sardinella aurita* from Izmir Bay.

Acknowledgment This research was supported by the Ege University, Scientific Research Project No. 2010/SUF/020.

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EXAMINATION OF IMPORT AND EXPORT AMOUNTS IN TURKEY'S FISHERIES PRODUCT WITH TIME SERIES

Hülya Saygi [1], Bahar Bayhan [2], Mehmet Ali Canyurt [1]* and Elif Çagri Tas [2]
[1] Ege University, Faculty of Fisheries, Department of Aquaculture, 35100 IZMIR, TURKEY - m.ali.canyurt@ege.edu.tr
[2] Ege University, Faculty of Fisheries, Department of Hydrobiology 35100 IZMIR, TURKEY

Abstract
In this study, import and export amounts in Turkey were examined with the help of the multiple linear regression model by using time series. For that purpose, the general production amount of Turkey's aquaculture was predicted by using the data of the Turkish Statistical Institute (TSI) between 2000-2011, with the help of import and export amounts of Turkey's aquaculture in the study. As a result of this study, a linear model was obtained, and according to the result of the variance analysis (F=2.852; p=0.079), the model was determined to be usable. Besides, it was determined that only 20.6% of the obtained model could be explained with these independent variables.

Keywords: Aquaculture, Fisheries, Fishes, Aegean Sea, Black Sea

Introduction
When we look at the recent import and export datum of fisheries in Turkey, we can see a fluxional course.

Time Series is called series which show the results ranged by time. The purpose of studying with time series is that the future values of the variables in the time series are predictable.

Time Series of Components, Time series are composed of five components; Seasonal fluctuations (M), Long Term Trend (T), Cyclical Fluctuations (K), Rassal Fluctuations (D).

The first three are called the systematic components of time series. Trend can be calculated in three ways: Easy, Moving averages, Regression analysis [1].

The main value is trend and the others are ratios whose averages are 100. Determination of trend The aim is to reveal the absolute value by eradicating the effects of seasonal, cyclical and rassal movements on series. The state of variance being constant in time, Trend is the most commonly used method in time series. Trend can be calculated in three ways: Easy, Moving averages, Regression analysis.

Material and Methods
The price datum and the amount of fisheries production, import and export between the years 1986 and 2011 obtained from TUIK were used [4]. Import and export datum were examined via time series analysis method. Model was found with the help of multiple linear regression models. The collected datum was evaluated by SPSS package.

Results
Import and export datum were used as the factors which affect the amount of production change according to years, in which case; Dependent Variable: Production (1000 tonnes) Independent Variables: Import (1000 tonnes), Export (1000 tonnes) (Fig.1.)[2,3].

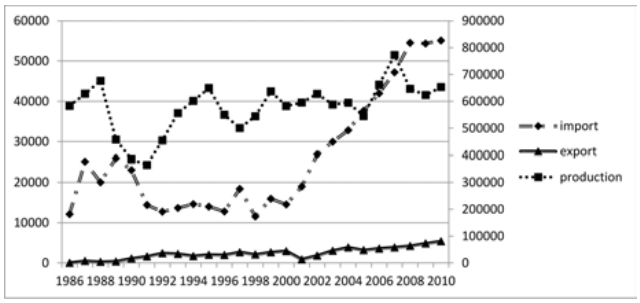

Fig. 1. Production, Import and Export.

The resulting regression equation;

Y = 2.8150 + 0.0011 (Import) + 0.0001 (Export) Independent variables in this model, but this is dealt with in 64.7 % percent explain. remaining 35.3 % other variables need to be disclosed (Tab. 1).

Tab. 1. Results of full model.

Variable	b	S(b)	Beta	VIF	t	p
Import	0,0011444	0,0001283	0,5624	1,5755	8,9232	0,000
Export	0,0001680	0,0000004	0,3280	1,5755	5,2051	0,000
Constant	2,8150000	0,3080000			9,1367	0,000
n=143		R^2=0,647		F=2.852		

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THE STATUS OF THE CATALAN STOCK OF ARISTEUS ANTENNATUS IN RECENT YEARS (2008-2010) COMPARED WITH TWENTY YEARS AGO (1984-1989)

Giulia Gorelli [1]*, Francesc Sardá [1] and Joan B. Company [1]
[1] Instituto de Ciencias de Mar - CSIC - gorelli@icm.csic.es

Abstract
The fishery of the red shrimp *Aristeus antennatus* is one of the main fisheries in the western Mediterranean. In this work we evaluated the status of the *A. antennatus* fishery in the Catalan region (NE Spain) in recent years, 2008-2010, and compared it with the last historical available data, 1984-1989. Fishing mortality and population biomass displayed high inter-annual variability. Population biomass values were higher for the recent period. Yield per recruit analysis showed a general overfishing pattern for both periods. In general inter-annual variability of estimates suggested the existence of non-fishery effects affecting the population dynamics of this species in the area.

Keywords: Fisheries, Decapoda, North-Western Mediterranean

Introduction
The red shrimp *Aristeus antennatus* is one of the main fisheries in the western Mediterranean, where this species is the main target of a deep-sea bottom trawling fleet. Its bathymetric distribution ranges from 100 to 3000 m depth. Ecology and biology of this species have been widely studied, except for the larval phase which is almost completely unknown [1], [2], [3]. In Catalonia it is fished at depths ranging from 400 to 900 m. Here, a great part of the fleets rely on this resource, which in some cases constitutes up to 50% of the income, as for the port of Palamós. Despite the economical importance of this resource in the area, fishery evaluations have not been conducted on regular basis. The last stock evaluation dates back to the period 1984-1989, when size structured data from the fishery were sampled and analyzed in Demestre and Lleonart, 1993 [4]. The aim of this study is to evaluate the status of the *A. antennatus* fishery in the Catalan region (NE Spain) in recent years, 2008-2010, and to compare the status of the stock at that time with the last historical available data, 1984-1989.

Materials and methods
We analyzed by means of a Length Cohort Analysis (LCA) and Yield per Recruit Analysis (Y/R) two series of fishery data (length frequencies in the catches and total catch weight) collected respectively during the two mentioned periods. The stock evaluation for the period 1984-1989 was conducted using length frequencies from Demestre, 1990 [5]. Length frequencies for the period 2008-2010 were obtained from a triennial monitoring data collection conducted by the Catalan regional Government. The statistical package VIT [6] was used to perform the analysis. The Von Bertalanffy growth parameters used in the analysis were taken from Sardá and Demestre, 1987 [7], while natural mortality estimates from Demestre and Martín, 1993 [8]. The parameters of the length weight relationship were obtained from Demestre, 1990 [5]. Annual catch data were supplied by the Catalan regional Government. Given the high sexual dimorphism of this species, the two sexes were analyzed separately.

Results
Mean length frequency distributions in the captures were similar for the two studied periods. Yearly population biomass values estimated by the LCA displayed high inter-annual variability, and were higher for the period 2008-2010 compared to the period 1984-1989 (Table 1). Estimations of the recruitment displayed high inter annual variability. Mean fishing mortality rates (mean F) showed inter annual variability, too, and displayed no trend between the two periods of study. The comparison of yearly mean F values with the corresponding $F_{0.1}$ reference point estimated by the Yield per Recruit analysis highlighted an overfishing pattern for each year of study. Yield per Recruit values showed a trend to slightly decrease among the two periods of study (Table 1).

Discussion
The biomass estimates obtained by LCA almost directly reflect catches, which were considerably higher in the period 2008-2010, as the model interprets high catches as high population biomass. In general, the elevated inter-annual variability of population estimates obtained in this study suggests the existence of non-fishery effects affecting the population dynamics of the red shrimp. Important ecological phenomena described in the area, such as cascading (strong submarine currents which occasionally and heavily affect the resources distribution and their availability in the fishing grounds) could play a crucial role masking the effect of the fishery itself [2]. In this case it would be recommendable the development and use of a stock assessment model able to take into account such effects, in order to produce reliable fishery evaluations on which to base management decisions.

		1984	1985	1986	1987	1988	1989	2008	2009	2010
♀	Recruits biomass	67	94	59	90	104	82	114	135	94
	Mean pop biomass	392	572	416	235	379	393	1067	1068	724
	Catches	253	315	212	217	327	265	628	581	438
	Mean F	1,09	1,05	0,88	1,24	1,53	0,96	0,98	1,24	1,29
	Y/R	9,39	9,68	8,99	10,39	9,11	9,32	8,14	9,00	8,57
	$F_{0.1}$/Mean F	0,48	0,51	0,59	0,51	0,35	0,52	0,46	0,41	0,38
♂	Recruits (tons)	30	35	25	35	48	84	29	42	25
	Mean pop biomass	42	52	40	40	72	145	91	71	48
	Catches (tons)	30	35	24	35	51	88	50	45	48
	Mean F	1,75	1,90	1,38	1,70	1,15	1,80	0,94	1,70	1,11
	Y/R	2,91	2,90	2,78	3,26	2,68	2,63	1,77	2,63	2,26
	$F_{0.1}$/Mean F	0,57	0,49	0,68	0,75	0,80	0,52	0,78	0,51	0,74

Fig. 1. LCA and Y/R analysis results for the years 1984-1989 and 2008-2010, for females and males separately. Biomass and catches in tons. When the proportion $F_{0.1}$/Mean F is lower than 1 overfishing occurs, and vice versa.

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AN INVESTIGATION ON THE RECRUITMENT OF HATCHERY-REARED TURBOT (*PSETTA MAXIMA* PALLAS, 1811) JUVENILES TO NATURAL POPULATION IN THE EASTERN BLACK SEA

Mustafa Zengin [1] and Aysun Gümüs [2]*
[1] Central Fisheries Research Institute, Trabzon, Turkey
[2] Ondokuz Mayis University, Faculty of Science and Arts, Department of Biology, Samsun, Turkey - aysung@omu.edu.tr

Abstract
This study, as being a pioneer work in Turkey was realized by releasing the artificially reared Black Sea turbot juveniles to natural environment. The enhancement of the exploited natural Black Sea turbot (*Psetta maxima* Pallas, 1811) stocks was the main objective in investigation of adaptation, growth and development and restocking capacity of tagged and released individuals.

Keywords: Restoration, Vertical migration, Black Sea

Introduction
Turbot (*Psetta maxima)* is one of the most important commercial species among demersal fishes inhabiting Turkish Black Sea Coasts. Unfortunately, the turbot stocks declined because of the overfishing by a continuously growing fishing fleet and inadvisable management strategies since the last of 1980s [1]. However, turbot has always been a primary target for marine stock enhancement. The first study for the turbot restocking was started in the Turkish Black Sea coast in 1999, with collaboration of CFRI (Trabzon Central Fisheries Research Institute) and JICA (Japan International Cooperation Agency [2].

Material and Method
During 1999-2002, around 30.000 hatched and reared fish of 0-age group and mean length of 13.9 (6.5-20.7) cm were released regularly from 11 different locations between Georgian Board and Sinop Cape. All individuals were tagged externally, numbered with T-bar tags of ten different colors. The material of the tag was composed of polyethylene. The tags were placed intramuscularly nearly between 10^{th} and 15^{th} rays of the dorsal fin. After release, a recapture study was carried out lasting to the end of 2005. For the collection of samples, cooperation was conducted with coastal fishermen offering little rewards such as money, t-shirt, some fishing equipment and posters.

Results and Discussion
In a period of 7 years, 2.2% of the released turbot were recaptured by gill-net and bottom trawl mostly in winter, spring and early summer (Tab. 1). Recaptures were made along the coastal sites within a range of average 60 km from the release locations. Maximum horizontal migrate is 200 km. Vertical migrations reached to a limit of 110 m depth of littoral zone from releasing points. Population migrates and becomes dense in depths of 30-40 m where spawning occurs. There was a linear relationship between vertical/horizontal migrations and age-size groups. The recapture rate appeared to be positively correlated with size of fish and age (Fig. 1).

Individual growth of recaptured fish in length was higher than wild fish caught in same location. Hatchery reared turbot reached to legal minimum catch size in the third year of growth (2+ age group). The latest data on recaptured fish showed that maximum length and weight of tagged turbot are 54.3 cm and 4335 g respectively. In three months following the release, the growth rate of turbot was negative (-0.14 g/day). On the contrary, the following months they have started to put on weight and daily growth rate increased. The daily growth rate is calculated as 0.99 g/day, 2.10 g/day and 2.35 g/day for the age groups of 1, 2 and 3 respectively. A positive correlation has been found between recapturing rate and the size of the fish.

Finally, it is concluded that the tagged turbot population grows a bit faster and matures earlier than the wilds at the same age [3]. Released hatchery turbots seemed to be able to adapt to natural diet within a few months [4]. The findings showed that restocking of turbot has many advantages for the enhancement of commercial fisheries in the Eastern Black Sea coast. Same results were obtained in the case of West European Coasts [5]. Releases of hatchery turbot have been proposed to enhance fisheries recruitment, integrated in a resource management programme of sustainable fisheries and habitat restoration.

Tab. 1. Yearly variation in the number of released and recaptured turbot individuals along the Eastern Black Sea coast (*Italic typefont represents mature individuals*)

Years	Number of released fish	Recaptured of tagging fish							Total
		1999	2000	2001	2002	2003	2004	2005	
1999	1839	98	16	*19 (%13.8)*	*3(%2.2)*	*1(%0.7)*	*1(%0.7)*	-	138
2000	4666	-	12	*58*	*11(%10.9)*	*12(%11.9)*	*6(%5.9)*	*2(%2.0)*	101
2001	3615	-	-	14	23	*36(%40.4)*	*10(%11.2)*	*6(%6.7)*	89
2002	18058	-	-	-	96	114	*44(%15.8)*	*24(%8.6)*	278
General	28178	98	28	91	133	163	61	32	606

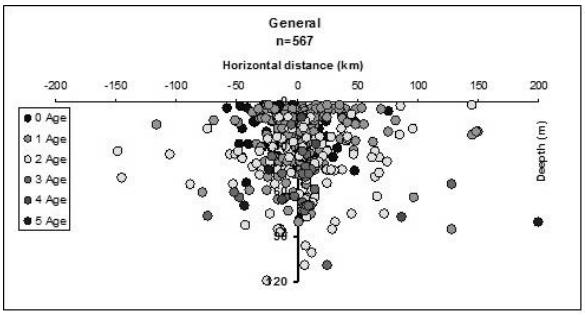

Fig. 1. Figure 1. Plot of vertical and horizontal distribution of released turbot for all age groups.

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RECRUTEMENT DE LA COQUE *CERASTODERMA GLAUCUM* (MOLLUSQUE, BIVALVE) DANS LA LAGUNE MELLAH (ALGÉRIE NORD-EST)

Khalil Melouah [1]*, Brahim Draredja [1] and Hayet Beldi [1]
[1] Université d'Annaba - khalilm11@yahoo.fr

Abstract
La détermination de la phase de recrutement chez la coque *Cerastoderma glaucum* a été étudiée dans la lagune Mellah de mars 2010 à février 2011. Le cycle biologique de cette espèce est caractérisé par un faible recrutement au début du printemps, alors que celui de l'été est plus important et s'étale de juin à septembre.

Keywords: Bivalves, Growth, Lagoons, Recruitment, South-Western Mediterranean

Introduction

Cerastoderma glaucum est un bivalve caractéristique des communautés benthiques phytophiles des milieux lagunaires [1]. Elle a été citée pour la première fois dans la lagune Mellah par Bakalem et Romano [2]. Puis, d'autres études ([3], [4]) traitant en général la répartition de la faune benthique a été réalisée.

Matériel et méthodes

La lagune Mellah est située à l'extrême Est algérien (Fig. 1). Elle totalise une superficie de 865 hectares, avec une profondeur maximale de 5,2 m. Sa communication avec la mer est assurée par un chenal et les apports en eau douce s'effectuent par trois rivières. Le prélèvement mensuel (mars 2010 - février 2011) de la coque est réalisé à partir de trois stations. Afin de récupérer les jeunes stades de ce bivalve, le sédiment est tamisé sur place sur une maille de 1 mm. Les individus sont dénombrés et mesurés (Lt) à l'aide d'un pied à coulisse, puis répartis en classes de tailles de 2 mm d'amplitude.

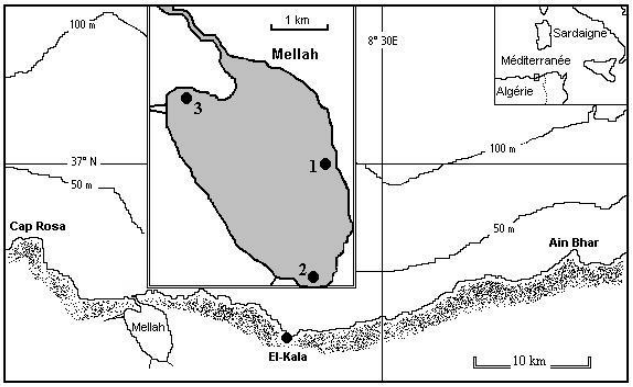

Fig. 1. Position géographique de la lagune Mellah et choix des stations.

Résultats et discussion

L'analyse de la structure des tailles de la coque du Mellah (Fig. 2), fait apparaître en mars un petit lot de juvéniles composé de 4 individus appartenant à la classe de tailles de [2-4[mm. Cette dernière disparaît, pour réapparaître en juin et s'étale sur toute la saison estivale jusqu'à septembre, où l'effectif atteint 20 individus. Le recrutement se poursuit jusqu'à la fin de la saison estivale, d'où l'intérêt du rôle du facteur thermique dans cette phase. Les plus fortes concentrations des jeunes recrues sont rencontrées au Nord-Ouest de la lagune riche en herbier à *Ruppia* sp. En effet, le tapis végétal constitue un abri idéal pour la survie des jeunes stades qui constituent une proie facile pour les prédateurs [5]. Nos constatations concernant l'arrivée de nouvelles recrues concordent avec les résultats rapportés par Labourg et Lasserre [1]. Chez cette même espèce, Guelorget et Mazoyer-Mayère [6] signalent un recrutement plus tardif en automne. Alors que Zaouali [7], indique trois périodes de recrutement ; de mai à juin, d'août à septembre et de décembre à janvier.

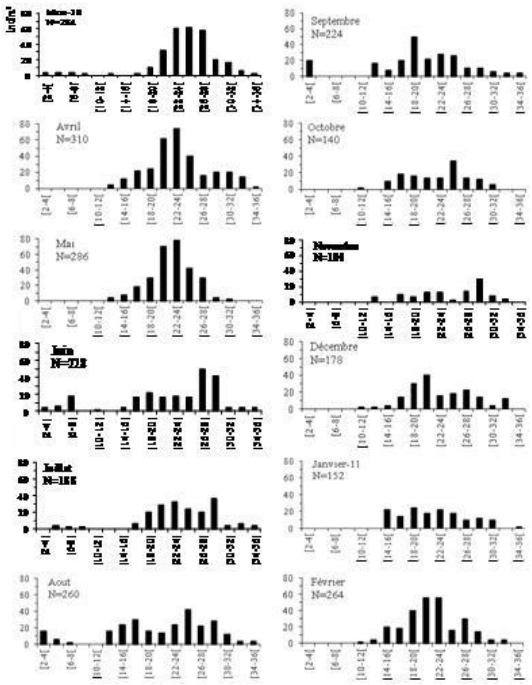

Fig. 2. Structure des tailles (mm) chez la coque *Cerastoderma glaucum* de la lagune Mellah.

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POLYMORPHISM IN *HOLOTHURIA (PLATYPERONA) SANCTORI* FROM THE ALGERIAN COASTAL AREA

Karim Mezali [1]*

[1] Universite abdelhamid iben badis F.S.N.V Departement des sciences de la mer et de l'aquaculture - mezalikarim@yahoo.fr

Abstract

The morphological, endoskeleton and genetic criteria were used to compare between individuals of two morphotypes of *H. (Platyperona) sanctori*. In this study, we concluded that both morphotypes (A & B) constitute the same species.

Keywords: Echinodermata, Genetics, Systematics, Algerian Basin

Introduction

The systematic study of holothurians "sea cucumbers" is quite complex. The morphology, size and distribution of ossicles in the body wall tissues are key characters in the determination of these species [1]. *Holothuria (P.) sanctori* is a southern species, which is distributed through the Mediterranean [2, 3] and is widely dominant in many parts of the Algerian Infralittoral [4].

Material and methods

The animals were collected in 3 stations [Sidi Fredj (Algiers), Figuier plage (Boumerdes) and Stidia (Mostaganem)] (Fig. 1B) and then anesthetized with $Mgcl_2.6H_20$ to describe their morphology [1]. The ossicles isolated from a tissue taken in the bleach (12 °) were measured using light microscope (X 20). The fraction of the 16S mtDNA gene and the primers AR (5'-CGCCTGTTTATCAAAAACAT-3') and BR (5'-GCCGGTCTGAACTCAGATCACGT-3') [5] were used. PCR amplification was performed on 49 µL with ddH_2O (30.8 µL), buffer 10 X (5 µL), dNTPs (5 µL), AR (2µL), BR (2 µL), Taq polymerase (0.2 µL), $MgCl_2$ (4 µL) and 1 µL of DNA template. The phylogenetic tree is constructed from the obtained sequences and mtDNA sequence of *Holothuria (Platyperona) forskali* is used as an out group.

Results

1. Morphology and endoskeleton analysis

The morphotype A is dark brown color and the morphotype B has a brownish color and is easily recognized underwater by its white spots clearly visible in dark middle and lightly visible in light middle (Fig. 1A). Ossicle measurements resulting from the comparative study are indicated in table 1.

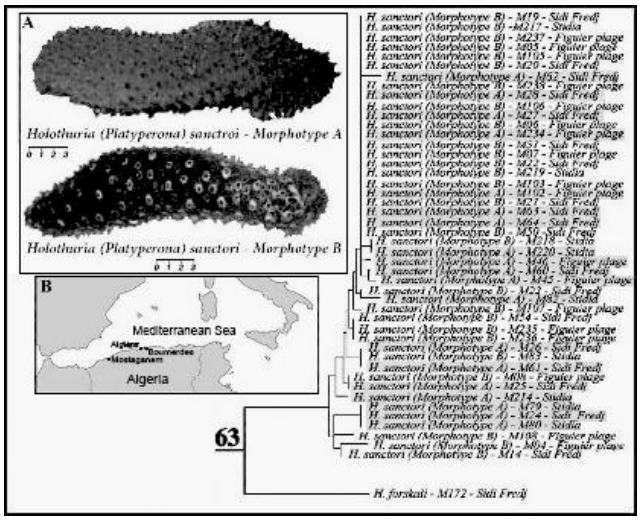

Fig. 1. The studied morphotypes (A); studied sites (B). Left: The 16S neighbour-joining tree using Kimura-2- parameter distance model. The (%) bootstrap1000 replicate is represented.

Tab. 1. The ossicles measurement. N = Number of ossicles.

		H. (P.) sanctori Morphotype A		*H. (P.) sanctori* Morphotype B	
		Bivium	Trivium	Bivium	Trivium
Tables	Height of the arrow (µm)	28.91	24.18	26.80	21.41
	Disc diameter (µm)	31.73	27.54	31.48	25.00
	Ratio Diameter/Height	**01.10**	**01.14**	**01.17**	**01.17**
Buttons	Length (µm)	58.07	79.38	56.47	70.36
	Width (µm)	25.85	26.93	27.24	28.91
	Number of holes	10	13	09	12
	Holes width (µm)	05.66	05.51	05.73	05.73
		Enlarged	Elongated	Enlarged	Elongated
Perforated plates	Length (µm)	81.83	99.23	72.28	-
	Width (µm)	66.64	34.55	60.52	-
	Ratio Length/ Width	**01.23**	**02.87**	**01.19**	-
	Diameter of perforation (µm)	08.45	08.70	11.64	-

2. Molecular analyses

The phylogenetic tree clearly shows that both *H. (P.) sanctori* morphotypes are closely grouped to a single clade with few alternative sites (Fig. 1 left). They are in fact monophyletic.

Discussion

The two morphotypes of *H. (P.) sanctori* are genetically identical and thus represent the same species rather than different species. These two polymorphic and ecotypic forms are characterized by the reduction of their ossicles in size and in number.

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GENETIC VARIATIONS AS REVEALED BY INTER- SIMPLE SEQUENCE REPEAT (ISSR) POLYMORPHISM IN *ULVA LACTUCA* (CHLOROPHYCEAE) FROM MARMARA COAST.

Isil Ezgi Eryilmaz [1], Seyma Z. Akarsu [1] and Dilek Unal Ozakca [1]*
[1] Bilecik Seyh Edebali University Faculty of Science and Art Department of Molecular Biology and Genetics - dilek.unal@bilecik.edu.tr

Abstract
Inter simple sequence repeat (ISSR) analysis was used to assess twenty attached *Ulva lactuca* samples collected from different sites distributed from the Marmara Sea. 6 ISSR primers were selected for final analysis. A total of 193 loci were obtained, of which 101 were polymorphic among the thallus studied. Genetic relationships were analyzed with Jaccard's (J) and Dice's (D) distance coefficients. Little genetic variations were found among the selected *U. lactuca* thallus, for instance, the genetic distances ranging from 0.039 to 0.178 with Dice coefficients.

Keywords: Genetics, Marmara Sea, Algae

Introduction: Distribution of genetic variation is not incidental and refers to genetic structure of a population [1]. Methods based on PCR amplifications using arbitrary primers, such as inter simple sequence repeats (ISSR-PCR), provide a new genetic marker by amplifying nuclear non-coding DNA sequences. These sequences, which are called microsatellites, evolve at a much faster rate and are less constrained by selection than protein coding loci. Thus, level of polymorphism is greater in these sequences [2]. ISSR method has been successfully used in studies on the genetic structure of many algae species [3]. *Ulva* sp. (Chlorophyta) is widely distributed from the intertidal to the upper subtidal zones around the world and an environmental problem, green macroalgal blooms, is growing by day by in coastal ecosystem. Major of green tide algae is derived from Ulvophyceae genera [4]. In this study, we investigated the genetic variations of *U. lactuca* collected from ten locations along the Marmara Sea.

Material and Methods: *Ulva lactuca* samples were collected from ten different locations along the Marmara coast, Bursa- Turkey.

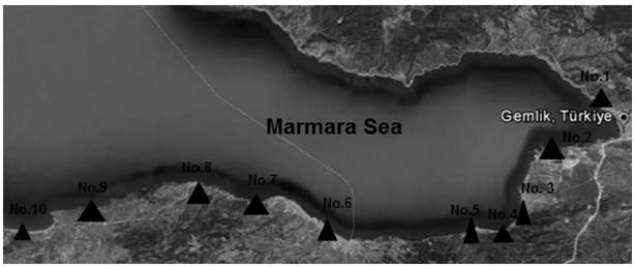

Fig. 1. Collecting points of *Ulva lactuca* in Marmara coast.

Samples coated with silica gels were cleaned with distilled water and preserved at -20°C. DNA extraction was performed according to microprep protocol by Fulton [5]. Extracted DNA amount and purity were checked (OD260/OD280) by nanodrop. After necessary dilutions, ISSR- PCR was performed with 12 ISSR primers; polymorphic bands were detected by 6 of them. Amplified DNA bands of each locus were recorded as binary present (1) or absent (0) in program. Pairwise comparisons were calculated from the 0/1 data matrix, and genetic distances were calculated using Jaccard's and Dice's method [6, 7].

Results and Discussion: In higher plants, ISSR analysis has been used to detect the organization, frequency and levels of polymorphism of different simple sequence repeats [2]. Previously studies demonstrated that the poly (GA) motif is more variable than poly(GT) motif [8, 9]. In the present work, we found that there was significantly difference between variations produced by these two motifs in *Ulva lactuca* thallus.

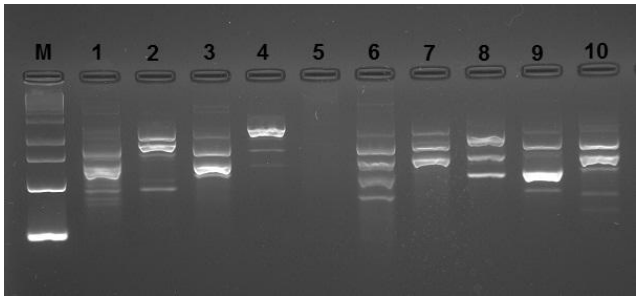

Fig. 2. Amplification of *U. lactuca* DNA samples with ISSR primer 818.

Wang *et al*. (2005) used ISSR technique to detect the genetic diversity of selected Laminaria gametophytes [10]. Wang *et al*. (2006) also reported that ISSR primer produced an average of 5.7 bands with 74% of them polymorphic in Undaria gametophytes [3]. In our analysis we found that there was an average of 6.9 bands, produced by each ISSR primer, with 52.33% of them were polymorphic.

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CONTRIBUTION A L'ETUDE DE LA VARIABILITE SPATIO-TEMPORELLE DE DISTRIBUTION ET DE RECRUTEMENT DES PRINCIPAUX STOCKS DEMERSAUX DE LA MEDITERRANEE MAROCAINE

Abdelaziz Zoubai [1]* and Yassine Zahri [1]
[1] Institut National de Recherche Halieutique - a.zoubai@gmail.com

Abstract
Ce travail a pour objet de déterminer l'abondance et le recrutement chez les principaux stocks demersaux en Méditerranée marocaine. Les résultats obtenus ont permis de relever une abondance plus marquée au niveau des strates côtières pour le pageot acarné, la bogue et le rouget de vase et au niveau des grands fonds pour le cas du merlu européen. Le recrutement plus prononcé chez ces espèces est observé en automne et surtout au niveau de la région Est de la méditerranée marocaine où le plateau continental est plus large.

Keywords: Demersal, Alboran Sea, Recruitment

Introduction

En Méditerranée marocaine, peu de travaux ont été consacrés à l'étude de la distribution des sparidés (bogue et pageot acarné), des mullidés (rouget de vase) et des merlucciidés (merlu européen). Ce travail entend contribuer à l'étude de la répartition de ces stocks, leur recrutement ainsi que leur variation spatio-temporelle dans cette région.

Matériel et méthodes

L'étude de la répartition bathymétrique et géographique des espèces est réalisée à partir du traitement des données (rendements et fréquences de tailles) collectées lors des 12 campagnes de chalutage scientifiques effectuées par l'INRH en Méditerranée marocaine, durant la période 2001-2009 durant les saisons d'été, de printemps et d'automne. La couverture de la zone d'étude est réalisée par un réseau d'échantillonnage de 45 stations (traits de chalut) se répartissant de la côte (50 m) jusqu'aux grandes profondeurs (500 m). Les données de taille et de rendement (kg/h) correspondant à chaque espèce ont été groupées en 3 strates bathymétriques (0-100 m, 101-200m, 201-500 m) et deux zones géographiques (zone Ouest et Est d'Al Hoceima). Cette subdivision géographique a été adoptée en raison de la largeur du plateau continental plus étendue dans la région située à l'Est de la Méditerranée marocaine [1]. Les indices d'abondance (kg/h) des espèces étudiées ont été calculés par strate bathymétrique et par zone géographique [1]. La détermination des principaux lieux et saisons de recrutement de ces espèces est faite sur la base de l'analyse des distributions de tailles établies par zone géographique, strate bathymétrique et par saison.

Résultats

1. Indice d'abondance :

L'analyse des indices d'abondance (kg/h) des espèces étudiées calculés par strate de profondeur et par zone géographique montre que pour le pageot acarné l'abondance décroît de l'Ouest à l'Est et de la côte (0-100 m) où les rendements les plus élevés sont réalisés (5,68 à 56,95 kg/h contre 1,3 à 14,4 kg/h respectivement) vers la strate de profondeur moyenne (101-200m) (soit 1,38 à 22,9 kg/h à l'Ouest contre 0,1 à 34,85 kg/h à l'Est); en revanche cette espèce apparaît en très faibles quantités au delà de 200 m (moins de 1 kg/h). Concernant la bogue, on constate que quelle que soit la zone, ce sparidé abonde particulièrement dans les strates de faibles profondeurs (0-100m) ; en effet, les meilleurs rendements enregistrés au niveau de ces strates varient entre 1,39 et 86,06 kg/h dans la région Ouest d'Al Hoceima contre 1,09 et 47,83 kg/h à l'Est. Au delà de 100 m, les rendements sont faibles. Le rouget de vase pour sa part, présente une abondance plus marquée durant toute l'année dans les fonds de moins de 100 m où les rendements observés varient entre 0,29 et 4,11 kg/h à l'Ouest d'Al Hoceima contre 0,68 et 7,88 kg/h à l'Est. Quelle que soit la zone, la distribution bathymétrique de cette espèce est limitée à 200 m. Le merlu européen, espèce à distribution bathymétrique plus large, abonde par contre au niveau des strates de grandes profondeurs (au delà de 200 m) (0,80 à 6,19 kg/h à l'Ouest contre 1,01 à 4,18 kg/h à l'Est).

2. Structure de tailles et recrutement :

Les distributions de tailles obtenues par saison et par strate bathymétrique et géographique permettent de relever chez le pageot acarné, la bogue, le rouget de vase et le merlu européen, une grande abondance de jeunes au niveau des strates côtières (0-100 m), ce qui traduit un recrutement plus marqué en automne surtout au niveau de la zone Est d'Al Hoceima caractérisée par un plateau continental plus large. Au-delà de cette strate de profondeur, s'observent surtout les individus âgés.

Discussion et conclusions

La variation spatio-temporelle observée chez espèces étudiées pourrait être expliquée par différents facteurs, dont notamment le type de fond où vit l'espèce [2], les conditions physico-chimiques (température en particulier) et hydrologique (upwellings etc...) qui exercent une influence directe sur leur cycle biologique [3]. Les résultats obtenus ont permis de relever que la saison d'Automne constitue pour les espèces étudiées, la principale période de recrutement. Cette période concorde bien avec celle observée dans d'autres régions. En effet, des études menées en Méditerranée espagnole situent la période de recrutement marqué au mois d'Août pour le merlu blanc [4]. Tandis que pour le rouget de vase, la période de recrutement plus prononcé coïncide avec la période située entre septembre et octobre [5].

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Session

Rarity and extinction

Modérateur : **Serge Planes**

DISTRIBUTION OF THE RARE *CYSTOSEIRA JABUKAE* ALONG THE FRENCH MEDITERRANEAN COAST

Aurélie Blanfune [1]*, Thierry Thibaut [1] and Marc Verlaque [2]
[1] University Nice Sophia Antipolis - EA 4228 ECOMERS Faculté des Sciences, Parc Valrose - blanfune@unice.fr
[2] Aix-Marseille University, Mediterranean Institute of Oceanography

Abstract
Among the Fucales, the rare *Cystoseira jabukae* Ercegovic has been rarely observed along the French Mediterranean coast. We analyzed historical data and mapped the current distribution of this species. Its first record in France dates back the 1990's at Scandola (Corsica). Extensive surveys showed that the species is still present between the sea surface and 35 m in depth, in some localities of Corsica, the Var and the Alpes-Maritimes.

Keywords: Algae, North-Western Mediterranean

Introduction
Some species of Fucales are been recorded in regression in the Mediterranean Sea [1]. We focus our attention on the past and present distribution of the rare *Cystoseira jabukae* Ercegovic along the French Mediterranean coasts. This species is thriving in the sublittoral zone [2].

Méthods
Historical records (before 2000) of *Cystoseira jabukae* have been analyzed in different sources. For the current distribution, we surveyed the entire French Mediterranean coasts (including Corsica) from 2003 to 2010.

Results
Historical data are scarce. In France, they come all from the Marine Reserve of Scandola (Corsica) from 1994 to 1998 (Verlaque herbarium, published paper [3] and unpublished report [4,5]). Currently, populations of *Cystoseira jabukae* are very rare. In Corsica, we only observed the species at Scandola in 2001, at Ajaccio in 2004 and in the Lavezzi Archipelago (Ratino Islet) (Figure 1).

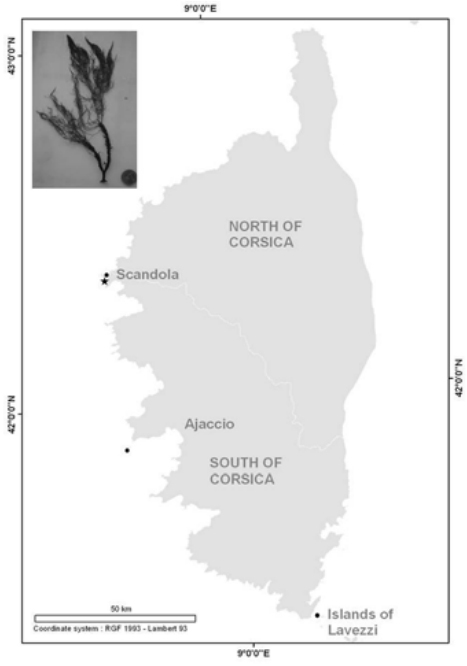

Fig. 1. Observations of *Cystoseira jabukae* in Corsica.

Along the French continental coast, only few more or less isolated individuals were observed in the departments of Var and Alpes-Maritimes (Figure 2).

Fig. 2. Observations of *Cystoseira jabukae* in the Var and th Alpes-Maritimes.

Any dense populations or communities were never found.

Conclusions
The rarity of the *Cystoseira jabukae* populations is alarming and the species could be considered as endangered. *Cystoseira jabukae* has been described by Ercegovic in 1952 but the only historical French data date back to 1994 whereas eminent phycologists as Bornet, Derbès and Solier, Flahaut, Sauvageau, Schousboe, Thuret, are sampling along the French Mediterranean coast since the 19th century. It is highly improbable that historical and recent French observations result from a recent introduction event. We hypothesize that the species was present for a long time but misidentified. The best candidates for such a misidentification could be spineless specimens of *C. sauvageauana* Hamel (= *C. selaginoides* Valiante).

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THE RESURRECTION OF *GIBBULA NIVOSA* (GASTROPODA: TROCHIDAE)

Julian Evans [1]* and Patrick J. Schembri [2]
[1] Marine Biology and Ecology Research Centre, University of Plymouth, Plymouth PL4 8AA, UK - julian.evans@um.edu.mt
[2] Department of Biology, University of Malta, Msida MSD2080, Malta

Abstract
The rediscovery of *Gibbula nivosa* from two widely separated cobble beds in 2006, after some 25 years during which no living specimens had been found, suggested that such beds may be an important habitat for this species. Systematic sampling of cobble patches at 15 different locations resulted in the discovery of another three populations, confirming the importance of cobble accumulations as a habitat for this species, but also showing that while certainly not extinct, *G. nivosa* is still quite rare within the Maltese Islands. This, together with its very narrow geographical range, being endemic to Malta, renders *G. nivosa* highly vulnerable to extinction.

Keywords: Biodiversity, Conservation, Endemism, Gastropods, Sicily Channel

Introduction
The Maltese top-shell, *Gibbula nivosa*, is a critically endangered marine trochid gastropod endemic to the Maltese Islands [1,2,3]. This species has always been rare and no live individuals were recorded between 1981 and 2006, despite intensive searches in localities where it used to occur [3]. In 2006, a population of *G. nivosa* was discovered within Sliema Creek, Marsamxett Harbour, while two individuals were also recorded off south-west Comino [1]. Although the main habitat of the Maltese top-shell has been considered to be leaves of the seagrass *Posidonia oceanica*, it has also been reported from under stones in shallow water [4], and the recently discovered populations were all recorded from such a habitat, indicating that cobble beds may be a more important habitat for *G. nivosa* than previously thought [1]. The present study was undertaken to assess the current status of the Maltese top-shell.

Material and Methods
A preliminary survey was carried out along the low-lying coasts of the Maltese Islands to map the presence of shallow-water 'cobble beds', defined as areas ≥ 25 m^2 having a continuous cover of pebbles and cobbles. Fifteen such beds were selected (Fig. 1), and four random samples were collected from each by SCUBA divers, using a 0.1-m^2 circular corer. The length and width of the sampled patched were also measured to estimate coverage. Samples were sorted in the laboratory, all molluscs present were identified, and any live individuals of *G. nivosa* were counted to obtain a measure of population density. Coverage and population density values were used to estimate the total population size within each of the sampled cobble beds with *G. nivosa*.

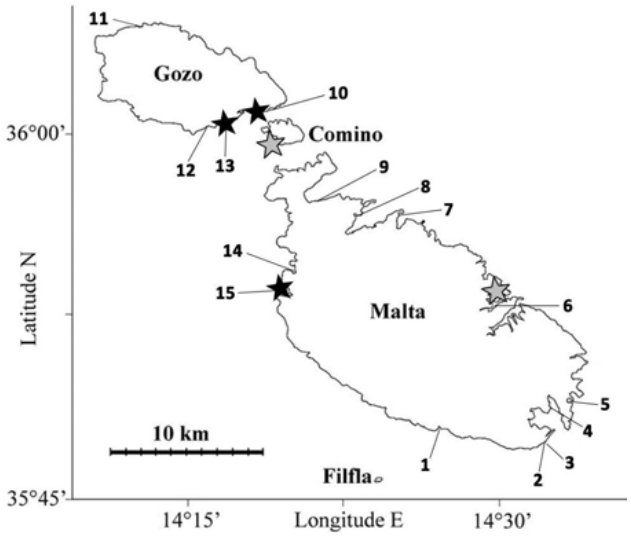

Fig. 1. Map of the Maltese Islands showing the location of the 15 sites with cobble/pebble habitats that where sampled (numbered 1-15); locations where live *Gibbula nivosa* populations were found in the present (black-filled stars) or recent [1,2] (grey-filled stars) studies are also indicated.

Results and Discussion
Live *G. nivosa* were recorded from three of the 15 sampled locations: Hondoq ir-Rummien (Site 10), Xatt l-Ahmar (Site 13) and Fomm ir-Rih (Site 15) (Fig. 1), with mean (±SD) densities of 2.0 ± 2.7, 0.5 ± 0.6 and 11.0 ± 13.4 ind./0.1 m^2, respectively. Given the restricted size of the cobble patches at the three sites, none of which exceeded 50 m^2, estimated population sizes were low, ranging between 250 and 4400 individuals. In the case of Hondoq ir-Rummien and Fomm ir-Rih, the bottom consisted of a sublittoral boulder scree adjacent to the coast, with *P. oceanica* meadows in deeper waters. Small patches of cobbles and pebbles were present as an enclave between these two habitats at depths of 7-12 m. Only the largest cobble patch was sampled at each site, and it is therefore possible that *G. nivosa* also occurred in cobble patches other than the ones sampled.

Following its rediscovery in 2006, *G. nivosa* has now been recorded from five separate locations around the Maltese Islands (Fig. 1), and other small populations may also exist in cobble patches around the Maltese coastline that have not been sampled. While never formally considered to be extinct, its reappearance after a 25-year period during which dedicated searches were unsuccessful [2] makes it a good example of a 'Lazarus species' [5]. All five presently known populations occur within accumulations of cobbles and pebbles, which therefore seem to be the main habitat for this species; past records from seagrass meadows may have resulted from collection of individuals during foraging excursions. This implies that past searches may have been unsuccessful because they were not made in the gastropod's primary habitat. Nevertheless, the present results also indicate that the Maltese top-shell is still a very rare species, being recorded from only three of the 15 sample sites, which, together with its very narrow geographical range (the Maltese Islands), renders it highly vulnerable to extinction.

Acknowledgements: Work on this protected species is in full conformity with the laws of Malta. We thank the Environment Protection Directorate of the Malta Environment and Planning Authority for issuing the necessary permits and for partial financial assistance; additional funding was provided through the European Social Fund under a STEPS scheme grant awarded to JE.

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LONG-TERM MONITORING IN A MULTI-STRESSED *PARAMURICEA CLAVATA* POPULATION

C. Huete-Stauffer [1]*, M. Previati [2], A. Scinto [3], M. Palma [3], U. Pantaleo [3], V. Cappanera [4] and C. Cerrano [1]
[1] Univ. Polytechnic of Marche - chuetestauffer@virgilio.it
[2] Centro Educazione Ambientale Imperia
[3] UBiCa
[4] Portofino MPA

Abstract
From 1999 to 2012 a population of *Paramuricea clavata* has been monitored at 25 m depth inside the Marine Protected Area of Portofino. Data were related to the local temperature trend in summer and autumn season. Results show a pattern strongly affected the recovery due to the 1999 and 2003 massive mortalities and reveal a suffering period also during 2007 and 2011, two years with prolonged summer conditions.

Keywords: Global change, Gulf of Genoa, Cnidaria, Population Dynamics

Background- Introduction
The recorded Mediterranean mass mortalities, during the last decades, have altered the structure of benthic assemblages in the NW Mediterranean Sea ([1], [2], [3], [4]). In the MPA of Portofino a slow recovery of benthic communities has been reported ([5], [6]) on behalf of monitoring efforts increased since the events of 1999 and 2003. Time series, concerning quantitative monitoring and temperature collection, aid in the understanding of recurrence of events and recovery patterns of these communities. Here we present a time series on the structure of a *Paramuricea clavata* population coupled with the temperature profiles of the monitored years (1999-2012).

Materials and methods
Fixed quadrats (five areas of $1m^2$) at 25m were monitored (bimonthly) from 1999 to 2002 (Fig. 1) recording the species and number of colonies, the maximum height (cm), the % damage level per colony, and the epibiosis stage (denuded skeleton=1, new=2, medium=3, old=4). From 2003 to 2012, the monitoring system considered minimum three haphazardously positioned quadrats ($1m^2$). Temperature data (2007-2011) were taken by a stable logger (www.ambienteinliguria.it). Complete depth profile data from previous years is unavailable for this area.

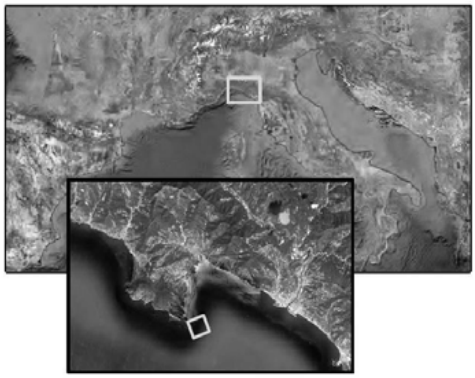

Fig. 1. Study area in the LIgurain sea, Portofino MPA. Detail of the study site, Punta del Faro.

Results and conclusions
Elevated damage percentages coincides with prolonged summer conditions (2007, 2009 and 2011) (Fig. 2). No colonies were detected in 2005 inside the considered quadrats, suggesting, as evidenced also by the high variance of the values of density in the years after, an increase in the fragmentation of the upper boundary of *P. clavata* population.
As shown from our data, no evident mass mortalities have occurred since 2008 in this area and it is possible to perceive at the moment a slow recovering picture as density is yearly increasing, though we also observed a total loss of *Paramuricea clavata* at -20 m. Temperature increase has deepened the upper limit of the gorgonian populations in the Portofino MPA, allowing more extended algal growth and becoming more susceptible to the insertion of allochthonous species.

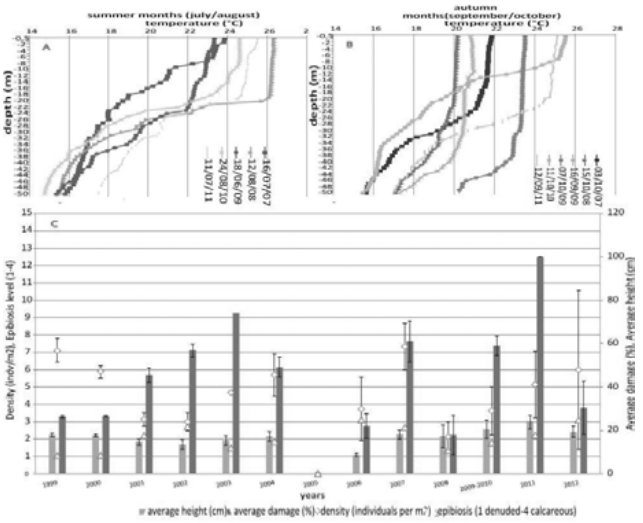

Fig. 2. Temperature and Paramuricea clavata population time series. Top graphs show the temperature profile in depth (A: summer; B: autumn) and bottom graph shows population analysis in time (C) at -25m considering height (cm), damage (%), epibiosis level (1-4) and density (number of colonies per m).

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CORAL MASS MORTALITY ASSOCIATED TO SEAWATER TEMPERATURE ANOMALIES IN THE LEVANTINE (CYPRUS) AND ADRIATIC (CROATIA) SEAS

C. Jimenez [1]*, A. Petrou [2], I. Cvitkovic [3], M. Despalatovic [3], M. Evriviadou [1], L. Hadjioanou [2] and M. A. Lange [1]
[1] Energy, Environment, Water Research Centre (EEWRC), The Cyprus Institute, P.O. Box 2121, 1645 Cyprus. - c.jimenez@cyi.ac.cy
[2] Enalia Physis Environmental Research Centre (EPERC), Acropoleos 2, Aglantzia 2101, P.O. Box 26728, 1647 Cyprus.
[3] Institute of Oceanography and Fisheries, Šet. I. Meštrovica 63, 21000 Split, Croatia.

Abstract
Marine ecosystems are experiencing rapid changes due to natural and anthropogenic disturbances. If proper management strategies are to be enforced, these changes on the structure and functioning of the ecosystems need to be documented. In this paper, we describe coral mortality events along the coast of Cyprus and Croatia, including sites with intense land-based human activities (e.g. agriculture). Two recent mass mortality events (2010, 2012) seem to have been induced by prolonged seawater temperature increases during a period of several weeks. Using image-analysis software, *Cladocora caespitosa* colonies were evaluated (% affected area). At nutrient-affected sites, macroalgae and filter feeder organisms compete with corals for space, resulting in higher partial-tissue mortality (>90%) exacerbating thus the effects of the warming event.

Keywords: Cnidaria, Levantine Basin, North Adriatic Sea, Mortality, Temperature

Introduction
The island of Cyprus, located in the high-oligotrophic region of the eastern Mediterranean, provides an appealing ground for the study of coastal ecosystems under limiting and contrasting environmental conditions. Such comparative ecological studies are valuable since responses to disturbances from the same habitat/species can be investigated in relation to the local environment. If proper management strategies are to be enforced, the changes on the structure and functioning of marine ecosystems in response to natural and anthropogenic disturbances need to be considered. In this paper, we describe the 2012 coral mortality event along the coast of Cyprus and compare it to a similar event in Croatia, including selected sites where land-based human activities are likely to have a direct impact on coral habitats.

Material and methods
Using image-analysis software, *Cladocora caespitosa* colonies were evaluated by calculating and comparing the area-percentage of healthy tissue, affected tissue (bleached and freshly necrotic) and bare skeleton (recent, old mortality). The photographic record was acquired during and one to two months after the warming event through systematic diving transects at the eastern coast of Cyprus (two localities, 2-6m depth) and in Croatia (Ciovo Island, depth ranges 5-10m, 10-15m, 15-20m)..

Results
On average, *C. caespitosa* colonies in Cyprus (Fig. 1A) had less than 15% of pigmented tissue, almost 20% of the colony area affected (bleaching and/or incipient necrosis) and around 15% with recent partial mortality associated to the 2012 warming event. One locality (Krio Nero) had a higher percentage of old mortality ($p<0.001$) which can be related to the 2010 warming event. Macroalgae covered significant areas of the coral colonies in Cyprus (30-40%). At the Croatian island of Ciovo (Fig. 1B), corals in general were less affected and had more pigmented areas than in Cyprus. However, the few sampled shallow water colonies in Croatia had the highest percentages (over 40%, $p<0.05$) of affected tissue.

Discussion and conclusions
The 2012 event seems to have been induced by prolonged seawater temperature increases during a period of several weeks in Summer (in August and September), representing the highest warming event of the last 30 years in Cyprus. Seawater temperature in the Levantine basin in general, has increased during the Summer months since at least the '90s [1]. At the nutrient-affected sites, macroalgae and other filter feeder organisms compete with corals for space, resulting in higher partial tissue mortality. Despite this fact, coral colonies are more abundant in those sites, which might be explained by the anthropogenic change of naturally limiting conditions (oligotrophy) of Cypriot waters and the physiology of the particular coral species (auto- vs. heterotrophy). Our results suggest that corals under artificially induced conditions (more commonly found elsewhere in the Mediterranean) respond to environmental disturbances impaired by the macroalgae-dominated community. Monitoring of the coral colonies and the water quality at the studied sites will continue on a seasonal basis, in order to better understand these altered ecosystems and to contribute to the definition of management strategies.

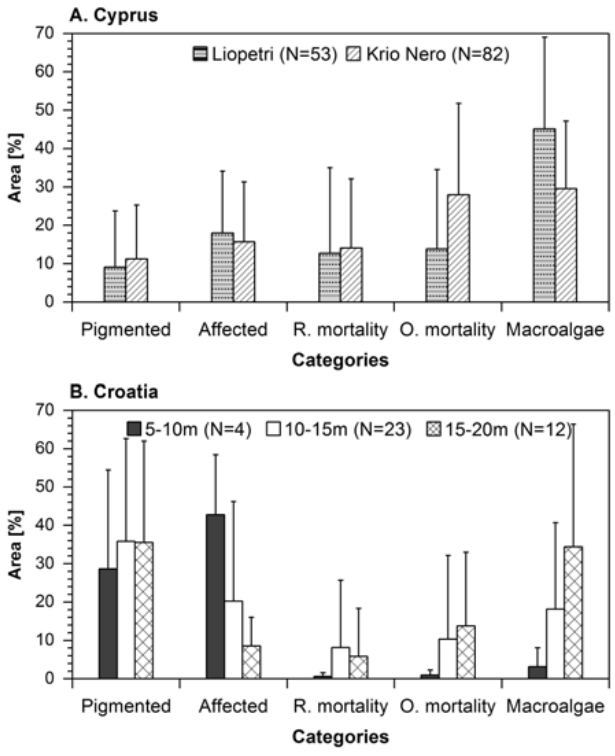

Fig. 1. Mean area-percentage (+1 SD) of tissue condition of *Cladocora caespitosa* colonies and macroalgae at two study sites in eastern Cyprus (A) and at three different depths in Ciovo Island, Croatia (B). Tissue mortality categorized as recent (R) and old (O). N= number of colonies.

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MEDITERRANEAN *LITHOPHYLLUM BYSSOIDES* (LAMARCK) FOSLIE RIMS: CHRONICLE OF A DEATH FORETOLD

Thierry Thibaut [1]*, Aurélie Blanfuné [1] and Marc Verlaque [2]
[1] University Nice Sophia Antipolis - EA 4228 ECOMERS Faculté des Sciences, Parc Valrose - thierry.thibaut@unice.fr
[2] Aix-Marseille University, Mediterranean Institute of Oceanography

Abstract
Most of the *Lithophyllum byssoides* rims have been mapped along the French Mediterranean coasts. These biogenic formations are frequent in Provence and along the west coast of Corsica, and rarer in other regions. Preliminary assessments of their current status showed that most of them are dead or in low vitaly due to the recent sea-level rise. These obversations question about the use of these rims as indicator of Good Ecological State in the european directives.

Keywords: Algae, North-Western Mediterranean

Introduction
In the Mediterranean Sea, under favourable environmental conditions, *Lithophyllum byssoides* (Lamarck) Foslie (Rhodophyta) constitutes at the lower part of the mid-littoral large biogenic constructions referred to as *L. byssoides* rims". Their development is a long process that requires a near-stable or slowly rising sea-level and high sea-water quality over long periods (several centuries). For this reason, they were widely adopted as indicator of Good Ecological State by The Europe (WFD, MSFD, Natura 2000). Unfortunately, today the regression dominates on all studied rims independently of the water quality. This situation has been attributed to the recent acceleration of sea-level rise [1,2]. This hypothesis was tested along the French Mediterranean coasts.

Method
The *L. byssoides* rims were mapped along the littoral cruising slowly on a small boat at few meters from the coast. The vitality of some rims has been evaluated using the method described by one of us [3].

Results
Lithophyllum byssoides rims are frequent along the Pyrénées-Orientales, the Bouches-du-Rhône and the Var departments and the west Corsica, and rarer in the Alpes-Maritimes and the East Corsica (Figure 1).

Fig. 1. Location (black bold lines) of *Lithophyllum byssoides* rims along the French Mediterranean Coast.

Preliminary evaluations confirmed a global regressive trend. Most of rims were dying. Dead parts of rims were most eroded than alive ones. Locally subtidal algae (*Corallina* spp.) grew on the upper surface of rims pointing out a sea-level unfavorable with the life of *L. byssoides* (Figure 2).

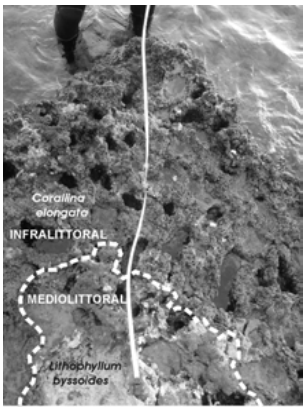

Fig. 2. Upper surface of a *Lithophyllum byssoides* rim colonised by infralittoral algae (Marseille 2013, © Mathieu Imbert).

Conclusions
The present well-developed algal rims were formed during ~300 years of sea-level stabilisation throughout the Little Ice Age (LIA) (1330 till 1640 cal AD). Since the end of LIA, the sea-level is rising at an increasing rate [4]. The average annual rise was estimated at 1.7 ± 0.3 mm.a^{-1} for the 1950-2009 period, and 3.3 ± 0.4 mm.a^{-1} for 1993-2009 [5,6]. The current rate appears too fast for the growth capacities of *L. byssoides* rims and these biogenic formations decline over thousand of kilometres of coast, excluding pollutions as the main cause of regression. Whereas the species *L. byssoides* is not threatened (young individuals are frequently observed higher on the littoral), the thousand years old rims seem to be condemned to disappear. These observations question about the use of *L. byssoides* rims in the European directives.

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Session

Rocky shores and artificial reefs

Modérateur : **Pierre Cresson**

ROCKY SHORE MOLLUSCAN ASSEMBLAGES FROM NATURAL AND ARTIFICIAL SUBSTRATA IN THE MALTESE ISLANDS

Leanne Bonnici [1]*, Joseph A. Borg [1], Julian Evans [2] and Patrick J. Schembri [1]
[1] Department of Biology, University of Malta, Msida MSD2080, Malta - leanne.bonnici@gmail.com
[2] Marine Biology and Ecology Research Centre, University of Plymouth, Plymouth PL4 8AA, UK

Abstract
The mediolittoral macrofaunal assemblages associated with concrete jetties and natural rocky substrata in two Maltese bays were compared to assess potential differences in the molluscan assemblages between artificial and natural hard substrata. The whole extent of the mediolittoral zone was sampled and the molluscs present were identified and counted. Overall species richness was significantly lower on jetties. Densities of species common on the natural rock, such as *Cerithium* spp. and *Eatonina* spp., were lower on jetties; however, the densities of *Patella* spp. were higher.

Keywords: Artificial reefs, Coastal engineering, Mediolittoral, Mollusca, Sicily Channel

Introduction: Jetties differ from natural shores by being vertical, which results in differences in wave interactions with the structure surface, and by having a different substratum composition and topography. These factors have consequences for the microhabitats required by specialist fauna [1]. Additionally, on jetties, the steep slope results in a considerable reduction in the extent of the mediolittoral zone, such that the area available for colonisation is much smaller [2]. The present study was carried out to test whether jetties support a reduced molluscan diversity, as compared to natural rocky shores within the same locality.

Method: Two localities in northern Malta, with similar exposure and geomorphology, were studied: Ghajn Zejtuna and White Tower Bay. Four stations at each locality, two situated on jetties and two on natural rock, were sampled between August and September 2011. At each station, the biota within three replicate 10 cm-wide belt transects of variable length, extending from the lower to the upper limits of the mediolittoral zone, were scraped off. The length of each transect was measured in order to standardise counts to the same unit area. In the laboratory, all live molluscs were sorted out from each sample, identified to the lowest possible taxon, and counted. Statistical analyses were carried out using PRIMER 6 (Plymouth Routines In Multivariate Ecological Research, PRIMER-E Ltd) and GMAV 5 (Institute of Marine Ecology, University of Sydney, Australia).

Results and Discussion: ANOVA indicated that the total number of species (Fig. 1) was significantly different ($p<0.05$) between the two shore types, with jetties having lower values (range: 2 – 7 species) than natural shores (range: 19 – 25 species).

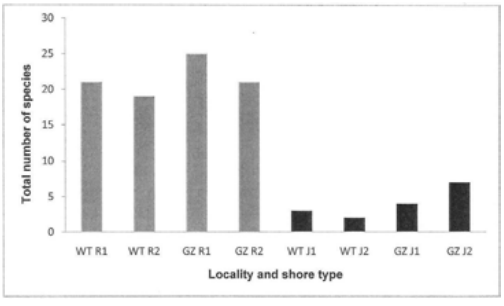

Fig. 1. Total number of mollusc species recorded at each station in the two localities; 'WT' and 'GZ' stand for White Tower Bay and Ghajn Zejtuna respectively; 'R' and 'J' stand for rocky shores and jetties respectively.

Nine species were common to both shore types, 20 species were only recorded on natural shores, while there were no species recorded solely on jetties (Tab.1). Total abundance of molluscs was always lower on jetties; however, this was not statistically significant. *Eatonina* spp. and *Patella* spp. contributed up to 50% to the dissimilarity (obtained from SIMPER analysis) between the two shore types at both localities; *Cerithium* spp. was also an important contributor to the dissimilarity between the two shore types at White Tower Bay.

Tab. 1. List of species recorded on both shore types, together with ones recorded only on natural shores, hence absent from jetties.

Species recorded from both shore types	Species recorded solely from natural shores	
Brachidontes pharaonis	Opisthobranchia sp.	*Lepidochitona corrugata*
Eatonina cossurae	*Acanthochitona* sp.	*Mitra cornicula*
Eatonina fulgida	*Alvania lanciae*	*Ocinebrina edwardsii*
Gibbula sp.	*Omalogyra atomus*	*Phorcus turbinatus*
Mytilaster minimus	*Cardita calyculata*	*Paludinella* sp.
Patella caerulea	*Cerithium* spp.	*Pisania striata*
Patella ulyssiponensis	*Columbella rustica*	*Pisinna glabrata*
Patella rustica	*Conus ventricosus*	*Setia* spp.
Skeneidae sp.	*Irus irus*	*Odostomia* sp.
	Jujubinus gravinae	*Rissoa* spp.

Eatonina spp. were recorded on natural shores at both localities; jetties at Ghajn Zejtuna had a lower abundance of these species, whilst these were absent on jetties at White Tower Bay. All local species of *Patella* (*P. rustica*, *P. ulyssiponensis* and *P. caerulea*) reached higher densities on jetties irrespective of locality. On the other hand, *Cerithium* spp. were absent on jetties in contrast to natural shores at White Tower Bay, whilst the same species were sparse at Ghajn Zejtuna independent of shore type. Most species recorded solely from the natural shores were small molluscs (not exceeding a maximum shell length of 6mm) with few exceptions; moreover, most of the individuals encountered in this study were juveniles. The majority of the species absent from jetties, as well as those recorded in higher abundances on rocky shores (e.g. *Eatonina* spp. and *Cerithium* spp.) are often recorded from the infralittoral or lower mediolittoral amongst algae, in sediment, or under stones[3][4] hence require a more or less moist environment. Such an environment is present within crevices in the mediolittoral zone but these microhabitats were sparse on the concrete jetties. The increased density of *Patella* spp. on jetties could possibly be due to a lower density of other grazers, thus reducing interspecific competition, or due to other biotic and/or physical factors. The present results corroborate those of previous studies that also recorded a lower diversity of mobile species on artificial structures when compared to natural rock, with a number of mollusc species typical of crevices and rock pools on rocky shores being absent from the artificial habitats [2].

Acknowledgements: This work was partially funded through the European Social Fund under the Strategic Educational Pathways Scholarship (STEPS) scheme grants.

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DISTRIBUTION AND DEMOGRAPHIC STRUCTURE OF *STRAMONITA HAEMASTOMA* (LINNAEUS, 1767) POPULATIONS ON THE ROCKY SHORES OF THE GULF OF TUNIS

Wafa Boulajfene [1]*, Jihen Boukhicha [1], Oum Kalthoum Ben Hassine [1] and Sabiha Tlig-Zouari [1]
[1] Université Tuis-El-Manar Faculté des sciences de Tunis - wboulajfene@gmail.com

Abstract
The eco-biological study of *Stramonita haemastoma* on the rocky coasts of the Gulf of Tunis revealed the ubiquity of the species, with varying density values depending on the stations. The average size of collected individuals was about 39.13 ±9.95 mm. The sex frequency analysis, showed females dominance. The presence of large sized immatures suggests that there is no relationship between sexual maturity and shell size in this species.

Keywords: Population Dynamics, Gulf of Tunis

Introduction
Stramonita haemastoma (Mollusca: Gastropoda) is a gonochoric gastropod occurring mainly in the lower shore level. In Tunisia, researches related to this species remain limited. For this purpose, an eco-biological study about the distribution, the abundance and the demographic structure of this gastropod was undertaken.

Material and Methods
A total of 12 rocky stations of the Gulf of Tunis were explored during the spring 2012, namely; Pilau Island, Sidi Ali El Mekki, Gammarth, Sidi Bou Saïd, Carthage, Salammbô, La Goulette, Soliman, Sidi Rais, Korbous, Port aux Princes and El Haouaria. In each station, density values were estimated by means of four 10x5m transects equidistant of 10m ([1]). Thus, a total sampling area of 500 m² was explored. In addition, 30 specimens were randomly collected at each station. Shell lengths were measured using an electronic caliper (1/100mm) and sex was determined based on the presence (female) or absence (male) of albumen and sperm ingestion glands.

Results and Discussion
S. haemastoma was found in all surveyed stations except those of Carthage and Salammbô. Estimated density values varied from one station to another?? (Fig. 1). Port aux Princes hosted few scattered individuals (0.4 ind/m²). As for Gammarth, it shelters a dense population of *S. haemastoma* (14 ind/m²). Average size was equal to 39.13 ±9.95mm in the entire Gulf of Tunis. Sizes oscillated between a minimum of 4 mm recorded at Sidi Rais and a maximum of 76.36 mm at La Goulette.

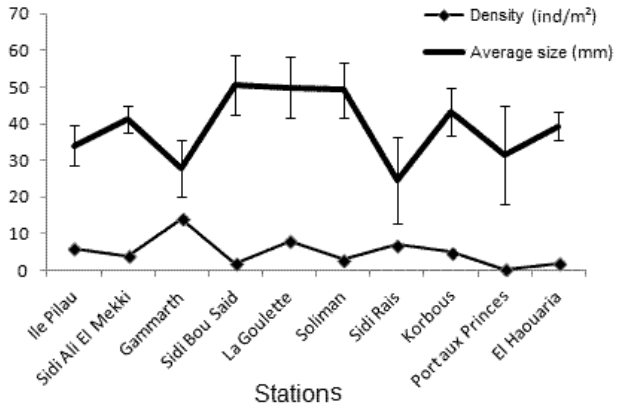

Fig. 1. Spatial variations of the density and the average size of *S. haemastoma*.

Out of a total of 300 collected specimens, males represented only 25.33% with an average size of about 37.28 ±10.38 mm (Fig. 2). Females were more frequent (49%), their average size was equal to 45.91 ±8.81mm. As for immature individuals (25.67%) they were generally small, 87% of them had a size between 15 and 20mm. However, some stations (Sidi Bou Saïd, La Goulette, Korbous and El Haouaria) showed large sized immature specimens (12.98 %) (40 to 55mm).

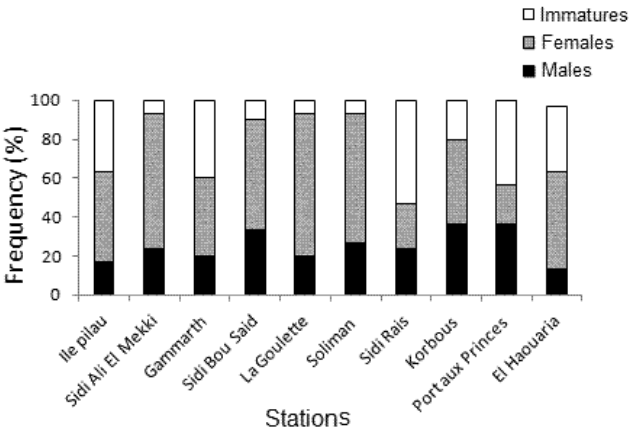

Fig. 2. Sex frequency in *S. haemastoma* in prospected stations.

Although the ubiquityof *S. haemastoma*, the species was not observed in Carthage and Salammbô. Whelk's absence at these stations could be attributed to its refuge in cracks and crevices. The average size estimated in the Gulf of Tunis (39.13 mm) was similar to that recorded in the Mediterranean coast of Morocco (43.06 mm) ([2]) but lower than that reported in the Atlantic Moroccan coast (71.68 mm) ([2]). The observation of large sized immature individuals, confirms that there is no relationship between sexual maturity and size in this species ([3]).

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MORPHOMETRIC DIVERSITY OF *STRAMONITA HAEMASTOMA* (LINNAEUS, 1767) ON THE ROCKY SHORES OF THE GULF OF TUNIS

Wafa Boulajfene [1]*, Jihen Boukhicha [1], Oum Kalthoum Ben Hassine [1] and Sabiha Tlig-Zouari [1]
[1] Faculté des sciences de Tunis Campus Universitaire de Tunis, 2092 El Manar, Tunis-Tunisie - wboulajfene@gmail.com

Abstract
A factorial discriminant analysis of morphometric data was performed on 210 specimens of *Stramonita haemastoma* collected from seven prospected stations on the Gulf of Tunis. This analysis showed that although the presence of an inter-populational morphological overlap between studied populations, shape differences were significant.

Keywords: Gastropods, Gulf of Tunis

Introduction
S. haemastoma is a key species contributing to the regulation of intertidal community structure by its predatory behavior. Works on the morphology of this gastropod remain deficient. For this reason, we investigated morphology in this species along the rocky coastline of the Gulf of Tunis.

Materials and methods
210 individuals were collected from 7 stations along the Gulf of Tunis during the spring 2012: Ile Pilau, Sidi Ali El Mekki, Sidi Bou Saïd, La Goulette, Soliman, Korbous, and El Haouaria. On each shell, 10 parameters were measured, using an electronic caliper (1/100 mm): Shell length (L), shell width (W), shell thickness (ST), last whorl length (WL), aperture length (AL), aperture width (AW), siphonal canal length (SL), siphonal canal width (SW), operculum length (OL), operculum width (OW). A logarithmic transformation of morphometric data was performed to increase linearity and normality. The following formula was used to reduce size effect ([1]): $Mtrans = logM - \beta (\log L - \log Lmean)$ where Mtrans is the transformed measurement, M the original measurement, β the within-group slope regressions of the log M vs. log L, L the shell length, and Lmean the overall mean of the length. The transformed variables were used to perform a factorial discriminant analysis (FDA). Afterwards, Wilks test was performed to evaluate the difference between the group means obtained by FDA. Furthermore, the estimation of PCS was used to assess the percentage of correctly classified individuals in their original samples and distinguish the overlap between populations.

Results and Discussion
The results showed that the two first axes explain 69.13% of the total variability. The contribution of the variables in the formation of discriminant axes was represented (Fig. 1).

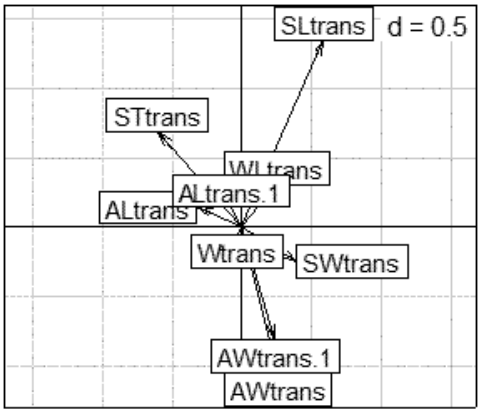

Fig. 1. Contribution of the variables in the formation of the two first discriminant functions.

The plot obtained with the two first discriminant functions (DF1 and DF2) revealed the presence of a large intra-populational heterogeneity leading to an inter-populational overlap (Fig. 2). The populations of La Goulette and Pilau Island have characteristic shapes. Morphological differences in the first sample were mainly associated to shell, operculum and aperture widths. In the second, they were related to shell thickness and aperture length. However, although the overlap between populations, Wilks test showed a significant difference between the groups means obtained by DFA (Wilks' lambda = 0.1671, F = 7.7743, p <0.05). PCS percentages varied between 46.66% in Soliman and 86.66% in Ile Pilau with a mean of 62.85%.

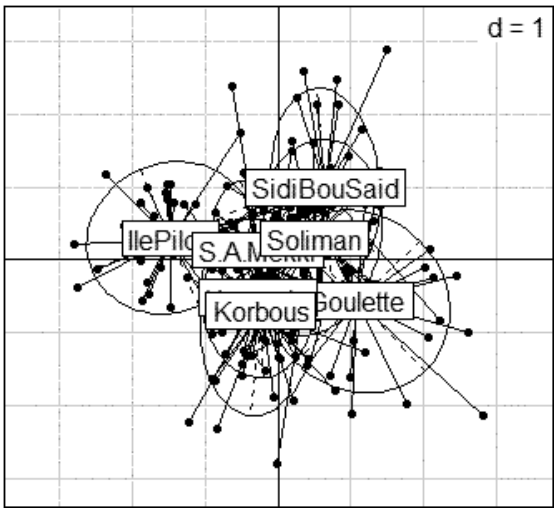

Fig. 2. Factorial Discriminant Analysis (FDA) of studied populations.

The results showed that although the presence of an inter-populational morphological homogeneity between studied populations on the Gulf of Tunis, shape differences are significant. This variability could be related to *S. haemastoma* habitat diversity and associated environmental conditions, particularly wave exposure and desiccation ([2]). These differences seem to confer physical advantages for individuals' survival in their respective niches.

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EFFECTS OF AN ARTIFICIAL REEF ON THE SOFT-BOTTOM COMMUNITY (WESTERN ADRIATIC SEA)

Beatrice Brunetti [1]*, Alessandra Spagnolo [1], Elisa Punzo [1] and Gianna Fabi [1]
[1] CNR-ISMAR Ancona (ITALY) - beatrice.brunetti.b@gmail.com

Abstract
The Porto Recanati artificial reef (Adriatic Sea) was investigated starting just after its deployment for a total of five years. Quantitative benthic samples were collected outside (K) and inside the reef (close and far from the concrete modules; C and F, respectively) to evaluate the influence of the artificial structures on the soft-bottom community. No differences were highlighted by MDS and Simper analysis among the three sites in the first year. Starting from the second year the homogeneity between K and F sites was confirmed, whereas C sites always appeared different from the others, due to the presence of hard-bottom species which were more numerous close to the structures.

Keywords: Artificial reefs, North Adriatic Sea, Zoobenthos

Introduction
Artificial reefs (ARs) are generally placed on soft seabed away from natural rocky substrates and may induce either physical and/or biological changes on the adjacent soft-bottom habitats. For example, they can affect currents and waves altering the sediment-size distribution and favouring accumulation of organic material on the seabed. An organic enrichment of sediments may be also induced by the activity of reef-associated organisms. In order to get a deeper knowledge about the benthic communities colonizing the surrounding soft-bottom and to spatially evaluate the reef influence on the seabed, Porto Recanati AR was investigated for five years after its deployment.

Material and Methods
The AR is located 5.5 km offshore at 12.5 m depth on silty-sand bottom. This reef, deployed in spring 2001, covers an area of about 54.5 ha and consists of 222 concrete pyramids (Py) and of 444 concrete poles (P). Each Py is made of five cubic blocks (2x2x2 m; total height: 4 m). The poles (height: 4 m) are placed at regular intervals between the Py and along the perimeter of the AR. Soft-bottom zoobenthic assemblages were sampled in summer from 2001, just after the AR deployment, to 2005. Two sites close to a pyramid (C), two inside the reef area but 15 m away from the structures (F), and two 200 m outside the reef (control sites: K) were randomly selected at each survey. Six samples (40x40 cm) were collected at each site using a suction sampler. Multivariate analyses were performed to identify temporal changes in the composition of macrofauna using PRIMER™ ecological software package ([1], [2]). Prior to analysis, species abundance data were square-root transformed. Similarity among communities having different spatial settlement was evaluated using MDS analysis. Similarity percentage breakdown procedure (Simper; [2]) were used to determine the contribution of individual taxa to the dissimilarity among the three sites (C, F, K), among years and the combination of these two main factors.

Results
In the overall, 202 taxa were identified, mainly polychaetes (75), molluscs (62), crustaceans (48) and echinoderms (10). Most of these taxa (145) were typical of soft bottoms (Sb) and 27 of hard substrates (Hb). The highest density was always obtained at C sites except in 2003 and 2004, reaching the maximum in 2002 (14.9±0.8 ind dm^{-2}). In 2003 and 2004 the greatest abundance was observed at K sites (8.5±2.8 ind dm^{-2} and 12.9±1.6 ind dm^{-2}, respectively) due to the occurrence of *Scapharca inaequivalvis* and/or *Corbula gibba*. Intermediate values were always recorded at F sites. A great homogeneity among sites was observed in 2001 (fig. 1; Tab. 1). The major contributors to this similarity were Sb species, such as *C. gibba*, *Calyptraea chinensis*, and *Kurtiella bidentata*, all censused at the three sites. Starting from 2002, Simper analysis showed low dissimilarity between F and K, intermediate between F and C and high between K and C. It was due to the settlement close the artificial structures of some Hb species (e.g., *Balanus improvisus*) not found at F and K sites or represented by a greater density than at F and/or K (e.g., *Pomatoceros triqueter*, *Hiatella arctica*). At C sites a greater abundance of some Sb organisms with a carnivorous habitus (e.g., *Nassarius nitidus*, *N. pygmaeus*) and/or filter-feeders (e.g., *Paphia aurea*, *K. bidentata*) was also highlighted.

Conclusions
The deployment of AR induced a gradual diversification of the benthic communities living in the surrounding soft bottom from the second year after the immersion. This effect was more consistent close to the structures due to a progressive settlement of Hb species, attracted by the presence of both artificial substrates and specimens of *Mytilus galloprovincialis* fallen down from Py, providing natural hard substrates and new habitat for marine epifaunal organisms rarely occurring in Sb communities. An increase of Sb species mainly represented by filter-feeders and carnivorous was also observed. The first ones were likely attracted by a turn-over of suspended material close to the structures, and the second ones by a greater preys availability.The influence of artificial structures appeared to gradually extend inside the AR up to 15 m from the structures, where a community with characteristics common both to those observed close to pyramids and at the control sites was censused.

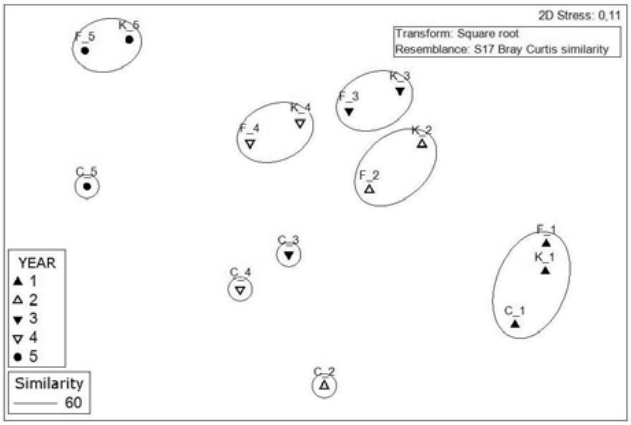

Fig. 1.
MDS based on abundance of the species. C = sites close the pyramids; F = far from pyramids; K = control sites.

Tab. 1. Simper analysis. Average percentage dissimilarities obtained between the three sites (C = close the pyramids; F = far from pyramids; K = control sites) in each sampling year (Y).

	YEARS				
Sites	1	2	3	4	5
K & F	31.00	31.76	28.33	30.00	32.17
F & C	35.36	46.25	36.34	31.40	39.94
K & C	34.00	49.93	46.20	47.16	44.88

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TROPHIC RELATIONSHIPS OF FISHES ON MARSEILLES' ARTIFICIAL REEFS ASSESSED BY STABLE ISOTOPE AND STOMACH CONTENT ANALYSES

Pierre Cresson [1]*, Sandrine Ruitton [1], Mélanie Ourgaud [1] and Mireille Harmelin-Vivien [1]
[1] MIO - Aix Marseille Université - pierre.cresson@univ-amu.fr

Abstract
Diets and trophic relationships of fishes of the Marseilles' bay artificial reef system were assessed by the coupled use of stable isotope and stomach content analyses. The results obtained in this artificial environment were comparable with those obtained in natural rocky environments, indicating that artificial reefs do not modify the feeding patterns and trophic structure of the fish community. The predominance of local prey in stomach contents, like some crustacean species, demonstrated that artificial reefs could provide diverse and abundant food resources for most fish species.

Keywords: Artificial reefs, Food webs, Fishes, Stable isotopes, North-Western Mediterranean

Introduction

With the deployment of more than 400 artificial reefs in the bay of Marseilles, RECIFS PRADO is the largest artificial reef program in the Mediterranean Sea. Artificial reefs are considered to be an effective tool to manage fisheries, mainly by their ability to enhance fish biomasses and to sustain small scale coastal fisheries [1]. This deployment represents also a unique scientific opportunity to understand the functioning of a coastal rocky environment under the influence of a large city. This work was aimed to assess the importance of artificial reefs as a food source for fish species, by the coupled use of carbon and nitrogen stable isotope and stomach content analyses. Stomach content analysis is a classical tool, commonly applied to understand the feeding habits of Mediterranean fishes [2]. Stable isotope analysis, a more recent technique in the field of trophic ecology of fishes, is also successfully used in Mediterranean ecosystems [3]. The coupled use of these two complementary techniques allows a better understanding of fish feeding patterns and their trophic relationships [4].

Material and Methods

In summer and winter 2010, 23 fish species were sampled in the Marseilles' bay artificial reefs by spear fishing and trammel nets. C and N stable isotope ratios were determined on white dorsal muscle by mass spectrometry. Prey observed in stomach contents were determined to the lowest taxonomic level and then weighed to assess their quantitative importance.

Results and discussion

The analysis of stomach contents revealed the importance of crustaceans and fishes as fish prey. Crustaceans were the most frequent prey item (80 % of occurrence) and the second of importance by weight. Fish was the first food item by weight. Mollusks, annelids, algae and *Posidonia oceanica* were also consumed, but in lower amounts. The importance of crustaceans in fish diet is consistent with patterns previously observed in other artificial reef systems [5]. The presence of the same crustacean species on the artificial reefs and in stomach contents confirmed the use of artificial reef organisms as a food source for fishes. These results highlighted also the importance of artificial reef complexity to provide shelter for small species and to increase the quantity of food available to predators. Fishes were classified into five groups depending on their diets: "zooplankton feeders", "soft bottom mesocarnivores", "rocky bottom mesocarnivores", "macrocarnivores" and "piscivores".

Fishes displayed a large range of isotopic ratios. For C, the observed range of 2 ‰ between minimal and maximal values reflected the dependence on at least two organic matter sources (planktonic and benthic). The high range observed for N (7 ‰) indicated at least three trophic levels among these species. They were classified in six groups depending on their isotopic ratios. Some discrepancies appeared between the two classifications based on stable isotopes or stomach contents. "Zooplankton feeders" was the only group to be totally common to the two classifications, due to the specificity of their diet on specific and isotopic points of view. Stable isotope ratios differed between benthic and pelagic piscivores, and between labrids and sparids in the "rocky bottom mesocarnivores" group. The coupled use of the two techniques allowed differentiating seven trophic groups among these fish species (Fig.1). The $\delta^{15}N$ value observed for sparids was surprisingly high for omnivorous species.

These results called for a careful interpretation of stable isotope ratios as a direct indicator of diet. They confirmed also that the deployment of artificial reefs does not modify fish feeding patterns and enhances the food resources available for fishes.

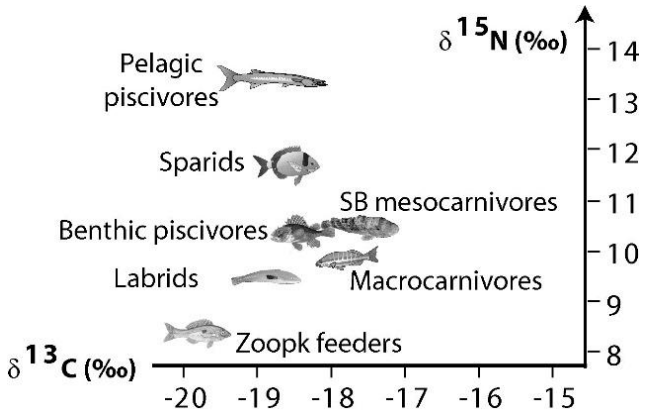

Fig. 1. Mean isotopic ratios of the fish groups living on the Marseilles' bay artificial reefs. Zoopk: zooplankton; SB: soft bottom.

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EFFECT OF DEPTH AND CANOPY HEIGHT ON THE NURSERY VALUE OF *CYSTOSEIRA BALEARICA* FORESTS FOR MEDITERRANEAN ROCKY REEF FISHES

A. Cuadros-Casado [1]*, A. Cheminée [2], E. M. Vidal [1], P. Thiriet [2], O. Bianchimani [3], S. Basthard-Bogain [3], P. Francour [2] and J. Moranta [4]

[1] IEO-COB Estació d'Investigació Jaume Ferrer, - amalia.cuadros@ba.ieo.es

[2] Université Nice Sophia Antipolis, EA 4228 ECOMERS, 06108 Nice Cedex 2, France

[3] Association Septentrion Environnement, Maison de la Mer, Corniche Kennedy, 13007 Marseille, France

[4] IEO—Centre Oceanogràfic de les Balears, Moll de Ponent s/n, 07015 Palma, Spain

Abstract

We studied effects of depth and *Cystoseira balearica* forests canopy height on coastal juvenile fish assemblages of Minorca Island. Results showed a clear differentiation of juvenile fish assemblages due to depth: assemblage in the shallowest range (3-4m) was characterized by higher densities of *Thalassoma pavo*, deeper ones (6-8, 10-12 m) by higher densities of *Coris julis*. Smallest juveniles of both species were more abundant within forests displaying the highest canopy height; meanwhile largest juveniles were more abundant within low *Cystoseira* forests. Also, both species showed predominantly a cryptic behavior on forest of higher canopy height, and a temporal one when canopy was lower. This study supports the importance of preserving healthy *Cystoseira* forests in order to preserve their nursery value for these two Labrid species.

Keywords: Teleostei, Algae, Life cycles, Bathymetry, North-Western Mediterranean

Introduction

Many fish species of the Mediterranean present at least some disjunction between adult and juvenile habitats. Usually adults occupy a broader range of depth and habitats, while juveniles appear in littoral waters in specific habitats [1], called juvenile habitats. For a given species, among juvenile habitats, nursery habitats are characterized by higher nursery value (i.e. contribution per unit area of individuals to adult populations). Nursery value can vary spatially according to factors that create site-specific variation. These factors may be biotic (such as structural complexity) or abiotic (such as water depth) [2]. Along the Mediterranean coasts, *Cystoseira* forests display a high nursery value for some Labridae species [3] but simultaneously are threatened by human pressures, and tend to regress [4]. It is important to understand site-specific factors molding suitability of this nursery habitat in order to design management actions that assure the replenishment of adult fish populations. We aim to study the effect of depth and micro-habitat characteristics (canopy height) on the nursery value of *Cystoseira* forests along Minorca Island coasts.

Material and Methods

In September 2012 we sampled 3 sites of 2 separated localities containing *Cystoseira balearica* forests of similar cover (>70%), at three depth ranges (3-4, 6-8, 10-12 m). In each depth range, a diver haphazardly selected 8 sampling points within the forest. The diver recorded canopy height and cover, as well as abundance, size and behavior of juvenile fishes during 5 minutes within a quadrate area of $1m^2$ [3]. Other habitat parameters (slope, etc.) were kept constant. Analysis of data where made by multivariate and univariate exploratory and inferential approaches, using R and Primer6/Permanova+ softwares [3].

Results and Discussion

Assemblages of juveniles significantly differed according to depth (Fig 1; PERMANOVA, F=10.6, p=0.004). Assemblages at shallow depth were characterized by higher densities of *Thalassoma pavo*, and deeper assemblages by higher densities of *Coris julis*. Additionally, we found for juveniles of *C. julis*, that different juvenile size classes showed contrasted abundance patterns according to depth, which was not the case for *T. pavo*. For both species, smallest juveniles were more abundant within forests displaying the highest canopy height (~13 cm); meanwhile largest juveniles were more abundant within *Cystoseira* forests displaying the lowest canopy height (~5 cm). Furthermore, both species showed more cryptic behavior in forests of higher canopy height, and a rather temporal behavior when canopy was lower. Results are consistent with previous studies investigating the range of depth distribution of juveniles of *C. julis* and *T. pavo* [1]. It has been previously demonstrated for *C. julis* a clear disjunction between adults and juveniles distribution. Not for *T. pavo* [1].

This study may support that when adults are well segregated from juveniles by depth, migration of juveniles to a broader range of depth occurs gradually as they grow and gain maturity. Also this study supports the importance of preserving healthy *Cystoseira* forests (with dense and high canopy) in order to guarantee their nursery value for these two Labrid species.

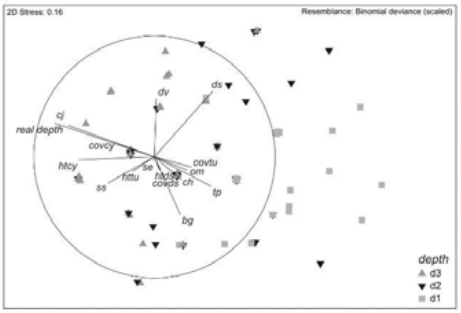

Fig. 1. 2D ordination plot of juvenile assemblage among sampled *Cystoseira* forests: non-metric multi-dimensional scaling ordination plot (nMDS). Correlation vectors (Spearman) are plotted – Juvenile taxa: tp: *Thalassoma pavo*, cj: *Coris julis*, ch: *Chromis chromis*, ds: *Diplodus sargus*, dv: *Diplodus vulgaris*, bg: Blennidae-Gobiidae, om: *Oblada melanura*, se: *Serranus* spp., ss: *Symphodus* spp. - Abiotic and biotic features: *Cystoseira* percent cover (covcy) and canopy height (htcy), turf percent cover (covtu) and depth (d1= shallow, d2= medium, d3 = deep)

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DISTRIBUTION AND ECOLOGY OF PROSOBRANCHIA GASTROPODS (MOLLUSCA) IN THE NORTH AEGEAN SEA (GULF OF EDREMIT-DARDANELLES)

Muharrem E. Sahin [1] and Mehmet Culha [2*]
[1] COMU, Fisheries Faculty, Dept. of Hydrobiology, Canakkale
[2] IKCU, Fisheries Facul., Depar. of Hydrobiology - msculha@gmail.com

Abstract
The purpose of this study is to determine the structure of community which formed by Prosobranchia (Gastropoda-Mollusca) species in the Anatolian coast of the Dardanelles Strait and the Gulf of Edremit. Samples were taken from a depth of 0.5 - 5 m from eight different stations with the 30x30 quadrate between November 2011 and May 2012. As a result of the study, 36 species belonging to 16 families and 4207 individuals were obtained. The maximum dominant species is Bittium reticulatum (Da Costa, 1778) with a 19% value. Station which has the highest number of species and individuals, including 29 species and 1188 individuals, was Ayvalik. Minimum number of species and individuals is 15 and Altinoluk became the least station that including 190 number of individuals.

Keywords: Biodiversity, Aegean Sea, Dardanelles, Gastropods, Mollusca

Introduction
It is estimated that there are about 5,942 benthic invertebrate species in the mediterranean (622 sponges, 420 cnidarians, about 500 bryozoa, 1,000 annelids, 2,000 molluscs, 154 echinoderms, 6 echiurians, 3 priapulidae, 33 siphuncles, 15 brachiopods, 1 pogonophore, 4 phonorids, 5 hemichordata and about 1,935 arthropods) (Zenetos et al., 2002, 2003). Sampling at the 8 stations was conducted seasonally at various biotopes at depths of 0.5m-5m. The present study was carried out to determine Mollusca fauna biodiversity (Prosobranch Gastropods) in Anatolian coasts of Dardanelles located at the upper-infralittoral zone of the Northern Aegean Sea coasts of Turkey.

Collection and evaluation of the study material
Mollusk specimens were obtained by sampling during November 2011 and June 2012 at 8 stations (Ayvalik, Gömeç, Altinoluk, Assos, Yeniköy, Geyikli, Kumkale and Dardanos). Samplings were performed at depth of 0,5-5m with quadrat (30x30 cm) and spatula for seasonaly. Physicochemical parameters was measured in-situ by YSI 556 MPS probe. Materials collected in the local area were fixed in formalin of 4% to be examined in the laboratory. As a result of the studies in Turkish coasts of the North Aegean Sea carried out 36 species and 4207 specimens have been identified. The seasonal distribution of the physicochemical parameters measured on site as in-situ.

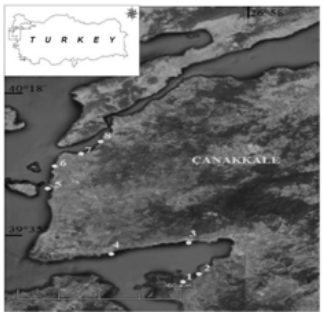

Fig. 1. Research area and sampling stations

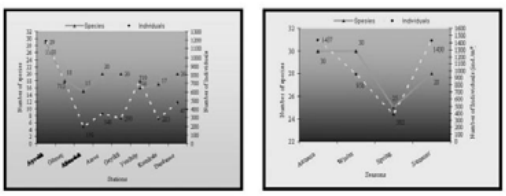

Fig. 2. Distributions of species-specimens and seasonal

Conclusion
As a result of the qualitative investigations on the species identified, Ayvalik station, with the greatest abundance, was found to be represented by 29 species whereas the second most abundant station was established to be assos, geyikli, dardanos stations with 20 species, respectively. As the stations were examined based on the number of specimens, the highest number of specimens (1188) were found at Ayvalik station followed by Yeniköy station (719 specimens) and Gömeç station (712 specimens). Otherwise, the lowest number of species and specimens (15, 190) was found at Altinoluk station (Figure 1). With regard to the seasonal distribution of the species found in study area, autumn and winter was the leading season with 30 species followed by summer; and spring (25 species) with the lowest number of species. In the present seasonal study, the highest number of specimens were observed in autumn, which provided relatively warm waters and optimum environmental parameters (Figure 2), whereas the lowest number of specimens were recorded in spring. The purpose of the present study was to determine the marine Prosobrancia mollusk species at the Anatolian coasts of Dardanelles. A total of 36 species were detected belonged to 16 families.

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MARINE UNDERWATER CAVES OF TARKHANKUT PENINSULA (BLACK SEA, UKRAINE), ITS BIOTA WITH EMPHASIS ON SPONGES FAUNA

Alexander Ereskovsky [1]*, Oleg A. Kovtun [2] and Konstantin K. Pronin [2]
[1] CNRS UMR 7263 IMBE - alexander.ereskovsky@imbe.fr
[2] Odessa National I. I. Mechnikov University, Odessa, Ukraine

Abstract
A detailed geomorphological description of five submarine shallow semi-submerged caves from peninsula Tarhankut, Crimea (Black Sea) realized. Investigated their biological characteristics with special attention to sponges species composition and distribution. It was detected seven sponge species (class Demospongiae). These species are tolerant to different hydrological conditions, and some of them have wide geographical distribution.

Keywords: Biodiversity, Black Sea

In recent decades, systematic surveys of littoral submarine caves have received particular attention from the scientific community. The particular environmental conditions of these habitats (absence of light, oligotrophy, and reduced hydrodynamic action) make submarine caves enclave mesocosms of the deep aphotic zone in shallow coastal areas [1]. Due to their relatively small size and ease of accessibility, environmental stability, and presence of communities of endemic and specialized species, dark submarine caves are excellent model habitats to address important ecological and evolutionary questions such as the influence of life cycle and habitat fragmentation on gene flow. In addition, all the information gathered on such habitats can be interpreted in the context of global climate change and can help increase awareness of the related pertinent issues. A special attention in the last decade is given to the submarine caves in the north-western Mediterranean [2]. However, information on the biodiversity of the underwater caves of the Black Sea is extremely fragmentary. The reduced salinity is the most important environmental factor influencing marine biodiversity in the Black Sea. Two to five times fewer species in various taxa of benthic animals live in the Black Sea as compared to the neighboring Mediterranean [3]. A good example of this pattern is the phylum Porifera (sponges): the Black Sea inhabited by 29 species of sponges (about 4.5% of Mediterranean). The main objectives of this study were (1) a detailed geomorphological description of several submarine shallow-water semi-submerged caves from peninsula Tarhankut, Crimea, and (2) their biological characteristics with special attention (3) to study the species composition and distribution of sponges habitat in these caves. It was investigated 5 caves: three semi-submerged and two submerged with length from 9 to 131 m and volume from 61 m^3 to 3060 m^3 (Fig. 1).

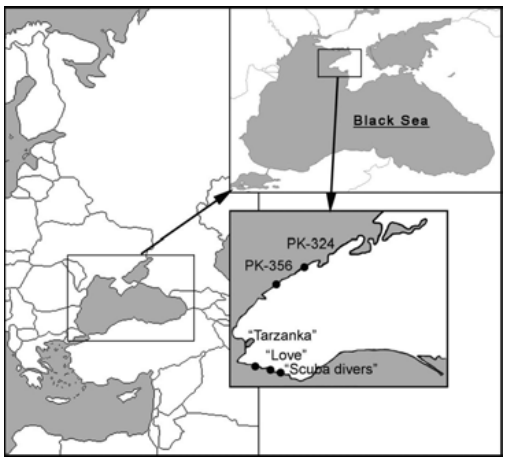

Fig. 1.

Fig. 1. Map of investigated caves.

All of them have karst-abrasive or karst origin. Our research of some caves in SW of Crimea haveshowa numberofnew and very rare troglobiont species, which confirms the existence in the Black Sea marine caves little-known communities. In investigated caves we have detected seven sponge species (all from the class Demospongiae) (Table 1).

Tab. 1. Sponges from underwater caves from Tarchankut (Crimea) and their distribution in relation to the entrance.

Tab. 1.

Sponges	Caves				
	«Scuba divers»	«The love »	PK356	«Tarzanka»	PK-324
Dysidea fragilis (Montagu, 1818)	0 - 3 m	0 - 4 m	0 - 6 m	0 - 4 m	0 - 4 m
Plone vastifica (Hancock, 1849)	0 - 67 m	0 - 40 m	0 - 15 m	0 - 20 m	0 - 9 m
Haliclona flavescens (Topsent, 1893)	0 - 92 m	0 - 40 m	6 - 22 m	2 - 20 m	9 m
Haliclona sp. 2 (branches)	12 - 46 m	6 - 55 m	No	2 - 20 m	No
Geodia stellosa (Czerniavsky, 1880)	24, 36 m	6 - 55 m	No	20 m	4-5 m
Suberites prototypus Czerniavsky, 1880	24 - 36 m	24 - 36 m	10 - 15 m	No	No
Clathria cleistochela (Topsent, 1925)	24 - 30 m	24 - 40 m	No	20 - 25 m	No

All these species have been described by previous authors from the adjacent open sea waters. These species are tolerant to different hydrological conditions, mostly temperature and salinity. Some of them have wide geographical distribution. Our study confirmed the dominance of sponges in the caves of Tarkhankut. However, the community structure of sponges, their abundance and biomass vary from caves. The species composition of sponges from the caves of Crimea is quite different from the sponges composition in Mediterranean caves. This is primarily because the geographical isolation of the Black Sea and the differences in the hydro-chemical parameters of the milieu (water salinity in Tarkhankut is 18-21‰.

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AGE, GROWTH AND FEEDING OF THE BLACK GOBY, *GOBIUS NIGER*, IN CANDARLI BAY (AEGEAN SEA)

Halit Filiz [1]*
[1] Mugla Sitki Kocman University Faculty of Fisheries - halit.filiz@mu.edu.tr

Abstract
Age and growth of 681 black gobies (*Gobius niger* L., 1758) (6.2-15.9 cm TL) were studied based on samples collected monthly from the Candarli Bay (Aegean Sea). Age determined from direct reading on otoliths was comprised from zero to five years. The parameters of the fitted Von Bertalanffy growth equation were L_∞= 17.62 cm, k= 0.278 yr^{-1}, t_0= -2.053 for males, and L_∞= 14.10 cm, k= 0.391 yr^{-1}, t_0= -1.198 for females. Stomach contents were mainly Mollusca (%IRI=54.21), Crustacea (%IRI= 36.22), Polychaeta (%IRI= 7.72), Foreminifera (%IRI= 1.40) and Teleostei (%IRI= 0.45).

Keywords: Fishes, Aegean Sea, Teleostei, Population Dynamics

Introduction
The black goby is widely distributed in Eastern Atlantic and Mediterranean Sea (include Black Sea). Despite its abundance along Turkish coasts, only one study [1] concerning the population dynamics parameters of *G. niger* exists. The species is not consumed as food, yet due to its high proportion in the bottom trawl discard, which contributed to its habitat loss and pollution, the black goby population has evaluated as least concern in Turkey [2], thus making any biological data that we could possess of great importance. In this study, information on the age, growth and feeding habits of *G. niger* are presented based on material collected in Candarli Bay, Aegean Sea.

Material and Methods
A total of 681 specimens obtained. Total lengths (TL, cm) were measured to the nearest 0.01 cm and wet weights (W, g) to the nearest 0.01 gram. The mean lengths at age were analyzed separately per sex and were compared statistically using Student's *t* test (p>0.05). Sagittal otoliths were removed, cleaned, dried and stored in labeled plastic tubes. Age was expressed in years, the birthday of the fish being considered to be 1st January. For the estimation of the individual growth rate, the von Bertalanffy growth equation (VBGE) was calculated. The growth performance index (Φ, phi-prime) was employed to compare growth rates. Stomachs were removed from 269 specimens, prey items were identified to group level, measured, counted and weighed on an electronic balance (precision 0.0001 g). Diet composition was evaluated using three measures: the numerical index (%N); the gravimetric index (%W), and frequency of occurrence (%F). The index of relative importance (IRI) was calculated and expressed as a percentage (% IRI).

Results and Discussion
The black goby specimens had total lengths ranging from 6.2 to 15.9 cm, with a mean value of 10.05 cm (S.D.= 1.90). Of the 269 black goby stomachs examined, 257 had food (95.5%) and 12 were empty (4.5%). Mollusca, Crustacea and Polychaeta constituted of 98.15% of the diet. Foraminifera and Teleostei comprised 1.40 and 0.45% of the diet, respectively. Age determination from direct observations on the otoliths resulted in the establishment of six age groups (0, I, II, III, IV and V) for the population sampled (Table 1).

Tab. 1. Comparison of maximum age and age at lengths records.

Area	Study	Locality	Sex	0+	I	II	III	IV	V
Mediterranean	[4]	Adriatic Sea	♂ ♀	7.7 6.2	9.4 7.8	11.9 9.5	13.5 10.4	14.5 11.8	15.5
	[5]	Mauguio Lagoon	♂	-	8.8-9.6	9.6-12.0	12.0-13.2	13.6	-
			♀	-	8.4-9.2	9.2-11.6	11.6-12.4	-	-
	[1]	Izmir Bay	♂	8.18	10.34	11.93	13.29	14.14	14.78
			♀	6.67	8.10	9.90	11.33	12.26	-
	This study	Candarli Bay.	♂	7.81	10.07	11.82	13.41	14.29	15.9
			♀	7.36	8.13	10.05	11.39	12.25	-
Atlantic	[3]	Verse Meer Lake	♂	5.5	8.2	9.5	12.0		
			♀	5.5	8.1	9.6	10.5	11.1	
	[8]	Norwegian coasts	♂+♀	-	4.4	7.1	8.6	9.6	9.3
	[9]	Stanswood Bay	♂+♀	~3	5.6	9.0	10.9	-	-
	[6]	Ria de Aveiro Lagoon	♂	7.6	10.8	11.8	-	-	-
			♀	7.2	10.5	11.5	-	-	-
	[7]	Obidos Lagoon	♂	7.8	10.5	12.2	13.5	-	-
			♀	8.0	10.3	11.9	12.0	-	-

The maximum age reached by specimens of black goby (i.e. 5 years) from the Candarli Bay is within the longevity limits observed over the biogeographical distribution area (Table 1). In terms of mean length per age group (except age V being only males) significant differences were found between the two sexes (p<0.05). Males attain a bigger length than females. These differences between male and female in growth rates and life span have already been noticed by [1, 3-7]. In this study, growth rate of the population has been found relatively low. However, the growth coefficient is highly variable among different studies (k= 0.19-0.91) (Table 2).

Tab. 2. Comparisons of growth parameters.

Area	Study	Sex	L_∞ (cm)	k (year^{-1})	t_0 (year)	t_{max}[A]	Φ' [B]	Locality
Mediterranean	[4]	♂ ♀	18.52 16.58	0.30 0.19	-1.689 -2.571	10.1 15.7	2.01 1.72	Adriatic Sea
	[1]	♂ ♀	16.69 14.84	0.30 0.32	-2.205 -1.459	10.0 9.3	1.92 1.85	Izmir Bay
	This study	♂ ♀	17.62 14.10	0.28 0.39	-2.053 -1.198	10.4 7.7	1.94 1.89	Candarli Bay
Atlantic	[9]	♂ ♀	11.7 15.1	0.91 0.91	0.32 0.32	3.3 3.3	2.10 2.32	Stanswood Bay
	[7]	♂+♀	16.66	0.34	-1.910	8.9	1.97	Obidos Lagoon

[A] t_{max}(life-span)= based on 3/k assumption
[B] $\Phi' = \log k + 2 \log L_\infty$

L_∞ estimated in this study was within the observed total length of males and females. The diet of black goby is based on small benthic invertebrates, generally similar to that of other populations. Therefore, Foraminifera comprised 1.40% of the diet. I believed those foraminiferans are ingested accidentally, together with the animal constituents of the diet.

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DIVERSITE DE LA FAUNE PARASITAIRE DE *BALISTES CAPRISCUS* (TELEOSTEI: BALISTIDAE) DU GOLFE DE GABES

Hichem Kacem [1]*, Abderrahmen Bouain [1] and Lassad Neifar [1]
[1] Université de Sfax, Faculté des Sciences, Tunisie - hichemkacem2007@yahoo.fr

Abstract
L'étude parasitologique de 249 spécimens de *Balistes capriscus* (Gmelin, 1788) en provenance du golfe de Gabès (Tunisie) a permis de récolter cinq espèces de parasites dont une nouvelle espèce de Digenea *Hypocreadium caputvadum* (Kacem, Derbel et Neifar, 2011) et deux espèces de parasites signalées pour la première fois en méditerranée.

Keywords: Parasitism, Fishes, Gulf of Gabes

Introduction
Balistes capriscus (Gmelin, 1789) est un poisson amphi-atlantique largement trouvé dans les eaux tropicales et tempérées tout au long des côtes Est et Ouest de l'océan Atlantique [1] et également en Méditerranée [2]. Plusieurs travaux portant sur les parasites du *B. capriscus* de l'océan Atlantique ont été menés [3, 4, 5] mais aucune étude n'a été réalisée en Méditerranée. Le présent travail fournit les premières données sur la faune parasitaire de *B. capriscus* des côtes du golfe de Gabès.

Matériel et méthodes
Durant les quatre saisons, 249 spécimens de *B. capriscus* de taille comprise entre 139 et 427 mm provenant de différentes localités du golfe de Gabès ont été examinés afin de rechercher les ectoparasites et les endoparasites. Les parasites prélevés sont identifiés. Pour chaque espèce parasite, la prévalence et l'abondance moyenne ont été calculées [6].

Résultats et discussion
L'examen des branchies de *B. capriscus* a permis de récolter une espèce de Monogenea *Ancyrocephalus balisticus* et deux espèces de Copépoda *Taeniacanthus balistae* et *Naobranchia variabilis*.
A. balisticus est un des rares représentants du genre *Ancyrocephalus* en Méditerranée. Ce genre se trouve principalement en Atlantique où il est bien diversifié. Ceci pourrait suggérer l'origine Atlantique de *B. capriscus*. *Naobranchia variabilis* présente une large spécificité d'hôtes. En effet, il a été signalé à plusieurs reprises en Atlantique chez plusieurs hôtes appartenant à des familles différentes tels que: Tetraodontidae (*Lagocephalus laevigatus*) Serranidae (*Centropristes striatus*; *Diplectrum formosum*), Pomadasyidae (*Haemulon plumieri*), Monacanthidae (*Ceratacanthus schoepfi*), Diodontidae (*Chilomycterus spinosus, Chilomycterus atinga, Chilomycterus schepfi*), Ogcocephalidae (*Ogcocephalus sp., Ogcocephalus radiatus*), Clupeidae (*Brevoortia paronus*). C'est pour la première fois qu'il est signalé en Méditerranée sur les filaments branchiaux de *B. capriscus.* Ceci est une preuve supplémentaire de l'origine Atlantique de *B. capriscus*. L'examen du tube digestif des poissons récoltés nous a permis de recenser 2 espèces de Digenea appartenant à 2 familles distinctes: Lepocreadiidae(*Hypocreadium caputvadum*) [7]; Apocreadiidae(*Neoapocreadium chabaudi*). Ce dernier a été mentionné chez *Stephanolepis hispidus* sur les côtes du Brésil [8]. Nous le signalons pour la première fois chez *B. capriscus* en Méditerranée et particulièrement dans le golfe de Gabès.

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TEMPORAL VARIATION OF LITTORAL FISH & ALGAE, SAMOS, GREECE

Adam King [1]*, Kirsteen MacKenzie [2], Anastasia Miliou [1] and Cristina Acasuso-Rivero [1]
[1] Archipelagos, Institute of Marine Conservation, P.O. 42, Pythagorio, 83103, Samos, Greece - adam@archipelago.gr
[2] University of Southampton, NOCS, European Way, Southampton, England, SO17 1BJ

Abstract
In the region of the eastern Aegean Sea, there is a lack of studies on ecologically important littoral rocky habitats. Using underwater visual census methods, this study focused on the assessment of inter-annual changes in biodiversity of fish and algae in rocky habitats between 2010 and 2012. 60% decline in overall fish population abundance was observed at individual reefs. Two important commercially fished species, *Oblada melanura* and *Mullus surmuletus*, displayed declines in population of 95% and 78% respectively over the three years, indicative of overfishing in the area. Algal biodiversity remained relatively constant, although the presence of the invasive *Caulerpa racemosa* is a cause for concern due to decline in biodiversity of reefs it colonizes.

Keywords: Algae, Aegean Sea, Fishes, Population Dynamics

Introduction
Shallow, algae covered rocky habitats act as feeding, refuge and nursery areas, to adult and juvenile fish of many species [1], [2]. These habitats are of particular ecological significance, and their conservation is of great importance in maintaining coastal fish diversity and abundance [2]. Within the Aegean Sea, the majority of research on shallow coastal fish assemblages has been conducted in the northern Aegean, while studies on benthic algae have been located primarily in the western Aegean Sea [3],[4],[5]. Few studies have been carried out in the eastern Aegean [2], and long-term studies of fish populations are generally lacking throughout the entire Mediterranean [6].

Material and Methods
This study attempts to address this lack of knowledge in the eastern Aegean by studying the inter-annual changes in shallow rocky habitat fish and algae using underwater visual census surveys (UVC) on the littoral zone waters of the Greek island of Samos. UVC surveys were conducted during the months of July to August, 2010 to 2012 inclusive, at three sites located on the south west coast of Samos. Fish transect surveys were conducted over an area of 250m^2, with 36 repeat surveys at per site, per year. 120 algal quadrats of 250cm^2 were conducted along the same transects as the fish.

Results and Discussion
A decline in fish population abundance and biodiversity was observed across all three sites over the three year period, with up to a 60% decline in population abundance at individual sites. Of the 43 fish species observed, 67% displayed a decline in abundance. Two important commercially fished species, *Oblada melanura* [7] and *Mullus surmuletus* [8] showed a 95% and 78% decline respectively, while *Chromis chromis* displayed a 85% decline in abundance (Fig. 1), a cause for concern for coastal diversity in littoral zone waters in the south part of Samos island. Depletion of shallow sublittoral communities in many areas can most likely be attributed to historical overfishing [9].

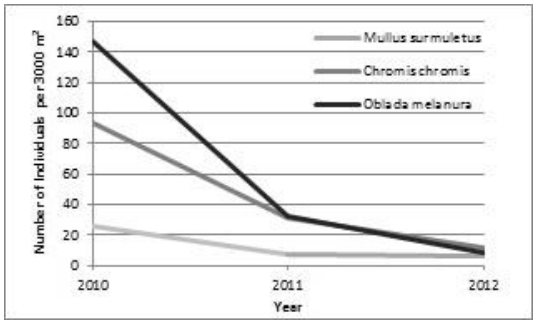

Fig. 1. Change in overall *Mullus surmuletus*, *Chromis chromis* and *Oblada melanura* population between 2010 and 2012 at three sites, Samos, NE Aegean Sea Greece.

Algal assemblages were considerably more stable than fish over inter-annual timescales and little variation in the overall algal biodiversity was observed over the three year period, with only minor changes in both abundance and species composition. However, in 2012 the presence of the invasive species *Caulerpa racemosa* was observed, which is of great concern for sublittoral rocky habitats around Samos, due to the associated decrease in the ecosystem biodiversity of reefs colonised by this invasive algal species [10].

Further longer term studies are essential for continued monitoring and conservation of sublittoral rocky communities and thus coastal biodiversity in the Aegean Sea. The large decline in fish biodiversity and abundance highlighted by this study implies future work should focus on the dynamics and community structure of fish populations over interannual and intra-annual time periods, and monitor the spread of invasive species in these communities.

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A STUDY ON MACROBENTHIC BIOTA OF UPPER-INFRALITTORAL ZONE IN SOME ISLANDS OF THE BLACK SEA AND THE SEA OF MARMARA

D. A. Orun [1]* and B Topaloglu [1]
[1] Istanbul University Faculty of Fisheries - orundeniz@hotmail.com

Abstract
The study was carried out to determine benthic biota of hard substrates with environmental variables in the islands, located both at Black Sea and the Marmara Sea,excluding Istanbul Strait. Samples were taken from upper-infralittoral zone of six stations in monthly intervals during a year between May 2011- April 2012. Seven groups organisms were found and Crustacea was the most abundant group.

Keywords: Zoobenthos, Infralittoral, Islands, Marmara Sea, Black Sea

Introduction
Biodiversity represents ecosystem, species and genetic diversity, includes all living groups. The size of diversity in a region is measured by the groups of species. This explained on the basis of conducted regional studies depending on faunistic and floristic studies [1]. Benthic samples were taken from 400 cm^2 size (20cm x 20cm) space (quadrate) by a spatula. It was washed through 500µm mesh sized sieve and fixed by 4% formaldehyde. Morphological characteristics of the samples were examined by stereo binocular microscope and the dominant structure of the communities were analyzed as qualitative and quantitative. For determination of physicochemical properties, water temparature, salinity and dissolved oxygen was measured for each station monthly.

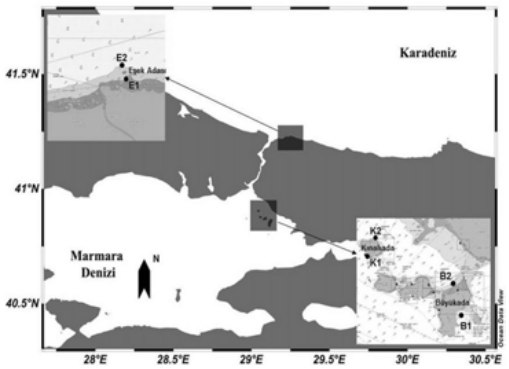

Fig. 1. Sampling stations

The Percentage of Dominance of Systematic Groups
To consider dominance of the systematic groups during the year depending on amounts of species, Crustacea takes the first place with 59 % (Figure 2). The percentage value of systematic groups depends on stations was represent in the figure 3. Polychaeta was the dominant group (33 %) in E2 (in Esek Island). Crustacea (22 %) in K1 (in Kinaliada Island); Mollusca (32 %) in E2 (in Esek Island); Echinodermata (52 %) in B1 (in Büyükada island) Nemertini 44 % in K2 (in Kinaliada); Platyhelminthes 22 % in E1 (in Esek Island); Oligochaeta 40 % in K1 (Kinaliada) was predominately found (Figure 2).
In previous studies, Topaloglu and Kihara (1993) studied on Istanbul Strait benthic communities and found 9 sistematic groups [2]. Balkis and Albayrak (1994) studied on benthic amphipods of Istanbul Strait and they found 9 groups [3]. Albayrak (1996) was studied on Echinoderm fauna of Istanbul Strait and he determined 8 systematic groups [4]. In 2001 Balkis and Albayrak studied on Vermes fauna of Istanbul Strait. In this study Turbellaria was being represented by 2 species, Nemertini by 1, Stematopoda by 4, Polycheta by 23 and Echiuroidea by 1 species [5].

We found an evident correspondence between systematic groups and the environmental situation at each site. According to its fauna, ecological parameters in stations with relatively lower results were poor in terms of diversity. In E1 (Esek Island station 1) and B2 (Büyükada Island station 2) which we found only four taxa, while the other stations were the sites with the greater diversity of benthic macroinvertebrates.

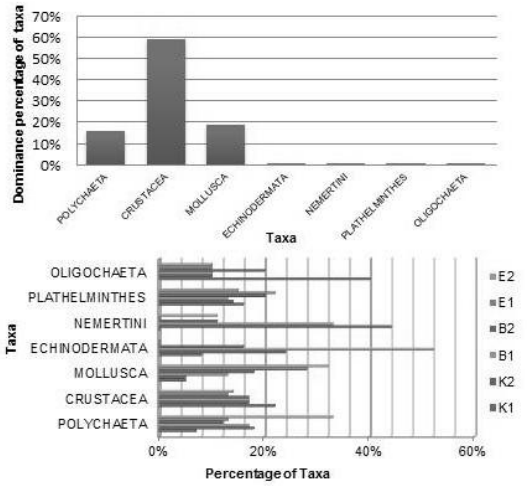

Fig. 2. Dominance percentage of the systematic groups and their distribution in the stations

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ÉVALUATION DE LA MACROFAUNE DU SUBSTRAT ROCHEUX DE LA COTE MOSTAGANEM

Aicha Oulhiz [1]* and Dina L. Soualili [1]
[1] Université Abdelhamid Iben Badis, Faculté des Sciences de la Nature et de la Vie - aichahoua@yahoo.fr

Abstract
Durant cette dernière décennie, la macrofaune benthique est utilisée pour évaluer la qualité d'un milieu. Dans cette étude, un inventaire des espèces du macrobenthos de trois sites à substrat rocheux de Mostaganem a été réalisé. Les indices de diversité et les descripteurs statistiques ont été utilisés. Les résultats ont montré un total de 29 espèces, représentées respectivement par 28 sp à Stidia, 16 sp à Kharouba et 21 sp à Hadjadj. Aussi, les stations (Stidia et Hadjadj) semblent être diversifiés et non polluées, par rapport à la station de Kharouba, qui montre les premiers signes de dégradation et de perturbation de son milieu.

Keywords: Biodiversity, Bio-indicators, Supralittoral, Algerian Basin

Introduction
Les écosystèmes côtiers marins du bassin méditerranéen possèdent, en particulier, une richesse spécifique en termes de biodiversité, qui les place immédiatement après les écosystèmes tropicaux. Cependant, ces derniers soufrent depuis fort longtemps de graves problèmes environnementaux (pollution, dégradation des ressources marines, des sols…) [1]. Ce qui n'est pas sans conséquences sur la santé humaine. Parmi les zones les plus affectées par cette pollution, on retrouve celles des cotes algériennes, qui sont considérées comme des zones à hot spot de pollution. C'est dans ce contexte que s'inscrit cette étude, où on se propose de faire une première évaluation de la qualité du milieu de trois sites à substrat dur de la cote de Mostaganem en déterminant les espèces macrobenthiques qui sont actuellement largement utilisées comme bioindicateurs ([2], [3]) pour évaluer la qualité des milieux des zones côtières.

Matériel et méthodes
Trois sites ont été sélectionnés, caractérisés par un substrat rocheux : Stidia, Kharouba et Hadjadj. Les sites ont été choisis d'une part, pour leurs différences d'exposition aux différentes sources de pollution, et d'autres parts pour la richesse biologique qui y règne. L'échantillonnage, a été réalisé en utilisant la méthode des quadras de 1m2, jeté le long d'un transect, définit au hasard sur le substrat rocheux de l'étage médiolittoral des trois sites étudiés, l'inventaire de la population d'invertébrés est réalisé pour quantifier l'abondance et la composition de la population d'invertébrés mobiles ou fixées présentes. La surface totale balisée est de 100 m² dans chaque site. Le calcul des indices biologiques [la richesse spécifique (S) et l'abondance (A)] définies par [4] a été réalisé. Aussi, les indices de diversité [indice de Shannon-Wiener (H') et l'indice d'équitabilité de Piélou] définis par [5] ont été calculés.

Résultats et Discussion
La richesse faunistique globale est très importante au niveau des côtes rocheuses de Mostaganem et principalement au niveau de la cote de Stidia. Elle est représentée par un total de 29 espèces appartenant à quatre groupes zoologiques : les Mollusques; les Arthropodes; les Echinodermes et les Cnidaires (Fig. 1).

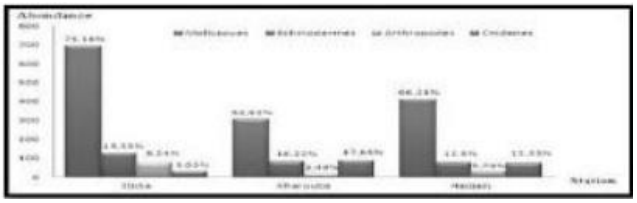

Fig. 1. Répartition des différents groupes zoologique dans les sites étudiés

L'analyse des indices de diversité de Shannon-Weaver et de régularité de Piélou (Fig. 2) met en évidence une présence de peuplements benthiques généralement structurés sur les sites de Stidia et Hadjadj, par apport au site de Kharouba. Sur la base de ses résultats, onpeut classer le degré de pertubation des sites selon le gradient suivant : Site Stidia → Hadjadj → Kharouba (plus perturbé).

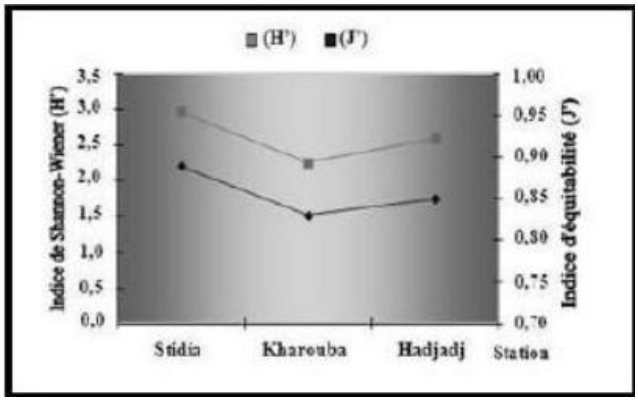

Fig. 2. Synthèse des indices de diversité des trois sites étudiés

Le schéma général d'organisation structurelle des peuplements montre que les sites de Stidia et Hadjadj se manifestent par un peuplement dense et diversifié par rapport au site de Kharouba. Les résultats ont montré, que le site de Stidia est caractérisé par les valeurs, les plus élevés, en abondance, en dominance et en richesse spécifique ainsi qu'en indices de diversité par rapport aux deux autres sites Hadjadj et Kharouba. Donc, l'analyse de la composition des peuplements benthiques a révélé un état général satisfaisant des sites de Stidia et de Hadjadj. Cependant, le site de Kharouba, semble présenter les premiers signes de perturbation et de dégradation du milieu.

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MACROFAUNA ASSOCIATED WITH A BANK OF *CLADOCORA CAESPITOSA* (L.) IN THE GULF OF TRIESTE (NORTH ADRIATIC)

Valentina Pitacco [1]*, Martina Orlando-Bonaca [1], Borut Mavric [1] and Lovrenc Lipej [1]
[1] National Institute of Biology, Marine Biology Station, Piran - Valentina.Pitacco@mbss.org

Abstract
The Mediterranean stony coral (*Cladocora caespitosa*, Linneus, 1767) is a native colonial, zooxanthellate, shallow-water coral. It is able to host a diversified faunal assemblage, which is still relatively unknown. A bank of *C. caespitosa* in the Gulf of Trieste was investigated in November 2010. Larger specimens were determined by rapid assessment. Stony coral colonies were measured and eventually broken down for infauna sorting and determination. Taxa composition in colonies differed markedly from surrounding areas. A large number of juveniles were observed in colonies, confirming the importance of this species as a nursery ground.

Keywords: Zoobenthos, North Adriatic Sea, Biodiversity

The Mediterranean stony coral (*Cladocora caespitosa*, Linneus, 1767) is a native colonial, zooxanthellate, shallow-water coral, particularly sensitive to global changes and anthropogenic activities. Due to its shape and size is able to host a diversified faunal assemblage (1). Nevertheless, very little is known about the macrofauna associated with this coral. Solitary colonies of *Cladocora* can be locally abundant (2), while banks are uncommon and have been reported only in the Ligurian (3), Adriatic (4) and Aegean Sea (5). In the Gulf of Trieste a bank of *C. caespitosa* was discovered recently close to Cape Ronek (Slovenia). The aim of the present work was to investigate the invertebrate fauna associated with this biogenic formation, in order to estimate to what extent this coral is important for biodiversity.

The biogenic bank close to Cape Ronek was investigated in November 2010. Largest organisms were determined by rapid assessment immediately after sampling; smallest organisms were stored in alcohol (70%) and analysed in laboratory. Percentage of living polyps was estimated and then colonies were broken down. All animals were sorted and determined to the lowest possible taxonomic level.

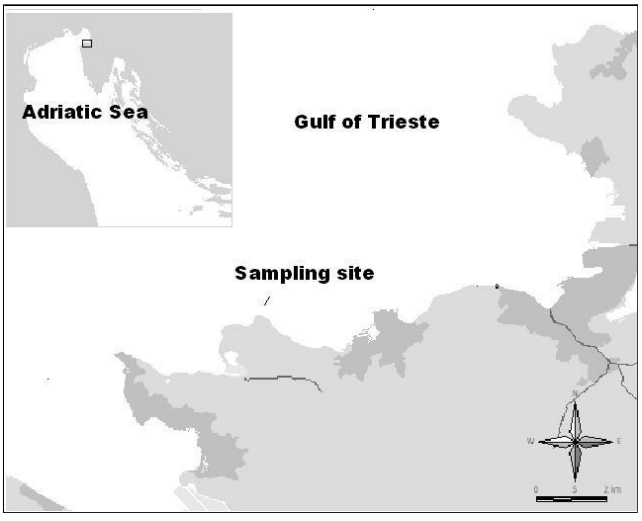

Fig. 1. The map of the sampling site.

Altogether 121 different taxa, belonging to 9 different phyla: Porifera, Cnidaria, Sipunculida, Mollusca, Anellida, Arthropoda, Bryozoa, Echinodermata and Tunicata were found.

Eighty-nine different taxa were identified in *C. caespitosa* colonies. The great majority were polychaetes (50%), followed by mollusks (25%) and crustaceans (16%). 3386 animals were counted; the most abundant were mollusks (50%), followed by polychaetes (20%) and crustaceans (7%). Many of these specimens were juveniles, confirming the importance of *C. caespitosa* colonies as a nursery ground for invertebrates.

In the detritic bottom surrounding colonies 223 individuals were found, belonging to 26 different taxa. Echinoderms were the most abundant (70%), followed by mollusks (22%). The groups with the higher number of taxa were found in mollusks (58%) and echinoderms (27%). Only 5 taxa (4% of the total) were found both within and without *C. caespitosa* colonies and only 3 of them were possible to determine at the species level (*Arca noae*, *Rocellaria dubia* and *Hiatella artica*). These results confirm that *C. caespitosa* is an important bioconstructor, able to create a habitat favourable for different assemblages compared to the surrounding areas. Infaunal assemblages in coral colonies exhibited similar taxa composition, but they differed markedly from assemblages in the surrounding area.

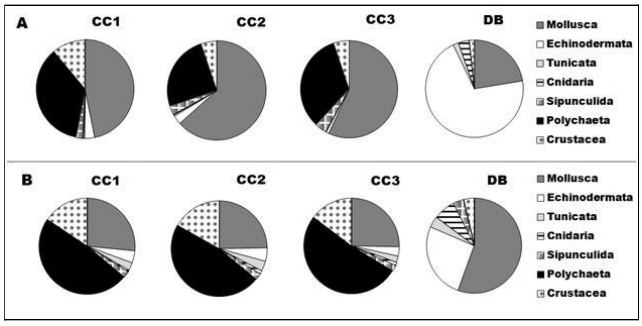

Fig. 2. Percentage of abundance (A) and richness (B) of different phyla (colonial organisms excluded).

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RAPID, SHORT AND IMPRESSIVE COLONISATION ON ONE MODULE TYPE OF ARTIFICIAL REEF BY DIDEMNIDAE ASCIDIANS

E. Rouanet [1]*, P. Bonhomme [1], A. Antonioli [1], P. Astruch [1], D. Bonhomme [1] and L. Le Direach [1]
[1] GIS Posidonie - Aix Marseille University - Campus de Luminy Case 901 - 13288 Marseille cedex 09 - France - elodie.rouanet@univ-amu.fr

Abstract
The seasonal study of ecological succession of benthic sessile assemblages associated with the Prado artificial reefs (Marseilles, France) shows rapid and short Didemnidae ascidian colonisation mainly on one module type AR.

Keywords: Artificial reefs, Tunicata, North-Western Mediterranean

Introduction
The colonisation of artificial reefs (AR) by benthic species plays an active role in the determining the structural complexity of the new habitats they provide. Monitoring of benthic colonisation dynamics is essential, especially to understand changes in species diversity, temporal and spatial patterns and benthic assemblages according to module types, which offers a basis for understanding the functioning of this new ecosystem. During the early years of the installation of ARs, assemblages develop very quickly, with the spread and intensive colonisation by pioneer taxa such as Didemnidae ascidians, then by secondary species.

Material and methods
Benthic assemblages associated with the Prado artificial reefs (Marseilles, France) were studied in every season from summer 2009 through autumn 2012 (14 sampling seasons), on 5 types of module (4 in concrete: metal and fakir baskets, cube piles, concrete baffled reefs and 1 in rock: quarry rocks), installed in 2008. Sessile benthic species were studied on the basis of photographic permanent quadrats measuring 25 cm x 25 cm, divided into 100 sub-quadrats. They were analyzed by the indirect visual estimation method [1, 2] to determine species richness and estimate sessile taxa cover (percentage). 200 pictures were taken and analyzed per sampling season.

Results
The morphology of the module types influences colonisation patterns [for more information see 3]. Didemnidae colonisation was significantly different between module types, where mean percent cover is higher in simple, well-lit modules (cube piles) than in complex and shaded modules (metal and fakir baskets, concrete baffled reefs). Values are very low in quarry modules sensitive to sedimentation (quarry rocks) (Fig. 1).

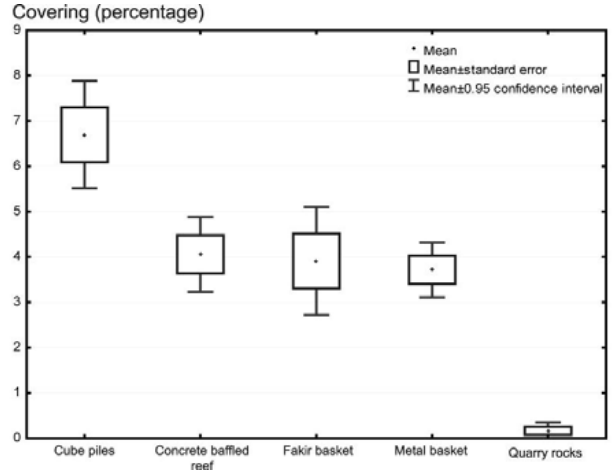

Fig. 1. Mean Didemnidae cover on different types of module (all sampling seasons included).

From the first samplings, on all concrete module types, Didemnidae rapidly reaches a maximum cover 2 years after installation of the ARs, and then these values quickly decrease through subsequent samplings. In spring 2010, on cube piles, Didemnidae occupied a third of its surface and in next sampling (3 months later), this surface was divided by 7.4 (Fig. 2). Mean Didemnidae percent cover was significantly different between years and seasons (Kruskal-Wallis test, $p<0.05$ for both factors). Although in time, peak fluctuations of percent cover were noted every year during the cold water season sampling (winter and/or spring), values were significantly different between these peaks (Kruskal-Wallis test, $p<0.05$) with a decrease over time (Fig. 2).

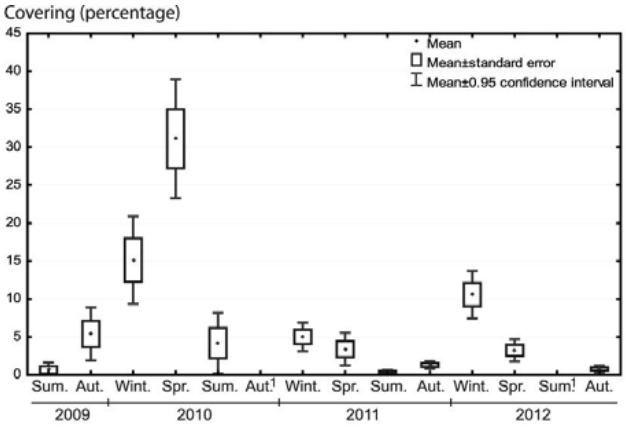

Fig. 2. Mean Didemnidae cover on cube piles module over time. [1]: no data; n = 48 quadrats per season.

Discussion
Settlement, maximum development and decrease of cover of Didemnidae ascidians were rapid after the installation of the Prado ARs and very rapid over time (1 year, from summer 2009 to summer 2010) especially on the well-lit module (cube piles). The decrease of Didemnidae percent cover though sampling seasons is benefits various taxa (macrophyta, corallinales, bryozoa, hydrozoa, porifera) [3]. This impact of this phenomenon on other sessile community development processes remains to be studied.

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Session

Soft bottoms

Modérateur : **Charles Boudouresque**

SOFT BOTTOM SIPUNCULANS IN THE ÇANAKKALE STRAIT (SEA OF MARMARA)

Sermin Acik [1]*
[1] Dokuz Eylul University Institute of Marine Sciences and Technology - serminacik@yahoo.com

Abstract
This study deals with the sipunculan species collected from 17 to 94 m depths at 7 stations in the Çanakkale Strait. A total of 4 species and 169 individuals belonging to four families were encountered. Three species [*Sipunculus* (*Sipunculus*) *nudus*, *Thysanocardia procera* and *Onchnesoma steenstrupii steenstrupii*] are new records for the Sea of Marmara. *Onchnesoma steenstrupii steenstrupii* was the most dominant and frequent species. Brief descriptions of the species and their biometrical and distributional features are given.

Keywords: Zoobenthos, Biometrics, Systematics, Marmara Sea

Introduction
The phylum Sipuncula has almost 150 species belonging to 17 genera worldwide (3), 36 species belonging to 9 genera in the Mediterranean Sea (2 and 4) and 20 species belonging to 9 genera on the coasts of Turkey (1 and 2). The aim of this study is to assess the sipunculan diversity in the Çanakkale Strait, and to give biometrical and distributional features of the species.

Material and Methods
Benthic samples were taken with a van Veen grab (sampling ca. 0.1 m^2 area) at 7 stations (17-94 m) in the Çanakkale Strait in December 2010 (Figure 1). The samples were sieved through a 0.5 mm mesh and fixed with 10% formalin. In the laboratory, sipunculans were identified, counted and preserved in 70% ethanol. Biometrical measurements of the smallest and largest individuals of each species were measured by using an ocular micrometer.

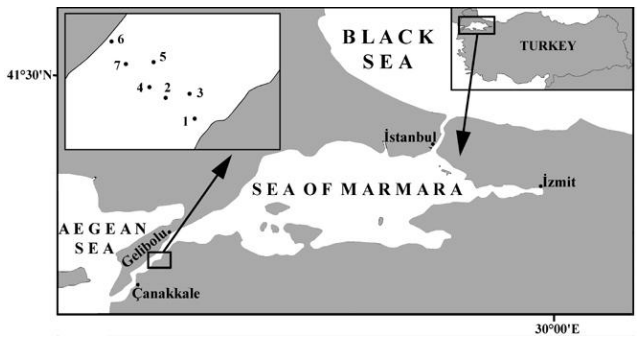

Fig. 1. Map of the investigated area with the location of sampling sites.

Results and discussion
The examination of materials collected on soft substrata in the Çanakkale Strait revealed 4 species and 169 individuals belonging to four families (Sipunculidae, Golfingiidae, Phascolionidae and Aspidosiphonidae). The family Phascolionidae had the majority of specimens (99 individuals, 58% of the total), followed by Aspidosiphonidae (68 individuals, 40%), Sipunculidae (1 individual, 1%) and Golfingiidae (1 individual, 1%), respectively. Among the species, *Onchnesoma steenstrupii steenstrupii* was the most dominant (58% of total number of individuals) and frequent (present in 100% of samples) species. The other common species in the area was *Aspidosiphon* (*A.*) *muelleri* (present in 71.4% of samples). *Sipunculus* (*S.*) *nudus*, *Thysanocardia procera* and *Onchnesoma steenstrupii steenstrupii* were newly reported from the area. With this new records, the known number of sipunculans in the Sea of Marmara was raised from 3 to 6.

Sipunculus (*Sipunculus*) *nudus* Linnaeus, 1766
Body wall thin, light brown. Trunk 120 mm long, 10 mm wide. Introvert bearing triangular scale-like papillae. The number of longitudinal muscle bands on trunk 30. Digitate processes present on brain. Intestinal spiral with 10 coils; attached to body by numerous mesenteries. Two contractile vessels without villi. Two pairs of retractors arise at same level; ventral pair from bands 1-7 and dorsal from bands 7-15. Nephridiopores anterior to anus. Spindle muscle unattached to body wall posteriorly. Two eye spots present.
Distribution Cosmopolitan species (3).

Thysanocardia procera (Moebius, 1875)
Body yellowish-red in colour, with circular base and rounded point. Trunk 4 mm long, 1.5 mm wide. Introvert 6 mm long, 0.7 mm wide. 7 tentacles surrounding bilobed nuchal organ. Distinct brown line present on oral surface of tentacle. Papillae on posterior end of trunk 20-35 µm height, 15-30 µm in diameter; papillae on anterior part of trunk 20-30 µm height, 10-20 µm in diameter. Contractile vessel with distinct villi. Nephridiopores at same level to anus.
Distribution Northeastern Atlantic Ocean and Mediterranean Sea (3).

Onchnesoma steenstrupii steenstrupii Koren & Danielssen, 1875
Pear-shaped or barrel-shaped trunk, 0.8-2 mm long, 0.6-1 mm wide. Introvert partly everted, 0.6-6 mm long, 0.2-0.5 mm wide. 22-23 radiating keels present at posterior part of trunk. Small wart-like papillae on surface of trunk, 15-25 µm long, 15-30 µm in diameter. Spindle and wing muscle absent. Anus located near mouth. Intestine with several coils. Only one retractor attached at posterior part of body. Some specimens with elliptical eggs; longer axis 100-150 µm in diameter, smaller axis 80-125 µm in diameter.
Distribution Atlantic, western Pacific and southwest Indian Oceans, Mediterranean Sea (3) and Red Sea (5).

Aspidosiphon (*Aspidosiphon*) *muelleri* Diesing, 1851
Body wall thin, semi-transparent. Trunk 3-8.2 mm long, 1-1.8 mm wide. Introvert 3.4-9.8 mm long, 0.5-1 mm wide. Introvert with 40-80 rings. Bidentate hooks 13-30 µm tall, 15-30 µm wide; unidentate hooks 15-25 µm long, 15-28 µm wide. Longitudinal musculature continuous. Anal shield with 10-16 longitudinal grooves. Caudal shield with 15-18 radial grooves. Intestinal spiral with 6-14 coils. Retractor muscles attached at near posterior part of trunk. Anus and nephridiopores placed at same level. This species was found within empty shells of gastropods and tubes of the polychaete species *Vermiliopsis* sp.
Distribution Indian Ocean (6), Northeastern Atlantic and Eastern Pacific Oceans, Mediterranean and Red Sea (3).

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NOW YOU SEE IT, NOW YOU DON'T: PRESENCE OF *CAULERPA RACEMOSA* VAR. *CYLINDRACEA* (CHLOROPHYTA, CAULERPALES) IN THE MALTESE ISLANDS

Jacqueline Barbara [1]* and Joseph A. Borg [1]
[1] University of Malta, Biology Department - jackie.barbara@gmail.com

Abstract
Caulerpa racemosa var. *cylindracea*, an invasive alga present in the Mediterranean Sea, was first recorded from the Maltese Islands in 1997. Between then and the mid-2000s, the alga spread rapidly and became abundant at most coastal sites around the islands. However, its spatial distribution and abundance decreased rapidly after 2006, such that the alga has become rare to encounter locally. The present work, which formed part of a broader study to assess the influence of *C. racemosa* on hard bottom infralittoral habitats, confirms a large decline in the distribution and abundance of this species in recent years in Maltese coastal waters.

Keywords: Alien species, Algae, Biogeography, Sicily Channel

Introduction
Caulerpa racemosa was first reported from the Maltese Islands in 1997 [1]. Since then, the species spread rapidly, such that it became ubiquitous and abundant around the Maltese Islands [2]. A study by Camilleri undertaken in 2005 [3] concluded that nutrient enrichment promoted an increased abundance of *C. racemosa* in Maltese coastal areas. The main objective of the present study was to gather data on the distribution and abundance of *C. racemosa* around the Maltese Islands, given that preliminary observations indicated a local decline of the species during the past six years.

Methods
Surveys using snorkeling and SCUBA diving were undertaken during summer 2009 at 11 sites located on the northeastern coast of Malta. All study sites had similar exposure and coastal geomorphological characteristics, and were located within the 2 m – 5 m depth range. Estimates of the abundance of *C. racemosa* were carried out at each site by recording the percent cover of the alga in each of three replicate 20 cm x 20 cm quadrats. From three of the sites where *C. racemosa* had a percentage cover greater than 10%, St. Paul's Bay, Salina Bay and Zonqor Point, the algae enclosed within the quadrat were scraped off using a small trowel and transferred to a mesh bag. In the laboratory, the algae from each replicate quadrat were separated according to species and then dried separately at 80°C for 24 hours to obtain estimates of dry weight per quadrat for each alga, including for *C. racemosa*.

Results & Discussion
Of the 11 sites surveyed, 5 did not support any *C. racemosa*, 3 had very sparse growth, and the remaining 3 supported a mean percentage cover of 38.33% - 65% (Tab. 1), although values of percentage biomass obtained from the latter sites were rather low (Tab. 1). Furthermore, the latter 3 sites, where *C. racemosa* had the highest percentage cover and biomass, happen to be characterized by relatively (i.e. compared to the other study sites) poor water quality and elevated nutrient levels. The findings contrast with those of previous studies; for example, in the present study *C. racemosa* was completely absent from St. Thomas Bay and Marsaxlokk, which are known previously to have supported extensive meadows of the alga [2]. Although it is difficult to identify with certainty the factor/s that have led to the observed decline of *C. racemosa* around the Maltese Islands, a possible reason may be decreased nutrient levels in coastal waters, which resulted from nationwide efforts and measures adopted in recent years to improve coastal water quality [4]. *C. racemosa* is a highly opportunistic species and generally invades habitats that are disturbed and degraded, including areas characterized by poor water quality and elevated nutrient levels. Improved water quality seems to have contributed to the decline of the invasive alga and/or increased vitality of native algal species, which have regained their original abundance.

Conclusions
The results of the present work support the hypothesis that the distribution and abundance of *C. racemosa* have declined around the Maltese Islands in recent years, and that this may have resulted from decreased nutrient levels in coastal waters, and the re-establishment of native algae in its stead.

Tab. 1. Estimates of percentage cover and biomass (± SD) of *C. racemosa* recorded from the 11 study sites.

Sites	Mean % cover of *C. racemosa*	Mean % dry weight (g) of *C. racemosa*
White Tower Bay	Absent	-
Armier Bay	Absent	-
St. Paul's Bay	61.6 ± 2.89	24.19 ± 1.89
Salina Bay	38.33 ± 2.89	13.25 ± 2.72
Bahar ic-Caghaq	7.67 ± 2.52	-
St. George's Bay	6.67 ± 2.89	-
Spinola Bay (St. Julians)	1.67 ± 2.89	-
Sliema Bay	Absent	-
Zonqor Point (Marsaskala)	65.00 ± 5.00	20.93 ± 0.89
St. Thomas Bay	Absent	-
Marsaxlokk	Absent	-

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EVIDENCE OF ANCHOR EFFECT IN A *POSIDONIA OCEANICA* SEAGRASS MEADOW UNDER LOW ANCHORING PRESSURE *VIA* A MULTI-CRITERIA GRID

E. Rouanet [1], P. Astruch [1], D. Bonhomme [1], P. Bonhomme [1], E. Rogeau [1], T. de Saint Martin [1] and C. F. Boudouresque [2]*
[1] GIS Posidonie, Aix-Marseille University, Luminy campus, 13288 Marseille cedex 9 France
[2] Aix-Marseille University, Mediterranean Institute of Oceanography (MIO) - charles.boudouresque@univ-amu.fr

Abstract
An index (MCAI: Multi-Criteria Anchoring Index) based upon nine parameters and their weighting is proposed. It evidences the effect of anchoring on the *Posidonia oceanica* seagrass meadow, even under relatively low mooring pressure.

Keywords: Posidonia, Monitoring, North-Western Mediterranean

Introduction

Posidonia oceanica is a Mediterranean seagrass that is sensitive to a variety of anthropogenic disturbances and stress, among them anchoring. The impact of large boats, e.g. cruise ships, is obvious [1,2]. As far as small pleasure boats are concerned, the maximum sustainable mooring pressure on *P. oceanica* meadows has be suggested to be two anchorage events ha^{-1} d^{-1} (annual average), the number of anchoring boats never exceeding 10 ha^{-1} for a given day [3]. Higher anchoring pressure would result in meadow regression. In contrast, under low mooring pressure, the effect of anchors proved to be more or less unclear, whenever the proxies of anchoring pressure were considered separately.

Material and methods

Six sites within the Port-Cros National Park (Provence, France, northwestern Mediterranean Sea), 7 to 9 m depth, were studied in 2011. Mooring has been banned at Site 2 (East Bagaud Island) since 1993 and Site 6 (Pointe Nord) since 2002. Anchoring pressure is very low in summer at Site 1 (East Bagaud Island: 0.08 boat ha^{-1} d^{-1}). It is relatively low at Site 3 (Saint-Pierre Cove: 0.12 boat ha^{-1} d^{-1}), Site 4 (Fausse Monnaie Cove: 0.13 boat ha^{-1} d^{-1}) and Site 5 (Pomme d'Or Point: 0.13 boat ha^{-1} d^{-1}) [4]. Parameters taken into account were: **(i)** *P. oceanica* percent cover, **(ii)** shoot density, **(iii)** bared rhizomes, **(iv)** % of plagiotropic (i.e. creeping) rhizomes, **(v)** number of free uprooted and broken shoots, **(vi)** compactness of the matte, **(vii)** fragmentation of the meadow, **(viii)** density of living individuals of the noble pen shell *Pinna nobilis* and **(ix)** ratio between living and dead or broken *P. nobilis* shells. Parameters (v), (viii) and (ix) are innovative.

Tab. 1. Multi-criteria grid of *P. oceanica* meadow parameters (i through ix), parameter marks (0 through 2) and parameter weighting (1 through 3). Study sites are ranked from absence of mooring (left: 2 and 6) to highest anchoring pressure (right: 4 and 5). In each box: the product of mark and weighting. White = normal status, light grey = intermediate status, dark grey = abnormal status. MCAI = overall mark for a given site.

Para-meter	Wei-ght	Site 2	Site 6	Site 1	Site 3	Site 4	Site 5
i	3	2 x 3 = 6	2 x 3 = 6	1 x 3 = 3	1 x 3 = 3	1 x 3 = 3	0 x 3 = 0
ii	2	1 x 2 = 2	1 x 2 = 2	2 x 2 = 4	1 x 2 = 2	1 x 2 = 2	0 x 2 = 0
iii	1	1 x 1 = 1	1 x 1 = 1	2 x 1 = 2	1 x 1 = 1	1 x 1 = 1	2 x 1 = 2
iv	2	2 x 2 = 4	2 x 2 = 4	1 x 2 = 2	1 x 2 = 2	2 x 2 = 4	2 x 2 = 4
v	3	2 x 3 = 6	2 x 3 = 6	0 x 3 = 0	0 x 3 = 0	0 x 3 = 0	0 x 3 = 0
vi	2	2 x 2 = 4	1 x 2 = 2	2 x 2 = 4	2 x 2 = 4	1 x 2 = 2	1 x 2 = 2
vii	1	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	1 x 1 = 1
viii	1	2 x 1 = 2	2 x 1 = 2	2 x 1 = 2	1 x 1 = 1	2 x 1 = 2	1 x 1 = 1
ix	3	1 x 3 = 3	2 x 3 = 6	2 x 3 = 6	1 x 3 = 3	1 x 3 = 3	0 x 3 = 0
MCAI		30	31	25	18	19	10

Results and discussion

For each parameter (i through ix), at each site (1 through 6), a mark was assigned, based on [3, 5] and field observations: 0 = abnormal, 1 = intermediate and 2 = normal. A few parameters were correlated with the anchoring pressure (i, v and vii), while most of them were not clearly correlated (Table 1). However, the 9 parameters considered are of strongly contrasted importance: percent cover, number of broken shoots and ratio between living ans broken *Pinna nobilis* shells matter more than e.g. bared rhizomes and compactness of the matte. Parameters were therefore weighted (1 through 3). For each parameter at each site, the site mark was the product of parameter mark and parameter weight. The overall mark (MCAI: Multi-Criteria Anchoring Index) for a given site was the sum of the nine site marks (Table 1). For more details, see [6]. While individual parameters give contrasted responses, if any, to low mooring pressure, the multi-criteria response (overall mark, MCAI; Table 1) unequivocally evidences, for the first time, the expected response of the seagrass meadow. However, it is worth noting that the evidence of an effect does not mean that it is beyond the resilience of the meadow: for example, the annual production of new shoots (*via* rhizome branching) can compensate shoot breakage (by anchors).

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SOFT-BOTTOM MACROBENTHOS MONITORING IN THE FRAMEWORK OF THE STARE-CAPMED PROGRAM

A. Donnay [1]*, C. Pelaprat [2], C. Fréjefond [2], S. Gobert [3] and P. Lejeune [2]
[1] STARESO SA - Océanologie, Université de Liège - annick.donnay@stareso.com
[2] STARESO SA, France
[3] Océanologie, Centre MARE, Université de Liège, Belgique

Abstract
STARE-CAPMED is a research program set up by the Stareso research station (Calvi, Corsica). Its aim is to improve the understanding of processes by which anthropogenic activities have adversed effects on the functioning of Calvi Bay coastal ecosystems. One of its work packages is the monitoring of soft-bottom macrobenthos along 5 gradients of potential anthropogenic pressures. First results suggest that, before summer (summer is the period where man-driven impacts are expected to be stronger due to high tourist frequentation) these sources of potential anthropogenic pressures perturb soft-bottom macrobenthos assemblages.

Keywords: Zoobenthos, Monitoring, Biodiversity, Ligurian Sea

Introduction
The STARE-CAPMED (STAtion of Reference and rEsearch on Change of local and global Anthropogenic Pressures on Mediterranean Ecosystems Drifts) research program aims to 1) improve the understanding of processes by which anthropogenic activities have adverse effects on the functioning of Calvi Bay coastal ecosystems and 2) establish Calvi Bay as a reference area for a long term monitoring to differentiate anthropogenic influences from global influences.
This program has ten work packages, including the monitoring of soft-bottom macrobenthos communities. Surveys are based on 5 potential anthropogenic sources: a wastewater treatment plant emissary, a fish farm, a harbor area, an open boat anchoring area and a river mouth. For each source, 3 areas are sampled: near the source, at a mean distance (±430 m from the source, at a depth of 20 m) and at a long distance (±1400m from the source, at a depth of 40 m).

Material and Methods
Samples were taken before (May) and after (September) the summer (i.e. the period where man-driven impacts are expected to be stronger due to high tourist frequentation). Applied methods followed ISO 16665. Sampling was done by SCUBA diving, using an Ekman grab (0.09 m²). At each station, three samples were taken for macrobenthos analysis, and a fourth one to investigate sedimentologic features. Samples were sieved (1 mm mesh size), sieve residues were fixed with buffered formalin. Specimens were sorted out, counted and identified to the lowest possible taxonomic level, usually the species. The World Register of Marine Species (WoRMS; [1]) was used as reference list. Samples characteristics (Richness Specific (S), Density, Shannon Diversity indices (H' ($\log_2$)), Pielou equitability (J')), Cluster analysis, MDS and Simper analysis were calculated using Primer 6 software. Most used indices were also calculated (AMBI, M-AMBI, IT, ABC Curve and Clarke Indices) to qualify the animal communities present in the sediment. Main sedimentologic characteristics were determined (Median, Skewness indices, Kurtosis indices, COT and MO values) to help for macrobenthic interpretation.

Results and Discussion
In samples from May 2011, a total of 5853 individuals, belonging to 372 species were identified. Polychaeta were the main taxa (64%). AMBI values were comparable across all samples. No macrobenthic assemblage from any area seemed to be majorly perturbed before summer. However, anterior results collected after summer time near the wastewater treatment plant emissary (1992, 2006) and the fish farm (2007, 2008) highlighted perturbations in soft-bottom meadows ecosystems.
The long-term monitoring of the bay system will allow differentiation of perturbations caused by global modifications (e.g. climate change) and perturbations originating from direct, small-scale anthropogenic influences. We can hypothesize that long-term global changes could indirectly induce modifications macrobenthic assemblages through several processes. First, a potential increase of bad weather events frequency and intensity could change the granulometry and organic matter contents near the river mouth and in shallow areas. Moreover, a modification of planktonic assemblages induces perturbations of food webs, and therefore changes organic matter inputs. Finally, the emergence of invasive species such as *Caulerpa racemosa* var. *cylindracea* could cause changes in granulometric conditions [2, 3]. The significant development of this alga in Calvi Bay [4], and its consequences on soft-bottom macrobenthos will be also investigated in the framework of the STARE-CAPMED program.

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APPLYING FOURIER ANALYSES TO ASSESS INFLUENCE OF ENVIRONMENTAL FACTORS ON SHELL MORPHOLOGY OF MEDITERRANEAN ENDEMIC BIVALVE *PINNA NOBILIS*

Laura Lozano [1]*, Maite Vázquez-Luis [2] and Salud Deudero [2]
[1] Université de Perpignan (UPVD) & Centro Oceanográfico de Baleares-IEO - laulzn@gmail.com
[2] Centro Oceanográfico de Baleares-IEO

Abstract
Environmental factors such as depth or hydrodynamics can influence the morphology of *Pinna nobilis*. In the present work the variation in shape morphology was studied by Fourier analysis according to different environmental conditions. Important differences were found within juveniles and adults. Discriminant analysis with elliptical Fourier descriptors was able to classify with high accuracy 97.1% of the individuals according to the factors studied.

Keywords: Bivalves, Balearic Islands, Sampling methods, Coastal systems

Introduction The pen shell *P. nobilis* is one of the largest mollusc species, reaching total anteroposterior lengths of up to 1.2 m [1]. Shell morphology is described as triangular, with a pointed anterior end and a more developed posterior part which has a broad and rounded shape. The shell shape is strongly influenced by local environmental factors. This study aims to (1) apply Fourier analysis to determine shell morphology discarding any subjectivity on the size; (2) identify different morphologies among adults and juveniles linked to environmental factors such as depth and degree of exposure to wave action.

Material and methods
For the analyses, digital photographs of *P. nobilis* shells were taken. A total of 136 photos for right valves were chosen because they were more abundant left ones from dead individuals of *P. nobilis* collected in *P. oceanica* seagrass meadows of the Balearic Islands. But when the right valves were absent, then the left one was used. All images of the shells were slightly modified, using Adobe® Photoshop® CS5, to prepare them for digitization. Fourier analysis was calculated with the SHAPE package Iwata and Ukai, 2002 [2]. A principal component analysis (PCA) (PRIMER 6 package) was used to summarize the variance in shape captured by the elliptical Fourier. Followed statistical analysis with SPSS software to verify the correctly classified according to the factors studied by discriminant analyses.

Results and discussion
Results showed two differentiated groups according to their morphology: juveniles and adults (Fig. 1). Moreover, morphologies on juveniles and adults were different within groups according to environmental factors assessed by Fourier analysis. For areas where exposure to hydrodynamics is null, the adults present a more elongated shaped. In contrast, in exposed areas its morphology is fan-shaped. This might be related to wave exposition since at unexposed areas shells can derive energy into growth without having to cope with hydrodinamical forces. However, this pattern does not apply to the juveniles since all have a similar morphology. Regarding discriminant analysis with elliptical Fourier descriptors, four main subgroups were distinguished for juveniles and adults (Table 1) and the 97,1% of individuals were correctly classified through the cross-validation procedure.

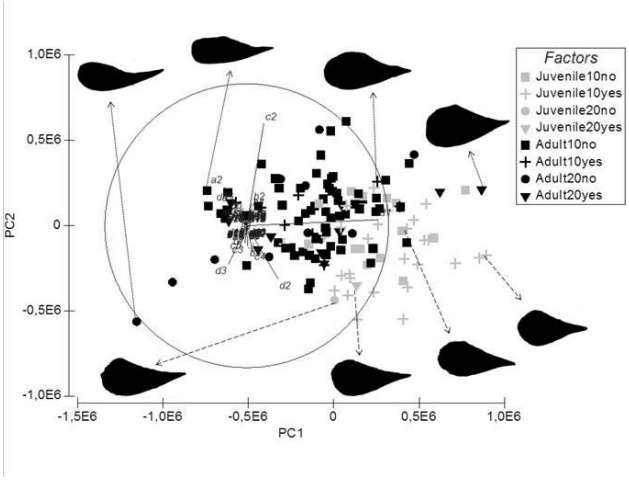

Fig. 1. PCA of the Fourier coefficients of an elliptical Fourier analysis of juveniles and adults according to environmental factors. Adult pictures presented at the top and juveniles pictures at the bottom.

Tab. 1. Discriminant analysis classification with the cross-validation testing procedure, expressed in percentages for juveniles and adults according to environmental factors.

		Predicted group membership (%)								
		Juvenile				Adult				
		10m-NO	10m-YES	20m-NO	20m-YES	10m-NO	10m-YES	20m-NO	20m-YES	n
Correctly classified: 97,1%										
Juvenile	10m-NO	100	0	0	0	0	0	0	0	14
	10m-YES	0	96,4	0	0	3,6	0	0	0	28
	20m-NO	0	0	100	0	0	0	0	0	1
	20m-YES	0	0	0	100	0	0	0	0	1
Adult	10m-NO	0	0	0	0	96,8	0	1,6	1,6	63
	10m-YES	0	0	0	0	0	100	0	0	8
	20m-NO	0	0	0	0	0	0	100	0	10
	20m-YES	0	0	0	0	9,1	0	0	90,9	11
n, sample size										

Conclusion
Image analysis technique allows us to clearly identify a wide arrange of *P. nobilis* shell morphologies related to environmental factors. This represents a useful tool to apply *P. nobilis* shell morphology as a bioindicator of the degree of exposure of the location.

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A 30-YEAR STUDY OF SEAGRASS BED FISH FAUNA SUBMITTED TO DIFFERENT WASTEWATER TREATMENTS (MARSEILLE, NW MEDITTEREAN)

M. Ourgaud [1]*, S. Ruitton [1], J. Bell [2], Y. Letourneur [3] and M. Harmelin-Vivien [1]
[1] Institut Méditerranéen d'Océanologie (MIO), Aix-Marseille Université, UM 110, Campus de Luminy, Case 901, 13288 Marseille Cedex 9, Marseille, France - melanie.ourgaud@univ-amu.fr
[2] Secretariat of the Pacific Community, BP D5, 98848 Nouméa Cedex, New Caledonia
[3] Université de la Nouvelle Calédonie, Laboratoire LIVE, Campus de Nouville, BP R4, 98851 Nouméa Cedex, New Caledonia

Abstract
The fish fauna of a *Posidonia oceanica* seagrass bed influenced by the Marseille sewage outfall was studied in summer and winter between 1980 and 2012, i.e. before and after improvements to the treatment of wastewater. A decrease in species richness, abundance and biomass was observed in summer, but not in winter. A modification of the trophic structure of the fish community also occurred in summer, with a decrease of zooplanktivores and labrids, and an increase in the relative importance of macrocarnivores.

Keywords: Teleostei, Posidonia, Sewage pollution, North-Western Mediterranean

Introduction
Posidonia oceanica seagrass beds provide shelter and food for a diverse fish community [1]. Like other Mediterranean coastal ecosystems [2], these seagrass habitats are subjected to human impacts, such as fisheries and sewage outfalls. The wastewaters of Marseille, the second largest city in France, remained untreated till 1987. They then received physico-chemical treatment that removed 70% of the particulate organic matter (OM). Since 2008, an additional biological treatment has been performed, retaining >90% of the dissolved and particulate OM. This raises the question 'Has the fish fauna associated with *P. oceanica* beds exposed to the sewage discharge been modified following these different treatment phases?'

Material and Methods
Fishes were collected with a small skid trawl in a *P. oceanica* bed located at Plateau des Chèvres (PC) near Marseille, a site frequently exposed to the wastewater of the Cortiou sewage outfall. Standardized trawls were conducted by day and night in summer and winter in 1980 prior to any wastewater treatment [3], in 2000 three years after the primary treatment phase [4], and in 2012 four years after the establishment of the secondary treatment plant.

Results and Discussion
The total number of fish species collected at PC has decreased slightly between 1980 (38 spp) and 2000 (32 spp), and was much lower in 2012 (25 spp). Labridae, Sparidae, Serranidae and Scorpaenidae remained the dominant families, but the diversity of Gobiidae, Syngnathidae, Mullidae and flatfishes was reduced. A significant decrease in fish abundance (70%) was observed in summer between 1980 and 2012 (ANOVA, $p<0.001$), while no difference in abundance was recorded in winter ($p>0.05$) (Fig. 1). The high seasonal variation in fish abundance observed in 1980, diminished over time and was nonexistent by 2012. Similar patterns were observed for fish biomass.

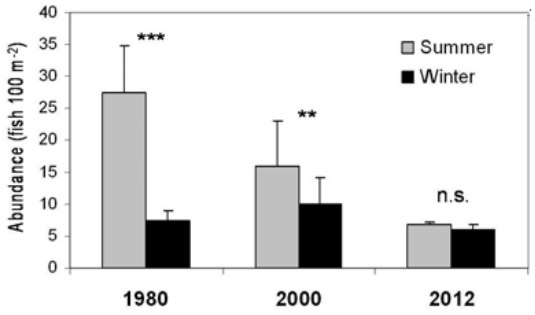

Fig. 1. Mean fish abundance in summer and winter at Plateau des Chèvres during years corresponding to different wastewater treatments.

The trophic structure of the fish community was modified only in summer. Mesocarnivores-1 (labrids) [5], which dominated in 1980 (46%), represented only 26% of the biomass in 2012. The relative importance of zooplanktivores also largely decreased from 1980 (25%) to 2012 (11%), whereas the biomass of macrocarnivores increased significantly (from 19% to 52%). While the decline in mesocarnivores-1 affected all the species, the decline in zooplanktivores was largely linked to the disappearance of the omnivorous *Boops boops*, which prefers waters rich in OM. The increase in macrocarnivore biomass was mainly due to *Scorpaena porcus*, and to *Diplodus sargus* and *D. vulgaris* for mesocarnivores-2. However, no modification of the trophic structure was observed in winter, where mesocarnivores-1 always dominated the community (55-60%), followed by macrocarnivores (22-27%) and zooplanktivores (9-15%).

Although the species richness of the *P. oceanica* fish fauna has declined since 1980, the improvement of wastewater treatments resulted in a decrease in fish abundance and biomass only in summer. The decrease in OM inputs resulted in the decline of species with a low trophic level and an increase in higher trophic level species. Thus, reductions in OM have resulted in a fish community that is now more similar to the typical *P. oceanica* seagrass fish communities of the region.

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REGRESSION OF *POSIDONIA OCEANICA* MEADOW: FACT OR FICTION

C. Pergent-Martini [1]*, M. Bonacorsi [1], P. Clabaut [1], V. Pasqualini [1] and G. Pergent [1]
[1] Université de Corse - pmartini@univ-corse.fr

Abstract
The extent of the regression of the *Posidonia oceanica* meadows has been the subject of considerable controversy. Studies of the historical data and previous aerial photographs show that in sectors exposed to moderate pressure, the areas covered by the meadows have remained generally stable. Rates of regression at Mediterranean basin scale should no doubt be relativised, at least concerning the upper limits.

Keywords: Mapping, Phanerogams, North-Western Mediterranean

Introduction
While the regression of the *Posidonia oceanica* (L .) Delile meadows is a fact evidenced in numerous publications [1], the extent of the regression has been the subject of considerable controversy at Mediterranean basin scale. Whereas many authors report massive regression (5 to 8% per year [2]), others propose more moderate values (0 to 10% in the course of the 20th century [1]). The lack of accurate previous references and / or the scarcity of data for many sectors of the Mediterranean make such interpolation difficult. Improvements in the techniques of underwater cartography, the more regular mapping of the sea bed (scientific research, regulatory measures) and the availability of increasing amounts of information regarding new sectors (e.g. the eastern basin) have made it possible to perceive more accurately the distribution of the meadows [3] and to better understand their patterns of change. The aim of the present article is to survey the changes in the areas covered by *P. oceanica* meadows over time along more than 100 km of coastline, presenting moderate pressure, and to determine whether the regressions mainly observed in the vicinity of major urban and industrial centres correspond to a general trend for the whole of the basin or whether they are limited to these sectors.

Materials and methods
The patterns of change over time of the *P. oceanica* meadows were surveyed along the coast of Cap Corse (Mediterranean, France) between 1995 and 2011 on the basis of aerial photographs and side scan sonar. In addition, the availability of aerial photographs dating back to 1960 has provided temporal series for the position of the upper limits of the meadow and of natural superficial monuments (barrier reefs, atolls). The cartographical method used is identical and is based on image processing (Envi 4.4®) and integration in a GIS software (ArcGis 9.3®) with calculation of the scale of reliability [4].

Results
The patterns of change in the areas covered by the *P. oceanica* meadows along the coast of Cap Corse (77% of bottoms between 0 and -40m, in 2011) show, in general, over the past fifteen years a slight decline of 2% (Tableau I), with an improvement in the accuracy of the mapping method used (mean reliability of 79% to 90%). Over the same period, the position of the upper limit has remained relatively stable (decline of 1%; Table I), although the precision increased between 1995 and 2011 (pixel size from 5m to 1m). The natural monuments of the Gulf of Saint-Florent show a natural progression of 2 to 10%, from 1960 to 2011. In contrast, off the port of Macinaggio, the meadow shows a slight regression (7%), between 1995 and 2011, and numerous trawling scars.

Table I: Patterns of change in the *P. oceanica* meadow along the coast of Cap Corse on the basis of aerial photograph and previous maps (a : Molinier [5], reliability = 33% ; b reliability = 79% ; c reliability = 90%).

	1960	1995	2011
P. oceanica meadows (ha)	12 963[a]	10 201[b]	9 970 [c]
Upper limits (0 to-15m) (ha)		2 675	2 645
Port of Macinaggio		169	159
Platform Reef (ha)	2.22		2.26
Barrier Reef (ha)	5.9		6.5
Atolls (m^2)	21		85

Discussion
The reliability of 'historic' maps must often be treated with caution and they can rarely serve as a basis for accurate assessment of the progression or regression of seagrass meadows. On the other hand, the available early 'raw data' (aerial photographs, sonograms) provide crucial information, notably when they are processed using recent and similarmethods. The patterns of change in the *P. oceanica* meadows along the coast of Cap Corse would appear to indicate the stability of the areas covered over the past decades, notably in the position of the upper limits. Other studies in sectors exposed to greater pressure also show that the regression of the upper limits has been relatively limited; for example, in the Provence Alpes Côte d'Azur region, 87% of the surface meadows (from 0 to -15m) have remained stable or progressed since the 1920s [6]. At Mediterranean basin scale, the presence of extensive meadows still preserved from the direct impact of human activities and the limited areas concerned by these impacts, when they do occur, argue in favour of observable rates of regression that are well below certain values recorded in the literature [2]. Nevertheless, the appearance of new forms of pressure (e.g. global change) and the conjunction of different kinds of impact may significantly reduce the resilience of *P. oceanica*, especially along the lower limit.

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SUCCESSIONAL PATTERNS OF MACRO-INVERTEBRATE COMMUNITY ON EMPTY PEN SHELLS TRANSPLANTED IN A SOFT-SEDIMENT HABITAT

L. Rabaoui [1], W. Belgacem [1], D. Ben Ismail [1], O. K. Ben Hassine [1] and S. Tlig-Zouari [1]*
[1] University of Tunis El Manar - Faculty of Science of Tunis, Tunisia - s.zouaritlig@gmail.com

Abstract
We describe here an experiment aiming to quantify the contribution of empty pen shells to the richness and structuring the macrofauna in soft-sediment habitat. Empty pinnids were planted and their associated fauna was followed along 120 days and compared to that of the surrounding soft-sediment habitat. The data obtained showed a succession of species richness and abundance, and consequently the diversity descriptors (H' and J') of empty shells fauna. The number of species found was slightly higher in soft-sediment habitat; whereas the highest abundance was noted with pen shells fauna. Multivariate analyses highlighted a discrimination, between the two sample types, due to the presence of some sessile and hard-substrata affinity species in empty pinnids and some motile soft-sediment species in the wider system.

Keywords: Biodiversity, Zoobenthos, Gulf of Gabes

Although the Mediterranean pen shell *Pinna nobilis* was reported to play an important ecological role as an association center of numerous macro-invertebrate species [1; 2], no studies were carried out about quantifying the contribution of this benthic mollusk to the richness and structuring the macro-faunal community of the wider ecosystem. The aim of this study was to compare the structure of associated fauna to empty shells of *P. nobilis* and that of the benthic fauna on soft sediment habitat in the area of Elketef, south-eastern Tunisia. Therefore, the objectives of this study were to follow the occupancy of empty *P. nobilis* shells transplanted and to compare the structure of the macrofauna assemblage associated to the "dead" pinnids and that of soft-sediment habitat. The experimental area was selected between the fishing port of Elketef and the southern edge of Elbibane lagoon (33°11'N, 11°28'E), at about two meter depth. Thirty six empty *Pinna* shells were transplanted along three transects, fixed parallel to the shoreline. In each transect, four empty shells were planted in a line, at three equidistant levels along the transect. The experiment lasted 120 days and samples of empty shells were taken at three times: after 30, 60, and 120 days from the starting date of the experiment. At each sampling time, three samples, of four *Pinna* empty shells each, were taken separately. In parallel, three samples of soft-sediment macro-invertebrates were collected. The species collected from empty shells and sediment samples were identified and counted. Diversity indices (S, N, H' and J') were calculated for each pinnids' sample and each soft sediment sample in each of the three sampling times. The dissimilarity/similarity between the *Pinna* empty shell and soft sediment samples was represented with a non metric multi-dimensional scaling (*nm* MDS). Moreover, the similarity of percentage test (SIMPER) was also carried out to define the species which better contributed to the dissimilarity between *Pinna* shell and soft sediment samples.

A total of 694 specimens belonging to 61 species were collected in empty *Pinna* shell and soft sediment samples. 46 species counting 393 individuals were encountered in *P. nobilis* shells; while in soft-sediment samples, 49 species were found corresponding to a total of 301 individuals. The results obtained herein showed a clear increase in the number of species, and relatively Shannon-Wiener index, along the experiment period. It is worth noting that Pielou's evenness index was found to tend to 1, confirming that the community of empty *Pinna* shells was well structured during the three sampling times (Fig. 1).

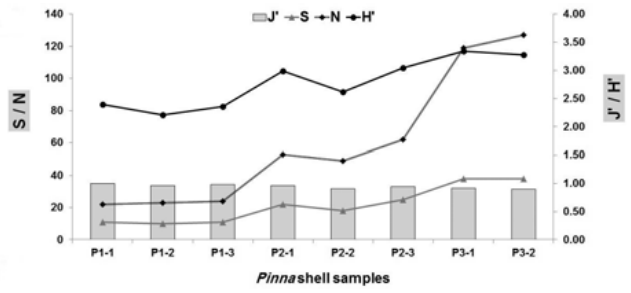

Fig. 1. Variations of species richness (S), total abundance of individuals (N), Shannon-Weiner diversity (H'), and Pielou's evenness index (J') estimated in empty *Pinna* shell samples collected during the three sampling times.

Similar patterns of diversity descriptors were also noted in a similar study with the congeneric species *Atrina rigida* [3]. Multivariate analysis (*nm* MDS) showed a clear separation between two clusters at the level of 20% similarity: the first cluster (A) was represented by empty shell samples, while the second cluster (B) grouped the soft sediment samples (Fig. 2).

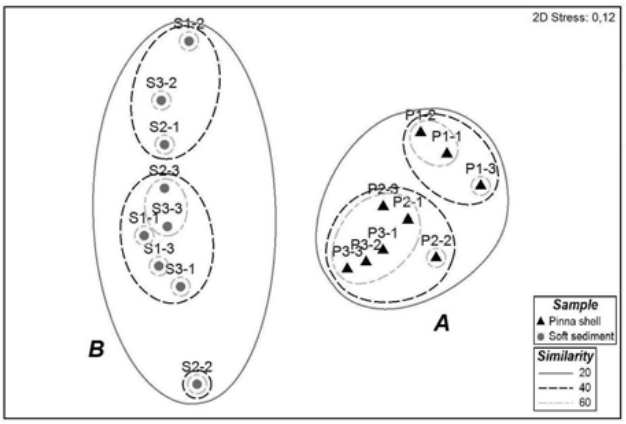

Fig. 2. Non metrical multi-dimensional scaling of *Pinna* shell and soft sediment samples, conducted based on the square rooted data abundances of the species found.

It is evident that the discrimination between empty *Pinna* shell samples is due to the temporal variations of shell colonization by sessile and motile species. With the soft-sediment samples, the discrimination obtained may be explained by the natural temporal variations in the composition and structure of benthic communities due to the seasonal shifts of temperature and salinity. Based on SIMPER analysis, this discrimination between the two types of samples is mainly due to the presence of some sessile and hard-substrata affinity species in empty *Pinna* shells and some motile and soft-sediment affinity species in the soft habitat.

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Session

Species interactions

Modérateur : **Chafika Rebzani Zahaf**

CANAKKALE STRAIT (TURKISH STRAIT SYSTEM) ASPECTS OF ZOOBENTHIC ASSEMBLAGES

Herdem Aslan Cihangir [1]*, Ferah Koçak [2] and Maria antonietta Pancucci-Papadopoulou [3]
[1] Canakkale Onsekiz Mart University Gokceada School of Applied Sciences - asherdem@comu.edu.tr
[2] Dokuz Eylul University, Institute of Marine Sciences and Technology, 35340 Inciralti/Izmir, Turkey
[3] Hellenic Centre for Marine Research Inst. of Oceanography, 19013 Anavissos Attica, Hellas

Abstract
This study deals with the structure of zoobenthic assemblages and their relationships with abiotic conditions in Canakkale Strait in 2006 and 2007. A total of 510 species (except Annelida) were identified.

Keywords: Biodiversity, Marmara Sea

Introduction
Fieldwork was carried out along the southern part of the Canakkale Strait, connecting the Sea of Marmara to the Aegean Sea (Turkey). The Strait has a well-defined two-layer stratification associated with a two-layer pattern of water exchange.

Material and Methods
Soft bottom samples (three replicates/station) were obtained seasonally during 2006 by means of 0.1 m2 van Veen grab at 11 stations from depths between 7-26 m. Seven more stations located in the middle of the Strait were sampled by means of van Veen grab, dredge and box-corer from depths between 40-83 m (Fig 1, 2).

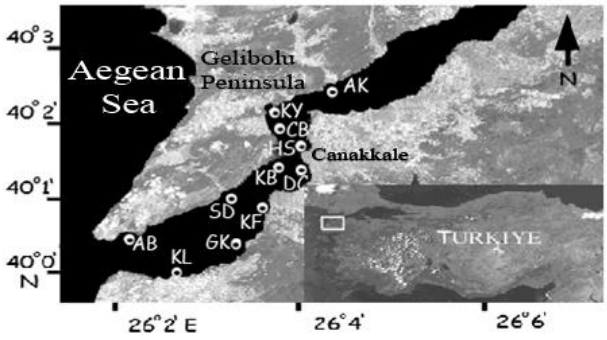

Fig. 1. Map of sites: a)coastal sites (seasonal samplings)

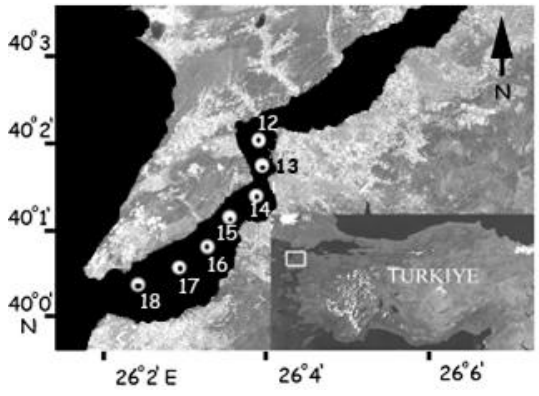

Fig. 2. B)mid-line area (6/ 2007).

Results
A total of 510 species (except Annelida) for a total of 48.969 individuals.m^{-2} were identified, of which 2 Foraminifera (*Cibicides sp.*, *Quinqueloculina seminula* (Linnaeus, 1758)), 9 Cnidaria (*Anemonia sp.*, *Actinia equina* (Linnaeus, 1758), *Caryophyllia (Caryophyllia) smithii* Stokes & Broderip, 1828, *Balanophyllia (Balanophyllia) europaea* (Risso, 1826), *Peachia hastata* Gosse, 1855, *Eunicella* sp., *Clytia* sp, *Nemertesia ramosa* (Lamarck, 1816), *Obelia* sp.), 283 Mollusca [1], 110 Peracarida Crustacea [2], 45 Decapoda Crustacea [3], 1 Leptostraca (*Nebalia bipes* (Fabricius, 1780)), 1 Pantopoda (*Anoplodactylus petiolatus* (Kroyer, 1844)), 3 Cirripedia (*Amphibalanus eburneus* (Gould, 1841), *Verruca spengleri* Darwin, 1854, *Balanus* sp.) 1 Insecta (Ephemeroptera: *Cloeon* sp.), 22 Bryozoa (*Calpensia nobilis* (Esper, 1796), *Monoporella nodulifera* (Hincks, 1881), *Puellina innominata* (Couch, 1844), *Puellina radiata* (Moll, 1803), *Reptadeonella violacea* (Johnston, 1847), *Cryptosula pallasiana* (Moll, 1803), *Porella concinna* (Busk, 1854), *Smittoidea reticulata* (MacGillivray, 1842), *Smittina* sp., *Escharina vulgaris* (Moll, 1803), *Schizomavella auriculata* (Hassall, 1842), *Schizomavella linearis* (Hassall, 1841), *Schizoporella* sp., *Cleidochasmidra* sp., *Microporella ciliata* (Pallas, 1766), *Microporella* sp., *Reteporella couchii* (Hincks, 1878), *Reteporella sudbourniensis* Gautier, 1962, *Reteporella* sp., *Turbicellepora coronopus* (Wood, 1844), *Tubulipora* sp., *Lichenopora radiata* (Audouin, 1826)), 6 Sipuncula (*Aspidosiphon muelleri muelleri* Diesing, 1851, *Sipunculus nudus* Linnaeus, 1766, *Aspidosiphon muelleri kovalevskii* Murina, 1964, *Golfingia vulgaris* (De Blainville, 1827), *Onchnesoma steenstrupii* Koren & Danielssen, 1876, *Nephasoma diaphanes* (Gerould, 1913)), 25 Echinodermata [4] and 3 Chordata (*Ascidiella aspersa* (Muller, 1776), *Ascidiella scabra* (Muller, 1776), *Branchiostoma lanceolatum* (Pallas, 1774)).

Discussion
The large number of rare species recorded led to very low similarity values among stations. No seasonal differences were found among stations. Among abiotic factors, sediment grain size seems to be more effective on zoobenthic distribution [1-4]. Hydrodynamism could be the main stressor factor regulating benthic assemblages and their distribution in Canakkale Strait. Seasonal reproductive periods showed differences according to the various zoobenthic groups. Different feeding types were distinguished for each benthic group. During warm seasons, the presence of the invasive macroalga *Caulerpa racemosa* in the southeastern part of Canakkale Strait seems to encourage settling of some scavenger species.

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PATHOGENICITY EXPERIMENT OF *LACTOCOCCUS GARVIAE* AND *YERSINIA RUCKERI* INFRESHWATER MOLLUSK, *UNIO CRASSUS* (PHILIPSSON, 1788)

Menekse Didem Ercan [1], Esin Baba [1]*, Canan Ontas [1] and Sabire Sömek [1]
[1] Mugla Sitki Kocman University Faculty of Fisheries - esinbaba48@hotmail.com

Abstract
In this study, two fish pathogenic bacteria (*Yersinia ruckeri*, *Lactococcus garvieae*) challenged with *U. crassus* for the pathogenicity characteristics onto mussels were investigated. For this purpose, 10^8 bacteria mL^{-1} were mixed in the water. Mussels were removed turbidity of the water and throw the bacteria as pseudo feces. No mortality and no symptoms of *U. crassus* were noted from any of the groups during observation period. Also, the pathogens were not isolated from the mussels.

Keywords: Bacteria, Aquaculture, Bivalves, Bio-indicators, Gokova Bay

Introduction
Freshwater mussels have ability to filter large volumes of water for respiration and feeding. Therefore these organisms can accumulate large number of bacteria in their body [1]. Since 1994, *Unio crassus* is in the Red List as endangered freshwater mussel species [2]. Aquaculture is one of the options for preventing extinction of this species but they required a host for their glochidia. Host fish are susceptible to some bacterial pathogens and we need to know whether *U. crassus* is also susceptible to these pathogens. In this study, two pathogenic fish bacteria (*Yersinia ruckeri* and *Lactococcus garvieae),*challenged with this mussel for the pathogenicity characteristics onto mussels were investigated.

Materials and Methods
U. crassus samples were collected at 0,5-1 m depth in the Tersakan Stream in Dalaman, Mugla. They transported to the laboratory as dry and put into 10 L of water in the bowls. Mussels were fed daily at a rate of 1% body weight per day with sea bass pellet. The mean weight 55 g and mean length 6 cm of 150 mussels were separated to 6 groups with 2 groups for control, 2 groups for *Y. ruckeri* challenge and 2 groups for *L. garvieae* challenge. Bacterial density was determined by spectrophotometer. 10^8 bacteria mL^{-1} was used both challenge experiment. Septic techniques were used to collect hemolymph samples for recovery of the bacteria. The hemolymph samples were inoculated onto Tryptic Soy Agar (TSA) medium. Suspect colonies were transferred from primary isolation plates and biochemically confirmed using standard bacteriological procedures [3].

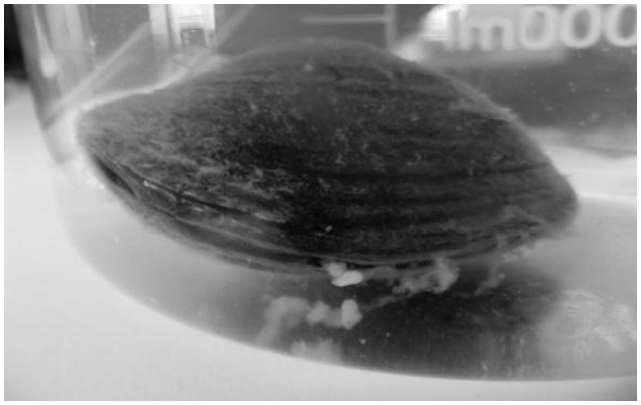

Fig. 1. Mussels cleaned the water and all the bacteria covered with mucus thrown out as pseudo feces.

Results and Discussion
In our study, both fish pathogens could not recovered from mussels. No dead *U. crassus* were noted from any of the groups during the four week observation period. In addition to any symptoms of mussel organs were observed. The previous studies showed that the mussels acquired the *Aeromonas salmonicida, A. sobria, A. hydrophila, Flavobacterium columnare, Pseudomonas fluorescens* cells by siphoning contaminated tank or water of natural habitats [1,4,5]. However, they recovered bacteria from hemolymph tissue of mussels contrary to our findings. Unionids and other freshwater bivalves are important components of freshwater ecosystem. Freshwater mussels also are propagated in captivity for production of pearls. However, infectious diseases of these mollusks have received relatively little attention. Several species of potentially pathogenic bacteria have been isolated from freshwater bivalves, but their role in diseases of bivalves has not been established [6]. Additional research is needed to determine whether other types of pathogens are present in freshwater bivalves. ?It has been shown that the bacterial flora within mussels changes rapidly [7,8]. Starliper et al. [8]; demonstrated that the bacterial flora in mussels changed significantly within 24-hr of a change in water supply. The finding that the bacterial flora rapidly responds to changing water supplies could be used favorably as a means to minimize the risk for introductions of pathogens. Also in this study we observed that, all the groups of mussels cleaned the water and all the bacteria covered with mucus thrown out as pseudo feces (Fig. 1). It was thought that, mussels put into fish tanks may be remove pathogens in the water and prevent outbreaks of fish disease. These findings should be supported by further studies.

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MORPHOLOGICAL EVIDENCE FOR ADAPTIVE DIVERSIFICATION OF SYMPATRIC MEDITERRANEAN *PATELLA* LIMPETS

Jihen Boukhicha [1]*, Oum Kalthoum Ben Hassine [1] and Sabiha Tlig-Zouari [1]
[1] Faculté des sciences de Tunis département de Biologie - boukhicha.jihen73@gmail.com

Abstract
The Mediterranean *Patella* limpets (*P. rustica, P. ferruginea, P. caerulea* and *P. ulyssiponensis*), occupy different positions in the shore. This stratification subjects them to a variety of environmental stresses. Shell and radula characters, as well as the (shell surface area/shell volume) ratio were investigated in these four species. We reported inter-specific differences in shell shape, radula relative size and the (SSA/SV) ratio among these limpets. The ecological implications of these strutural adaptations for species survival in their respective niches are discussed.

Keywords: Gastropods, Stratification, Mediolittoral, Mediterranean Ridge

Introduction
The extended distribution of limpets which occur from the upper to the lower shore levels subjects them to a variety of environmental stresses. The Mediterranean *Patella* species encountered in the Tunisian coasts often coexist on the same shore showing different zonation patterns. *Patella rustica* is restricted to the upper midlittoral. *P. ulyssiponensis* dominates the lower midlittoral and the infralittoral and *P. ferruginea* and *P. caerulea* the middle midlittoral. Since the position of the animal in the shore influences the time to air exposure, these species can exhibit varying degrees of structural adaptations.

Material and Methods
In this study, we aimed to investigate shell and radula characters in Mediterranean *Patella* species. In order to do so, 1200 specimens were collected from 22 rocky stations covering the entire Tunisian coastline (from Algero-Tunisian (Tabarka) to Tuniso-Libyan (Zarzis) frontiers). Samples were dissected to remove the radula. Shell was separated from the visceral mass. Shell length (SL), shell width (SW), shell height (SH), shell length from apex to anterior end (SAA) and from apex to posterior end (SAP) and radula length (RL) were measured to the nearest 0.01mm using a digital caliper.
The following shell parameters were estimated for each species: shell conicity (SH/SL), Cone eccentricity (anteroposterior position of the apex: SAA/SAP), Base ellipticity (SW/SL) and radula relative size (RL/SL). The means were then compared using ANOVA. The shell surface area (SSA) and shell volume (SV) were calculated using the formulas of the surface area and volume of a parabolic cone ([1]): SAA=3.6 x R x *SR*(R^2+(4/3) x SH) and SV=(3.14 x R^2 x SH)/2 , with R=(SL+SW)/4. The Log (SSA/SV) ratio was then plotted against shell length, the comparison of the regression slopes was carried out by ANCOVA.

Results and Discussion
The morphological study revealed that shell conicity was highest in *P. rustica* and lowest in *P. ulyssiponensis.* Shell cone eccentricity indicated a very asymmetrical cone in *P. ferruginea* and a more centered apex in *P. rustica*. Shell base ellipticity showed a narrower shell base in *P. ulyssiponensis* and broader in *P. caerulea.* Radula relative size increased from *P. ulyssiponensis* to *P. rustica* (Tab.1).

Tab. 1. Means of the variables describing shell shape and radula relative size.

Shape parameter (Variable)	*P.rustica*	*P.ferruginea*	*P.caerulea*	*P.ulyssiponensis*	ANOVA
Conicity (SH/SL)	0.375	0.326	0.301	0.296	<0.01
Cone eccentricity (SAA/SAP)	0.750	0.563	0.690	0.622	<0.01
Base ellipcity (SW/SL)	0.792	0.807	0.823	0.707	<0.01
Radula relative size (RL/SL)	2.206	-	1.257	1.094	<0.01

Thus, the shells of these species were different in shape, from the flat cone with a narrow base in the low-shore limpet, *P. ulyssiponensis*, to the tall cone with a broad base in the high-shore limpet *P. rustica. P. ferruginea* and *P. caerulea* exhibited intermediate shell shapes between these two extremes. These species-specific combinations of characters are likely to confer specific advantages for limpet survival on the higher shore levels where thermal and desiccation stress are harsh (taller cone: greater water reserve), and on the lower shore levels, where hydrodynamic forces are intense (flatter cone: stronger adhesion to the substratum).

The regressions of the Log (SSA/SV) vs SL plots revealed that all slopes were negative indicating that the ratio progressively decreases as shell length increases (Fig.1). In this context, many studies ([1], [2]) indicated that, in limpets, decreasing the (SSA/SV) ratios by increasing size results in lower body temperature and desiccation. Considering that thermal conditions in rocky shores are harsh, it appeared that shell shape in all Mediterranean *Patella* limpets can be directly related to their resistance to desiccation and high temperature stresses.

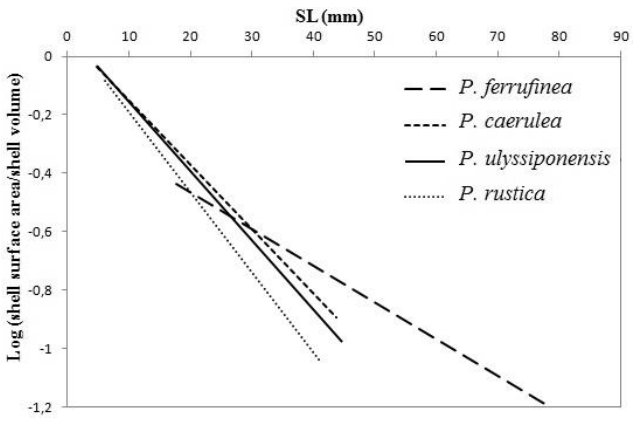

Fig. 1. Plots of the Log (shell surface area/shell volume) against shell length.

The comparison of the Log (SSA/SV) vs SL plots showed that all slopes were significantly different (ANCOVA, p<0.001). Except for small shells, *P. rustica* and *P. ferruginea* displayed respectively the lowest and highest (SSA/SV) ratios. The positions of the curves did not match with species distribution levels in the shore. This is most probably related to differences in external shell architecture as has been demonstrated for other limpets ([3]). In fact, heavily ridged shells (*P. ferruginea*) seem to be able to lose heat more readily than smoother shells (*P.rustica*). Furthermore, radula relative size also increased with increasing level in the shore, suggesting that this might be due to a decreasing abundance of algae with increasing shore level. This result is compatible with the view of [4], according to which, radula length is positively correlated to its increasing usage and abrasion. These data reinforce the evidence of adaptive diversification in Mediterranean limpets and highlights its utility in exploiting their respective niches and its ecological implication for survival.

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EPIPHYTIC DIATOM COMMUNITIES ON *ULVA LACTUCA* LINNAEUS IN HOMA LAGOON, AEGEAN SEA

Fatma Colak Sabanci [1]* and Tufan Koray [1]
[1] Ege University, Faculty of Fisheries - sabanci.fatma@gmail.com

Abstract
The taxonomical composition of epiphytic diatoms was investigated at four stations in Homa Lagoon during June 2006 and June 2007. In total, 79 taxa belonging to 23 genera were identified. *Cocconeis scutellum*, *Ctenophora pulchella*, *Grammatophora oceanica*, *Synedra affinis* var. *parva* and *Tryblionella acuminata* were dominat at all stations. The collected seasonal samples at each station constituted three seperate groups in the MDS plot, which were correlated with a combination of environmental variables such as the concentrations of silicate and pH (ρr=0.19).

Keywords: Algae, Diatoms, Lagoons, Izmir Bay, Aegean Sea

Introduction
Diatoms are the major contributors markedly to primary production in estuarine ecosystems and play an important role in food webs in waters. Coastal lagoon ecosystems are a particular type of estuarine systems which varies from freshwater media to excessive salty water media. Homa Lagoon, where the present study is carried out, has both marine, brackish water and fresh water forms in the region due to its wide spectrum of ecologically different biotopes. Studies conducted in this area have been focussed on the physical and chemical properties of the lagoon [1], bivalve culture [2], but microphytobenthic surveys have been conducted recently [3; 4] . The objectives of this work were to describe the species composition of diatom assemblages, to determine which environmental factors explain the composition of epiphytic diatoms and to make a contribution to the largely unknown algal flora of Turkey.

Material and Methods
Homa Lagoon (38° 33' 10"N, 26°49'50"E) is located 25 km to the northwest of the Gulf of Izmir and within the borders of the town of Menemen (Fig. 1). The lagoon has a surface area of 1800 hectares and the depth of the fish trap is maximum 1.5 meters and its depth mostly varies between 0.5 and 1 meter.

Fig. 1. Location of stations in the Homa Lagoon

For the collection of epiphytic diatom samples, the macroalgae *Ulva lactuca* Linnaeus was chosen in the research region. Samples were processed by standard methods, including 10% HCl, 30% H_2SO_4, $KMnO_4$ and oxalic acid [5]. Cleaned diatoms were mounted permanently on slides with Naphrax and identified at 1000× magnification by means of phase−contrast optics with OLYMPUS × 100 Plan-apochromatic oil immersion objectives. Identification at species level was made following descriptions of [6]. In order to determine the temporal distribution patterns, the qualitative data of all stations in each sampling period were analyzed using the cluster and multidimensional scaling (MDS) techniques, based on the Bray-Curtis similarity, using the PRIMER package. Patterns in community structure identified by cluster and MDS analysed were linked to the environmental variables using the BIOENV procedure of Primer.

Results and Discussion
During study periods, total of 79 taxa belonging to 23 genera were identified to the genus or species level. *Cocconeis scutellum*, *Ctenophora pulchella*, *Grammatophora oceanica*, *Synedra affinis* var. *parva* and *Tryblionella acuminata* were dominant among the epiphytic diatom species. When the taxa composition was examined, maximum number of species with18 taxa were found at station 2 and station 3 in September 2006, minimum number of species with 4 taxa was found at station 1 in March 2007. Based on Bray-Curtis similarity values higher than 40%, three groups of stations can be recognized. The stress value for the two-dimensional MDS plot was 0.15, indicating a proper group separation. According to the results of the BIOENV analysis, best matching parameters were the concentration of silicate and pH (ρr=0.19), but effective parameters on species composition in this study area had stated lagoon water temperature, the concentration of nitrogen and silicate [3]. On the other hand as our study was a qualitative study, it was difficult to infer the possible environmental factors which affected the species occurrence and the seasonal fluctuations in the assemblages without quantitative data. Since the distribution of benthic diatoms is not only controlled by the substratum but also by biotic and abiotic factors, the species defined in lagoonal systems are usually quite mixed and often difficult to interpret.

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MACROFAUNAL DIVERSITY OF INFRALITTORAL COBBLE BEDS IN THE MALTESE ISLANDS

J. Evans [1]*, M. J. Attrill [1], J. A. Borg [2], P. A. Cotton [1] and P. J. Schembri [2]
[1] Marine Biology and Ecology Research Centre, University of Plymouth, Plymouth PL4 8AA, UK - julian.evans@um.edu.mt
[2] Department of Biology, University of Malta, Msida MSD2080, Malta

Abstract
The Mediterranean "biocoenosis of infralittoral pebbles" has been poorly studied, but is generally considered to be impoverished. Systematic sampling of cobble beds at 17 sites around the Maltese Islands yielded a total of 35,687 individuals belonging to 310 different taxa. Very shallow sites (<2 m depth) had a slightly poorer faunal assemblage than deeper ones (2-12 m depth), but still included 152 taxa. These results suggest that infralittoral cobbles beds may not be as impoverished as previously thought, probably due to the high structural complexity of these habitats.

Keywords: Biodiversity, Infralittoral, Zoobenthos, Sicily Channel

Introduction
In shallow waters of the Mediterranean Sea, accumulations of pebbles and cobbles (particles between 4 mm – 256 mm) occurring in wave-exposed rocky coves support a distinct biotic community known as the "biocoenosis of infralittoral pebbles" [1]. No detailed ecological studies on this biocoenosis appear to have been carried out, but it is generally considered to be impoverished [2]. However, databases of Mediterranean marine fauna list "under stones" as the microhabitat of quite a number of species, and this habitat can be important recruitment ground for decapod Crustacea [3,4], indicating that infralittoral pebbles may be more species diverse than previously thought. In addition, coarse gravel sediments do not only occur in indentations along rocky coasts, but also in slightly deeper waters such as within inter-matte regions of reticulate *Posidonia oceanica* beds where a different suite of species could potentially be present. The present study was carried out to assess the macrofaunal diversity of infralittoral cobble beds in the Maltese Islands, in order to determine whether they are indeed impoverished habitats.

Material and Methods
Seventeen study sites having a continuous cover of pebbles and cobbles of at least 25 m^2 were selected from around the Maltese Islands; these included sites with cobble beds in both very shallow (<2 m) and deeper (2-12 m) waters. In 2011, four random samples were collected from each site by SCUBA divers. The pebbles within a 0.1 m^2 corer were carefully removed by hand and the basal layer of finer granules was scooped out separately. An air-lift suction sampler was simultaneously employed to reduce the risk of missing highly motile organisms, thus ensuring that quantitative samples of the total benthic fauna were collected. Samples were sorted in the laboratory and fauna retained by a 0.5 mm mesh were identified to the lowest possible taxon. Statistical analyses of the resulting species X site matrix were carried out using PRIMER v6 (Plymouth Routines In Multivariate Ecological Research, PRIMER-E Ltd.).

Results and Discussion
A total of 35,687 individuals, belonging to 310 separate taxa were recorded from a total sampling area of 6.8 m^2. The most common groups were Mollusca (118 taxa), Crustacea (89 taxa) and Polychaeta (74 taxa). Spirorbinae spp. accounted for 52.4% of all individuals and 90.3% of the polychaetes; thus Polychaeta was the most abundant faunal group overall, but non-spirorbid polychaetes comprised only 5.6% of the total fauna (Fig. 1). When sessile fauna are excluded, crustaceans were the dominant group; this agrees with studies of cobble sites in Norway, England and Italy [3]. The most ubiquitous species included the tanaid *Leptochelia savignyi*, the decapods *Athanas nitescens* and *Xantho pilipes*, numerous amphipods (of which *Ampithoe ramondi*, *Gammarella fucicola*, *Maera grossimana*, *Melita hergensis* and *Microdeutopus* spp. were the most abundant), the chiton *Ischnochiton rissoi*, the gastropod *Gibbula varia*, the polychaetes *Nereis rava*, Ophelidae spp. and Spirorbinae spp., and the ophiuroid *Amphipholis squamata*.

Cluster analysis indicated that the cobble bed assemblage composition varied with depth, with the very shallow (< 2m) sites generally grouping separately from the deeper ones (Fig. 2). The deeper sites (Cluster B) included 278 different taxa, versus the 152 taxa of 'Cluster A' sites, while 120 taxa were common to sites in both clusters. These results suggest that the biocoenosis of infralittoral cobbles and pebbles may not be as impoverished as previously thought, even if only the very shallow beds described in [1] are considered. This is probably due to the high structural complexity of the cobble habitats, which are characterised by vertical stratification: upper cobble layers can provide numerous interstitial spaces affording shelter to fauna [3,4] while the basal layer of finer sediment supports an infaunal assemblage.

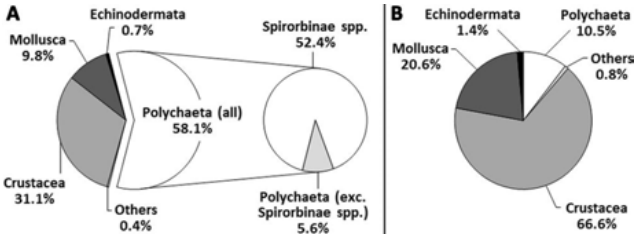

Fig. 1. Percentage abundance of major faunal groups from infralittoral cobble beds at 17 sites when considering (**A**) all macrofauna, and (**B**) non-sessile macrofauna only.

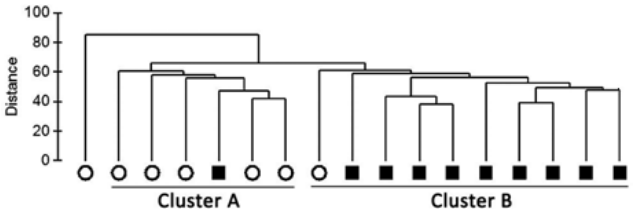

Fig. 2. Dendrogram from group-average hierarchical cluster analysis based on Bray-Curtis resemblances, produced using square root-transformed abundance data for macrofauna from infralittoral cobble beds at 17 sites (Empty circle: Depth <2 m; Filled square: Depth 2-12 m).

Acknowledgements: This research work was partially funded through the European Social Fund under a STEPS scheme grant awarded to JE.

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ASSESSING ADAPTIVE ABILITIES OF THE MEDITERRANEAN RED CORAL *CORALLIUM RUBRUM* IN AN HIGHLY VARIABLE ENVIRONMENT USING COMMUN GARDEN AND RNA-SEQ APPROACHS.

Anne Haguenauer [1]* and Didier Aurelle [1]
[1] IMBE UMR 7263 Centre d'Océanologie de Marseille - anne.haguenauer@imbe.fr

Abstract
To understand the underlying mechanisms of adaptation to thermal stress in the mediterranean red coral, *Corallium rubrum*, we studied two populations: a shallow one living at the edge of the specie's range (5 m depth), and a deeper one living in more stable thermal environment (40 m). A common garden experiment in aquaria showed different molecular phenotypes depending on the depth of origin of the individuals and of their thermal history. The transcriptome of individuals sampled in situ at 5 m or 40 m depth is currently under analysis, with more than 10^8sequences for both populations. Our study will offer consistent elements to discuss the hot topic "plasticity vs local adaptation" in a context of climate change, and our results emphasize the conservation value of marginal populations.

Keywords: Cnidaria, Global change, Genetics, North-Western Mediterranean

Mediterranean benthic ecosystems, including Mediterranean red coral *Corallium rubrum*, have been deeply impacted by thermal anomalies during the last decades [1]. Adaptive capacities for marine species facing climate change can be understood at two different levels, at the individual level (i.e. phenotypic plasticity) and at the population level (i.e. selection). The Mediterranean red coral, *Corallium rubrum*, is well suited to study adaptative evolution in heterogenous environment. This sessile species is present in contrasted environments with a strong genetic structure [2], and differences of response to thermal stress between populations. To understand the underlying mechanisms of adaptation to thermal stress in this species, we studied three *C. rubrum* populations from different depths (5 m, 20 m and 40 m depth) and therefore different thermal regimes in the same area. We submitted red coral colonies to different heat shocks in aquaria that mimicked in situ stresses in common garden conditions. We measured the expression levels of several candidate genes by real-time PCR. Heat Shock Protein 70 (HSP 70), considered as a real molecular phenotype [4], showed significant differences of expression depending on the depth of origin of the individuals and of their thermal history.

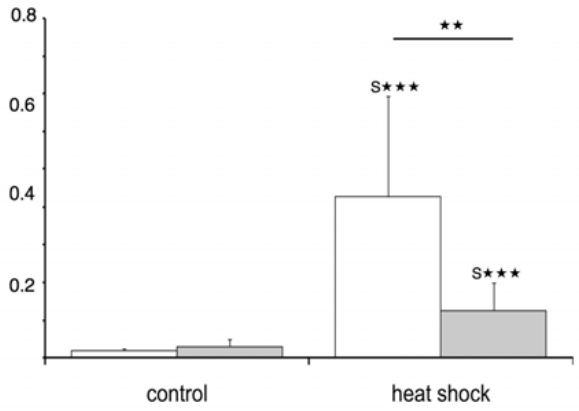

Fig. 1. HSP 70 induction after heat shock for 5 m population (white bars) and 40 m population (grey bars). HSP 70 mRNA expression was calculated using COI as reference gene. Results are represented as mean ± SD. Stars indicates significant differences (3 stars $p<0.008$, 2 stars $p<0.016$), S indicates significant differences between control and stress condition in the same population.

A RNA-seq experiment (Illumina technology) performed on individuals sampled *in situ* at 5 m and 40 m depth is currently under analysis, with more than 10^8 sequences for both populations. This analysis will provide usefull data to look for potential genomic basis for red coral adaptation to climate change. Our study will offer consistent elements to discuss the hot topic "plasticity vs local adaptation" in a context of climate change, and emphasizes the conservation value of marginal populations [5].

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ACOUSTIC DETECTION OF BENTHIC ASSEMBLAGES IN A LAND-LOCKED SHALLOW MARINE ENVIRONMENT: GULF OF GERA, LESVOS, GREECE

Evaggelia Manoutsoglou [1], Thomas Hasiotis [1]* and Antonis Velegrakis [1]
[1] Dept. of Marine Sciences, University of the Aegean, Mytilene, Lesvos isl., Greece - hasiotis@marine.aegean.gr

Abstract
In this contribution a geophysical data set and sediment samples and camera images for ground-truthing are used in order to study the morphology of the Gulf of Gera. The observed hummocky relief is due to benthic assemblages and it can be discriminated to five different sub-classes according to their morphological characteristics. The hummocks is probably the result of the regional oceanographic conditions, slow gas seepage and the protected from scallop dredging environment.

Keywords: Aegean Sea, Coastal systems, Mapping, Zoobenthos, Sediments

Introduction
The Gulf of Gera is an enclosed embayment located in the island of Lesvos. It connects with the Aegean Sea through a narrow channel that has a width of 300-800m, a length of 6.5km and depths ranging from 10 to 30m. The area of the gulf is ~42.5Km^2, with a maximum depth of ~18m. The Gulf of Gera receives discharges from seasonal streams/small rivers. Previous studies had focused on the sedimentology and sediment geochemistry [1] as well as on the anthropogenic influences on benthic ecology [2]. The present study examines the embayment seabed morphological features.

Materials and Methods
A single-beam echo-sounder and a side scan sonar survey were conducted for the detection of the seabed morphology. Scuba diving at 2 sites, a drop down camera system and sediment sampling at 43 stations were employed to ground-truth the geophysical results. Grain size analysis was carried out with dry sieving for the coarse fraction and with laser – diffractometry for the fine fraction. For the side scan sonar processing and data analysis/mapping, the SonarWiz Map and ArcGis were used, respectively. Additionally, a 3.5kHz old analog profile aided to the investigation of the subbottom structure of the gulf.

Results and Discussion
The main morphological features identified are numerous small hummocks that populate the seafloor (Fig. 1). They appear in water depths deeper than 12m covering an area of 16.3km^2, have an average height of 1.0m and occur individual or locally coalescing. Based on the hummocks morphological characteristics (shape, dimensions and distribution), 5 sub-areashave been distinguished, each showing a unique pattern (Figs. 1 and 2). An interesting finding is that the sub-area with the higher hummocks (up to 2.0m) appears to develop near the entrance of the bay.

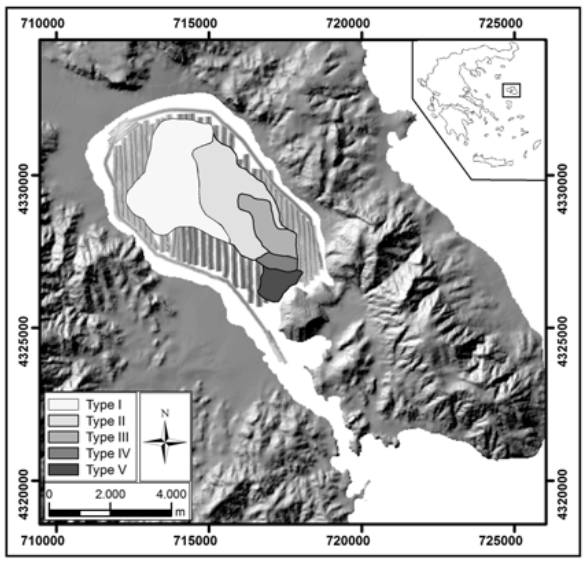

Fig. 1. Hummocky sub-areas extent, over the side scan sonar mosaic.

The 3.5kHz subbottom profile has shown the presence of an almost homogeneous surficial layer 4-9m in thickness that overlies almost concordantly earlier sedimentary units at the central part of the embayment. The bottom-echo becomes more intense at the top of the hummocks. Acoustic anomalies, mainly as small in extent acoustic turbid zones as well as plumes within the surficial layer, imply the potential presence of gas in the sediments. The video images and the seabed sampling revealed that the hummocks consist of assemblages of bivalves (mainly) and gastropods of various sizes, together with fine-grained sediments. Species that are met in considerable abundance are the *Mytilus galloprovincialis, Turritella communis, Vermetus semisurrectus* and *Ostrea edulis*. Very fine muddy sediments are found in the greater part of the embayment and also seem to constitute the hummocks matrix material.
The hummocky seabed morphology may be (i) related to the oceanographic conditions prevailing in the gulf [3], (ii) associated with the slow seepage of gas that has been reported also elsewhere to be connected with high concentration of bivalves and other benthic life [4] and (iii) possibly favored by the prohibition of scallop dredging in the area.

	SIZE			GENERAL SHAPE			DENSITY			IN CONTACT		SIDE SCAN SONAR
	Small	*Medium*	*Large*	*Circular*	*Elongated*	*Irregular*	*Sparse*	*Dense*	*Very dense*	*Yes*	*No*	
Type I		✔		✔				✔			✔	
Type II	✔			✔			✔				✔	
Type III	✔	✔		✔	✔		✔				✔	
Type IV			✔			✔			✔	✔		
Type V			✔			✔			✔	✔		

Fig. 2. Qualitative morphological characteristics and corresponding side scan sonar images of the hummock sub-areas.

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GROWTH AND MORTALITY RATES OF *PINNA NOBILIS* JUVENILES UNDER DIFFERENT EUTROPHICATION LEVELS

Laura Lozano [1]*, Maite Vázquez-Luis [2], Elvira Alvarez [3] and Salud Deudero [2]
[1] Université de Perpignan (UPVD) & Centro Oceanográfico de Baleares-IEO - laulzn@gmail.com
[2] Centro Oceanográfico de Baleares-IEO
[3] Direcció General del Medi Rural i Marí, Govern de les Illes Balears

Abstract
The present work assessed the survival and growth rates of *Pinna nobilis* juveniles in a range of eutrophic conditions (fish farm vs MPA) around Mallorca. A high mortality rate of juveniles appears in the locality of high human impact. However, the growth rate of individuals in this area was higher compared to the oligotrophic environment. Differential survival rates are indicating large impact of organic loads and anthropogenic related activities in the first life stages of a vulnerable species.

Keywords: Marine parks, Eutrophication, Growth, Bio-indicators, Balearic Islands

Introduction
The pen shell *Pinna nobilis* is a long-lived organism, presenting a life span of more than 20 years. Its responsiveness to environmental perturbations makes it a good bioindicator of water quality and, therefore habitat conditions [1,2]. Eutrophication and aquaculture-derived effects are affecting benthic species especially at oligotrohic environments. In this study, our mains objectives were (1) to compare the growth plasticity of *P. nobilis* in two trophic environments around Mallorca, (2) to evaluate the success of survival in each environment.

Material and methods
Pinna nobilis juveniles were suspended in the water column at 5 meters depth with seed collectors. 25 individuals were located within the port of Andratx (39 ° 32'38 .36 "N, 2 ° 22'50 .95" E) under a fish farm, i.e. eutrophic environment with high anthropogenic impact. In contrast, 26 individuals were situated in MPA Cabrera National Park (39 ° 8'45 .65 "N, 2 ° 55'54 .48" E), an oligotrophic environment free of any sewage or organic dumping. During the 2 years study (Feb. 2011-Feb. 2013), pen shells were monitored by measuring the length and width of each individual together with mortality rates (6 visits in Andratx and 5 in Cabrera). Growth was calculated by linear regression through the 2 years.

Results and discussion
The study showed that in a eutrophic environment *Pinna nobilis* juvenile survival rates after the first days of exposure to anthropic conditions are a key factor to the population's sustainability. We found a drastic population decline in Andratx samples at the first monitoring visit where the number of individuals is halved, and a smaller percentage decline in the next few days, keeping a survival percentage of <30% at endpoint (Fig. 1). In contrast, Cabrera's survival percentages are larger than 80%. Although survival success in the eutrophic environment is much lower than in the oligotrophic one (difference >50% between the two environments), surviving individuals present higher growth rates (22.65 ± 12.2 mm mean for Andratx and 85.71 ± 4.28 mm mean for Cabrera) (Fig. 2). However, this growth is not natural, since individuals were suspended in the water column, while their natural habitat is benthic and associated mainly to seagrass meadows. However, other studies report higher growth rates in normal conditions [3,4]. The environmental conditions where *P. nobilis* develops will influence their ability to assimilate nutrients. Differential survival rates are indicating large impact of organic loads and anthropic related activities in the first life stages of a vulnerable species.

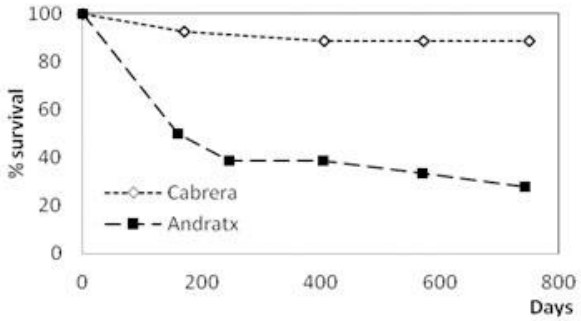

Fig. 1. Temporal variation of survival percentage of *P. nobilis* juveniles in the two environments studied.

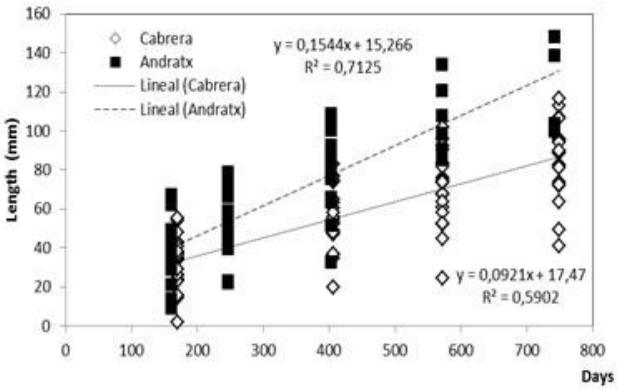

Fig. 2. Growth rate in shell length for *P. nobilis* juveniles in Andratx (eutrophic) and Cabrera (oligotrophic).

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SPATIAL DIFFERENCES OF STABLE ISOTOPE COMPOSITION AT BIVALVE *PINNA NOBILIS*: ARE THEY RELATED TO NUTRIENTS CONCENTRATIONS OR TO POTENTIAL FOOD SOURCE?

K. Magraner [1]*, S. Deudero [1], M. Vázquez-Luis [1], C. Alomar [1] and J. Alonso-Santos [1]
[1] Centre Oceanogràfic de les Balears - kikamagraner@gmail.com

Abstract
Increased anthropogenic nutrient loading (i.e., eutrophication) due to increasing human population in coastal areas will enhance the degradation of coastal marine ecosystem. The results of our analysis in the mantle of *P. nobilis* suggest an enrichment of $\delta^{15}N$ isotopic values in sites with high concentration of population density. $\delta^{15}N$ signature have been proposed as better tracers of eutrophication than $\delta^{13}C$. The fan mussel *P. nobilis* is a good bioindicator of changes of the Mediterranean littoral environmental quality as proposed by other authors. Spatial differences of stable isotope composition at *P. nobilis* are connected to potential food sources quality/quantity related to nutrients enrichment.

Keywords: Stable isotopes, Nutrients, Balearic Islands, Eutrophication, Bivalves

Introduction Carbon isotopic compositions of animals reflect their diet within about 1 ‰[1] and can be used to identify potential food sources for *P. nobilis* [2]. Several studies have focused on changes in $\delta^{15}N$ as an effect of changes in nutrient loadings from sewage treatment plants [3]. Initial impacts are likely to be missed if measurements are restricted to physicochemical water properties [4]; even though this problem can be solved if indicator organisms are used [4]. The aim of this study was to use *Pinna nobilis* as indicator of anthropogenic effects using stable isotopes analysis ($\delta^{13}C$ and $\delta^{15}N$) in mantle tissue. We hypothesized that: (i) there are spatial differences among localities at different scales (ii) *Pinna nobilis* stable isotopes concentrations are reflecting nutrient concentrations at the studied sites or if they are more influenced by potential food sources.

Material and methods Samples of *P. nobilis* were collected at Balearic Islands (Spain). A total of six sampling stations were selected under an eutrophication gradient and with regard to protection level. A total of 57 *P. nobilis* mantles were sampled. Potential common food sources for *P. nobilis* were collected: phytoplankton, zooplankton, living leaves of *P. oceanica* (P. leaves), epiphytes of *P. oceanica* leaves (P. epiphytes), decaying leaves of *P. oceanica* (P. detritus), the rhizomes of leaving *P. oceanica* (P. rhizomes), and particulate organic matter (POM). Nutrients were determined such as environmental variables. Stable isotope mixing models are used to determine the percentage contribution of the food sources to the fan mussel *P. nobilis*. In this study, we applied the SISUS Bayesian Mixing model.

Results and discussion The results for *P. nobilis* did not show evidence of size-related isotopic variability. The results obtained demonstrated that *P. oceanica* epiphytes made the highest contribution to the $\delta^{15}N$ signature of *P. nobilis* in Andratx, since this sampling site had the highest contribution of sewage compared to the other sampling sites (Figure 1). SISUS results showed that zooplankton made the highest contribution to the $\delta^{13}C$ signature in Illetes, Cargoler and Andratx (Figure 1); these results agree with those found by Davenport et al. [5] which demonstrated that the bivalve *P. nobilis* feeds on zooplankton. *Pinna nobilis* exhibits spatial differences at microscale and mesoscale level in N stable isotope composition as reflected by our results. In this study the mantle of *P. nobilis* was analyzed, providing values of $\delta^{15}N$ of 1.71‰ in Santa Maria Bay and 3.25‰ for Andratx (Figure 2). These variations could be related to nutrients availability of the studied sites [1]. Therefore, *P. nobilis* seems to provide indication of environmental quality linked with anthropogenic nutrient inputs.

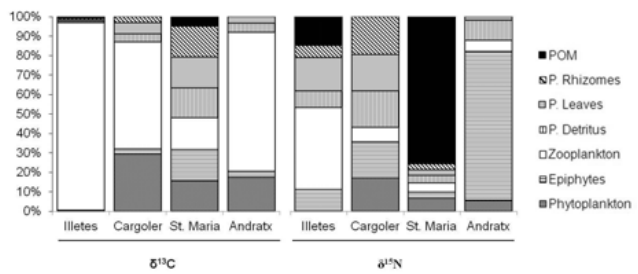

Fig. 1. Mean value from SISUS potential food sources contribution (%) of $\delta^{13}C$ (left) and $\delta^{15}N$ (right) to the diet of *Pinna nobilis* at different studied sites.

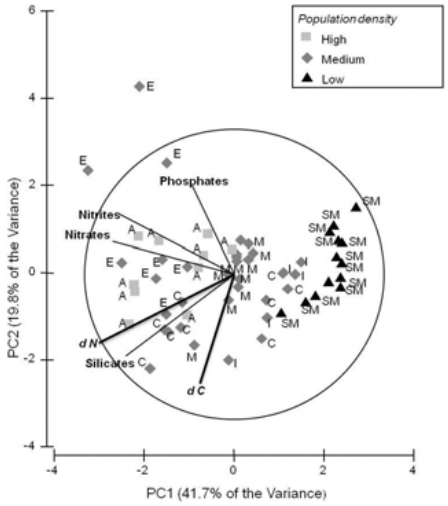

Fig. 2. Results of principal component analysis (PCA) of nutrients means and population density from the different studied sites (A-Andratx; C-Cargoler; E-Espalmador; I-Illetes; M-Migjorn; SM-Santa Maria). Values in brackets represent the percentage of variance explained by the PCA

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COMMUNITY COMPOSITION, DISTRIBUTION AND DIVERSITY OF INVERTEBRATES FROM DEEP-SEA MEDITERRANEAN CANYONS AND ADJACENT SLOPES (FROM 850 TO 3000 M DEPTH).

Ariadna Mecho [1]*, Eva Ramirez-Llodra [1], Jacopo Aguzzi [1] and Joan Batista Company [1]
[1] Institut de Ciències del Mar (ICM-CSIC) - mecho@icm.csic.es

Abstract
Information of bathyal and abyssal non-crustaceans invertebrates is scarce in the Mediterranean Sea, especially in submarine canyons. The present study presents an updated taxonomical classification for these groups and reports new data on their distribution and density in canyon areas and adjacent open sedimentary slopes. Samples were collected from 220 trawls and 36 ROV dives conducted in the Blanes, Palamós and Cap de Creus canyons and their adjacent slopes (north-western Mediterranean), between 850 and 3000 m depth. The most abundant Phylum was the Echinodermata, representing 52.9% of the total invertebrate density (calculated as ind.•km^{-2}), and 48.6 % of the total invertebrate biomass (calculated as kg.•km^{-2}). Five rare species for the Mediterranean were found: a sipunculid, 3 echinoderms and 1 carnivore ascidian.

Keywords: Bathyal, Canyons, Zoobenthos, Systematics, North-Western Mediterranean

Introduction
The western Mediterranean deep basin is composed by a complex collection of markedly different habitats, including sedimentary slopes, submarine canyons and seamounts. The specific geomorphologic characteristics of these habitats and associated abiotic processes result in large scale heterogeneity of the continental margin, allowing for the establishment and maintenance of diverse faunal communities [1]. In the deep Mediterranean Sea, these communities are mainly constituted by fishes and decapod crustaceans, which have been object of intensive taxonomical studies in comparison with other deep-sea fauna such as echinoderms, sipunculids or echiurans [2, 3]. Here, we present a complete taxonomical classification and we redefine the distribution, biomass and abundance of all non-crustacean invertebrates collected in our surveys in the NW Mediterranean since 2008. The results are discussed in relation to the geomorphological and environmental characteristics of the different habitats sampled.

Material and Methods
Samples were collected during 11 oceanographic cruises conducted in the Blanes, Palamós and Cap de Creus canyons and their adjacent slopes between 850 to 3000 m. A total of 220 benthic hauls were conducted and 36 ROV video transects were performed in the three canyons and adjacent area. Of those hauls, 121 samples were obtained by means of an otter-trawl Maireta system, other 43 hauls were conducted with an Agassiz dredge and finally, 56 samples were obtained with an epibenthic sledge.

Results
More than 4686 non-crustacean invertebrates belonging to 60 species were sampled. The most abundant Phylum was the Echinodermata representing 52.9% of the total non-crustacean invertebrate density, followed by the Phyla Brachiopoda (17.4%), Cnidaria (12.9%), Mollusca (10.4%), Echiura (2.7%) and Porifera (2.3%). The Sipuncula, Annelida, Bryozoa, Arthropoda and Chordata together represented 1.1% of the total density. Unidentified specimens represented only 0.3 % (Fig. 1a).
In terms of biomass, the Phylum Echinodermata represented 48.6 % of the total non-crustacean invertebrate biomass, followed by the Phyla Cnidaria (22.5 %), Mollusca (19.9 %), and Brachiopoda (7.2 %). All remaining Phyla represented less than 1% each one (Fig. 1b). The most speciose Phyla were the Mollusca (with 23 species) and Echinodermata (with 11 species). From the 60 species identified, five were considered rare in the Mediterranean Sea. These species were the sipunculid *Phascolosoma (Phascolosoma) turnerae* Rice, 1985, three echinoderms *Hedingia mediterranea* (Bartolini Baldelli, 1914), *Penilpidia ludwigi* (von Marenzeller, 1893) and *Gracilechinus alexandri* (Danielssen & Koren, 1883), and the carnivore ascidian *Dicopia antirrhinum* C. Monniot, 1972. Additionally,10 from the 60 species identified were only reported inside canyon areas.

Discussion
Our study presents new information about taxonomical classification of Mediterranean Sea deep-sea non-crustacean invertebrates and increases the geographic and bathymetric distribution of some of these species. Additionally suggests that canyons could be an important habitat for specific species only present inside the canyons and for rare species.

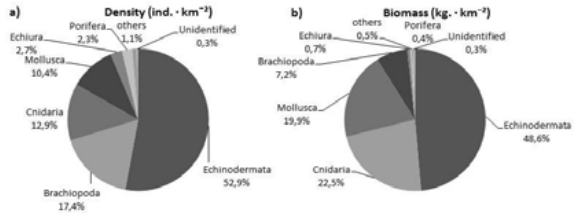

Fig. 1. Non-crustacean community composition. a) Percentage of density (ind.•km^{-2}) by Phylum. b) Percentage of biomass (kg.•km^{-2}) by Phylum.

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NEMATODES DISTRIBUTION WITHIN *MYTILUS* COMMUNITY ON THE NORTH-WESTERN BLACK SEA SHELF

Mihaela Muresan [1]*
[1] NIRD for Marine Geology and Geoecology - GeoEcoMar - mmuresan@geoecomar.ro

Abstract
Free-living nematodes from the Romanian shelf have been assessed in relation with the particular niche offered by *Mytilus galloprovincialis* community for feeding, habitat and interspecific relations. An overall of 60 species with densities between 133 and 2,028,580 ind.m^{-2} were found.

Keywords: Biodiversity, Zoobenthos, Black Sea

Introduction
Mytilus community forms one of the most representative community on the NW shelf Black Sea between 30 – 55 m depth, occupying within these limits the muddy sediments biotope. It offers a diverse niche for a rich community of free-living nematodes, being particularly important for their thriving at the limits with the fluctuating environment in terms of salinity gradient from north to south and oxygen concentration deficiency in sediments as moving deeper towards *Modiolula* community.

Material and method
During HYPOX project, in May, July and September 2010 and April 2011, 25 samples were collected within *Mytilus galloprovincialis* community using a Multicorrer, along 4 transects crossing the NW Romanian shelf (Fig.1). The first top 5 cm were retrieved from the tubes and preserved on board with 4-5% formaldehyde buffered.

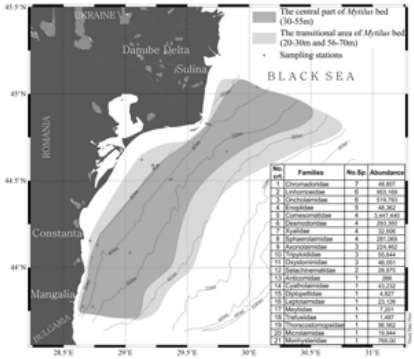

Fig. 1. Nematodes population structure within the *Mytilus* community on the Romanian Black Sea shelf (*Mytilus* distribution map after Teaca, et all., *in press*)

Results and discussions
The assessment of taxonomic diversity revealed a number of 60 species of nematodes belonging to 21 families (Fig.1). In terms of trophic species groups, 37% of species were predators, the rest pertaining to groups of selective deposit feeders, non-selective deposit feeders and epidetritivores. Nematodes densities distribution within stations recorded greater abundances in the northern part of the Romanian shelf, where opportunistic species dominated. Thus, the greatest frequency (F%) and dominance (D%) after abundance had by far the species such as *Sabatieria abyssalis* (F%-84; D%-33) and *S. pulchra* (F%-76; D%-23), *Viscosia minor* (F%-92; D%-7) followed by *Terschellingia longicaudata* (F%-72; D%-10). Generally with low abundances, but found in more than half of the stations were *Eleutherolaimus longus*, *Linhomoeus sp*. Nematodes species richness indices showed a good correlation with distribution of *Mytilus* density within the community, but the muddy substrate had also a favourable influence on species from Linhomoeidae and Comesomatidae. Thus, the greatest diversity of nematodes was recorded, with some exceptions, within the stations situated between 27–50 m depth, comparative with that found at the lower limit of the *Mytilus* community (20-27 m depth), mainly in the northern sector. Actually, between 27 and 50 m depth, the total number of species was 60, while at the inferior fringe (littoral zone) were found only 20 species, but the fewer number of samples taken in this area could bias the results. Anyway, the most frequent associations of nematodes were constituted of *S. abyssalis, V. minor, T. longicaudata, Linhomoeus sp., Halalaimus sp., E. longus, Cobbionema acrocerca.* Slender nematodes have a cryptic life between the *Mytilus* bissus, taking advantage of niche offered and the bacterial mats and organic matter that usually accumulate within the mussels` colonies. Big size omnivores/predators are favoured, here, by prey abundance consisting of other meiobenthic groups, especially ciliates and nematodes. The r-strategists nematodes (non-selective feeders) were the most abundant group. Thus, the easy way of obtaining food and shelter in between mussels and the rich community of tubicole and errant polychaets and oligochaets [1] conducted to an overwhelming community of *Sabatieria*. Excepting *T. longicaudata*, the selective feeders' category had a low contribution (6%) in the nematodes community.
Within the Hypox project some questions have been raised. Can benthic organisms survive after hypoxic events? How their populations have recovered in case those were affected? In the present study, I put the question: Have the nematodes been affected? Has the *Mytilus* community a protective role in their case? I tried to answer to these questions based on the observations on populations' diversity and density found in the summer of 2010 (late July/early August) when a strong hypoxic event occurred, comparing with the same populations parameters found in May 2010 and April 2011. Thus, in July 2010, the sample taken at 42 m depth in Constanta area, the nematodes had very low diversity; an overall of 5 species were found and densities of 105,070 ind.m^{-2}. In the same station, in May 2010, 8 species and 204,288 ind.m^{-2} were found, while in April, 2011, 18 species and 31,790 ind.m^{-2}. Regarding the qualitative composition, in July prevailed *S. abyssalis* (91,936 ind.m^{-2}), in May dominated also *S. abyssalis* with 142,000 ind.m^{-2}, but also predator species and deposit feeders. In April 2011, a rich community of predators, even in very low densities, was present, while *S. abyssalis* recorded much reduced densities comparing with the previous year.

Conclusions
An overall of 60 species of nematodes within *Mytilus* community have been found. It has been evinced a pattern distribution of their densities, a much numerous community being encountered in the northern part, where opportunistic species dominated. In the central part of the *Mytilus* community, the densities were also greater than at its fringe. A variety of morphological and trophic types were also found. It is assumed that *Mytilus* offers a good habitat for nematodes populations in case of dramatic climate events, but this depends of severity and period of exposure. As a preliminary conclusion, it could be said that the nematodes from the *M. galloprovincialis* community has a good resilience capacity, the colonizers (deposit feeders) and predators/omnivores – persisters being the populations' recovery triggers.

Acknowledgements: The author would like to thank the European Commission for their support as part of the FP 7 program, PERSEUS and HYPOX projects and DG Env Program - MISIS project.

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SCLERACTINIAN *OCULINA PATAGONICA* DE ANGELIS, 1908 EL-KALA ALGERIA

Chafika Rebzani Zahaf [1]*, Amina Karali Otsmane [1], Myriam Benali [1] and Radia Belkessa Hellel [2]
[1] Faculté des Sciences Biologiques / USTHB Alger - chafikarebzanizahaf@gmail.com
[2] Bureau d'Etude Vert et Bleu

Abstract
The scleractinian Oculina patagonica is a species native of Atlantic waters, it's reported for the first time in El-Kala waters, at extreme east of Algeria. Characterization of some colonies observed has revealed an important development of Oculina patagonica; the species presence goes back to more than twenty years. Integrity signs of ecosystems where it has been met are particularly reflected by a high diversity level. Nevertheless, the sizeable extension of colonies out competing those of the endemic Astroides calycularis, corroborates the possible threat constituted by the species on the marine ecosystems of El-Kala

Keywords: Alien species, Monitoring, Competition, Algerian Sea

Introduction
One of the actual priorities in assessing marine ecosystems is the reporting of introduced and/or invasive species. In Mediterranean, some of them (lessepsian or Atlantic) have been given particular attention due to the rapid extension of their distribution areas.The Scleractinian *Oculina patagonica* is one of the most studied introduced species at the level of Mediterranean basin. This species, native of Atlantic waters was introduced *via* maritime traffic and transporting species of economical interest. Within the framework of the biological and ecological study of the marine part of the Parc National d'El-Kala (PNEK) [1], we have listed numerous colonies of *O. patagonica* in three different sites (Fig.1). This first record in the region of El-Kala is the third in Algeria after those of îles Habibas [3] and that of Algiers [6]. In this same framework, we conducted campaigns of biometric measurements of colonies at the Cap Segleb.

Materials and methods
Colonies were observed by scuba diving, they were localized, photographed and depth was recorded. Vertical and horizontal extensions of ten colonies of Cap Segleb were measured. Samples have been taken by scratching for a precise indentifying of the species.

Results
Oculina patagonica has been reported at three distinct sites, respectively at 8m, 12m and 0.5 to 2.5m depth (tab.1).

Tab. 1 Geodesic coordinates of *Oculina patagonica* localizations.

Sites	Depth (m)	Geodesic coordonates (UTM)	Observation
Calle Prisonnière	8m	x=429554 y 4089050	Scuba diving along transect
Cap Gros	12m	x=446613 y=4085738	Scuba diving along transect
Cap Segleb	0.5 to 2.5m	x= 465506 y= 4088242	Ponctual scuba diving

At Cap Segleb, we recorded most important number of colonies on an area surface of 300m^2. Around twenty colonies were listed; they have predominantly regular hemispheric shape (tab.2).

Tab. 2: Biometric measurements of *Oculina patagonica* colonies at Cap Segleb (ST3)

N°colony	(VE-HE) cm	Depth	N° colony	(VE-HE) cm	Depth
1	57-46	80cm	6	16-14	80cm
2	16-21	1,20m	7	15-20	80cm
3	41-33	1.20m	8	21-35	2,50m
4	11-20	60cm	9	6-6	2.50m
5	27-15	60cm	10	77-60	50cm

Discussion
Besides the important number of colonies, their extensions, compared to those of other colonies recorded and measured in Cap Nègre (10 to 40cm) and Galîte (35 to 41cm) in Tunisia, show an important development of *Oculina patagonica* in El-Kala waters, with a maximal extent of colony n°10 (77-60cm). Studies carried out by FINE and collaborators [1] on some colonies, revealed a linear growth rate of 0.6 to 0.75cm/year, experimental colonies transplantations in Marseille showed an annual growth rate a little less than 1m/year [3], implying that a medium colony of an average diameter of 20cm could exist since more than 15 years. According to those authors, it is strongly dependent on colonies shapes. In the present study, some cases of fusing colonies have been observed, reminding how difficult is estimating a colony age whose big dimensions might be due to this fusion. Encrusting colonies of *Oculina patagonica* develop on vertical rocky walls and caves, with coralligenous enclaves species, like the endemic scleractinians *Astroides calycularis* and *Cladocora caespitosa*, reminding the threat of switch by *O. patagonica* that has greater aptitudes for adapting to disturbances and environmental stress.

Conclusion
At present state, the marine ecosystems response to the introduction of *Oculina patagonica* in El-Kala waters is not perceptible, and sites where it has been reported shows integrity signs of marine ecosystems. Nevertheless, changes can occur in structure of these assemblages with apparition of competitive behaviors for space and food, knowing *O. patagonica* has high adaptive abilities thanks to its reproductive mode (sexual and asexual) described by (Karamarsky-Winter et *al.*, 1994) [1], to its Maximal occurrence in disturbed sites (urban pollution, artificial reefs, marinas…), as well as in healthy waters, to the Early maturity of individuals (1-2years old), to the Hermatypic species status showing high adaptive abilities. Developing monitoring programs for assessing the evolution of *O. patagonica* colonies is essential to evaluate their impact on marine ecosystems in El-Kala, essentially by studying growth, reproduction, depth, temperature and salinity intervals for this species survival, as well as functioning of the ecosystems housing it.

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COMMUNITY STRUCTURE OF MACROZOOBENTHOS ASSOCIATED WITH *ZOSTERA NOLTII* HORNEM. MEADOWS IN THE SOUTHERN ROMANIAN BLACK SEA COAST

Victor Surugiu [1], Ciprian C. Manzu [1], Irina Rosca [1] and Adrian Teaca [2]*
[1] "Alexandru Ioan Cuza" University of Iasi, Faculty of Biology
[2] NIRD for Marine Geology and Geoecology - GeoEcoMar - adrianxteaca@yahoo.com

Abstract
Species composition, abundance and diversity of macrozoobenthos associated with a *Zostera noltii* bed from the Romanian Black Sea coastal area were assessed in July and October 2010. A total of 1055 individuals belonging to 37 taxa were identified during the study. *Hydrobia acuta* was the dominant species of the assemblage with 20.9% of the total abundance. This species, together with *Mytilaster lineatus*, was also the most frequently encountered. The species richness and abundance were higher in summer than in the autumn.

Keywords: Biodiversity, Phanerogams, Zoobenthos, Black Sea

Introduction. The seagrass community is an important element of coastal benthic environments. Seagrass beds are among the most productive marine communities. As key primary producers, seagrasses represent an important source of food for many organisms, especially in the form of detritus. Eelgrasses are also grazed directly by waterfowl and by some fish species. The dense, matted root system of eelgrasses stabilise soft sediments, improve the nutrient supply of the water column and acts as an important source of organic detritus. Seagrass meadows also increase habitat diversity, providing shelter for a wide variety of marine organisms. For these organisms the seagrass communities serve as important feeding and nursery grounds [1]. In spite of the rich body of literature on the biodiversity of the fauna of seagrass worldwide, there is very few information regarding the qualitative composition, seasonal dynamics and quantitative distribution of zoobenthos from *Zostera* meadows along the Romanian Black Sea coast. Therefore, the aim of this study is to assess species composition and diversity of macrobenthic fauna from *Zostera noltii* beds at the southern Romanian Black Sea coast.

Material and Method. Quantitative samples from a dwarf eelgrass meadow located at Mangalia between 0.6 and 2.3 m depth have been collected by SCUBA and free diving on 28 July 2010 and 2 October 2010 (Fig. 1).

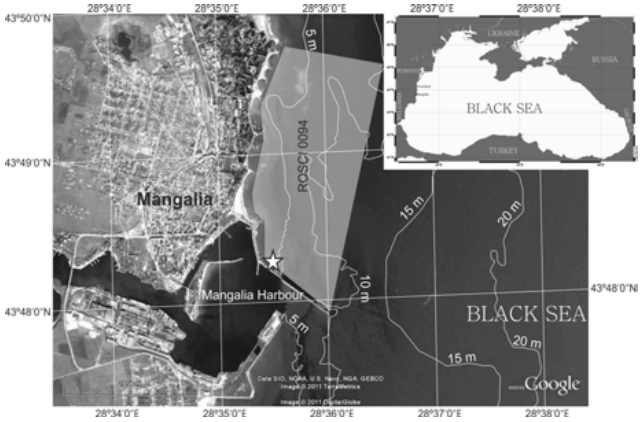

Fig. 1. Map of the southern Romanian Black Sea coast with location of the sampling site

During each sampling campaign seven random replicate samples have been taken in the centre of the meadow with a 10-cm-diameter hand-held corer (to ~10 cm depth). Samples were washed on a 0.5-mm sieve and the retained organisms were preserved in 10% formalin and then transferred to 70% ethanol. All associated macrofauna was sorted under a binocular, identified as possible to the lowest taxonomic rank and counted. The community structure of zoobenthos encountered in *Zostera noltii* meadows was assessed using the following univariate indices: frequency (*F*%), dominance (*D*%), species richness (*S*), Shannon-Wiener diversity index ($\log_2$ base, *H'*), and Pielou's evenness index (*J'*). Cluster analysis and non-metric multi-dimensional scaling (nMDS), based on Bray-Curtis similarity coefficient, has been performed on abundance data.

Results and Discussion. A total of 1055 individuals belonging to 37 taxa (29 species) were identified during the study. Dominant groups in terms of number of taxa were Arthropoda (13 taxa), Annelida (12 taxa), and Mollusca (10 taxa). Mollusks accounted for 59.8% of the total number of individuals, followed by polychaetes (23.4 %) and crustaceans (14.9%). The most abundant species in the *Zostera noltii* meadow were *Hydrobia acuta* (20.9% of the total number of individuals), *Rissoa* sp. (10.9%), *Spio decoratus* (10.6%), *Mytilaster lineatus* (9.3%), and *Ericthonius difformis* (8.4%). According to the frequency index, 16 taxa were designated as constant ($F \geq 50\%$), 3 species were classified as common ($25 \leq F < 50$) and 18 as rare ($F < 25$). The species with highest frequency of occurrence were *Hydrobia acuta* and *Mytilaster lineatus* (100%), *Rissoa* sp., *Abra segmentum* and *Cyclope neritea* (92.86%), *Cerastoderma glaucum* (85.71%) and *Spio decoratus* (64.28%). The mean number of species (16.5±1.6 S.E.) and that of individuals (11,192 ± 2069 ind. m^{-2}) was higher in July than in October (11.3±1.2 S.E. and 8007±1307 ind. m^{-2} respectively). The Mann-Whitney *U*-test showed a statistically significant difference in species number between the two sampled seasons ($U=6$; $P<0.05$), but no statistically significant changes were evidenced for total abundance ($P>0.05$). Also, both diversity and evenness values were usually higher in summer ($H'=3.82$, $J'=0.79$) than in autumn ($H'=3.12$, $J'=0.65$). These seasonal changes were delineated as well by the multivariate techniques (Fig. 2).

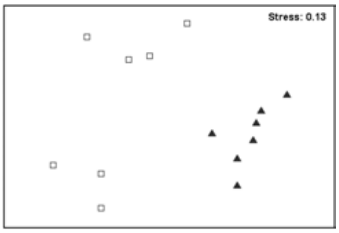

Fig. 2. NMDS ordination plot of samples collected from *Zostera noltii* habitat showing the groups determined by cluster analysis (filled triangles = summer; open squares = autumn).

The faunal assemblages of *Zostera noltii* from the Romanian littoral of the Black Sea proved to be relatively poor as compared to those from the Ukrainian [2], Turkish [3] or Bulgarian coasts [4]. However, the total abundance and species richness of dwarf eelgrass canopy is higher than that of the adjacent bare sediment.

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DEPTH DISTRIBUTION OF *CIDARIS CIDARIS* (LINNAEUS, 1758) AND *STYLOCIDARIS AFFINIS* (PHILIPPI, 1845) (ECHINODERMATA, ECHINOIDEA) AROUND THE MALTESE ISLANDS.

Kimberly Terribile [1]* and Patrick J. Schembri [2]
[1] Department of Biology, University of Malta, Msida MSD2080, Malta - kimberly.terribile@um.edu.mt
[2] Department of Biology, University of Malta, Msida MSD2080, Malta

Abstract
The sea urchins *Stylocidaris affinis* and *Cidaris cidaris* (family Cidaridae) are abundant on circalittoral and deeper bottoms off the Maltese Islands. Different authors quote different depth ranges for the two species. The depth distribution in Maltese waters was studied based on material from MEDITS surveys. *S. affinis* was found at depths of 50-550m with the highest relative abundance between 50m and 150m, predominantly on maerl or coarse sedimentary substrata. *C. cidaris* was found from ca. 50m to depths greater than 550m, mostly on sandy-mud.

Keywords: Deep sea ecology, Deep waters, Echinodermata, Sicily Channel

Introduction
Stylocidaris affinis and *Cidaris cidaris* are the most common sea urchins on circalittoral and deeper sedimentary bottoms around the Maltese islands. There is general agreement between authors that these species have different but overlapping bathymetric ranges; *S. affinis* is more commonly found in shallower waters than *C. cidaris*, which has a wider depth range. However, different authors give different depth ranges. For example, Tortonese [1] gives a bathymetrical range of 30-1000m and 50-2000m for *S. affinis* and *C. cidaris* respectively, while correspondingly, Koehler [2] gives 30-150m and 50-400m, and Koukouras *et al.* [3] give 5-180m and 20-250m.

Material and Methods
Samples were collected in 2009, 2010 and 2011 using the MEDITS trawling gear [4] during MEDITS (Mediterranean International Trawl Survey) surveys carried out in the General Fisheries Commission for the Mediterranean's Geographical Sub-Area 15, which includes the Malta 25 nautical mile Fisheries Management Zone. Cidarids were sorted from the by-catch, preserved and transferred to the laboratory where they were identified and counted. Although the two species differ in coloration (normally, *S. affinis* has a reddish coloration and *C. cidaris* is greenish), each individual was identified on the basis of the structure of the large globiferous pedicellariae, which have well defined terminal teeth in *C. cidaris*, but which lack terminal teeth in *S. affinis* [5]. Abundance was standardised to N^o/km^2 of seabed trawled. The grain-size distribution of sediment collected by grab from each station was determined using standard granulometric analysis and sediments were classified following the Udden-Wentworth scale.

Results
The samples from stations in the 51m to 200m depth range had a more or less similar abundance of *C. cidaris* and *S. affinis*, however the relative abundance of *C. cidaris* increased in the deeper stations (Figure 1).

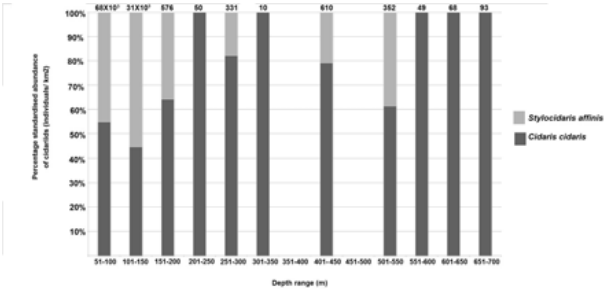

Fig. 1. Stacked bar graph showing the relative abundance of cidarids at different depth ranges around the Maltese Islands, based on MEDITS samples. The figures above each bar are the total number of individuals collected per km^2 from that depth range. No samples were collected from the 351-400m and 451-500m ranges.

Granulometric analysis showed that stations >100m in depth all had sandy-mud bottoms, while stations <100m in depth had bottoms of gravelly sandy-mud, most of which were maerl habitat.

Discussion
In Maltese waters, the two cidarids have a considerable bathymetric distribution, extending from ca. 50m to ca. 700m. At the shallower end (50m - 200m), there is total overlap in distribution with all stations having relative abundances of 45 - 65% and 35 - 55% for *C. cidaris* and *S. affinis*, respectively. The highest relative abundance of *S. affinis* recorded was 55% from the 101-150m range, which suggests an affinity of *S. affinis* for upper circalittoral depths where the bottom is predominantly maerl, or gravelly sandy-mud with rhodoliths. The relative abundance of *S. affinis* with respect to *C. cidaris* decreases with depth such that between 251m and 550m the abundance of *S. affinis* ranges from 17% to 39%. Only *C. cidaris* was present at depths greater than 550m where the bottom is muddy, implying an affinity of *C.cidaris* for fine sediment in the lower circalittoral and upper bathyal.

All the shallower stations where *C. cidaris* was the sole cidarid (200-250m and 300-350m) had fine sediment bottoms. Conversely, where *S. affinis* occurred at large depths (400-450m and 500-550m) the surficial sediment was relatively coarse due to large quantities of empty molluscan shells and shell fragments. This shows that the distribution of the two cidarids is not determined by depth alone, but that the nature of the bottom may be more important. Both species co-occur on rhodolith bottoms at the shallow end of their bathymetric range, however, *S. affinis* can only occur in deep water if there are coarse inclusions, such as shell fragments, in the sediment.

Where both species co-occur, it is crucial to identify each individual on morphological characters, since coloration alone is not diagnostic (some *C. cidaris* individuals in the present study had an orange colour whereas some *S. affinis* had a reticulated coloration rather than the normal overall reddish coloration). Misidentification may be one of the reasons contributing to the variance in depth records of the two species in the literature.

Acknowledgements
This project is part of an ongoing collaboration between the Marine Ecology Research Group of the Department of Biology of the University of Malta and the Fisheries Control Directorate at the Agriculture and Fisheries Regulation Department, Government of Malta. We acknowledge the kindness of the staff of both institutions for their assistance during the course of the project.

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A PRELIMINARY STUDY OF DENSITY AND AREA COVER OF A SHALLOW WATER SPONGE *SARCOTRAGUS SPINOSULUS* IN DOGANBEY, CENTRAL AEGEAN SEA, TURKEY

Eda N. Topçu Eryalçin [1]*, Bülent Topaloglu [1], Mert K. Eryalçin [2] and Bayram Öztürk [1]
[1] Istanbul University Fisheries Faculty Marine Biology Dept. - edatopcu@istanbul.edu.tr
[2] Istanbul University Fisheries Faculty Aquaculture Department

Abstract
Sarcotragus spinosulus is a massive sponge undergoing disease/mortality risks in the Mediterranean Sea. It is among the dominant macrobenthic species of photophilic assemblages in Doganbey area. The aim of this study was to provide a basis for future monitoring attempts of this species in Doganbey, Aegean Sea.

Keywords: Zoobenthos, Aegean Sea, Porifera, Density

Introduction

Sarcotragus spinosulus is a demosponge species inhabiting photophilic assemblages and is generally abundant in shallow waters not exceeding 20 m of depth. Sarcotragus sponges are massive sponges that constitute a habitat for several other species [1]. In the Mediterranean Sea, mass mortality events affected a wide range of species [2] including several sponges and *S. spinosulus* was also reported to be affected by mass mortalities related to anomalously high sea-water temperatures [3]. Another threat for *S. spinosulus* is the canopy development by *Caulerpa racemosa* on sponge surface that can lead to its smothering and even death [4]. In consequence of these risks that might affect *S. spinosulus*, monitoring of its populations is important in order to determine any disease/mortality events. The aim of this study was to provide a basis for future monitoring attempts of this species in Doganbey area.

Material and Methods

The study area (Fig. 1) consisted of boulders spread among sandy bottom/posidonia meadows. *Sarcotragus spinosulus* was among the dominant macrobenthic species of photophilic assemblages covering rocky substratum from 1 to 5 meters deep (Fig. 2). 7 plots of 10 m diameters were randomly laid overall the area in August 2012 and sizes of all *S. spinosulus* specimens within the plot were measured via snorkeling. 3 measurements were considered in order to calculate the sponge size: surface length, width and height. Area and surface calculations were performed by considering the sponge shape as the half of an ellipsoid.

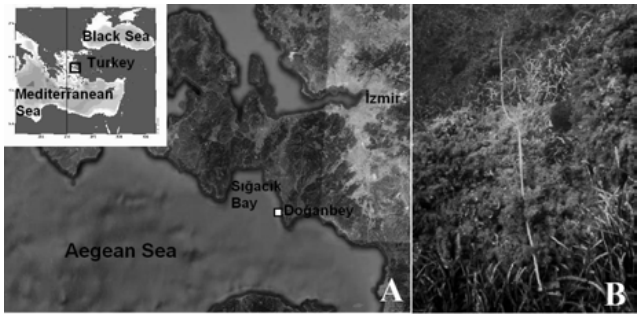

Fig. 1.
Location of the study area (A); The study area consisted of boulders spread among sandy bottom/posidonia meadows (B).

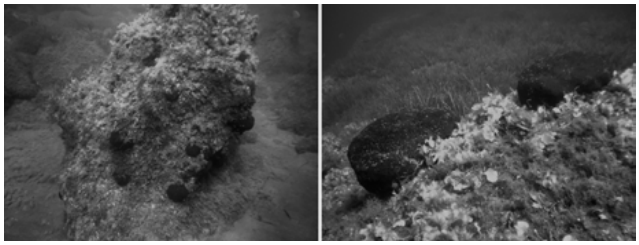

Fig. 2. *Sarcotragus spinosulus* specimens in Doganbey area

Results and Discussion

A total of 165 *S. spinosulus* specimens were observed over an area of 550 m^2. We didn't observe any injuries characteristic of sponge diseases [5] and all sponges within the plots were almost free of epiphytes. *S. spinosulus* density was 0.30±0.18 specimens.m^2 of the area including the soft substratum. The density value seems low compared to other density values [3; 5; 6] because we worked within continuous plots on a mixed substratum and did not use quadrats placed exclusively on rocky surfaces. We estimated *S. spinosulus* density over rocky surface as 1-3 specimens.m^2 via examinations of scaled pictures. The area cover by *S. spinosulus* was 51,32 cm^2/m^2 of the area including the soft substratum. 41% of *S. spinosulus* specimens in Doganbey were 100-1000 cm^3 in volume. 37% were smaller than 100 cm^3 whereas 14% were 1000-3000 cm^3. 5% of the specimens were 3000-5000 cm^3 and only 2% were larger than 5000 cm^3. *S. spinosulus* is the dominant macrobenthic species of Doganbey shallow water benthic community and this study provides a basis for its future monitoring attempts.

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ABUNDANCE, SIZE, AND GROWTH RATE OF *GEODIA CYDONIUM* (DEMOSPONGIAE: GEODIIDAE) IN THE NORTHERN ADRIATIC TEMPERATE BIOGENIC REEFS

Eva Turicchia [1]*, Davide Poli [1], Marco Abbiati [2] and Massimo Ponti [2]
[1] Student in Marine Biology (master degree) Università of Bologna - turice01@yahoo.com
[2] Dipartimento di Scienze Biologiche, Geologiche ed Ambientali (BiGeA), Alma Mater Studiorum Università di Bologna

Abstract
Northern Adriatic subtidal biogenic reefs host a large population of *Geodia cydonium* showing heterogeneous distribution with patches of high densities and large mean sizes. Its optimal distance from the coast, in terms of bio-volume, was 4-5 nm. The growth rate in diameter of *G. cydonium* has been estimated in 25.60 ± 11.15 % year^{-1} (± s.e.). Despite the relatively high growth rate, the heterogeneous and fragmented spatial distribution of *G. cydonium* suggests the needs of specific management and conservation strategies of this ecologically and aesthetically valuable species.

Keywords: Porifera, Conservation, Growth, Continental shelf, North Adriatic Sea

Introduction *Geodia cydonium* (Jameson, 1811) is an Atlanto-Mediterranean massive demonspongiae very variable in size, shape and habitus, from sessile and non-sessile morphs ([1], [2]). *G. cydonium* is a habitat forming species, hosting many epibiontic and endobiontic species ([3]). It is listed among the endangered or threatened species (Annex II, Barcelona Convention, 1995), however, its abundance, distribution, and biology are still now not well known. In the northern Adriatic Sea, *G. cydonium* dwells on the subtidal biogenic reefs occurring at 7 to 30 m ([4]). The aims of the present study were to quantify the abundance, distribution, size, and growth rate of *G. cydonium*.

Material and methods Randomly selected specimens of *Geodia cydonium*, leaving on 2 outcrops off Chioggia, were labelled and measured (maximum height, diameter and circumference) since August 2006 and re-measured every time they have been found until 2011. During the summer 2011, population densities and specimens mean size were measured along 10x2 m transects on 5 randomly selected outcrops between Chioggia and Caorle, ranging from 7 to 22 m in depth and from 2 to 8 nm from the coast. A total of 34 transects and 114 specimens were measured. Differences among sites were assessed by one-way ANOVA after check of the homogeneity of variances using the Bartlett test (transform: square root). Volumes of the specimens were obtained by approximating the shape to a sphere. The relationship between distance from the coast and mean size was investigated by non-linear correlation. SCUBA diver volunteers data were obtained from the Reef Check Italia *onlus* database.

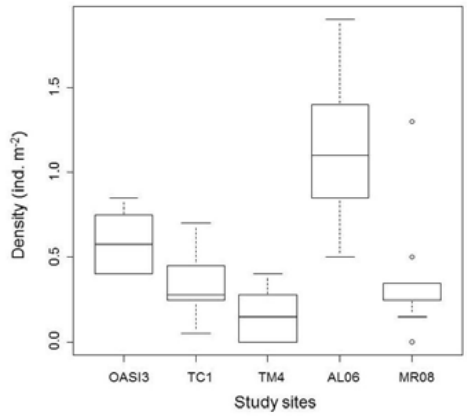

Fig. 1. Box-and-whisker plots of the densities of *Geodia cydonium* in the study sites, ordered by distance from the coast.

Results *Geodia cydonium* showed almost spherical shapes; size range was close to the largest reported in the literature. The estimated growth rates were 25.60 ± 11.15 % year^{-1} (± s.e.) and 14.07 ± 5.15 % year^{-1} (± s.e.) in terms of diameter and circumference, respectively. *G. cydonium* densities among outcrops varied from 0.16 ± 0.05 ind. m^{-2} to 1.15 ± 0.24 ind. m^{-2} (± s.e.; ANOVA P<0.001; Fig. 1). The mean bio-volume of the single specimens reached the higher values at 4-5 nm from the coast (Fig. 2). *G. cydonium* was very abundant in several places along the Adriatic and Ionian coasts (e.g. Porto Cesareo basin, Marsala lagoon, Rovinj) in the '70s, but since the end of the last century most of these populations have become progressively rarefied with smaller individuals (G. Corriero, pers. com.). Reports by volunteers show that the Italian distribution of *G. cydonium* is very fragmented (www.progettomac.it).

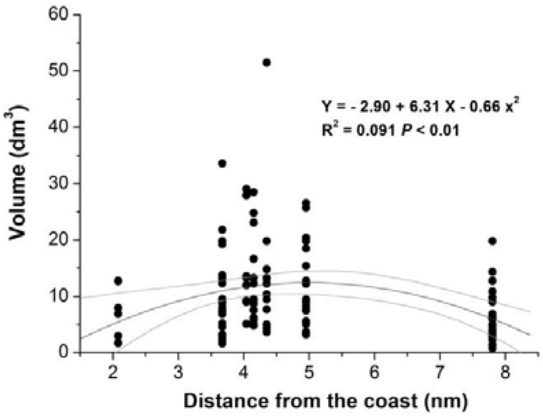

Fig. 2. Non-linear correlation between distance from the coast and specimens sizes in terms of estimated bio-volume.

Discussion *Geodia cydonium*, living on the northern Adriatic subtidal biogenic reefs, showed locally high densities and large mean sizes. Its largest sizes are reached at 4-5 nm from the coast, may be due to the interplay between water turbidity and food availability, largely affected by rivers load, sediments re-suspension, and planktonic blooms. Despite the relatively high growth rate, the heterogeneous and fragmented distribution of *G. cydonium* highlights the need of specific management and conservation strategies for this endangered and ecologically valuable species. **Acknowledgments** The Diving Center Tegnùe Chioggia provided the logistic support and Reef Check Italia *onlus* valuable data.

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Session

Traceability - fish

Modérateur : **Cemal Turan**

PHYLOGENETIC CHARACTERIZATION OF GENEUS *TRACHINUS* BASED ON COI, 12SRDNA AND 16SRDNA SEQUENCES IN THE SOUTHERN AND CENTRAL PART OF ADRIATIC SEA

D. Skaramuca [1]*, D. Franjevic [2], P. Tutman [3], S. Matic-Skoko [3], P. Korlevic [4], D. Đikic [2], Z. Franic [5] and B. Skaramuca [1]
[1] University of Dubrovnik, Dubrovnik, Croatia - daria.skaramuca@zg.t-com.hr
[2] University of Zagreb, Faculty of Science, Division of Biology, Zagreb, Croatia
[3] Institute of Oceanography and Fisheries, Split, Croatia
[4] Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany
[5] Institute for Medical Research and occupational Health, Zagreb, Croatia

Abstract
Due to great morphological diversity among species of genus *Trachinus* it is not easy to identify them unequivocally based only on biometric traits. Three different mitochondrial phylogenetic markers (COI, 12SrDNA, 16SrDNA) were examined on total of 87 samples. Results of phylogenetic analyses on all gene markers have managed to distinguish successfully different species among genus *Trachinus*.

Keywords: Fishes, Systematics, Genetics, South Adriatic Sea

Familie Trachinidae (Weeverfish) consists of 2 genera: *Trachinus* and *Echiichthys*. Weeverfish are known for their venomous spines on the gill covers and first few dorsal fins. All species live in sandy or sandy-muddy habitat buried in the ground of benthic, coastal or open ocean area. In the Adriatic Sea four (4) species of Weeverafish are present: *Trachinus draco*, *Trachinus radiatus*, *Trachinus araneus* and *Echiichthys vipera*. Due to great morphological diversity among species of genus *Trachinus* it is not easy to identify them unequivocally based only on biometric traits. (Figure 1.)

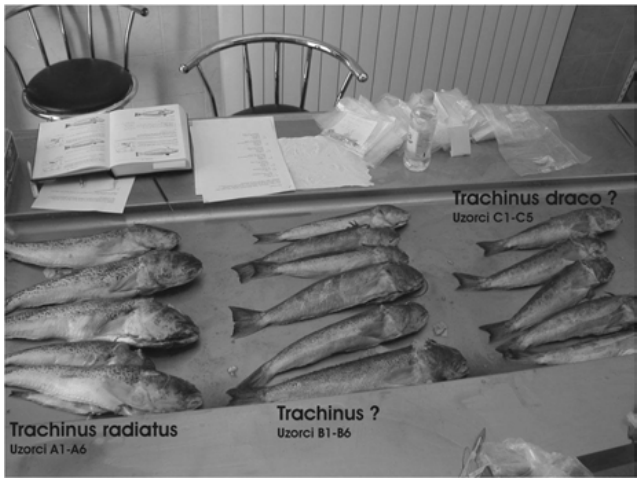

Fig. 1. Caught samples of genus Trachinus.
Question marks represent samples which species discrmination cannot be concluded from morphological and meristc measurements.

The goal of this research was to distinguish species belonging to Trachinidae. Upon DNA extraction (Quigen, DNeasy Tissue kit), and PCR amplification (Quigen, HotStartTaq Plus Master Mix Kit) data for analyses was obtained by standard Sanger sequencing of following markers COI, 12SrDNA and 16SrDNA. Primers used for philogenetic analyses were:
16S [2]
16Sar 5' - CGC CTG TTT ATC AAA AAC AT - 3'
16Sbr 5' - CCG GTC TGA ACT CAG ATC ACG T - 3'
12S tRNA-Val [2]
12SL 13-L5' - TTA GAA GAG GCA AGT CGT AAC ATG GTA - 3'
Titus l-h 5' - GGT GGC TGC TTT TAG GCC - 3'
COI [1]
LCO-1490 5' - GGT CAA CAA ATC ATA AAG ATA TTG G - 3'
HCO-2198 5' - TAA ACT TCA GGG TGA CCA AAA AAT CA - 3'
Phylogenetic analyses were performed via three different methods: Maximum Parsimony (MP), Maximum Likelihood (ML), and Bayesian analysis (BA). Results on all gene markers have shown the same identification pattern of species discrimination (Figure 2.).

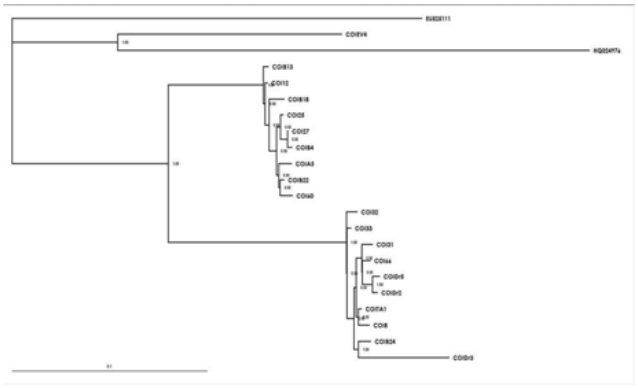

Fig. 2. Rooted consensus phylogram of COI genes from Adriatic Trachinidae inferred via Bayesian analysis after TVM+G model of nucleotide substitution using "Metropolis-coupled Markov Chain Monte Carlo" method. Numbers in nodes represent posterior probabilities. Genetic distance d=0.1

Therefore, our research proved that used genetic markers and applied methods of molecular phylogenetics reconstruction are excellent for species determination quandary inside genus *Trachinus*. It is necessary to conduct further detailed morphological and meristic studies in order to dermine the differences observed by means of molecular phylogenetic analyses.

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GENETIC POPULATION STRUCTURE OF THE ENDANGERED DUSKY GROUPER, *EPINEPHELUS MARGINATUS*, IN THE MALTESE ARCHIPELAGO AS REVEALED BY 14 MICROSATELLITE MARKERS.

Molly Sørensen [1]* and Adriana Vella [1]
[1] Conservation Biology Research Group, University of Malta - molly.sorensen@alumni.ubc.ca

Abstract
The objective of this study is to describe the genetic population structure of the endangered marine fish, *Epinephelus marginatus*, in the Maltese archipelago for the purpose of localized conservation management planning. Genetic population structure was determined by examining 89 individuals collected within Malta's Fisheries Management Zone with 14 microsatellite markers. Results of genetic clustering by admixture analysis found one continuous population (K = 1) inhabiting the Maltese archipelago. Further genetic analysis describes a population decreasing in size ($Theta_{(mean)}$ = 2.2), which has gone through a significant size reduction in the past ($M_{(mean)}$ = 0.41) and shows signs of inbreeding (F_{IS} = 0.10, P > 0.001). Results suggest that management should be designed to reflect the archipelago as a single conservation unit.

Keywords: Conservation, Genetics, Teleostei, Islands, South-Central Mediterranean

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]. Within Malta's Fisheries Management Zone (FMZ), catch landings data (kg) show, over a 62 year period between 1947 and 2009 a decrease in catch landings of over 90% [2]. 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 [3]. Localized population structure parameters include pelagic larval dispersal influenced by surface current direction during spawning season along with limited juvenile stage movement. Within Malta, the archipelago is surrounded by a 100 m bathymetry shelf. The predominant surface current direction, during the spawning months of June through August, is from the tip of the archipelago in north-west Gozo toward south-east Malta [4]. The purpose of this research is to describe and define the status of the Maltese population of *E. marginatus* in order to best develop a comprehensive conservation management and monitoring strategy.

Materials and Methods
A total of 89 *E. marginatus* specimens were sampled from the Maltese archipelago FMZ between 2007-2009. Fourteen polymorphic microsatellite markers were used in this study to explicate the population structure. Individuals were genotyped using a Roche 454 Genome Sequencer FLX. Genetic clusters were inferred using multilocus genotype admixture analysis with the software Structure 2.3.4 [5] while molecular and diversity indices and F-statistics were calculated using the software Arlequin 3.5 [6].

Results
A total of 227 alleles were observed within 14 polymorphic loci. Based on multilocus admixture analysis of 89 individuals a single genetic cluster (K = 1) was inferred from the genotypic data. Within group analysis reveals genotypic disequilibrium in 31 loci pair. Mean observed heterozygosity was H_O = 0.68 and the expected heterozygosity was H_E = 0.76. Rare breeding size males (T ≥ 85 cm) were present in all groups with a significantly higher incidence of large size individuals (T ≥ 70 cm) observed, at the tip of the archipelago, in north-west Gozo. Positive Theta (Hom) values were read as an indication of a population decreasing in size ($Theta_{(mean)}$ = 2.2). The Garza-Williams index, for detection of population reduction, interpreted M values less than 0.7 to be indicative of a recent population size reduction and anything less than 0.43 as specific to remnant populations and of a significant size reduction in the past ($M_{(mean)}$ = 0.41). In addition, a global F_{IS} test within the FMZ accepted the null hypothesis of an inbred population ($F_{IS(global)}$ = 0.01, P > 0.001).

Discussion
The Maltese islands are inhabited by single congruent population of *E. marginatus*, likely due to biogeographical isolation due to depth range and larval retention patterns. The 90% decline of catch landing within the FMZ over the last half century is consistent with the results of Theta(Hom), M and F_{IS}, which collectively point to a population which has gone through a significant size reduction in the past, is trending downward and consequently shows indications of moderate inbreeding. In addition, north-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. 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 Gozitan individuals.

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MICROSATELLITE LOCI FOR ATLANTIC BONITO *SARDA SARDA*

C. Turan [1]*, M. Gurlek [1], D. Erguden [1], D. Seyhan [1], A. N. Reyhaniye [1] and A. Uyan [1]
[1] Molecular Ecology and Fisheries Genetics Laboratory, Faculty of Marine Sciences and Technology, University of Mustafa Kemal, Iskenderun, Hatay, Turkey - turancemal@yahoo.com

Abstract
Various microsatellite loci were tried for *Sarda sarda* using microsatellite primers which were described or developed for other Scombrid species to understand if they available usage for *S. sarda*. Only five microsatellite loci were successfully amplified with new developed PCR conditions and used for routine analysis of stock identification of *S. sarda*.

Keywords: *Atlantic Bonito, Sarda sarda, microsatellite marker*

Keywords: Genetics, North-Eastern Mediterranean

Introduction

Atlantic Bonito *Sarda sarda* (Bloch, 1793) is a member of family Scombridae and distributed along the tropical and temperate coasts of the Atlantic Ocean, the Mediterranean Sea, and the Black Sea [1] inhabits pelagic neritic waters about 200 m deep [2]. Atlantic Bonito is a migratory species, and little is currently known on the genetic differences between the populations.

Molecular genetics techniques utilize to identify stock structure of marine species. In recent years, microsatellite markers have increasingly been used to identify genetics differences between stocks [3, 4, 5].

There are several genetic studies about microsatellite analysis of some Scombrid species reveal the heterogeneity and characterize stocks. Davies et al. [6] investigated in Albacore Tuna (*Thunnus alalunga*, Bonnaterre, 1788) with twelve polymorphic microsatellite loci and found significant differences between stocks. Similarly, McDowell et al. [7] isolated and characterized seven tetranucleotide markers and these primer sets were also used to amplifying other tuna species. Takagi et al. [8] developed several microsatellite loci for investigating genetic polymorphism in Thunnus species.

To our knowledge, no specialized microsatellite markers currently exist for the Atlantic Bonito *S. sarda*, but there are some for other Scombrid species. In this study, many microsatellite loci were tried for *S.sarda* using other microsatellite primers which were described or developed for other Scombrid species to understand if they available usage for *S. sarda*. Only five microsatellite loci were successfully amplified and used for routine analysis of stock identification of *S. sarda*. The primer sets Tth4 [9], Ttho6, Ttho7 [8], Tth8, Tth34 [7] have been chosen for a successful amplifying process. New PCR conditions were developed for each primer.

Materials and Methods

Genomic DNA was extracted using Standard phenol-chloroform isoamyl alcohol technique [10], and total 459 individuals were extracted and total DNA was visualized by gel electrophoresis (%1.5) and quantified by spectrophotometric assay. To specify and avoid amplifying non specific sequences touchdown PCR method has been used.

Results and Discussion

After screening of the primers developed for other Scombrid species with different PCR conditions, only five microsatellite loci were found to be appropriate for routine analysis. The annealing temperature for each primer set was arranged according to the melting temperature of the primer sets (Table 1). Polymerase chain reaction (PCR) was carried out using a reaction volume of 15µl containing 1U Taq polymerase (Thermo scientific), 2 µM of each primer, 200 mM dNTPs, 25mM MgCl2,10m MTris-HCI pH 8.8, 50 mM KCI and 1 µl template DNA (≈10-25ng). PCR temperature profile consisted of two stages. In first stage; pre denaturation at 95°C for 5 min followed by 20 cycles of denaturation at 94°C for 30 s, annealing at primer-specific temperature for 45s, extension at 72°C for 2 min. Second stage followed by 20 cycles of denaturation at 94°C for 30s, annealing temperature at 56°C for 45s, extension at 72°C for 2 min and final extension at 72°C for 5min. PCR products were separated by electrophoresis on 7.5% polyacrylamide gel and visualized by silver staining. Gel analyzer (1-D Gel Analysis) software version 2010a was used to determine the alleles detected by electrophoresis.

Tab. 1. Five microsatellite loci for Atlantic Bonito (Sarda sarda)

Locus	GenBank No	Primer sequences	Repeat motif	Size range (bp)	T_m °C
Tth4	AY396534	F:GAAACGCAGCCGGAGAGGAAAGAG R:ATGTGAGGGGGATGGGAGCTTGT	(GT)	202-283	66.1
Tth06	AB043132	F: TTCTGCTTCTTTCTTCTGG R: GAAAACACAGGGATTATGG	(CACA)	111-190	52.4
Tth07	AB043133	F: ACTGGATGAAAGGCGATTAC R: ACAGAGGAGCATAACAGAAAC	(CACA)	135-280	55.3
Tth8	AF441227	F:CCTGTTTGAGTGTTTATCTGTGCG R:GGTGTTGGCTATTGAGGAAATGC	(CTGT)	200-312	61.0
Tth34	AF441230	F: GATGCCATTTCTCTGTCATCTG R: AAGCCGTTCCCTCAGTGTC	(CTGT)	100-210	57.9

This study preliminary reveal reliable usage of microsatellite loci for Atlantic Bonito *S. sarda*. As a result, the selected microsatellite loci developed and described in other studies for other Scombrid species (Takagi et al. 1999, Clark et al. 2004 and McDowell et al., 2002) can be used for *S. sarda* with the PCR conditions described here.

Acknowledgements: Thanks to the Scientific & Technological Research Council of Turkey (TUBITAK-111T481) for financial support.

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MOLECULAR SYSTEMATICS OF GENUS TRACHURUS IN TURKISH MARINE WATERS

M. Gurlek [1], D. Erguden [1], D. Yaglioglu [2], F. Turan [1] and C. Turan [1]*
[1] Molecular Ecology and Fisheries Genetics Laboratory, Faculty of Marine Sciences and Technology, University of Mustafa Kemal, Iskenderun, Hatay, Turkey - turancemal@yahoo.com
[2] Faculty of Biological Science, University of Duzce, Duzce, Turkey

Abstract
The systematic relationship of three species of genus Trachurus (Trachurus trachurus, Trachurus mediterraneus, Trachurus picturatus) from Turkish marine waters was investigated using restriction fragment length polymorphism analysis of the mtDNA 16 S, ND 3/4 and ND 5/6 genes.

Keywords: *Phylogeny, Trachurus, mtDNA genes*

Keywords: Genetics, North-Eastern Mediterranean

Introduction
The species of the genus *Trachurus* are widely distributed throughout oceanic waters of temperate, tropical and subtropical seas [1, 2]. Three species of the genus *Trachurus*, *Ttrachurus trachurus*, *Trachurus. mediterraneus* and *Turachurus picturatus*, are found in Turkish waters [3]. The phylogenetic relationships of the three *Trachurus* species using RFLP (restriction fragment length polymorphism) analysis of mtDNA fragments amplified in polymerase chain reaction (PCR). Mitochondrial genes have substantially different rates of evolution and, correspondingly, different levels of resolution for phylogenetic reconstructions [4].

Materials and Methods
Trachurus samples (*T. mediterraneus*: TM; *T. trachurus*: TT; *T. picturatus*: TP) were collected separately by commercial fishing vessels from seven fishing ports in the Black, Aegean, Marmara and north-eastern Mediterranean. Total DNA was extracted from muscle using the Standard phenol: chloroform: isoamyl alcohol procedure [5]. Three mtDNA genes (ND 3/4, ND 5/6, 16 S rDNA) were amplified using universal primers. The primers were;
16 S F: 5'-CG (CT) AAG GGA A (ACT) G CTG AAA-3'
R: 5'-CCG GTC TGA ACT CAG ATC ACG TAG-3'
ND5/6 F: 5'-AAC AGT TCA TCC GTT GGT CTT AGG-3'
R: 5'-TAA CAA CGG TGG TTC TTC AAG TCA-3'
ND3/4 F: 5'-TAA (C/T)TA GTA CAG (C/T)TG ACT TCC AA-3'
R: 5'- TTT TGG TTC CTA AGA CCA A(C/T)G GAT-3'
PCR-products were digested by the set of 6 restriction endonucleases: *Bsur*I, *Alu*I, *Ehe*I, *Hin6*I, *Rsa*I, *Xho*I.
PCR amplification conditions were as follows: 94°C for 4 min followed by 35 PCR cycles. Strand denaturation was made at 94°C for 30 s, annealing at 52°C / 20s 72°C and primer extension at 72°C for 1.5 min. A final extension at 72°C for 5 min was performed. The PCR cocktail were; 1.5 µl 10 x polymerase buffer, 0.5 µl dNTP (10 mM), 0.3 µl Taq DNA polymerase (3 U / µl), 0.10 µl primers, 1 µl template DNA, and water for a total reaction volume of 25 µl. Same amplification conditions were used for all genes.

Results and Discussion
16S rDNA Gene: A total of 34 composite haplotypes was found within 270 individuals. In terms of haplotype diversity were 12, 13, 15 for *T. mediterraneus*, *T. trachurus*, *T. picturatus* respectively.
In UPGMA analysis *T. trachurus* and *T. mediterraneus* revealed close relationship and *T. picturatus* was found to be genetically highly distinct from the two Trachurus species (Figure 1.)

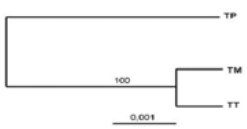

Fig. 1. UPGMA tree of Trachurus species based on 16 S rDNA.

The average nucleotide differences between species have been identified as 0.004924 the highest nucleotide diversity (0.007521) was found between *T. picturatus* and *T. mediterraneus*. The lowest nucleotide differences (0.001262) was detected between T. mediterraneus and T. trachurus.
ND 5/6 Gene: PCR-products were digested by the set of 6 restriction endonucleases: *Bsur*I, *Alu*I, *Ehe*I, *Hin6*I, *Rsa*I and *Xho*I. A total of 2 composite haplotypes was found within 270 individuals. Haplotype diversity was observed as 1, 2 and 1 for *T. mediterraneus*, *T. trachurus*, *T. picturatus* respectively.
In UPGMA analysis, *T. trachurus* and *T. picturatus* were genetically closer to each other and *T. mediterraneus* was found to be highly divergent from *T. trachurus* and *T. picturatus* (Figure 2).
ND3/4 gene: it was monomorphic and RFLP analysis revealed no haplotype diversity and divergence.

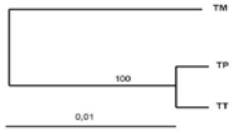

Fig. 2. UPGMA tree of Trachurus species based on ND 5/6.

Separate analysis of three mtDNA gene resulted in different patterns of phylogenetic relationship among the species of Trachurus genus, and only two genes of mitochondrial genes showed polymorphisms.
Acknowledgements: Thanks to the Scientific & Technological Research Council of Turkey (TUBITAK-104Y256) for financial support.

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CLASSIFICATION OF SPECIES WITHIN THE GENUS *HEXANCHUS* AND *HEPTRANCHIAS* THROUGH MTDNA SEQUENCES.

Noel Vella [1]* and Adriana Vella [1]
[1] Conservation Biology Research Group, Department of Biology, University of Malta - noel.vella@um.edu.mt

Abstract
In this study, the mtDNA region from the 12S rRNA gene to the 16S rRNA gene has been sequenced from a number of Hexanchidae specimens (*Hexanchus griseus*, *Hexanchus nakamurai* and *Heptranchias perlo*). A total of 150 polymorphic nucleotide positions have been identified, with the interspecific divergence being 5.46%, while the intraspecific divergence between the identified haplotypes ranged between 0.24% and 0.95%.

Keywords: Elasmobranchii, South-Central Mediterranean

Introduction
The Family Hexanchidae (Order: Hexanchiformes), has only four extant species [1], making this Family one of the smallest shark groups, with its members being described through morphological characters [1,2]. Nonetheless in other shark Families, mtDNA sequences have been readily used as genetic markers to identify or confirm very similar species [3,4].

Methodology
Tissue samples were collected from *Hexanchus griseus* (Central Mediterranean n=6; North-East Atlantic n=4; South-West Pacific n=5; and North-East Pacific n=4); *Hexanchus nakamurai* (North-West Pacific n=4) and *Heptranchias perlo* (Central Mediterranean n=4; North-East Atlantic n=1; and North-West Pacific n=2). DNA was extracted using proteinase K digestion followed by standard phenol-chloroform extraction method. Amplification was carried out using 12SA (AAACTGGGATTAGATACCCCACTAT) and 16SA (ATGTTTTTGATAAACAGGCG) primers [5] (95°C for 4min followed by 30 cycles of 30sec at 95°C, 30sec at 55°C and 1min at 72°C, with a final extension of 10min at 72°C). PCR products were sequenced in both directions using ABI3730xl. Additionally, two homologous sequences [3], one of *Hexanchus vitulus* (a synonym to *Hexanchus nakamurai*) and one of *Heptranchias perlo* were also added to the analyses. Sequences were then aligned together using Geneious R6 and the shortest homologous sequence was used for analyses (1404bp). Intraspecific and interspecific variation were estimated using Arlequin v3 [6], while a Maximum Likelihood phylogram was constructed using the best fit mutation model through MEGA v5 [7].

Results and Discussion
150 polymorphic nucleotide positions were recorded, forming 11 haplotypes. The intraspecific variation ranged between 0.24% and 0.95%, with the highest genetic differences being noted between the most distant sampling locations (Fig 1). Mediterranean specimens of *Hexanchus griseus* and *Heptranchias perlo* shared haplotypes with specimens from the North-East Atlantic Ocean.

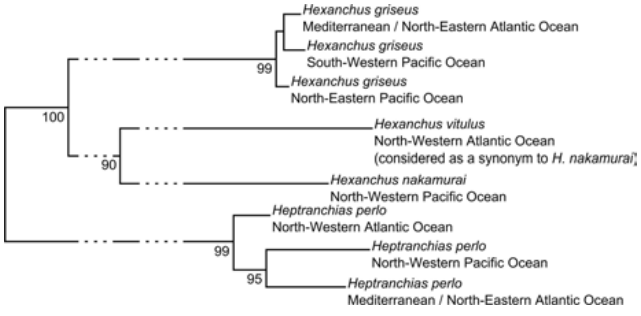

Fig. 1. A schematic phylogram of the three Hexanchidae species analysed in this study. The numbers near nodes represent bootstrap values.

The interspecific genetic divergence was around 5.46%. Clear genetic divergence was noted between the genus *Heptranchias* and the genus *Hexanchus*, with the latter being monophyletic. The genetic divergence within the species *Hexanchus nakamurai*, a senior synonym to *Hexanchus vitulus* [2], was quite high. In fact *Hexanchus nakamurai* specimens collected from the North Western Pacific Ocean exhibited a 4.4% divergence from that originating from the North Western Atlantic Ocean (Fig 1). Similar observations were noted in another study [4], using a different gene, where again high intraspecific divergence was recorded between *Hexanchus nakamurai* of Indo-Pacific origin and that of an Atlantic origin. Thus it can be concluded that there is a possibility of a third species within the genus *Hexanchus*, that is *Hexanchus nakamurai* might be split into a species within the Atlantic Ocean and another one in the Indo-Pacific Ocean. Given that *Hexanchus nakamurai* has been recorded in the Mediterranean Sea, then its identification would be best if supported by phylogenetic analyses to better understand the evolutionary connections of this poorly known species

Acknowledgments
We would like to thank all the Maltese fishermen for supporting the project, the International Ocean Institute for awarding the Elizabeth Mann Borgese Bursary towards this study, Ms. Liz Dent an intern who assisted in this project and a number of entities who aided in tissue collection including: Mr. F. Burns, Marine Scotland Science, Scotland; Dr. J. Correia, APECE and Flying Sharks, Portugal; Dr. M. Freitas, Director of the Marine Biology Station of Funchal and curator of the Museum of Natural History of Funchal, Madeira; Dr. H-C, Ho, National Museum of Marine Biology and Aquarium, Taiwan; Dr. K. Maslenikov, The University of Washington Fish Collection, Washington, USA; Dr. A. Stewart, New Zealand Foundation for Research Science and Technology through Te Papa Biosystematics of NZ EEZ fishes subcontract within NIWA's Marine Biodiversity and Biosecurity OBI program (contract C01X0502); Dr. H.J. Walker, Marine Vertebrates Collection, Scripps Institute of Oceanography, USA; Dr. N. Ziani, AILERONS, France.

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PHYLOGEOGRAPHY OF THE *HEXANCHUS GRISEUS*, INFERRED FROM THE MTDNA CONTROL REGION.

Noel Vella [1]* and Adriana Vella [1]
[1] Conservation Biology Research Group, Department of Biology, University of Malta - noel.vella@um.edu.mt

Abstract
The mtDNA control region has been sequenced for 129 specimens of Hexanchus griseus. Signficant genetic differences were noted between the Pacific Ocean and the Eastern Atlantic Ocean (including the Mediterranean), giving clear indication of population heterogeneity between Oceans.

Keywords: Elasmobranchii, Malta Trough, Aegean Sea, Valencia Trough

Introduction
Hexanchus griseus is a cosmopolitan shark that is found to occur in various areas around the globe, including the Mediterranean Sea [1, 2]. It is one of the largest Mediterranean sharks, but little is known about its biology and distribution. IUCN has assessed this species as Nearly Threatened on a global scale [3], while in the past year its status on a regional scale, has been downgraded from Nearly Threatened to Vulnerable [4, 5].

Methodology
This study looked into the genetic structure of this shark, using the complete mtDNA control region as a molecular tool to identify subtle differences between 129 individuals originating from different geographical origins, with the main focus being the Mediterranean Sea population. The control region was amplified using newly designed primers, and it was sequenced through the use of five sequencing reactions.

Results and Discussion
The first genetic differences noted were based on the length of the control region. The number of VNTRs varied between locations, but since the mutation processes leading to the formation of VNTRs are different from the other point mutations noted in the control region, then their data was not used in this phylogeographic study. A total of 1258bp were analysed, and exhibited 14 polymorphic sites, with the maximum genetic difference between specimens being that of 1%. The haplotypic diversity noted was 0.743 ±0.023, while the nucleotide diversity was 0.0015 ±0.0010. The mean pairwise difference between individuals was 1.943 ±1.110, and had a Ti/Tv of 1.75, while three indels were also recorded.
Nested clade phylogeographical analysis and the phylogenetic tree (Figure 1) for the control region has shown that there are no sharing of haplotypes between distant locations. In fact, specimens from the Pacific Ocean formed a clade which is distinct from that noted in the Atlantic Ocean (including the Mediterranean Sea), and so the greatest genetic divergence was noted between these two Oceans. Moreover no haplotypes were shared between the North-eastern Atlantic Ocean and the South-eastern Atlantic Ocean. On the other hand Mediterranean specimens do share a haplotype with the North Atlantic Ocean, indicating recent divergence between these two locations.

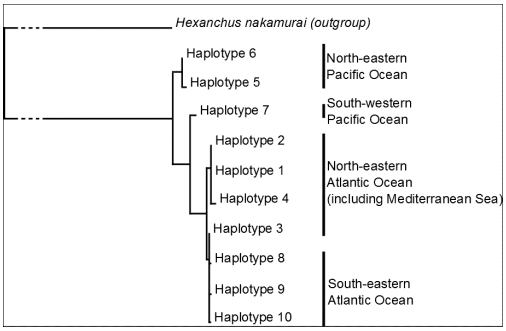

Fig. 1. A phylogram based on Maximum Likelihood analysis of the control region (1258bp) of *Hexanchus griseus* (haplotypes 1 - 10).

It can be concluded that even though this shark is a cosmopolitan species, still its population is subdivided into groups that are genetically different from each other. This stresses the need for conservation measures to tackle each group separately.

Acknowledgments
We would like to thank all the Maltese fishermen for supporting the project, the International Ocean Institute for awarding the Elizabeth Mann Borgese Bursary towards studying this species, and a number of international entities who aided in tissue collection, including: Mr. F. Burns, Marine Scotland Science, Scotland; Dr. M. Freitas, Director of the Marine Biology Station of Funchal and the curator of the Museum of Natural History of Funchal, Madeira; Mr. J. Gamatham and Mr. P. Kainge, The National Marine Information and Research Centre, Ministry of Fisheries and Marine Resources, Republic of Namibia; Dr. J. Guallart and Nuria Bufort and captain and crew of the fishing ship "Pausep", Valencia, Spain; Dr. H-C, Ho, National Museum of Marine Biology and Aquarium, Taiwan; Dr. H. Kabasakal, Ichthyological Research Society, Istanbul, Turkey; Dr. P. Lymberakis, Natural History Museum of Crete, Crete, Greece; Dr. K. Maslenikov, The University of Washington Fish Collection, Washington, USA; Dr. A. Miliou, Archipelagos, Institute of Marine and Environmental Research of the Aegean Sea, Greece; Dr. A. Stewart, New Zealand Foundation for Research Science and Technology through Te Papa Biosystematics of NZ EEZ fishes subcontract within NIWA's Marine Biodiversity and Biosecurity OBI program (contract C01X0502); Prof. F. Tinti and Dr. A. Velona, Dept. Experimental and Evolutionary Biology, Faculty of Sciences, University of Bologna, Italy; Dr. H.J. Walker, Marine Vertebrates Collection, Scripps Institute of Oceanography, University of California, USA; Dr. N. Ziani, AILERONS, France.

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Session

Traceability - invertebrates

Modérateur : **Evrim Kalkan**

PRELIMINARY STUDIES ON GENETIC DIVERGENCE OF SOME SEA URCHINS ON THE SOUTHERN LEVANTINE BASIN OF EGYPT

Elzahrae Elmasry [1], H. A. Omar [1], F. A. Abdel Razek [1]* and M. A. El-Magd [2]
[1] National Inst. of Oceanog. & Fish., (NIOF), Egy. - fatma_abdelrazek@hotmail.com
[2] Biotechnology Lab., Fac. of Vet. Med., Kafr Elsheikh Univ.

Abstract
There's no assessment for the sea urchin diversity in the Mediterranean despite the critical role they have as keystone species. Recent surveys in the Mediterranean show new data about sea urchin diversity and newly introduced species. Data from western Mediterranean countries to Egypt show records of 4 species *Paracentrotus lividus, Arbacia lixula, Sphaerechinus granularis and Psammechinus microtuberculatus.* While the Eastern Mediterranean countries to Egypt show the presence of Diadema setosum which is a recent invader from the Red Sea. Still the southern Levantine, of Egypt coast, lack complementing data for such findings.

Keywords: Biodiversity, Levantine Basin, Echinodermata, Genetics

Introduction
The morphological similarity between the species most common in the Mediterranean Levantine basin along with the lack of studies in Egypt that tackles the biology and ecology of these organisms have resulted in confused nomenclature. Furthermore, the uncertain geographical extent due to continuous introduction of new species has resulted in inconclusive reliability on biogeography [1]. The purpose of this study is to use genetic analysis as a reliable way for classification. Molecular methods depend on isolation and identification of 16S mitochondrial DNA gene was successfully used as a most preferred model for molecular genetics ecology as it support the relationship between morphology and genetics [2]. Therefore, we aimed to isolate and identify 16S mitochondrial DNA gene from selected sea urchins from several locations in Egypt to be used further for sequencing and subsequently in taxonomic and phylogenetic analyses.

Materials and Methods
The samples are collected by SCUBA diving from 2 rocky shore stations of Alexandria coast Abu Qir bay and Miami area Fig (1).

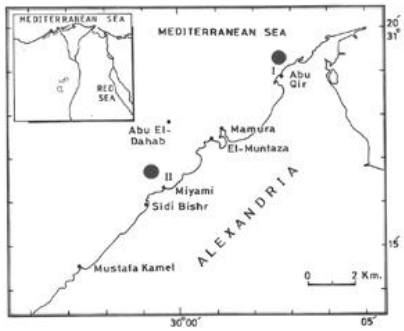

Fig. 1. Map showing locations of collection sites.

Four distinct morphological groups were selected. Gonad and gut specimens were collected from the 4 groups in order to examine their genetic variability. Specimens were quick frozen in liquid N2 and then ground in a clean, sterilized mortar. The genomic DNA was then extracted using Gene JET genomic DNA extraction kit following the manufacturer protocol (Fermentas, #K0721). To amplify partial 16S mitochondrial DNA region (approximately 450-500 bp), two universal primers (F:5'GACGAGAAGACCCTGTGGAGC3' and R:5'ACTTAGATAGAAACTGACCTG3') were designed using Primer 3.0 software based on conserved regions in published sea urchin and sea star sequence data [3]. The PCR was carried out following the manufacturer protocol (Fermentas, #K1071) in Techne TC-plus thermal cycler. PCR products were electrophoresed on 1% agarose gels using 1X TAE buffer containing 200 ng/ml ethidium bromide and then photographed.

Results and Discussion
The morphological examination resulted in 4 inconclusive regular sea urchin groups and they were expected to be *Arbacia lixula, Paracentrotus lividus, Psammechinus microtuberculatus and Sphaerechinus granularis*. However it is known that the juvenile individuals of *A. lixula* and *S. granularis* are sometimes confused with *P. lividus*. The *P. microtuberculatus* is also confused with *P. lividus* when the later has a lighter green color.
The amplified 16S mitochondrial DNA products from all four selected sea urchins showed four bands with different sizes (ranged from 450bp to 500bp) (Fig. 2).

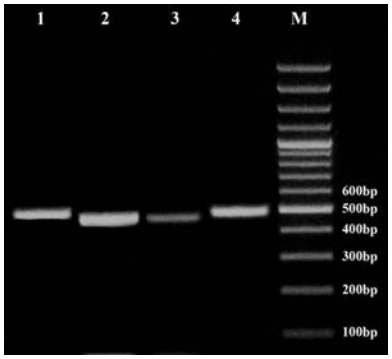

Fig. 2. PCR of 16S mitochondrial DNA fragment of 4 sea urchins (lanes 1-4), M= Marker.

The resulted PCR products are of different size, it is possible that these four sea urchins may be of different species or subspecies. Further confirmation using sequencing will be helpful for taxonomy and phylogenetic classification which will be done shortly after. We conclude that the molecular identification using 16S mitochondrial DNA is proved to be a more reliable way than the morphological approach to solve persisting problems in classification among individuals of sea urchins.

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FIRST DATA ON GENETIC DIVERSITY OF THE SMALL PEARL OYSTER *PINCTADA RADIATA* (LEACH, 1814) IN MEDITERRANEAN POPULATIONS BY MEANS OF THE MITOCHONDRIAL *COX1* MARKER

M. Barbieri[1] , A. Deidun[2] *, F. Maltagliati[3] , A. Zenetos[4] , S. Tlig-Zouari[5] , F. Gianni[6] , D. P Cilia[7] and A. Castelli[8]
[1] Dipartimento di Biologia, Università di Pisa, via Derna 1, 56126, Pisa, Italy
[2] IOI-MOC, University of Malta - alan.deidun@um.edu.mt
[3] Dipartimento di Biologia, Università di Pisa, via Derna 1, 56126, Pisa, Italy
[4] Marine Biological Resources Institute, HCRM, PO Box 712, Mayro Lithari, Anavyssos, Greece GR 19013
[5] Unité de Recherche de Biologie, Parasitologie et Ecologie des Organismes Aquatiques. Faculté des Sciences de Tunis – Département de Biologie; 2092 Campus Universitaire, Tunis. Tunisie
[6] Faculté des Sciences, Université de Nice, EA 4228, ECOMERS, 06108 Nice cedex 2, France
[7] St Paul's Missionary College, Emanuele Vitale Street, Rabat, RBT 2020, Malta.
[8] Dipartimento di Biologia, Università di Pisa, via Derna 1, 56126, Pisa, Italy

Abstract
This study gives a first molecular insight into the genetic structure of *Pinctada radiata* by analysing a mitochondrial DNA marker in four South-Central Mediterranean populations of this lessepsian bivalve. Specimens were collected from four central Mediterranean locations. Six polymorphic sites were found, defining seven haplotypes. Haplotype and nucleotide diversity values were low to moderate. The low levels of within-population genetic diversity detected in the present study are consistent with a scenario of founder effect, as expected for an invasive species. The shallow genetic structuring among the sampled populations may result from two factors – long larval duration which promotes the homogenization of the genetic pool through an effective gene flow or the current populations may not have had enough time to differentiate.

Keywords: Genetics, Bivalves, Alien species, South-Central Mediterranean

Introduction: The small pearl oyster *Pinctada radiata* was the first lessepsian bivalve reported in the Mediterranean. Successively its introduction for aquaculture purposes has been also documented (Serbetis, 1963; Zenetos *et al.*, 2004). Zibrowius (1992) proposed vessel-mediated dispersal as the most likely modality of introduction, either within fouling communities or as larvae in ballast waters. The three-week larval stage provides a high dispersal potential, as a consequence, species' geographical distribution within the Mediterranean Sea is expected expand progressively. With the present study a first molecular insight is provided into species genetic structure by analysing four Mediterranean populations of *P. radiata* by means of a mitochondrial DNA marker.

Materials & Methods: A fragment of the *COX1* gene was amplified and sequenced in a total of 47 individuals. 10-15 specimens were collected from four south-central Mediterranean locations – Qalet Marku and Bahar ic-Caghaq (Malta), Agios Nikolaos (Crete, Greece) and Gulf of Gabes (Tunisia). Within population genetic diversity was estimated by haplotype (h) and nucleotide (π) diversity indices. A median-joining network was constructed to depict relationships among haplotypes. Analysis of molecular variance (AMOVA Excoffier *et al.*, 1992) was carried out to partition genetic diversity in the within- and among-population genetic diversity.

Results: Overall, six polymorphic sites were found, defining seven haplotypes. Haplotype and nucleotide diversity values were low to moderate, ranging from h = 0.200 to 0.694 and π = 0.0005 to 0.0020, respectively. Highest and lowest values for both estimators were obtained for the Greek and Tunisian populations, respectively. Thirty-five individuals (74%) shared the haplotype H_1, and each of the other six haplotypes differed from H_1 by one mutational step. AMOVA partitioned the largest part of molecular variance (95%) in the within-populations level; the remaining 5% was relative to the among-populations component, that however was significant (Φ_{ST} = 0.054, P = 0.043).

Discussion: The low levels of within-population genetic diversity detected in the present study are consistent with a scenario of founder effect, which is expected for an alien invasive species (Nei *et al.*, 1975). However, the comparison with estimates of samples collected in the species' native range is needed to validate this hypothesis. Nonetheless, the estimates calculated in the present study were lower than those found in the Mediterranean for the alien bivalve *Brachidontes pharaonis*, using the same molecular marker (Sirna Terranova *et al.*, 2007). Moreover, population bottlenecks in Mediterranean *P. radiata* cannot be excluded; at this regard, dramatic demographic collapses has been documented in Tunisia ((Zaouali & Beaten, 1985). The shallow genetic structuring among the sampled populations may result from two main factors. On one hand, the long larval duration may promote the homogenization of the genetic pool through the action of an effective gene flow; on the other hand, current populations may have had not enough time to differentiate since the founder event. The present study represents a first insight into the genetic diversity of the invasive bivalve *P. radiata* in the Mediterranean Sea. In order to disentangle the relative contributions of current and historical factors, the analysis of a larger number of individuals and sampling locations is needed. Moreover, it is fundamental to include populations from the native species' range.

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PHYLOGEOGRAPHICAL ANALYSIS OF *OCTOPUS VULGARIS* (MOLLUSCA, CEPHALOPODA) IN THE MEDITERRANEAN: INSIGHTS FROM THE COI MITOCHONDRIAL GENE

K. Fadhlaoui-Zid [1]*, D. Sanna [2], D. Aurelle [3], S. Ezzeddine [4], A. Castelli [5], M. Casu [2] and F. Maltagliati [5]
[1] Institute of Biotechnology Beja & National Institute of Marine Sciences and Technologies - karimafadhlaoui@yahoo.fr
[2] Dipartimento di Scienze della Natura e del Territorio, Università di Sassari, Via F. Muroni 25, 07100 Sassari, Italy
[3] Aix-Marseille université, CNRS, IMBE UMR 7263, 13007 Marseille, France
[4] National Institute of Marine Sciences and Technologies
[5] Dipartimento di Biologia, Universita` di Pisa, Via Derna 1, 56126 Pisa, Italy

Abstract
This work reports a genetic data of *Octopus vulgaris*, marine species of high commercial value, from nineteen localities of Atlantic, Mediterranean and the Adriatic regions. We used mitochondrial DNA cytochrome c oxidase subunit I (COI) gene to investigate the genetic structure of common octopus. Our results indicated a significant genetic structuring in the study area (Phi_{ST} = 0.136, P <0.001) and highlighted a significant break between Western and Eastern Mediterranean basins. Moreover, our results indicate that O. *vulgaris* in the study area consists of four genetic stocks with an overall significant analogous F_{ST} (Phi_{CT} = 0.167, P< 0.001) value.

Keywords: Genetics, Mollusca, Cephalopods, North-Central Mediterranean

Introduction
The common octopus *Octopus vulgaris* (Cuvier, 1797) is the most important commercial octopus species of the Mediterranean region. It has a wide geographical distribution, including the Mediterranean Sea, the Eastern Atlantic from Southern England to south-western Africa, the Azores, the Canary Islands, Cape Verde, St Helena, the Tristan da Cunha Island, the southeast coast of South Africa in the Indian Ocean, the oceanic islands of the central Southern Indian Ocean, and the waters of Taiwan and Japan. According to FAO statistics, the annual world landings of cephalopods (squids, cuttlefishes and octopuses) was 4313.510 t in 2008 (FAO, 2010). Moreover, the common octopus accounts for about 50% of the total world octopus caught [1].
The objective of the present work was to investigate the phylogeography of this species across a large part of its geographical range, in order to identify the occurrence (if any) of genetic subdivisions over this area. To accomplish this, we employed sequences of the mitochondrial cytochrome oxidase I (COI), a marker largely employed in phylogeographical surveys.

Materials and methods Samples of O. *vulgaris* (513 specimens) were collected from nineteen localities including Mediterranean Sea (western and eastern basins, WM and EM, respectively), Adriatic Sea and Atlantic Ocean. A 641-bp COI fragment was amplified by PCR, using HCO-LCO primer pairs. Both strands were sequenced with the same primers used for PCR. Estimates of population genetic parameters were calculated using Arlequin v.3.5 (Excoffier & Lischer. 2010). Genetic relationships among haplotypes were assessed through the construction of a median-joining network using NETWORK 4.6.0.0 and Network Publisher version 1.2.0.0 (www.fluxusengineering. com). Analyses of molecular variance (AMOVA) were performed in Arlequin to assess the degree of genetic differentiation among individuals, sampling sites and geographical groups with statistical significance assessed by permutation. The main hypothesis tested by AMOVA was the differentiation of WM and EM populations; in particular, we made an attempt to assess the consistency of our results with the four biogeographical discontinuities described by Bianchi (2007) [2].

Results and discussion
The analysis of 513 individuals of O. vulgaris gave 55 haplotypes defined by 49 polymorphic sites. Haplotype diversity (h) was higher in WM samples compared to EM counterparts. It ranged from h=0.416 (Zarzis, Tunisia) to h=0.919 (Porto Santo Stefano, Italy). The haplotype network is presented in Fig.1. The AMOVA testing for overall population genetic structuring among populations was highly significant (Phi_{ST} = 0.136, P <0.001). The largest part of variation was within (86%) rather than among populations (14%). When considering WM versus EM, genetic variation showed the highest significant differentiation when Strait of Sicily and Portopalo samples were grouped in the WM region (Phi_{CT} = 0.102, P< 0.001), consistently with Bianchi's (2007) discontinuity No. 1. The genetic divergence observed between WM and EM samples corroborated results obtained by Fadhlaoui-Zid et al. (2012) [3]. The Siculo-Tunisian Strait is therefore effective in restricting gene flow between the two basins. In addition, significant genetic divergence was detected among the four main biogeographical regions (Atlantic Ocean Eastern Mediterranean, Western Mediterranean and Adriatic Sea) (Phi_{CT} = 0.167, P< 0.001). From a fisheries perspective, the four major genetic stocks identified by our study should be considered for resource management purposes.

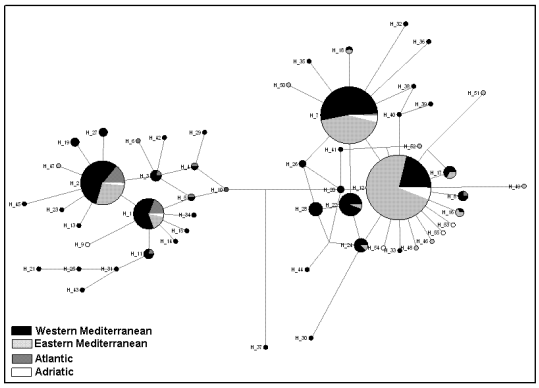

Fig. 1.
Median-joining network among 55 COI haplotypes. Size of circles is proportional to the frequency of each haplotype. The geographical region where each haplotype was found is shown in the legend.

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POPULATION GENETIC STRUCTURE OF THE MARBLED CRAB, *PACHYGRAPSUS MARMORATUS* FROM TURKISH COASTS OF THE BLACK SEA AND THE EASTERN MEDITERRANEAN

Evrim Kalkan [1]*, Selahattin Ünsal Karhan [2] and Rasit Bilgin [1]
[1] Department of Environmental Sciences, Institute of Environmental Science, Bogaziçi University, 34342 Bebek, Istanbul, Turkey - evrimkalkan@gmail.com
[2] Department of Biology, Faculty of Science, Istanbul University, 34134 Vezneciler, Istanbul, Turkey

Abstract
The population genetic structure of *Pachygrapsus marmoratus* has been investigated along the Turkish coasts using cytochrome c oxidase subunit I gene (COI) sequences. Our findings revealed high genetic similarity between Black Sea / Turkish Straits System and Mediterranean populations of the species. On the other hand, the composition of mtDNA haplogroups in the haplotype network indicated a weak but discernable differentiation between populations.

Keywords: Crustacea, Genetics, Black Sea, Marmara Sea, North-Eastern Mediterranean

Introduction
The marbled crab, *Pachygrapsus marmoratus* (Fabricius, 1787) (Crustacea: Decapoda: Brachyura: Grapsidae), is a widespread species inhabiting the rocky shores in the Black Sea, the Mediterranean Sea and the eastern Atlantic coasts of Europe and Africa (for details of distribution see d'Udekem d'Acoz, 1999 and Dauvin, 2012). Population genetic structure of the species has been recently investigated throughout the western Mediterranean Sea and the eastern Atlantic Ocean and it has been suggested that there is a recent and weak genetic differentiation between European Atlantic and some Mediterranean populations of *P. marmoratus* (Fratini et al., 2012).

The purpose of the present work is to investigate population genetic structure of *P. marmoratus* on the Turkish coasts from the easternmost part of the Black Sea to the eastern Mediterranean (Aegean and Levantine coasts) using mitochondrial DNA gene cytochrome c oxidase subunit I (COI). That way we aimed to test the hypothesis that the Turkish Straits System (TSS), consisting of the Bosphorus Strait, the Sea of Marmara and the Dardanelles, which is the only connection between the Black Sea and the Mediterranean, may act as a phylogeographic break having a potential to separate the Black Sea and the Mediterranean populations by restricting the gene flow between them.

Materials and Methods
A total of 122 specimens of *P. marmoratus* were collected from 17 sites including 5 from the Black Sea (6 specimens), 3 from the TSS (28 specimens), 7 from the Aegean Sea (67 specimens) and 2 from the Levantine Sea (21 specimens) between 2009 and 2012. We amplified COI mitochondrial DNA gene fragment of these specimens by means of polymerase chain reactions (PCR).

Results and Discussion
Thirty-six COI haplotypes were found in the area of investigation. The haplotype network displayed a star-like shape, with three main haplotypes in the center, surrounded by several rare haplotypes (Fig.1). These main haplotypes differ from each other by only 1-2 mutations in the haplotype network. COI mtDNA sequence data set, the AMOVA test (?=0.51) and shape of the haplotype network showed high level of genetic similarities between Black Sea / TSS and Mediterranean (Aegean and Levantine Seas) populations of *P. marmoratus*. So, the TSS does not seem to act as a distinct phylgeographic break for the populations of the species in this case. All the same, a geographic distribution pattern of haplogroups is discernable, which may indicate a weak restriction of gene flow at least towards one direction, from the Mediterranean to the Black Sea. Extending the sampling sites and increasing the sample size will be useful for better understanding the population structure of *P. marmoratus* and effects of the TSS on the gene flow among its populations.

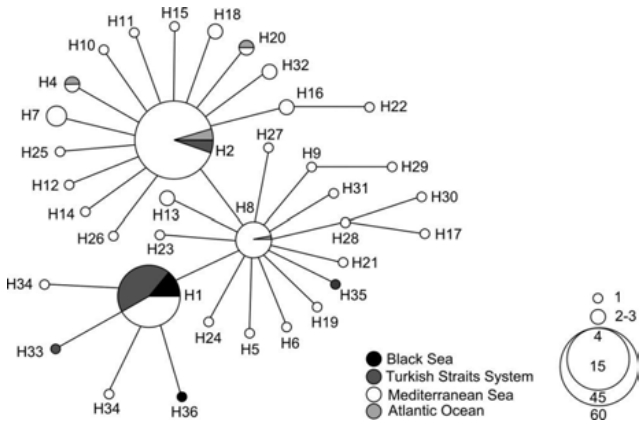

Fig. 1. The haplotype network based on COI sequences from Pachygrapsus marmoratus

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GENETIC STRUCTURE AND DIVERSITY OF THE YELLOW GORGONIAN *EUNICELLA CAVOLINI*: ECOLOGICAL AND EVOLUTIONARY INFERENCES.

M. B Masmoudi [1]*, P. Hammami [2], N. E Topçu [3], L. Chaoui [4], M. H Kara [4] and D. Aurelle [5]
[1] Université d'Annaba. Laboratoire Bioressources marines, Algérie/Université Aix Marseille, France - mauatassem.masmoudi@univ-amu.fr
[2] Universite Montpellier II, UMR 7263 IMBE CNRS, 13007, Marseille, France
[3] Istanbul University Fisheries Faculty -Istanbul, Turkey
[4] Université d'Annaba. Laboratoire Bioressources marines, Annaba 23000, Algérie
[5] Aix-Marseille Université, CNRS UMR 7263 IMBE, 13007, Marseille, France

Abstract
The Mediterranean yellow gorgonian *Eunicella cavolinii* (Cnidaria, Octocorallia) is among sessile species who have suffered mass mortality events following thermal anomalies in the North-Western Mediterranean Sea. We present here the first data on the genetic diversity and structure of this species. The results obtained with four microsatellite markers indicate a strong differentiation between the most distant samples considered here (North Africa, Turkey and France). At a regional scale genetic differences are lower though often significant. No significant differentiation is observed between depths on the same site.

Keywords: Marmara Sea, North-Western Mediterranean, Algerian Basin, Cnidaria, Genetics

Introduction
Many marine invertebrates have suffered in recent years, the combined action of anthropogenic pressures and climate change. Thermal anomalies have already affected various sessile species, particularly populations above the thermocline [1]. The impact of such perturbations depends on the diversity of response between individuals and populations, and on dispersal at the metapopulation level.
Eunicella cavolinii (Koch1887) is a sessile species that was affected by mortality events during the past two decades, with variable levels of tissue necrosis depending on location, depth and individuals [2]. Its distribution is highly patchy in the Mediterranean Sea, which makes the metapopulation dynamics related to the major role of dispersal and gene flow. Genetic analyzes are a starting point for understanding the genetic structure of the yellow gorgonian and to estimate the spatial connectivity at different scales. This will give us some insights into the potential of recolonization in cases of local extinction. Analyzing levels of gene flow will also help understanding how this species might evolve in contrasted ecological conditions.

Materials and methods
We performed an analysis of the genetic diversity of this species using four microsatellite loci and 17 shallow samples separated by an interval of a few tens of meters to hundreds of kilometer issued from contrasted environments of the Mediterranean Sea (Fig. 1).

Fig. 1. Map of the 17 samples of *E.cavolinii* (black and white stars). Samples were collected at different locations and depths for the areas indicated by a white star.

Results
All loci were polymorphic with a total number of alleles ranging from 13, for C20 and C30, to 24, for S14, with a mean value of 17.8 alleles per locus. The observed and unbiased expected heterozygosities varied respectively between 0.30 for SIV (Turkey) and 0.63 for KIA (Algeria) (mean value over populations 0.48 ± 0.23), and between 0.38 for SIV and 0.76 for KIA (mean value over populations 0.55 ± 0.25). The results indicate similar levels of genetic diversity to those observed in the congeneric species *E. singularis* [3]. This diversity is nevertheless lower than that observed with microsatellites for other Mediterranean octocorals (H_{exp} = 0.77 for the red coral, *Corallium rubrum* [4], [5] and H_{exp} = 0.74 for the red gorgonian *Paramuricea clavata* [6], [7]). Pairwise differentiation tests between populations showed high values of Fst (Overall Fst = 0.11), especially between the most distant samples North Africa, Turkey and France. A Principal Coordinates Analysis illustrates the differences between samples and highlights the clear genetic differences between regions (Fig. 2). The non-significant comparisons included mostly samples from sites that were taken at different depths.

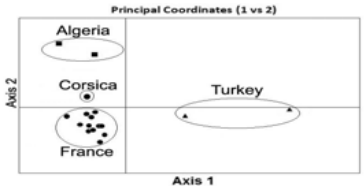

Fig. 2. Principal Coordinates Analysis of the genetic differences between samples.

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Session

Unique ecosystems

Modérateur : **Ricardo Aguilar**

IMPORTANCE OF SEAMOUNTS-LIKE FEATURES FOR MEDITERRANEAN MARINE HABITATS AND THREATENED SPECIES

R. Aguilar [1]*, X. Pastor [1], S. Garcia [1], P. Marin [1] and J. Ubero [1]
[1] Oceana - raguilar@oceana.org

Abstract
Oceana's exploratory ROV's dives in Western Mediterranean seamounts have collected more than 300 hours of video from deep-sea ecosystem. Findings of threatened species and habitats, like carnivorous sponges, elasmobranches, coral gardens, sponge aggregations, coralligenous beds, etc. or even new species for science like giant foraminifera (Astrorhizidae), or new species for the Mediterranean (i.e. *Anomocora fecunda*), makes this geological features "hotspots" and shelter of species and habitats in regression or considered rare in other Mediterranean areas.

Keywords: Deep sea ecology, North-Western Mediterranean, Deep sea corals, South-Western Mediterranean, Biodiversity

More than 200 underwater elevations have been registered in the Mediterranean (1). They are widely distributed along this sea, but the highest density is in the Western Basin, mainly in Alboran and Tyrrhenian Seas; Sicilian Channel and Balearic Islands are also other important points. Since 2006, Oceana has carried out six expeditions in the Mediterranean performing 129 ROV's dives over 16 seamounts, surveying 208.350 m^2 between -37 and -638 meters deep.

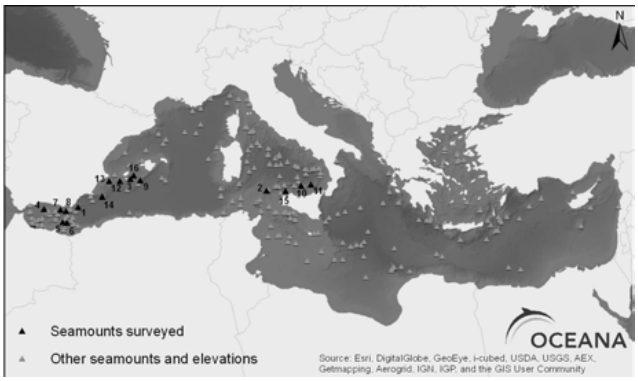

Fig. 1. Abubacer ridge (1), Aceste seamount (2), Ausias March Bank (3), Avempace bank (4), Cabliers bank (5), Catifas bank (6), Chella bank (7), El Sabinar bank (8), Emile Baudot seamount (9), Enareta seamount (10), Filicudi banks (11), Formentera bank (12), Nao mound (13), Palos bank (14), San Vito ridge (15), Ses Olives bank (16).

Cold water corals: *Dendrophyllia cornigera* found in all the seamounts. Reefs of *Lophelia pertusa* and *Madrepora oculata* on Cabliers, Catifas, Chella and Avempace. Other corals found are *Anomocora fecunda, Caryophyllia* spp., *Desmophyllum dianthus, Stenocyathus vermiformis, Pourtalosmilia anthophyllites* and*Javania caileti*. **Gorgonian gardens:** *Paramuricea clavata* and *Eunicella verrucosa* are the commonest on top of seamounts. Other species are *Viminella flagellum*, *Callogorgia verticillata, Acanthogorgia* spp., *Placogorgia coronata, Swiftia pallida, Muriceides lepida, Villogorgia bebrycoides, Bebryce mollis, Nicella granifera* and *Paramuricea macrospina*. **Black corals:** *Leiopathes glaberrima* and *Antipathes dichotoma in* San Vito, Filicudi, Emile Baudot, etc. but also *Antipathella subpinnata & Parantipathes larix* in Chella or Cabliers. **Bamboo corals:** *Isidella elongata* on muddy beds in Ses Olives. **Sea pens:** *Pennatula* spp., *Pteroeides griseum, Virgularia mirabilis* and *Veretillun cynomorium* on soft detritic bottom, *Funiculina quadrangularis* is less abundant, but *Kophobelemnon stelliferum* is the most abundant in some seamounts. **Sponge aggregations:** *Asconema setubalense* found for the first time in the Mediterranean. *Phakellia* spp. on bathyal rocky beds. *Axinella* spp. and tens of different species over rodolith beds. But also in muddy bottoms, like *Thenea muricata*. ***Gryphus vitreus*:** Largest beds on Aceste and Emile Baudot. ***Leptometra phalangium* beds:** Present in all the seamounts; highest abundance in El Sabinar and Avempace. **Coralligenous beds:** Both rodolith beds and coralligenous concretions present in shallower peaks. **Oyster reefs:** *Neopycnodonte zibrowii* in Abubacer, Chella and Emile Baudot. *N. cochlear* also found in Chella. **Mussels' reefs:** Subfossil reefs of *Modiolus modiolus* found in Chella.

Threatened/rare species**: Astrorhizida.** New species of giant foraminifera found in Palos bank. ***Asbestopluma hypogea*.** First recorded in deep areas(2). Registered on Chella, Ausias March, Emile Baudot & Enareta. ***Spongia agaricina*.** Large individuals on Emile Baudot and Ausias March. ***Aplysina* spp. & *Tethya* spp.** in Chella and Emile Baudot. ***Anomocura fecunda*.** Discovered on Chella bank. ***Anthomastus* sp.** Registered in Chella and Cabliers. ***Nidalia* isp.** Identified in Ausias March, Palos bank and El Sabinar. ***Dendrobrachia bonsai*.** Rare gorgonian(3) in Cabliers, Catifas and Chella bank. ***Nicella granifera*.** Found in Chella, Avempace and Cabliers. ***Sideractis glacialis*.** One citation for this species in the Mediterranean(4). Sighted on Ses Olives, Chella and Formentera. ***Savalia savaglia*.** in Chella, Avempace, Cabliers and Emile Baudot. ***Kinetoskias* cf. *smithii*.** First cited in the Mediterranean closed to Gibraltar strait(5). Recorded between Ses Olives and Ausias March; also in Emile Baudot. ***Charonia lampas*.** Gastropod on top of Ausias March and Chella. ***Ranella olearia*.** Common in Emile Baudot, Chella and Palos. ***Neopycnodonte zibrowii*.** Recently discovered mollusk(6) found in Abubacer and Chella. ***Peniagone* sp**. Elasipodid in deep muddy bottoms in Ses Olives and Emile Baudot. ***Epinephelus caninus*.** Aggregations in Chella and Palos Banks. ***Gaidropsarus granti*.** Recorded in Chella bank. Species only found in islands and seamounts(7). ***Cetorhinus maximus*.** Basking over Palos bank. ***Galeus atlanticus*.** It was found in Chella. ***Oxynotus cetrina*.** Several individuals spotted in Chella bank.

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LEIOPATHES GLABERRIMA FOREST FROM SOUTH WEST SARDINIA: A THOUSAND YEARS OLD NURSERY AREA FOR THE SMALL SPOTTED CATSHARK *SCYLIORINUS CANICULA*.

A. l Cau [1]*, M. C. Follesa [1], M. Bo [2], S. Canese [3], A. Bellodi [1], R. Cannas [1] and A. Cau [1]
[1] University of Cagliari Department of Life Science and Environment - alessandrocau@unica.it
[2] University of Genova, DISTAV, Corso Europa 26, 16132 Genoa, Italy
[3] ISPRA, Via Vitaliano Brancati, Rome, Italy

Abstract
Presence of over 200 spotted catshark *Scyliorinus canicula* egg capsules associated with long lived black coral *Leiopathes glaberrima* was observed in the South West Coast of Sardinia, describing a thousand years old nursery area for Elasmobranches. The forest, composed by 153 colonies, was discovered during a ROV survey carried out in October 2011 over a rocky elevation of the sea bottom, at depths between 188 and 210 meters. The described zone represents an important component of the ecosystem that deserves special protection.

Keywords: Conservation, North-Western Mediterranean, Deep sea corals, Elasmobranchii

Introduction
Elasmobranches consists of some of the most threatened marine species in the last century, with serious consequences on the entire ecosystem, because of their top position among the food web [3]. Because of this, the importance of identifying shark nursery areas is increasing in order to implement conservation or management measures [1]. Deep gorgonian fields are a sheltered and ventilated spot that increases survivorship of catsharks [1,2]. In this study we report on a *L. glaberima* forest as nursery area of the spotted catshark *S. canicula*, a species that although assessed as Least Concern in the IUCN red list 2012 is object of an increasing scientific interest .

Materials and Methods
The study area, denominated Carloforte shoal (CS) (39°13'42.70"N; 8° 0'9.01"E) is located 11 nautic miles from San Pietro island, SW coast of Sardinia. Before exploring CS, it has been mapped using Multibeam in order to obtain a detailed 3D geomorphological map of the seabed. Video and photo footage of the forest was gathered by a ROV (Remotely Operated Vehicle) "Pollux" during a survey conducted in October 2011 on board of the R/V Astrea, working at depths between 188 and 210 m. A total of 197 minutes of video was recorded during the survey over CS. Every image was elaborated with the software ImageJ in order to calculate the frame area (in m2) and the abundance of black coral colonies (N° m-2 ± ES).The dimensional scale calibration was performed using ROV's laser leds.The occurrence of catshark egg capsules was estimated also on the basis of 215 high resolution photographs.

Results and Discussion
A total of 245 capsules of S. canicula over 153 colonies of L. glaberrima was observed(Fig.2). Size, shape, and texture of the capsules were very similar to those reported for the same species by [4].. Over the total number, in 98 colonies capsules were absent while the maximum was 44 eggs over a 2 meters tall colony. Observed capsules were at different stage of maturation: some of them had a clean surface with a clearly visible yolk, while others were covered with sediments and degraded. This variance in capsule types proves that this area has possibly been a nursery for several generations. Numerous specimens of S. canicula were observed in the area, moving on the muddy bottom surrounding the rocky pinnacle(Fig.1). Other species than the spotted catshark were observed during the survey as a prove that other organisms take advantage of this habitat. By serving as nursery for marine predators, CS is an important component of the ecosystem that deserves special protection[3]. Effectively, considering that the height of the rocky pinnacle is enough to create a physical barrier against trawling, the studied area represents not only a physical protection from harvesting, but also a precious sanctuary for catshark capsules associated with long lived black corals that deserves special protection due its important ecological role.

Fig. 1. *S.canicula* swimming over the muddy bottom around the rocky pinnacle

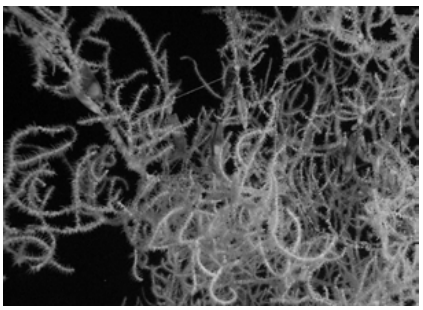

Fig. 2. Capsules of *S.canicula* laying on a *L.glaberrima* colony

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ACHZIV SUBMARINE CANYON :AN OASIS IN THE WARMING OLIGOTROPHIC LEVANTINE BASIN?

M. Elasar [1]*, D. Kerem [1], D. Angel [1], L. Steindler [2], B. Herut [3], E. Shoham-Frider [3], O. Barnea [4] and A. Almogi [5]
[1] Dept. of Maritime Civilizations, Charney School of Marin Sciences, University of Haifa - mroditi@campus.haifa.ac.il
[2] Dept. of Marine Biology, Charney school of Marine Sciences, University of Haifa
[3] Israel Oceanographic & Limnological Research, National Institute of Oceanography
[4] The School of marine Sciences, Ruppin Academic Center
[5] Geological Survey of Israel

Abstract
In the Mediterranean, as well as globally, submarine canyons were found to support relatively rich food-webs. It is not known whether this trend applies to ultra-oligotrophic waters bodies. High number of cetaceans sightings above Achziv Submarine Canyon (ASC), motivated the present pioneering study of the local underlying food-web in an attempt to collect more evidence in support of ASC serving as a production "hotspot". All biological data obtained from ASC will be innovative and will throw light on a deep water habitat never before investigated.

Keywords: Canyons, Deep sea ecology, Cetacea, Levantine Basin, Food webs

Introduction
Submarine canyons are potential sinks for particulate materials, including macrophytic debris, organic-rich sediments, and particle-bound pollutants moving along shores and across shallow platforms [1]. By intercepting and trapping littoral sediment drifts, submarine canyons with their heads close to the shoreline, can also act as main drivers of local sediment transport and deposition, thus funneling materials towards the adjacent deep sea [2]As a consequence, canyons often are sites of intense organic enrichment and benthic productivity, producing scavenger-based ecosystem services that may serve as food for higher trophic levels, up to and including top predators such as marine mammals [3]. ASC, one of the prominent submarine valleys of the steep northern Levant margin, is located 3 km off the northernmost reach of the Israeli Mediterranean coastline. Starting 3 km NW of the mouth of Sha'al River, the sinuous canyon runs for about 40 km (to the northwest, reaching a water depth of 1900 m [4] (Fig 1).

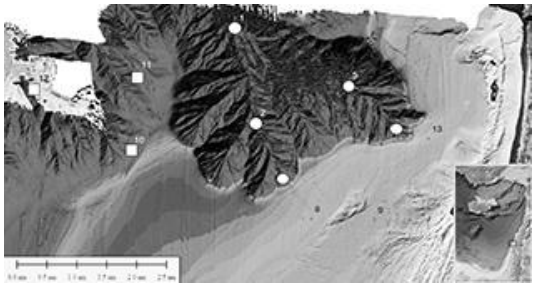

Fig. 1. Sampling stations inside ASC (circles) and adjacent slope (squares).

Material and Methods
Seven research cruises along 3 years were conducted atop ASC, and isobathic control sites. CTD profiles were obtained and samples taken from the water column (nutrients, chlorophyll, bacteria and plankton), seafloor (total organic carbon, benthic invertebrate composition) and fish, mollusks and crustaceans from trap, net and hook systems. The cruises followed and partly coincided with 6 years of marine mammals' surveys in the area.

Results
Preliminary results indicate a high number of common bottlenose dolphin (*Tursiops truncatus*) sightings per unit effort above the ASC relative to the adjoining area to the south with similar survey effort (Fig 2). Benthic invertebrate composition of pooled samples showed higher mean (±SD) abundance (26.9±49.1 vs 5.2±7.2 organisms/500ml; p=0,023) and diversity (6±4.4 vs 2.3±2.1 taxa; p=0.014) inside the canyon and in the adjacent slope, respectively.

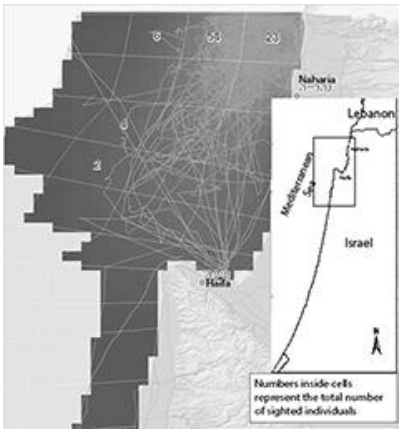

Fig. 2. Grided map of Israel's northern coastline showing survey paths and sightings of common bottlenose dolphin (*Tursiops truncatus*). Upper two cells overlay the ASC.

Discussion
The Mediterranean as a whole and the Levantine basin in particular are ones of the most climatically affected oceanic bodies. Further warming is likely to accentuate oligotrophicity, causing a retreat of local biota into potential productivity hotspots such as the ASC. The collected samples will serve as a belated but essential baseline against which such trends may be evaluated. Along with a declaration process of the ASC and its surrounds as a Marine Protected Area, understanding the regional ecosystem's forming factors is essential.

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EXPLORING DEEP-SEA BENTHOPELAGIC FAUNA USING A BAITED LANDER IN THE SANTA MARIA DI LEUCA COLD-WATER CORAL PROVINCE

P. Maiorano [1]*, L. Sion [1], F. Capezzuto [1], R. Carlucci [1], F. Mastrototaro [1], M. Panza [1], A. Tursi [1] and G. D'Onghia [1]
[1] Department of Biology, University of Bari - CoNISMa LRU of Bari - porzia.maiorano@uniba.it

Abstract
The benthopelagic fauna of the Santa Maria di Leuca cold-water coral province was investigated using the baited lander MEMO during 3 video surveys carried out in 2010 and 2011. The depth examined was between 547 and 790 m. A total of 19 benthopelagic species and 1 at genus level were identified. *Paromola cuvieri, Conger conger* and*Helicolenus dactylopterus* resulted the most abundant species in the coral habitat.

Keywords: Deep sea corals, Biodiversity, Ionian Sea, South-Central Mediterranean

The video inspections are generally less invasive on the fragile deep-sea ecosystem than other experimental or fishing gears and they could also provide information on the habitat selection of the species, their distribution and behaviour. As part of the CoralFISH 7FP EU project and OBAMA-PRIN research, the baited lander MEMO (Marine Environment MOnitoring system) was deployed in the Santa Maria di Leuca cold-water coral province (Central Mediterranean) in June and November 2010, and March-April 2011. MEMO consists of a stainless steel metallic frame, 2 digital cameras, a multiparametric probe, a currentmeter (doppler), an acoustic modem, and an ICT infrastructure capable of managing the entire system. The deployments were carried out in two types of habitat: a coral habitat, that is on a coral mound (C) and a non coral habitat, that is on a muddy bottom (NC). A total of ten deployments between 547 and 790 m were carried out, for a total time of 52 and 38 hours of video records in the coral and non coral habitats respectively. The different species have been identified through morphological characteristics observed in the video frames. The total number of individuals by species has been standardised to the time of video record (N/h) in both coral and non coral habitats. A total of 19 benthopelagic species (1 cephalopod, 5 decapod crustaceans, 5 cartilaginous fishes and 8 teleost fishes) and 1 crustacean at genus level (*Munida spp*.) were identified. In particular, 15 of them in coral habitat and 14 in non-coral habitat. The crustaceans *Bathynectes maravigna, Geryon longipes* and *Munida spp*, the velvet shark *Etmopterus spinax* and the teleosts *Lepidopus caudatus* and *Pagellus bogaraveo* were exclusively recorded in coral habitat. *Paromola cuvieri, Conger conger* and*Helicolenus dactylopterus*, wereobserved in the two habitat typologies;their abundance was greater in the coral habitat than in non-coral habitat; they also resulted the most abundant species in the coral habitat (Fig. 1). Although *P. bogaraveo* has been often observed in the coral habitat, due to the fast swimming of the different individuals its count and abundance estimation could be largely
biased and not included in the figure.

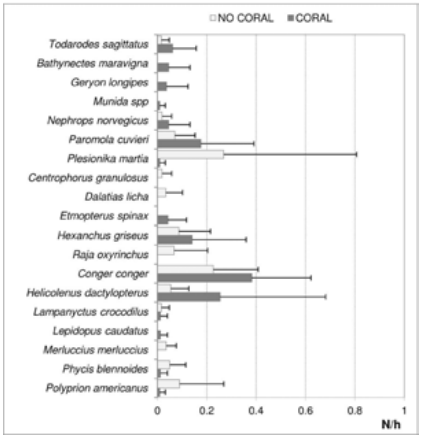

Fig. 1. Average number per hour (N/h) by species recorded in coral and non coral habitats of the SML coral province.

Although a baited lander generally attracts scavenging fish and so it is highly selective [1], the present results confirm the preferential distribution of some benthopelagic species in the SML coral province (Fig. 2) and the exclusive occurrence of *P. bogaraveo* in the coral habitat previously detected by towed cameras and longling surveys [2,3,4]. Although the scavenger behaviour can explain the high frequency of *P. cuvieri* and *C. conger* in both coral and non coral habitats, their greater abundance in the coral habitat, together with *H. dactylopterus*, seems to be indirectly linked to the presence of corals, indicating an habitat selection in some deep-sea species.

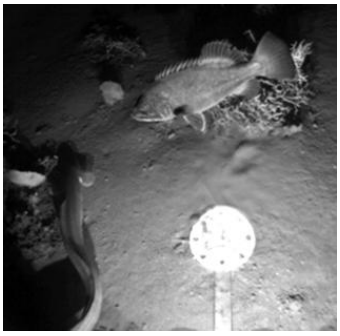

Fig. 2. Digital frame showing *Conger conger* and *Polyprion americanus* in the coral habitat of the SML coral province.

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LES EAUX MAROCAINES, ÉSPACE SINGULIER DANS LA ZONE HOT SPOT ATLANTOMÉDITERRANÉENNE?

Mohamed Menioui [1]*
[1] Université Mohamed V-Agdal, Rabat - mohamed.menioui@gmail.com

Abstract
Le littoral marocain, de par sa situation géographique à la croisée des masses d'eaux d'origines et de densités différentes a toujours suscité l'intérêt des scientifiques et des naturalistes, Plusieurs expédions scientifiques internationales y ont été organisées et nombreuses nouvelles espèces y ont été découvertes.

Keywords: Biodiversity, South-Western Mediterranean

Avec ses deux façades atlantique et méditerranéenne, un détroit, des conditions hydrologiques particularités hydrologiques (upwelling), … le Maroc a toujours suscité l'intérêt des scientifiques. Porcupine (1870), Challenger (1873-1876), Travailleur (1882), Talisman (1883), S.S. Valdivia (1893), Princesse Alice et l'Hirondelle (1885, 1915), M. sars (1910), Calypso (1958, 1962), etc. sont certaines des expéditions internationales organisées dans ses eaux qui se continuent jusqu'à nos jours.

Ces investigations ont abouti à la découverte de nombreuses espèces nouvelles (*Natica marrocana*, *Raja marrocana*, *Nereis marrocensis*, *Diopatra marrocensis*, *Fusus marrocanus*, *Plumularia marrocana*, *Stylaster marrocanus*, *Synoicum marrocana*, etc.,…qui portent toujours le nom du Maroc.

Récemment, des prélèvements, très localisés (Fig. 1) y ont permis la découverte de bien d'autres espèces, dont certaines sont validées et publiées:

- *Cerapopsis takamado* Menioui & Myers, 2000 [1], connue de la baie de Dakhla;
- *Bathyporeia ledoyer*i d'Udekem d'Acoz & Menioui 2004 [2], identifiée également dans la baie de Dakhla;
- *Bathyporeia microceras* d'Udekem d'Acoz & Menioui 2004 [2] identifiée également dans la baie de Dakhla;
- *Bathyporeia elkaim*i d'Udekem d'Acoz & Menioui 2004 [2], connue de la région de Rabat, de Dakhla, mais également de la lagune de Khnifiss;
- *Bathyporeia watkini* d'Udekem d'Acoz, Echchaoui & Menioui 2004 [3],
- *Leucothoe Brunnonis* Krapp-Schickel & Menioui 2005 [4], découverte à la Dakhla;
- *Urothoe atlantica* Bellan Santini & Menioui 2005 [5], trouvée dans la baie de Dakhla et découverte dans la Baie de Mdiq;
- *Arcturinoides dakhla*, Menioui et Poor 2007 [6] jusqu'à présent connue de Dakhlala - crevette *Hippolyte lagarderei* d'Udekem d'Acoz, identifiée dans le lagon de Temara, non loin de Rabat.

Certains de ces taxa présentent également d'autres particularités comme:

- l'isopode *Arcturinoides* Kensley, 1977, n'est connu à l'échelle planétaire que par trois espèces : *A. sexpes* en Afrique du Sud , *A. gibbosus* Müller, 1989 dans le Golf d'Aden et l'espèce marocaine *A. dakhla* ;
- le genre *Cerapopsis* Della Valle, n'a été connu que par une seule et unique espèce *C. longipes*, depuis plus d'un siècle (1893-2000) avant la découverte de l'espèce marocaine *C. takamado*,
- l'espèce *Bathyporeia microceras*, endémique du Maroc est morphologiquement très différente es autres espècs du genre ;

Aujourd'hui, trois autres espèces viennent d'être identifiées et sont particulières par leurs répartitions géographiques :

- une espèce du genre *Calozodion* Gardiner, 1973, nouvelle pour la science ;
- le Tanaidacé *Chondropodus* Gutu, 2006 cantonnée qui n'est connu dans le monde que par deux espèces dont une, *C. curvispinus*, qui vient d'être identifiée au Maroc et ;
- le genre *Plectrocopus* Gutu, 2006, monospécifique, connue par l'unique espèce P. spicatus vient également d'être identifié au Maroc.

Conclusion : En plus de la richesse spécifique des eaux marines marocaines, nombreux éléments de cette biodiversité paraissent particuliers. Les recherches taxonomiques, même peu développées sur les crustacés, ont permis de mettre en évidence l'originalité de cette partie de la province lusitanienne qui se singularise en effet, par ses caractéristiques hydrologiques particulières en tant que zone de mélange entre les eaux méditerranéennes et atlantiques et de transition entre les eaux froides du Courant des Canaries et celles chaudes du contre courant équatorial. Ces côtes sont également certaines des quelques rares régions dans le monde baignées en permanence par des upwellings. Il en découle un enrichissement aussi bien quantitatif que qualitatif de la biodiversité marine du Maroc, qu'on commence à peine à connaître et dont l'exploration suggère davantage d'investigations. Il est enfin important de signaler que pour les autres groupes taxinomiques, en particulier les mollusques, nombreuses espèces, non encore identifiées, semblent bien différentes de celles connues, ce qui suggère certainement d'autres originalités taxinomiques et biogéographiques.

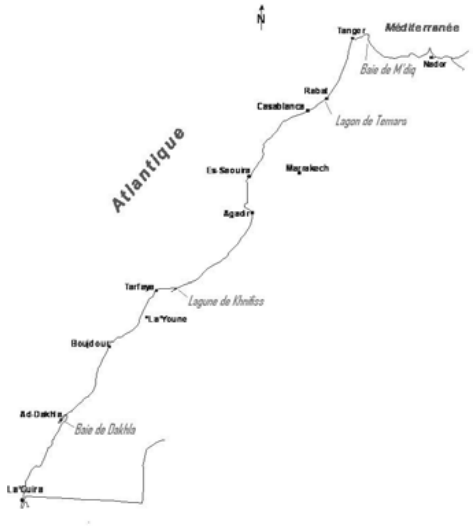

Fig. 1. Carte de dispersion des nouvelles espèces.

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Session

Water column habitats - 1

Modérateur : **Mouna Bellakhal Fartouna**

OBSERVATIONS OF WATER COLUMN HABITATS BY COMBINING ACOUSTIC BACKSCATTER DATA AND ZOOPLANKTON SAMPLING IN THE NORTHEASTERN BLACK SEA

Elena Arashkevich [1]*, Alexander Ostrovskii [1] and Vladimir Soloveyv [1]
[1] Shirshov Institute of Oceanology RAS - aelena@ocean.ru

Abstract
High-frequency acoustic technology was used to measure the vertical distribution of mesozooplankton. Simultaneously the stratified net sampling was performed to obtain taxonomic and quantitative characteristics of aggregation layers. Collected data revealed the fine structure of mesozooplankton vertical distribution driven by both physical-chemical and behavioral processes.

Keywords: Acoustics, Zooplankton , Black Sea

The Black Sea is a deep basin with the thin active layer. It is characterized by permanent anoxia below the sharp halocline. The depth of the oxic/anoxic boundary varies in time and space within 100-180 m depth interval, depending on the water circulation [1]. After vernal formation of thermocline, four different types of habitats corresponding to physical-chemical properties of the water column are distinguished: i) the upper mixed layer (UML), ii) thermocline, iii) cold intermediate layer (CIL), and iiii) suboxic zone. We studied how the physical-chemical and behavioral properties drive the vertical structure of mesozooplankton distribution in the NE Black Sea. The acoustic scattering technique is a useful tool for observations of distribution and abundance of marine zooplankton [2, 3]. The moored automatic mobile profiler Aqualog [4] equipped with the acoustic Doppler current meter Nortek Aquadopp (2MHz) was deployed at the upper part of the continental slope at the depth of 265-270 m (44°29.44? N, 37°58.38?E) in June 2011 and September 2012. The current meter had a side-looking sensor head transmitting and receiving sound along three narrow acoustic beams. Transducers are mounted on one side to assure that the beams are pointing into the undisturbed flow away from the hydrodynamic boundary layer around the profiler. The profiler also carried the CTD probe Idronaut Ocean Seven 316plus with the dissolved oxygen and oxidation-reduction potential sensors. The profiler made repeated round trips between the near-surface ocean layer and the anoxic zone every 1 h. As a result of the profiling survey we got the time series of the vertical profiles of the ocean parameters including the amplitude of the acoustic backscatter.

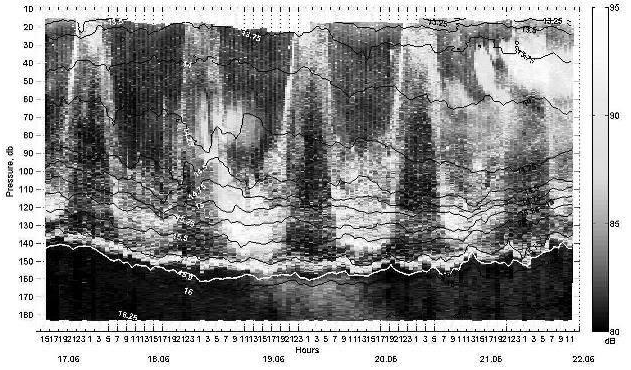

Fig. 1. Time–depth plot of the acoustic backscatter obtained by the profiler Aqualog at the mooring site in the NE Black Sea on June 17–22, 2011. The lines indicate isopycnals of the density anomaly sigma-theta.

Zooplankton was sampled nearby the moored profiler to study the taxonomic and quantitative patterns of zooplankton vertical distribution. Juday net hauls targeted aggregation layers manifested themselves in the in-situ backscattering data. Six layers were sampled: UML, thermocline, two layers in CIL, and two layers in suboxic zone, from the depth of sigma-theta between 15.4 and 15.7 and between 15.7 and 15.9. Time of sampling corresponded with the day and night time aggregations of migrating zooplankters in the deeper and upper layers, respectively, as well as with upward and downward migration. During the surveys, the upper mixed layer had the temperature of 24-25 oC and was inhabited by thermophilic zooplankters (mainly cladocerans and copepod *Acartia clausi*). In both seasons, maximum of fluorescence was located in thermocline and this layer was permanently occupied by heterotrophic dinoflagellate *Noctiluca scintillans* and the younger copepodite stages of *Calanus euxinus* and *Pseudocalanus elongatus*. The older stages of two latter species performed the diel vertical migrations: they aggregated in the lower part of CIL during the daytime and ascended to the thermocline at night. The lower boundary of their daytime aggregation coincided with oxygen concentration of c. 30 micromole/l. The deepest layer of zooplankton aggregation was mainly formed by diapausing *Calanus euxinus* (CVs). Its thickness was 5-7 m and it was limited from below by sigma-theta=15.9. Oxygen concentration in this layer was 3-5 micromole/l. The backscatter amplitude of this aggregation was enhanced persistently throughout day and night (Fig.1). General pattern of fine scale stratification of water column revealed from the backscatter data corresponded to the zooplankton vertical distribution obtained by means of net sampling (Fig.2).

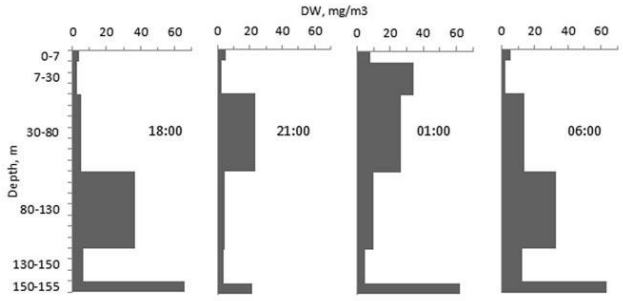

Fig. 2. Vertical distribution of non-gelatinous zooplankton (DW/m3) in the NE Black Sea in 21-22 June 2013

Both migration amplitude and aggregation depth depended on the position of thermocline and the depth of the suboxic layer. It was also modified by zooplankton response to variations in oxygen concentration at the different stages of their life span.

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FLUCTUATIONS SPATIO-TEMPORELLES DU PEUPLEMENT PHYTOPLANCTONIQUE AU NIVEAU D'UN ECOSYSTEME LAGUNAIRE AU NORD DE LA TUNISIE

Mouna Bellakhal Fartouna [1]* and Meher Bellakhal [1]
[1] EMA- Institut Supérieur de Pêche et d'Aquaculture de Bizerte - nephertitim@yahoo.fr

Abstract
Un suivi bimensuel de la qualité de l'eau, de la dynamique et de la structure du peuplement phytoplanctonique, au niveau de la Lagune de Bizerte, a révélé une variation haline assez importante (23.1 – 40.9), une turbidité très irrégulière, un pH alcalin, une forte oxygénation et une température variant entre 12 et 32°C. Sur le plan taxonomique, on a pu identifier 163 taxa (104 diatomées et 53 dinoflagellés) parmi lesquels 23 sont susceptibles d'être nuisibles. L'un des taxa, doté d'un pouvoir toxique assez important à savoir *Alexandrium spp*, a atteint une densité de 63 764 cel.l^{-1}.

Keywords: Lagoons, Phytoplankton, Systematics, Tunisian Plateau

Introduction
Le choix de la lagune de Bizerte pour la présente étude repose sur plusieurs raisons dont les plus importantes sont la richesse du point de vue biodiversité des peuplements phytoplanctoniques dans les écosystèmes lagunaires, les phénomènes sporadiques d'eutrophisation signalés par plusieurs auteurs ainsi que l'effet de la qualité des eaux sur l'activité conchylicole à savoir l'élevage des moules et des huîtres [1], [2], [3], [4]. L'eutrophisation des écosystèmes aquatiques est à l'origine un phénomène ancien et naturel résultant de l'enrichissement des eaux en éléments minéraux nutritifs. Il en résulte un accroissement de la production de biomasse végétale (phytoplancton, macrophytes), une diminution de l'oxygénation et des phénomènes de mortalités [5], [6]. Dans ce travail nous nous sommes intéressé aux fluctuations spatio-temporelles des paramètres physico-chimiques de l'eau ainsi qu'aux concentrations du phytoplancton afin de comprendre la dynamique du peuplement phytoplanctonique dans la lagune de Bizerte.

Matériel et méthodes
La lagune de Bizerte, localisée sur le littoral Nord de la Tunisie septentrionale correspond à une dépression de forme elliptique. Elle est située entre 37° 8' et 37° 14' de latitude Nord et 9° 46' et 9° 56' de longitude Est. La superficie de cette lagune est d'environ 150 km^2 et sa profondeur maximale peut atteindre 12 m. Ce plan d'eau est en communication permanente avec la mer Méditerranée par l'intermédiaire d'un chenal rectiligne et étroit d'une profondeur de 12 m et d'une longueur de 7 km [1]. Les prélèvements ont été réalisés en surface selon la méthode de l'IFREMER. Les échantillons récoltés ont été fixés « *in situ* » au moyen du formol neutralisé au Borax (3%). L'identification et le comptage des taxa phytoplanctoniques ont été effectués par le biais de microscope photonique inversé à contraste de phase de type HUND selon la méthode d'Utermöhl [7]. Les paramètres physico-chimiques de l'eau ont été prélevés « *in situ* » à l'aide d'un multi-paramètre de type WTW.

Résultats et discussion
La température de surface au niveau de la station de Menzel Jemil peut être partagée en 2 périodes : Une période de réchauffement qui caractérise la saison estivale et le début de la saison automnale. Il s'agit d'un réchauffement progressif qui atteint 2 maxima de 31°C l'un le en août et l'autre en septembre. Une seconde période de refroidissement de la masse d'eau qui s'étend de début octobre jusqu'à la fin du mois de décembre. Le début de cette période est caractérisé par une chute thermique puis une température de l'ordre de 23°C. Pendant la saison estivale la station S1, la plus côtière, a connu une influence de la température atmosphérique. L'évolution moyenne bimensuelle de la salinité a été caractérisée par un maximum en juin de l'ordre de 40.87. Les fortes salinités, enregistrées au niveau de la lagune, sont incontestablement liées aux aménagements en amont du lac Ichkeul qui ont engendré la transformation de la lagune en bassin de concentration où les apports en eau douce ne compensent pas la forte évaporation. De ce fait la salinité se trouve nettement plus élevée au niveau des stations S1, S2, S3 qu'au niveau de la station plus au large (S4). La variation de l'oxygène dissous moyen a évolué de manière progressive de 4.85 mg/L en juin à 8.87 mg/L en août avec une valeur ponctuelle assez élevée de l'ordre de 17.31 mg/L enregistrée en mi-septembre. En dépit de la faible variation du pH, les écarts types ont témoigné d'une certaine hétérogénéité spatiale. Les valeurs moyennes du pH ont oscillé entre 8 en juin et 8.27 en novembre. A l'échelle spatiale, c'est la station S2 qui a enregistré la valeur la plus faible du pH (7.9). La valeur moyenne maximale de turbidité (11.57 NTU) a été enregistrée en septembre alors que le minimum (1.40 NTU) a été observé en décembre. Au cours de la saison estivale la turbidité a oscillé entre 2.45 et 5.25 NTU, avec une homogénéité spatiale, ce qui traduit une turbidité relativement faible caractéristique de la saison estivale où l'action du vent est limitée. Concernant les fluctuations spatio–temporelles des densités cellulaires moyennes du phytoplancton total, on remarque l'existence de 2 pics principaux le premier au enregistré au début de septembre (412 257cel.l-1et le second à la fin d'octobre (461 728cel.l-1). Le peuplement phytoplanctonique au niveau de la lagune de Bizerte est composé pricipalement de 5 groupes à savoir les diatomées, les dinoflagellés, les chlorophycées, les euglénophycées et les cyanobactéries. Sur le plan taxonomique, on a pu identifier 163 taxa (104 diatomées et 53 dinoflagellés) parmi lesquels 23 sont susceptibles d'être nuisibles. L'un des taxa, doté d'un pouvoir toxique assez important à savoir *Alexandrium spp*, a atteint une densité de 63 764 cel.l^{-1}.

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THE SEASONAL EVOLUTION OF PARTICULATE MATTER RELATED TO MICROPHYTOPLANKTON COMMUNITIES IN THE EASTERN PART OF THE GULF OF LION (MISTRALS/SPECIMED PROJECT)

S. Boussabat Ben Neji [1]*, B. Quéguiner [2], K. Leblanc [2], M. Golbol [2], V. Cornet-Barthaux [2], S. Hélias Nunige [2], D. Malengros [2] and O. Grosso [2]

[1] Aix-Marseille University, Mediterranean Institute of Oceanography (M I O), 13288, Marseille, Cedex 9, France ; Université du Sud Toulon-Var, 83957, La Garde Cedex, France ; CNRS-INSU/IRD UM 110/ Universi-ty of Carthage, Faculty of Sciences of Bizerte - soumaya.boussabat@univ-amu.fr

[2] Aix-Marseille University, Mediterranean Institute of Oceanography (M I O), 13288, Marseille, Cedex 9, France ; Université du Sud Toulon-Var, 83957, La Garde Cedex, France ; CNRS-INSU/IRD UM 110

Abstract

The elemental (C, N, P, Si) composition of the suspended particulate matter is monitored monthly since June 2010 at two contrasted (coastal and offshore) stations of the eastern Gulf of Lion. Surprisingly, nutrient levels are similar at both stations even though detailed seasonal evolutions are different. Both environments have very low levels of phosphate and show recurrent seasonal depletion of this nutriment. Si/N nutrient ratios close to 1 do not reveal potential limitation of diatoms by silicic acid availability although very low levels can be reached in surface waters of the coastal station. The particulate organic matter composition is indicative of marine planktonic origin with C/N ratios close to Redfield and C/Chl a ratios < 50 on average.

Keywords: Phytoplankton, Systematics, Geochemical cycles, North-Western Mediterranean

Introduction

We present data for nutrients, particulate organic matter composition and phytoplankton evolution acquired in the framework of the MISTRALS program, the SPEciMed (Structures of Planktonic Ecosystems in the North-western Mediterranean) project since June 2010.

Methods

Particulate matter composition was analyzed on a CHN analyzer for N and C and by wet oxidation followed by chemical analyses of nitrate and phosphate for N and P (coherence of the two data sets was controlled via organic nitrogen measurements by both methods). Nutrients were analyzed by classical chemical analyses on autoanalyzer for nitrate, nitrite, phosphate and silicic acid. Chlorophyll was measured by a fluorometric method. Phytoplankton species identification, counting and biomass estimations were assessed from microscopical examinations.

Preliminary results

First results show successive periods of phosphate depletions at the two stations, indicative of P limitation during most of the seasonal cycle. Outside from these periods, potential limitation by N or Si (for diatoms) also occur (Fig. 1), as previously shown in this area by Leblanc et al. (2003). Diatoms are the dominant component of microphytplankton. When looking at the C to chlorophyll relationship, a residual concentration of 32 and 38 micrograms C per L respectively at the coastal and the offshore station, together with average C/N elemental ratios close to 6.3, is interpreted as reflecting the presence of a large heterotrophic component.

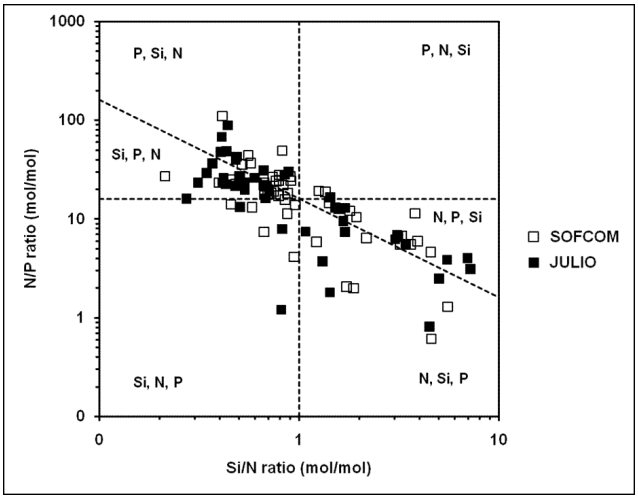

Fig. 1. Si:N:P molar ratio of all data collected at a coastal (SOFCOM) and an offshore (JULIO) stations east of the Gulf of Lion from June 2010 to December 2012. In each area, delimited by the Brzezinski (1985) ratio and by the Redfield et al. (1963) ratio (Si:N:P = 16:16:1), the potential limiting nutrients are reported in order of priority.

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FROM SPECTRAL ANALYSIS TO MODELLING OF ZOOPLANKTON MIGRATION PATTERNS

T. Ciuffardi [1]*, S. Pensieri [2], P. Picco [1], E. Schiano [2], E. Fanelli [1] and R. Bozzano [2]
[1] ENEA Marine Environment Research Centre - tiziana.ciuffardi@enea.it
[2] CNR National Research Council of Italy, Genoa, Italy

Abstract
A method to identify and reconstruct the zooplankton migration patterns based on the spectral analysis of time series of acoustic data is proposed. The method has been validated on long term time series of acoustic backscatter data collected by a 300 kHz ADCP unit in the Ligurian Sea.

Keywords: Zooplankton , Ligurian Sea, Vertical migration, Acoustics, Monitoring

Introduction
Zooplankton presents different migration behaviours according to the species and phase of life, among these, diurnal inverse and twilight migrations have been identified [1]. Acoustic profiling instrumentations provide a long-term and high temporal resolution monitoring, measuring backscatter due to the amount (biomass) of zooplankton, but do not provide detailed information about the species composition [2]. Spectral analysis methods can be used to characterize the vertical migration patterns and their time and space distribution, even in the absence of net sample collection. Here we present a method to identify and reconstruct the zooplankton migration pattern based on the spectral analysis of long term time series of acoustic backscatter from a 300 kHz ADCP unit.

Data and Methods
An upward-looking RDI Sentinel 300 kHz ADCP was operating in the Central Ligurian Sea (43°47.77' N; 9°02.85 E) from 13 September 2003 to 22 February 2006 for a total of 768 days. It monitored the upper thermocline from a depth of 90 m to the surface with 8 m vertical resolution and time step of 1 h during the first deployment, then increased to 30 minutes. After quality check, echo intensity data have been converted into backscattering strength (Sv) according to [3], for each depth cell along each beam and then averaged.

Results and Discussion
The analysis of data clearly shows a 24 h square-wave shape with higher values during night time and minima during day time, due to the main daily zooplankton migration. Minor peaks are also present. Vertical migration lasts one or two hours, then the organisms remain at the reached level for several hours (Fig.1 upper).

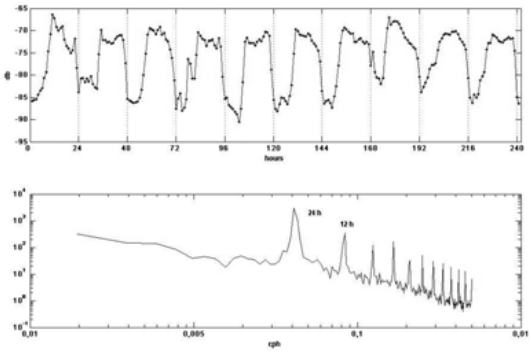

Fig. 1. Ten days sample of hourly backscattering strength data (upper panel) and its corresponding power spectrum (lower panel)

For each bin level, time frequency analysis was performed with a ten days moving window and 24 h time step. The spectra were then time and vertically averaged. The resulting spectrum is dominated by 24 h peak. A secondary peak is on 12 h and a series of peaks appears on the other sub harmonics (8h, 6h,...nh). The spectrum on a simulated 24 h square-wave signal revealed the presence of higher harmonics, but the 12 h secondary peak did not appear. Thus, only 24 h and 12 h periodicity can be assumed representative of vertical migration. To validate this assumption, a second simulation was performed on a signal composed by two square-waves, one having 24 h period and an amplitude of 20 and the other having 12 h period, amplitude 6 and 3 hours phase (Fig.2 upper).

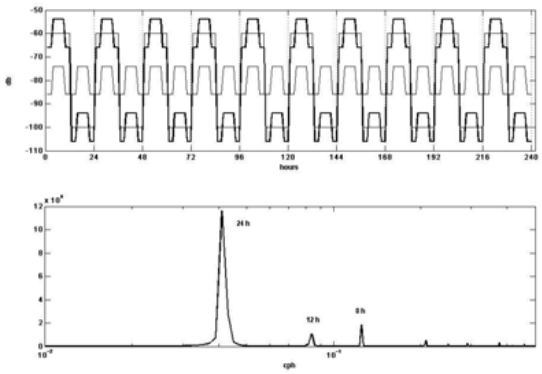

Fig. 2. Ten days of simulated square-wave hourly data (upper panel) and its corresponding power spectrum (lower panel)

The resulting power spectrum in Fig. 2 (lower panel) is consistent with the one obtained from the ten days sample reported in Fig. 1, leading to the identification of two main migration patterns (daily and twilight).
To investigate the occurrence of these patterns, the amplitude of the 24 h and 12 h harmonics were extracted from each spectrum obtained in the previous described time-frequency analysis. Higher amplitude values were observed in late autumn for both 24 h and 12 h signals.

Conclusions
Long term acoustic monitoring devices proved to be a powerful tool to support the study of zooplankton distribution and its variability on many different temporal scales that cannot be satisfactorily resolved by using the discrete net sampling. Two main migration patterns (daily and twilight) have been identified in the study area, characterised by higher amplitude values in late autumn.
The main advantage of the proposed methodology to process such kind of acoustic data is the opportunity to infer the zooplankton composition and its temporal variability through the identification of their migration patterns. At the same time, the presented approach allows to convert biological qualitative observations into a quantitative time series to define a metric for the comparison with ecological numerical models.

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ICHTHYOPLANKTON ASSEMBLAGES OF THE THERMAIKOS, TORONEOS AND SIGGITIKOS GULFS IN JUNE 2004 AND 2005

Ioannis Fytilakos [1], Apostolos Siapatis [2], Maria Danelli [3]* and George Verriopoulos [1]
[1] Department of Zoology-Marine Biology, National and Kapodistrian University of Athens
[2] Hellenic Centre for Marine Research
[3] GEOMAR, Helmholz Center for Ocean Research - mdanelli@hotmail.com

Abstract

Fish egg and larval assemblages of two ichthyoplankton surveys carried out in the N.W. Aegean Sea in June 2004 and 2005 were analysed in relation to topographic and oceanographic conditions. The nMDS analysis showed two main geographical groups of stations characterized by different environmental parameters (depth, temperature, salinity and chlorophyll-a) as well as different species composition.

Keywords: Ichthyoplankton, Bathymetry, Chlorophyll-A, Aegean Sea

Introduction Examining spatial and temporal patterns with respect to the distribution and abundance of ichthyoplankton in relation to oceanographic conditions may provide insight into the adaptation of spawning strategies to the prevailing physical and biological processes, as well as the effect of the variability in these processes on year-class strength [1].**Materials and Methods** A grid of 13 stations (Fig. 1) was sampled during two ichthyoplankton surveys in the Thermaikos, Toroneos and Siggitikos gulfs in June 2004 and 2005, using a 60-cm bongo net (0.250 & 0.500 mm nets) with oblique tows. In addition, environmental parameters (temperature, salinity and chlorophyll-a) were measured using a CTD. The eggs and larvae of the 250 mm net were sorted and identified into taxa (family, genus and species if possible) and their abundance expressed as individuals per 10 m^2 filtered water.

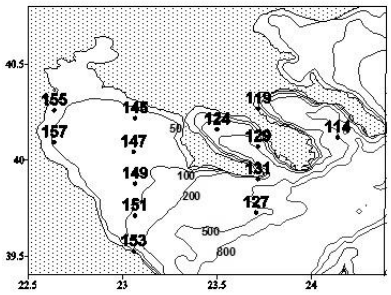

Fig. 1. Map of the study area.

nMDS plots of a Bray-Curtis similarity matrix were produced taking into account the most abundant taxa (taxa with only one occurrence at all 26 stations were excluded). Data were transformed [log(x+1)] to enhance the contribution considering only the most abundant taxa. **Results and Discussion** A total of 53 taxa belonging to 36 families were identified during the two surveys. In the 2004 survey, 47 taxa of fish larvae and 9 taxa of fish eggs were identified. The most abundant larvae were the small pelagic *E. encrasicolus* (28.9% of the total abundance) and *S. aurita* (24.3%),followed by the bathypelagic *C. maderensis* (14.6%). Regarding eggs, the most abundant *species* were *S. aurita* (38.6%)and *E. encrasicolus* (31%). In 2005, 43 taxa of fish larvae and 9 taxa of fish eggs were identified, with bathypelagic larvae *C. maderensis* (25.1%) and *H. benoiti* (15.9%) being the most abundant species, followed by the small pelagic *E. encrasicolus (14%)* and *S. aurita* (12%). Eggs were dominated by small pelagic *E. encrasicolus (37%)* and *S. aurita* (11%). Despite the fact that the main species synthesis is not generally altered between the two years, the total abundance measured in 2005 was almost half for the eggs and almost one third for the larvae compared to 2004. This reduction is caused mainly by small pelagic *E. encrasicolus* and *S. aurita* and less by bathypelagic *C. maderensis* and *H. benoiti*. It is possible that such a decrease is due to the reduction of chlorophyll–a (approximately 40%) in the Thermaikos gulf in 2005 compared to 2004, which is directly affected at the spawning behaviour of small pelagic species in this area. MDS analysis showed two well defined geographical groups of stations, those of Thermaikos and Toroneos + Siggitikos gulfs respectively. Environmental factors and major contributor species are plotted as correlated vectors. The Thermaikos group of stations is characterized by lower depths and higher values of salinity, temperature and chlorophyll-a in comparison with the Toroneos + Siggitikos group (Fig.2a). Regarding the major contributor species, the Toroneos + Siggitikos group is correlated mainly with larvae of bathypelagic species such as *C.maderensis, H.benoiti, M. punctatum, C. braueri* and two neritic species, namely, *C.chromis* and *C. julis* with large dispersal patterns. On the other hand, the Thermaikos group is correlated mainly with eggs and larvae of small and medium pelagic species such as *E.encrasicolus, S.aurita, S. japonicus T. mediterraneus* and larvae of demersal species such as Gobiidae, *S. hepatus, C. macrophalma* and *Callionymus spp* (Fig. 2b)

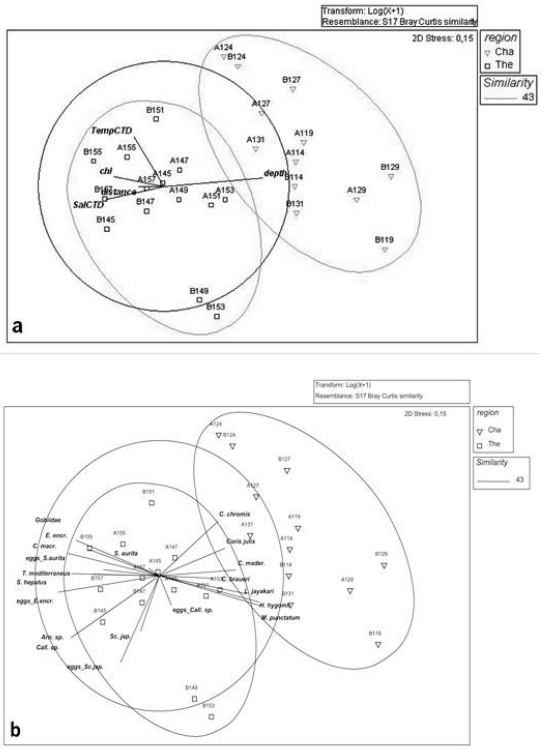

Fig. 2. Plot of the stations distributed using n-MDS analysis. Env. factors (a) and the major contributor species (b) are plotted as correlated vectors.

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BIOCHEMICAL COMPOSITION OF VARIOUS TISSUES OF THE CLAM *DONAX TRUNCULUS* FROM THE GULF OF TUNIS DURING GAMETOGENESIS PERIOD

Dhouha Boussoufa [1], Nabila Ghazali [1] and M'Hamed El Cafsi [1]*
[1] Faculté des Sciences de Tunis, Tunisie - mhamed.elcafsi@gmail.com

Abstract
The total lipid, protein and glycogen contents of foot, mantle, visceral mass, gonado-digestive gland, gills and adductor muscles of *Donax trunculus* (Mollusca, bivalvia) from the Gulf of Tunis were analysed during gametogenesis period of the species. Results showed that protein was the major component in the mantle, gills, visceral mass and gonado-digestive gland followed by lipid and glycogen. However, glycogen concentrations in the adductor muscles were greater than those of proteins. The highest levels of lipids, proteins and glycogen were found respectively in gills, foot and adductor muscles which act as reserve organs during gametogenesis.

Keywords: Chemical analysis, Gulf of Tunis, Bivalves

Introduction
Donax trunculus (Linnaeus 1758) Mollusca: Bivalvia, is an Atlantic-Mediterranean warm-temperate species. It has a high commercial value, particularly on the Southern coast of Portugal and Spain [1]. In Tunisia, *D.trunculus* shows a large distribution with sufficient densities to consider its commercial exploitation. Generally, gametogenesis takes place during winter and spring and gamete emission starts in late spring and summer. In this work, a special attention will be given to study the composition in glycogen, proteins and total lipids of six organs (foot, gonado-digestive gland, visceral mass, mantle, gills and adductor muscles) of *Donax trunculus* during the gametogenesis period.

Materials and methods
Samples were taken from the sandy beach of the Gulf of Tunis (the North Eastern coast of Tunisia) in February 2007. Protein levels (mg/g wet weight) and glycogen content (mg/g wet weight) were determined by the methods of Lowry et al. [2] and Du Bois et al. [3] respectively. Total lipids from each sample were extracted with chloroform: methanol (2:1, v/v) [4, 5](mg/g wet weight). The biochemical data have been converted by application of the calorific factors; 5.7 cal/mg for protein, 9,5 cal/mg for lipid, and 4,2 cal/mg for glycogen [6], to give values for the energetic content of the tissues of *Donax trunculus.* 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
This study showed that proteins were the major component in the whole individual (61.3 ± 14) and in the foot (81.9±12.5) followed by glycogen and lipids (Tab.1). In the mantle, gills, visceral mass and gonado-digestive gland, lipid levels were higher than those of glycogen. However, proteins still the major biochemical component. In the adductor muscles glycogen concentrations (87.1±10) were greater than those of proteins and lipids ($p<0.05$). The energetic contents of adductor muscles (1,01 Kcal/g wet weight), gonado-digestive gland (0,9 Kcal/g wet weight) and gills (0,84 Kcal/g wet weight) were significantly higher than those of Mantle (0,51 Kcal/g wet weight) and visceral mass (0,48 Kcal/g wet weight). During gametogenesis, the storage of fat, protein and glycogen in the gills, foot and adductor muscle respectively constitutes an energy reserve which will be exhausted during the maturation and release of gametes. In fact, the mobilization and utilization of energy substrates (mainly glycogen and lipids) is essential for the maintenance of metabolism, growth and reproduction of molluscs and other invertebrates [7].

Tab. 1. Biochemical composition of D.*trunculus* during gametogenesis period

	Protein	Glycogen	Total lipid	Calorific content
Whole individual	61.3±14	37.8±11.5	30.8±3	0.8
Gonado-digestive gland	70.3± 9	23.7±14	42.6±6.7	0.9
Foot	81.9±12.5	25.3±3.1	17.7± 4	0.74
Visceral mass	44.1±3	5.6±1.72	22±3	0.48
Mantle	55.1±6.3	6.3±1	18.4± 3	0.51
Gills	56.6±5.4	3.5±0.1	53.6±12	0.84
Adductor muscles	57.5±4.7	87.1±10	34±7	1.01

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MICRONEKTON GROUPS CONTRIBUTING TO THE NIGHT SCATTERING LAYERS IN THE WESTERN MEDITERRANEAN

M. P. Olivar [1]*, P. Abelló [1], A. Quetglas [2], A. Castellón [1], A. Bernal [1], B. Molí [1], A. Sabatés [1], M. Iglesias [2], D. Simao [1] and E. Massutí [2]

[1] Institut de Ciències del Mar (CSIC) - polivar@icm.csic.es

[2] Instituto Español de Oceanografía, Centre Oceanogràfic de les Balears.

Abstract

In the present study the biomass and numerical contribution of micronekton organisms responsible of the night Scattering Layers of the upper water column were investigated. Relative abundance in weight and number of individuals of the different groups collected using midwater trawls performed concurrently with the detection of the scattering layers by echosounders are presented.

Keywords: Vertical migration, Open sea, Pelagic, North-Western Mediterranean

Vertical nyctimeral migrations of the different mesopelagic fishes, decapods and cephalopods of the shelf-break and slope zone off the Mallorca Island (western Mediterranean) were already analysed in previous documents (1, 2, 3), showing upper displacement of many species during the night and very low concentrations in the upper layers during day time. Here we investigate the overall relative contribution of the several micronekton groups to the Epipelagic and Deep Scattering layers (DSL) detected with acoustic methods. To this aim the night micronekton samples obtained on the slope region off Mallorca Island in two cruises (December 2009 and July 2010) were analysed. Samples were collected by means of modified Pelagic Trawls (PT, with mouth opening of 200 and 100 m2 for the December and July, respectively) with a cod-end of 10 mm. Complementary information on the presence of the smallest fishes was obtained with an Issaks-Kidd midwater trawl (IKMT of 3 m2) and mesh size of 3 mm to collect smaller specimens.

The nets were placed at the denser scatter layers detected during night time with the Simrad EK60 echosounder at 18, 38, 70, 120 and 200 kHz. Hauls were carried out in the epipelagic layers (hauls from 40 to 80 m) and at the 400 m deep scattering layer (DSL).

Night collections obtained with the PT showed that crustaceans and fish were the most diverse groups contributing to the scattering layers, with crustaceans represented by 14 decapods, 5 amphipods, 3 euphausiids and 1 lophogastrid, and fish represented by 13 species of myctophiforms, 7 stomiiforms and 1 aulopiform.

Most of the biomass in the upper 400 m was due to fishes and crustaceans in winter, and fishes and gelatinous plankton (shiphonophora and jellyfish) in summer (Fig. 1). Molluscs and tunicata accounted for less than 20% of the overall weight obtained in these midwater hauls. In winter all groups showed higher biomasses at the epipelagic levels than at the DSL, but in summer differences were less pronounced. Among fish, those that rendered the highest biomass were species of the family Myctophidae, and particularly Ceratoscopelus maderensis, being higher in summer. Most mesopelagic fishes reach the epipelagic layer during the nyctimeral migration, except for Argyropelecus hemigymnus and the Cyclothone braueri and C. pygmaea, which do not migrate to the near surface layers (these last two species were seldom caught with PT, but their vertical location could be established through the IKMT hauls). Therefore myctophiforms and stomiiforms contributed to the night DSL, and myctophiforms were the main fish responsible for the Epipelagic scattering layers. Crustaceans biomasses were mainly due to the eufausiids and decapod concentrations, with the euphausiid Meganyctiphanes norvegica being the main contributor (both at the epipelagic and DSL), although more abundant in the epipelagic layers. The decapods Sergestes arcticus and Pasiphaea multidentata were the next species of this group in terms of weight. Mollusca were represented by cephalopods, with the main biomass due to Todarodes sagittatus, and the pterpod Cymbulia peroni, whose collections during the winter period accounted for most of the mollusc biomass, particularly at the epipelagic layers. The tunicata Pyrosoma atlanticum showed higher concentrations in winter, and in both periods the highest concentrations were found in epipelagic samples. In summer, however, the contribution of Salpa maxima in the DSL made that higher tunicate biomasses appeared at the DSL. The patterns showed some differences when considering the number of organisms, mostly due to the number of euphausiids, which enhanced the importance of the crustacean group. This was particularly relevant in the winter period, when large concentrations of M. norvegica were collected, at the near surface and DSL, making this group the first in numerical abundance, nevertheless collections of Cyclothone braueri with the IKMT net indicated that these are numerically the most abundant mesopelagic fish in hauls performed with this net at the DSL (1). Although we are aware that the values presented here are strongly dependent on the type of nets and hauls performed and that they can not be taken as the actual biomasses, we think that the results presented offer a clear insight into the main groups responsible for the upper column scattering layers detected with echosounds at night. In summary, myctophid fishes, eufausiids and some invertebrates, particularly Cymbulia peroni and Pyrosoma atlanticum, in winter, and medusae in summer, are the most common and abundant (both in weight and number of individuals) organism encountered in the epipelagic and DSL acoustically detected. Interestingly, other very abundant mesopelagic fishes, such as Cyclothone spp and Argyropelecus hemigymnus, are also important contributors, but just to the DSL.

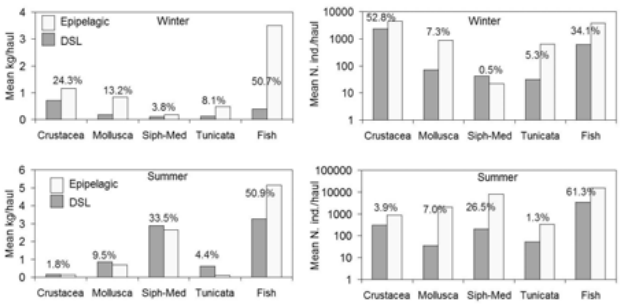

Fig. 1. Contribution of the different micronekton groups to the night Epipelagic and Deep Scattering Layers. Left graphs show mean weight per haul and right graphs indicate mean number of individuals per haul in logarithmic scale.

Acknowledgements: This research was funded by Spanish program CTM2008-04489-C03-01-02.

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THE BIOMASS DISTRIBUTION OF ZOOPLANKTON IN CILICIAN BASIN: SPRING AND AUTUMN 2008

Tuba Terbiyik Kurt [1]*, Zahit Uysal [2], Yesim Ak-Örek [2] and Sevim Polat [1]
[1] Cukurova University, Faculty of Fisheries, Department of Marine Sciences, 01330, Sariçam, Adana, Turkey - tterbiyik@cu.edu.tr
[2] METU, Institute of Marine Sciences, P.O Box: 28, 33731, Erdemli, Mersin, Turkey

Abstract
The aim of the current study was to describe the biomass distribution of zooplankton in the Cilician Basin. A total of 20 stations were visited during March and September 2008 as a part of the SESAME (WP3) project. Zooplankton samples were taken from standart depth layers (i.e. 0–50, 50–100, and 100–200 m) using a WP-2 closing net (200 µm). In general, zooplankton biomass was more abundant in coastal areas and was concentrated in the upper layer (to a depth of 100 m) in sampling periods. A similar distribution in biomass was observed in previous studies conducted in other areas of the Eastern Mediterranean.

Keywords: North-Eastern Mediterranean, Zooplankton , Biomass

INTRODUCTION
The Cilician basin is one of the most important regions in the oligotrophic Eastern Mediterranean Sea due to its width and shallow continental shelf, including Mersin and Iskenderun Bays. River inputs, which seem to be the main fresh-water and nutrient sources for the entire Levantine Sea of the oligotrophic Eastern Mediterranean waters, and primary production levels were comparatively higher in the basin [1]. In this study, zooplankton biomass distribution was investigated in order to understand the status of secondary productivity in the Cilician basin.

MATERIAL AND METHODS
Two oceanographic cruises were conducted in the Cilician basin during March and September 2008. Zooplankton samples were taken vertically at 20 stations (Figure 1) from standard depth layers (i.e. 0–50, 50–100, and 100-200 m) using a WP2 closing net (200 µm). Zooplankton biomass was measured as dry weight (mg m^{-3}) according to [2].

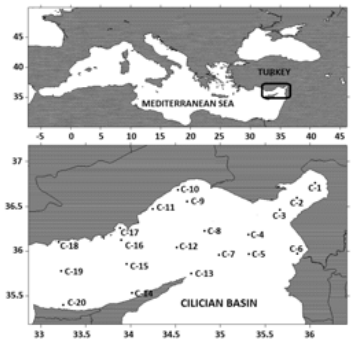

Fig. 1. Sampling stations

RESULTS
Mean zooplankton biomass in the integrated water column (0-200 m) was slightly more abundant in the spring (7.96 ± 6.3 mg m^{-3}) than the autumn (5.7 ± 3.1 mg m^{-3}) and fluctuated from 1.73 to 29.32 mg m^{-3} and from 1.68–to11.5 mg m^{-3}, respectively (Figure 2). The increase in zooplankton biomass was evident in the continental shelf region of the basin, including Mersin and Iskenderun Bays in the autumn. However, zooplankton biomass was higher only in the Iskenderun Bay and the northwestern part of the basin in the spring, excluding Mersin Bay. In the remaining areas of the Cilician Basin, zooplankton biomass showed a nearly homogeneous distribution thorughout the study period. Zooplankton biomass was concentrated in the upper 100 m layer of the study area, and a decrease in biomass values was observed with depth (Figure 2). The observed pattern of distribution in zooplankton has been reported previously in the Mediterranean Sea [3] and closely follows the presence of potential food materials, mainly phyto- and microzooplankton with populations primarily condensed in the upper layer. Furthermore, a previous study conducted in the Cilician Basin [4] illustrated the presence of two contrasting ecosystems: (1) the coastal ecosystem with high concentrations of bacteria, cyanobacteria, phytoplankton, and chlorophyll-*a*; and (2) an extreme oligotrophic offshore ecosystem that is almost denude of such food items. This productive structure in the coastal area could contribute to an increase in zooplankton biomass. We are currently assessing species identification assays and abundance measurements to complement the results already obtained. Furthermore, statistical analyses of ecological variables will be applied to understand the effects of environmental factors on zooplankton in the Cilician basin.

Acknowledgements Present study was conducted in the Cilician basin within the framework of SESAME. Thanks are also due to academic and technical staff of the Institute of Marine Sciences of METU.

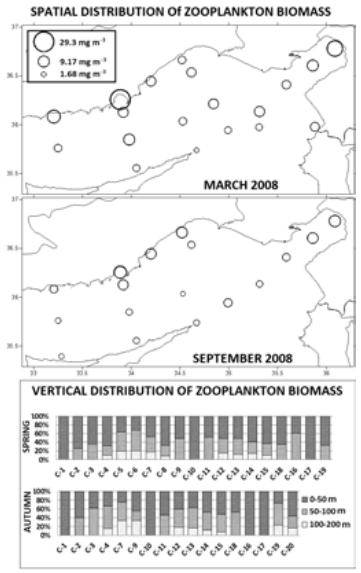

Fig. 2. Spatial and vertical distribution of zooplankton in Cilician basin.

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Session

Water column habitats - 2

Modérateur : **Boris Espinasse**

SPATIAL AND TEMPORAL VARIATION IN THE CONDITION FACTOR OF SMALL PELAGIC TELEOSTS IN THE GULF OF LIONS (NW MEDITERRANEAN)

D. Banaru [1]*, T. Ballerini [1], C. Michelot [1], B. Le Bourg [1] and C. Saraux [2]
[1] MIO (Mediteranean Institute of Oceanography), Aix-Marseille University, Campus de Luminy, case 901, 13288 Marseille, France - Daniela.Banaru@univ-amu.fr
[2] IFREMER, UMR 212 EME (Ecosystèmes Marins Exploités), Av. Jean Monnet, 34203 Sète, France

Abstract
This paper presents data on the condition factor for sardines, anchovies and sprats in the Gulf of Lions in 2011. The condition factor was estimated through both morphometric measures and C/N ratios. Globally, sprats exhibited a better condition than sardines and anchovies. Sprats showed a better condition in the coastal area, while anchovies presented the best condition on the continental shelf and on the shelf break. The central area was the most favorable for sardines and the most unfavorable for sprats. All species presented a better condition in June than in July. These results suggest an important influence of habitat and feeding resources on small pelagic teleosts condition.

Keywords: Biometrics, Teleostei, Coastal waters, Gulf of Lyon, Trophic relations

Introduction
The study area is situated in the Gulf of Lions (42.4-43.5° N; 3.0-5.4° E) where sardines (European pilchard, *Sardina pilchardus* (Walbaum, 1792)) and anchovies (European anchovy, *Engraulis encrasicolus* (Linnaeus, 1758) were traditionally the most important species in terms of both biomass and fishery landings (about 50%) [1, 2]. However in recent years the biomass of sprats (European sprat, *Sprattus sprattus* (Linnaeus, 1758)), a non-commercial species, has strongly increased while the biomass of sardines and anchovies has decreased causing an important fishery crisis (Bigot J. L., pers. comm.). The three species potentially compete for food and habitat. Individual condition, a strong proxy for fitness and a good indicator of the population health are thought to be strongly related to their feeding environment. Here we tested the hypothesis that the condition factor is species-, space-, and time-dependent.

Materials and methods
A total of 1181 samples of sardines (334), anchovies (365) and sprats (482) varying in size between 3.5 and 16.5 cm, were collected in the Gulf of Lions, covering the western, central and eastern areas, and comprising the coastal area (0-50 m), the continental shelf (50-200 m) and the shelf break (>200 m) (Fig. 1). Sampling was carried out during the IFREMER scientific surveys MEDITS and PELMED in June and July 2011 onboard of the N/O Europe.

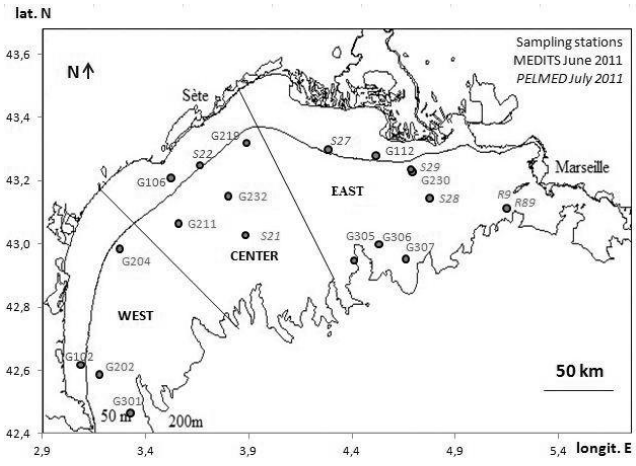

Fig. 1. Sampling stations in the Gulf of Lions

The condition factor was estimated by means of morphometric measures and C/N ratios (related to the lipid content). Individual body-length and wet-weight were used to calculate the relative condition factor Kn (see formula in [3]). Sub-samples of muscle (sardines 10-12 cm, n=31; anchovies 10-11 cm, n=44; sprats 9-10 cm, n=35) were analyzed for C/N ratios using continuous flow mass spectroscopy (CF-IRMS). Data were tested for normality and homogeneity of variance and the effects of different factors (species, area, depth, month) on Kn and C/N values were tested using parametric (Independent T-test (T) or one-way ANOVA (F)) and non-parametric (Mann-Whitney (U) or Kruskal-Wallis (H)) analyses of variance.

Results and discussion
C/N values indicated a better condition for sprats (4.33 ± 0.60) compared to sardines (3.22 ± 0.11) and anchovies (3.17 ± 0.06) (H = 72.2; p= 0.000). Sardines had the best condition in the central area according to C/N values. Contrarily, sprats showed here the lowest condition according to Kn values (Table 1). Anchovies' condition increased with depth, i.e. it was higher on the continental shelf and shelf break than in the coastal area. On the contrary, sprats appeared to be in better condition in the coastal area. All species exhibited a better condition in June than in July (Table 1). The condition factor varied according to the species considered and in space and time. These results might be explained by environmental conditions, potential differences in the composition of plankton assemblages, and individual diet. More data and further analyses are needed in order to better understand the effect of the habitat on these three species of small pelagic teleosts in the NW Mediterranean.

Tab. 1. Kn et C/N values according to species, area, depth and month. For the meaning of T, F, U, H see text, p is the p-value, *p < 0.05, **p < 0.01, ***p < 0.001, ns = nonsignificant.

Species	Factors	Kn T/F/U/H	p, rank	C/N T/F/U/H	p, rank
Sardines	area	F=2.76	ns	F=9.69	p=***, East=West<Center
	depth	T=0.34	ns	F=3.21	ns
	month	T=7,83	p=**, June>July	T=0.18	ns
Anchovies	area	F=0,51	ns	F=2.40	ns
	depth	T=6.28	p=***, coast<shelf=s-break	F=10.00	p=***, coast<shelf=s-break
	month	T=2.65	ns	T=7.00	p=*, June>July
Sprats	area	H=15,9	p=***, Center<East<West	H=1,00	ns
	depth	U=8708	ns	U=95.00	p=*, coast>shelf
	month	U=3141	p=***, June>July	U=145.0	ns

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OCCURRENCE OF TWO LANTERNFISH *LAMPANYCTUS CROCODILUS* (RISSO, 1810) AND *LAMPANYCTUS PUSILLUS* (JOHNSON, 1890) LARVAE IN THE SOUTHERN TYRRHENIAN SEA

D. Giordano [1], A. Perdichizzi [1], A. Profeta [1], B. Busalacchi [1]*, A. Cosenza [1], F. Perdichizzi [1] and P. Rinelli [1]
[1] Institute for Coastal Marine Environment (IAMC) - barbara.busalacchi@iamc.cnr.it

Abstract
Distribution, abundance and size structure of *Lampanyctus crocodilus* and *Lampanyctus pusillus* larvae were analysed. Data were collected during an ichthyoplankton cruise carried out during June 2006. Samples from a total of 39 stations were collected using a Bongo net with 60 cm diameter. Data of abundance were mapped and the results showed that these two lanternfish species were most abundant near Cape Cefalù, in the western part of the study area

Keywords: Ichthyoplankton, Larvae, Mapping, Tyrrhenian Sea

Introduction
Mesopelagic fish are abundant along the continental shelf in the Atlantic, Pacific, and Indian Oceans, but have lower abundance in Arctic and sub-Arctic waters. The dominance of mesopelagic fish larvae in oceanic ichthyoplankton has been described in various parts of the world's oceans ([1], [2], [3]). Most mesopelagic fish spend their larval stages in the productive epipelagic zone of the upper 200 m [3]. They move to the mesopelagic zone when they begin the transformation from the larval to the juvenile stage, when most species start diel vertical migration [4]. Patterns of larval fish distribution originate from complex spatial and temporal interrelationships that are strongly affected by the seasonality and duration of their meroplanktonic existence [5]. The aim of this study was to give some information on the abundance, distribution and size structure of these two lanternfish larvae collected in the southern Tyrrhenian Sea.

Material and methods
Samples were collected during an ichthyoplanktonic survey carried out in June 2006 in the southern Tyrrhenian sea (between Cape Cefalù and Rasocolmo) along the Sicilian coasts. A total of 39 stations were sampled. Oblique tows at constant speed of 2 knots were carried out using a Bongo 60, equipped with a 500 µm mesh size net and a flowmeter. Oblique hauls, from 200 m to the surface were carried out. Samples were fixed in 4% borax-buffered formalin immediately after capture and then analyzed in the laboratory. Larvae of lanternfish were identified according to morphological, morphometric and pigmentation features [6]; the number of larvae collected for each station was expressed as number of larvae/ 10 m^2 of sea surface [7].

Results and discussion
In the ichthyoplanktonic survey, 98 larvae of *L. crocodilus* and 79 larvae of *L. pusillus* were collected. The body is short and plump in *L. pusillus* and more elongate in *L. crocodilus*. In *L. pusillus* melanophores are present on the occipital region, snout, tip of the lower jaw, and posterior margin of the gill cover. There are 32-34 vertebrae in *L. pusillus* and 36-37 in *L. crocodilus* and the transformation stage occur at 12 mm SL in the first and at 19-22 mm SL in the second specimens. The size-frequency distribution of *L. pusillus* ranged from 2.0 to 6.3 mm and from 2.2 to 7.4 mm in *L. crocodilus*. Notochordal flexion is complete in larvae by 5 mm in *L. pusillus*. Distribution maps of the two lanternfish showed that *L. crocodilus* was most abundant in front of Cape Cefalù, in the western part of the study area, in offshore waters, while *L. pusillus* was abundant in front of Cape Cefalù and also in front of S. Agata di Militello (Fig.1,2).

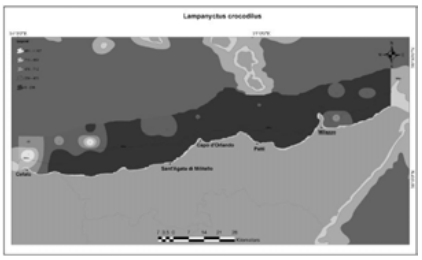

Fig. 1. Distribution map of Lampanyctus crocodilus (number per 10 m^2 of sea surface)

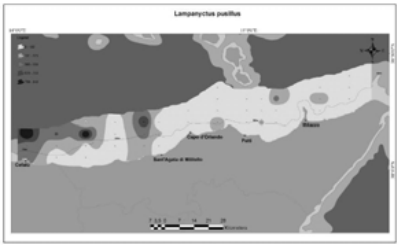

Fig. 2. Distribution map of Lampanyctus pusillus (number per 10 m^2 of sea surface)

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THE EFFECT OF ENVIRONMENTAL FACTORS ON THE ICHTHYOPLANKTON ASSEMPLAGES IN THE NORTH AEGEAN SEA IN SUMMER 2008

M. Danelli [1]*, A. Siapatis [2], S. Somarakis [2], M. Giannoulaki [2] and A. Machias [2]
[1] GEOMAR, Helmholz Center for Ocean Research - mdanelli@hotmail.com
[2] Hellenic Center for Marine Research

Abstract

This paper presents the correlation of ichthyoplankton assemblages and environmental factors such as depth, temperature, salinity and chlorophyll-a in the North Aegean Sea during the summer of 2008. Depth and chlorophyll-a appeared to have played a significant role on the ichthyoplankton distribution.

Keywords: Ichthyoplankton, Chlorophyll-A, Temperature, Bathymetry, Aegean Sea

Introduction The importance of ichthyoplankton surveys is to detect the spawning areas and protect species in order to enhance their recruitment. North Aegean Sea is an important area for spawning species such as anchovy, round sardinella and Pacific mackerel [1]. The presence and the distribution of ichthyoplankton assemblages are influenced by abiotic environmental factors such as: temperature, salinity, currents, bathymetry and food availability [2, 3].

Materials and methods Ichthyoplankton samples were collected at 212 stations in the time period 12 June – 21 July 2008 in the North Aegean Sea by using WP2 sampler (mouth opening: 0.255 m , mesh-size: 0.200-mm). Environmental parameters (temperature and salinity) were recorded by using CTD sensor. Additionally, monthly satellite data of chlorophyll- a and SST were used for statistical analysis coming from NASA website. In order to define ichthyoplankton assemblages, a hierarchical cluster analysis of a Bray-Curtis similarity matrix calculated between species by ranked larval abundance was performed, considering only those species or groups that represented 1% of the total catch [4]. All data were transformed by log (x+1). Multivariate statistical analysis was performed using the Primer 6 and PERMANOVA+ software packages.

Results and discussion From the ichthyoplankton analysis a total of 35 taxa of eggs and fish larvae were identified which belong to 35 families. The most abundant larvae species were *Engraulis encrasicolus* (60% of the total abundance), *Sardinella aurita* (9%) *Gobiidae* (4%) *Serranus hepatus* (4%),*Trachurus mediterraneus* and *Scober japonicus* respectively (3%), *Chromis chromis* (2%) and *Hygophum hygomii* (2%). The most abundant eggs species were *Engraulis encrasicolus* (51%), *Sardinella aurita (6%*) and *Scomber japonicus (5%*). The Principal Coordinated Ordination (PCO) conducted on stations, which were labeled with their depth, allowed us to distinguish a gradient between the depths. Overlaid four environmental factors; temperature(CTD Sst,Sst, salinity (CTDSal), chlorophyll –a (Chla) and depth(Depth) with vectors it can be observed that the concentration of chlorophyll-a and the CTD SST is increased as the depth is decreased and the salinity is increased as the depth is increased (Fig.1). Plotting the most abundant species as correlated vectors on PCO plots two district groups were defined: the first group includes eggs and larvae of pelagic and neritic species such as *Engraulis encrasicolus (E.enc.,E.enc.eggs), Sardinella aurita (S.aur.), Scomber japonicas(S.jap), Gobiidae(Gob), Serranus hepatus (S.hep), Arnoglossus sp.(Arn), Callionymus sp.(Call),* and *Chromis chromis (C.chr)* and the second one larvae of meso-bathypelagic species like *Ceratoscopelus maderensis(C.mad), Hygophum hygomi(H.hyg), Myctophum punctatum(M.pun)* and *Maurolicus muelleri(M.muel)* (Fig.2). Combining the environmental factors with the species distribution, a significant effect of depth (P=0.001) and chlorophyll-a concentration (P=0.01) was observed by using Permanova test. Species belonging to the first group distributed to stations which are characterized with high concentration of chlorophyll-a and low depth in contrast to species belonging to bathypelagic group distributed to stations with greater depths with relatively low values of chlorophyll-a. Similar correlation of fish larvae assemblages with the environmental factors was observed in the same region [1, 3].

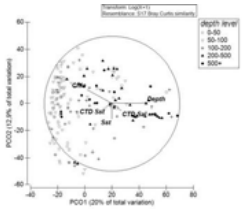

Fig. 1. PCO of stations distribution correlated with environmental factors.

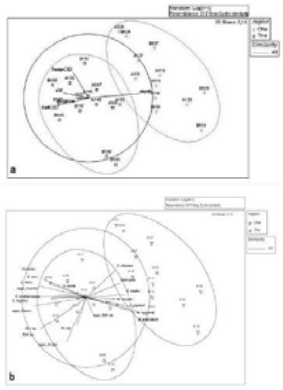

Fig. 2. PCO of stations distribution correlated with most abundant species

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DETECTING HABITATS CONSIDERING THE MESOZOOPLANKTON SIZE STRUCTURE AND ENVIRONMENTAL CONDITIONS IN THE GULF OF LION, NW MEDITERRANEAN SEA.

Boris Espinasse [1]*, François Carlotti [1], Meng Zhou [2] and Jean-Luc Devenon [1]
[1] Mediterranean Institute of Oceanography - boris.espinasse@univ-amu.fr
[2] University of Massachussetts

Abstract
Environmental conditions and zooplankton size structure and abundance were investigated in the Gulf of Lion at two periods (May 2010 and January 2011). Several analytic tests were performed in order to define several ecoregions representing different habitats of plankton communities. Three main habitats were found: Coastal area, Rhône plume influence and continental shelf. The size structure of zooplankton community differ following areas and their environmental conditions. The slope of the Normalized Biomass Size Spectrum (NBSS) was weaker in stratified waters and sharper in coastal area meaning presence of more large size zooplankton organisms relatively to small organisms in the zone of Rhône plume influence.

Keywords: Zooplankton , Coastal systems, Biogeography, Analytical methods, Gulf of Lyon

Introduction
The gulf of Lion in northwestern Mediterranean Sea is characterized by a large continental shelf reaching up 40 miles width. Several hydroclimatic processes induce a complex hydrodynamics: several rivers, and especially the Rhône, flow into the gulf of Lion carrying on freshwater, land particles and nutrients; the Northern Current follows the continental slope southward and intrusions of the current inside the shelf occurs draining oligotrophic waters; the winds such Mistral and Tramontane, strong and frequent, create coastal upwellings and control the Rhône plume moving and dilution[1]. Such changing conditions create several habitats for plankton communities in the Gulf of Lion.

Samples strategy
During two cruises (26 April to 7 May 2010, 23 January to 4 February 2011), the whole French continental shelf of the Gulf of Lion was sampled to obtain an overview on the zooplankton community size structure and environmental condotions. 6 transects from the coast to the open ocean were conducted for a total of 135 stations. A laser optical plankton counter (LOPC) was used to estimate abundance, biovolume, and general characteristics of size spectra [2]. The vertical distribution of, the LOPC counts, the chla concentration and the hydrological parameters was investigated in order to highlight their interactions and the main structures.

Main results
Different patterns of particle distributions occur following the water column structure and the bathymetry. A Principal Components Analysis (PCA) was done on physicals and biological parameters to interpret the links between the different parameters. A clustering test allowed us to define 3 spatial areas corresponding potentially to different types of habitat (Fig. 1):
(1) the coastal area, (2) the Rhône plume and (3) the continental shelf area.

The zooplankton size distribution was investigated within the three areas using the normalized biomass size spectrum (NBSS)[3]. The coastal area was characterized by the steepest NBSS and highest chla concentrations, the upwelling and the formation of deep water participated to keep the water mixed. The Rhône plume showed the lowest NBSS slopes associated with strong water stratification. These waters were rich in nutrient promoted high chlorophyll a concentrations in the surface water layer and carried on the continental shelf a lot of organic matter. The continental shelf showed the lowest abundances and was hit by the Liguro-Provençal current depending on the season. The NBSS slopes were higher during winter, meaning the proportions of large organisms were more important during the post bloom period.

We acknowledge the funding support of the ANR COSTAS (N° 2009 CESA 007 002) and the help of the crew of the Tethys R/V.

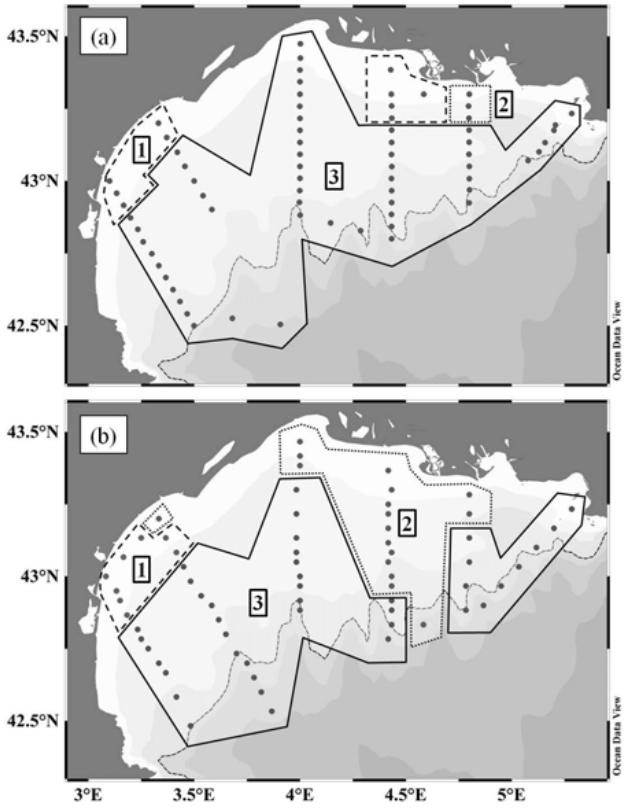

Fig. 1. Spatial distribution of the 3 zones defined by the cluster analysis for (A) COSTEAU 6 (January) and (B) COSTEAU 4. Zone 1 corresponds to 'Coastal area', Zone 2 to 'Rhône plume' and Zone 3 to 'Continental shelf'. Black dots represent the stations.

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MESOZOOPLANKTON IN A STRATIFIED SEMI-ENCLOSED MARINE ENVIRONMENT (VELIKO JEZERO, SOUTH ADRIATIC SEA): ABUNDANCE, BIOMASS AND BIODIVERSITY PATTERNS

Marijana Miloslavic [1]*, Davor Lucic [1], Barbara Gangai [1] and Ivona Onofri [1]
[1] Institute for Marine and Coastal Research University of Dubrovnik - marijana.miloslavic@unidu.hr

Abstract
During a one year study, an analysis was made on the species composition, abundance and biomass distribution of mesozooplankton in the semi-enclosed marine lake Veliko Jezero, in relation to the main physical-chemical properties of the water column. Copepods were found to be the dominant group over the entire sampling period. The highest abundance and biomass were recorded during the summer, while the lowest values were related to the bottom hypoxia during autumn. Increased salinity in the surface during autumn suggests a stronger inflow of open Adriatic waters and coincides with increased biodiversity.

Keywords: Zooplankton , Copepoda, South Adriatic Sea

Introduction
Due to its restricted communication with the open sea, Veliko Jezero (VJ) provides a strong vertical gradient of habitat qualities for zooplankton with strong stratification during the summer, absence of upwelling events [1], relatively stable physical-chemical conditions in deep layers [2] and occasional hypoxia-anoxia in deep layers during stratified conditions [1]. Furthermore, since the whole north-western part of the island of Mljet, including VJ, has been protected as a national park for the past 50 years, limited human activities makes this area very suitable for ecological studies. Thus, isolated zooplankton populations in VJ provide a good opportunity for better understanding the factors that influence their spatial and temporal dynamics. The goal of this study was to examine how a strong vertical gradient in habitat qualities within an enclosed body of water can effect changes in mesozooplankton abundance, biomass and community structure.

Material and Methods
Sampling was carried out monthly from February 2008 to February 2009 at three stations in the VJ (Fig. 1): station A (46 m depth), station B (40 m depth), and station C (33 m depth). A total of 78 samples were collected by vertical hauls from two different depth layers (0-20 m and 20 m to the bottom) using a modified Nansen opening-closing net (125-µm mesh size, 54 cm opening). Hydrographic sampling (temperature, salinity and dissolved oxygen profiles) was performed with a SeaBird OC25 probe. Seawater samples (500 mL) for the measurement of chlorophyll *a* were collected with a Niskin bottle from depths of 0, 2, 20 and 30 m.

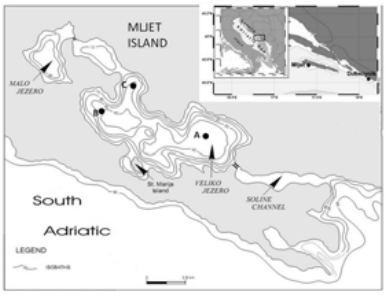

Fig. 1. Location of the sampling stations in the South Adriatic Sea

Results and Discussion
Since VJ is located in a protected national park where human activities are negligible, changes in zooplankton community structure might be related to natural environment variations and ecological interactions. Naturally restricted exchanges with adjacent waters through the Soline Channel (depth 2.5 m, width 10 m) hinder the outflow from deeper layers, which results in significant difference in the density of the surface and bottom layers. Therefore, the layer below 20 m depths was characterized with constantly low temperatures (<13°C), high salinity (>38,3) and Chl *a* concentration. Hypoxia (1 ml/l) was recorded during the autumn at stations A and B below 35 m depths. Increased salinity in the surface during the autumn suggests a stronger inflow of open Adriatic waters. The degree of isolation strongly influences the composition of the community. Therefore, zooplankton populations in the lake were characterized by high abundance and a low number of species compared to the neighbouring open Adriatic. A total of 58 mesozooplankton taxa were identified. Copepods accounted for between 19% and 62% of total mesozooplankton density with the most abundant cyclopoida-oithonids (*Oithona similis* and *O. nana*), and small calanoids *Paracalanus parvus* and *Acartia clausi*. *Paracalanus parvus*, *Centropages typicus*, *C. kröyeri*, *Isias clavipes*, *Oithona nana* and *Euterpina accutifrons* showed their higher preference for the surface layer (0-20 m), while *Calanus helgolandicus*, *Diaixis pygmaea*, *Mesaiokeras hurei* and *Oithona similis* inhabit layers below 20 m depth. Other zooplankton groups that have been recorded in significant numbers throughout the year are *Oikopleura dioica*, *Sagitta setosa*, *Limacina* spp., as well as Bivalvia larvae. A higher Shannon-Wiener biodiversity index was recorded in the upper layer (1.6) than in the bottom (1.3) with a maximum during the late autumn. A positive relationship between total abundance and temperature was recorded with a maximum (24670 ind./m^3) at station C in August in the 0-20 m layer. Average biomass values were higher in the bottom layer (17,4±10,6 mg/m^3) than in the surface (12,0±7,7 mg/m^3). Oxygen decrease at the bottom of stations A and B coincide with the annual minimum of abundance and total dry weight. On the contrary, at station C, where hypoxia was not recorded, a minimum of abundance and biomass was noted in February 2009. Biological forcing could also be an important driver of zooplankton community structure in VJ. Apart from food resources, predation is another biological force that affects zooplankton dynamics. Chaetognaths, with a dominance of *Sagitta setosa*, were present all year round with an average of 73 ind/m^3. Another important component of the VJ zooplankton is the jellyfish *Aurelia* sp. 5 [3], whose food items were copepodites and small adult copepods *Oithona nana* and *Paracalanus parvus*. Nevertheless, our analyses were based on the data available, indicating strong physical forcing as the primary influence on variation in zooplankton dynamics of VJ.

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MISTRALS/SPECIMED PROJECT: SEASONAL AND INTERANNUAL VARIABILITY OF PLANKTON COMMUNITIES STRUCTURE AND BIOGEOCHEMICAL CYCLES IN NORTH-WESTERN MEDITERRANEAN

B. Quéguiner [1]*, F. Carlotti [1], K. Leblanc [1], I. Salter [2], M. Golbol [1], L. Guilloux [1], V. Cornet-Barthaux [1], S. Hélias Nunige [1], D. Malengros [1], O. Grosso [1], S. Boussabat Ben Neji [3], E. Maria [2] and C. Tricoire [2]

[1] Aix-Marseille University, Mediterranean Institute of Oceanography (M I O), 13288, Marseille, Cedex 9, France ; Université du Sud Toulon-Var, 83957, La Garde Cedex, France ; CNRS-INSU/IRD UM 110 - bernard.queguiner@univ-amu.fr

[2] Observatoire Océanologique de Banyuls-sur-mer, Université Pierre et Marie Curie, CNRS-INSU UMR 7621, Banyuls-sur-mer, France

[3] Aix-Marseille University, Mediterranean Institute of Oceanography / University of Carthage, Faculty of Sciences of Bizerte

Abstract

The structure of plankton communities is observed on a monthly basis since May 2010 at four stations at the entrance and output of the Gulf of Lion. The first observations document the seasonal and annual variability of particulate matter stoichiometry (particulate organic carbon, nitrogen, and phosphorus, biogenic silica, lithogenic silica and aluminum), nutrients (nitrate, ammonium, phosphate and silicic acid) and taxonomic composition and carbon biomass partition of phytoplankton and zooplankton. Associated to these direct observations by chemical analyses and/or microscopy, vertical profiles of particle size spectra, made by combining LISST (Laser In Situ Transmissiometer Scaterrometer) and LOPC (Laser Optical Plankton Counter), reveal the small-scale vertical structures and the heterogeneity of the plankton vertical distributions.

Keywords: Plankton, Geochemical cycles, Monitoring, Instruments and techniques, North-Western Mediterranean

Introduction

The Gulf of Lion is a shelf ecosystem whose complex dynamic is influenced by the proximity to the Northern Mediterranean Current whose incursions occur in the eastern part, the freshwater inputs from the Rhône and the small coastal rivers of the western part, as well as a particular wind regime dominated by northerly (Mistral) and northwestern (Tramontane) winds. Up to now few studies have investigated the structure of plankton communities and the relationships with the biogeochemical cycles on a seasonal basis (e.g. Leblanc *et al.*, 2003, 2005 ; Gaudy & Champalbert, 1998). As part of the MISTRALS program, the SPEciMed (Structures of Planktonic Ecosystems in the North-western Mediterranean) project is a 4-year observation study of plankton communities including bacteria, phyto-, microzoo- and mesozooplankton and associated biogeochemical cycles of major elements (C, N, P, and Si).

Methods

Samples are collected on a monthly basis since May 2010 at 4 stations located in the eastern (in front of Marseille) and western (in front of Banyuls/mer) regions of the study area. Hydrological and biogeochemical parameters are sampled in the conventional manner since 2010 with a rosette equipped with a CTD, a fluorometer and a transmissometer. Pico- and nanoplankton are assessed by flow cytometry (bacteria, autotrophic picoplankton, nanoflagellates). Microzoo-and microphytoplankton are studied by microscopic analysis. Mesozooplankton is sampled by vertical hauls of WP2 net (200 microns mesh net) and identified by microscopy. The rosette is also equipped with a LISST and a LOPC allowing vertical continuous description of the size structure of particles in the range 2 microns–35 mm.

Preliminary results

The first results serve to document the structure of phytoplankton (dominated by the group of diatoms) and zooplankton (copepods are the main component of mesozooplankton) communities. These are closely related and exhibit a strong interannual variability (Figs. 1 and 2). Thus the success of the development of mesozooplankton appears to be directly related to the intensity of the phytoplankton bloom. Mesozooplankton peaks occur a few weeks after the phytoplankton bloom. However, the interannual variability of particulate organic matter concentrations is less than that of chlorophyll *a*, which suggests allochthonous inputs and redistribution within the ecosystem of the Gulf of Lion. The continuation of data acquisition will now focus on the search for species-specifi relationships between phytoplankton and zooplankton while LISST and LOPC data will be used to highlight the vertical structuring of populations in relation to the seasonal evolution of the surface mixture layer.

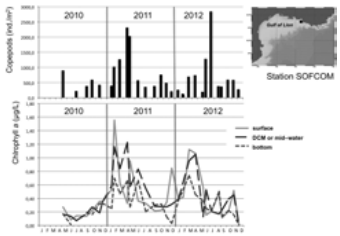

Fig. 1. Seasonal and interannual variability of zooplankton (copepod numbers) and phytoplankton (chlorophyll a concentration) at a coastal station in the eastern region of the Gulf of Lion (off Marseille).

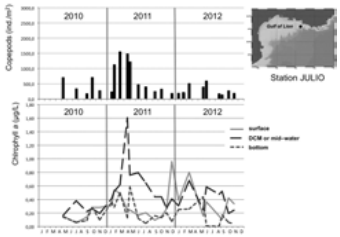

Fig. 2. Same as Figure 1 for an offshore station characterized by intrusions of the Northern Mediterranean Current.

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Session

Water column habitats - 3

Modérateur : **Bernard Quéguiner**

FLUCTUATIONS SPATIO-TEMPORELLES DES TINTINNIDES AU NIVEAU D'UN REJET D'UNE CENTRALE ELECTRIQUE A L'EST DE LA TUNISIE

Meher Bellakhal [1]* and Mouna Bellakhal Fartouna [1]
[1] Unité de recherche: Exploitation des Milieux Aquatiques. ISPA de Bizerte. BP15- Errimel- 7080- Tunisie - meher2976@yahoo.fr

Abstract
Le rejet d'une centrale électrique dans la baie de Sousse provoque une élévation de la température de l'eau qui a atteint 36°C durant la période d'étude. Cette élévation est susceptible de perturber la répartition spatio-temporelle du peuplement planctonique entre-autre les Tintinnides. En effet, ces derniers ont présenté les abondances relatives les plus importants (75.7%) et les densités les plus élevées (2248 cellules/L) au niveau des stations les plus proche du rejet.

Keywords: Thermal pollution, Zooplankton , Tunisian Plateau

Introduction
L'un des problèmes écologiques actuels majeurs est le réchauffement global. Du fait de son effet perturbateur sur les différents écosystèmes, plusieurs approches ont été élaborées pour mieux comprendre ses répercussions sur les écosystèmes aquatiques en particulier [1]. L'une de ces approches consiste à étudier l'impact des effluents d'eaux chaudes, éjectées dans les écosystèmes côtiers, par les centrales d'électricités sur les communautés benthiques et pélagiques [2]. Ces études ce sont particulièrement focalisées sur l'influence de ces effluents d'eau chaude sur le peuplement planctonique [3,4]. Les Tintinnides représentent une sous-classe des Ciliés qui sont des Protozoaires généralement de grande taille (50 à 300 µm). De structure complexe dont le corps présente des cils diversement répartis et un noyau complexe formé d'un micronucleus, assumant les fonctions sexuelles et un macronucléus à fonctions de nutrition. Les Tintinnides sont essentiellement marins et exclusivement pélagiques. Leur corps se termine par un pédoncule qui permet à l'organisme de se fixer à la paroi d'une loge qu'ils sécrètent nommée lorica [5]. Quelques espèces sont connues comme des indicateurs des caractéristiques hydrologiques bien définies du milieu [6]. D'autres auteurs ne considèrent pas les Tintinnides comme indicateurs écologiques des écosystèmes marins en raison de leur temps de génération assez rapide de l'ordre d'une journée et de leur adaptation assez importante aux variations des conditions physico-chimiques au sein des masses d'eau [7]. Nous avons pu identifier dans cette étude 14 espèces appartenant à 8 genres dont nous avons étudié les fluctuations spatio-temporelles et établi une classification selon leur abondance relative.

Matériel et méthodes
A proximité d'une centrale électrique, au niveau de la baie de Sousse située sur la côte Est de la Tunisie (35°50' N ; 10°50' W), 20 stations d'échantillonnage, 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, ont été prospectées saisonnièrement durant 2 ans. 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 été également choisies. Les échantillons ont été récoltés à l'aide d'un filet à plancton de 70 µm de mail et fixés au formol neutralisé au Borax (4 à 5%). L'identification et le dénombrement des Tintinnides ont été effectués selon la méthode d'Utermöhl [4].

Résultats et discussion
A l'échelle saisonnière, les Tintinnides ont nettement dominé le peuplement microzooplanctonique au printemps avec une abondance relative moyenne de 95.55% ce qui correspond à la densité moyenne maximale de l'ordre de 1166 cellules/L. En automne, les Tintinnides ont été les moins abondants en représentant uniquement 9.08% des microzooplanctons totaux. Alors qu'en hiver, la densité a été minimale avec une valeur moyenne de 40 cellules/L. A l'échelle spatiale, les Tintinnides ont été les plus abondants au niveau de la station 12 située sur la première radiale et à l'isobathe 2 m avec une abondance relative de 75,70% contre une valeur minimale de 8.06% au niveau de la station 45 située sur la 4ème radiale et à l'isobathe 5 m. En revanche les densités moyennes ont variées entre une valeur maximale de 2248 cellules/L au niveau de la station 22 et une valeur minimale de 91 cellules/L au niveau de la station 210. La classification des 14 taxa de Tintinnides identifiés, selon leurs abondances relatives, montre l'existence de 4 catégories : 4 espèces abondantes, 3 espèces peu abondantes, 4 espèces rares et 3 qui sont accidentelles (voir tableau ci-dessous).

Tab1- Classification des taxa de Tintinnides selon leur abondance relative

Espèces abondantes AR > 10%	**Espèces peu abondantes 1%< AR <10%**	**Espèces rares 0.1% < AR < 1%**	**Espèces accidentelles AR < 0.1%**
Tintinnopsis beroidae	*Tintinnopsis sp*	*Stenosemella elongatum*	*Helicostomella subulata*
Metacylis sp	*Favella spp*	*Favella ehrenbergii*	*Eutintinnus tubulosus*
Stenosemella ventricosa	*Eutintinnus sp*	*Leprotintinnus botnicus*	*Coxliella annulata*
Tintinnopsis campanula		*Steenstruppiella steenstrupii*	

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HYDROLOGICAL FIELDS AND WEATHER CONDITIONS DURING THE 2 CRUISES COSTEAU 4 AND 6 CONDUCTED IN THE GULF OF LION, NW MEDITERRANEAN SEA.

Boris Espinasse [1]*, Jean-Luc Devenon [1], Meng Zhou [2] and François Carlotti [1]
[1] Mediterranean Institute of Oceanography - boris.espinasse@univ-amu.fr
[2] University of Massachussetts

Abstract
The whole French continental shelf of the Gulf of Lion was sampled at two seasons (April 2010 and January 2011) to detail hydrological fields at the same time of other biological and biogeochemical parameters. Main physical structures were well identified such as the zone of Rhône plume influence, the position of the Northern Current and the areas where cooling processes took place. Impact of river discharges and strong winds on surface layer waters were also investigated.

Keywords: Hydrography, Circulation, River input, Gulf of Lyon

COSTEAU cruises #4 and 6 of the ANR-COSTAS Project have permitted to achieve a dataset of hydrological parameters at the scale of the Gulf of Lions (Western Mediterranean Sea) at the same time of other biological or biogeochemical ones (B. Espinasse, oral com, this issue). These cruises, each of a couple of week duration, took place two times to describe different seasonal contrasted situations, namely between April 25 to May 2nd; January 23 to 27, 2011. During the January cruise, strong northern winds blew regularly during this cruise and play an important role in mixing and cooling the water column.
The Rhône discharge up to 3410 m^3 s^{-1} two weeks before the cruise, largely over the annual average (1721 m^3 s^{-1}) but still under the usual flash flood value (5000 m^3 s^{-1}). In April, winds intensities were weakest and the directions changed frequently. Rhône discharge was slightly under annual average, down to 1343 m^3 s^{-1} during the two weeks preceding the cruise.
Few examples of results obtained by CTD casts during the COSTEAU 4 cruise are showed hereafter for the salinity field for surface values (Fig. 2), the whole domain being covered in less than one week, and for a vertical cross section acquired along an offshore transect linking CTD casts during a day (Fig. 1). On another hand, the weak values of currents (inertial oscillations) measured with a hull-mounted ADCP have permitted to look these spatial distributions as quasi-stationary ones and well representatives to a great extent of their mean value during the time scale under consideration. The Rhone Region of Freshwater Influence (ROFI)[1] , characterized by S < 37, can be seen to spread over a wide surface of the inner part of the Gulf, especially far away from the near mouth river plume zone (S < 33). Typical marine salinity values (S > 38) are more likely encountered in water masses advected by the North Current above the slope at the Eastern entrance of the gulf, and sometimes also deeper on the shelf. Though the formation of coastal dense waters was observed in the center part of the gulf during the COSTEAU 6 cruise (January 2011), no cascading phenomena were recorded along the continental slope, most probably because these waters were not sufficiently dense. All the results of the 2 COSTEAU cruises #4 and 6 are going to be compared with predictions of the hydrodynamical circulation model MARS3D (IFREMER)[2] to get a better and refined insight of spatial and temporal scales of variability.

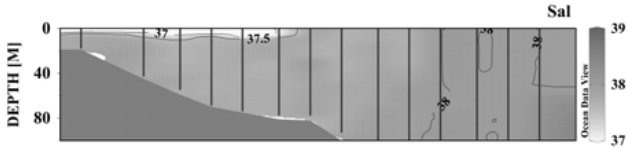

Fig. 1. Vertical distribution of the sea salinity along the transect D during COSTEAU 6 (January 23 to 27, 2011). Black vertical straights represent the CTD casts.

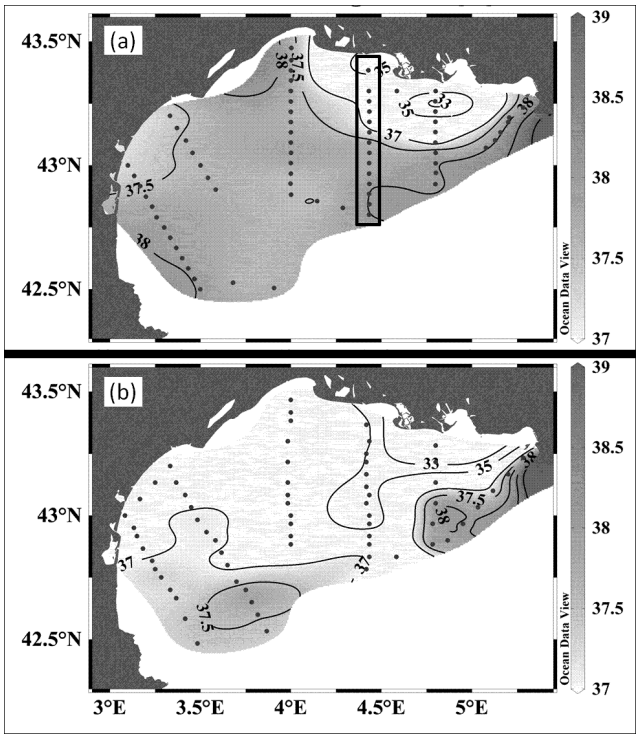

Fig. 2. Spatial distribution of the sea surface temperature during (a) COSTEAU 6 (January 23 to 27, 2011) and (b) COSTEAU 4 (April 27 to May 2nd, 2011). Stations are represented by the black dots and the transect D, detailed in Fig.2, is surrounded in black.

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SALINITY AND TEMPERATURE TOLERANCE OF ALIEN COPEPODS *ACARTIA TONSA* AND *OITHONA DAVISAE* IN THE BLACK SEA

Elena Hubareva [1]* And Leonid Svetlichny [2]
[1] Institute Of Biology Of The Southern Seas - ehubareva@mail.ru
[2] Institute Of Biology Of The Southern Seas

Abstract
Effects of salinity and temperature on mortality, egg production and hatching success of *Acartia tonsa* and *Oithona davisae* were studied in the laboratory. The salinity tolerance ranges of these species living in the Black Sea at 18 psu amounted to 2 - 30 psu and 3 - 40 psu for *A. tonsa* and *O. davisae*, respectively. However, after long-term acclimation to 30 and 40 psu the salinity tolerance ranges can be extended up to 40 psu and 50 psu in *A. tonsa* and *O. davisae*, respectively. In the Black Sea *A. tonsa* survive cold period (6 - 8°C) in the stage of resting eggs whilst *O. davisae* overwinter as pre-fertilized females and begin to produce eggs after spring increase in temperature.

Keywords: Copepoda, Alien species, Salinity, Temperature, Black Sea

Introduction
Copepods *Acartia tonsa* and *Oithona davisae* (identified firstly as *O. brevicornis*) were transported to the Black Sea with ship ballast water and established there self-sustaining populations [1, 2, 3]. To colonize new habitat, both species originated from temperate eutrophic coastal areas of the Pacific and Atlantic Oceans had to acclimate to low temperature and salinity of the Black Sea. In order to evaluate the environmental adaptability of *A. tonsa* and *O. davisae*, we conducted laboratory studies of the effects of salinity and temperature on mortality, egg production and hatching success of these species in the Black Sea.

Material and methods
Females of *A. tonsa* and *O. davisae* collected in Sevastopol Bay at 18 psu during autumn-winter period were subjected at 20ºC to a gradual salinity decrease or increase at a rate of 2-3 psu per h during 6 -10 h. In *A. tonsa* and *O. davisae* during 5 d acclimated to 30 and 40 psu, respectively, salinity was gradually increased up to 70 psu. The salinity tolerance ranges in studied species were estimated taking into account the lethal salinity values affecting 50 % of the original numbers in 5 d. Cumulative effect of temperature and salinity on hatching success of subitaneous eggs in *A. tonsa* from autumn population was studied, and the effect of temperature on egg production in O. davisae during winter was investigated.

Results
The salinity tolerance ranges of *A. tonsa* and *O. davisae* living in the Black Sea at 18 psu amounted to 2 – 30 psu and 3 – 40 psu, respectively, after 5 d following gradual salinity changes during 6 - 10 h (Fig. 1 A).

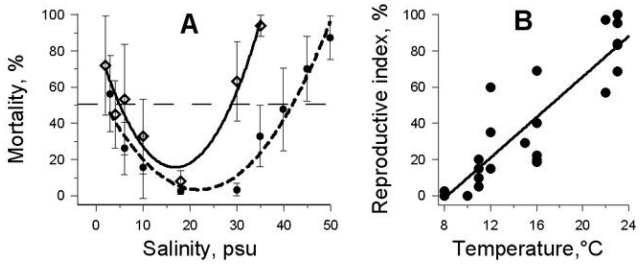

Fig. 1. Salinity tolerance ranges (A) of *Acartia tonsa* (solid line) and *Oithona davisae* (short-dashed line) collected from the Black Sea (18 psu). Salinity tolerance range in females of both species was between the two points denoting 50 % mortality (horizontal long-dashed line) after 5 d of exposure to a given salinity. Relationship between the reproductive index of *Oithona davisae* and experimental temperature (B). Values are means ± SD.

However, after 5 d of acclimation to 30 psu (for *A. tonsa*) and 40 psu(for *O. davisae*) salinity tolerance ranges can be extended up to 40 psu in *A. tonsa* and to 50 psu in *O. davisae*.

A decrease in temperature affected hatching success of *A. tonsa* in the same way as an increase in salinity did. At 18 psu hatching success of subitaneous eggs in *A. tonsa* constituting 78 % at 18 psu and 20°C reduced 2-fold at the same salinity and 8°C and decreased sharply to about 10 % at 40 psu and 8°C. Due to lack of low-temperature tolerance, *A. tonsa* in the Black Sea survive winter in the stage of resting eggs. Life cycle pattern of *O. davisae* in the Black Sea is similar to that in Fukuyarna Harbor (the Inland Sea of Japan) [4]. According to our data, during January to March 2013 the share of females changed from 75 to 100 % of *O. davisae* population. Females transferred from the Black Sea (8°C) to the laboratory after 2-3 d began to lay viable eggs. Reproductive index expressed as the share of egg-carrying females in *O. davisae* population increased in proportion to temperature reaching 100 % at 24°C (Fig. 1 B). This indicates that the maintenance of *O. davisae* population in the Black Sea during cold period depends on the ability of the pre-fertilized females to keep the sperm in a spermatheca until spring increase in temperature.

Acknowledgements: This work was supported by the project PERSEUS (FP7-287600).

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SPATIAL VARIABILITY OF PHYTOPLANKTON IN THE GULF OF LION IN SPRING AND AUTUMN

B. Quéguiner [1]*, K. Leblanc [1], B. Espinasse [1], F. Carlotti [1], M. Golbol [1], V. Cornetr-Barthaux [1], S. Hélias Nunige [1], D. Malengros [1], O. Grosso [1], M. Zhou [2] and Y. Zhu [2]

[1] Aix-Marseille University, Mediterranean Institute of Oceanography (M I O), 13288, Marseille, Cedex 9, France ; Université du Sud Toulon-Var, 83957, La Garde Cedex, France ; CNRS-INSU/IRD UM 110 - bernard.queguiner@Univ-amu.fr

[2] Aix-Marseille University, Mediterranean Institute of Oceanography (M I O) / University of Massachusetts Boston, Boston, MA 02125

Abstract

Two seasonal cruises have been conducted in the Gulf of Lion between 2009 and 2011 to document the spatial distribution of plankton communities in spring and autumn. Results obtained for the phytoplankton compartment evidence the major impact of the Rhône River on the horizontal and vertical distributions of phytoplankton biomass. During spring (April-May) 2010, a phytoplankton bloom was observed starting in the plume of the river and then transported westward by the shelf currents. The coastal bloom was dominated by small diatoms: *Chaetoceros* spp. (subg. Hyalochaete) and *Nitzschia longissima*/*Cylindrotheca closterium* cluster. In the course of its westward displacement the bloom progressively sunk and maximum biomass was found close to the bottom in the western part of the study area.

Keywords: Phytoplankton, Diatoms, Blooms, North-Western Mediterranean

Introduction We present data for nutrients, chlorophyll biomass and phytoplankton size spectra and communities acquired in the framework of the COSTAS program in autumn 2009 and spring 2010.

Methods Nutrients were analyzed by classical chemical analyses on autoanalyzer for nitrate, nitrite, phosphate and silicic acid. Chlorophyll was measured by a fluorometric method. Phytoplankton species identification and counting were made by microscopical examinations. A Laser In Situ Scatterometer Transmissiometer (LISST) was also deployed during the autumn 2009 cruise.

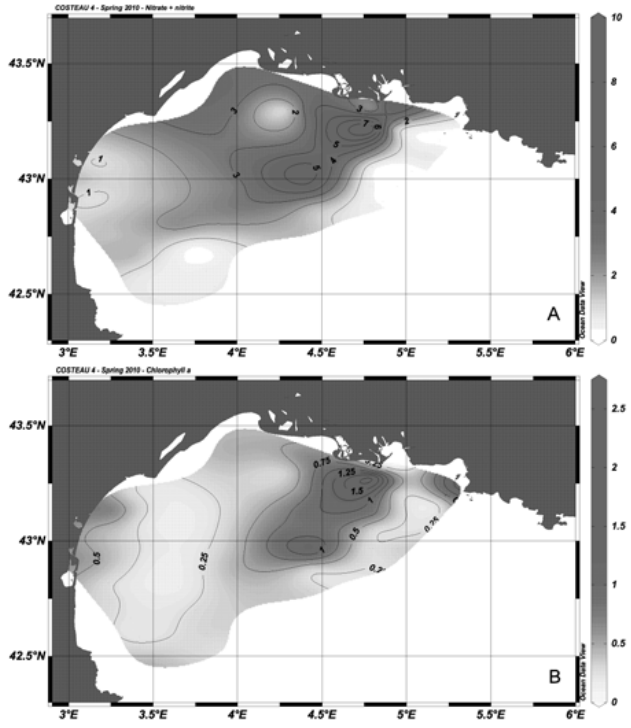

Fig. 1. Surface concentrations of A) nitrate + nitrite (µM) and B) chlorophyll a (µg/L) during the spring (March-April 2010) cruise COSTEAU 4 in the Gulf of Lion.

Preliminary results The distribution of nutrients and phytoplankton is strongly influenced by 1) river inputs (especially Rhone River) and 2) exchange with the North Mediterranean Current (Fig. 1 and 2).

Small delicate diatoms belonging to the genera *Chaetoceros* (subg Hyalochaete), *Nitzschia*, and *Pseudo-nitzschia*, dominated the microphytoplankton of the gulf of Lion. These species developed in spring in the vicinity of the Rhône River plume and were also abundant in autumn together with larger species of the genera *Rhizosolenia* and *Leptocylindrus*. The microphytoplankton community was quite similar to the one observed in 1999-2000 at an eastern offshore station by Leblanc et al. (2003). The eastward displacement of coastal waters was accompanied by the sinking of the spring bloom.

Occasional vertical deployments of a LISST in autumn also allowed observations of small-scale vertical structures inside and below a Deep Chlorophyll maximum (Fig.3).

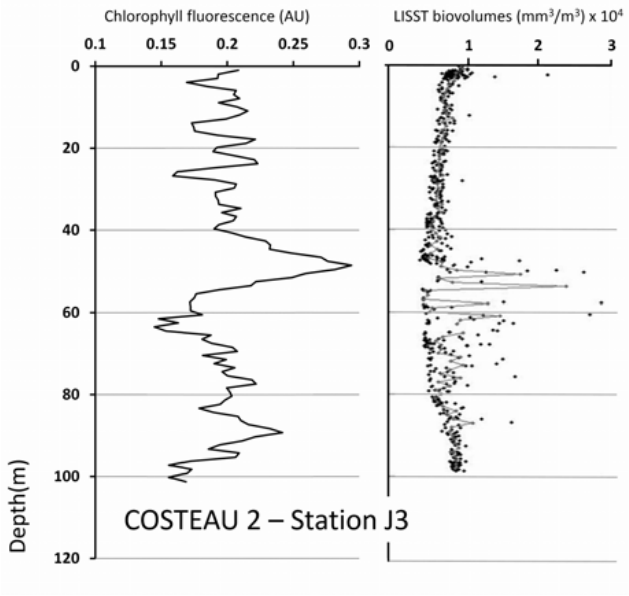

Fig. 2. Comparison of 1 m–averaged fluorescence profile (AU: arbitrary units) and particle biovolumes (1 m–averaged line and individual counts) inferred from LISST measurements at station J3, 43°N/4°36'E (October 2009) during the autumn cruise COSTEAU 2 in the Gulf of Lion.

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INTERANNUAL AND SEASONAL VARIATIONS OF COASTAL MESOZOOPLANKTON ABUNDACE AND BIOMASS IN ISKENDERUN BAY

Tuba Terbiyik Kurt [1]* and Sevim Polat [2]
[1] Cukurova University, Faculty of Fisheries, Department of Marine Sciences, 01330, Sariçam, Adana, Turkey - tterbiyik@cu.edu.tr
[2] Cukurova University, Faculty of Fisheries, Department of Marine Sciences, 01330, Sariçam, Adana, Turkey

Abstract
Mesozooplankton was studied during the period between 2008 and 2012 in coastal waters of the Iskenderun Bay in order to characterize temporal distribution of mesozooplankton and their relationship with some environmental factors. Interannual and seasonal fluctuations in abundance and biomass of mesozooplankton were observed in coastal waters of Iskenderun bay. Mesozooplankton peaks were found mainly in spring, summer and autumn, but these peak times were changed among the years. Mesozooplankton was well correlated with all measured environmental variables at 0.01 significant levels. As a result, trophic elements and abiotic factors of study area seems to be effected mesozooplankton standing stock

Keywords: Coastal waters, Zooplankton , Biomass, Iskenderun Bay

Introduction
The coast of marine environment areas are sensitive and variable because of being affected from both variations in terrestrial input and open sea waters. Living organisms, such as zooplankton, are mostly affected these variability. There are several zooplankton studies concerning the distribution of zooplankton groups, abundance and biomass in southern coastal area of the Turkey [1, 2]. However, there aren't any information about interannual variation of mesozooplankton. The aim of this study is to increase our knowledge about seasonal and interannual distribution of zooplankton biomass and abundance as well as impact of some environmental parameters on zooplankton distribution.

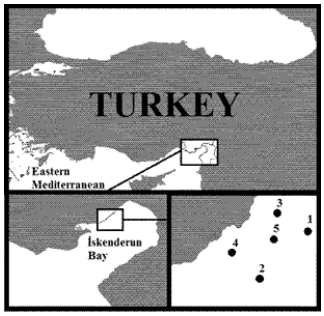

Fig. 1. Study area

Material and Methods
Iskenderun Bay is located in the Eastern Mediterranean. The Bay is approximately 65 km long and 35 km wide, giving surface water body area of a 2275 km (Figure 1). It is a shallow coastal area averaging 100 m maximum depth. Samplings were performed at five stations in the western coastal waters of Iskenderun Bay between 2008 and 2012. Zooplankton was sampled vertically during April, July, October and December of each year. Two samples was towed using WP-2 net (200 μm) at each station for abundance and biomass measurements. Biomass was measured as dry weight and determinated according to [3]. Temperature and salinity were measured using YSI 650 CTD probe at the surface and depths of 5m., 10 m. and 15 m. Chlorophyll-a and phytoplankton abundance were obtained from water samples taken simultaneously at the same depths using a Niskin water sampler. The spearman rank correlation was applied to estimate relationship between environmental factors and mesozooplankton amount by using SPSS V17 software.**Results and Discussion**
Interannual and seasonal fluctuations in mesozooplankton abundance and biomass were observed in the study area (Figure 2). Mesozooplankton abundance varied from 582 ind m^{-3} (spring, 2012) to 10892 ind m^{-3} (spring, 2011), while biomass varied between 2.7 mg m^{-3} (spring, 2012) and 31.38 mg m^{-3} (autumn, 2008). Mesozooplankton peaks were observed mainly in spring, summer and autumn, but these peak times were changed in the years. Spring and autumn mesozooplankton peaks were observed in first two years, whereas spring and summer peaks were observed following two years. In last year, summer and autumn peaks were found. The present study provided results on seasonal variation of zooplankton abundance, biomass and size structure within five-year period in Iskenderun Bay, about which we had limited information. Although five-year study is inadequate to explain interannual variations of zooplankton, it can help to determine the effect of environmental factors varied among years on zooplankton. Mesozooplankton was well correlated with all measured environmental variables at 0.01 significant level. Positive correlation was observed phytoplankton abundance with both biomass and abundance of mesozooplankton. Mesozooplankton abundance was positively correlated with temperature and negatively correlated with salinity, while positive correlation was found between mesozooplankton biomass and chloropyll-a. As a conclusion, it seems that the trophic elements and abiotic conditions was the main factor affecting the mesozooplankton standing stock. Additionally, predation and competitation by planktivorous fishes could be effected structuring the zooplankton community [4]. However, since the effect of fish predation was not studied in this study, it would be inconvenient to comment on the subject.

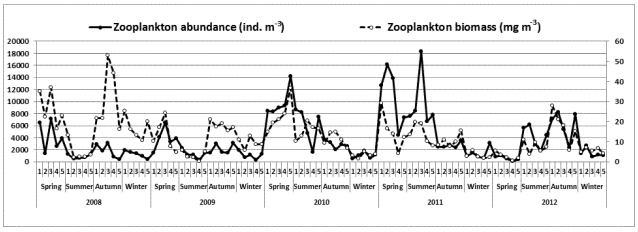

Fig. 2. Interannual and seasonal variations of mesozooplankton in coastal waters of Iskenderun bay

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ZOOPLANKTON COMMUNITY STRUCTURE IN THE GULF OF BANDIRMA (MARMARA SEA): 2006-2008

Benin Toklu Aliçli [1]*, Neslihan Balkis [1] and Muharrem Balci [2]
[1] Istanbul University, Faculty of Science Department of Biology - benin@istanbul.edu.tr
[2] Istanbul University, Institute of Science

Abstract
Zooplankton composition and some environmental variables were investigated seasonally between November 2006- August 2008 in Gulf of Bandirma, Marmara Sea. During the study, 9 Copepoda, 3 Cladocera, 1 species from phylum Cnidaria , 1 species from phylum Ctenophora; 2 holoplankton groups and 8 meroplankton groups were recorded . *Acartia clausi*, which is pollution indicator was dominat species in May 2008.

Keywords: Zooplankton , Marmara Sea

The Marmara Sea has to distinctive water masses that flow in different directions between Mediterranean Sea and Black Sea through Bosphorus and Dardanelles [1, 2, 3]. The Gulf of Bandirma is located in the southern Marmara Sea, Turkey. The Gulf of Bandirma is effected by industrial pollution and anthropogenic activity with high population density. Material was collected seasonally at 3 stations November 2006-August 2008 in Gulf of Bandirma using WP2 plankton net. All zooplankton samples were preserved in 4% buffered formaldehyde. In
additionally some abiotic and biotic parameters was measured at study area.

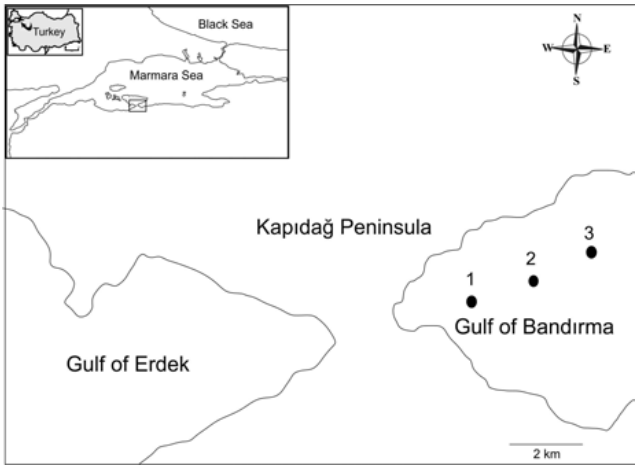

Fig. 1.
Sampling stations in the Gulf of Bandirma

Temperature was chanced between 6.5 °C and 26 °C, salinity 21.4 ppt and 38.5 ppt and also dissolved oxygen value 3.5mg L^{-1}-15.62 mg L^{-1} in the Gulf of Bandirma. Chlorophyll-a ranged between 0.21 µg L^{-1} and 14.79 µg L^{-1} [4]. During the study, 9 Copepoda, 3 Cladocera, 1 species from phylum Cnidaria (*Liriope tetraphylla*), 1 species from phylum Ctenophora (*Pleurobrachia pileus)*; 2 holoplankton groups (Apendicularia, Chaetognatha) and 8 meroplankton groups (Decapoda larvae, Bivalvia larvae, Gastropoda larvae, Polychaeta larvae Echinodermata larvae, Cirripedia larva, Fish eggs and larvae) recorded in Gulf of Bandirma. *Acartia clausi* and *Paracalanus parvus* were the dominant species in the Gulf. *Acartia clausi*, which is pollution indicator was dominat species (1660 ind/m^3) in May 2008. Zooplankton can reflect changes in biotic and abiotic factors of the environment. Indeed, the important environmental problem to be as mucilage formation was observed in 2008 [5]. As a result of excess nutrient loading into coastal areas can cause marine eutrophication and mucilage formation. Cladoceran, *Penilia avirostris* was dominant in August 2008. Indeed, the recent study support the result of the present study [6].

Tab. 1.
Correlation results measured among abiotic and biotic paremeters
(Temp: Temperature; DO: Dissolved oxygen; Chl-a: Chlorophyll-a; TZ: Total zooplankton; ** p<0.01, * p<0.05)

	Temp	Salinity	DO	Chl-a	N	P	Si	TZ
Temp								
Salinity	-,382**							
DO	-,194	-,265						
Chl-a	-,179	-,293*	-,025					
N	-,099	,625**	-,362*	-,368*				
P	,112	-,274	,143	,576**	-,043			
Si	-,278	,614**	-,007	-,536**	,693**	-,201		
TZ	,466**	,377**	-,441**	-,485**	,599**	-,046	,364*	

In the the Gulf of Bandirma, salinity has higher negative correlation with temperature (p<0.01) and chlorophyll-a (p<0.05). Also, there are strong positive correlation of total zooplankton with temperature and salinity (p<0.01). The main environmental gradient was generated by water temperature and salinity. On the other hand, total zooplankton abundance was negatively correlated with DO and chlorophyll-a (p<0.01) in the Gulf of Bandirma due to the grazing activity of its on primary producers.

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COMITÉ 6

Ecosystèmes côtiers

Président : Enric Sala

Rapports des modérateurs

Advances in ecosystem-based fishery

Nadira Ben Chikh, Algérie

Résumé

La session s?est très bien déroulée. Le débat, au-delà de quelques questions pointues concernant les méthodes utilisées par certains des auteurs, a porté sur une question plus globale: le fait que la plupart des informations concernant la pêche et l?aménagement des écosystèmes sont fragmentées car les études demeurent spécifiques à une région bien précise de la Méditerranée. Une campagne de recherche englobant des informations sur l'ensemble du Bassin méditerranéen est donc recommandée.

Aquaculture impacts on ecosystems

Tanya Tsagaraki, Hellenic Center for Marine Research, Greece

Résumé

During this session a broad range of subjects was covered regarding aquaculture impacts on ecosystems. Topics covered included cultured species health issues, effects of new technologies on cultured species and water bodies, transfer to higher trophic levels and changes in water column chemical and biological characteristics. The attraction of wild fish to farm cages was also discussed along with the ecological effects on an ecosystem level. Although the presentations were not many in number, many interesting topics were brought up and presented during the session.

The discussion that followed the presentations revolved around technical issues regarding sampling approaches and results and, more importantly on the future prospects and issues faced in the field of aquaculture-environment interactions. It was apparent that the development and expansion of aquaculture raises new questions and prospects for future work which the scientific community needs to anticipate and address. The topics covered were diverse and covered issues that have to be considered towards implementing an ecosystem approach to aquaculture.

Biogeographic patterns

Sakina-Dorothée Ayata, LOV, France

Résumé

The session started with a general presentation of the biogeographic patterns of the Mediterranean Sea that could be divided into eight ecoregions following Spalding (2007). The contrasted environmental conditions of the Mediterranean Sea could also allow its division into a dozen of biogeochemical regions, and so we asked how related to these biogeochemical regions were the biogeographic patterns. We then introduced the different presentations by underlining the various methodologies that will be used, the different organisms that will be studied, and the different spatial scales that will be considered.

Following the 3-min communications, a mini-debate started with questions addressed to the different speakers. The important role of the resting stages of planktonic organisms was underlined in the high inter-annual variability of planktonic communities. The mesh size of the plankton nets used during sampling was mentioned. Questions also dealt with the connectivity patterns between the western and eastern basins, the role of the Sicilian strait as an area where ecological niches were overlapping, and as a genetic break identified a little further East than the strait. The last interventions mentioned the few number of specialists of taxonomic identification of copepods in the Med Sea and the different biases that may arise from sampling planktonic organisms.

Biogeographic trends

Sakina-Dorothée Ayata, LOV, France

Résumé

The session started with a brief introduction on the biogeography Mediterranean Sea and the spatial and temporal trends of this biogeography, such as the replacement of certain species by others (extinction, invasion). Three communications followed, presented in a clear and didactic manner. Thereafter the questions mostly addressed specific points, such as the correspondance between the observed abundances' patterns and the hydrodynamical patterns, or the high inter-annual variability of the stocks.

Coastal fisheries

Celia Vassilopoulou, HCMR, Agios Kosmas, Helliniko, Greece

Résumé

Most presentations addressed different issues linked with small scale fisheries, while there were also a number of works on trawl fisheries operating in relatively shallow waters. More specifically, four presentations dealt with trawl fisheries, discussing the effects on habitats and species (Muntadas), trawl discards (Yemisken), as well as the composition of catches in the Black Sea (Yildiz), and in the Levantine Basin, although the latter presentation did not refer to coastal grounds. Five presentations focused on issues related to small scale fisheries; using pingers to reduce by-catch of cetaceans (Ayadi), assessing landings over different habitat types (Seary), studying beach seine catches (Uzer), and addressing the need to collaborate with fishers for more effective management (Meli, Vassilopoulou). One further presentation discussed the capacity of purse seines, while another concerned targeted efforts for restocking caramote prawns.

In general, a high diversity of topics was covered, and an interesting discussion took place following the presentations which highlighted the need to consider the key factors/drivers of each fishery in the specific areas to achieve sustainable management of the resources.

Conservation successes, failures

Sylvaine Giakoumi, Greece

Résumé

During this session a number of conservation issues were presented, mainly exploring the impacts of anthropogenic activities on biodiversity. The examples varied from multiple to single species and threats, assessed stressors? impacts, potentials for recovery and suggested plans for conservation. Further, an intersting example of collaboration between Mediterranean countries exchanging expertise and technology through projects was presented.

Successes and failures of Mediterranean Marine Protected Areas (MPAs) was the main discussion topic during the general debate. Examples of successful MPAs were given, highlighting the successful engagement of stakeholders or ?shareholders?. On the other hand, the lack of enforcement was pointed out as the major failure of current MPAs. In order to achieve the 10% protection target expected by CBD - the Convention on Biological Diversity- there is an urgent need to strengthen enforcement in current MPAs, while expanding present / or creating new MPAs thru systematic approaches that explicitly account for socio-economic factors.

The cost of conservation management was also discussed. The success story of Medes MPA indicates that in the long run, an MPA can be a source of profit and significantly outbalance initial costs. Private sector investments could also play an important role in the creation of new MPAs, but in those cases the engagement of local shareholders should always be secured. Cultural differences throughout the heterogeneous Mediterranean basin prevent the adoption of a single model for the development and management of MPAs. Nevertheless, the fact that conservation can be profitable and that an MPA may be a self-sustainable venture is a message that should be dispatched to shareholders and decision-makers, particularly important in an era of economic recession.

Economic dimension of coastal systems

N/A

Résumé

Modérateur absent

Pollution and environmental impacts

Vesna Milun, Croatia

Résumé

The presentations included the impact of a power plant on macro-zooplancton abundance as the result of sea temperature elevation (M. Bellakhal). Offshore gas platforms and their biological impacts were further presented (A. Gomeiro) in detail. Another communication focused on the possible influence on seawater quality of recent ship wreck (G. Romanelli). Toxic jellyfish blooms pointed out a problem of great concern in relation to human activities and alien species (B. Galil).

The discussion from the audience was mainly directed to the first theme mentioned.

Pollution hotspots, large cities

Bruno Andral, France

Résumé

Mediterranean cities represent complex systems and hot spots that require special attention. About 120 large cities are located along the Mediterranean coast, about 50% with over 100,000 inhabitants have no wastewater treatment plant. 14 major cities exceeding one million inhabitants including

Due to the fast growing populations of these coastal cities particularly in the southern and eastern areas, large quantities of biological (i.e. viruses, bacteria) and chemical contaminants are released into the sea, through domestic and industrial waste discharges (from, e.g., incinerators, landfills, waste water treatment plants, sewers), the existence of one or more rivers crossing the city, harbour activities, urban runoff (episodic events), coastal structures (e.g., groins and beaches), and desalinisation plants and the release associated to the rainstorms that wash the soil rapidly.

When they host a major harbour, they also provide a main vector for ?biological contamination? like alien species in the waters ballast. Some important sources, as submarine groundwater discharges, atmospheric input are still poorly understood. Other activities related to cities include: fisheries, structures in the open sea (which entail changes in water circulation), off-shore natural resources (e.g., oil, gas, sand, and gravel) extraction, spill accidents (oil and Hazardous and Noxious Substances, HNS), ship-based pollution, etc.

The growth of urban settlements is difficult to stop. Often, Mediterranean cities are trapped between mountains and the sea. Consequently, they tend to expand along the coastline and towards the sea, reclaiming wetlands and the often narrow, shallow marine areas. This inevitably affects the distribution of sediments and coastal ecosystems.

Many of the marine problems related to big cities stem from a lack of adequate knowledge regarding natural fluxes of, and human intervention on waters and sediments, major inputs of material and energy as well as marine ecosystem functioning. A number of recent initiatives, e.g., ICZM protocol, MSFD, and H2020, may help in formulating efficient policies to address these problems. The present document attempts to contribute to the fulfilment of these efforts.

Most of the responses until now are based on regulations and ad-hoc management which are poorly linked to long-term planning and monitoring of the effectiveness of the measures proposed and/or applied. Part of the failure is due to the minimum involvement of various actors, lack of coordination, and low awareness of the general public.

The 13 session presentations were very diverse in their topics (contaminants inputs in the field and modeling their fate in the marine environment and the trophic network, chemical contamination of sediments and biota, modeling discharges of bacteria, effects of water discharges from different processes, methods of détection and analysis) but each emphasized the need to consider the large cities as unique systems which encompass the marine and land domains, together with the human activities carried out therein. Yet, the impact of coastal metropolises on the environment is still not fully assessed and understood, and it is important to increase the knowledge to work in close partnership with relevant, concerned actors of civil society and other key stakeholders to therefore contribute to a new governance model.

Remote sensing

Patrick Bonhomme, AMU, France

Résumé

Remote sensing is the science of gathering information at a distance. The technology provides a descriptive, analytical way to identify geographic features. This includes (i) aerial photographs, (ii) satellite imagery, (iii) acoustic data and (iv) radar imagery. Remote sensing technologies are used to get data sets for a large area in a short amount of time. They are usually the most cost-effective means of getting information for areas that are inaccessible, far away, difficult to traverse but also for areas too large to effectively manage or assess with traditional surveying methods. The use of remotely sensed data is increasing nowadays due to (i) the emergence of commercial remote sensing satellites, (ii) the recent advancements in geographic information systems (GIS) and (iii) the image processing capabilities.

In this session a large variety of applications were presented like the development of a web interface to get real-time sea surface currents in the Malta Channel, the use of side-scan sonar to map habitat or cultural marine heritage, the analysis of the range of the fluctuations of chlorophyll-a concentrations induced by the passage of cyclones, a Posidonia oceanica distribution model based on ecological models, and the assessment of anchoring pressure on Posidonia meadows based upon the development of an automatic high frequency digital photography device. In the end, only three questions were asked to the speakers. The session ended 10 minutes early.

Session

Advances in ecosystem-based fishery

Modérateur : **Nadira Benchikh**

A STANDARDIZED MODEL TO INVESTIGATE THE EFFECTS OF FISHERIES IN THE MEDITERRANEAN SEA: THE CASE OF THE GULF OF LION

Daniela Banaru [1], Tosca Ballerini [1]* and Capucine Mellon-Duval [2]
[1] MIO (Mediteranean Institute of Oceanography), Aix-Marseille University, Campus de Luminy, case 901, 13288 Marseille, France - tosca.ballerini@univ-amu.fr
[2] IFREMER, UMR 212 EME (Ecosystèmes Marins Exploités), Av. Jean Monnet, 34203 Sète, France

Abstract
This paper presents the structure and the particularities of a standardized Mediterranean food web model applied to the Gulf of Lion shelf to investigate the effects of fisheries. This work in developped in the framework of EU-FP7 research program PERSEUS.

Keywords: Gulf of Lyon, Coastal systems, Food webs, Models, Fisheries

Introduction
The Gulf of Lion (GOL) (42°26.3′N, 3°9.9′E; 43°12.6′N, 5°27.5′E) is one of the most productive areas in the NW Mediterranean Sea. Historically, this region has been important for fisheries, with about 90% of the Mediterranean French landings coming from here.
An initial ECOPATH model [1] for the entire GOL region (between 0 and 2500 m, corresponding to 20 400 km^2) was developed in order to describe the food web structure and the fishing impacts on this marine ecosystem [2].
Here, the initial model for the whole GOL region was reduced to comprise the continental shelf only (between 20 and 200 m, 11 000 km^2) where the majority of fishing occurs (between 85% and 100% of total landings according to the fishing gears) and the trophic groups were modified to be consistent with the structure of a standard model for exploited coastal ecosystems in the Mediterranean Sea.

Materials and methods
The ECOPATH "GOL-shelf" model was parameterized for the period 2000-2009. Biomass data come from IFREMER scientific surveys MEDITS and PELMED onboard of the R/V Europe while landings data were taken from the Fisheries Information System, IFREMER. The model comprises 36 trophic groups (2 primary producers, 1 detritus, 1 discards, 11 invertebrate groups, 12 fish, 1 seabird, 1 marine mammal and 7 fishing gears) and it is implemented in both wet-weight and phosphorous.

Results and discussions
Ecosystem groups, fishing gears and main interactions in the "GOL-shelf" model are shown in Figure 1. Trophic levels ranged between 1 for primary producers and 4.8 for marine mammals.
The trophic level of fisheries ranged between 2.6 (various gears on small boats) and 4.1 (purse seine on 24-40 m boats). Sensitivity analyses showed a large negative impact of large trawls (24-40 m) on all food web groups, while the small purse-seine (12-24 m) had the lowest impact.
The main differences between the initial GOL model [1] and the standardized "GOL-shelf" model occurred in terms of biomass and flows.
The "GOL-shelf" model will be used for intercomparisons with similarly structured ECOPATH models for other marine ecosystems in the Mediterranean Sea [3, 4] in the framework of the EU-FP7 research program PERSEUS. Better understanding of the structure and functioning of exploited marine coastal ecosystems is essential for an ecosystem-based approach of fisheries management.

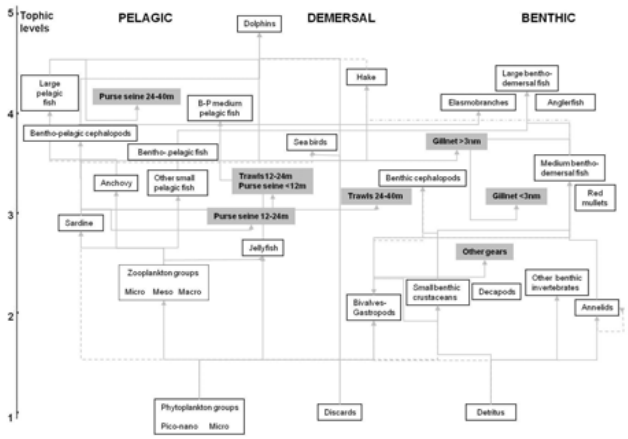

Fig. 1. Structure of the standardized Mediterranean food web model applied to the Gulf of Lions continental shelf.

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EVALUATION DE LA PRODUCTION HALIEUTIQUE DANS LE SECTEUR DE LA PÊCHE D'ANNABA, EST ALGÉRIEN.

A. Diaf [1]*, N. Benchikh [1], F. Z. Bouhali [1], S. Ladaimia [1] and A. B. Djebar [1]
[1] Laboratoire d'écologie des milieux marins et littoraux, Université Badji Mokhtar Annaba, Algérie - rym_dz23@yahoo.fr

Abstract
La production halieutique de la décennie (2001-2011) dans le secteur d'Annaba est estimée en relevant une période d'accroissement continu de 2001 à 2004 suivie d'une baisse remarquable en 2005 pour aboutir à une amplification du rendement de la pêche entre 2006 et 2011 coïncident avec le développement du secteur. La pêche présente une dominance des petits pélagiques dans les débarquements des 2 ports de pêche d'Annaba et de Chétaibi. La flottille de pêche relevant d'Annaba affiche une progression quantitative et de qualitative, en passant de 257 à 504 navires. La pêche dans le secteur d'Annaba est une activité ancestrale, sa durabilité dépend de la préservation et de la bonne gestion de l'écosystème, de la ressource et de l'organisation de l'activité de pêche.

Keywords: Fisheries, Algerian Sea, Fishes, South-Central Mediterranean

Introduction: L'activité de pêche en Algérie présente une façade maritime de plus de 1200 km renferme une surface de 9,5 millions d'hectares. La pêche et l'aquaculture sont devenues des activités économiques importantes en termes de production alimentaire et de création d'emplois.
Matériels and Méthodes: Annaba est situé à 670km à l'Est d'Alger, étendue sur un littoral long de 80 km depuis Sidi Salem à l'Est (36°53'27" Nord, 08°15'30" Est), jusqu'à Chétaibi (37°05'21" Nord, 07°22'34" Est) à l'Ouest. La méthode d'étude appliquée repose sur une démarche d'investigation auprès des services de la direction de la pêche et des ressources halieutiques (DPRH) [1] et auprès pécheurs du port de pêche d'Annaba et les gardes côte. La récolte de données a conduit à une analyse statistique des rendements de pêche de la dernière décennie de 2001 à 2011.
Résultats: L'analyse de la production halieutique montre 3 périodes bien distinguées : la première allant de 2001 à 2004, marqué par un accroissement continu de la production. Elle est passée de 2116 tonnes à 9046,74 tonnes. De 2004 à 2005, la production connaît une chute considérable avec 8322,92 tonnes. La troisième phase coïncidait avec le développement de secteur de pêche allant de 2006 à 2011 est caractérisée par un accroissement de la production marquant 8361,61 tonnes en 2011. Les captures de pêche, concernant les 2 ports d'Annaba et de Chétaibi, présentent une dominance des petits pélagiques dans les débarquements par rapports aux autres espèces. Cependant la capture des grands pélagiques, crustacés et les mollusques durant cette décennies reste constant par rapport aux poissons démersaux qui semble augmentée entre 2006 et 2009 au niveau d'Annaba et entre 2007 et 2009 au niveau de Chétaibi. Les 6 catégories de pêche son comparées durant la dernière décennie entre les 2 ports. Les valeurs moyennes de chacune sont obtenues à l'aide du test t de Student pour des échantillons indépendants, dont la production de la pêche des poissons démersaux, des grands pélagiques, des requins et raies et des mollusques est statistiquement non significatif, alors que la pêche des petits pélagiques et des crustacés est statistiquement très hautement significative. Ceci concorde avec les résultats précédemment démontrés en exposant l'évolution de la production halieutique par catégorie de pêche durant une décennie (2001-2011). Le nombre de navires connaît un saut effectif essentiellement à partir de 2003 ou le nombre a doublé en 2011. Il est passé de 259 à 504 navires, soit une évolution de 95%. Le nombre des petits métiers reste supérieur aux autres types d'embarcation, alors que les sardiniers sont plus les chalutiers. L'équipage à bord des navires de pêche, se distingue en 3 catégories de professionnels de pêche : les patrons de pêche, les mécaniciens et les marins pécheurs. En regroupant les 2 ports de pêche d'Annaba et de Chétaibi, le collectif marin qui comptait 1606 embarqués en 2001, est passé à environ 3881 inscrits en 2011, soit une évolution de 65% entre les deux années. Cependant, la flottille relevant d'Annaba renferme depuis 2007 un effectif majoritaire de professionnel de la pêche provisoirement inscrit qui contribuent à l'amélioration du rendement de la pêche.
Discussion: La réorganisation de la pêche particulièrement à Annaba doit s'intégrer dans le contexte plus vaste de la politique maritime Algérienne en cours de construction. Selon le bilan des activités du secteur de la pêche, une nette progression de la production qui a atteint les 9046,74 tonnes de poisson de toute nature pour l'année 2004 pour la seul willaya d'Annaba, alors qu'elle était de 2116 tonnes en 2001. Cette avancée s'explique, par l'engouement des jeunes aux métiers de la mer, en 2002 de nombreux jeunes, qui passent par l'école de pêche, ont lancé des projets d'investissement. La production de la pêche durant la dernière décennie (2001-2011),concernant les 2 ports d'Annaba et de Chétaibi, présentent une dominance des petits pélagiques dans les débarquements par rapport aux autres espèces. Ceci représente un facteur principal qui peut expliquer les fluctuations annuelles des débarquements totaux. En effet, l'abondance des petits pélagiques est liée à l'abondance de la nourriture, en particulier le plancton (Zaghdoudi,2006) [2]. Cependant, la pêche en dernière année 2011 n'a pas été bonne. Une baisse sensible de la production de la pêche du golfe d'Annaba a été enregistrée avec seulement 8361,61 tonnes contre 8672,15 tonnes en 2010 et 8720,45 tonnes en 2009, ce qui représente une réduction de la production de plus de 10%. Cette situation s'explique, par les aléas climatiques et par la rareté du poisson et souvent qu'ils soutiennent d'être obligés d'aller au large sans pour autant que la pêche soit fluctueuse. Ceci se répercute sur les prix des différentes espèces de poisson et fruits de mer qui augmentent au grand dam des consommateurs. La flottille de pêche de la willaya d'Annaba a été renforcée atteignant 504 unités en 2011 avec 45 chalutiers, 123 sardiniers, 336 petits métiers. Cependant, malgré l'acquisition de nouvelle embarcation, la flottille de pêche est caractérisé par son état vétuste et, particulièrement, par un taux d'immobilisation très élevé à cause de la difficulté de s'approvisionner de la pièce de rechange du fait de sa rareté sur le marché et les difficultés économique en raison de la difficulté d'accéder aux crédits bancaires. Cet état de fait a laissé une partie importante de la flottille immobilisée dans le port, soumise à de grave détérioration à pour conséquence une faible rentabilité économique par rapport au capital investi.
Conclusion : Le domaine de la pêche de la willaya d'Annaba dispose comme moyens de pêche de chalutiers, de sardiniers, et de petits métiers qui en croissant contribuent à l'augmentation de l'effort de pêche. La flottille relevant d'Annaba affiche cette dernière une progression que quantité et de qualité renfermant toutefois un effectif majoritaire de professionnel de la pêche provisoirement inscrit qui contribue à l'amélioration du rendement de la pêche. L'importance de la pêche et son développement, entraîne une répercussion importante, suite à la surexploitation et l'épuisement amplifiés des ressources halieutiques, ce qui conduit à soutenir de la pêche continentale par le développement de l'aquaculture. Cette nécessité est induite par l'impératif du maintien de l'équilibre entre la satisfaction des besoins en poissons et l'exploitation des ressources halieutiques, de manière à ne pas hypothéquer l'avenir du secteur, et d'éviter le massacre et l'extinction des espèces (MPRH) [3].

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A TROPHODYNAMIC APPROACH FOR THE EVALUATION OF FISHERY MANAGEMENT PLANS IN THE GULF OF GABES (SOUTHERN TUNISIA)

G. Halouani [1]*, T. Hattab [1], F. Ben Rais Lasram [1], M. S. Romdhane [1] and F. Le Loc'h [2]
[1] Institut National Agronomique de Tunisie - ghassen.halouani@gmail.com
[2] IRD, UMR 212 Écosystèmes Marins exploités, IRD-IFREMER-Université Montpellier 2

Abstract

An Ecopath with Ecosim food web model of the Gulf of Gabes (southern Tunisia) was constructed in order to describe its trophic structure and functioning. To assess the impacts of fisheries, an Ecosim routine was applied to predict temporal variation of catches. The model was fitted with time series data of landings for the period 1995-2008. Then, several fishery management plans were simulated by implementing different biological rest-periods. To a better evaluation of each management plan, ecological and socio-economic indicators were calculated. These indicators were used to i) establish a ranking between the fishery management plans, ii) study the effects of conservation measures on the ecosystem.

Keywords: Fisheries, Food webs, Models, Gulf of Gabes

Introduction

The Mediterranean Sea is under natural and anthropic threats and is consequently subject to great changes on its biodiversity and functioning [1]. Fishing activity is one of the factors affecting the Mediterranean ecosystems [2] and especially the gulf of Gabes which is the most important fishing area in Tunisia. Thereby, it would be relevant to quantify fishing activities impacts on the structure and functioning of this ecosystem to further asses fishery management plans (FMPs). The Ecopath with Ecosim (EwE) modelling approach has been used to study the trophic structure of the Gulf of Gabes. Thus, a mass-balance model was developed using Ecopath 6.2 to characterize interactions between resources, to identify keystone species and to evaluate the level of exploitation of the fishery [3]. The trophic model represents an average annual situation of the ecosystem (2000-2005), including 41 functional groups [4]. Among these groups, sharks, zooplankton and benthic molluscs were identified as keystone groups. Furthermore, an important bentho-pelagic coupling has been highlighted. This study revealed that the Gulf of Gabes is unlikely to be sustainably fished and was subject to a high level of exploitation such as other Mediterranean ecosystems [4].

Method

Based on initial parameters inherited from the Ecopath of the Gulf of Gabes an Ecosim model was applied to provide temporal dynamic simulations [3]. This model was fitted to available data of landings for the period 1995-2008. To this end, time series of fishing effort by fishing gear type, catches data and biomasses of main functional groups as well as primary production in the study area (1997-2007) were used to calibrate the Ecosim model. The outputs were compared to the time series of landings to assess the goodness of fit. Then, several fishery management plans were implemented by simulating different rest-periods to analyse the ecosystem feedbacks (Fig. 1). This methodology is part of the integrative approach "Back to the Future" [5], which consists of modelling past ecosystem and simulating management plans as policy goals for the future. For this purpose, ecosystemic indicators (Trophic Level of catches, Kempton Q, Fishing In Balance) and socio-economic indicators (landings and total value of catches by fishing activity) were calculated for each measure throughout the period 1995-2008. Thereafter, an overall ranking between the fishery management plans was established based on the results of these indicators (Fig. 1).

Results and discussion

Results showed that conservation measures involving restriction on the activity of benthic trawls (e.i. Sc5, Sc6, Sc7 and Sc8) were more effective than those requiring a complete closure of the fishery (e.i. Sc1, Sc2, Sc3 and Sc4), (Fig. 1). Indeed, the reduction of bottom-trawling fishing effort has positive impacts on the coastal fishing (20% increase in coastal catches), thus leading to the improvement of the social indicator of these fishing management plans. Furthermore, the contribution of each management measure in terms of catch occurs mainly (up to 80%) during the first two years after the end of the fishing management plan. The exponential decrease of this contribution can be explained by the resiliency of the ecosystem. Besides, according to the Ecosim model, the increase in catches due to the application of conservation measures is not proportional to the duration of the management plan. In fact, comparing two similar scenarios Sc1 and Sc2 corresponding to a closure of the fishery respectively 1 and 2 years has shown that the contribution of the second year in terms of gains in catches is about 50% lower than the first year. Which means that, multiplying the duration of the closure 2 times is equivalent to increasing benefits of the conservation measure by a factor of 1.5. In this perspective, Ecosim could be a relevant modeling tool to evaluate and develop management plans aiming the sustainability of fisheries.

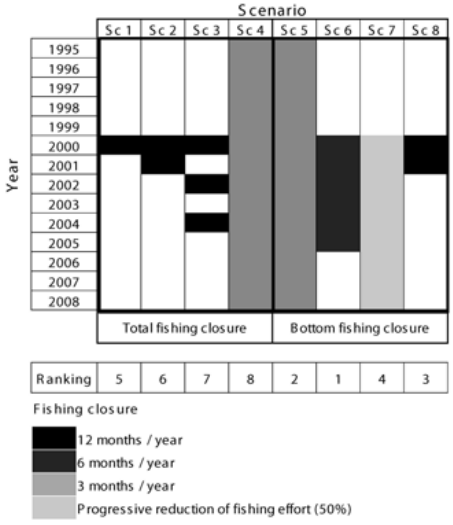

Fig. 1. Fisheries management plans and their ranking

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POSSIBLE LINK BETWEEN THE BASIC SCIENCE AND NATIONAL ECONOMIC STRATEGY: A *FISHY* HYPOTHESIS FROM THE NORTHERN ADRIATIC

Romina Kraus [1]* and Nastjenjka Supic [1]
[1] Rudjer Boskovic Institute - kraus@cim.irb.hr

Abstract
Long-term analysis of oceanographic conditions leading to extreme phytoplankton blooms in the northern Adriatic revealed that specific February conditions in the region might play a key role in the entire Adriatic anchovy stock. Even the preconditioning of the February conditions might be feasible. These findings could be a valuable input in the national economic strategy for a sustainable development *via* monetary stimulation grants that Croatia provides for fishery.

Keywords: North Adriatic Sea, Phytoplankton, Blooms, Fishes, Circulation

Introduction
One of the most productive regions of the generally oligotrophic Mediterranean Sea is the northern Adriatic. The Po River freshets induce high production rates in this region, which are especially pronounced in the western part, close to the delta (Fig. 1). Consequently, a west-to-east descending phytoplankton abundance gradient usually forms. However, the area affected by large blooms sometimes enlarges and, in extreme cases, large phytoplankton blooms occur over large areas with a pronounced southward current near the eastern coast between stations SJ107 and RV001 (the Istrian Coastal Countercurrent; ICCC). To broaden our knowledge about factors which induce and/or spread large blooms in the region, we have related the phytoplankton abundance to basic oceanographical and atmospheric parameters and to the Po River discharge rates. In order to investigate possible effects of large blooms on the bio-production in the Adriatic, we compared our data to the Adriatic anchovy catch, *Engraulis encrasicolus* (L.), one of the most important commercial fish species in the Adriatic [1]. We have also investigated surface fluxes and Po River discharge rates for several months preceding a bloom.

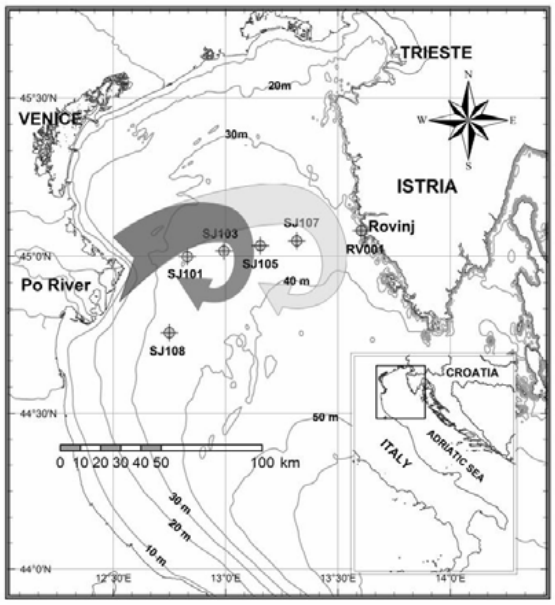

Fig. 1. Northern Adriatic map with sampling stations, along with hypothetic February paths of freshened Po River waters which favour large (dark grey) or extremely large (light grey) anchovy catch in the subsequent year.

Data and methods
We analysed three types of data obtained in the northern Adriatic (Fig. 1) during the period 1990-2004 at 6 stations at the Po River delta-Rovinj section (further on: Po section): monthly/seasonally collected oceanographic data, including components of geostrophic currents relative to 30 dbar surface between stations, monthly averages of surface fluxes and Po River rates, and yearly averages of fish catch data. Correlations were determined with a simple linear regression analysis.

Results with discussion
The highest seasonal phytoplankton blooms are the February ones. The largest February bloom at SJ107, SJ108 and SJ101 occurred in 2004. At the time the ICCC was very pronounced, while cold, low salinity, low density and nutrient rich waters from the vicinity of the Po River delta spread in a thick layer over the northern Adriatic and broadened phytoplankton from the western region over to the eastern one. Large February blooms at these three stations were preceded by an intense Po River influx during the previous June-August, by an intense evaporation in the preceding November and, interestingly, by low Po River rates in November and December. A large phytoplankton abundance at SJ101 and SJ107 in February along with specific distribution of geostrophic currents across the Po section in the same month highly correlated with the anchovy catch of the same year. The obtained correlations were highly dependent on the year 2004, when ICCC, phytoplankton and yearly anchovy catch were of outstanding values. However, a very high bloom at SJ101, which occurred in February 2000, when freshened waters occupied only the western part of the northern Adriatic, preceded another large anchovy catch in 2000. An excess feeding of the anchovy in the pre-spawning period (February) can lead to a higher than usual amount of anchovy eggs, two months later. As the anchovy obtains the commercial length of around 9 cm in about four and a half months, the April generation might significantly contribute to the total amount of the fish catch in the same year (anchovy season lasts throughout the year, with an exceptionally high maximum in September). Based on the obtained results we hypothesize that a February circulation type is basic for the increment of anchovy stock in the same year (Fig. 1). We would like to validate our hypothesis in an international, multidisciplinary study of a larger scope with field data and modelling expertise, as we believe that our insights should be vital in moderating grants for stimulation of anchovy fishing and ultimately could preserve anchovy stock from overfishing in the Adriatic.

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A COMBINED METHODOLOGY FOR ASSESSMENT OF THE COMMON DENTEX (*DENTEX DENTEX*) IN THE NORTHERN CORSICA (FRANCE)

M. Marengo [1]*, S. Agostini [1], N. Tomasi [1], V. Valliccioni [1], B. Marchand [1] and E. D. Durieux [1]
[1] University of Corsica Pasquale Paoli UMR 6134 SPE/UMS 3514 Stella Mare –CNRS/UCPP - marengo@univ-corse.fr

Abstract
The common dentex represents a great economic interest for the artisanal fishing in Corsica (France). A combined sampling approach was developed using logbooks and boardings on 11 fishing vessels in the region Bastia-Cap Corse. The purpose of this paper is to evaluate the complementarity and reliability of the methods used (logbook, boarding weighing and size class) for assessing fishing of the common dentex in the Northern Corsica (France). The implications of such methodological approaches for fisheries assessment are discussed.

Keywords: Fisheries, Monitoring, Corsica Trough

Introduction and Methods
In the Mediterranean Sea, artisanal fisheries are characterized as commercial fishers operating in small boat and targeting a high diversity of species [1]. The common dentex *Dentex dentex* (Linnaeus, 1758) is considered as a "noble" species and represents high commercial value for the artisanal fisheries [2], [3]. Under the program Marittimo: Marte +, 11 individual "logbooks" were distributed to fishermen representative of the artisanal fishing activity of the "Bastia-Cap Corse" fishing management area. These logbooks allowed a monitoring of their activity during the fishing season from April to October 2012 based on daily catch declaration. In addition, 38 boardings were conducted by scientists on vessels of these fishermen. The "boarding weight" was calculated using individual weightmeasured onboard using a spring balance (accuracy 0.4 g). A "boarding size class" weight estimation was calculated using the biometric relationships (size-weight): Small (0-40 cm = 0,5971 kg), Middle (40-60 cm = 2,7791 kg), Large (60-80 cm =7,6515 kg) [4], this estimation method being the most used in the Corsican fisheries monitoring.

Results and Discussion
A total of 40 common dentex were sampled over the study period. Results showed a significant difference between these three catch data (Friedman test, p = 0,018), on average in comparison with the "boarding weight" catch, an overestimation of 40% of the "boarding size class" catch and underestimation of 40% of the "logbook" catch. It might be interesting to refine knowledge of the biometric data of common dentex, in order to increase the reliability of the estimated values from these size classes. For "logbook" data, results were heterogeneous during the season and between the fishermen. Generally, fishermen do not enroll the small catches (<2 kg /day) that are not commercialized, this fact could explain this underestimation.The main advantage using fishermen logbook is their usefulness for monitoring the fishing effort according to the seasons. The interest to combine these methods is to obtain a better estimate of the production of common dentex, over the seasons, and to provide tools for fisheries assessment for integrated management and sustainable use of fisheries resources in Corsica.

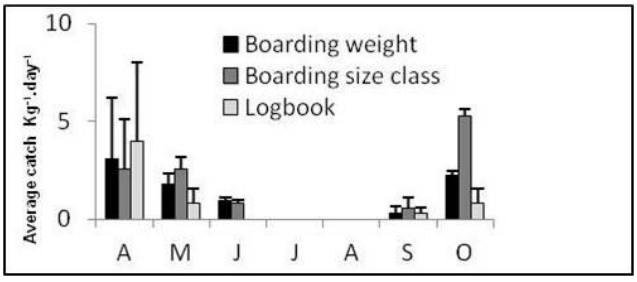

Fig. 1. Comparison of the average catch "boarding weight", compared with the average catch "boarding size class" estimation (all size classes combined) and average catch "logbook" during the fishing season (April-October 2012) for common dentex.

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MANAGEMENT PLAN FOR THE BOAT SEINE "SONSERA"

P. Sanchez [1]*, A. Colmenero [1], M. Demestre [1], A. Garcia De Vinuesa [1], J. Lleonart [1], P. Martin [1] and E. Vallejo [1]
[1] Institut de Ciencies del Mar-CSIC - pilar@icm.csic.es

Abstract
A management Plan for the Catalonian "sonsera" (boat seine) is carried out in order to allow the use of this fishing gear. The Co-management Committee of the "sonsera" was formally created with the specific mission to ensure a sustainable activity of the fishery. The fishery is currently being subject of a scientific study to accurately evaluate the state of the stock and its impact on the ecosystem.

Keywords: Fisheries, Monitoring, North-Western Mediterranean

Introduction
The sand eel fishery is carried out traditionally by 25 artisanal boats scattered around 6 fishing ports in the northern coast of Catalonia (NW Mediterranean). Fishing boats operate on a daily basis and landings are entirely devoted to direct human consumption, as the species is highly appreciated in the region.
The "sonsera" is a boat seine use in some parts of Catalonia to catch. Gymnammodytes cicerelus and G. semisquamatus [1] (known as "sonso") as well as some small gobids. "Sonsera" can be referred to both, the gear and the boat [2].
The capture of those species are not possible with any other method due the mesh size necessary to catch the target species, and a depth less than 50 m. Seeing that the EU regulations exclude this kind of fishing, the application of a Management Plan for this fishery it is necessary in order to allow the "sonsera".
A Co-Management Committee (Administration, boat seine's fishermen, scientists and NGOs) was established as the legal figure that is the responsible for the implementation of the Management Plan. The unique authorized sand eel fishery is devoted for provide the necessary information to develop the Management Plan.
The objectives of the management plan are:
Maintenance of historical small-scale fisheries and subsequent adoption of appropriate management measures.
Monitoring the state of exploitation by determining the amount of each catch, fishing effort and the basic biological parameters. Identification the impact of the fishing gear on ecosystem.
Identification of a set of indicators needed to verify both the state of exploitation and the effectiveness of the management measures taken.
Data necessary for the achievement of the objectives:
Fishery data (data series on catches and effort of the boat seine fleet; fleet dynamics during the fishing seasons targeting sand eel (Gymnammodytes cicerelus and G. semisquamatus and gobids). Data on the catches of the boat seine during at least an annual cycle on board professional boat seiners (specific composition of the catches and by-catch).
Biological data on target species (duration of the reproduction period and size-at-first-maturity, and special distribution of the target species). The material will be collected during the on board sampling and examined in the laboratory.
Bio-economic data related to the boat seine fishery.
Analysis of the collected data, diagnosis and definition of the fishing regulations
The analysis of the fishery data is expected to provide a first assessment of the status of exploitation of the target species of the boat seine fishery (sad eel and the dominant gobid species). The methodologies will include at least pseudocohort analysis and depletion model for the cpue data. The spatial distribution of fishing effort during the sand eel and gobids fishing seasons will also be analyzed.
Evaluation of the impact of the fishing gear at ecosystem level. Technical measures will be defined based on the diagnosis, for the sand eel and gobids fisheries.
The economic impact of the measures on these fisheries will be evaluated.
Implementation of the defined fishing regulations: monitoring and surveillance
An essential part of the Management Plan will be the monitoring of the technical measures that will be applied. Surveillance will be the responsibility of the Co-Management Committee. This Management Plan is proposed for duration of 3 years. The result of the application of the technical measures will be revised at least twice during the year by the Co-Management Committee.
Progress of the scientific study up 30 April 2013.

The scientific study started on August 2012 and will be finish on July 2013. Data on landings, effort and landings-per-unit-effort are obtained from the DGPAM (General Direction of Fishing and Maritime Affairs) of the Catalan Government for the period 2000-2012 on a monthly basis.
On the Catalan coast 5 ports report landing of Gimnamodytes spp., with an average of total landings of 403.4 tones for the period 2000-2012 with a maximum of 818,9 tones in 2012 and a minimum of 43.4 in 2007 (Fig 1).

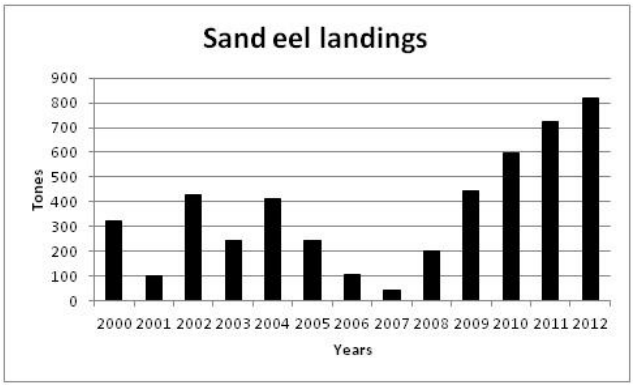

Fig. 1. Sand-eel (Gymnammodytes cicerelus+ G. semisquamatus) annual landings over 2000- 2012 in the five fishing ports in the northern Catalan Coast where the the fishing with "sonsera" is performed.

From 1 August 2012 to 30 April 2013, a total of 91 hauls were carried out on the 5 study ports. A total of 32577 individuals were measured, from them 87.3% were G. cicerelus (Table 1)
Tab. 1. Summary of sand eels measured up to April 2013

Sand eels measured	*G. cicerelus*	*G. semisquamatus*	TOTAL
Arenys	13601	2501	**16102**
Blanes	7592	687	**8279**
Palamós	1634	346	**1980**
Sant Feliu	3988	178	**4166**
L'Estartit	1632	418	**2050**
TOTAL	**28447**	**4130**	**32577**

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MODELLING TEMPORAL EVOLUTION OF THE PRODUCTION FROM COASTAL FISHERY AND BOTTOM TRAWLING DURING ONE DECADE (1995-2006) IN THE GULF OF GABES (TUNISIA).

S. Mosbah [1], M. Verdoit-Jarraya [1]*, M. Ghorbel [2], O. Jarboui [2] and P. Lenfant [1]
[1] Université de Perpignan, CEFREM UMR 5110 CNRS-UPVD - CEFREM - marion.jarraya@univ-perp.fr
[2] Institut National des Sciences et Technologies de la Mer (INSTM), Centre de Sfax BP 1035 – 3018 Sfax ,Tunisie

Abstract
In the Gulf of Gabès, coastal fishing and bottom trawling are the two predominant fishing activities providing the main part of the fishing production. So far, no study has attempted to model the temporal evolution of the production from these two fisheries. The objective of this study was to propose an explanatory model of the evolution of the production from these two fishing activities during one decade (1995-2006) using time series analysis. The fitted models were both adequate but those explaining bottom trawling's production was more significant than those of coastal fishing. This can be explained by the different practices of coastal fishing on the contrary to bottom trawling. For the latter, the seasonal effect was more pronounced.

Keywords: Tunisian Plateau, Coastal management, Fisheries, Models, Time series

Introduction
The Gulf of Gabès is the most important fishing area in Tunisia (south-western Mediterranean Sea) where bottom trawling and coastal fishery are the most predominant fishing activities. Fisheries management not only requires the knowledge of the biological and the dynamics parameters of the resources but also needs a fine description of the temporal evolution of fishing production. Many authors used time series analysis to explain the production and abundance of species ([4], [5]) and the dynamics of fisheries ([2]). The purpose of this study was to describe data series of the production from coastal fishery and bottom trawling activity in the gulf of Gabès during one decade.

Material and methods
The database for this study obtained from the General Direction of Aquaculture and Fisheries of Tunisia, contains monthly production data from bottom trawling and coastal fishery from 1995 to 2006 in the gulf of Gabès; A classical time series decomposition was used. The bases of this method were described in details in the works of Kendall and Stuart [1] and Makridakis and Wheelwright [3]. Fitted models were implemented in 3 steps: first, the deseasonalized time series data was determined using centered moving average, then this series was adjusted with the adequate model and finally the seasonal components was identified. The established model appears as follows:

$$Yt = St * Tt * Et$$

With: t the period; Y: the production; S: the seasonal component ;T: the trend cycle component and E: the irregular component.

Results and discussion
1. Temporal evolution of coastal fishery and bottom trawling production
For coastal fishing (Fig 1, top), the adjusted trend of the production shows two phases: an important decrease of the production followed-up by a low increase. For the bottom trawling activity (Fig 1, down), it shows also two phases but opposite to coastal fishing: a considerable increase of the production of this activity followed-up by a low decrease of catches.

2. Seasonal components
Regarding the seasonal components, we notice that the both fishing activities had the same evolution: an increase of the production from September to January. Besides, the seasonal effect is more important for bottom trawling activity.

Conclusion
This study allowed us to establish the first model which explains the production from coastal fishery and bottom trawling activity in the gulf of Gabès. The adjustments of the models were significant, besides those for coastal fishery was less significant due to the various techniques and fishing areas. The two activities had similar seasonal effect on the production, but the variance was less marked for the coastal activity which present a great capacity to maintain a stable production by changing fishing gears in response to resources availability.

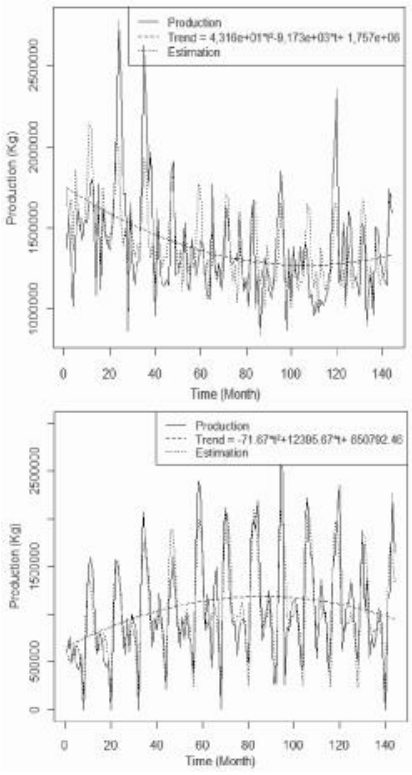

Fig. 1. Trend and fitted model of the temporal evolution of production from coastal fishery (top) and bottom trawling (down) (1995-2006).

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Session

Aquaculture impacts on ecosystems

Modérateur : **Tatiana M. Tsagaraki**

WASTE FEED FROM FISH FARMS OF THE EASTERN MEDITERRANEAN AND ATTRACTION OF WILD FISH

Nikos Neofitou [1]*
[1] University of Thessaly - nikneof@uth.gr

Abstract
Fish are attracted to floating structures, including coastal cage fish farms, sometimes in dense aggregations. To understand better the influence of aquaculture on wild fish stocks, we carried out samplings by fishing bait and trammel netting around two Eastern Mediterranean farms. A total number of 54 individuals belonging to 12 species were captured. Striped mullet, salema and white trevally were the species that consumed pellets in great quantity. The results of this preliminary study indicates that feeding behavior of wild fish around fish cages can have important ecological consequences on reducing the environmental effects of aquaculture in Pagasitikos gulf.

Keywords: Aquaculture, Fecal pellets, Fishes, South-Eastern Mediterranean

Introduction
Several previous studies have investigated assemblages of wild fish associated with marine fish farms in the North European and Mediterranean temperate locations [1]. Nevertheless, only few of them have examined the stomach content of wild fish in order to determine the percentage of uneaten pellets that consumed by them [1]. No publication has addressed this topic in the Eastern Mediterranean. Therefore, the specific aims of this preliminary study in a semi-enclosed gulf of the Eastern Mediterranean were to investigate the temporal persistence of wild fish around coastal aquaculture and to study the diet of these fish in order to determine the percentage of uneaten pellets that consumed by them.

Materials and methods
This preliminary study was carried out in Pagasitikos gulf which is located in the Western Aegean Sea. Two marine fish farms were examined: The first is situated at the southeast part and the second at the southwest part of Pagasitikos gulf. These are henceforth referred to as AS and BS farm, respectively. Sea bream *Sparus aurata* and sea bass *Dicentrarchus labrax* are intensively cultured in these farms where they are fed both pelleted and extruded diets. At the time of the study, the average annual standing stocks were 130 and 92 t for AS and BS farms, respectively. The study applied two different sampling methods. One sampling was carried out at the AS farm by fishing bait and two samplings at the BS farm by trammel netting in order to catch wild fish under fish cages. The fishing bait at the AS farm was made in one day (in September) from the walkway of the cages, directly after the early feeding time. The trammel nettings at the BS farm were carried out in two nights (one in September and one in October) and the purpose of the sampling time was to catch as many wild fish around fish cages as possible. The net was 28 to 30 mm square mesh and hauls were made directly adjacent to cages and around the fish farm by lowering the net into the water using a fishing boat. All measurements and analyses of fish stomachs were done according to the procedure described by [2].

Results and discussion
In the present study, we found 12 different species of fish associated with the two farms studied, belonging mainly to the Sparidae and Carangidae (75% of the total captured fish). Combining this total number with similar observations from [2], a total of 33 species belonging mainly to the Clupeidae, Sparidae, Mugilidae and Carangidae were found. The stomach content analysis of wild fish captured around sea cages of the AS and BS farms are shown in Figure 1. Striped mullet, salema and white trevally were the species that consumed pellets in grate quantity (57% of the total captured fish at the AS farm). In previous studies, [2] reported that Mugilids were the taxa that consumed pellets in greatest quantity. This study demonstrates that sampling by fishing bait directly after the feeding time was the most appropriated method (AS farm) in contrast with trammel netting during the night since all the wild fish that captured with this method were fed on natural food or had an empty stomach (BS farm). This finding may imply that in the second case, pellets were digested until the night or that nets stressed fish causing them regurgitation. Furthermore, the preliminary results of the study indicates that feeding behavior of wild fish around fish cages can have important ecological consequences on reducing the organic wastes which are directly released into the receiving environment and may causes eutrophication and/or stress on benthic organisms in Pagasitikos gulf, which is in agreement with the results of previous studies in this region [3, 4].

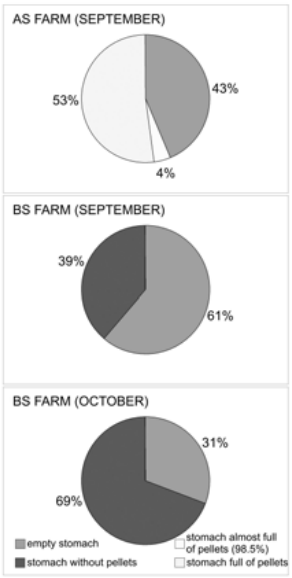

Fig. 1. Stomach content analysis of wild fish around sea cage's over all samplings

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EFFECTS OF ANTIFOULING PAINTS ON FARMED FISH OF THE EASTERN MEDITERRANEAN

Marina Nikolaou [1]*, Nikos Neofitou [1], Konstantinos Skordas [1] and Labrini Tziantziou [1]
[1] UNIVERSITY OF THESSALY - maze55@live.com

Abstract
In this preliminary study, was examined the accumulation of copper and zink as basic ingredients of antifouling paints in cultured sea bass and sea bream. Samplings were carried out in four Eastern Mediterranean fish farms. Two of them used nets treated with antifouling paints whereas the other two utilized untreated nets. The results showed that almost in all cases the concentrations of heavy metals were higher in fish collected from cages treated with antifouling paints. Furthermore, statistical analysis revealed significant differences in copper and zinc concentrations among the samples from the farms with different use of treatment. These preliminary results indicate that the use of antifouling paints may exert toxic effects in cultured fish.

Keywords: Aquaculture, Fouling, Metals, Fishes, North-Eastern Mediterranean

Introduction
Marine fouling is a growing global phenomenon and it is widely accepted that in the aquaculture industry is an expensive problem. The main protective method against fouling involves the use of toxic antifouling paints. Nevertheless there is little information regarding pollutant levels in cultured fish [1]. The impact of antifouling on the concentration of heavy metals in cultured fish in the Eastern Mediterranean has been addressed only in one experimental study [2]. Therefore, the specific aim of this preliminary study in four aquaculture sites of the Eastern Mediterranean was to detect whether the concentrations of copper and zinc would be related to the use of antifouling treated nets.

Materials and methods
Cultured sea bass *Dicentrarchus labrax* and sea bream *Sparus aurata* were supplied from four fish farms which are located in the Aegean and Ionion Sea (Eastern Mediterranean). Two of them used nets treated with antifouling paints whereas the other two utilized untreated nets. These are henceforth referred to as AF and NAF farms, respectively. A total number of 40 individuals were analyzed (n=10, TW=399.46±109.81g sea bass & n=10, TW=327.70±88.65g sea bream at AF farms; n=10, TW=420.80±73.43g sea bass & n=10, TW=366.98±42.54g sea bream at NAF farms). Metals were analyzed in muscle, liver and gills separately for each tissue and fish (n=120). Samples (about 0.5 g) were dried at 80°C for 48h, weighted and wet digested with concentrated HNO3. Quantitative determinations of copper (Cu) were carried out by graphite furnace atomic absorption spectrometer and zinc (Zn) were carried out by flame atomic absorption spectrometer, using standard addition methods. The one-way analysis of variance (ANOVA) was used to determine statistical significant differences between fish exposed to antifouling treated and un-treated nets.

Results and discussion
Heavy metals concentrations in tissues of the two studied species are summarized in Figure 1. These results showed that almost in all cases the concentrations of heavy metals were lower in samples collected from untreated nets. Maximum concentration of copper and zinc was detected in the liver (28.50 and 435.25 mg kg^{-1} dry wt, respectively) of sea bass at the AF farms. Mean concentration of zinc in liver of sea bass and sea bream was 19 and 14 times higher in AF farms compared to NAF farms. Results generally showed that almost always highest metal concentrations appeared in liver for both studied species, which is in agreement with other studies [2, 3]. In another similar study of the North Europe on farmed salmon, [3] reported lower concentrations of copper in muscle and higher in liver compared to our data. Furthermore, one way ANOVA showed significant differences in heavy metals concentration among the samples of the AF and NAF farms for both studied species ($p<0.001$). All the above mentioned indicates the negative effect of antifouling coatings on cultured fish. In any case, concentration of copper and zinc in muscle of both studied species did not exceed the maximum limits for food (30 and 100 mg kg^{-1} dry wt, respectively) [4].

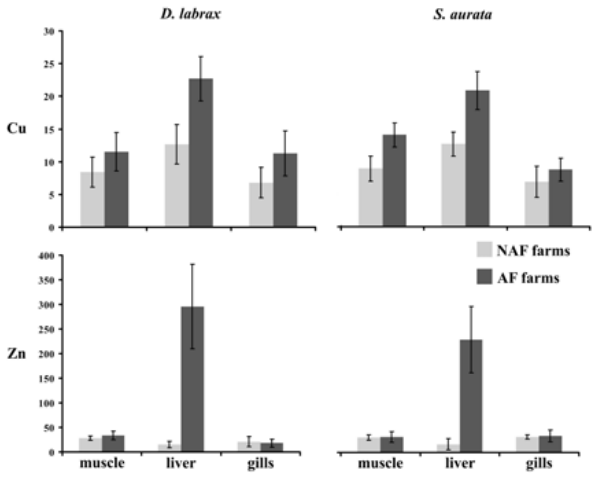

Fig. 1. Mean±SD concentrations of copper and zinc in muscle, liver and gills of cultured sea bass and sea bream (mg kg^{-1}, dry wt)

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FIRST REPORT OF SOME PARASITES FROM THE MEDITERRANEAN MUSSEL, *MYTILUS GALLOPROVINCIALIS* LAMARCK, 1819, COLLECTED FROM THE TURKISH BLACK SEA

Ahmet Özer [1]* and Sevilay Güneydag [1]
[1] Sinop University Faculty of Fisheries and Aquatic Sci - aozer@sinop.edu.tr

Abstract
This is the first study on parasites of *Mytilus galloprovincialis* Lamarck, 1819 in Turkish waters. Mussel samples were collected every month between August 2012 and January 2013 at 3 stations in the Sinop coasts of the Black Sea. A total of 840 mussels were examined for parasites using standard parasitological investigation procedures. Five parasite species were identified: *Nematopsis legeri* (de Beauchamp, 1910), *Urastoma cyprinae* (Graff, 1882), *Parvatrema duboisi* (Dollfus, 1923), *Polydora ciliata* (Johnston, 1838) and *Peniculistoma mytili* (Morgan, 1925) Jankowski, 1964. Overall infection prevelance (%), mean intensity and abundance values were 59.88%, 54.73 ± 6.03 and 32.77 ± 2.78, respectively. Infection indices for each parasite species were also determined and presented.

Keywords: Bivalves, Black Sea, Parasitism

Introduction
The Mediterranean mussel (*Mytilus galloprovincialis* Lamarck, 1819) is native to the Mediterranean, Black and Adriatic Seas, but has spread mostly via ballast water and ship hull fouling to many other regions worldwide. It is a major component of the littoral fauna in the Black Sea and is an aquatic product which has economical significance. Total bivalve production value was 45.412 tonnes in 2009 in Turkey ([1]) and all were harvested from nature via mussel collection. A dramatic decrease of 35% was occurred in the years 2007-2011 especially in the Black Sea as a possible impact of predatory marine snail *Rapana venosa* on natural populations. Despite sevaral studies conducted on the parasites of *M. galloporovincialis* where it is distributed ([2], [3], [4], [5]), there is no parasitological report in Turkey. So, this is the first study identifying its parasite fauna and presenting infection indices in Sinop coasts of the Black Sea in Turkey.

Materials and methods
Sampling was carried out between August 2012 and January 2013 at 3 sampling stations representing three ecologically different environments in Sinop coasts of the Black Sea. Mussels were collected by scuba divers and transported in local water to parasitology laboratory at the Faculty of Fisheries and Aquatic Sciences. A total of 840 mussels were examined for parasites using standard methods. Infection prevalence (%), mean intensity and abundance values (with Standard Error) were determined in accordance with [6].

Results
During the investigation period, a total of 5 parasite species were identified; *Nematopsis legeri* (de Beauchamp, 1910) (Porosporidae), *Urastoma cyprinae* (Graff, 1882) (Urastomidae), *Parvatrema duboisi* (Dollfus, 1923) (Gymnophallidae), *Polydora ciliata* (Johnston, 1838) (Spionidae) and *Peniculistoma mytili* (Morgan, 1925) Jankowski, 1964 (Peniculistomatiade). The most prevalent was *N. legeri* (P:47.73%, M.I±S.E: 65.78 ± 7.43), *P. mytili* was less common (P:8.33%, M.I±S.E: 7,62 ± 1.07) and least abundant were *P. duboisi*, *U. cyprinae* and *P. ciliata* (P:4.88%, M.I±S.E: 6.28 ± 0.87; P:3.39%, M.I±S.E: 9.09 ± 1.20 and P:1.30%, M.I±S.E: 1.0 ± 0.00, respectively). Overall infection prevalence (%), mean intensity and abundance values were 59.88%, 54.73 ± 6.03 and 32.77 ± 2.78, respectively.

Discussion
The Mediterranean mussel *Mytilus galloprovincialis* is native to all seas surrounding Turkey. Despite its economical value, there is no study on the parasites and their infection indices in Turkey. Here in the present study, we provided first and detailed data on its parasites and infection indices in nature in Turkish Black Sea coasts.

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CHANGES IN WATER COLUMN PLANKTON COMMUNITY COMPOSITION IN RESPONSE TO FISH FARMING IN THE EASTERN MEDITERRANEAN

T. Tsagaraki [1]*, P. Pitta [1], C. Frangoulis [1], G. Petihakis [1] and I. Karakassis [2]
[1] Institute of Oceanography Hellenic Centre for Marine Research - tatiana@hcmr.gr
[2] Biology Department, University of Crete

Abstract
Changes in plankton community composition as a response to fish farming were examined in an exposed site in the N. Aegean Sea. Geochemical variables were measured along with abundance and biomass for all plankton groups from bacteria to mesozooplankton. Results showed that farm effects are maximized at stations 100-200 m downstream from the farm. The implications for assessing community responses to perturbations in a dynamic environment are discussed within the context of fish farming.

Keywords: Aquaculture, Food webs, Phytoplankton, Zooplankton , Aegean Sea

Introduction
Although it is widely accepted that the amount of nutrient released by fish farms is substantial ([1], [3]) it has proven quite elusive detecting them in the field ([7]; [8]). It has been shown that the released nutrients are rapidly assimilated into the food web resulting in a quick transfer of nutrients to higher trophic levels [6]. The transfer up the food web has also been shown through increased biomass of wild fish near farming zones [4], the use of farming areas as settlement sites for juveniles [2] and even increase of top level predators in the farm vicinity [5]. However, changes in plankton community structure continue being hard to detect. In this study, the range of organisms studied allow us valuable insights as to how communities fine-tuned for oligotrophic conditions respond to nutrient additions from a farming environment.

Materials and Methods
Station selection was based on current velocity and direction as measured on the day of sampling used CODE type drifters. Water samples were taken within the fish farm area and at 80, 100, 200 and 500 downstream from the fish farm, along with two control stations one upstream and one downstream of the main current direction. Water samples were collected and analysed for particulate and dissolved nutrients, chlorophyll, bacteria, nanoflagejlates and microplankton while mesozooplankton was collected by vertical net tows. Microplankton cells were identified to the genus level and, where possible, to the species level. The dimensions of each cell were measured to obtain the biovolume and calculate the carbon content. Mesozooplanktin was scanned, identified to group level and the abundance, size and biomass of the dominant groups were determined.

Results and Discussion
The community upstream from the farm was typical of oligotrophic conditions in the late summer. At the farm cages and at 80m downstream nanoflagellate abundance started to increase and diatom biomass decreased. Ciliate biomass also started to increase and at the same time cladoceran abundance dropped by an order of magnitude. At the "impacted" stations 100 and 200m downstream the abundance of bacteria, nanoflagellates, cladocerans and copepods peaked and larger dinoflagellates and ciliates also increased. Further downstream these groups slowly returned to background levels. The major changes observed are conceptually summarized in Fig. 1. The results of this study indicate that, as a result of nutrient addition by fish farming operations, the plankton community structure is altered moving from a microbial loop dominated food web upstream from the farm to a more multivorous food web in proximity to the cages.

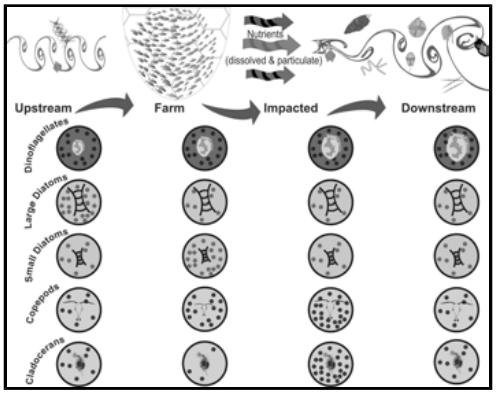

Fig. 1. Conceptual diagram depicting the most important changes in community structure as expressed through abundance (dots within group bubble) and size (organism with group bubble) at different distances from fish farm cages.

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LES MÉTAUX LOURD DANS LE SÉDIMENT ET LEUR IMPACT SUR LE DÉVELOPPEMENT DE LA CONCHYLICULTURE (BAIE DE DAKHLA, MAROC)

H. Zidane [1]*, M. Menioui [2], A. Mouradi [3], A. Orbi [1], F. Zidane [4] and J. Blais [5]
[1] Institut National de Recherche Halieutique - zidaneinrh95@hotmail.fr
[2] Institut Scientifique Rabat
[3] Université Ibn Tofail/Faculté des sciences Kénitra
[4] Université Hassan II, Faculté des sciences Ain chok Casa I
[5] Institut National de la Recherche Scientifique-ETE, Québec

Abstract
La détermination des concentrations des métaux lourds dans le sédiment superficiel de la baie de Dakhla, au niveau de 36 prélèvements, a montré des taux relativement élevés malgré l'absence de toute pollution industrielle. La concentration en Cd dépasse le seuil à effet néfaste, ce qui nécessite un suivi des investigations pour identifier la source de contamination et évaluer l'impact sur le milieu et l'aquaculture.

Keywords: Sediments, Aquaculture, Metals, Antalya Bay

Introduction
La baie de Dakhla, située au sud du Maroc, est parmi les écosystèmes les plus productifs du pays et recèle des potentialités écologiques, biologiques et socioéconomiques d'une grande importance avec des gisements naturels de coquillages exploitables tel que :*R. decussata*, *V. verrucosa*, *C. edule*…. Actuellement, elle est le premier pôle conchylicole à l'échelle nationale et l'un des principaux pôles touristiques. Cette étude a pour objet d'identifier la contamination spatiale des sédiments par les éléments métalliques toxiques (Cd, Cr, Cu, Pb, Zn) et indésirables (Al, S, Fe, Ni) et de leur impact sur le développement de la conchyliculture.

Matériels et Méthode
Le réseau d'échantillonnée (fig.1) a concerné les zones conchylicoles et touristiques. D'autres prélèvements, témoins, Taourta et OumLabouire ont été effectués dans la zone franchement marine. Au total, 12 stations ont été échantillonnées, du 1 au 9 juillet 2007, avec 3 réplicas, chacune. Les sédiments récoltés ont été tamisés puis digérés avec du HNO_3, HF et $HClO_4$ selon la méthode No. 3030I [1]. Chaque série de digestion a été validée en parallèle par la digestion d'échantillons certifiés de sédiments (PACS-2, NRCC, Ottawa, Canada). Les mesures des métaux ont été effectuées par spectrophotométrie au plasma à couplage inductif (ICP-AES) (appareil Thermo Jarrell Ash, modèle Atom Scan 25).

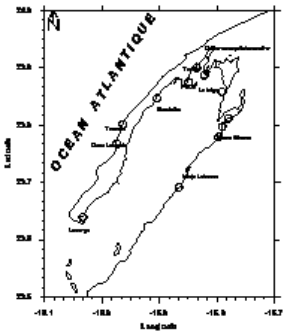

Fig. 1. Situation géographique des stations des prélèvements

Résultats & Discussion
Les teneurs moyennes enregistrées dépassent largement celles observées en 1997 et 2004 [2, 3, 4]. Le Fr, le Ni, l'Al et le S sont présents dans la baie à des concentrations importantes, mais inférieures au seuil à effet mineur. On note une moyenne maximale de 13,4mg/g (Fer), 16,7µg/g (Ni) et 8812µg/g (S) à HojaLalmera. Concernant l'Al, la valeur moyenne maximale enregistrée, à la même station (19mg/g), dépasse le seuil à effet néfaste. Le Cd et le Zn présentent une répartition spatiale similaire à celles du Fr, Ni, Al et S avec, cependant, des concentrations respectives de 4,6µg/g et 58,8µg/g. La classification ascendante hiérarchique (fig. 2) met en évidence la particularité de la station HojaLalmera. Les concentrations moyennes du Cu, Pb et Cr se répartissent d'une manière homogène dans toute la baie avec des valeurs ne dépassant pas le seuil à effet néfaste. Les plus fortes moyennes sont enregistrées à PK25 et Oumlabouir connues pour leur Intense activité touristique.

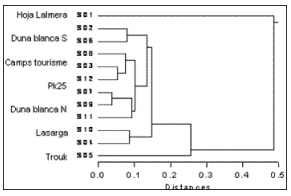

Fig. 2. Classification ascendante et hierarchique des stations

Généralement, le sédiment est utilisé comme indicateur de l'impact des activités anthropiques sur l'environnement aquatique [5, 6], or l'Est de la baie en est dépourvue et par suite cet enrichissement en métaux au niveau de la zone HojaLalmera est à mettre en relation avec les phénomènes d'upwelling permanent et les masses d'eau océanique rentrant par la cote Est [7,2] et les rejets miniers (com. Pers).

Conclusion Ce travail a permis de mettre en évidence la forte contamination de la baie de Dakhla par certains métaux lourds et ce, malgré l'absence de toute pollution anthropique et industrielle. La question des concentrations en Cd, dépassant le seuil à effet néfaste, reste posée et suggère un suivi rigoureux pour identifier la source de contamination et évaluer son impact sur le milieu et sur les activités aquacoles.

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Session

Biogeographic patterns

Modérateur : **Sakina-Dorothée Ayata**

ECOREGIONALISATION OF THE MEDITERRANEAN SEA

G. Reygondeau [1], J. Irisson [1], S. Ayata [1]*, C. Guieu [1], F. Benedetti [1], S. Gasparini [1] and P. Koubbi [1]
[1] LOV UPMC CNRS - ayata@obs-vlfr.fr

Abstract
The discipline of biogeography aims to study the spatial distribution of species in relation with environmental and geographical gradient. Main accepted biogeographies of the ocean only focus on one or two trophic levels of marine ecosystems and thus can hardly be applied for an ecosystem-based management. In this study, we have attempted to identify the main multi trophic associations from phytoplankton to mammals for the Mediterranean Sea. Based on more than 1 millions observations covering 1230 species and on recent statistical approach, the ecoregions of the Mediterranean basin are identified. For each ecoregions the main species association and habitat type are identified and effect of human pressure (both climate change, fisheries and pollution) are discussed.

Keywords: Biodiversity, Biogeography, Coastal systems, Pelagic, North-Central Mediterranean

The discipline of biogeography aims to study the spatial distribution of species in relation with environmental and geographical gradient. Based on the last 20 years of research in this new multidisciplinary field of science, three partition of the global ocean are accepted by the scientific community at a global scale. These global geographical frameworks respectively delineate the main oceanographical, ecological and fisheries basin features. Nonetheless, this division are usually static and focussing on few components of marine ecosystems and thus cannot be applied at a regional scale for an optimal ecosystem resources management. The aim of the work in the MERMEX/PERSEUS projects is first to integrate all biological observations made in the Mediterranean basin and second to infer an ecoregionalisation of the basin based on multi-trophic spatial occurrences of the main species detected. To do so, all Mediterranean databases including open access, national or project cruises and international database have been gathered. Then, based on ecological niche model coupled phytosociological analysis, the spatial distribution and species association of the more dominant species were retrieved. Finally, a multi agglomerative procedure has been applied to detect the ecoregions of the Mediterranean basin and is related to the main biotopes retrieved previously (see other talk proposed during the symposium). The obtained ecoregions delineate the characteristic species assemblage at a multi-trophic level of the Mediterranean Sea and hence, approximate the main trophic web of this basin. These ecoregions are now used as a reference ecological state in the European project PERSEUS.

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CHECK LIST OF PLANKTON IN THE GULF OF VLORE (ALBANIA)

Genuario Belmonte [1]*
[1] University of the Salento; CoNISMa OU of Lecce - genuario.belmonte@unisalento.it

Abstract
A check list of plankton species in an Albanian coastal area is presented. Data derive from 384 samples collected with 3 different sampling devices at 20 stations over 2 years (2007-2008) in two oceanographic cruises in the framework of the Interreg CISM project coordinated by CoNISMa. A total of 425 plankton organisms were recognized, 300 of them as species. The plankton of the Gulf of Vlore was dominated by Crustacea, Dinophyta, Diatomeae, and Ciliophora. Only Penilia avirostris was collected with all the sampling devices, this demonstrating that an integrated sampling effort provides a more effective description of the reality. The checklist will be useful for studies in neighbouring areas, suchj as that of the FP7 CoCoNET project. The present inventory is also useful in the framework of EU Marine Strategy Directives

Keywords: Biodiversity, Otranto Strait

Introduction
The check list of plankton species in an Albanian coastal area is presented for the first time. This kind of biodiversity assessment will be of interest for present projects in the South Adriatic Sea and Otranto Channel which will describe the connectivity existing between the two (Italian and Balkan) opposite coasts. Furthermore, any reference list will represent the occasion to judge the representativeness of samples, or surveys, to be carried out in the future.
A list of 151 taxa is already available for benthos of the same area (Gulf of Vlore) (Maiorano et al., 2011). The present contribution wants to add information about the biodiversity of a potentially valuable area for economy (fishery and tourism) and nature protection.

Methods
Over a 2-year PERIOD (2007, 2008), 384 samples were collected using various devices (Niskin bottle, sediment core, plankton net) from 20 sampling stations (18 in the water column, 2 on the sea bottom). The sampling was carried out during two oceanografic cruises conducted in the framework of the CISM Interreg Project coordinated by CoNISMa.

Results and Discussion
A total of 425 different categories of organism were recognized, 300 of them at species level. The plankton assemblage was dominated by Crustacea (133 categories, 85 species), followed by Dinophyta (120 categories, 103 species), Diatomeae (42 categories and species), and Ciliofora (37 categories and species).
Among Crustacea, Copepoda were predominant (110 categories, 79 species).
The data are presented in published, peer-reviewed papers (on phytoplankton, microzooplankton, and resting stages) (Moscatello et al., 2011; Rubino et al, 2013), as well as one paper in preparation (on mesozooplankton) (Belmonte et al., 2012).
Eighy-six categories were found in sediment samples (as resting stages), 219 categories were collected by Niskin bottle and 196 categories by plankton net. Only one category (the Cladoceran *Penilia avirostris*) was collected with all sampling devices, demonstrating that an integrated sampling effort can provide a more effective description of reality. In addition, for 60 cases the record derives from resting stages found in the sediments, with no active stages of the same species found in the water column.
Since this is the first complete inventory of plankton biodiversity in an Albanian bay, nothing can be said about the possible presence of Non Indigenous Species.
The present report is the first assessment of the biodiversity of an area which is scheduled to become part of a Marine Protected Area.
The checklist is also be particularly useful for other studies in neighbouring areas, for example, the study of the water column biodiversity of the South Adriatic Sea and Otranto Channel, which was conducted in the framework of the FP7 CoCoNET Project to assess the connectivity of MPAs on opposite sides of the same basin. The present inventory is also useful in the framework of EU Marine Strategy Directives, which call for reliable data on which to base the assessment of the Environmental Status of marine basins.

Acknowledgments I would like to thank the colleagues which participated with me at the study of the Plankton in the frame of the CISM project: Carmela Caroppo (IAMC CNR Taranto, phytoplankton), Fernando Rubino (IAMC CNR Taranto, dinophyta and related cysts), Salvatore Moscatello (Lab. of Zoogeography and Fauna, Unisalento-CoNISMa Lecce, sample collection and microzooplankton, with related resting stages), Edmond Hajderi (University of Our Lady of Good Council, Tiranë, sample collection and cruise coordination), Margherita Licciano (Lab of Systematic Zoology, Unisalento Lecce, for identification of polychaete larvae), Francesco Denitto (Lab. of Zoogeography and Fauna, Unisalento-CoNISMa Lecce, for the identification of Hydrozoa), Irene Vaglio (Lab. of Zoogeography and Fauna, Unisalento-CoNISMa Lecce, for the identification of Calanoida), Gianmarco Ingrosso (Lab. of Zoogeography and Fauna, Unisalento-CoNISMa Lecce, for the identification of resting stages in the sediments)

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DISTRIBUTION AND BIOGEOGRAPHY OF THE COPEPODS IN THE MEDITERRANEAN SEA (MERMEX/PERSEUS)

F. Benedetti [1]*, G. Reygondeau [1], J. Irisson [1], S. Gasparini [1], P. Koubbi [1], C. Guieu [1] and S. Ayata [1]
[1] LOV UPMC CNRS Laboratoire d'Océanographie de Villefranche (LOV, UMR 2093) UPMC CNRS - fabio.benedetti24@gmail.com

Abstract
Subtask 1.1.6 of PERSEUS and WP5 of MERMEX aim to propose a more extensive and accurate identification of the pelagic ecosystems within the Mediterranean Sea (bioregionalization). In this context, the aim of this work is to characterize the biodiversity by focusing on the most abundant component of zooplankton: the copepods. We implemented a new dataset of copepod occurrences from the ones already available online, completed with punctual datasets from various published studies. From these numerous punctual observations we gathered, we computed and mapped copepod species richness. Then, we identified areas that could be clustered together on the basis of species' presence. Finally, we modelled the ecological niches (environmental envelopes) of the most recorded species to define ecoregions.

Keywords: Zooplankton , Biodiversity, Copepoda, Mapping, Extra-Mediterranean regions

Introduction
The interest from stakeholders and scientists has been growing towards a better understanding of the biodiversity's spatiotemporal dynamics in the Mediterranean Sea. The subtask 1.1.6 of PERSEUS and the WP5 of MERMEX aim to propose a more extensive and accurate identification of the pelagic ecosystems within the Mediterranean Sea (bioregionalization), i.e. to propose a geographical framework where specific physical and chemical conditions are relatively stable, and where specific communities are likely to be found. The aim of this work is to characterize the biodiversity across the whole Mediterranean basin and to provide a more accurate bioregionalization of the Mediterranean Sea by focusing on the most abundant component of zooplankton: the copepods. Copepods are small (1 to 2 mm) crustaceans of prime interest for the study of pelagic food webs, both from a biological or a biogeochemical point of view. Indeed, they represent the intermediate between the primary production and the higher trophic levels. They are also a key element of the marine biogeochemical cycle of carbon through their production of particulate and dissolved organic matter. Besides, copepods are particularly fit for our purposes since they are ectotherms (meaning their internal temperature is the same as the one encountered in their environment) and unexploited by human activities. As part of the PERSEUS and MERMEX programs, a new dynamic mapping of the biogeochemical provinces has been established (Reygondeau et al., in prep). Some regions of the Mediterranean appear more stable, from a biogeochemical point of view, whereas others appear as much more variable "ecotones". In this context, we wondered how the copepod diversity was distributed over the Mediterranean Sea, and whether the copepod communities significantly differed between the different biogeochemical regions previously described.

Material and Methods
The first part of our work was to review the many studies conducted on the whole Mediterranean Sea (Razouls et al, 2005; Siokou-Frangou et al, 2010) and implement a new database of copepod occurrences from the ones already available online (COPEPOD/ IOBIS, Gbif, SESAME), completed with punctual datasets from various published studies. A total of 94959 punctual observations were gathered within an unprecedented database. From the latter, we have managed to compute and then map copepod diversity in terms of species and genus richness, and relate these to sampling effort, expressed as the number of net tows per geographical cells of 1°. Second, using an adequate distance's measurement for our dataset, we performed a clustering method to identify regions which could be gathered on the basis of their copepod communities. The last part of our study aimed to define the ecological niches (environmental envelops) of the most present species within the new dataset (Reygondeau et al., 2012). These models show the regions of the Mediterranean Sea that are favourable to the development of the species.

Main results and Discussion
We were able to describe the distribution of copepod diversity across the Mediterranean Sea, both at the species and at the genus level. Our data set covered all the Mediterranean Sea, except along the Libyan coast. The highest sampling efforts were recorded in the northwestern part of the Western basin, especially due to CPR (Continuous Plankton Recorder) data, while the lowest effort occurred near the Southern coasts (Levantine Basin, Algeria...) (Fig.1). It appeared that higher sampling effort did not lead to any particular increase in copepod diversity. Indeed, a few tows are enough to characterize the community, if taxonomic identification is done properly. Our results stress the need to realize a few tows in the depleted areas, using comparable sampling strategies. The clustering on raw observations evidenced a large community structure between the Western and Eastern basins, which could be characterized by significantly indicative species. Finally, we were able to estimate the probability of occurrence of 178 species over the whole Mediterranean Sea using niche modelling. These results were then used to describe a biogeography of the copepods in the Mediterranean Sea and to compute an estimate of copepod diversity. Also, clustering on all the niches confirmed and slightly refined the West/East community structure. Comparison with the biogeochemical regions (Reygondeau et al., in prep) hinted towards a "bottom-up" control of the copepod communities.

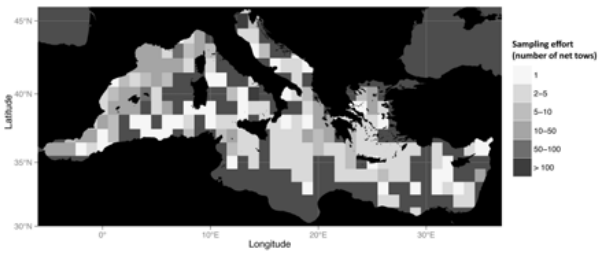

Fig. 1. Copepod data set and sampling effort. The map indicates the spatial coverage of our copepod observation data set. The number of sampling tows projected on a rectangular grid of 1° is also indicated

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CALYX NICAEENSIS (RISSO, 1826) (PORIFERA, DEMOSPONGIAE). IS IT A RARE AND THREATENED SPECIES?

C. Cerrano [1]*, A. Molinari [2], P. Bernat [2], R. Baldacconi [3], B. Calcinai [1] and V. Macic [4]
[1] DISVA, Università Politecnica delle Marche - c.cerrano@univpm.it
[2] RSTA, Cooperative Research Society, Genova, Italy
[3] Reef Check Italia onlus, Italy
[4] IMBK, Kotor, Montenegro

Abstract
As for many other benthic organisms, sponges are disappearing from several areas. The climate warming seems to be one of the most important causes involved in the phenomenon. Here we gather information on the distribution of the cup-shaped demosponge *Calyx nicaeensis* furnishing a first baseline for future monitoring and first observations regarding its natural history.

Keywords: Porifera, Conservation, North-Western Mediterranean

Introduction
Climate warming is altering the phenology and the distribution of a wide number of species both on land and underwater. To define which species are more vulnerable it is urgent to draw future scenarios for possible mitigation measures. In the Mediterranean Sea,filter feeders such as sponges and octocorals are among the phyla most affected by extended mortality events [1, 2]. Here we gather all the reports we found on the demosponge *Calyx nicaeensis* (Haplosclerida, Phloeodictyidae), a species that seems to be under fast regression in the NW Mediterranean Basin. The lack of a documented baseline does not allow knowing if this species is rare or actually endangered by anthropogenic impacts.

Material and Methods
To supply information about the distribution of *Calyx nicaeensis*, a detailed bibliographic study was performed, adding also unpublished record available on the web and recent records from Apulian coasts and Montenegro. Photo documentations allowed to highlight some peculiar aspects of the natural history of this species related to the collection of rolling coarse sediments and its asexual reproductive strategies (Fig. 1).

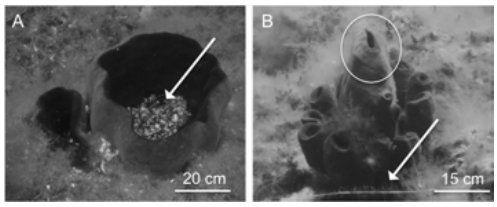

Fig. 1. Fig.1 *Calyx nicaeensis.* A) Sediment accumulation in the exhalant cavity B) Asexual reproduction by basal buds.

Results
Distribution. This sponge has a wide bathymetric range (down to 400 m depth) [4] but is mainly reported from 5 to 55 m depth in many areas of Mediterranean Sea (Tab.1). Its habitat is both *Posidonia oceanica* meadows and coralligenous concretions. When shallow, it is found in pre-cave conditions. *C. nicaeensis*, being with a vertical growth, in several cases was noted damaged by lost fishing lines. Sediment collection. Cup-shaped sponges inevitably entrap coarse sediments. These sponges have different strategies to manage this mound of coarse particles in the exhalant cavity. *C. nicaeensis* likely tend to collapse the osculum when filled by sediments (Fig. 1A). Asexual reproduction. This species shows a peculiar strategy of asexual reproduction, producing buds from the sponge base (Fig. 1B).

Conclusions
The findings of *Calyx nicaeensis* here reported cannot confirm an actual regression phase, anyway this species is certainly disappeared from the Ligurian Sea after its finding in the '60s [3]. A recent documentation from Montenegro, allows mentioning as a threat for this species areas with human impacts (e.g. artisanal fishery, coastal constructions, diving, sewage) and invasive species such as the algae *Caulerpa racemosa* and *Womersleyella setacea.* In conclusion, this species has a distribution highly fragmented, limited in few spots of the Mediterranean, asking for adequate and urgent conservation measures at Mediterranean level [5].

Tab. 1. Tab. 1. Historical and present finding of *Calyx nicaeensis*.

Author	Year	Site	State	Depth
Schmidt	1862	Kvarner Gulf	Croatia	-
Balsamo & Crivelli	1863	Naples	Italy	-
Topsent	1925	Naples	Italy	-
Topsent	1928	Tolon	France	20-50m
Tortonese	1958	Punta Torretta, Portofino	Italy	30-40m
Vacelet	1960	Corsica Channel	France	335-367m
Rubio M	1971	Blanes	Spain	
Benito J	1981	Itea-Calpe-Benidrom	Spain	
Le Granchè Philippe	1983	Anse de Fico, capo di Feno, Corse	France	wreck
Juan A	1987	Columbretes	Spain	
Ocana et al	2000	PN Acantilados de Maro-Cerro Gordo (Andalucia)	Spain	
Anonymous	2002		Cyprus	13-14m
Mustapha	2003		Tunisia	-
Pansini Longo	2003	Review		-
Kefalas et al.	2003	Aegean Sea	Greece	30-60m
Voultsiadou	2005	Aegean Sea	Greece	3-10m
Horst Dominique	2006	Cap Antibes	France	13m
Maran Vincent	2007	Sec de la Jaune Garde, Porquerolles	France	15m
Baldacconi	2007-08	Porto Cesareo	Italy	30m
Pansini Longo	2008	Review		
Manuel Maldonado	2008	punta de la Mona (Andalucia)	Spain	
Horst Dominique	2009	Cap Antibes	France	13m
Koukouras & Athanasios	2010		Greece	-
Villechalane Marc	2010	Cap Sormiou, Marseille	France	18m
Vesna Mačić	2010	Lustica Peninsula,	Montenegro	10-12m
Vesna Mačić	2010	Lustica Peninsula	Montenegro	10-12m
Baldacconi	2010-12	Nardò	Italy	3m
Anonymous	2011	Al-Gomas	Lybia	-
Andrè Frédéric	2011	Sec de la Jaune Garde, Porquerolles	France	18m
Baldacconi	2011	Palmi	Italy	30m
Baldacconi	2011	Otranto	Italy	10m
Andrè Frédéric	2011	Sec de la Jaune Garde, Porquerolles	France	18m (necrotic)
Molinari & Bernat	2011	Lustica Peninsula	Montenegro	14 m
Lakhrach et al	2012	Gabes Gulf	Tunisia	31-45m
Hollebecq Céline	2012	île de Jarre, Marseille	France	8m
Mačić & Molinari	2012	Lustica Peninsula	Montenegro	26 m

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RECENT TAXONOMIC DISCOVERIES CONCERNING THE GENUS *MYTILUS* IN THE ADRIATIC SEA: IMPLICATIONS FOR BIOMONITORING

Bojan Hamer [1], Emina Durmiši [2]*, Vedrana Nerlovic [1] and Nicolas Bierne [3]
[1] Ruder Boškovic Insitute Center for Marien Research
[2] Juraj Dobrila University of Pula, Pula, Croatia - edurmisi@unipu.hr
[3] Universite Montpellier 2, Institut de l'Evolution, Sete, France

Abstract
Mussels *Mytilus* spp. belong to a group of key species in coastal marine ecosystems. This work demonstrates the dominant presence of Mediterranean mussel *M. galloprovincialis* along eastern Adriatic coast. Morphometric characteristics of sampled mussels were inside normal values for *M. galloprovincials*, with a height/length ratio of 55.89 ± 5.08 % and a width/length ratio of 38.76 ± 3.42 %. Populations of Croatian Adriatic Sea were nearly fixed for the G allele at the Me 15/16 locus as it is usually observed with M. galloprovincialis samples. However, two specimens among the 110 analysed showed a heterozygote genotype: one with an E (*M. edulis)* allele and one with a T (*M. trossulus*) allele. By sequencing PCR products we proved that the 126 bp, 168 bp and 180 bp bands correspond to the G, T and E alleles previously reported.

Keywords: Mollusca, North Adriatic Sea, Genetics

INTRODUCTION
There are four species of mussel of the genus *Mytilus*: *M. californianus* Conrad, 1837; *M. edulis* Linnaeus, 1758; *M. galloprovincialis* Lamarck, 1819 and *M. trossulus* Gould, 1850 [1]. In Europe *M. galloprovincialis* is found in the Black Sea, the Mediterranean Sea and the Iberian Atlantic coasts, *M. edulis* predominates in central and northern Europe, and *M. trossulus* occurs in the Baltic Sea and presumably in some other areas in northern Europe [2]. Identification of *M. edulis, M. galloprovincialis* and *M. trossulus* based on shell shape and morphometric parameters is usually uncertain because of the extreme shape plasticity exhibited by mussels under environmental variation [2]. Molecular markers now allow for positive identification of species although introgression sometimes obscures, if not biases when dismissed, the interpretation [3]. However, no large-scale detailed studies have been carried out to characterise the possible occurrence, even at low frequency, of heterospecific diagnostic alleles in the Mediterranean Sea [4, 5].

RESULTS
Morphometric characterisitcs of mussel shells
Morphometric characterization was done for collected *Mytilus galoprovincialis* (M.g). on the basis of 110 specimens, commercial *M. edulis* and *M. galloprovincialis* 20 specimens each. Morphometric measures were within normal values for *M. galloprovincials*: height/length 55.89 ± 5.08 % and width/length 38.76 ± 3.42 %.

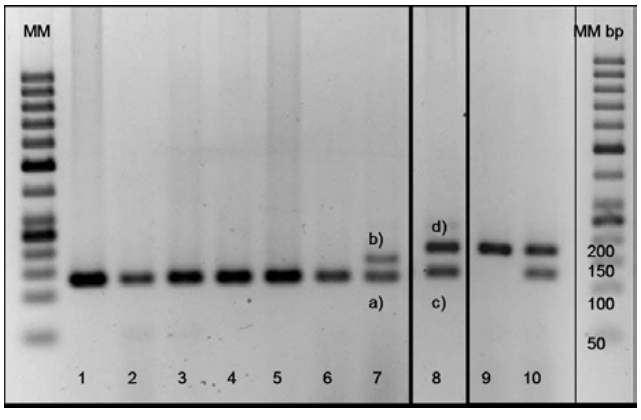

Fig. 1. Agarose gel with Me 15/16 PCR products: 1-6) *Mytilus galloprovincialis*, 7) heterozygous mussel with *M. galloprovincialis* and *M. trossulus*-type alleles, 8) heterozygote mussel M. g. and M. e. 9) control M. edulis and 10) composite sample of M. e. and M. g. with Mw markers (MM).

PCR sample analyses using Me 15/16 primers
Mytilus galloprovincialis (G) alleles were identified in all mussel samples/specimens at all 22 investigated sites. For the first time the presence of mussel heterozygote genotype were detected: M. *galloprovincialis – M. edulis* (GE-type alleles, site 9. Borik) and *M. galloprovincialis – M. trossulus* (GT-type alleles, site 15. Vranjic) using PCR (Mefp-1) amplification and sequencing analyses.
Although there was a tendency for the height/length values of heterozygote individuals to be closer to *M. edulis* (GE: h/l 46.90 %, w/l 38.45 %, GT: h/l 48.91 %, w/l 39.11 %), this was not significant.

Sequence analyses of PCR Me 15/16 products
Purified bands were directly sequenced using the same primers and obtained sequences were afterwards blasted: bands 1-6, 7a, 8c corresponded to *M. galloprovincialis*-type allele (Accession number: D63778.1, 3e-50), band 7b (*M. trossulus*, D50553.1, 5e-54), band 8d (*M. edulis*, AY845258.1, 9e-82), and band 9 (M. edulis, AY845258.1, 2e-83). After comparing the blast results we are confident that different sized PCR products represented the presence of *M. galloprovincialis, M. edulis* and *M. trossulus* adhesive foot protein gene alleles.

CONCLUSIONS
Morphometric measures were within normal values for *M. galloprovincials*: height/length 55.89 ± 5.08 % and width/length 38.76 ± 3.42 %.
Different alleles of the Me 15/16 locus and hybrids are detected in mussel populations of Croatian Adriatic Sea.
Species of the "*M. edulis* complex" or hybrids look very similar but have different growth rates, physiology adaptation, fitness, and therewith different aquacultre potential, pollution and stress tolerance.
Therefore, to prevent possible inaccurate interpretation of biomarker results, beside genetic identification of sampled species, additional parameters are welcome, making sure that the response measured is representative for the species and not for a particular individual of group of specimens.

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BATHYMETRIC COMPARISON OF MEGAFAUNA IN THE SOUTH PART OF KYPARISSIA BAY, IONIAN SEA, GREECE

Giorgos Gitarakos [1]*, Pavlos Vidoris [1], Kostas Efthimiadis [1] and Argyris Kallianiotis [1]
[1] H.A.O. - Demeter, Fisheries Research Institute - geogitar@yahoo.gr

Abstract
Three samplings were carried out with bottom trawler in the southern part of Kyparissia Bay to record the fish fauna and to compare the different depth zones. It came out that the depth zones of 40 and 60 meters were more similar between them compared to that of 20 meters. The mean similarities of hauls inside each depth zone as well as the main species responsible for that similarity were calculated with ANOSIM and SIMPER analyses. The level of differentiation between depth zones was calculated with Two-way ANOSIM. The conclusion was that between depth zones species differed significantly, but similarities were also noticed. The most significant mean difference was between the 20 and 60 meter zones.

Keywords: Bathymetry, Ionian Sea, Trawl surveys

Introduction: A series of samplings took place in the southern part of Kyparissia Bay during the maturation study for the creation of an artificial reef. The maturation study aims at the recording of the area's fish fauna in the reef submersion area, the comparison of different depth zones and the assessment of the ecosystem's disorder by calculation of biodiversity indices. **Materials and methods:** Three seasonal samplings were carried out during 2010 (23/5, 2/6 and 30/9) with professional bottom trawler in selected routes so that the hauls to be parallel to the isobaths of 20, 40 and 60 meters. Three hauls per sampling were carried out. The catches were determined in the field in the taxonomic level of species and then they were weighted and measured. Species densities calculated in kilograms per km² were used for the comparison of the depth zones. Only the species that were recorded in at least 2 out of the 9 hauls were used in the statistical analysis. The dendrogram of similarities between the stations (cluster analysis) was calculated with non-parametric, multivariate analysis using the statistical program PRIMER (1) and by the triangular similarity matrix, based on the Bray - Curtis similarity indices between stations, after the transformation of data in [(χ½)½] was carried out. The statistical tests for the differentiation between depth zones and the determination of the main species responsible for the calculated differences were based on the statistical analyses ANOSIM (2) and SIMPER (3). **Results and discussion:** 61 species (47 fish, 6 cephalopods and 8 crustaceans) were recorded during the three sampling periods. 31 of them were used in the analyses since they were recorded in 2 or more hauls. The dendrogram of similarities (Fig.1) indicates that the stations were grouped per depth zone and that the depth zones of 40 and 60 meters are more similar between them than the one of 20 meters which is grouped separately.

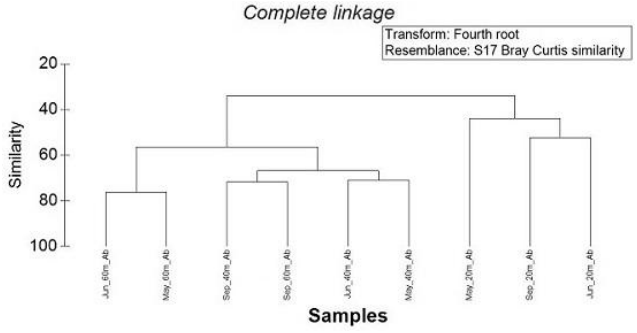

Fig. 1. Dendrogram of similarities for 9 stations sampled during 3 sampling periods. Y axis states % similarity between stations.

Average similarities (%) between hauls in each depth zone and species that contribute to that similarity were calculated with SIMPER analysis (Table I). Two-way ANOSIM was used to calculate *R* values that reveal differentiation between depth zones. *R* values (*R* global 0,667 with significance level 19,5%) show that although there are significant differences between depth zones, there are also similarities concerning species presence and relative abundance. Mean differentiation between the 20 and 40 m. zones was 43,44%, between the 40 and 60 m. zones was 35,71% and between the 20 and 60 m. zones was 52,97%.

Tab. 1. Average similarity for the grouping of stations for 20, 40 and 60 m. zones – Species responsible for the grouping of depth zones (Species) – Average abundance (Av.Abund) per zone - Average similarity of species abundance (Av.sim) - Similarity to standard deviation ratio (Sim/SD) – Contribution % to the similarity (Contrib%) – Cumulative contribution (Cum%).

Group 20m. zone	Average similarity 47,87%				
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Mullus barbatus	15699	13,15	16,85	27,46	27,46
Pagellus erythrinus	1943	7,09	4,29	14,81	42,27
Trigla lucerna	130	4,76	6,7	9,94	52,21

Group 40m. Zone	Average similarity 70,17%				
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Mullus barbatus	21828	10,46	5,38	14,9	14,9
Pagellus erythrinus	9792	9,93	14,69	14,15	29,06
Spicara flexuosa	4590	8,59	36,3	12,24	41,3
Serranus hepatus	1056	5,57	35,59	7,94	49,24
Trachurus mediterraneus	495	5,07	17,08	7,22	56,46

Group 60m. Zone	Average similarity 70,14%				
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Sardina pilchardus	3234	7,21	9,8	10,28	10,28
Spicara flexuosa	7576	6,49	8,35	9,25	19,53
Parapenaeus longirostris	1369	6,03	8,61	8,59	28,12
Mullus barbatus	3586	5,89	8,56	8,4	36,52
Boops boops	1095	5,08	8,75	7,25	43,77
Serranus hepatus	639	4,87	9,86	6,94	50,71

The main species cumulatively responsible for at least 50% of zonal differentiation and their individual contribution was calculated with SIMPER analysis. Those were (with their contribution in parenthesis) *Mullus barbatus* (8,44%), *Spicara flexuosa* (6,58%), *Pagellus erythrinus* (6,31%), *Lepidotrigla cavillone* (5,76%), *Serranus hepatus* (5,51%), *Trachurus mediterraneus* (5,21%), *Boops boops* (4,8%), *Spicara smaris* (4,64%), *Bothus podas* (4,46%) for the differentiation between 20 and 40m., *Parapenaeus longirostris* (9,26%), *Sardina pilchardus* (8,34%), *P. erythrinus* (7,77%), *M. barbatus* (6,37%), *Trigloporus lastoviza* (5,24%), *Engraulis encrasicholus* (4,68%), *Pagellus acarne* (3,67%), *Citharus linguatula* (3,48%), *S. flexuosa* (3,33%) between 40 and 60m. and *S. pilchardus* (9%), *P. longirostris* (7,33%), *Merluccius merluccius* (5,86%), *B. boops* (5,42%), *S. flexuosa* (4,72%), *T. mediterraneus* (4,7%), *M. barbatus* (4,19%), *S. smaris* (3,88%), *S. hepatus* (3,78%) and *Sepia elegans* (3,38%) for the differentiaton between 20 and 60m. zones.

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BATHYMETRIC DISTRIBUTION OF NON-DECAPOD CRUSTACEAN INVERTEBRATA SPECIES IN THE DEEP NORTHERN AEGEAN SEA

Onur Gönülal [1]*
[1] Istanbul University - ogonulal@istanbul.edu.tr

Abstract
The objective of the present study is to describe non-crustacean invertebrata species community in the deep northern Aegean Sea. We sampled non-crustacean invertebrata inhabiting the depth zone between 500 and 1500 m off the Gökçeada island (northern Aegean Sea). A total of 15 species of non-crustacean invertebrata has been identified at 33 stations.

Keywords: Deep sea ecology, North Aegean Trough, Zoobenthos

Introduction
The deep-sea environment is characterised by distinct vertical gradients of pressure, light, temperature and food availability [1]. The Mediterranean differs from other deep-sea ecosystems in terms of its species composition [5]. Typical deep-water groups, such as foraminifera and glass sponges are absent in the deep Mediterranean, while other faunistic groups (fishes, decapod crustaceans, mysids and gastropods) are poorly represented compared to the NE Atlantic [3] . Reviews on the biology and ecology of the Mediterranean deep sea have been published in recent years [4-5]. Depth-related changes in benthic fauna have frequently been studied in North-West and Central Mediterranean sea. Methods The deep-slope non-crustacean invertebrata fauna of the North Aegean sea was sampled with baited traps. A total of 33 stations were sampled between May 2010 and November 2011 in north eastern Aegean Sea trench (Fig 1). A total of 15 species belonging to various order were determined in five bathymetric intervals, 500-600 m, 600-800 m, 800-1000 m, 1000-1500 m. The results were analysed in terms of composition and distribution of benthic and benthopelagic bait-attracted species depth strata.

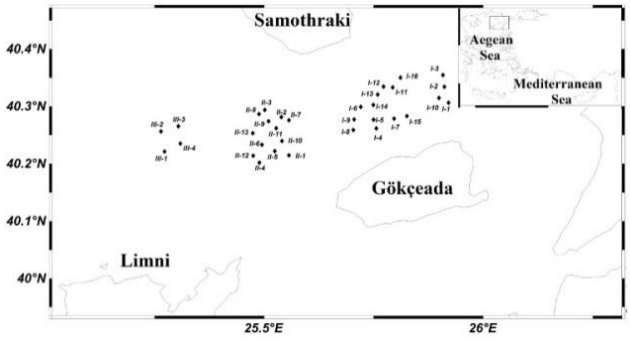

Fig. 1. Sampling station

Results and Discussion
The paucity of number of species in reported from deep sea ecosystems is mainly caused by sampling difficulties that result in low replicate numbers. Occurrence and percentage occurrence in all samples and bathymetric ranges were calculated for each species (Table 1). The most common species was *Euspira fusca*. It is followed by *Eurydice spinigera*. *Epimeria cornigera* and Polychaeta III sp. were present only at the deepest stratum (1000-1500 m). Changes in the species composition of the non-decapod crustacean fauna in the Northern Aegean sea consist basically in a decrease of the number of species with depth although the lowest numbers were not found at the deepest stations In adddition two pelagic gastropod *Diacria trispinosa* and *Cavolinia gibbosa* together with the gastropoda *Scaphander punctostriatus* are new record for the Turkish seas.

Tab. 1. Depth range, occurrence in numbers of each species in the total of samples (O), and percentage occurrence of each species in the total samples (% F) within each depth interval *new record for the Turkish seas

Systematic groups	Species	Depth Stratum (m) 500-600	600-800	800-1000	1000-1500	O	% F
Ophiuroidea	*Amphiura chiajei*	0	0	2.6	1.1	3	9.37
	Amphiura sp.	0	0	5.7	0	2	6.25
Mollusca	*Euspira fusca*	13.8	10.3	7.7	0	5	15.62
	*Diacria trispinosa**	1.1	0.4	0	0	3	9.37
	*Cavolinia gibbosa**	1.9	0.4	0	0	3	9.37
	Abra abra	0	0	2.6	2.6	2	6.25
	*Scaphander punctostriatus**	0	0	0.4	0.4	2	6.25
Amphipoda	*Scopelocheirus sp.*	0.4	5.5	0	0	3	9.37
	Epimeria cornigera	0	0	0	1.9	4	12.5
	Platyscelus serratulus	2.6	0	0	0	1	3.12
Leptostraca	*Nebalia abyssicola*		0	0	0	3	9.37
Isopoda	*Eurydice spinigera*	0	0	0	2.6	2	6.25
Polychaeta	Polychaeta I sp	1.5	0	0	0	2	6.25
	Polychaeta II sp	1.1	5.7	0	0	1	3.12
	Polychaeta III sp	0	0	0	1.9	3	9.37
Number of total species		7	5	5	6		

Acknowledgment The author thanks Prof Dr Bayram ÖZTÜRK and Eda TOPÇU for their help

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THE TURKISH STRAITS SYSTEM - PHYLOGEOGRAPHIC BREAK FOR THE CARIDEAN SHRIMP *PALAEMON ELEGANS* (CRUSTACEA: DECAPODA)

Evrim Kalkan [1]*, Selahattin Ünsal Karhan [2], Mehmet Baki Yokes [3] and Rasit Bilgin [4]
[1] Department of Environmental Sciences, Institute of Environmental Sciences, Bogazici University, 34342, Istanbul, Turkey - evrimkalkan@gmail.com
[2] Department of Biology, Faculty of Science, Istanbul University, 34134 Vezneciler, Istanbul, Turkey
[3] Department of Molecular Biology & Genetics, Faculty of Arts & Sciences, Haliç University, 34381 Sisli, Istanbul, Turkey
[4] Department of Environmental Sciences, Institute of Environmental Sciences, Bogazici University, 34342, Istanbul, Turkey

Abstract
The population genetic structure of *Palaemon elegans* has been investigated along the Turkish coasts using 16S rRNA and COI mitochondrial genes. Our findings revealed two distinct haplogroups in the region which were defined in a previous study. Dispersal of these two haplogroups which potentially correspond to separate cryptic species seems to be affected by the two layered current regime of the Turkish Straits System.

Keywords: Crustacea, Genetics, Black Sea, Marmara Sea, North-Eastern Mediterranean

Introduction
The detection of population differentiation in the marine realm is not straightforward due to the high dispersal capabilities of eggs, larvae and adults (Palumbi 1994; Ward et al. 1994). In addition, geographic barriers, considered to comprise one of the main mechanisms of speciation are far less obvious in the marine environment (Cunningham & Collins 1998; Palumbi 1994; Ward et al. 1994). However, all these generalizations may not be valid in every situation. Many studies have shown that high dispersal capabilities of marine organisms do not necessarily translate into high levels of realized gene flow (see Patarnello et al. 2007). In addition, straits can act as potential geographic barriers to gene flow in the marine environment (e.g. Briggs & Bowen 2012; Goldstien et al. 2006). In this study, we investigated the role of a unique marine ecosystem, the two-layered current regime of the Turkish Straits System (TSS), on the genetic structure of *Palaemon elegans* Rathke, 1837 populations. The system, consisting of the Bosphorus Strait, the Sea of Marmara and the Dardanelles, is the only connection between the Black Sea and the Mediterranean.

Materials and methods
210 samples of *P. elegans* were collected from 21 sites comprising the Black Sea (six), TSS (four) and the Mediterranean (eleven), and partial fragments of the mitochondrial large subunit rRNA (16S) and cytochrome oxidase subunit I (COI) genes were amplified and sequenced.

Results and discussion
The results showed 33 haplotypes and 52 variable sites (30 parsimony informative sites) for 16S ($h = 0.78 \pm 0.018$ and $\pi = 0.0151 \pm 0.0026$), and 78 haplotypes and 59 variable sites (34 parsimony informative) for COI ($h = 0.91 \pm 0.015$ and $\pi = 0.0395 \pm 0.0007$). Two different haplogroups (referred to as Group I and Group II) were retrieved for both of the genes in the haplotype networks. The analysis of molecular variance (AMOVA) indicated high levels of genetic structure among the populations ($\Phi = 0.78$ for 16S and $\Phi = 0.91$ for COI) when populations were grouped as Group I and II. Phylogenetic trees constructed using neighbor-joining and maximum likelihood methods also supported the differentiation of the groups I and II as two distinct clades. Reuschel et al. (2010) revealed a complex population structure in *P. elegans* and clearly distinct genetic lineages using 16S rRNA and COI mitochondrial genes with samples from Northeastern Atlantic, Baltic Sea, entire Mediterranean, Black Sea and Caspian Sea. Their defined haplogroups of Type II and Type III match our groups II and I, respectively. In our study, Group I with samples distributed relatively evenly includes specimens from all sampling sites. On the other hand, Group II consists mostly of samples from the Mediterranean, with only a few from the Black Sea and the TSS. It is likely that due to the two-layered currents of the TSS flowing in opposite directions (from the Black Sea to the Aegean at the top layer, and vice versa in the bottom), Group I was able to disperse from the Black Sea to the Mediterranean relatively easily after the last ice age. On the other hand, group II, originating in the Mediterranean was not able establish itself as effectively in the Black Sea (which has brackish water characteristics). Type III in Reuschel et al. (2010) which correspond to our Group I also seems to prefer brackish water habitats. Reuschel et al. (2010) suggested that these different genetic types may correspond to separate cryptic species and our findings also support the existence of two taxa of *P. elegans* around Turkey as well.

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FISH COMMUNITIES AND THEIR DEPTH DISTRIBUTION AT VERTICAL CORRALIGEN REEFS IN THE ADRIATIC

Alen Soldo [1]* and Igor Glavicic [1]
[1] DEPARTMENT OF MARINE STUDIES, UNIVERSITY OF SPLIT - soldo@unist.hr

Abstract
Transect visual census method was used to investigated fish communities at vertical corraligenous reef from the surface to 50 m of depth. Total of 32 different fish species were observed, while the analysis indicated that temperature is the dominant factor influencing the depth distribution of the fish species during the summer period.

Keywords: Biodiversity, Central Adriatic Sea, Fishes

Introduction
Nowadays, in many marine habitats capture methods for obtaining various data are not allowed, thus replaced by non-destructive observational techniques, such as underwater visual census methods (UVC). Within various UVC methods, transect method is often used, but it is usually based on research of horizontal transects at depths mainly to 15 m, rarely exceeding 20 m, and nearly never 40 m. Consequently, underwater reefs with vertical walls deeper of 40 m were not investigated, so far.

Material and Methods
The study was carried out during July-August 2012 in area of the island of Hvar channel, central eastern Adriatic. Exact point of study was underwater reef, more than 200 m distant from a coastline, shaped as elliptical truncated and oblique cone. Highest point of the reef is at 9,1 m of depth, while deepest at 60,7 m. One side of the reef has a nearly uniform slope of an 90 degrees angle and exactly that part of the reef was chosen for this study. Base of the chosen part is at 50 m of depth, thus, that was also a deepest depth of the investigated area. Each transect length was 50 m, while width, or height as transects are vertical, was 5 m, making total of 10 transects. Two same divers were used each time, both experienced and skilled in diving and in fish and other marine species identification, for a recording of transects [1]. Compressed air was used for deeper depths while Nitrox as a decompression gas. Total of 15 dives were carried out using HD video camera while additional two dives were performed using photo camera for obtaining high resolution photos of smaller species used for their accurate identification. Temperature changes were measured at the end of each transect and additionally stored by Mares Icon HD diving computer.

Results and Discussion
Cover of the investigated reef area is coralligenous, with dominant species, depending on depth, green algae *Codium bursa* and *Flabellia petiolata*, bryozoan *Pentapora fascialis*, ascidian *Halocynthia papillosa*, and corals *Eunicella cavolini* and *Parazoanthus axinellae*. Total of 32 different fish species were observed, belonging to 13 families, with Sparidae, represented by 9 species, as dominant. Composition of fish species observed during this research showed high similarities with results of census study on the rocky coasts in western Adriatic area [2]. *Diplodus vulgaris* was dominant by number and total weight. Within all species only *Chromis chromis* was observed in all transects, from surface to 50 m. Second most distributed fish was *Coris julis*, absent only from surface to 8 m depth. Third most distributed species was *Gobius auratus*, present in all transects, except in water column, as this species lives exclusively in close contact with bottom. Correspondence analysis of species depth distribution (Fig.1) showed high similarities of transects 5-15 m, 25-35 m and 35-45 m. Transects 5-15 m and 45-50 m were most different compared to others probably due to reason that 5-15 m transects were above thermocline, while 45-50 m transect is the only one in contact with sandy bottom. The analysis indicated that temperature is the dominant factor influencing the depth distribution of the species during the summer period. Lowest number of species was observed exactly above and below the thermocline which usually occurred from 12 to 16 m of depth (Fig. 2). Species observed exclusively above the thermocline were *Symphodus tinca, Triperygion delaisi, Serranus scriba, Oblada melanura, Sparus aurata* and *Sarpa salpa*, while species observed only below the thermocline were *Labrus bimaculatus, Phycis phycis, Conger conger, Gobius geniporus, Gobius cruentatus, Gobius kolombatovici, Thorogobius ephipiatus, Serranus cabrilla, Scorpaena notata, Scorpaena scrofa, Spondyliosoma cantharus, Lithognathus mormyrus* and *Trigla lyra*.

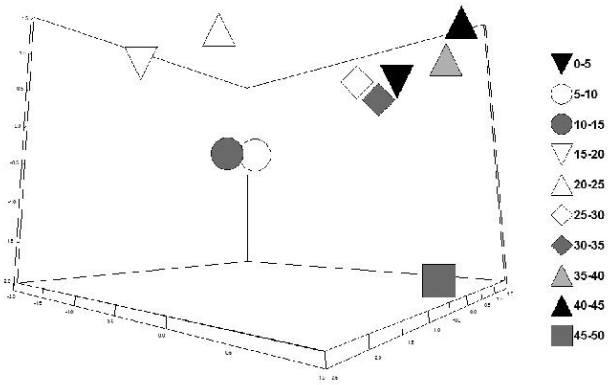

Fig. 1. Correspondence analysis of fish species depth distribution.

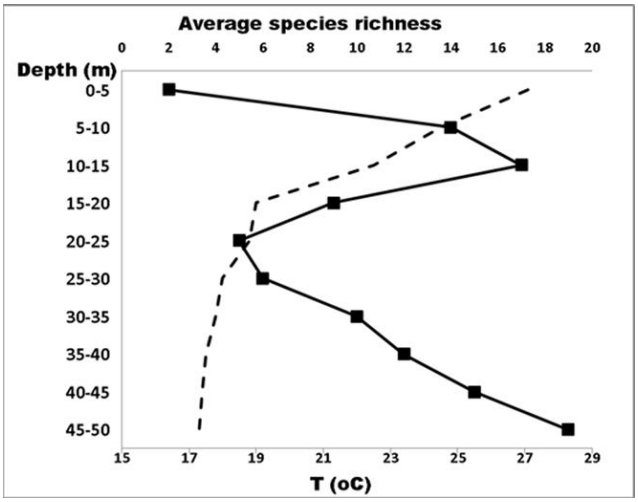

Fig. 2. Average species richness (solid line) in relation to depth and temperature (dashed line).

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OSTREOPSIS: RÉPARTITION DU STOCK MACROAGAL SUR LES CÔTES MÉDITERRANÉENES FRANÇAISES - DÉTERMINISMES ENVIRONNEMENTAUX.

Hubert Grossel [1], Thierry Thibaut [2]*, Aurélie Blanfuné [2] and Camille Brissac [1]
[1] IFREMER La Seyne-sur-Mer Laboratoire Environnement Ressources / Provence-Azur-Corse
[2] Université de Nice EA 42-28 ECOMERS - Thierry.THIBAUT@unice.fr

Abstract
Cartographie du stock d'*Ostreopsis* macroalgal sur les côtes méditerranéennes françaises. En région PACA les Alpes-Maritimes sont des sites favorables, ainsi que la région de Marseille. En Corse, l'*Ostreopsis* est ubiquiste, mais la côte Ouest est la plus concernée. En Languedoc-Roussillon, l'*Ostreopsis* est très faiblement présent. Une analyse temporelle avec imagerie satellitaire et modélisation montre la complexité de l'évolution des stocks, mais pointe le rôle possible des dessalures issues des bassins versants.

Keywords: North-Western Mediterranean, Coastal waters, Blooms, Algae, River input

Le projet OSCREEN, soutenu par l'Agence de l'Eau RM&C, a permis à l'été 2011 de cartographier la présence du microflagellé épibenthique potentiellement toxique *Ostreopsis* spp sur le littoral méditerranéen français.

Les évaluations ont été faites à partir de trois prélèvements de macro-algues en juin, juillet et août, sur 80 stations du littoral méditerranéen français. Après séparation des macro-algues, les cellules d'*Ostreopsis* ont été dénombrées soit par la méthode Utermhöl, soit avec des lames de Sedgewick-Rafter, après avoir établi l'équivalence des méthodes.

On a pu ainsi établir la variabilité de sa présence sur les trois régions Provence-Alpes-Côte d'Azur, Corse et Languedoc-Roussillon. L'*Ostreopsis* se révèle présent à des niveaux très variables, sans doute en raison de la configuration de la côte (faciès rocheux et couverture macroalgale), et de la variabilité de facteurs environnementaux tels que la température et la salinité.
1. en région PACA, le secteur Est (globalement les Alpes Maritimes) réunit les sites où les dénombrements sont les plus significatifs. Le Var et les Bouches-du-Rhône semblent moins touchés, à l'exception de la région de Marseille (exemple des îles du Frioul).
2. en région Languedoc-Roussillon, l'*Ostreopsis* est présent, mais à des niveaux faibles qui semblent indiquer l'absence d'enjeu d'ordre sanitaire ou environnemental.
3. en Corse, l'*Ostreopsis* est ubiquiste, et la côte occidentale atteste de niveaux de présence significatifs, surtout entre Propriano et l'Île Rousse.

Sur huit stations d'observation, une analyse temporelle des stocks macroalgaux d'*Ostreopsis spp.*, couplée avec l'utilisation d'outils d'imagerie spatiale et de modélisation hydrodynamique, a montré la complexité des interprétations des tendances, mais a mis en évidence le rôle probable des dessalures et de leurs apports induits sur l'ampleur des efflorescences de l'*Ostreopsis spp.* La figure 1 illustre la relation entre la variabilité de la salinité établie pour chacun des huit sites, *t*émoin des conditions pluviométriques qui ont caractérisé l'été 2011 ainsi que des apports des bassins versant , et l'importance des stocks d'*Ostreopsis* macro-algal rencontrés sur ces sites.

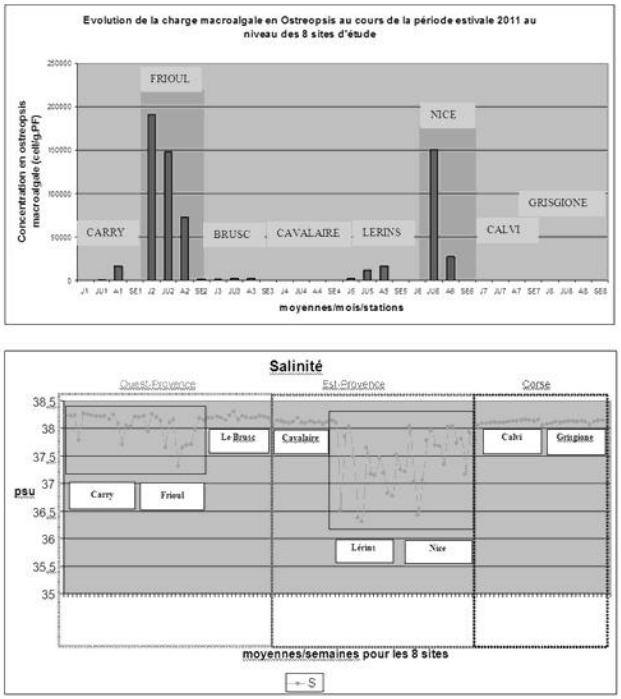

Fig. 1. Relation entre les stocks marcoalgaux d'*Ostreopsis* et la variabilité de la salinité sur les huit sites

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Session

Biogeographic trends

Modérateur : **Carlo Froglia**

ON THE RECENT INCREASE OF *PENAEUS (MELICERTUS) KERATHURUS* STOCK IN NORTHERN AND CENTRAL ADRIATIC SEA: POSSIBLE EXPLANATIONS

Carlo Froglia [1]*, Giuseppe Scarcella [1] and Alessandro Lucchetti [1]
[1] C.N.R. - ISMAR, u.o.s. Ancona, Largo Fiera della Pesca, 60125 ANCONA - ITALY - c.froglia@alice.it

Abstract
The penaeid shrimp *Penaeus (Melicertus) kerathurus*, never recorded in the Northern Adriatic before the 20th century, has become a valuable fishery resource in the last 20 years. The stock increase in the Adriatic may be related to the warming of the basin and the build-up of suitable nursery grounds all along the West coast, after the construction of detached breakwaters to reduce erosion of sandy beaches.

Keywords: Central Adriatic Sea, Fisheries, Tropicalization, Decapoda, North Adriatic Sea

The caramote shrimp is a large Mediterranean autochthonous shrimp that lives on soft bottoms of the continental shelf, usually at less than 60 meters depth; juveniles enter lagoons and are common on coastal grounds in late summer and autumn. It is caught mainly with bottom trawls and fixed set nets. Therefore it could not escape attention of fishermen and early naturalists. It was reported, already in the early 19th century, from all over the Mediterranean Sea as: *Cancer kerathurus* Forskål, 1775 (Smirne and Alessandria), *Alpheus caramote* Risso, 1816 (Nice), *Melicertus tigrinus* Rafinesque-Schmaltz, 1814 (Sicily).
But in the Adriatic Sea, one of the best studied areas of the Mediterranean Sea, it was unknown until the second half of the 19th century. The first record, from the South-eastern Adriatic, dates to 1863 [1] and Pesta in 1918 [2] still considered its presence in the North Adriatic Sea as doubtful.
Nowadays it is a highly valuable fishery resource in the northern and central Adriatic Sea (GSA-17), with annual landings estimated around 500 tons, peaking in the last quarter of the year, when the new generation of shrimps, born in summer, moves offshore and is fully recruited to the fishery.
Penaeus kerathurus has always been a high priced shrimp, due to its large size and the quality of meat, but statistics of its landings are not available for the Adriatic Sea prior to 1980's, because the few specimens caught were sold in mixed boxes of first category sea-food. Landings significantly increased at the end of 1980's and separate statistics for the product auctioned in the main gross fish-markets were recorded. Data available for the main fishing harbour of the Central Adriatic (Ancona) and of the North Adriatic (Chioggia) [3] are presented in Fig. 1.

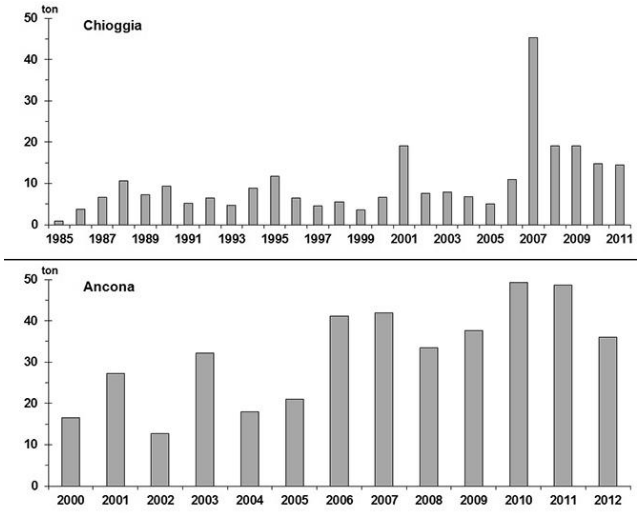

Fig. 1. *Penaeus kerathurus* auctioned yearly in the fish-markets of Ancona and Chioggia.

A marked reduction of the landings of *Nephrops norvegicus* was recorded in the same years. *Nephrops norvegicus* is a cold-temperate species, distributed from southern Iceland to Morocco, whereas *P. kerathurus* is a warm-temperate species, distributed from Angola to southern England.

Thus the increase, and northward expansion, of the Adriatic stock of *P. kerathurus* could be regarded as another example of "meridionalization" of northern sectors of the Mediterranean sea, as consequence of its warming [4]. But at least two other factors have acted synergically.
1) The Italian annual ban of trawling for 30-45 days at the end of summer, in force since 1987, and the other measures taken more recently to reduce the fishing effort exerted by towed gears in coastal waters have been highly beneficial to *P. kerathurus*, characterized by short life-span (max. <3 years), fast growth and reproduction at the end of first year of life (in the early summer). Limited effects could be expected from this reduction of fishing effort, for *N. norvegicus*, that has a different life history (long living, slow growing and first spawning only in the third year of life).
2) In the last 50 years, detached breakwaters have been built parallel to the shore, at 100-200 m from shoreline, all along the West Adriatic coast, to reduce erosion of sandy beaches [5]; these man-made structures form a kind of narrow "lagoon" (Fig. 2) that extends for hundreds of kilometers south of the Po River Delta and acts as a new suitable nursery ground for the shrimps, enhancing recruitment.

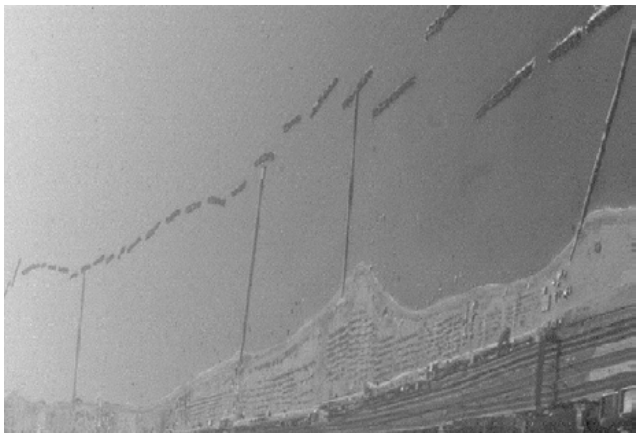

Fig. 2. Central Adriatic, aerial view of breakwaters built in front of the shoreline

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20-YEARS OCCURRENCE OF THE INVASIVE ALGA *CAULERPA RACEMOSA* VAR. *CYLINDRACEA* IN GREECE

Panayotis Panayotidis [1]* and Konstantinos Tsiamis [1]
[1] Hellenic Center for Marine Research - ppanag@hcmr.gr

Abstract
The green seaweed *Caulerpa racemosa* var. *cylindracea* is one of the most aggressive and broadly distributed invasive taxa in the Mediterranean Sea. In the present study, an updated range expansion of the alga is provided for the Greek coasts, based on literature sources and recent personal collections. Moreover, invasive events hitherto reported from the Greek coasts are also cited in detail

Keywords: Algae, Aegean Sea, Alien species, Ionian Sea

The green alga *Caulerpa racemosa* var. *cylindracea* (Sonder) Verlaque, Huisman & Boudouresque (Bryopsidales, Caulerpaceae) is one of the most notorious and aggressive invaders in the Mediterranean Sea ([1]). Since the last decade of the 20th century it has exhibited a spectacular expansion in the whole Mediterranean basin ([2]). Its presence has been related with negative impacts to the native benthic communities ([3]). Nevertheless, some positive impacts have been reported from deeper un-vegetated habitats (Relini, personal communication).
In the present study an updated range expansion of *C. racemosa* var. *cylindracea* (hereafter *C. racemosa*) along the Greek coasts is presented, based on both literature records and our recent collections (years 2007-2013), as part of one of the authors (KT) PhD thesis.
After 20 years since its first report from Greece (1993 in Zakynthos Island [4]), today *C. racemosa* var. *cylindracea* can be found in the majority of the Greek seas (Figure 1), presenting an extremely high dispersion rate, possibly related with translocation in short distances through shipping (anchoring and fishing equipment). In fact, an ongoing gradual expansion from the S. Aegean towards the N. Aegean Sea can be observed (Figure 1).

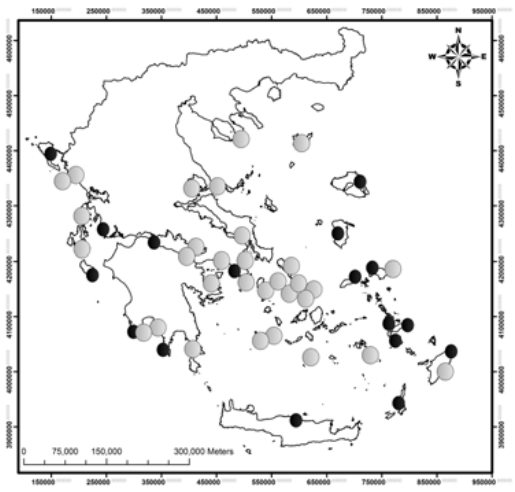

Fig. 1. Distribution records and range expansion of Caulerpa racemosa var. cylindracea in Greece. Both old (before 2007 - black dots) and new records (after 2007 - grey dots) are also given.

C. racemosa is present through the whole year, but higher abundances have been recorded during summer months. Holocarpic plants have been also recorded during summer. There is an intense polymorphism of the thallus depending on the depth and the hydrodynamism (vesicles distichously to spirally arranged on the erect fronds).
C. racemosa presents a broad ecological niche, since it has been found on both polluted and pristine sites, in hard and soft substrates, from surface level down to 70 m depth. However, more abundant populations have been found on rocky slopes with macroalgae and on dead *Posidonia* mattes ([5], [6]).
Although *C. racemosa* has been found on numerous Greek coasts, only in 5 cases invasive behavior has been reported (Table 1). During our recent deep-sea exhibition using ROVs down to 120 m depth in the Greek Ionian Sea, vast meadows of *C. racemosa* lying between 40-70 m depth on sandy and muddy bottoms were detected (Table 1). This monopolization of the sea-bottom should be related with the empty ecological niches found on those depths and substrates. On the other hand, in swallower habitats, where competition from the native flora is much higher, *C. racemosa* abundance seems to be restricted in lower values.

Tab. 1. Invasive events of *Caulerpa racemosa* var. *cylindracea* in Greece

Site	Season	Depth	Substrate	Reference
Laganas, Zakynthos Isl.	Spring 2001	2-3 m	rocky / sandy	[7]
Agios Kosmas, Saronikos	June 2007	2 m	rocky	[8]
Chios Isl.	August 2009	0-10 m	rocky	[9]
Kalamaki, Korithiakos	July 2012	30-40 m	sandy	present study
Argostoli, Kephallonia	March 2013	40-80 m	muddy	present study

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LES *ANTHOZOAIRES HEXACORALLIAIRES* DES EAUX FROIDES ET CÔTIÈRES AU NORD DU MAROC: CAS DES AIRES MARINES PROTÉGÉES

Mohammed Ramdani [1]* and Najat Elkhiati [2]
[1] Université Mohammed V Agdal Institut Scientifique Rabat - mramdani@israbat.ac.ma
[2] Université Hassan 2 Ain Chock, Faculté des Sciences Casablanca

Abstract
Les analyses des spécimens pris par les chalutiers opérant dans la mer d'Alboran et les recherches menées à bord du bateau M.S. Meriane en 2006, dans la baie de Cadiz, ont montré la répartition des colonies coralliennes d'eau froide entre Tanger et Al Hoceima. La majorité des colonies sont observées à l'état fossile et ~5% montrent des formes de vie. Les polychètes, mollusques et crustacés observés à l'intérieur ou à proximité du corail des abysses sont menacés par les chalutiers dans l'aire marine protégée d'Al Hoceima et le reste de la côte marocaine en Méditerranée.

Keywords: Alboran Sea, Bathyal

Introduction: La rive sud de la mer d'Alboran a connu la mise en place dune aire marine protégée incorporée dans le parc national d'Al hoceima en 2004 et 4 autres sites d'intéreêt biologique et écologique en cours de réflexion pour les inclure dans les aires marines protégées : Cap des Trois fourches, Sebkha Bouareg (Lagune de nador), l'Embouchure de la Moulouya et la côte des Ghomara. Une faune importante de corail tapisse les fonds marins dans cette rive ; cependant, de nombreuses colonies ne sont connues qu'à l'état fossile dans la zone bordant Tanger au sud de la baie de Cadiz (Gardner, 2001 ; Rodrigues & Cunha, 2005 ; Depreiter *et al.*, 2005 ; Van Rensbergen, P., 2005 ; Van Rensbergen *et al.*, 2005 et Hilário et al., 2010). L'éruption des volcans de boue dans les abysses était la cause de la disparition d'un grand nombre de colonies coralliennes, ce qui a permis de classer ces habitats écologiques parmi les points chauds « hotspot » et les proposer pour des aires marines protégées. La survie de ces colonies menacées de disparition est particulièrement préoccupante chez les scientifiques.

Matériel et méthodes: Les nouvelles technologies océanographiques utilisées dans la partie sud de la baie de Cadiz a servi de base pour la découverte des volcans de boue et les récifs coralliens d'eau froide, à partir de 1999 (Gardner, 2001 ; Rodrigues & Cunha, 2005). La recherche marine menée récemment à bord des chalutiers dans la région d'Alhoceima et du cap des Trois fourches ainsi qu'à bord du bateau Maria S. Meriane en 2006 a permis d'identifier la distribution des principaux domaines de coraux d'eau froide à la frontière des profondeurs de la partie ouest méditerranéenne.

Résultats et discussion Les sédiments récupérés par le carottier multiple dans les zones des volcans de boue aux environs de Tanger, sont peuplés par une importante population d'annélides Pogonophores. Ces vers tubicoles paraissent parfaitement adaptés à la vie en surface des habitats profonds bien oxygénés que dans les strates profondes riches en méthane et en sulfure. Cette population massive de pogonophores est en mesure d'exploiter l'énergie du méthane pour le métabolisme et la croissance. En termes de mode de distribution des colonies du corail d'eau froide dans la baie de Cadiz au large des côtes marocaines, une analyse à été portée sur les *anthozoaires hexacoralliaires (Scléractinaires).* Une attention particulière a été accordée à l'interaction de l'écoulement du fluide actif des volcans de boue avec la présence spatiale des colonies de corail. Les zones parcourues par des caméras OFOS étaient Mercator MV et sa structure de crête adjacente, la crête de Vernadski, l'escarpement du Pen Duick, Renard Ridge, Meknès MV t Captain Arutyonov. En outre, les coraux ont été cartographiés et recueillies le long des pentes profondes affectées par les masses d'eau méditerranéennes. Les communautés coralliennes observées sont majoritairement mortes t à l'état fossile. Aucune trace de vie des espèces *Lophelia pertusa*, *Madrepora oculata*, *Dendrophyllia cornigera*, *D. alternata* et D. cornucopia. Une analyse minutieuse des sédiments ramenés par les carottiers à boîte donne des preuves que l'espèce de corail *Stenocyathus vermiformis* (Pourtalès, 1868) présente peu de formes vivantes dans certains sites visités. Les unités sédimentaires de surface sont dominées par *Dendrophyllia* sp. et Stenocyathus vermiformis. *Spondylus gussoni* est l'espèce de bivalve qui semble étroitement liée lié au squelette de corail. Plus bas escarpoements des volcans de boue, cet assemblage est remplacé de plus en plus par *Madrepora oculata* et Lophelia pertusa. On remarque une association formée de *Desmophyllum crista galli* et *Caryophyllia sarsiae* ou *Caryophyllia calveri*. Selon une étude sur les Hydraires des zones bathyales dans la partie sud de la baie de Cadiz, (Maura *et al.*, 2008), les auteurs se basés sur les séquences des gènes d'ARN mitochondrial et ont identifié 6 familles espèces ont été identifiées dans la zone des abysses bordant les côtes marocaines au voisinage de Tanger : Les Eudendriidae représentée par : *Eudendrium rameum ; Eudendrium* sp. 1 et *Eudendrium* sp. 2. Les Lafoeidae : *Acryptolaria conferta*, Lafoea cf. *dumos*a, *Zygophylax biarmata* et *Zygophylax levinseni marrocanum.* Nous avons observé également cette dernière espèce dans les escarpements chalutables du cap des Trois Fourches et aux environs des iles Shafarinas (cap de l'eau). Les Haleciidae : Halecium sp. 1 ; Les Sertulariidae est représentée par Sertularella gayi robusta, Sertularella polysonias Plumulariidae Nemertesia cf. antennina ; Nemertesia ventriculiformis et Polyplumaria flabellata. La famille des Aglaopheniidae avec: *Aglaophenia lophocarpa - Aglaophenia tubulifera.* Ces colonies coralliennes sont liées à l'eau froide (température allant de 4 à 13 ° C). Elles sont généralement observées à l'état fossile, et quelques localités montrent des formes de vie, à des profondeurs allant de 500 à 3500 mètres sur la baie ibéro-marocaine et au sud de la mer d'Alboran. Ces colonies de coraux d'eaux froides se développent très lentement (dix fois moins vite que les coraux tropicaux d'eau chaude) et forment des structures tridimensionnelles très fragiles et vulnérables. La faune des hexacoralliaires est moins diversifiée dans le versant sud de la mer d'Alboran selon nos observations et la menace provient particulièrement du chalutage intensif dans la région.

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REGIONAL EXTINCTIONS AND INVADERS' DOMINATION: AN ECOSYSTEM PHASE-SHIFT OF LEVANT REEFS

Gil Rilov [1]*
[1] National Institute of Oceanography Israel Oceanographic and Limnological Research (IOLR) - rilovg@ocean.org.il

Abstract
The previously Atlanto-Mediterranean dominated biota of the Levant rocky reefs is showing recent major shifts in its biodiversity. Several ecologically-important species (a vermetid gastropod, sea urchins and a large predatory snail) exhibited major population collapses while several key taxonomic groups (gastropods and bivalves and to some extent fish) are completely dominated by IndoPacific invaders. I suggest that this biogeographic shift may be partly driven by global climate change. The southeastern coastal waters of the Mediterranean have warmed by 1.5-2 °C in the past two decades and may have become too hot for some indigenous species and more hospitable to tropical species. Recent lab experiments indicate that the abundant sea urchin, *Paracentrotus lividus*, is indeed dying during peak summer SST on the Israeli coast.

Keywords: Global change, Zoobenthos, Alien species, Levantine Basin, Echinodermata

The marine biota of the Levant basin was until recently dominated by Northeastern Atlantic and Atlanto-Mediterranean species. However, a major shift in the past few decades is transforming this sea into a new phase in which prevailing indigenous species are disappearing and (mostly) tropical species are taking over by their massive invasion. This has been recently demonstrated with trawl fishery data [1], and here I show that the same process is occurring on rocky reefs, a dominant ecosystem in the shallow waters of the Levant shores.

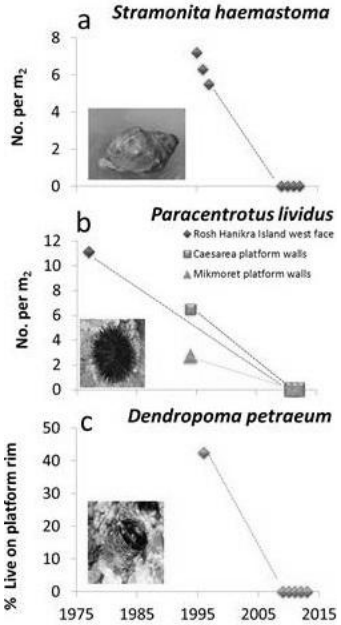

Fig. 1. Changes in (a) whelk density on intertidal rocks (a site in north Israel. The species in the 1990' showed no recruitment of juveniles), (b) urchin density at 3 subtidal reefs where anecdotal surveys were done in the past (today the species is extremely rare), and (c) percent cover of the vermetid at the edge of an intertidal reef on the central coast where the species was still abundant in the mid 1990' (the species was patchy then at both the site and coast scales). *Dendropoma* was still around in the early 2000's [5], but in the past 5 years it has been extremely rare along the Israeli coast (ecologically extinct). The dotted lines demonstrate trends; the trajectory is unknown.

Using past sporadic data and data from a current survey and monitoring program along the entire Israeli coast I show evidence for population collapses and possibly regional near-extinctions of four ecologically important and once highly abundant benthic species (Fig. 1): an ecosystem engineer (vermetid gastropod – *Dendropoma petraeum*), a predator (whelk – *Stramonita haemastoma*, [2]) and herbivores (two sea urchins – *Paracentrotus lividus*, and *Arbacia lixula*). Comparing literature species descriptions to the current surveys suggests that dozens of once abundant native molluscan species are now rare or absent along the Israeli coast. The reasons for the collapses are unknown but because the Levant represents the eastern edge of these species distribution and conditions there are already extreme, climate change (SST has increased by at least 1.5 °C in the past two decades) cannot be ruled out [3]. Recent lab experiments indicate that today's peak summer SST is indeed killing urchins, but past (1980-90's) temperatures do not.

The other side of the change is species additions through bioinvasions [4]. Recent data reveal a massive domination of subtidal rocky reefs and some intertidal reefs by (mostly) Indo-Pacific species. For example, of all benthic fishes (excluding cryptic species) that were counted underwater, more than half were invasive. Other taxonomic groups have dominant invaders, but the most outstanding result is the total domination of the gastropod and bivalve macrofauna by invasive species – 99.5% and 99%, respectfully, of all individuals from those groups counted on the rocks were aliens. The largest bivalve, the invasive oyster-like species, *Spondylus spinosus*, now forms in some areas extensive aggregations that completely change the structure of the reefs. Clearly, the ecological implications of these species collapses and invasions, including their effects on ecosystem functions, must be profound and should be urgently studied.

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Session

Coastal fisheries

Modérateur : **Vassiliki Vassilopoulou**

LES PINGERS COMME MOYEN D'ATTÉNUATION DES INTERACTIONS NÉGATIVES DU GRAND DAUPHIN AVEC LES FILETS MAILLANTS AUX ÎLES KERKENNAH (TUNISIE)

Amani Ayadi [1]*, Mohamed Nejmeddine Bradai [2] and Mohamed Ghorbel [1]
[1] INSTM (Centre de sfax) - instm.amani@hotmail.com
[2] INSTM (Centre de sfax)

Abstract
Aux îles Kerkennah, le grand dauphin entre en interaction avec les filets de pêche et engendre des problèmes socio-économiques épineux. Pour résoudre ce problème, une expérimentation de pingers Aquamark 210 a été effectuée dans le but d'atténuer ce phénomène. Avec le soutien des pêcheurs locaux, les pingers Aquamark 210 ont été expérimentés sur les filets maillant durant la saison estivale. Dans l'ensemble, les filets équipés de pingers ont été plus attaqué que les filets sans pingers. La capture par unité d'effort a été diminuée de 47.5%. Nos résultats suggèrent que les pingers Aquamark 210 testés au niveau des pêcheries artisanales aux îles Kerkennah augmentent le taux d'interaction, mais une étude plus étendue dans le temps serait nécessaire.

Keywords: Acoustics, Cetacea, Tunisian Plateau, South-Central Mediterranean, Coastal waters

Introduction
En Méditerranée, les dauphins sont impliqués dans la déprédation des poissons dans différents engins de pêche, notamment les filets maillants et les filets trémails [1, 2]. En réponse à ce problème, les pêcheurs adoptent souvent des méthodes agressives telles que l'alimentation répugnante pour maintenir les cétacés loin de leurs filets de pêche. Les dispositifs de dissuasion acoustiques tels que les pingers ont été essayés dans plusieurs régions maritimes pour faire face à ce problème: Spain [1]; Italy [3]; Greece [4]; Morocco [5], mais leur efficacité reste encore discutable. La dernière décennie a vu un effort de recherche accru sur l'efficacité de ces dispositifs de dissuasion acoustiques et les résultats montrent que l'efficacité peut varier considérablement entre les zones de pêche, les espèces et l'engin de pêche. Dans ce contexte, l'Institut National des Sciences et Technologies de la Mer (INSTM) avec le soutien financier d'ACCOBAMS (Accord sur la Conservation des Cétacés de la Mer Noire, de la Méditerranée et de la Zone Atlantique Adjacente), a entrepris une étude sur l'efficacité du dispositif acoustique Aquamark 210 conçu pour éloigner les dauphins des filets maillants.

Matériel et méthodes
Pour cette étude, 32 opérations de pêches ont été réalisées durant le mois de Juillet 2010. 16 opérations de pêche ont été équipées par des pingers Aquamark 210 et 16 ont joués le rôle de contrôle (non équipé par des pingers). Au cours des opérations de pêche, les pingers ont été fixé en haut du filet (prés des flotteurs). Au total, nous avons utilisé 27 km de filets maillants dont 12 km sont équipés par des dispositifs acoustiques. Les opérations de pêche ont été réalisées à une profondeur moyenne de 3.9 m et une durée moyenne de mouillage de 46 min.

Résultats et discussion
Etude de la capture par unité d'effort (CPUE)
La capture par unité d'effort totale (kg/50 m de filet) est de l'ordre de 0.132 kg. Cette CPUE varie selon la présence ou l'absence des pingers. Pour les filets maillants équipés de pingers, cette CPUE est de 0.098 alors qu'elle est de 0.166 kg pour les filets sans pingers; cette différence est statistiquement significative (F=4.74, p = 0.038). La figure 1 illustre la variation de la capture par unité d'effort totale en présence et en absence des pingers dans la pêche par les filets maillants à Kerkennah.

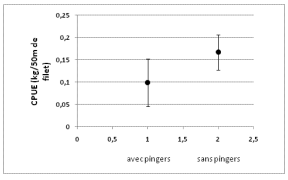

Fig. 1. Variation de la capture par unité d'effort totale en présence et en absence des pingers dans la pêche par les filets maillants à Kerkennah.

Etude de la valeur de la production
Il est à signaler que le prix moyen de poissons est plus élevé pour les pièces de filets non équipées de pinger que dans l'autre cas (43.75 DT (Dinar Tunisien) contre 20.62 DT). Cette différence est statistiquement significative (F=5.4 et p = 0.026). Dans cette étude, les filets équipés de pingers ont subi plus de dégâts, à la fois en termes de production et de pertes à gagner. Il semble que les dauphins s'approchent des pingers au lieu d'être repoussés, ce même résultat a été reporté ailleurs [7]. Il est possible que les dauphins soient alertés des filets et poissons par la présence des pingers. Dans notre cas, l'effet des pingers sur les dauphins peut confirmer l'hypothèse proposée par Kraus et Brault [8] selon laquelle les dauphins ne sont pas gênés par les sons émis par les pingers.

Conclusion
Dans notre étude, les pingers n'ont pas éloignés les dauphins des filets maillants. D'autres études prouvent que les filets maillants équipés de pingers présentent une CPUE plus importante que ceux sans pingers (0.96±0.10 kg/km/h > 0.50±0.06 kg/km/h) [9].

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DISTRIBUTION OF UPPER CONTINENTAL SLOPE FISHES IN THE NORTHEASTERN LEVANTINE SEA (MEDITERRANEAN SEA)

Cem Dalyan [1]*, Emre Yemisken [1] and Lutfiye Eryilmaz [1]
[1] Istanbul University Faculty of Science, Department of Biology - dalyan_cem@yahoo.com

Abstract
30 trawl operations were carried out in the Levantine Sea with the aim to determine the distribution of upper slope fish assemblages. In total, 63 fish species were observed, as mostly composed with *C. agassizi*. The border between the upper and middle slope determined by the soft bottom communities, is at 400-500 m depths in the Mediterranean Sea. Our findings support this information for the Levantine Sea.

Keywords: Fishes, Continental slope, Levantine Basin

Introduction
The major factor on changes of faunal composition for the marine environment is the depth, especially being decisive in upper continental slope organisms that the stocks could be considered instead of exploited coastal fisheries resources [1,2,3]. Moreover, fishing activities are gradually increasing on the upper slope zone of the northeastern Levantine Sea. Yet, there isn't any comprehensive study on distribution of upper slope fishes and their stocks in the Levant Sea. The aim of the present study is to report first data on spatial and temporal characteristics of fish assemblages in the upper slope of northeastern Levantine Sea.

Materials and Methods
This study was carried out between 221 and 777 m depths, 9 – 24 nautical miles off Iskenderun Bay trimonthly (February – May – August – November) in 2010, with 30 trawl operations. Towing speed was measured by GPS as 2.5 – 2.7 knots. Towing time was between 65 and 180 min. The all specimens are identified to the lowest taxonomic category possible. The operations were performed with commercial fishing vessels. In total 63 species (13 Chondrichthyes species belonging to 9 families and 50 Actinopterygii species belonging to 33 families) were collected. Because F. commersonii is found in coastal waters, it was excluded from the analysis and was assumed as an incidental catch. Abundance data was analyzed with multivariate analysis techniques in the package Primer 6 [4].

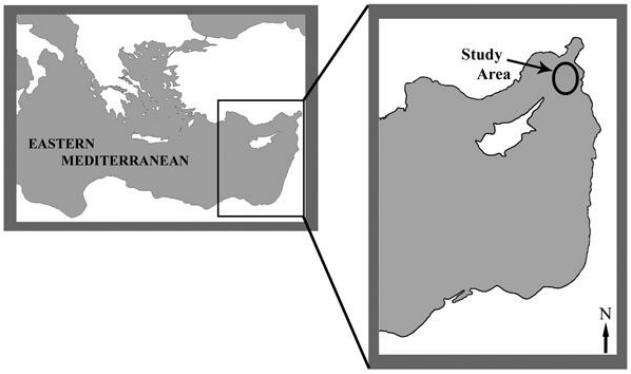

Fig. 1. Study area in the northeastern Levantine Sea.

Results and Discussion
Chlorophthalmus agassizi, Coelorhynchus caelorhynchus, Dipturus oxyrinchus, Helicolenus dactylopterus, Lepidorhombus whiffiagonis, Lophius budegassa, Merluccius merluccius, Phycis blennoides, Scyliorhinus canicula, Synchiropus phaeton were found in all depth ranges between 200 and 800 m. C. agassizi has the highest abundance and biomass per unit area and dominancy among fish species (Fig 2). H. dactylopterus was represented with the highest frequency value in sampling periods. The maximum number of species was observed at 200 – 299 m depth contour but the highest abundance score was obtained at 300 – 399 m depths. Shannon-Wiener index and Pielou's evenness index achieved the maximum values at 200 – 299 and 700 – 800 depth contours. In sampling periods, the highest average number of fish species was obtained in August with nineteen species. High abundance values were estimated in November although the Margalef diversity index and Simpson's dominance index were of lowest value.

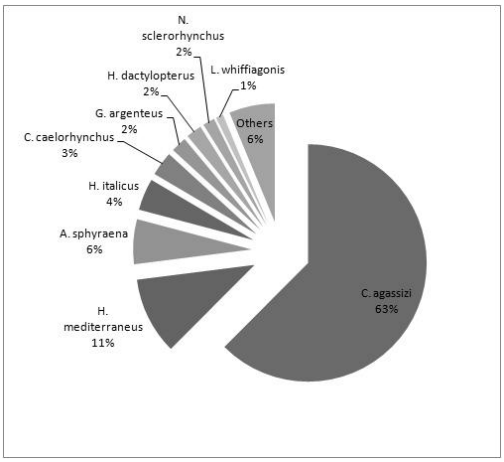

Fig. 2. The percentages of the species abundance observed in the northeastern Levantine Sea.

In the present study, spatial and temporal distribution of fish species were examined in the upper slope of Levantine Sea, ranged from 200 to 800 m depths. The lower limit of the upper slope that is theoretically adopted as 800 m, is revealed as 400 – 500 (450) m depth such as the West and Central Mediterranean Sea.

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ECONOMIC ASSESSMENT OF TURKISH PURSE SEINERS OPERATED IN THE BLACK SEA

A. Cemal Dincer [1]* and Tanju Mutlu [2]
[1] Karadeniz Technical University Faculty of Marine Sciences - cdincer@ktu.edu.tr
[2] Recep Tayyip Erdogan University, Vocational School of Technical Sciences, Rize, Turkey

Abstract
To assess and evaluate the economic performance of Turkish purse seiners operated in the Black Sea, five representative commercial fishing vessels of different lengths were examined. The data related to the catches of the vessels were obtained from the two consecutive fishing seasons of 2010 and 2011 years. Economic information concerning the cost and earnings was based on the data sheets given to vessels and field surveys.Net present value (NPV) method was used as economic criteria to compare the profitability of the vessels. It was found that optimum engine power for the fishing vessels was about 3000 HP and the optimum gross tonnage (GT) was about 250.

Keywords: Fisheries, Black Sea

introduction Approximately 70% of Turkish sea fishing catch (500.000 tons) is obtained by purse seiners and based on the major pelagic species sush as anchovy**,** horse mackerel, and bonito [1]. Among these species the anchovy is the major catch component coming from the Black Sea and amounts to about 280.000 tons yearly. Fishing for anchovy is practised by purse seining with a single mother vessel [2]. Previous studies on the economic performances of the Turkish purse seiners are rather old and lack to some extent [3,4]. Since then, the occurrences of dramatic increases in the capacity of fishing fleet causes the need to re-examine the economic assessments of such vessels.

Materials and methods

Catch data were obtained from fishing experiments carried out by five commercial purse seiners in the Black Sea in years 2010 and 2011 seasons. Lengths of the vessels were 20, 28, 36, 37 and 49 m and lettered by A, B, C, D and E, respectively. Engine powers in HP varied from 400 to 4300 and the gross tonnages were also varied from 49 to 490 from the smallest to the largest one. For the economic analysis of fishing, catch was valued according to local market price. All costs were expressed in Turkish currency (1 TL = US$ 0.555=€ 0.434, 4 April 2013). The net present value (NPV) was used as a technique to evaluate the fishing investments of the vessels.

Results and discussions According to results of NPV calculations, the NPV values in 10^3 TL for the vessels A, B, C, D and E are found to be 331, 996, 1180, 1618 and 1351, respectively. Since all vessels under examination have positive NPV values, they are all considered to be profitable from the point of view of investment projects. However, with the highest NPV the Vessel D appears to be the most profitable one and because of the lowest NPV the vessel A is the least profitable investment. The variation of NPV values according to engine powers and tonnages are shown in Figure 1 and Figure 2. From these figures the optimum values for power and tonnages can be read as 3000 HP and 250 GT, respectively.

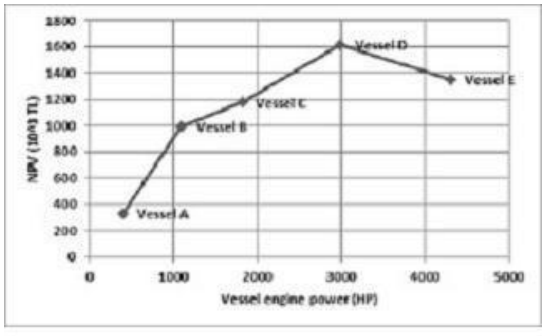

Fig. 1.

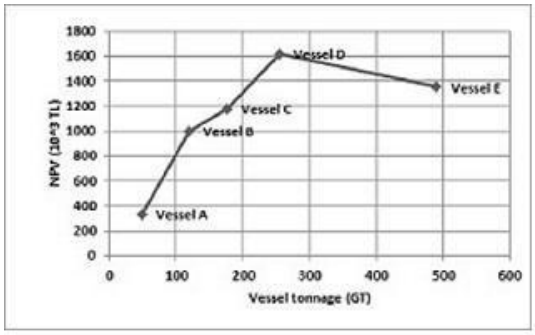

Fig. 2.

The tendency among fishers to increase the fishing capacity of the vessels by means of larger sizes and higher powers beyond the optimum points is not only meaningless for economic view point but may also endanger the fishing sustainability.

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FISHERMAN COOPERATION: THE KEY FOR A SUCCESSFUL CONSERVATION.

Valentina Melli [1]*, Emilio Riginella [1], Marco Nalon [1] and Carlotta Mazzoldi [1]
[1] University of Padua, Department of Biology - valentinamelli@hotmail.it

Abstract

Artisanal fishery often offers the best opportunities for impact mitigation but it's also the most traditional and difficult to change. Trap fishery, an artisanal method that targets cuttlefish spawning adults in spring, exploits cuttlefish female attraction to traps for egg laying. The present study estimated the impact of traps on cuttlefish eggs and tested the efficacy and suitability of a management measure to mitigate this impact in the Northern Adriatic Sea. Results showed that over 3 millions of eggs, in less than 3 miles of coast, are likely destroyed by this fishery. The use of ropes, attached inside traps, allowed to collect on average 23.7% of the eggs, without affecting catch rate of adults. The efficacy of this mitigation measure is discussed considering fishermen attitude towards it.

Keywords: Fisheries, Coastal management, Conservation, North Adriatic Sea

Introduction

Overexploitation and the indirect impact of several anthropic activities has caused the decline of marine resources [1]. If, on one hand, several regulations have been introduced to protect coastal ecosystems, on the other one, social and economic factors have often compromised the efficacy and the compliance of the laws. A representative case of study in the North Adriatic Sea is the common cuttlefish, *Sepia officinalis*, an important resource traditionally exploited by the artisanal fishery [2]. In spring, when cuttlefish migrate near the coast for reproduction and egg deposition [3], artisanal fishermen take advantage of such local abundance using traps to catch the adults. Cuttlefish females use the surface of the fishing gear to attach hundreds of eggs (Fig. 1) that will need from 20 to 50 days to hatch [4]. As the eggs start accumulating on the trap they alter its functionality and need to be removed. To protect cuttlefish eggs from destruction, traps cleaning by water pressure washer has been forbidden during the reproductive period.

Fig. 1. Trap with eggs and cuttlefish.

Methods and Results

Interviewing all the 20 fishermen that perform trap fishery in the coastal area nearby Chioggia's inlet (about 3 miles in length) we were able to verify that, regardless the law, still the 80% of them use water pressure washer as the main cleaning method. Precedent studies [5] showed that this practice has an high impact on the eggs and results in their destruction. To investigate the impact of trap fishery on cuttlefish eggs, surveys were conducted on fishing boats. We assessed that an average of 947.14 ± 587.03 eggs were attached to each trap at the moment of the cleaning. Considering that each fisherman is allowed to use 250 or 400 traps (depending on the license) we estimated that every year over 3 millions of eggs, in less than 3 miles of coast, are likely destroyed by this fishery, due to trap cleaning procedures. In this study we proposed and tested the efficacy and suitability of a mitigation measure, that fishermen may easily apply. The measure consisted in the use of removable ropes attached inside traps, as additional substrate for egg deposition. Ropes allowed to recover on average 23.7% of the eggs. Besides the actual efficacy in reducing egg loss, a second result makes this mitigation measure promising: the presence of ropes in the traps did not reduce the catch. This aspect contributed to the positive attitude that fishermen showed towards the measure because it allows to both maintain their current income and preserve the future resource.

Conclusions/Significance

The case study underlines the need of dialogue with fishermen to reach the common aim of preserving fundamental resources. Considering fishermen' point of view and fishing dynamics we were able to delineate a mitigation measure that obtained considerable results in reducing the described impact and could be easily accepted. This measure, directly and actively involving fishermen in the management of their resources, could represent an outstanding step in filling the gap between fishery management authorities and stakeholders.

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INTEGRAL ASSESSMENT OF TRAWLING EFFECTS IN A MEDITERRANEAN FISHING GROUND: CHANGES IN BENTHIC FUNCTIONAL COMPONENTS AND CONSEQUENCES FOR TARGET SPECIES

Alba Muntadas Olive [1]*, Montserrat Demestre [1], Silvia De Juan [2] and Chris L. Frid [3]
[1] Institut de Ciències del Mar (ICM-CSIC) - amuntadas@icm.csic.es
[2] National Institute of Water and Atmospheric Research (NIWA)
[3] School of Environmental Sciences, University of Liverpool

Abstract
Long-term changes in the fishing regime affect both the commercial target species and functionality of benthic ecosystems. The effects of short-term changes in fishing effort, were evaluated for an infaunal community from a Mediterranean fishing ground that is characterised by well-defined intra-annual trawl fleet dynamics tightly related to the main target species in the area: *Mullus barbatus*. Results suggest that, despite chronic trawling clearly modifing the infaunal community structure, changes linked to variability in the effort regime were too small to influence the *M. barbatus* population at the within-year time scale.

Keywords: North-Western Mediterranean, Fisheries, Biodiversity

Introduction: Normally, trawl fleet dynamics in the Mediterranean follow the life cycle pattern of the most important target species, which may lead to a marked variability in the fishing effort within a year. Moreover, trawling fleets can be controlled by closed seasons that aim to protect vulnerable life stages of target species. Fishing activities affects benthic communities and, consequently, demersal target species that are tightly linked to benthic habitats. Therefore, the proposed integral assessment that considers responses of the different ecosystem components to fishing pressure could be an advance in the framework of an ecosystem-based fisheries management. A trawl fishing ground located in the Catalan Sea (NW Mediterranean) with well documented fishing fleet dynamics was selected to study the effect of variable fishing effort on infaunal benthic functionality and the potential indirect consequences on M. barbatus, the most important target species in this fishing ground.

Methods: The study period was from June to November 2003 and the selected trawl fishing ground is regulated by a two month closure in summer (July and August). Two study sites were selected within the fishing ground: a fished site and an un-fished site used as a reference. In each site, infauna samples were obtained before (low effort), during (no effort) and after (high effort) the closed season. To analyse the effects of fishing effort on the community functionality, 11 biological traits were selected and split up into categories. Afterwards, these traits' categories were assigned to 25 infaunal taxa selected from a total of 147 after the criteria of abundance and frequency of occurrence. Multivariate analysis (MDS, PERMANOVA and SIMPER), based on Bray Curtis similarity matrix, were conducted to study changes on the Biological Traits composition. At the same time, daily landings of M. barbatus were available from records at the local port fish auction covering the year of the study (Fig.1).

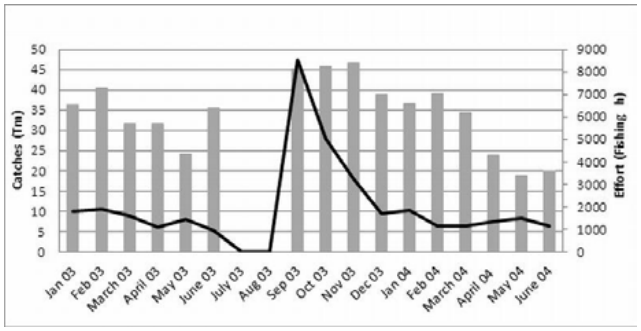

Fig. 1. *M.barbatus* catches (line) and trawling fishing hours (bars) during the study period

Results:MDS plot and PERMANOVA analysis show that infaunal Biological Traits composition from fished and reference sites were clearly different ($p< 0.001$). Significant temporal variability was also detected ($p<0.01$) and the pair-wise test showed that community composition before the closed season was different from those during and after the closed season ($p<0.01$ and $p<0.05$ respectively). However, the overall dissimilarity between groups was low (10.3% and 8.6-%) and more than 10 traits were necessary to explain 50% of dissimilarities. SIMPER (Diss/SD index >1.5) highlighted the traits' categories high flexibility, intermediate fragility, crawl, less than 1year of life span, filter feeding and 2 or more reproductive events per year as somewhat important to discriminate groups (Table 1). Catches of M.barbatus follow its life cycle, being highest during the recruitment season,from the end of August to November [1] which coincides with the highest effort period (Fig.1).

Tab. 1. Trends of the trait categories highlighted by SIMPER by Site (Control/Reference) and Time (over the year)

Trait category	Site	Time
Intermediate fragility	No differences	Decreasing during closed season in the reference site
High Flexibility	Higher in reference	Decreasing during closed season in the reference site
Filter Feeding	Higher in reference	Decreasing during closed season in the reference site
Crawl	Higher in reference	No clear pattern
>2 rep events per yr	Higher in reference	Decreasing during and after the closed season in the reference site Decreasing after the closed season in the fished site
<1yr life span	Higher in reference	Decreasing during and after the closed season in the reference site

Discussion: The effect of chronic trawling impact on the infaunal Biological Traits composition was evident [2]; however, short-term changes related with the within-year trawling fleet dynamics were not so obvious. Several traits varied over the study period, however, dissimilarities were low. Nevertheless, these are expected results considering the short duration of the closed season, while benthic communities would need longer periods to respond to changes [3]. M. barbatus, feed manly on amphipoda and polychaetes [4], might be affected by changes in any of the infaunal selected traits. For example, changes on the traits' categories less than 1year of life span and 2 or more reproductive events per year, might affect infauna productivity, leading to changes in food availability. The last trait follows a decreasing trend after the closed season in the fished site, which might lead to lower food availability in the following months.

Acknowledgements: This study was funded both by the EU project RESPONSE (Q5RS-2002-00787) and by COMSOM project (CTM2008-04617). We thank the participants in the "Veda" cruises, the crew of the RV "Garcia Del Cid" and the Fishermen's Association of St.Carles. Alba Muntadas was supported by a CSIC JAE_predoc grant cofounded by the FSE (European Social Funds).

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ARTISANAL FISHERIES LANDINGS BY SEABED HABITAT IN FOURNI, NE AEGEAN, GREECE: PRELIMINARY RESULTS

R. Seary [1]*, X. Apostolidis [2], E. Bintoudi [3], J. Shepperson [3], A. Jeffery [3] and A. Miliou [3]
[1] Swansea University, Department of Biosciences, SA2 8PP, UK - 630994@swansea.ac.uk
[2] Aristotle University of Thessaloniki, School of Biology, Department of Zoology, Laboratory of Ichthyology, Box 134, 54124, Thessaloniki, Greece
[3] Archipelagos, Institute of Marine Conservation, PO Box 42, Samos, Greece

Abstract
Data on fishing activity and landings over different types of benthic habitats are presented for the artisanal fishing fleet operating in Fourni island complex (NE Aegean Sea, Greece). Coralligène (25 %) and rocky (20.69 %) substrates were the most targeted habitat types. Both biomass and species richness of landings by fishing trip did not differ significantly between the most highly fished seabed habitat types. Such information has important implications for the development of a successful spatial management plan of fisheries resources.

Keywords: Fisheries, Aegean Sea

Introduction
Seabed habitat type and fishing pressure both largely affect the structure and function of fish assemblages [1, 2]. However, in the Mediterranean Sea, little effort has been devoted to investigating the distribution of fishing activity among different seafloor habitats and their importance in terms of catches to the fishery. Herein, we analyzed the small-scale fishing fleet landings of Fourni island complex (NE Aegean Sea) in relation to benthic habitat type. The study area is characterized by a dynamic, multi-gear, small-scale fishing community and the presence of diverse seabed habitats, consisting mainly of *Posidonia oceanica* meadows, coralligène reefs, sand and rocky substrates. Such information can be useful in the design of an adequate spatial management plan of fisheries resources in the area.

Materials and methods
Port side landings surveys were conducted daily, between March 2012 and December 2012, on artisanal fishing boats operating in the Fourni Island complex and using trammel nets or longlines. The latter two are the fishing gears used most frequently by the artisanal fishing fleet. Landings' biomass and species richness by fishing trip were recorded along with information on gear configuration (i.e. total surface area of nets and number of hooks, respectively). Fishermen were interviewed about the structure of the seabed habitat where fishing took place. In detail, fishermen were asked about the presence or absence of rocks, coralligène formations, *P. oceanica* and sand, which are the main seabed habitat types in the area. Landings were corrected for effort, expressed as kg per m^2 of net and kg per 100 hooks for trammel nets and longlines respectively. One-way Anova was used to compare landings per unit of effort and species richness over different seabed habitat types. Only seabed habitat types with a significant number of observations were used in the comparisons.

Results and Discussion
verall 62 fishing trips were sampled. Fishing occurred over various single and mixed type seabed habitats (Fig. 1). Single type seabed habitats consisted of rocks (20.69 %) and coralligène reefs (25 %), followed by mixed habitats of *P. oceanica* and sand (20.69 %). Landings per unit of effort (LPUE) did not differ significantly between the most frequently fished seabed habitat types both for trammel nets (one-way Anova, $F_{2,53} = 0.56$, $p = 0.577$) and longlines (one-way Anova, $F_{1,23} = 0.96$, $p = 0.337$). Comparison of landings' species richness between habitats also showed no significant differences for longlines (one-way Anova, $F_{1,23} = 0.187$, $p = 0.185$) and trammel nets (one-way Anova, $F_{2,53} = 0.39$, $p = 0.681$).
Rocky substrates, coralligène reefs and *P. oceanica* meadows are complex habitats of high ecological value. Coralligène reefs, in particular, are very vulnerable and not persistent to anthropogenic disturbances due to their low turnover rates [3, 4].These habitat types receive the highest fishing pressure while are equally important in terms of productivity to the fishery. The degradation of these habitats in the NE Aegean would have high socioeconomic impact on fishing communities. Hence their protecting and sustainable management is essential to achieve a degree of fisheries sustainability which will also benefit the fishing community. Such a purpose can only be achieved by the design of a Fisheries Protected Area based on detailed seabed habitats mapping data [5, 6].

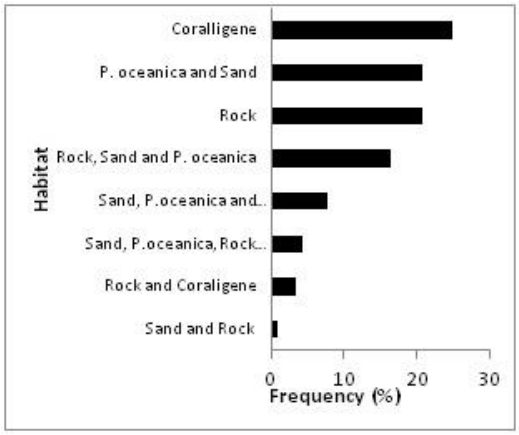

Fig. 1. Number of fishing trips (%) by seabed habitat type, Fourni, NE Aegean.

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SOME REMARKS ON THE BEACH SEINE FISHERY IN THE ISTANBUL STRAIT

Ugur Uzer [1]*, Taner Yildiz [1] and F. Saadet Karakulak [1]
[1] Istanbul University - uguruzer@istanbul.edu.tr

Abstract
This study aims at giving the results of the catch composition, by-catch and discard ratios in beach seine fishery in the Istanbul Strait. Samples were caught by commercial beach seine vessel from the depth interval 40-65 m, in the period of December 2009 and March 2010. The most abundant commercial species in terms of number and weight were *Mullus surmuletus* and *Trachurus trachurus*.

Keywords: Fisheries, Bosphorus Strait

Introduction
Beach seine nets have been used in fisheries for several thousand years and on every continent [1]. In Turkey beach seines were used in Aegean Sea especially in Izmir, Black Sea especially in Trabzon and Samsun, in Istanbul Strait for demersal fishes and in Marmara Sea for rose shrimp. There are a lot of studies on seine nets in the Aegean Sea [2, 3], limited studies in the Sea of Marmara [4]. However, there were no available data in the Istanbul Strait. In this study, observers were used to quantify the catches of beach seines operating in the Istanbul Strait and to evaluate the impact of this fishing gear in terms of by-catch and discards.

Materials and methods
Scientific operations were carried out on a commercial beach-seine vessel with a length of 14 m and 160 HP, totally 20 fishing trips between December 2009 and March 2010, covering the entire fishing period, in the Istanbul Strait. A beach seine net specialized for catch of bony fishes with a total length of approximately 143 m was used in the experiments. The mesh size of the cod end was 26 mm and fishing took place in depths 40-65 m. Operations were carried out in generally 60 minutes depending on the condition of the deep currents, on the towing speed and amount of yield caught in the cod-end. The total catch was sorted into the retained and discarded components by the fishermen. The total weights and numbers of each individual species were recorded.

Results and discussion
From 20 beach seine operations, 26 osteichthyes, 2 crustacea and 1 mollusca species belonging to three different taxonomic groups were obtained. It was determined that *M. surmuletus*, *T. trachurus* and *Scorpaena porcus* were most caught. Besides the red mullet which were target species, it was determined that 28 different species belonging to the three taxonomic groups were also caught. Of all the non-target species, it was seen that 13 were commercial, 14 were non-commercial, and only one was under threat species. The total catch consist of the target species, which were 77.48% in numbers and 65.90% in weight, and the non-target catch ratio was 22.52% in numbers and 34.10% in weight, respectively (Table1). In this study, it was found that the discard ratio in the beach seines together with the small-scale fleet having limited catch efforts in the Istanbul Strait was low but the ratios of the commercial species under the legal length size were high. The minimum landing size (MLS) for *M. surmuletus* was 13 cm. It was determined that the total lengths of *M. surmuletus* ranged from 6.5 to 17.30 cm (mean length 10.29±0.08 cm) and the catch ratios of both species, under MLS, was calculated as 70.70%. It was clear from the data that the growth overfishing was seen in the commercial species. It was reported that the ratios of commercial fish species under the MLS in the Aegean coasts were 75% for *Pagellus erythrinus*, 23% for *Mullus barbatus*, 7% for *M. surmuletus*, and 42% for *Diplodus vulgaris* in the beach seine fishery (with 36 mm cod-end mesh size) [5]. In another study carried out in the Aegean Sea, the ratios of non-commercial fish species under the MLS were 5.3% for *Boops boops*, 33.5% for *Spicara* sp., 39.7% for *M. barbatus*, 79.6% for *P. erythrinus*, 93% for *D. vulgaris*, and 73% for *Loligo vulgaris* in the beach seine fishery (with 32 mm cod-end mesh size) [2]. It was determined that the beach seines employed in the Aegean Sea damaged the juvenile fish stocks found in this area with the aim of protection and nutrition as well as *Posidonia oceanica* meadows especially in coastal regions. It was also found that they were not selective enough due to the fact that they caught the fish having smaller size, and when considered the high amount of by-catch and discard ratios, they were extremely harmful for the coastal ecosystem [6]. In order to protect the coastal regions as well as the juvenile fish from capture, beach seines have been banned in Turkish territorial waters (except for the Edremit Bay, the Sea of Marmara, the Istanbul and Canakkale Straits) since 2001 [7] and then the use of these nets were also banned in the Istanbul and Canakkale Straits in 2011[8]. On the other hand, all forms of trawling in the Sea of Marmara are already prohibited, so the deep-water beach seines are exceptionally allowed to catch only the pink shrimp.

Tab. 1. The number and weight of specimens and the frequency of occurrence (F) for the species caught in the Istanbul Strait.

Species	N	%N	W	%W	F (%)	Use
Osteichthyes						
Arnoglossus laterna	11	0.02	0,085	0,01	20	Discard
Atherina boyeri	9	0.02	0,121	0,01	10	Discard
Callionymus lyra	6	0.01	0,174	0,02	20	Discard
Callionymus risso	13	0.02	0,357	0,04	15	Discard
Chelidonichthys lucerna	78	0.14	3,181	0,37	40	By-catch
Engraulis encrasicolus	1	0.01	0,005	0,01	5	By-catch
Eutrigla gurnardus	225	0.41	6,544	0,77	25	By-catch
Gaidropsarus mediterraneus	8	0.01	0,168	0,02	25	Discard
Gobius niger	78	0.14	1,410	0,16	30	Discard
Liza aurata	17	0.03	1,138	0,13	10	By-catch
M. merlangus euxinus	187	0.34	2,270	0,27	60	By-catch
Mullus surmuletus	42952	77.48	559,971	65,90	100	Target
Ophidion rochei	3	0.01	0,083	0,01	5	Discard
Pegusa nasuta	155	0.28	7,172	0,84	50	Discard
Pomatomus saltatrix	24	0.04	1,653	0,19	30	By-catch
Sardinella aurita	2	0.01	0,027	0,01	5	By-catch
Sardinella maderensis	8	0.01	0,101	0,01	5	By-catch
Scorpaena notata	192	0.35	6,490	0,76	70	Discard
Scorpaena porcus	1131	2.04	47,997	5,64	100	By-catch
Serranus hepatus	1	0.01	0,007	0,01	5	Discard
Spicara maena	293	0.53	11,191	1,32	75	By-catch
Sprattus sprattus	20	0.04	0,249	0,03	5	By-catch
Synaptura kleinii	1	0.01	0,043	0,01	5	Discard
Syngnathus acus	3	0.01	0,047	0,01	15	Under protection
Trachinus draco	27	0.05	0,781	0,09	45	Discard
Trachurus trachurus	9585	17.29	191,572	22,50	100	By-catch
Crustacea						
Liocarcinus depurator	349	0.63	2,961	0,34	25	Discard
Eriphia verrucosa	50	0.09	3,628	0,43	35	Discard
Mollusca						
Loligo vulgaris	10	0.02	0,619	0,07	25	By-catch
Total	55439		850,057			

Acknowledgements The present work was supported by the Research Fund of Istanbul University. Project No: 4230.

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USING SMALL-SCALE FISHERS' PERCEPTIONS TO FRAME KEY ISSUES OF MANAGEMENT CONCERN

Aikaterini Dogrammatzi [1], John Charalabus [1] and Vassiliki Vassilopoulou [1]*
[1] HELLENIC CENTRE FOR MARINE RESEARCH - celia@hcmr.gr

Abstract
Greek small-scale fishers' perceptions on issues of concern that need to be tackled towards achieving environmental and socio-economic sustainability are being identified through the questionnaire approach.

Keywords: Fisheries, Coastal management, Competition, North-Eastern Mediterranean

Small-scale fisheries (SSF) are an important social component of local coastal communities and are a source of high quality seafood with a low ecological impact. They dominate the Mediterranean fisheries (about 80% of units) and it is widely recognized that special attention should be paid by policy makers and fisheries managers to the territorial and flexible dimension of the sector, particularly in anticipation of the finalization of the CFP reform, as well as to the increasing complexity of coastal areas in terms of use conflicts and environmental threats (1). SSF are seriously threatened by concurrent uses of the coastal zone and the integrated management of those uses is necessary (2). In countries, like Greece, where SSF are extremely diverse, scattered geographically and employ large numbers of people, significant problems in the existing system associated with a top-down, central management regime have been highlighted (1). In the present study, Greek fishers' perceptions of the SSF sector regarding critical issues linked with management deficiencies were identified through targeted interviews.
Interviews were based on open-ended questions that encouraged interviewees, who were professional small scale fishers, to express themselves in their own way, and enabled openness since they were encouraged to talk about their major concerns in relation to the status and prevailing local conditions in SSF in their region. Interviews took place in 2012 in seven ports (Figure 1), located either in the mainland or in an Island, where SSF is considered as an important socio-economic activity. Most interviews took place in the premises of fishers' associations or at facilities in the port, had about one hour duration, and usually were attended by a few representatives of the local association (from three to twelve). Although there was a general discussion after each question, at the end they all agreed to a final statement reflecting common local issues/problems. During analysis, responses were categorized to convert a qualitative response into a quantitative one, to enable prioritization of emerging issues in the different areas.

Fig. 1. Locations where small scale fishers'interviews were conducted in Greece.

Viewpoints on issues that were discussed during the interviews were grouped into three categories (Table 1) and visualize major concerns of fishers in the seven areas under study. The first category comprises problems arising due to conflicts between human uses (both inter and intra-sectoral), the second category includes issues related to ecosystem degradation, and the third category takes account of economic constraints placed on the sustainability of fishers' livelihood. Among conflicts with human activities, competition for common resources with trawlers was highlighted in all areas as of major concern. Problems with recreational fisheries, and the need for more effective management of the sector was mentioned in certain occasions. As for intra-sectoral issues, gear (net) soak time, the need for allocation of rights to fishery resources, and discarded fishing gears were underlined in many cases (Table 1). Restrictions of fishing activities due to allocation of parts of the marine space to certain uses such as aquaculture, or to protection of priority conservation species (i.e. seals) were among complaints made in specific areas. As for ecosystem degradation, decline of the fishery resources, was cited as a key impact linked with pollution and over fishing, the latter by trawlers, in all study areas (Table 1). Then, habitat loss or damage due to pollution effects, mainly associated with agricultural runoff, as well as establishment of certain non-indigenous species raised concerns in particular localities. Finally, issues adding to the financial burden of small scale fishers were vessel operational costs linked with the high prices of petrol, gear maintenance costs due to damages caused by certain protected species, decrease of market demand and/or shift towards cheaper species as a result of the economic crisis, and unfair competition due to imported cheaper fishery products. Outcomes reveal several issues, stemming mainly from the lack of an holistic approach for effective management; important recommendations were made by fishers in terms of improving conditions and developing efficient management plans. A co-management bottom-up approach based on community cohesion founded on norms, trust, communication, commitment and respect for leaders can prevent the tragedy of the commons (3), and be a realistic solution for sustainable fisheries in complex cases like the SSF in Greece.

Tab. 1. Critical issues, grouped in three categories, as identified by the small-scale fishers in the seven study areas in Greece.

	Areas						
	A	B	C	D	E	F	G
Conflicts with uses							
Trawlers	*	*	*	*	*	*	*
Recreational				*	*		*
Small-scale		*	*	*	*	*	*
Aquaculture	*	*					
MPAs							*
Ecosystem degradation							
Decline of resources	*	*	*	*	*	*	*
Habitat loss/damage	*	*		*	*	*	
Non-indigenous species					*		
Financial burdens							
Operational costs	*	*	*	*	*	*	*
Gear repair costs			*	*	*	*	*
Decrease/shift in market demand	*	*	*	*	*	*	*
Imported fishery products		*			*	*	

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RESTOCKING TRIAL OF *MELICERTUS KERATHURUS* (DECAPODA, PENAEIDAE) IN THE SHALLOW COASTAL WATERS OF SOUTHWESTERN SICILY (MEDITERRANEAN SEA)

S. Vitale [1]*, L. Cannizzaro [1], F. Lumare [2], M. Arculeo [3] and S. Mazzola [1]
[1] Consiglio Nazionale delle Ricerche, Istituto per l'Ambiente Marino Costiero (CNR-IAMC), Detached Units of Mazara del Vallo and Capo Granitola, Italy - sergio.vitale@cnr.it
[2] Università del Salento, Unità di Ricerca di Gambericoltura, Lecce, Italy
[3] Università di Palermo, Dipartimento di Biologia Ambientale e Biodiversità, Palermo, Italy

Abstract
A test on the restocking trial of Caramote prawns was carried out in the southwestern Sicilian coast from wild breeders. The number of specimens released was probably too low to allow for a lasting effect on the population. In the future, an higher number of nauplii must be released for several years.

Keywords: Decapoda, Aquaculture, Coastal management, Sicily Channel

The penaeid shrimp Caramote prawn, *Melicertus kerathurus* (Forskäl, 1775), is widely distributed in the entire Mediterranean except in the Black Sea [1]. This species plays an important economic role in some Mediterranean coastal regions, as in Greece ≈ 3,250 t, Tunisia ≈ 2,300 t, Spain ≈ 200 t Albania ≈100 t [2] and Italy ≈ 250 t [3]. The high demand of penaeid shrimps have stimulated, on the one hand, the developing of aquaculture activities and on the other hand, repopulation actions with the aim to support artisanal fishery in various countries worldwide [4, 5, 6, 7]. A test on the restocking trial of this species was carried out in the year 2004, in the shallow coastal area between Capo San Marco and Capo Granitola (southwestern Sicilian coast, Fig. 1).

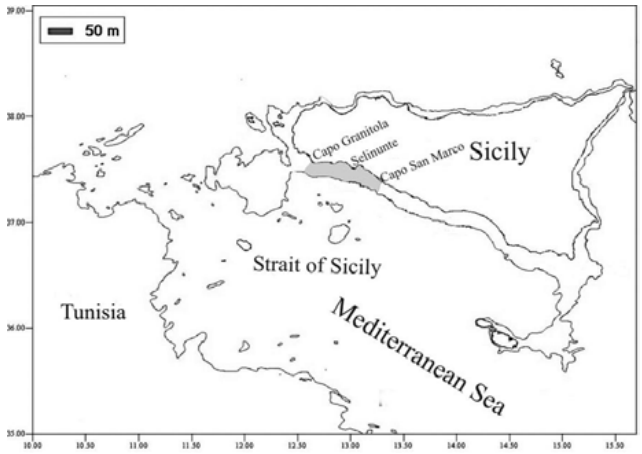

Fig. 1. Map of the study area showing the Selinunte harbour and the fishing ground where small craft catch Melicertus kerathurus (light grey).

Breeders from the restocking area were caught by trammel net throughout the entire fishing area during one night in July 2004. Females, completely intact and with spermatophore in the thelycum, were selected and transported in aquaculture plants. The restocking technique used in the aquaculture plant was that proposed by Lumare [8]. As the eggs began to hatch, the larvae (nauplii) were fed with *Chaetoceros* sp; after 5 - 6 days from their birth, the diet was integrated with *Artemia salina* nauplii. From the mysis III stage, that is after about 10 days from birth, larvae are called post-larvae. At that stage, the diet was also integrated with artificial feed for post-larvae shrimp made up of fish flour, fish oil, krill flour, wheat flour, vitamins and minerals. The post-larvae at the PL22 stage were lowered into the sea in a stretch of sandy water off-shore from Selinunte, with a depth between 50 and 100 cm, opportunely fenced and cleared of other materials and eventual predators. The post-larve were then released after about 36 hours of adaptation.

A total of 148,799 eggs were released, from which 82,888 nauplii hatched at a percentage of 56%. Only 6,000 nauplii reached the PL22 sub-stage, that is after 32 days from their birth and they were sown with success (Tab. 1).

Tab. 1. Number of specimens caught for the reproduction, mature females, females selected for the reproduction, number of breeders, eggs released, nauplii hatched and nauplii PL22.

No. of specimens caught	Mature female
156	100
Female selected and shipped	
63	
No. breeders "useful"	Eggs released
22	148,799
nauplii hatched	post-larvae PL22
82,888	~ 6,000

The number of specimens released was probably too low to allow a lasting effect on the population. In the future, an higher number of nauplii must be released for several years. Worldwide, the restocking activities with shrimps did not have great success, since they constitute the production of a common good without any real interest to the private investor. On the contrary, the shrimp production represents an important stimulus for the private entrepreneurial activity (FAO, 2008). The production of shrimps in the world aquaculture reached about 4.23 million t in 2006, compared to a production of shrimps from catch of 4.84 million t. The recent implementation of "local management plans" along the Sicilian coasts (Regulation EC No 1198/2006) allows to support measures of common interest, like restocking strategy: if these strategies will be tested systematically for some years, they could be an important opportunity to verify the real increases of natural stocks and the profitability for the artisanal fishing activity.

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FISH DISCARD IN ISKENDERUN BAY TRAWL FISHERIES

Emre Yemisken [1]*, Cem Dalyan [1] and Lutfiye Eryilmaz [1]
[1] Istanbul University Faculty of Science, Department of Biology - emredy@yahoo.com

Abstract
The aim of this study is to determine the discard fish composition, abundance and biomass of trawl fisheries in Iskenderun Bay. The 44 hauls were performed by commercial trawl vessel during 2010 (May, August and October), 2011 (January) and 2012 (December). Data analysis were shown that there is no statistically significant differences between depth and discard fish rates (p=0.087, p> 0.05). *Equulites klunzingeri* dominated among discard fish species, especially between 30 – 60 m depth ranges in Iskenderun Bay.

Keywords: Fisheries, Iskenderun Bay

Introduction

Discard catch, composed of undersized marketable and unmarketable species, is an important problem in multispecies trawl fisheries, also having an influence on the dynamics of marine ecosystems. Comparison of discard rates shows variability depending on depth and season [1]. The purpose of this study is to contribute to the knowledge of discard catch and its composition in Eastern Mediterranean trawl fisheries.

Material Methods

Iskenderun Bay, located in the Levantine Sea, is an important fishing zone in the Eastern Mediterranean Sea (2) (Fig.1). The trawl operations were carried out in the Iskenderun Bay, from May 2010 to December 2012. A total of 44 hauls were performed at depths between 30 m and 110 m. Data was collected by using commercial trawl vessels (23 m length) with engine powers up to 400 HP. The stretched codend mesh sizes of trawl nets were 44 mm. Biomass and abundance data were recorded as discard and landing catch. Subsampling was performed for the most abundant species. The whole catch was stored in lab at – 20 ºC. After identification of the species, the total length (mm) and body weight (g) were measured for each individual. Sampling season and discarded fish biomass CPUE (kg/h) were compared by Kruskal Wallis (3). Pearson correlation was used to explain the relation between discard fish ratios and their haul depth.

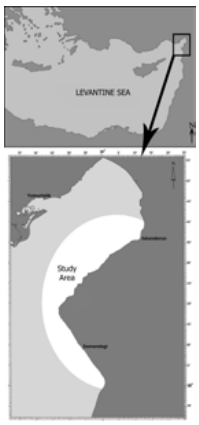

Fig. 1. Study area in and around Iskenderun Bay (Levantine Sea)

Results and Discussion

In 44 hauls 87930 individuals were obtained belonging to 101 fish species. The total fish catch was calculated as 2720 kg, 1052 kg of them were discarded. Discard catch consisted of 74 species (n=54119). The average of the total fish biomass caught per haul was 42 kg/h and the average of the discard biomass was estimated as 15.8 kg/h. 38 % (varied from 12 % to 71 % per haul) of the total fish catch biomass was constituted of discard fish. The highest seasonal discard biomass ratio was recorded in August (43.68 %) (Fig 2). A weak negative relationship between discard fish rates and depth is shown (r= -0.261, p=0.086, p>0.05). Discard fish biomass did not show any significant differences among sampling seasons (p=0.69, p>0.05). Discard catch is well studied in Mediterranean Sea. Discard fish catch was found between 34 – 44 percentages in Greek waters (4). Furthermore, Damalas and Vassilopoulou (2013) mentioned that the discard rate in trawl fisheries was between 31 % and 64 % in Central Aegean Sea (5). Kinacigil et al. (1999) reported that discard was estimated between 42.8 % and 50 % in total catch for shrimp trawl fisheries in Tasucu Bay (Northeastern Levantine Sea) (6). Our estimated data demonstrated similar rates with other fishing regions in the Mediterranean Sea.

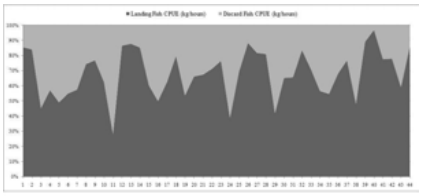

Fig. 2. Landing Fish and Discard Fish CPUE (kg/h)

Saurida undosquamis, *Nemipterus randalli*, *Sparus aurata and Mullus barbatus* were the main commercial species in the region. In the 1980's, *S. undosquamis* and *E. klunzingeri* were of highest biomass in total catch; 23 % and 14 % respectively (7). In this study, there is similar considering results in the highest biomass of the fish species; *S. undosquamis* 36 % (16,6 kg/h) and *E. klunzingeri* 10 % (7.79 kg/h) (n=1196 per hour). Discard was comprised mostly of unmarketable species such as *Equulites klunzingeri*, *Citharus linguatula*, *Champsodon sp.*. The present study might be helpful for planning an ecosystem-based management in the region.

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CATCH COMPOSITION IN BOTTOM TRAWL FISHERY IN THE WESTERN BLACK SEA (TURKEY)

T. Yildiz [1]*, A. Baskaya [1], U. Uzer [1], A. E. Kahraman [1] and F. S. Karakulak [1]
[1] ISTANBUL UNIVERSITY, FACULTY of FISHERIES - yldztnr@istanbul.edu.tr

Abstract
The present study aims at giving the first results of the catch composition in bottom trawl fishery in the Western Black Sea. Samples were caught by commercial trawl from the depth interval 30-100 m, in the period of October 2010 – April 2011. The most abundant commercial species in terms of number and weight were *Mullus barbatus* and *Merlangius merlangus*. Total catch rate varied between 6.5 and 862.7 kg/h.

Keywords: Trawl surveys, Demersal, Fisheries, Black Sea

Introduction
The Black Sea is a unique sea, which is considered to be world's most isolated sea. The Black Sea is the world largest water body containing H_2S, and its hydrogen sulfide layer begins 150-200 meters below the surface [1]. Therefore, the commercial fishery is carried out mainly down to a depth of 100 m. On the other hand, considering the length of the coastal area, the amount of the fish caught, and the fishing fleet capacity, the Black Sea is the most important fishing area of Turkey and surrounding countries [2]. The aim of the present work is to assess the catch composition in commercial bottom trawl fishery in the Western Black Sea.

Material and methods
Samples were collected during 34 experimental surveys, carried out between October 2010 and April 2011 in the Western Black Sea (Turkey). A commercial trawler was used equipped with a trawl of 40 mm cod-end mesh size (from knot to knot). The duration of each haul ranged from 70 to 150 minutes and their depth varied from 30 to 100 m. For calculations and evaluations, all the catches were standardized to one fishing hour.

Results and Discussion
A total of 34 species were recorded, of which 25 were osteichthyes, 4 crustaceans, 2 chondrichthyes, 2 echinoderms and 1 molluscs. *Mullus barbatus* and *Merlangius merlangus* were the dominant commercial species. Some of the other abundant species were *Alosa immaculata*, *Gobius niger*, *Neogobius melanostomus*, and *Scorpaena porcus*. The most abundant commercial species in terms of number and weight were *M. barbatus* and *M. merlangus* (Table 1). *M. barbatus* (mean: 108.07 kg/h, min: 38.52 kg/h, max: 1220 kg/h) and *M. merlangus* (mean: 23.83 kg/h, min: 3.8 kg/h, max: 59.4 kg/h) constituted 95% of the total catch. Total catch rate varied between 6.5 and 862.7 kg/h (439 and 54785 individuals/h).
In this study, the length values obtained from the commercial species such as *M. barbatus* and *M. euxinus* caught by trawlers were compared with the minimum landing size (MLS) mentioned in Turkish Commercial Fishing Regulations numbered 3/1 published in 2012. The minimum landing size for both species is 13 cm [3]. It was determined that the total lengths of *M. barbatus* and *M. merlangus* ranged from 6.8 to 15.5 cm (mean length 9.88±0.04 cm) and from 6.2 to 20.0 cm (mean length 11.03±0.06 cm), and the catch ratios of both species, under MLS, were calculated as 93% and 87%, respectively. These findings show that the growth overfishing occurred when the commercial species were caught. Therefore, it is necessary that the minimum mesh size in the codend of bottom trawl nets should be increased, and in this way, the improvement of selectivity suppose the reduction of catch of the small size individuals.
It is indicated in the last Turkish Commercial Fishing Regulations that the minimum diamond mesh codend less than 40 mm was prohibited [3]. On the other hand, the Members and Cooperating entities of GFCM shall adopt and implement, at latest by 31 January 2012, a minimum 40 mm square mesh codend or a diamond mesh size of at least 50 mm, of acknowledged equivalent or higher size selectivity, for all trawling activities exploiting demersal stocks when operating in the GFCM Area [4]. Because Turkey is a member of GFCM, the implementation of this recommendation for the Black Sea is quite important in terms of sustainable fisheries.

Acknowledgements
The present work was supported by the Research Fund of Istanbul University. Project No: 4231.

Tab. 1. The mean number and weight of specimens per fishing hour (N/h and Kg/h), coefficient of variation (CV) and the frequency of occurrence (F) for the species caught in the western Black Sea.

Species	N/h	CV	Kg/h	CV	F (%)
Osteichthyes					
Alosa immaculata	64.42	197.62	2.74	252.07	79.41
Amoglossus laterna	0.08	484.12	0.0004	435.31	5.88
Amoglossus kessleri	0.15	315.45	0.006	370.76	8.82
Callionymus lyra	0.02	583.10	0.002	583.10	2.94
Engraulis encrasicolus	3.40	496.89	0.015	500.56	17.65
Gaidropsarus mediterraneus	0.81	125.99	0.026	140.94	55.88
Gobius niger	2.68	141.11	0.053	139.92	76.47
Hippocampus hippocampus	0.56	226.24	0.001	257.97	23.53
Merlangius merlangus	2289.85	198.68	23.83	192.59	82.35
Mesogobius batrachocephalus	0.11	331.69	0.16	357.46	8.82
Microchirus variegatus	0.05	406.02	0.003	583.10	5.88
Mullus barbatus	8797.32	108.26	108.07	135.84	88.24
Neogobius melanostomus	5.25	114.17	0.22	127.26	76.47
Ophidion rochei	0.11	583.10	0.000003	583.10	2.94
Parablennius tentacularis	0.08	295.18	0.00085	369.71	11.77
Platichthys flesus	0.11	252.65	0.006	333.89	14.71
Pomatomus saltatrix	18.21	412.59	0.31	406.23	11.77
Psetta maxima	0.09	246.87	0.30	336.34	14.71
Scorpaena porcus	3.42	190.58	0.08	158.36	67.65
Spicara maena	0.02	583.10	0.0001	583.10	2.94
Sprattus sprattus	9.62	561.99	0.03	551.16	14.71
Syngnathus acus	2.27	234.91	0.02	238.80	26.47
Trachinus draco	2.93	192.28	0.06	192.83	79.41
Trachurus mediterraneus	46.79	127.95	0.33	117.78	67.65
Uranoscopus scaber	3.39	198.20	0.16	200.33	41.18
Chondrichthyes					
Raja clavata	0.89	172.78	0.76	320.09	38.24
Squalus acanthias	0.04	406.06	0.04	481.83	5.88
Crustaceans					
Carcinus aestuarii	0.04	583.10	0.0003	583.10	2.94
Eriphia verrucosa	0.06	434.64	0.0000006	583.10	2.94
Liocarcinus depurator	11.72	129.72	0.15	176.20	47.06
Maruppenaeus japonicus	1.14	425.64	0.0000003	583.10	2.94
Echinoderms					
Asterias rubens	2.71	172.39	0.04	191.41	23.53
Marthasterias glacialis	0.08	487.97	0.02	480.14	2.94
Molluscs					
Mytilus galloprovincialis	2.15	301.16	0.03	282.33	23.53
TOTAL	10786.64		132.90		

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Session

Conservation successes, failures

Modérateur : **Sylvaine Giakoumi**

URAL RIVER DELTA: A PROPOSED UNESCO-MAB BIOSPHERE RESERVE ON THE CASPIAN SEA

L. Cantelli [1]*, G. E. Marcheselli [1], F. Scarelli [1], T. Kerteshev [2] and G. Gabbianelli [1]
[1] University of Bologna - luigi.cantelli@unibo.it
[2] GEF-UNPD Kazakhstan

Abstract
The Ural River Park Project is an international collaboration aimed to support the sustainable developement and the environmental protection of the Ural delta area, on the Kazakhstan coast of the Caspian Sea. The great variety of habitats and the remarkable biodiversity hosted in these vast wetlands are endangered by pollution and environmental degradation an by the scarce environmental awareness of the local people, the project has been directed to the establishment of a Unesco-Mab Biosphere Reserve, involving directly the local Authorities and population. In this regard, the project has been focused on the proposal of a management plan for the delta area particularly focused on the interaction between the environment and the socio-economic features of the area.

Keywords: Coastal management, Conservation, Deltas, Extra-Mediterranean regions

During the past decennia, the level of water and sediment contamination in the Caspian Sea has increased as a result of anthropogenic activities, leading to a great pressure on the environment. The main sources of contaminants include untreated waste from industry and agricolture, offshore oil and gas extraction, processing and transportation, and marine dumping. The northern portion of the Caspian Sea, and more specifically the Kazakhstan coast, is particularly threatened by those negative factors impacting the environment, because of the great relevance of this area for its biodiversity. In fact, the Ural delta area is characterized by an vast wetland, covering more than 110,500 ha[1]. The site is a unique river delta, comprising a large variety of marine/coastal and inland wetland types. The specific geomorphological, sedimentological and hydrological features of these land-sea transition environments, located in close proximity to semi-desert areas and characterized by the interaction between marine and fluvial-deltaic dynamics, have created a range of marine and freshwater habitats supporting a huge amount of wildlife species of grate international and national ecological interest, notably millions of migratory birds (nesting, migrating and wintering), 13 of which are IUCN threatened bird species [2]. Moreover, the river mouth is a nesting place for two important endemic (and endangered) species: the Caspian seal and the Beluga Sturgeon (along with other species of sturgeon)[3].

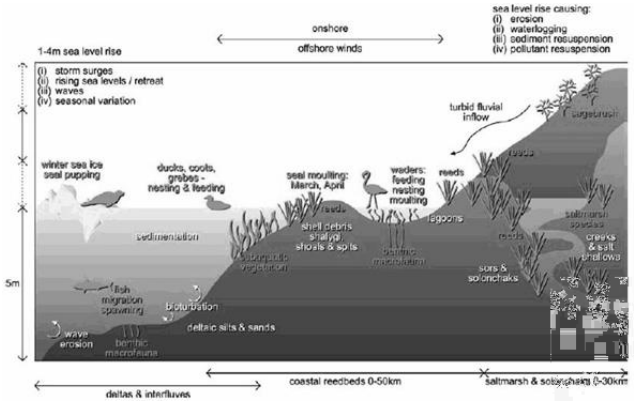

Fig. 1. habitat sensitivity in the Ural delta and adjacent coastal zone.

Therefore, in 2009 the Government of Kazakhstan has designated the Ural river and the adjacent Caspian Sea coast as Wetland of International Importance[4], part of North Caspian Nature Reserve (Ramsar Site 1856/2KZ002). In this view, under the high patronage of the Ministry of Environmental Protection, the Ural River Park Project had started, which is a collaboration between the Kazakhstan Institutions on local and national levels, the University of Bologna and the Po Delta Park – Emilia Romagna region, with the support of ENI. The URPP aims to support the national efforts in promoting the sustainable use of wetlands and coastal resources in the Ural delta area and to contribute to the progress of the area with the final goal to switch on the "Ural River Unesco Mab Biosphere Reserve", according to the program of joint work between the Ramsar Convention on Wetlands and the Unesco Mab[5]. The proposed Unesco- Mab Biosphere Reserve area, which covers about 331,000 hectares, includes the delta of the Ural River (?om the delta plain, just south of Atyrau, including the submerged prodelta area) and a significant part of the surrounding wetlands and reedbeds and will contain the existing State Nature Reserve "Ak-Zhayk", which protection status is now defined as "State Reserved Zone of the North Caspian Region", as determined by the Law of the Republic of Kazakhstan on Specially Protected Areas (15,07,97), article 48. Accordingly, an updated management plan has been prepared for the site, in total cooperation with National and local Authorities to play the important role of regulators guardians, facilitators and educators within the community; within the framework of the Integrated Coastal Zone Management (ICZM) methodology to describe and plan the complex interactions between the resource system and its potential users; using approaches and intemational procedures such as those indicated by the the UNESCO – MAB Biosphere Program. In facts, not only the environmental features, but also the interrelations among the environmental processes, the specific economical activities existing along the coast and their impact on the ecosystems have been taken into consideration, in order to achieve a complete knowledge of all the key factors involved in the sustainable developement and protection of the area, with particular attention on raising the local population awareness about the potential and the preciousness of their own land, form both the naturalistic and the economic points of view.

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PLANNING FOR CONSERVATION IN THE MEDITERRANEAN SEA: AN ECOREGIONAL APPROACH

S. Giakoumi [1]*, V. Gerovasileiou [2], M. Sini [3], T. Mazor [4], J. Beher [4], H. Possingham [4], M. E. Çinar [5], P. Dendrinos [6], A. Gucu [7], A. A Karamanlidis [6], P. Rodic [8], P. J Schembri [9], E. Taskin [10], A. Zenetos [1] and S. Katsanevakis [11]
[1] Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, Greece - s.giakoumi@uq.edu.au
[2] School of Biology, Aristotle University of Thessaloniki, Greece
[3] Department of Marine Sciences, University of the Aegean, Greece
[4] ARC Centre of Excellence for Environmental Decisions, University of Queensland, Australia
[5] Ege University, Faculty of Fisheries, Department of Hydrobiology, Turkey
[6] MOm/Hellenic Society for the Study and Protection of the Monk seal, Greece
[7] Middle East Technical University, Institute of Marine Sciences, Turkey
[8] State Institute for Nature Protection, Croatia, Department for Wild and Domesticated Taxa and Habitats
[9] Department of Biology, University of Malta, Malta
[10] Department of Biology, Faculty of Arts & Sciences, Celal Bayar University, Turkey
[11] European Commission, Joint Research Centre, Institute for Environment and Sustainability, Italy

Abstract
Our study demonstrates that setting conservation targets for each Mediterranean ecoregion, can lead to outcomes more comprehensive in the representation of the Mediterranean biodiversity overcoming the great variability in availability of biodiversity and socioeconomic data among countries.

Keywords: Biodiversity, Conservation, Coastal management, North Adriatic Sea, Aegean Sea

Despite the agreement by most Mediterranean countries to conserve 10% of the sea by 2020 under the Convention on Biological Diversity, only 4.6% of the Mediterranean Sea is currently included in Marine Protected Areas (MPAs). Furthermore, there is a striking imbalance in MPA distribution, as 96% is located in the northern basin [1]. Consequently, current MPAs only partially protect the Mediterranean biodiversity in terms of functional and phylogenic diversity [2].

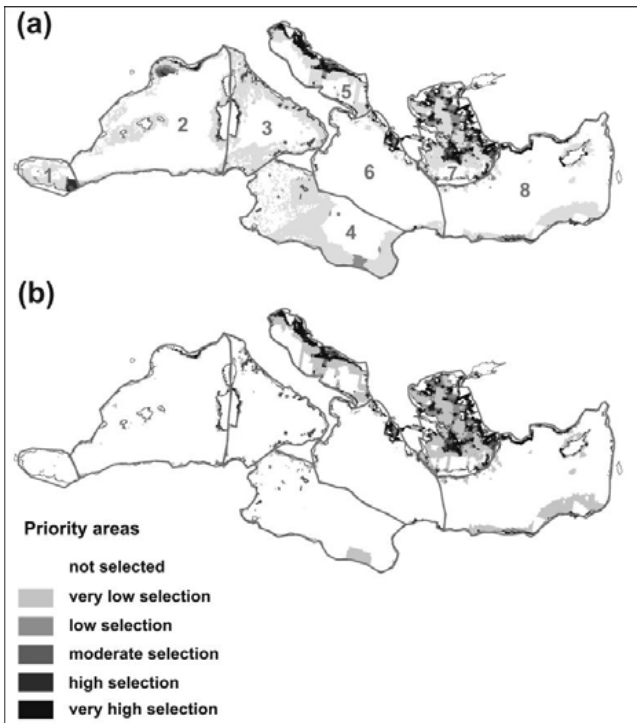

Fig. 1. Priority areas for *P. oceanica*, coralligenous formations and marine caves in the Mediterranean Sea: a) with ecoregion targets; b) without ecoregion targets. Planning units depicted in darker shades present higher selection frequency and therefore are of higher priority. The red polygons correspond to the 8 Mediterranean Ecoregions: 1. Alboran Sea, 2. Algero-Provencal Basin, 3. Tyrrhenian Sea, 4. Tunisian Plateau/Gulf of Sidra, 5. Adriatic Sea, 6. Ionian Sea, 7. Aegean Sea, and 8. Levantine Sea.

We identified priority areas throughout the Mediterranean Sea for the conservation of *Posidonia oceanica* meadows, coralligenous formations, and marine caves. To achieve this goal, we set conservation targets on the critical habitats, according to EU guidelines (60% of their distribution), as well as for each Mediterranean ecoregion (10% of the planning area) as defined by Notarbartolo di Sciara and Agardy [3], and used the prioritization software Marxan. The socioeconomic data included in the analyses, contained information on opportunity cost for fishing and aquaculture across the Mediterranean Sea.

While the spatial distribution of priority areas changed after setting ecoregional targets, the Adriatic and Aegean Seas remained high priority areas for conservation (Figs. 1a, b). The more even distribution of priority areas in our proposed network, in comparison to a whole-basin approach ignoring ecoregion representation, makes this plan more representative of the functional diversity across the basin. Moreover, it increases the resilience of the ecosystems to ongoing environmental and biological changes in the Mediterranean Sea, such as climate change and the introduction of invasive species.

Acknowledgements
SG was supported by the project NETMED co-financed by the Greek State and the European Union. We would like to thank Dr. Ameer Abdulla, the diving clubs and independent divers that enriched our databases.

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FORCE' FP7 PROJECT AS A SUCCESSFUL MODEL FOR COOPERATION WITH EUROPE'S NEIGHBOURS IN THE CONTEXT OF CAPACITIES BUILDING

Suzan Kholeif [1]*
[1] National Institute of Oceanography and Fisheries - suzan_kholeif@yahoo.com

Abstract
The international competitiveness of modern economies is linked increasingly to their ability to generate, adapt and use new knowledge. S&T are considered to be key factors contributing to achieving sustainable development, prosperity and economic growth of marine resources in Mediterranean and North African. The exchange of expertise will enable scientists to carry out research aimed at supporting the implementation of the sustainable development of marine resources. In collaboration with a strong EU partnership, FORCE FP7 project considers a successful capacity building model to fill Scientific and technology gaps as means of increasing sustainable yields. Also, FORCE will promote the principles outlined in Horizon 2020.

Keywords: Fisheries, Aquaculture, South-Eastern Mediterranean

FORCE "Fishing and aquaculture-oriented research capacity in Egypt" is designed to strengthen the capacity of the National Institute of Oceanography and Fisheries of Egypt (NIOF) to carry out research activities that aim to support the implementation of sound policies based on a scientific basis for sustainable development of fisheries and aquaculture in Egypt, as well as in the entire Mediterranean North African region. The overall objectives of FORCE are; to identify the potential for more efficient collaboration between research institutions, that are focused on fisheries and aquaculture as a means of scientific and technological development and increasing sustainable yield, based in the EU and NIOF; to support NIOF in the development of a "toolbox" to assess the environmental impact of aquaculture activities; to disseminate the best practices and raise awareness among scientists, fishery inspectors and policy makers. FORCE will promote the principles and objectives outlined in the Horizon 2020 framework and EU Marine Strategies thus supporting the attainment of competent sustainable management of fisheries. FORCE will enhance the capacity building of NIOF for a comprehensive strategy and improve women's capacities to contribute effectively to a real improvement in the socio-economic conditions of the fishery community.

PRELIMINARY RESULTS

⇒ According to Law 4/94 and its amended by law 9/ 2009 every new establishments are required to carry out an Environmental Impact Assessment (EIA) before construction. The scoping EIA form B is general for all projects. As the aquaculture industry is growing fast in Egypt, there is a need to develop a special guideline for full-fledged EIA for aquaculture projects due to their potential Impacts on surrounding environment. FORCE assisted the Egyptian Environmental Affairs Agency (EEAA) and General Authority for Fish Resources (GAFRD) to amend FORM B to be specific for EIA requirements for new establishment of Aquaculture projects. Moreover, FORCE will offer the experience for improving the EIA system in Egypt through: provide a "tool box" for Environment Impact Assessment (EIA) of finish aquaculture (Fig 1); help the developers how to choose the best location (site selection) and operate the facilities; help EEAA in reviewing process; help the license authority in following up the project and improve the quality of fish specially sea bass and sea bream which can be exported to EU market

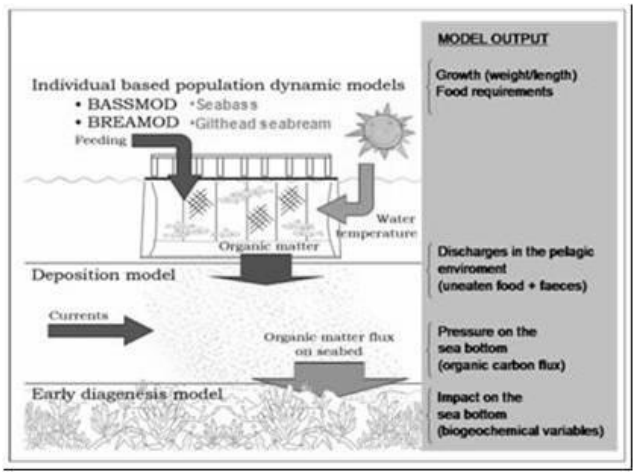

Fig. 1. Conceptual model of the impact of the release of organic matter from a fish farm on the seabed (by Roberto Pasters)

⇒ A review of the main fishing techniques and gears in Egypt, as well as of the technical properties, was carried to give a complete picture of the situation and to compare this with the current situation of other Mediterranean countries. This review implied: - an overview of the main fishing gears used in Egypt; - the main technical properties of the different fishing gears; - the characteristics of the fishing fleets in different harbours; - the characteristics of different fisheries; - the collection of information on the Egyptian legislation; - to identify the lack of information and weak points. This review made possible to initialize a technical database for Egypt by means of which it will be possible to propose new legislation with respect to gears, to propose ways how to re-structure the fleet in order to have more sustainable fishing gears and to achieve a balance between different gear types. This review should be considered as a first attempt in Egypt given that no other technical information is available for Egyptian fishing gears.

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DONNÉES SUR LA RÉGÉNÉRATION DE L'HERBIER À *POTAMOGETON PECTINATUS L.* DE L'ICHKEUL (TUNISIE SEPTENTRIONALE)

A. Shili [1]*, B. Chaouachi [2], L. Baccar [3], N. Ben Maïz [4] and C. Boudouresque [5]
[1] Institut National Agronomique de Tunisie. Université de Carthage. - shili.abdessalem@inat.agrinet.tn
[2] Faculté des Sciences de Tunis, Université Tunis El Manar, Tunisie.
[3] Eco-Ressources International.
[4] Société de Promotion du Lac de Tunis.
[5] Mediterranean Institute of Oceanography (MIO), Aix-Marseille University.

Abstract
Ce travail décrit les conditions de réapparition et la répartition de *Potamogeton pectinatus* L. (Potamogetonaceae) dans la lagune de l'Ichkeul suite à une année exceptionnellement pluvieuse (2002-2003). Ainsi, après une succession d'années sèches conduisant à une forte restriction des apports en eaux douces et par conséquent à la disparition des herbiers à *P. pectinatus* (de 1994 à 2002), une seule année était suffisante pour lessiver l'excès de sels et abaisser les salinités à des valeurs relativement faibles (salinité printanière : 8), permettant la germination des plantules à affinité dulçaquicole. L'herbier à *P. pectinatus* s'est étendu sur 18 km^2 notamment au Nord et un peu moins à l'Est et au Sud-Est de la lagune.

Keywords: Lagoons, Phanerogams, Hydrology, South-Central Mediterranean, Monitoring

Le Parc National de l'Ichkeul (Nord de la Tunisie) est inscrit sur les listes des réserves de la biosphère, du patrimoine mondial de l'UNESCO et de la convention de Ramsar. Il constitue un important site d'hivernage des oiseaux migrateurs pouvant abriter des colonies dépassant 200 000 individus. Dans le cadre de la planification hydraulique des ressources et d'utilisation des eaux du nord de la Tunisie, les aménagements projetés dans le bassin de l'Ichkeul consistent en l'installation des barrages sur six principaux oueds qui alimentent la lagune. Trois barrages ont été déjà mis en eau couvrant 46% du bassin versant de l'Ichkeul et trois autres sont prévus (couvrant 25% des surfaces du bassin versant). Cependant, les aménagements hydrauliques entrepris dans l'Ichkeul, aggravés par des conditions de sécheresse étendues sur quelques années, ont conduit à une diminution importante des apports en eau douce entraînant des modifications dans la biodiversité et dans la répartition des macrophytes ([1], [2]). Par conséquent, les oiseaux aquatiques qui sont essentiellement des phytophages ne disposent plus des ressources nutritives des herbiers à *Potamogeton pectinatus* L [3].

Nous avons effectué une campagne de mesures cartographique dans la lagune de l'Ichkeul durant la saison automnale de l'année 2003. Les observations ont été faites le long de plusieurs transects radiaux en direction du centre de la lagune. Nous avons déterminé, pour chaque station, la couverture végétale du substrat et le taux de recouvrement des espèces dominantes pour une surface de 1 m^2. Le diagnostic est fait par comparaison avec les situations antérieures observées à la même saison durant 1993, 1994 et 1998 (marquées par des saisons sèches). Les changements importants enregistrés en 2003, se résument comme suit : -une année 2003 particulièrement pluvieuse (802 mm à Tinja contre 600 mm pour une année normale) qui fait suite à trois années très déficitaires (1999-2002) ; -une chute de la salinité de l'eau suite à un lessivage de l'excès de sels. C'est la plus importante baisse enregistrée depuis 1993 (8 en mai 2003), -une extension de la limite du plan d'eau du lac entraînant l'inondation prolongée des marais, favorisant ainsi le développement des scirpes, appréciés par les oies cendrées. Malgré l'impact de la succession des années sèches, un herbier plus ou moins dense à *P. pectinatus* a été localisé (en 2003) dans le secteur Ouest, le long des berges Nord de la lagune mais également dans le secteur de Tinja, habituellement occupé par les espèces à affinité marine (Fig. 1). Le développement d'un herbier à *P. pectinatus* le long des berges nord de la lagune ainsi que dans le secteur de Tinja constitue un changement de l'aire de répartition de cette espèce qui n'a pas été observée dans cette zone depuis le début des années 1990s [1]. L'herbier à *P. pectinatus* s'ést étendu sur une surface de 18 km² alors qu'il occupait 30 km² lors de sa dernière apparition dans la lagune en 1993. Ainsi, de grandes modifications ont été relevées au niveau de la disposition des herbiers, surtout à partir de l'année 1994 [1]. *P. pectinatus* a constitué, jusqu'à l'année 1993, la principale macrophyte de la lagune. Cependant, après une succession d'années séches conduisant à une sévère restriction des apports en eau douce, la prairie à *P. pectinatus* a totalement disparu suite à l'élévation importante de la salinité de l'eau.

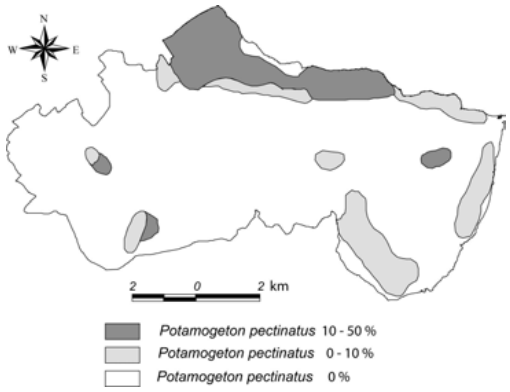

Fig. 1. Recouvrement (en %) des herbiers à *Potamogeton pectinatus* dans la lagune de l'Ichkeul (automne 2003).

Cette situation a duré jusqu'à l'année 2002, et un doute c'est instauré sur la capacité de régénération de l'herbier à *P. pectinatus*, très important pour l'équilibre de l'écosystème lagunaire. Situation qui a conduit à l'inscrption de l'Ichkeul sur la liste du patrimoine mondial en péril (en1996). A la grande surprise des chercheurs qui s'intéressent au suivi écologique de l'Ichkeul, il a suffit d'une seule année hydrologique exceptionnellement humide (2002-2003) pour que l'herbier puisse se reconstituer. Rappelant qu'une salinité <10 au début de la saison printanière est une condition sine qua non à l'apparition des jeunes pousses de *P. pectinatus* et ces conditions ont été bien établies en 2003. Le cas de l'Ichkeul est un exemple type qui montre l'importance des macrophytes benthiques comme outil d'aide à la décision. En effet, la régénération des herbiers à *P. pectinatus*, confirmée par un suivi cartographique montrant l'évolution progressive de l'herbier, a permis de reconsidérer le statut écologique du Parc National de l'Ichkeul qui ne figure plus, depuis 2006, sur la liste de l'UNESCO du patrimoine mondial en péril.

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IMPACT OF BOAT ANCHORING ON THE MEDITERRANEAN ENDEMIC BIVALVE *PINNA NOBILIS*: AN EXPERIMENTAL APPROACH

C. Morell Luján-Williams [1], G. Banach-Esteve [1], M. Vázquez-Luis [1]*, J. Borg [2], E. Álvarez [3] and S. Deudero [1]
[1] Centro Oceanográfico de Baleares - maite.vazquez@ba.ieo.es
[2] Department of Biology, Faculty of Science, University of Malta
[3] Govern de les Illes Balears. Direcció General de Medi Rural i Marí.

Abstract
The impact of boat anchoring on the Mediterranean endemic bivalve *Pinna nobilis* Linnaeus (1758) was assessed experimentally in the field by installing non-biological mimic units of the bivalve in the islands of Mallorca and Malta. In each of these two Mediterranean localities, two study areas having different levels of boat anchoring activities: 'control' (no anchoring allowed) and 'impacted' (anchoring allowed), were used for the field experiment. A significant number of *P. nobilis* mimic bivalves were affected by boat anchoring in the impacted areas; the impact was 3 times higher in impacted areas compared to control areas. Boat anchoring also had an adverse impact on *Posidonia oceanica* meadows, since seagrass cover was lower in the impacted areas.

Keywords: Bivalves, Endemism, Balearic Islands, Malta Trough, Coastal management

1. Introduction Anchoring by recreational boats causes an adverse impact on vulnerable and protected habitats and species. *Posidonia oceanica* seagrass meadows are the main habitat of the endemic fan mussel *Pinna nobilis*, the largest Mediterranean bivalve. Both *P. oceanica* and *P. nobilis* are under threat due to anthropogenic activities, especially in shallow coastal waters. Boating activities are increasing in Mediterranean coastal areas, especially during the summer months. Since boat anchoring causes physical damage to seagrass habitat [1], the activity can also affect the associated *P. nobilis* populations, given the large size of the bivalve. However, such direct physical adverse impact has never been assessed. Therefore, the aim of the present study was to evaluate the impact of boat anchoring on *P. nobilis* by using a field experimental approach in two Mediterranean islands that are support a high level of boating activities.

2. Materials and methods Deployment of non-biological mimic units of *P. nobilis* in *Posidonia oceanica* meadows within the 3 m to 10 m depth range was carried out during the period July to October 2012 using SCUBA diving. The experiment was conducted in two areas having different levels of boat anchoring activities: 'control' (no anchoring allowed) and 'impacted' (anchoring allowed), in the islands of Mallorca and Malta. The experimental design comprised 3 factors: 'protection' (fixed, with two levels, impacted and control), 'locality' (random and nested in protection, with 5 levels nested in control and 7 levels nested in impacted), and 'site' (random and nested within protection and locality, with three levels). For each treatment, 5 mimic bivalve units were deployed on the seabed within *P. oceanica* meadows. Statistical analysis was performed using PERMANOVA. Additionally, data on *P. oceanica* meadow cover and on the natural population of *P. nobilis*, were recorded for Mallorca.

3. Results The results indicated a significant impact of boat anchoring on the *Pinna nobilis* mimic units (Fig. 1, p value = 0.031). Of the affected mimic units, 12.09% were found leaning at an angle, 35.16% were found lying horizontally on the seabed and 52.75% were not found. The adverse impact of boat anchoring is also reflected on the *P. oceanica* habitat, since seagrass cover was significantly higher in the control areas (p-value: 0.001) in Mallorca.

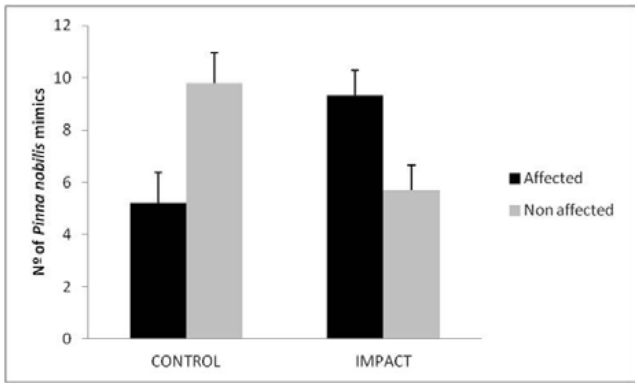

Fig. 1. Overall mean percentage affected and non affected (± standard error) *Pinna nobilis* mimic units.

4. Discussion The present results clearly indicate that *P. nobilis* mimic units were significantly affected by boat anchoring in impacted areas. Our findings highlight the importance of regulating coastal recreational activities [2] by adopting appropriate measures, for example, controlling the number of boats that enter areas where anchoring is allowed without any limitations [3]. A possible solution to minimize the impact of boat anchoring is to install mooring buoys and having environmental education programs in place to inform boat owners of the adverse effects of anchoring on *P. oceanica* and their associated biota. Such measures are important for protecting natural marine resources and improving future planning and decision making, thereby ensuring effective coastal management.

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CAS D'ÉTUDE DE LA GESTION MENÉE DANS QUATRE AIRES MARINES PROTÉGÉES DE MÉDITERRANÉE

Chloë Webster [1]* and Marie Romani [1]
[1] Mediterranean Protected Areas Network (MedPAN) - chloe.webster@medpan.org

Abstract
Quatre AMP, membres du réseau MedPAN, ont fourni les éléments relatifs à différents aspects de la gestion menée depuis plusieurs années et des résultats qu'ils ont obtenus sur leurs sites. Le cas du Parc National Marin de Zakynthos en Grèce permet de mettre en avant l'importance d'une gestion intégrée de la zone côtière, le cas du Parc Naturel de Telašcica en Croatie concerne la nécessité d'impliquer les parties prenantes dans la gestion de l'AMP, le cas de la Réserve Naturelle de Bonifacio en France permet de montrer le partenariat solide mis en place avec les pêcheurs artisanaux et l'aire protégée de Kas-Kekova en Turquie expose comment développer un tourisme durable.

Keywords: Marine parks, North-Western Mediterranean, North-Eastern Mediterranean, Biodiversity, Coastal management

Parc National Marin de Zakynthos, Grèce : Gestion Intégrée des Zones Côtières

Le principal enjeu du Parc National Marin de Zakynthos est de protéger l'une des plus importantes plages de ponte de la tortue Caouanne (*Caretta caretta*) en Méditerranée, tout en maintenant et en développant des activités économiques d'une manière durable. Environ 700 000 touristes visitent Zakynthos pendant la saison estivale. Le Parc a été créé en 1999. Des actions ont été entreprises afin de sensibiliser les touristes et la population locale sur les questions environnementales et de les impliquer dans les activités de terrain, d'organiser et de contrôler l'utilisation de la plage, de limiter les déchets, de mettre en oeuvre des codes de conduite et la certification des opérateurs locaux et plus généralement de limiter l'impact négatif des activités humaines sur les espèces protégées et les écosystèmes. Les intrusions des visiteurs et de la population locale dans les zones réservées ont été considérablement réduites, tandis que les délimitations de la zone marine et terrestre ont progressivement amélioré le contrôle des activités touristiques. A titre d'exemple, la délimitation des zones marines du Parc, en collaboration avec la police portuaire, a contribué à appliquer la réglementation sur la vitesse et l'accès des bateaux, et a permis de diminuer les risques pour les tortues et de protéger les habitats marins uniques de la zone. Le système d'ancrage sur bouées choisi a aussi évité la destruction des herbiers de Posidonia oceanica. Les conflits avec les populations locales et les parties prenantes ont diminué et le Parc est de plus en plus intégré dans le contexte socio-économique local. Le Parc National Marin de Zakynthos est régulièrement cité comme référence par l'Union Européenne pour la mise en oeuvre de la directive Habitat en Grèce et comme un exemple de gestion intégrée des zones côtières efficace.

Parc Naturel de Telašcica, Croatie : participation des parties prenantes dans la gestion de l'AMP

Le Parc Naturel de Telašcica a été créé en 1988, mais ce n'est que depuis peu qu'il est activement géré. Couvrant environ un tiers de l'île de Dugi Otok, le Parc concerne directement un millier de résidents locaux. Les populations locales se sont montrées au départ méfiantes à l'égard des mesures de gestion qui pourraient être imposées par le Parc. Au cours de ces dernières années, Sunce, une ONG locale, et le WWF se sont appliqués à démontrer les avantages d'une coopération étroite avec toutes les parties prenantes, pour une meilleure gestion de la zone. Une grande attention a été accordée à la communauté des pêcheurs. Malgré la baisse constante des stocks de poissons, le concept de pêche durable était difficile à accepter. Certains représentants de la communauté ont finalement pris part à des séances d'information et à des ateliers pour discuter du plan de zonage et du nouveau règlement de la pêche. Les autorités de gestion du Parc ont été formées à une gestion efficace des AMP, à la fois en termes de conservation mais également de concertation avec les parties prenantes. Historiquement perçu comme une menace par la population locale, le Parc gagne jour après jours de nouveaux partisans et les principes de protection de l'environnement progressent.

Réserve Naturelle de Bonifacio, France : préserver la pêche artisanale

L'Office de l'Environnement de la Corse (OEC) qui gère la réserve collabore activement depuis 1999 avec la Prud'homie des patrons pêcheurs de Bonifacio dans le cadre de la gestion du stock halieutique des Bouches de Bonifacio. Les suivis réguliers effectués sur les îles Lavezzi depuis 1992 puis étendus à l'ensemble de la réserve en 2000, jouent un rôle primordial dans la compréhension du fonctionnement des écosystèmes et permettent de prendre des mesures de gestion adaptées pour leur préservation. En 1982 déjà, les pêcheurs de la prud'homie de Bonifacio ont mis en place 2 cantonnements de pêche et une limitation du maillage restrictive. Ils ont par la suite largement participé au long processus de la création de la Réserve en 1999. Depuis 2000, ce partenariat se concrétise avec la participation des patrons pêcheurs aux différentes études menées sur la réserve en termes de gestion de la ressource halieutique. En retour, les pêcheurs sont indemnisés pour la mise à disposition de leurs navires et de leurs engins de pêche ainsi que pour les contraintes imposées par les suivis. Aujourd'hui les suivis scientifiques menés en partenariat avec les pêcheurs ont identifié un indice de biomasse moyen 6 fois plus élevé dans les zones protégées, ce qui engendre des revenus plus importants pour les pêcheries.

Aire de Protection Spéciale (SEPA) de Kas-Kekova, Turquie: développer le tourisme durable

L'Aire Spécialement protégée de Kas-Kekova est un hot-spot de la plongée en Méditerranée. Cet afflux de touristes doit cependant être géré pour limiter les dommages comme la détérioration des herbiers marins, la pêche illégale et les pollutions. La gestion du tourisme est un chapitre essentiel dans le premier plan de gestion de Kas-Kekova. L'Association sous-marine de Kas, KASAD, qui fédère la plupart des clubs de plongée de la région, a contribué à la définition du plan de zonage. Ensemble, ils ont identifié l'emplacement des sites de plongée et se sont mis d'accord sur l'installation d'un système de bouée afin d'éviter l'utilisation d'ancres et de protéger les herbiers sensibles. A ce jour, 5 sites de plongée sont équipés en tant que projet pilote.

Les sessions d'information et de consultation intensives avec les acteurs locaux, tels que KASAD ou les opérateurs de bateaux touristiques, ont conduit à d'importants engagements informels, qui sont appliqués avant même l'adoption officielle de la législation.

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Session

Economic dimension of coastal systems

Modérateur : **Michalis Skourtos**

DESIGN OF AN ECONOMIC AND ENVIRONMENTAL GIS-DATABASE TO ASSESS THE ECONOMIC IMPACT OF COASTLINE EROSION TO TOURISM. THE CLIMATOURISM DATABASE.

George Alexandrakis [1]* and Nikolaos Kampanis [1]
[1] Institute of Applied and Computational Mathematics, Foundation for Research and Technology, Hellas - alexandrakis@iacm.forth.gr

Abstract
A novel database, functioning as a supporting tool for the estimation of the economic impact of beach erosion to tourism, is described. The conceptualization, design and implementation of the database are discussed. The proposed database aims to provide realistic data to estimate the economic value of the beach, through a hedonic pricing econometric model.

Keywords: Erosion, Economic valuation, Gis, Cretan Sea

1. Introduction
Tourism is one of the principal sectors for the economy, especially in the Mediterranean countries. With the majority of the touristic activities concentrated around coastal areas, coastal erosion, among others, poses a significant threat to coastal economies that depend heavily on revenue from tourism. The ClimaTourism Database focuses on the identification of the vulnerability of the coast to sea level rise and associated erosion, in terms of expected land loss and economic activity. To achieve this, a database with environmental and economic data has been developed, as a supporting tool for economic impact to tourism. This multipurpose database needs to consider social, economic and environmental factors, whose interrelation will be better comprehended after being distributed and analyzed within the geographical space. The conceptualization, design and implementation of a regional GIS database, and its application to the Cretan Isl. in Greece, are presented.

2. Conceptual Model
The ClimaTourism database modeling combines environmental and economic data, under a multipurpose approach. The estimation of the vulnerability of the coast is implemented in two scales. The larger scale estimates the vulnerability in a regional level, with the use of the CVI method [1]. Subsequently, a smaller scale focuses on highly vulnerable beaches with high touristic and economic value. For this, the BVI method [2] is used, in order to identify the key factors that result to beach erosion. Finally the economic value of vulnerable beaches is estimated with the use of a hedonic pricing method [3]. There are three types of data that are used: (a) Raw data, derived from maps and remote sensing products, field observations, laboratory analyses, and social and economic features. (b) Analytical data, that are produced by analyzing the previous groups and (c) thematic data, created by interpreting the various types of data. In order to analyze large amounts of data -in a variety of formats, produced by numerous methods, and with different levels of accuracy- the database has been developed in a GIS form, organized in four levels. The first level concerns the gathering of raw data. In the second level the organization of the data is made. In level 3, new thematic data can be generated for further utilization. The applications of the database are implemented in level 4. The database flow chart and the conceptual model are illustrated in Figure 1.

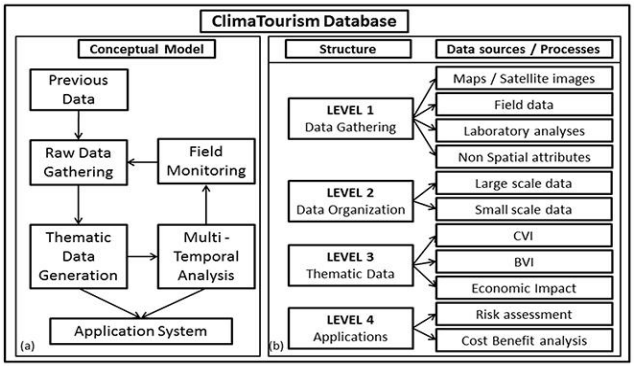

Fig. 1. Database flow chart and conceptual model.

3. Database design, implementation and geographical coverage
The geographical coverage of the large scale dataset covers the area of the Cretan shoreline and the area offshore which is included in the coordinates (Upper left 35.43N 24.69E, Low Right 34.91N 26.31E). At this scale, data about elevation, geomorphology, sea level trends, shoreline displacement, tide ranges, and wave heights are used. The small scale data set covers the areas of the beach zones. These data are derived by the numerical estimation of the processes that control beach evolution. This estimation depends on the calculation of other important variables, such as granulometry, wave characteristics, the geomorphology of the beach zone (e.g. beach slope), and, analytical data derived from these variables (e.g. wave run up). The socio-economic data that will be used for the database applications are included in this dataset. Details of the relational database, such as entities, relationships, tables, maps and, glossary of terms for data surveying, can be found in D1.4 deliverable, in the ClimaTourism WEB page (http://www.iacm.forth.gr/Climatourism).

4. Econometric model
A hedonic pricing model [4] is used to estimate the value of beach width that is capitalized in tourism income:

$$\ln(BL_{ij})=a_1(A_{ij})+ a_2(T_{ij})+ a_3(P_{ij})+ a_4(W_{ij})$$

where Beach Land value (i) in location (j) (BL_{ij}), is a function of Accommodation facilities (A_{ij}), number of hotels, Cafes, restaurants, hotel beds in a 200m from the beach buffer zone; Tourist activities (T_{ij}), number of enterprises that use the beach (e.g. water sports), beach area used for touristic activities; Property values in the proximity of the beach (P_{ij}); width of the beach at the property location (W_{ij}).

5. Expected results and conclusions
The expected outcome of the database is the identification of the most vulnerable and under high risk touristic coastal areas, and the estimation of the economic impact from beach land loss. Research of the economic implications of beach erosion were mainly focus in the cost of coastal protection measures and less in the income losses from tourism. A join environmental and economics approach of the problem can provide a management tool to mitigate the impact of beach erosion in tourism, through a realistic cost-benefit analysis for planning protection measures.

Acknowledgments
This work is supported by of the Action «Supporting Postdoctoral Researchers» of the Operational Program "Education and Lifelong Learning" (Action's Beneficiary: General Secretariat for Research and Technology), co-financed by the European Social Fund (ESF) and the Greek State.

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PRELIMINARY STUDY OF THE MANAGEMENT OF *POSIDONIA OCEANICA* BANQUETTES IN SPANISH COASTAL BEACHES.

Juan Eduardo Guillén Nieto [1]*, Joaquín Martínez Vidal [1], Alejandro Triviño Pérez [1] and Gabriel Soler Capdepón [1]
[1] Instituto de Ecología Litoral - j.guillen@ecologialitoral.com

Abstract
We performed a preliminary study on the management of *Posidonia oceanica* banquettes in various Spanish Mediterranean beaches. The biomass based on dead leaves that reaches the shorelands was estimated in 1,975 tonnes/year/km. Its annual removal cost exceed 100,000€ per municipality in 7.7% of the cases studied. There is a public ignorance about the environmental role of the banquettes residues. Thus, most people do not identify this biomass as natural; it is considered waste and its presence in the beaches responsibility of the administration.

Keywords: Posidonia, Coastal management, South-Western Mediterranean

Introduction:
Accumulations of leaves and debris from the seagrass *Posidonia oceanica* are commonly found along the Mediterranean coast. They form structures from a few centimeters to several meters thick, which are defined as "banquettes", consisting of leaves, rhizomes and sediments (Jeudy de Audoly Grissac & 1985; Boudouresque and Meisnesz 1982; Jeudy de Grissac, 1984). Although the banquettes often have been cited as having a role in the protection of beaches against erosion (Mateo *et al*., 2003, Boudouresque and Jeudy de Grissac, 1983), these are usually removed from beaches and coves to promote the exploitation of tourism in the Mediterranean region (Duarte, 2004). De Falco *et al*. (2008) estimate in 19-44 m^3 the sediment loss in 1,000 m^3 of banquettes disposed.

Material and Methods:
It has been studied for 13 areas in the Spanish Mediterranean coast (Formentera, Menorca, Benidorm, El Campello, Orihuela, Pilar de la Horadada, Santa Pola, Villajoyosa, Jávea, Vinaroz, Xilxes, Torreblanca and Lorca), using waste data and surveys focused on participation of beach users and local technicians.

Results:
In all cases, residues are principally composed of *Posidonia oceanica* banquettes (76.92%), the rest are various algae or other seagrasses (*Cymodocea nodosa*, mainly). The amounts of *P. oceanica* which are removed in the study areas have an average value of 1,975.11 tonnes/year/km, but this value is subject to high variability (sd 2,649.96), depending on each beach and year. Thus, the data obtained evidences a direct relationship between sea storms and tons of *P. oceanica* collected. In 2011 there was a high frequency of sea storms, higher than annual average, with an exceptional episode (March 2011) where the waves reached 4 meters high, coinciding with the maximum amounts given in the study. The residues of *Posidonia oceanica* collected were transferred to waste landfills in the 55% of the cases, to be treated as household waste, only 10% was used for environmental purposes, such as dune restoration, other uses were: farming (18%) , agriculture (11%), and other (6%). Another highlight of the study was the public perception of the residues, with results of 92.8% identified the presence of banquettes as waste, compared to the rest that considered as natural. Citizens likewise considered to local administration responsible for the presence of residues of *P. oceanica* on beaches (53.8%), compared with 15.4% who point out the ocean currents or other natural causes. Regarding the economic cost that municipalities expended for treatment of *Posidonia oceanica* residues, the survey revealed that the majority annual cost per municipality is less than 25,000€ (53.8% of cases), 7.7% intended between 25,000 and 50,000€, 15.9% expended between 50,000 and 100,000€, and 7.7% expended more than 100,000€ to treat the residues.

Acknowledgments:
The study is part of the project Seamatter financed by the European LIFE Programme (LIFE11 ENV/E/000600). We thank the municipalities of El Campello, Benidorm, Lorca, Orihuela, Pilar de La Horadada, Santa Pola, Torreblanca, Villajoyosa, Vinaroz, Xàbia, Xilxes, and the Island Councils of Formentera and Menorca, for providing their data for this study.

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AN INTEGRATED VULNERABILITY INDEX FOR SMALL PORTS UNDER A CLIMATE CHANGE THREAT

T. Kyrtzoglou [1]*, A. Kontogianni [2], T. Hasiotis [1], A. Velegrakis [1], I. Monioudi [1] and M. Skourtos [3]
[1] University of Aegean, Greece - mar06045@aegean.gr
[2] Dept. of Mechanical Engineering, University of West Macedonia, Greece
[3] Agricultural Universty of Athens, Greece

Abstract
The present paper presents the analytical and empirical aspects of an integrated vulnerability index for fishing/small ports based on the IPCC methodology for coastal vulnerability assessment. Six corresponding steps were adopted in order to assess the fishing ports vulnerability index (VIP-F). Geo-physical and socio-economic parameters are taken into account. The proposed index consists of three sub-indices: a physical index, a social and an economic index, all depending on differentially weighted variables. The development and a primary application of the proposed index were implemented in 47 fishing and small commercial ports of Lesvos Island, Greece. The proposed methodology can be adapted for vulnerability assessment of larger ports.

Keywords: Global change, Coastal systems, Aegean Sea

Introduction
Vulnerability in a broad sense defines the magnitude of the threat posed by climate change to humans. That includes both the degree to which an ecosystem service is sensitive to global change plus the degree to which the sector that relies on this service is unable to adapt to the changes. Thus, in a quantitative sense vulnerability is considered to be a function of exposure, sensitivity and coping capacity. [1] Both geo-physical and socio-economic indicators are accordingly used to quantify vulnerability to climate change impacts and prioritize policy responses. Coastal zones have attracted major investments which are susceptible to hazards such as storm surges and coastal erosion. Fishing ports (i.e. small ports for professional and amateur fishing boats) are among those investments. Climate changes along with the projected mean sea level rise, increases pressures to the coastal areas and consequently is expected to affect their economic growth [2]. The aim of this study is the development of a composite vulnerability index mainly for fishing ports but also for small island ports and the empirical application of this index to the fishing and other commercial small ports of Lesvos Island.

Methodology
Based on the IPCC methodology [3], [4], as adapted within CLIMSAVE project [5], for coastal vulnerability assessment, six (6) interlinked steps were adopted in order to assess the VIP-F.These steps are: (i) delineation of the study areas and identification of local climate change impacts through local data collection. (ii) production of an inventory for the fishing ports' characteristics (construction materials, size, orientation, sea-level sign etc). Data collected and analyzed referred to wind intensity/ direction, frequency of extreme wind observations, the incident wave's characteristics (height, period) and the effective fetch length at the fishing port entrance. (iii) identification of relevant stakeholders: professional and amateur users of the ports. (iv) calibration of physical changes through fishermen observations and corresponding impacts on the fishing ports (effects on the construction and the vessels). (v) Calculation of fishing ports adjustment costs according to two SLR scenarios. The engineering adaptation measures examined are: pier lifting, pier extension, deepening and enrichment with boulders. The required volumes of material, as well as the appropriate prices were also calculated. (vi) Estimation of the fishing ports' vulnerability through the adopted vulnerability index. The suggested VIP-F consists of three sub-indices: the physical, the social and the economic, dependent on differentially weighted variables. Each variable was introduced into a calibrated table, where 1 corresponds to the worst case and 6 to the best. The calibration was based on the maximum and minimum value of each variable, multiplied by a corresponding weighting factor. The VIP-F is finally given by the following formula:
VIP-F = [(Physical sub-index x 0.5) + (Social sub-index x 0.25) + (Economic sub-index x 0.25)].

Results and conclusions
The first results show that from a total of 47 fishing and small ports in Lesvos, 83% has VIP-F values higher than 3 (with a range between 3.1 and 3.9), implying medium vulnerability. 17% of the examined small ports shows a VIP-F value lower than 3 , being thus the most vulnerable. Mytilini (the islands' capital city) port has a value of 4.6, indicating that it is the less vulnerable port in the whole island. Nevertheless due to its importance for social/economic activities on the island, it still must be considered for adaptation measures to future climatic changes. Since the cost of protecting measures seems to be very high for all fishing ports, this index will help ranking the investment opportunities of the highest importance to the society. This in turn will support a cost effective allocation of investment funds for climate change adaptation measures for small or bigger ports.

Acknowledgement
This work was supported by the European Community 7th FP under Grant Agreement No. 287600 for the project 'Assessing and predicting the combined effects of natural and human-made pressures in the Mediterranean and the Black Sea, in view of their better governance' (PERSEUS) www.perseus-net.eu. It was also partly supported by European Community 7th FP under Grant Agreement No. 244031 'Climate Change integrated Assessment Methodology for cross-sectoral Adaptation and Vulnerability in Europe' (CLIMSAVE) www.climsave.eu

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AQUATIC GENETIC DIVERSITY: ASSESSING ECONOMIC VALUE

A. Issari [1], S. Matsiori [1]*, A. Exadactylos [1], G. Ekonomou [1] and D. Vafidis [1]
[1] Department of Ichthyology and Aquatic Environment School of Agricultural Sciences University of - steriani@uth.gr

Abstract
This study explores the factors influencing people's Willingness To Pay (WTP) for protecting aquatic genetic diversity. WTP was derived from a face-to-face survey of 350 respondents randomly selected residents of Volos city. Significant relationships are found between environmental people's WTP and its age and functional uses of genetic resources.

Keywords: Economic valuation, Biodiversity, Aegean Sea

Introduction
Economic valuation of biological resources supports conservation policies of these resources [1] and also recognises the importance of them valuation [2]. The objective of this paper was to investigate people's WTP for aquatic genetic diversity conservation by exploring the determinant factors that affect respondents' WTP. According to [3] the majority of previous studies have quantified genetic diversity measuring direct use benefits of biological resources in terms of inputs to the production of market goods [4,5,6].

Materials and methods
A CV survey was carried out to 350 randomly selected residents of Volos city. Volos is a coastal port city in Thessaly situated in the middle of the Greek mainland and is built along the Pagasitikos Gulf. A questionnaire was constructed and tested according to guidelines established by the NOAA panel [7]. Respondents were asked whether they would support a conservation program of aquatic genetic resources. Implementation of the program would cost them a specified amount of money (in €) in a one-time payment. In the second phase respondents were asked if they were willing to pay a specific amount of money to confirm their participation. The discrete choice model has become the most used approach for determining whether people are willing to pay for a non-market good [8]. Follow-up a Principal Components Analysis (PCA) was used as a tool for measuring different public perceptions and preferences with regard to importance of aquatic genetic resources.

Results and Discussion
The results revealed that most respondents (53.4%) were males. Mean age was 30.93 years, while mean monthly income was 942.57 €. Most respondents were formally educated (13.3 years) and all the respondents were engaged in at least one economic activity. PCA was used to measure different public perceptions with regard to importance of aquatic genetic resources (Table 1).

Tab. 1. Importance of aquatic genetic diversity

Factors Identi-fication	Variance Explained (%)	Cronba-ch's a	Total Cronba-ch's a	KMO	Bartlett's Test of Sphericity
Species Tolerance	30.59	0.82	0.87	0.82	App. χ^2 (1376,44) df = 190 p = .000
Functional Uses	12.88	0.75			
Pharmacy Production Services	7.78	0.81			
Conserva-tional Uses	5.99	0.71			
-	5.39	0.52			

Collected data, in the form of a binary variable (1=Yes and 0=No), on the amount that the respondents were willing to pay as well as a number of explanatory variables were used in a logistic regression model formulation (Table 2). The results of PCA indicate that the populations' ability to resistance, tolerance is the most important service provided by aquatic genetic diversity. Next, with the help of the extracted factors we explore how the level of importance may yield additional insight to explain individuals' WTP for its protection. Our empirical analysis illustrates that non one of socio-economic characteristics (e.g., age, household size, and income), except age, had significant effect on people WTP. On the other hand our results linked aquatic genetic resources with its functional uses (indirect use values).

Tab. 2. Description of explanatory variables and logistic regression results

Variables' description	b	Wald
Constant	1.367 [0.013]	1.415
Peoples's WTP (BID)	-0,008 [0.000]	11.423
Respondents age in years	2.114 [0.001]	7.059
The importance of aquatic genetic diversity functional uses (PCA 2nd Factor)	0.377 [0.002]	3.023
Changes in aquatic genetic diversity	0.941 [0,025]	5.058
Importance of aquatic genetic diversity for future life quality	0.459 [0.023]	5,170
intention to participate in aquatic genetic protection projects	0.782 [0.006]	3.528
McFadden R^2	0.326	
Correct predictions	79.0%	
Chi²(8)	75.346 p=0.000	
Mean WTP (€)	**9.970**	

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LANDSCAPE APPROACH TO THE ASSESSMENT OF MPA ECOSYSTEM SERVICES

Tatyana V. Pankeieva [1]* and Natalya A. Milchakova [1]
[1] Institute of Biology of the Southern Seas - tatyanapankeeva@yandex.ua

Abstract
The design procedure of ecosystem services are given for marine protected areas (MPA) on the basis of landscape and resources of macrophytes (using the example of the National natural park, Tarkhankut Peninsula, Crimea). Use of this technique allows identification of priority areas for the creation and organization of marine protected areas in the coastal zone of the Black Sea.

Keywords: Conservation, Black Sea, Ecosystem services

Anthropogenic pressure on the coastal zone in many areas of the Black Sea have led to the degradation and decrease in areas of natural habitat, reducing biological and landscape diversity, reducing their ecosystem services. Giving the value of ecosystem services with application towards MPA, the landscape approach and resource data for macrophytes could be one structural form of the economic calculation. Despite the extensive range of the scientific research on this topic, some aspects remain poorly explored by the government, including the assessment of ecosystem functions of seascapes. Coastal ecosystems, including estuaries, coastal wetlands,seagrass beds and algae, coral reefs and the continental shelf were disproportionately high in value. They cover only 6.4% of the world's surface but are responsible for 43% of the estimated value of the world's ecosystem services [1]. The coastal zone is defined as the economic valuation of ecosystem services MPA that can be given through the evaluation of services including macrophyte data resources and benthic landscape structure. As major primary producers, macrophytes provide the normal functioning and stability of the coastal ecosystem and, therefore, a sustainable environment, including the MPA. Coastal landscape structure reflects patterns of distribution of benthic landscapes with their features of geology, geomorphology, hydrology and biota. For the valuation of ecosystem services, calculation of macrophytes by subdivisions shall possess a natural property of integrity, which is typical of benthic landscapes. The developed method of valuation for ecosystem services, based on MPA landscape structure of the seabed and macrophytes resources, provides performance in few stages: physical and geographical characteristics of the area, structure and resources of bottom vegetation, to create the landscape map of the coastal zone, ecosystem services assessment of macrophytes including benthic landscape structure, mapping of the of bottom landscapes for ecosystem services assessment, and analyses of the full sets of data. Taken as a basis for mapping the coastal landscape sector of the coastal zone, the territorial unit for the assessment of ecosystem services is the bottom benthic landscape with bottom vegetation and macrophytes communities. For each floor of the landscape, the following parameters are calculated: area (ha), stocks (t, wet weight) and biomass of macrophytes (t/ha, wet weight). According to published data, the value of ecosystem services is estimated at $34,000 per ha per year for the bottom vegetation [2, 3]. Since stocks and biomass of macrophytes within landscaped boundaries have different values, the recommended method is to calculate the value of the ecosystem services to all areas of the coastal zone, including MPA. For this, calculate the ratio of ecosystem services (K) of macrophytes as a function of their biomass (t/ha), which is calculated on a peer review from a regional perspective. Valuation of ecosystem services, taking into account the landscape structure and bottom vegetation parameters, is carried by the following formula:

$$V = S \times D \times K \quad (1)$$

where V - the value of ecosystem services within the macrophyte landscape contours (in $); S - area of the landscape contour (km^2); D - a certain value of the ecosystem services of bottom vegetation, with 1 hectare = $34000 [2,3], K – the calculated coefficient, taking into account the biomass of macrophytes (t/ha). This technique has been tested for the bottom vegetation and landscapes of the Tarkhankut Peninsula coastal zone, which is a National natural park of Ukraine with a high level of landscape and biological diversity. This is confirmed by the high value of ecosystem services, benthic landscape and vegetation, and is designed by the proposed method (see Fig. 1).

In conclusion, the necessity of costing the benthic landscapes and bottom vegetation has taken into account their high ecological value. This technique can be applied to estimate the value of MPA ecosystem services along the Ukrainian part of the Black Sea coastal zone where full sets of data for macrophytes resources and bottom landscape structure exist to promote friendly and sustainable of natural resources, aimed at preserving the most valuable natural complexes. The advantage of this approach is not only the ability to characterize the unique landscape and biological diversity and ecosystem services for MPA, but also to give them an economic assessment, to determine the benefits and losses, to develop ways and means of preserving these services of the coastal ecosystems.

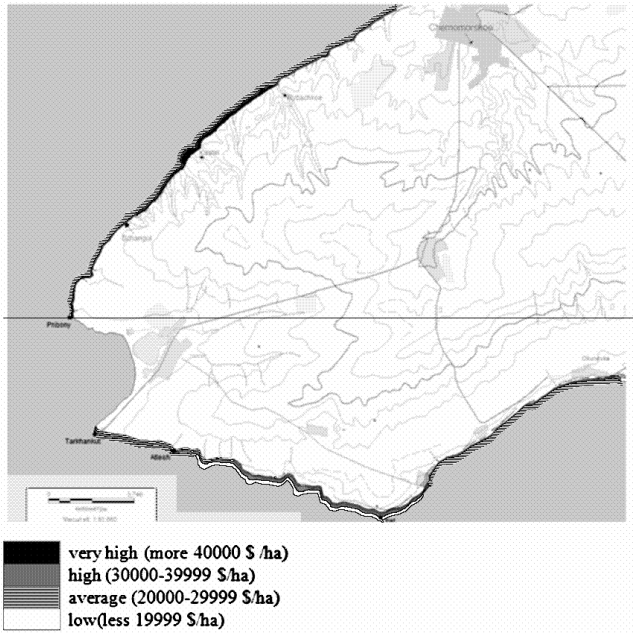

Fig. 1. Value of ecosystem services of the benthic landscape of the Tarkhankut Peninsula

Acknowledgements. This research has received funding from the EC (FP7/2007-2013) under Grant Agreement No. 287844 for the project CoCoNet.

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IMPACTS OF OFFSHORE WIND FARMS ON MARINE ECOSYSTEM (A REVIEW)

Lilija V. Bondareva [1], Vladimir V. Alexandrov [1] and Valentina G. Riabohina [1]*
[1] Institute of Biology of the Southern Seas, Sevastopol, Ukraine - valryabog@yandex.ru

Abstract
The environmental impact of offshore wind farms (OWF) is reviewed to consider possible threats for the Black Sea ecosystems due to the wind power development planned in this region. The physiological and biochemical responses of marine species to vibrations created by OWF are poorly investigated and thus are important subject for future research.

Keywords: Black Sea, Coastal management, Wind

At present the successful development of wind energy, especially in the coastal zone, gradually led to the construction of Offshore Wind Farms (OWF). This is due to the fact that the wind speed reaches higher levels around offshore areas of the sea than on land. Usually the shallow areas (depth up to 30 m), with a distance from the coast of 30–90 km are selected for OWF. There are no OWF in the Black Sea yet, but wind power development is considered for this region [1], so it is necessary to study possible threats from OWF. There are many publications on evaluating the effect of Wind Farms (WF) on the biota and environmental conditions especially on climate. Because of the wind energy development in offshore areas the number of studies describing the effect of OWF on environment is rising. It is proposed to perform an analysis of the WF environmental impact during all the main phases of their life cycle, which includes the production of power equipment, construction of the facilities, operation, dismantling and disposal of obsolete and worn-out elements [2]. It is obvious that direct impact of the OWF production and disposal on marine ecosystems is excluded.

Environmental impacts during the WF construction do not differ from those in other capital construction projects. Construction works disturb and destroy benthic communities and substrate; the noise of construction machinery is an additional source of animal disturbance, but the impact of WF construction process is limited in time [2]. The estimated lifetime of modern WF is about 25 years [2]. During the stage of their operation WF impact human, flora and fauna, air, water and land use through various types of noise, vibration, electromagnetic radiation, optical effects, mechanical effects and waste [2]. For minimizing the environmental impacts technical characteristics and location of WF are of a large value; for example reduced vibration, design features protecting birds, WF placement far away from birds migration routes, especially from the stopover points [2,3].

Erecting of OWF in the sea leads to the emergence of new sources of noise and vibrations. Propagation of sound in air and water mediums differs, so effect of sound on biota in these mediums considered to differ too. The harmful influence of noise on human activity is well-known, noise is also the main component of disturbance to wildlife. Acoustic vibrations can affect living organisms directly, because of the resonance phenomenon: vibration at resonant frequency of an organ would cause organ damage [4,5]. Low-frequency mechanical vibration is a factor of strong influence for marine animals and for humans [4]. It impacts all biological objects negatively even at the molecular and biochemical levels; this impact depends on specific conditions [4,6]. Mechanical vibrations have a destructive effect on the conformation of enzymes (e.g. catalase), reducing their functional activity. This effect depends on the amplitude and the frequency range of vibration; the degree of the enzyme inactivation is proportional to the vibration intensity [6]. Experimentally proven that the joint action of noise and vibration results in an increase of sugar, cholesterol and lipoprotein content in rat's blood [4]. Acoustic safety of OWF is very important for fish because their mechanoreceptors provide successful foraging, defense and recognition of the individuals of the same species; mechanical vibrations can influence the shoal formation and the reproduction of fish. The perception of mechanical vibrations is species specific; high sensitivity to low frequency vibrations was found for four species of Black Sea fish: sea snake, rass goby, rock bass and sea ruff [4].

The OWF have specific effect on the marine environment that result from fouling of underwater structures; the OWF potential for new habitats creation is discussed. Usually, the artificial reefs are regarded as means to improve ecosystems of the Black Sea, although the hydrotechnical constructions can have neutral or even negative effect on aquatic ecosystems [7]. This is due to species composition of fouling communities in the Black Sea, their productivity and development can vary significantly depending on the substrates, the location of the object, eutrophication and other factors [8].

The impact of WF on birds and bats is well-known [3] and depends on the location of WF, especially on their proximity to the birds migration routes. It is clear that OWF will be perceived by birds as a place to rest. Identifying the influence of OWF is especially important for the Black Sea, because this basin is a part of main bird migrations routes [9]. Bats are often victims of WF on land; apparently this is a genuine problem for OWF as well. The migration path of bats often coincides with the migration routes of birds; there is evidence of finding bats in the open sea. Several papers discuss the impact of WF on some climatic characteristics: change in wind speed, humidity, air composition (CO_2) and near-surface air temperature. The rotation of the turbines results in vertical mixing of heat in the atmosphere, which affects the temperature and can slightly change the evaporation [10].

Thus, possible negative impacts on biota and environment are possible as a consequence of the wind power development in the Black Sea. They have to be considered during the planning such an activity in this region taking into account their influence on the MPA network to be created. The physiological and biochemical responses of marine species to mechanical vibrations in aquatic environments are poorly investigated and thus are important subject for future research.

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Session

Pollution and environmental impacts

Modérateur : **Vesna Milun**

OIL POLLUTION IN COASTAL SURFACE WATER FROM VARIOUS REGIONS OF MARMARA SEA

Esra billur Balcioglu [1]*
[1] Istanbul University Fisheries Faculty Marine Biology Department - ebillur@istanbul.edu.tr

Abstract
Oil pollution of the Marmara Sea was investigated at 17 stations during February 2013. Total hydrocarbons were determined against chrysene standard using spectrofluorophotometer. The highest oil pollution was found as 11,9 µg/L at Station 7 in Dardanelles and 2,71 µg/L at station 3 in Istanbul Strait. According to results oil concentrations in some stations are much higher than limit value. Long term monitoring is necessary on pollution due to busy traffic of Marmara Sea.

Keywords: Coastal waters, Surface waters, Petroleum, Marmara Sea

Petroleum hydrocarbons are usually introduced into the environment as a result of anthropogenic activities which increased dramatically in the last two decades and they are also released into the aquatic environment through wastewaters, from coke and petroleum industries, vehicle traffic, and oil spills [1]. In Marmara Sea oil pollution is mostly caused by the inflow from Black Sea, as well as heavy shipping traffic and the Izmit refinery. The Dardanelles was also affected by the pollution carried from the Sea of Marmara and shipping/tanker traffic [2,3,4]. In this study oil pollution was determined in the coastal surface water of the Marmara Sea at 17 stations in 2013 February. The seawater samples were taken in 2,8 L amber glass bottles and 15 ml dichlormethane (DCM) was immediately added for preservation. The samples were extracted with DCM and distilled. The residue was taken with hexane and analyzed by spectrofluorophotometer (Shimadzu RF 5301) at 310/ 360 nm (ex/em). Chrysene was used as reference according to suggestion (Aldrich) [5-8]. Names of the stations are listed as 1- Garipce, 2- Rumeli Kavagi, 3- Kumkapi, 4- Büyükçekmece, 5- Tekirdag, 6- Gallipoli, 7- Karakova Cape, 8- Seddülbahir, 9- Kumkale Cape, 10- Gocuk Cape, 11- Lapseki, 12- Erdek Bay, 13- Marmara Island, 14- Kinaliada, 15, Kadikoy, 16- Anadolu Hisari, 17- Anadolu Feneri. Sampling stations are shown in Figure 1.

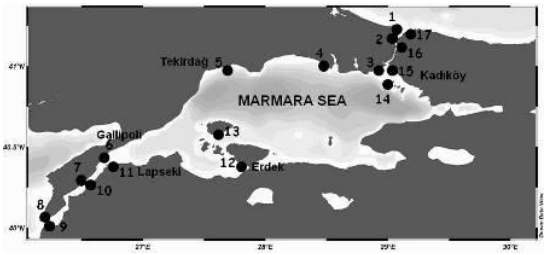

Fig. 1. Sampling Stations in Marmara Sea

The equation of calibration curve for Iraq crude oil: for chrysene:
y= 2134,05*C – 3,5469 r = 0,99.
The oil pollution levels examined in sea water are shown in Figure 2. Oil pollution was investigated at various regions in Marmara Sea by Güven et al., 2005 [2], Güven et al. in 2001-2002 [3], Güven and Ilgar in 1996-1997 [4], in Golden Horn by Cumali and Güven, 2008 [5]. Güven and Ilgar indicated that coastal areas were more polluted than mid-points of Dardanelles and also Sea of Marmara in1996 [4]. Limit value of oil in sea water is reported as 2,5 µg/L by WHO. We found the highest oil level at station 7 as 11.9 µg/L. This case is related to location of shipyard being close to station 7 in Dardanelles. Besides other higher concentrations were found as 10,2 µg/L at Gallipoli and 9,4 µg/L at Lapseki stations in Dardanelles. Gallipoli and Lapseki stations are located at the enterence of Dardanelles and these high concentrations are related to waiting of ships at the enterence. In Istanbul Strait the highest level was found as 2,71 µg/L at station 3 (Kumkapi) where is fishing vessels and yachts station. According to findings oil concentrations in some stations are much higher than limit value indicated by WHO. This study showed that oil pollution had varied among the stations and long term monitoring is necessary on the pollution to understand change in pollution level in Marmara Sea having busy traffic.

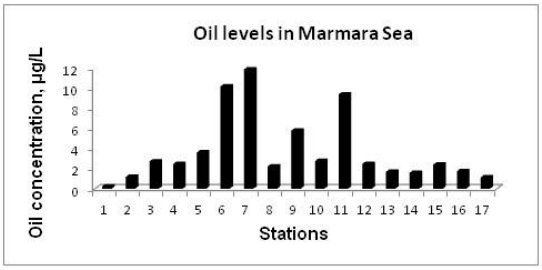

Fig. 2. The oil concentrations found in the samples (µg/L)

Acknowledgement: The author thanks to Prof.Dr. K.C.Guven, Prof.Dr. B. Ozturk, Assoc. Prof. Dr. N. Balkis, Assist. Prof. Dr. A. Aksu for comments.

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CORALLINA SP. AND *PATELLA CAERULEA* (LINNAEUS, 1758) AS QUANTITATIVE BIOLOGICAL INDICATORS FOR TRACE METALS IN THE TUNISIAN COASTAL WATERS

Hela Belkhodja [1]* and Mohamed S. Romdhane [2]
[1] UR: Exploitation des Milieux Aquatiques Institut Supérieur de Pêche et d'Aquaculture de Bizerte - hela.belkhodja@yahoo.fr
[2] Institut National Agronomique de Tunis, 43 av. Charles Nicolle, 1082, Tunis - Tunisie

Abstract
The concentrations of trace metals (Fe, Mn, Cu, Cd, Cr, Ni, Al, Pb) were measured in two marine organisms of environmental relevance: red algae (*Corallina sp*.) and mollusk limpet (*Patella caerulea* Linnaeus, 1758). The samples were collected at two coastal stations located in the north coasts of Tunisia (Bizerta Channel: CB and La Goulette harbour: LG). These areas are influenced by anthropogenic activities (harbour, industrial and urban wastes). Metal concentrations measured in the limpet indicate that the area of Bizerta Channel was the most polluted. We found high variability of metal bioaccumulation among the two species analysed. The order of metal accumulation in the red algae was Al>Fe>Mn>Pb-Cu>Ni>Cr>Cd, while in the limpet the order was Fe>Al>Mn>Cu>Pb-Ni>Cr>Cd.

Keywords: Algae, Mollusca, Metals, Tunisian Plateau

Marine organisms can be used as monitors to give information on concentrations of trace metal in the surrounding environment. Especially, macroalgae and limpet species are usually used to indicate heavy metal levels in coastal waters throughout the world [1].There have been made numerous studies on the trace metal concentrations of the bivalve and gastropod molluscs in the Tunisian marine environment, but limited information exists on the content of the trace metals in algae of the Tunisian coastal waters. In benthic food webs, marine algae are key links and they act as time-integrators of pollution [2]. Their sedentary nature is another reason why marine algae species are well fitted as monitor organisms in heavy metal monitoring.
The aim of the present study was to determine the levels of Fe, Mn, Cu, Cd, Cr, Ni, Al, Pb in red algae *Corallina sp.* and the limpet *Patella caerulea*, sampled seasonally during 2006-2007, from two different stations in the north coasts of Tunisia (Bizerta Channel: CB and La Goulette harbour: LG). Algal samples and between 30 and 40 specimens of *P. caerulea* were handpicked in the tidal zone from the two studied sites. Organisms were depurate and soft tissues were dried, pulverized and mineralized. Heavy metals analyses were performed in the limpet and algae samples according to the methods described by AOAC [3] and Riget et al. [4].

Tab. 1. Mean concentrations of metals in tissues of *P. caerulea* and *Corallina sp*. collected from the north coasts of Tunisia since summer 2006 until the spring 2007. [a] $mg.g^{-1}$

	Fe[a]	Mn	Cu	Cd	Cr	Ni	Al[a]	Pb
Stations	The mean metal concentrations in *P. caerulea* ($\mu g.g^{-1}$ dry weigh)							
CB	2.59±0.18	5.14±0.83	5.59±0.47	1.63±0.27	2.78±0.59	3.43±0.8	0.40±0.03	3.51±0.67
LG	1.86±0.17	10.76±2.49	9.29±1.43	0.78±0.24	1.00±0.36	3.00±1.12	0.35±0.06	3.61±0.8
	The mean metal concentrations in *Corallina sp.* ($\mu g.g^{-1}$ dry weigh)							
CB	2.29±0.96	36.55±12.68	8.43±3.17	0.76±0.2	2.21±0.92	2.90±0.6	2.53±1.41	7.79±5.68
LG	2.52±1.14	60.80±16.16	13.15±9.62	0.78±0.27	1.28±0.7	2.51±1.49	4.11±1.55	9.26±5.41

The mean heavy metal concentrations determined in *P. caerulea* and *Corallina sp*. are shown in Table 1. Results revealed that in CB station, concentrations of Fe, Cu, Cd, Cr and Ni are significantly higher (ANOVA, $P<0.05$) in soft tissues of *P. caerulea* than in *Corallina sp*., otherwise, in *Corallina sp.*, the rates of Mn, Al and Pb are significantly higher than in *P. caerulea* (ANOVA, $P<0.05$). However, in LG station, except the Cd and the Ni, the mean concentrations of all metals are significantly higher than the rates found in tissues of *Corallina sp*. than in those of *P. caerulea* (ANOVA, $P<0.05$).
In the present study, comparison between stations for the concentrations for all metals revealed that the highest values of the heavy metal in *Corallina sp*. were found at LG station for Fe, Mn, Cu, Cd, Al and Pb (Table 1). However, the highest values in the limpet were found at CB station for Fe, Cd, Cr, Ni and Al.
High concentrations of trace metals registered in CB and LG stations are probably related to the degree of water contamination. High levels of heavy metals in the limpet registered in CB station are caused by wastewater discharges and by the important maritime activities in this area. This zone is also submitted to the impact of industrial activities which cause atmospheric and chemical aquatic pollution [5]. In LG station, the high concentrations in Fe, Mn, Cu, Cd, Al and Pb in tissues of the red algae could be explained by the fact that this station is located at the trade fishing harbour characterized by the important port activity. Besides, this station receives wastes from ships, industrial, urban and agriculture effluents from closed areas via Medjerda Wadi, Khlij channel and Meliane Wadi [6].
The patterns of heavy metal accumulation rates in decreasing order were Al>Fe>Mn>Pb-Cu>Ni>Cr>Cd in the red algae and Fe>Al>Mn>Cu>Pb-Ni>Cr>Cd in The limpet, where Pb, Cu and Ni were changeable in their order at different stations. The observed variation in metal levels in these marine organisms at different stations may be related to the environmental conditions of the area and to the physiological conditions of biota regarding the metal.

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IMPACT D'UN REJET D'UNE CENTRALE ELECTRIQUE SUR LE PEUPLEMENT MICROZOOPLANCTONIQUE AU NIVEAU DE LA COTE EST DE LA TUNISIE

Meher Bellakhal [1]* and Mouna Bellakhal Fartouna [1]
[1] Institut Supérieur de Pêche et d'Aquaculture - meher2976@yahoo.fr

Abstract
Des proliférations massives et fréquentes de méduses au niveau de la baie de Sousse, située à l'est de la Tunisie, ont conduit à la suspicion du rejet d'une centrale électrique implantée dans cette zone. En effet, ce rejet provoque une élévation de la température de l'eau jusqu'à 36°C susceptible de perturber la prolifération du phytoplancton puis celle du zooplancton via le réseau trophique. 5 groupes microzooplanctoniques ont été identifiés. A l'échelle saisonnière la densité moyenne la plus importante (2814 cellules/L) a été enregistrée en automne alors qu'à l'échelle spatiale les densités les plus élevées ont été enregistrées au niveau des stations les plus proches du rejet où elles ont atteint 4883 cellules/L.

Keywords: Coastal systems, Thermal pollution, Zooplankton , Tunisian Plateau

Introduction
Le littoral, interface entre la terre et la mer, est un milieu complexe, riche sur le plan écologique et très convoité. Actuellement, 60 % de la population mondiale vit à moins de 60 km des côtes et l'urbanisation littorale risque de s'amplifier, puisqu'on attend 75 % de la population mondiale sur les côtes en 2025 [1]. Selon le PNUE (Programme des Nations Unies pour l'Environnement), 80 % des pollutions marines sont d'origine terrestre et anthropique [2]. La pollution thermique présente un danger néfaste pour l'équilibre écologique des écosystèmes côtiers [3]; [4]; [5]; [6]; [7]. C'est dans ce cadre que la Baie de Sousse a été au cours de ces dernières décennies exposée à des activités anthropiques assez intenses qui ont provoqué une pollution à l'origine de plusieurs problèmes d'ordre environnemental. Parmi ces problèmes on cite la prolifération massive et inhabituelle de méduses qui touche cette zone de plus en plus fréquemment au cours de la saison estivale. La centrale d'électricité, implanté dans cette zone a été soupçonnée dans cette perturbation par son effluent d'eau chaude qui provoque une élévation de la température de l'eau dans la zone limitrophe. L'objective de ce travail est donc d'étudier l'impact de ce rejet sur la répartition spatio-temporelle de quelques groupes microzooplanctoniques.

Matériel et méthodes
A proximité d'une centrale électrique, au niveau de la baie de Sousse située sur la côte Est de la Tunisie (35°50' N ; 10°50' W), 20 stations d'échantillonnage, 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, ont été prospectées saisonnièrement durant 2 ans. 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 été également choisies. Les échantillons ont été récoltés à l'aide d'un filet à plancton de 70 µm de mail et fixés au formol neutralisé au Borax (4 à 5%). L'identification et le dénombrement du microzooplancton a été effectué selon la méthode d'Utermöhl.

Résultats et discussion
Les fluctuations saisonnières du microzooplancton ont été assez hétérogènes. En effet, il a été relativement le plus abondant au printemps avec une abondance relative de 5% par rapport au microplancton total tandis que sa densité était la plus importante en automne avec 2814 cellules/L. Durant l'été elle a été de l'ordre de 1646 cellules/L, 227 cellules/L en hiver et 1217 cellules/L au printemps. A l'échelle spatiale, le microzooplancton a été relativement le plus abondant au niveau de la station 42, située dans la 4ème radiale et à l'isobathe 2 m, avec une abondance relative moyenne de 9.64%. La densité moyenne la plus élevée a été enregistrée au niveau de la station 22, très proche du rejet, et elle a été de l'ordre de 4883 cellules/L. Les observations de terrain ont montré que les proliférations de méduses suivent bien l'évolution spatio-temporelle de ces densités et sont plus fréquentes en automne et en été notamment au niveau des stations proches du rejet. Durant la période d'étude, ce sont les Ciliés non loriqués qui ont dominés le peuplement microzooplanctonique avec les valeurs d'abondance relative et de densité moyenne les plus importantes. En 2ème rang on trouve les Tintinnides. Nous trouvons par la suite, selon un ordre décroissant de leurs abondances relatives : les nauplii de Copépodes, les larves de Lamellibranches, les larves d'Annélides, les larves de Gastéropodes et les Rotifères. Les Ciliés ont été omniprésents au niveau de la Baie de Sousse durant la période d'étude. Ils se sont de même imposés sur le plan quantitatif avec une densité moyenne de 829 cellules/L ce qui correspond à l'abondance relative la plus importante de l'ordre de 52.55%. A l'échelle spatiale, les Ciliés ont dominé le peuplement microzooplanctonique surtout au niveau de la station 45 où on assiste à une abondance relative maximale de l'ordre de 84.82%. En revanche, la densité moyenne a été maximale au niveau de la station 22 avec une valeur de 2310 cellules/L. Au niveau de la station OH1, située à l'embouchure du rejet, cette densité a été la plus faible avec une valeur de 140 cellules/L. Les Tintinnides ont représenté le groupe microzooplanctonique le plus important sur le plan qualitatif en étant omniprésents marquant leur présence au niveau de toutes les stations et durant les 4 saisons d'étude. Sur le plan quantitatif, ils représentent le deuxième groupe le plus important avec une abondance relative annuelle de 40.68% et une densité moyenne de 533 cellules/L. Les nauplii de Copépodes ont été classés parmi les taxa omniprésents en étant assez fréquentes et ubiquistes. Sur le plan quantitatif, ils ont présenté une densité moyennes annuelle de l'ordre de 87 cellules/L ce qui correspond à 5.30% du microzooplancton total. Les larves de Lamellibranches ont présenté un rôle secondaire aussi bien sur le plan quantitatif que sur le plan qualitatif. Elles ont été absentes pendant le printemps et n'ont fait aucune apparition au niveau de 11 stations. Les larves d'Annélides sont à leur tour classées parmi les taxa secondaires aussi bien sur le plan quantitatif que qualitatif où elles se trouvent au cinquième rang avec une densité moyenne de l'ordre de 8 cellules/L ce qui correspond à 0.34% du peuplement microzooplanctonique.

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LONG TERM FLUCTUATIONS AND TRENDS OF METALS IN SARONIKOS GULF (GREECE) AS RECORDED BY THE MUSSEL WATCH PROGRAMME

Vassiliki-angelique Catsiki [1]* and Evangelia Strogyloudi [1]
[1] Hellenic Centre for Marine Research - cats@hcmr.gr

Abstract
Bioaccumulation of metals was studied in mussels from Saronikos gulf during the period 1986-2012 in order to investigate temporal trends and control the effectiveness of the wastes treatment. Results showed a decreasing metal gradient towards the open sea. The temporal evolution comprises important variations. It was found that the operation of the wastes treatment unit caused a temporal reduction in metal bioavailability, followed by an increase, as the quantity of wastes increased too.

Keywords: Monitoring, Bio-accumulation, Saronikos Bay

Introduction
The worldwide increase of marine pollution requires control strategies based on regular monitoring of contaminants, frequently performed through the analysis of sessile marine organisms [1]. The present paper aims to describe long term fluctuations and temporal trends of metals in Saronikos gulf (Central Aegean Sea, Greece) by the means of *Mytilus galloprovincialis* in order to control the effectiveness of the wastes treatment and the measures taken. Note that the municipal and part of the industrial wastes are treated since 1996.

Materials and methods
Mytilus galloprovincialis samples were collected from 4 coastal stations seasonally during 1986 to 2005 and scarcely till 2012. During each sampling occasion 4 to 6 replicates of composite samples from the soft parts of 20 specimens of similar size were analysed by AAS for Cu, Cr, Ni, Zn, Fe, Mn and occasionally for Cd and Pb. The accuracy was tested with reference materials.

Results and discussion
Metal levels in the 1537 samples showed that, with some exceptions, Saronikos Gulf's mussels are generally moderately contaminated by metals [2]. Results showed a decreasing metal gradient towards the open sea; Elefsis' bay mussels being the more contaminated [3]. In addition bioaccumulation was elevated during the cold periods of the year.
The Locally Weighted Regression smoothing technique, used to reduce temporally limited changes, showed that most metal levels maintained relatively constant during the period 1985-89, followed by an increasing period till 1993 for Cr & Mn and till 1997 for Zn. During 1997, with the exception of Cr, metals either reach their higher levels (Cu, Fe, Zn), or they have a secondary pick (Ni, Cd, Mn). The year 1997 coincides with one year of operation of the wastes treatment unit, time probably necessary for a first sign of the effectiveness of the Athens' wastes treatment. However during 1993-94 important industries ceased to function. Especially Cr presents its minimal levels during 1997, fact showing that all metals have not the same origin. After 1997 the concentrations temporally return to their previous levels of 1985 and either continued to decrease or start to increase again.
Regression analysis showed that Cu, Cd, Ni and Mn levels present a statistically significant decrease in relation to 1985. On the contrary Fe & Zn (metals especially related with domestic sewages) have a statistically significant increase, while for Cr the observed fluctuations mask the overall trend.
Although the sewages treatment and the reduction of industrial activity in the area had obviously result to decrease trends, we can not neglect the significant gradual augmentation of the quantity of the treated sewages released into Saronikos gulf, that probably cause the observed increase trends.
In conclusion although a reduction is observed for most metals, the increasing trends of Fe and Zn should be taken into consideration by the decision makers since the actual sewage treatment only indirectly removes metals.

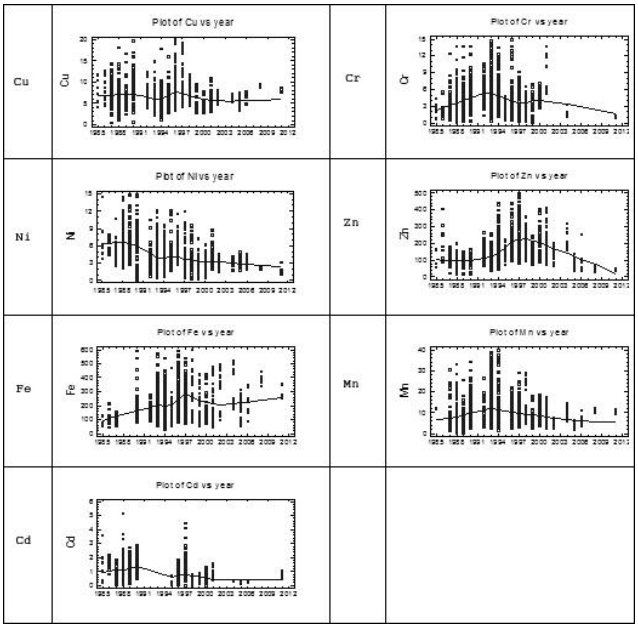

Fig. 1. Temporal evolution of metals in *M.galloprovincialis* from Saronikos

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TOXIC BANKS: ENCYSTED RESTING STAGES IN HAIFA PORT, ISRAEL

Fernando Rubino [1], Manuela Belmonte [1] and Bella Galil [2]*
[1] Institute for Coastal Marine Environment, CNR, Talassografico "A Cerruti", Via Roma 3, 74123 Taranto, Italy
[2] National Institute of Oceanography, Israel Oceanographic and Limnological Research, POB 8030, Haifa 31080, Israel - bella@ocean.org.il

Abstract
Shipping-mediated introduction and transfer of alien and harmful biota increase with fleet and port expansion. The Mediterranean is a key world maritime route but only voluntary arrangements for ballast water management. Encysted resting stages in the sediments in the port of Haifa, Israel, were sampled on the eve of a major port enlargement project, with the aim of recording the diversity and abundance of the assemblages. Our findings reveal among the cysts present the potentially toxic bloom-forming *Scrippsiella trochoidea*, and the potentially toxic *Alexandrium minutum* and *Gymnodinium uncatenatum* associated with Paralytic Shellfish Poisoning.

Keywords: Plankton, Levantine Basin, Biodiversity, Sediments, Toxic blooms

Studies of benthic resting stages of marine plankton provide information of past and present environmental conditions such as eutrophication, pollution loads and blooms of toxic species. Accumulation of encysted resting stages in ports, form "seed banks" for certain taxa of marine plankton. Haifa port, enclosing the Kishon estuary, Israel's most polluted river, is impacted by nutrient enrichment and industrial waste water, physically altered by construction and frequent dredging, and prone to establishment of ship-transported alien species. The present survey, the first such survey in Israel, was conducted on the eve of a major port enlargement project, with the aim of recording the diversity and abundance of encysted resting stages produced by plankton in surficial sediments and examining the relationship between their structure and different environments within the port. Considering the small number of samples (8 stations, 3 replicates each), species richness (80 cyst morphotypes, 55 produced by dinoflagellates) is remarkably high when compared with results elsewhere in the Mediterranean: in Thermaikos Gulf, Greece, only 36 dinocysts were recorded [1], though 76 dinocyst types were identified from a one year study in Mar Piccolo, Gulf of Taranto, Italy [2]. In addition, we report the highest number of ciliate cyst types recorded from marine sediments. Ciliate cysts were particularly abundant at the Kishon zone where *Strombidium conicum* dominated the ciliate community. The finding in all our samples of *Alexandrium minutum* cysts, a well-known toxin-producer dinoflagellate, responsible for paralytic shellfish poisoning [3] represents a risk potential, as well as *Gymnodinium uncatenatum*,another causative of PSP[4],reported for the first time in the Mediterranean Sea. The cyst assemblages were dominated (44%) by the calcareous cysts of the peridiniacean cosmopolitan bloom-forming species *Scrippsiella trochoidea*, which lethal effects have been unambiguously demonstrated [5]. Cyst assemblages respond to changes in nutrient levels and pollution: in oligothrophic environments, species richness and abundance increase with nutrient enrichment, only to decline with rising eutrophication and pollution, whereas the percentage of heterotrophic and mixotrophic dinoflagellates and ciliates increases [6]. Our results support this: in the Kishon estuary ciliates were more abundant than elsewhere in the port, whereas dinoflagellates' abundance is diminished. These trends hold true both for full and empty cysts. The autotrophic/heterotrophic ratio (A/H) (including ciliate species) reveals that heterotrophic species are more abundant where environmental conditions are extreme. The presence of potentially toxic species, together with many new records of dinoflagellates and ciliates, underscore the need to improve our knowledge of ports' cyst bank assemblages, including stratigraphic analyses, in order to estimate the potential risk of shipping-mediated introduction and transfer of alien and harmful bloom-forming taxa. This is particularly critical as the Mediterranean is a key world maritime route with 30 % of worldwide traffic, 25 % of oil transport, and 450 ports and terminals. Long-term demographic trends and the introduction of larger vessels are driving factors of port development and expansion, yet until the time that the Ballast Water Management Convention enters into force, only voluntary ballast water management are in effect in the Mediterranean.

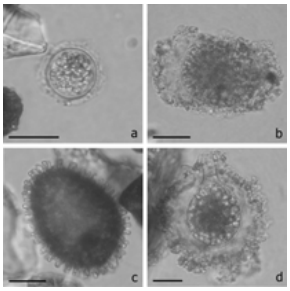

Fig. 1. The most abundant resting stages collected from surface sediments in Haifa port.
a. *Alexandrium minutum* (dinoflagellate); b. *Gymnodinium uncatenatum* (dinoflagellate); c. *Scrippsiella trochoidea* (dinoflagellate); d. *Strombidium conicum* (cliate).
Scale bars: 20 μm

Acknowledgements The work of M. Belmonte was supported by a doctoral fellowship in Fundamental Ecology from the University of Salento, Lecce, Italy (XXIV cycle). Support for this research was provided by CNR and Italian Ministry of University (FR), by IOLR, and by the European Community's Seventh Framework Programme (FP7/2007-2013) for the projects *Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors* (VECTORS) (BSG).

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DEVELOPMENT OF AN INTEGRATED ECOLOGICAL, CHEMICAL AND BIOLOGICAL APPROACH TO EVALUATE THE ENVIRONMENTAL IMPACT OF MEDITERRANEAN OFF SHORE GAS PLATFORMS

A. Gomiero [1]*, E. Punzo [1], A. De Biasi [2], L. Kozinkova [2], P. Polidori [1], A. Santelli [1], P. Strafella [1], A. Spagnolo [1], M. Girasole [1], S. Dinarelli [1], A. Negri [3], A. Viarengo [3] and G. Fabi [1]

[1] National Research Council - alessio.gomiero@an.ismar.cnr.it

[2] CIBM

[3] Dep of Science and Tecnological Innovation - Università del Piemonte Orientale "A. Avogadro"

Abstract

The pressure for more energy demand is a strong driver for the construction of offshore oil and gas platforms. This also applies to the Adriatic Sea where, since 1960 several gas field were commissioned. The continuous expansion of the gas industry may potentially produce detrimental effects on marine communities, especially in such a peculiar semi-enclosed basin like the Adriatic sea which contains ecosystems that are subject to intensive anthropic pressures, like unsustainable fishing and inputs of environmental pollutants. To date, the environmental effects of gas platforms are poorly understood. Thus, a multidisciplinary approach based on chemical, biological and ecological investigations was performed to evaluate the ecological status as well as the water column and the sediments quality near a gas platforms.

Keywords: Monitoring, Bio-indicators, Sediments, Biodiversity, North-Eastern Mediterranean

The rapid expansion of the gas industry may potentially produce detrimental effects on marine communities, especially in deep-water ecosystems [1]. During perforation, drilling fluids are used to assist perforation, and their discharge often increases pollutants in sediments close to platforms and/or changes the sedimentation rates and grain size composition [2]. On the other hand, the platform production phase is characterized by the discharge of large quantities of a complex mixture of organic and inorganic chemicals named produced water (PW) which comes from the routine separation of water present in the oil and gas reservoir. Impacts of offshore oil and gas activities have reduced around some installations, but the evidence base for environmental impacts is limited. Benthic communities can be used to monitor the effects of gas and oil drilling activities since many organisms are sessile or have limited mobility and respond quickly to mechanical and chemical disturbances [3]. Hence, an in situ monitoring data using biological effects methods with endpoints reflecting long term, ecological, effects would support a comprehension of the oil and gas production related adverse effects on acquatic ecosystem. On this context, biological indicators or markers (biomarkers) can be used to measure the biological responses related to the exposure to environmental pollutants [4]. Common for all of the methods is the capability of performing time-integrating response assessment to complex mixtures over extended periods of time, which is often required in environmental monitoring Since most of these sub lethal stress index are highly sensitive and responses occur at lower concentrations and/or prior in time to more adverse effects at a higher organization level, they have become convenient early-warning tools for assessing the potential for long term effects. In our work we tested whether changes in soft-bottom communities were associated with changes in the sediment chemistry as well as to monitor the quality of the water column thought the assessment of marine organisms health status. 24 sampling sites were selected at 5, 30, 60, 120 and 1000 m from two orthogonal transects centered on the gas platform. Samples were collected using a Van-Veen grab for benthic community and ecotoxicological investigation and by a box-corer for physical– chemical analyses. Total content of Al, Cd, Cr, Ba, Cu, Hg, Ni, Pb, Zn and PAH_{16} were estimated in sediments and mussels. To assess the ecotoxicity of sampled sediments the Microtox assay, the *C. orientale* mortality test and the mortality and bioaccumulation rate in *Hediste diversicolor* ragworm were performed. Two seasonal surveys, one in summer and one in winter, were carried out on native mussels (*M. galloprovincialis*). Bivalves were hand-collected by scuba divers at 5–10 m depths close (CA) to and far (FA) from the galvanic anodes placed on the submerged parts of the rig and in the Portonovo Bay (middle Adriatic Sea). The survival on air, the micronucleus test, the comet test, the catalase activity, the citosolic content of malondaldeide, the metallothionein levels, the real-time quantitative PCR on Mt_{10} (III), Mt_{20} (IV) as well as the levels of lipofuscin, neutral lipids and the lysosomal membrane stability on cryo sections of mussel's digestive glands were measured. AFM and SEM microscopy ultra structural analysis were performed on samples of mussels digestive glands and gonads.The composition and abundance of macrofauna communities was assessed. The Clarke "W", the AMBI and the BENTIX index were estimated and compared following Teixeira *et al.*, [5]. An overall evaluation of results confirmed the absence of marked biological effects caused by the activities of the model platform. Even if a chemical contamination and to a lesser extent biological disturbance in these areas is recorded in the first phases of platform's set up, the area of contamination and biological disturbance is decreasing in space within few years. Biomarkers also showed the same gradient from the discharge point, but it is still uncertain how the specific biomarkers affect the individual organisms, the populations or the ecosystems. Future research activity is addressed to find a better link between biomarkers and ecological risk. Further positive aspects of these structures need to be better studied in the future as pipelines, platform legs and subsea templates may act as shelter for fish and other mobile marine organisms, also offering greater food availability and provide a habitat for benthic organisms usually associated with hard substrates [6], [7].

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ASSESSMENT OF THE TROPHIC STATUS OF THE MERSIN BAY WATERS (NORTHEASTERN MEDITERRANEAN)

Mehmet Salih Kaptan [1]*, Süleyman Tugrul [1] and Mustafa Koçak [1]
[1] Institute of Marine Sciences Middle East Technical University - mkaptan@ims.metu.edu.tr

Abstract
The eutrophication related biochemical biochemical parameters were measured seasonally in the Mersin Bay located in the Northeastern Mediterranean Sea between 2008 and 2011. The results showed 5-10 fold spatial and seasonal changes were observed in nutrients (DIN, TP), Chl-a and Secchi disc depth (SDD) in the shelf waters of the bay. The assessment of trophic conditions of the bay surface waters by cluster analysis, TRIX and UNTRIX approaches show that the inner bay water reached "eutrophic" conditions compared to the offshore properties.

Keywords: Eutrophication, Mersin Bay, North-Eastern Mediterranean, Nutrients

Introduction:
Land-based inputs (river + domestic waste discharges) have enhanced eutrophication in the NE Mediterranean coastal waters [1]. In the present study, the spatial and temporal variability of eutrophication related indicators (DIN, TP, Chl-*a*, DO%, SDD) were studies to assess trophic levels of Mersin Bay surface waters polluted by the major rivers (Seyhan, Ceyhan, Berdan) and discharges of domestic wastewaters from the Mersin city. Different classification methods were applied to determine the tropic status of the water bodies in the bay [2,3].

Materials and Methods:
Data were collected seasonally by R/V-Bilim-2 at 50 stations (Fig. 1) between September 2008 and February 2011 (funded by TUBITAK Grant #: 107G066). Nutrients and DO were measured on board by a multichannel autoanalyzer and the Winkler titration method. TP and Chl-a samples were kept under deep freeze until their analysis in the laboratory.

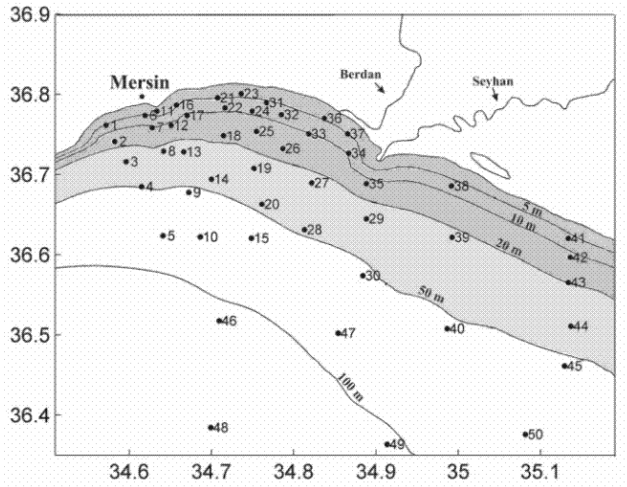

Fig. 1. Locations of sampling stations visited in the Mersin Bay shelf zone

Results and Discussion:
The surface water concentrations of TP, DIN and Chl-*a* in the bay increased 5-10 times from the oligotrophic offshore (Average TP: 0.1 µM; DIN: 0.36 µM, Chl-*a*: 0.09 µg/L, SDD:15 m) to the eutrophic nearshore waters (<20 m) (Table 1), which were very consistent with similar changes in primary productivity and algae abundance. The classifications methods of Cluster Analysis, TRIX and UNTRIX consistently show that the inner bay was occupied by eutrophic water body (boundary ~ 20 m depth counter), where the outer bay (>40m deep) waters exhibited oligotrophic properties. The water body in between was classified as "mesotrophic" (Fig. 1). Comparison of the results of original TRIX, UNTRIX and modified TRIX (TRIX-IMS having modified "a" and "b" coefficients) showed that the TRIX underestimates the impacts of excessive nutrient loads on the oligotrophic water bodies. The inner bay with an annual average TRIX value of ~4.5 remains at "mesotrophic" level. Therefore, the modified TRIX (TRIX-IMS) and UNTRIX approaches explicitly categorized the inner bay water body as "eutrophic" compared to the "oligotrophic" waters of the outer bay.

Tab. 1. Annual averages of eutrophication related parameters determined by different classification methods in the 3 different water bodies of the Mersin Bay.

		Cluster Analysis	TRIX	TRIX-IMS	UNTRIX
TP (µM)	E	0.45		0.41	0.37
	M	0.20	0.45	0.18	0.17
	O	0.12	0.20	0.10	0.15
DIN (µM)	E	4.83		3.81	3.56
	M	1.73	4.41	1.34	1.14
	O	0.50	1.51	0.37	0.62
Chl-*a* (µg/L)	E	1.31		1.23	0.99
	M	0.37	1.30	0.37	0.34
	O	0.14	0.41	0.11	0.13
SDD (m)	E	3.42		3.23	3.75
	M	6.58	3.03	6.03	6.17
	O	17.24	5.72	17.64	13.81

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ESTIMATION OF THE SOURCES OF PCDD/F POLLUTION IN THE SEDIMENTS OF IZMIT BAY

Aykan Karademir [1]* and Halim A. Ergul [2]
[1] Department of Envronmental Engineering Kocaeli University - aykan@kocaeli.edu.tr
[2] Department of Biology, Kocaeli University

Abstract
The study presents an evaluation of the possible sources of PCDD/F pollution in the surface sediments of the Izmit Bay (Turkey) based on a mass balance model for PCDD/F congeners. The model was applied for the estimation of the effect of atmospheric deposition, soil erosion and wastewater discharges on the PCDD/F levels in the sediments. The model results suggested that OCDD levels in the sediment samples could be explained mainly by the effect of atmospheric deposition processes. The differences between the modeled and observed levels of highly-chlorinated PCDFs indicated that the industrial discharges in the past could be a significant contributor to the PCDD/F pollution in the sediments.

Keywords: Sediments, Marmara Sea, Models

Introduction: Izmit Bay (Fig.1), has been subjected to substantial pollution problems since 1960s. The bay has been receiving wastewaters of more than 400 industries in different sectors including the largest petroleum refinery of Turkey, several metallurgical and chemical plants, automotive and tyre factories etc., together with the untreated or inadequately treated domestic wastewaters from 2 million inhabitants living around the bay. Karademir et al. [1] gives an assessment of the PCDD/F levels in the surface sediments of Izmit Bay. The study presents a modeling approach applied to estimate the impact of atmospheric deposition and surface runoff on the PCDD/F levels of surface sediments in the Izmit Bay. The main object of the modeling study is to assess the role of industrial wastewaters in the PCDD/F pollution in the bay, which is unknown due to the lack of data related to discharges in the past.

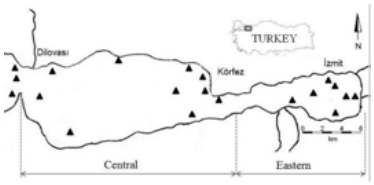

Fig. 1. The study area

Modeling Approach: For modeling, the algorithms and assumptions given in USEPA [2] were used. The principal assumption is that PCDD/F inputs to the bay result from (a) atmospheric deposition, (b) erosion of soil from watershed area of the bay by surface run-off, (c) municipal wastewater discharges, and (d) industrial wastes; while PCDD/F output from the bay takes place through the outflows to the Marmara Sea. The mass balance statement: [Net mass of contaminant entering the water body] = [An amount which remains sorbed to suspended materials] + [An amount which remains as dissolved in the water column] + [An amount which remains sorbed to particles settling to the bottom]. Atmospheric PCDD/F concentrations and deposition rates (DR_a) in Kocaeli were taken from Bakoglu et al. [3]. Total surface area of the bay (W_{aw}) was considered as 310 km^2. Wastewater inflow was computed as 240 000 m^3 per day, while the PCDD/F concentrations (C_{ww}) of wastewater were taken from Yee et al. [4]. Due to the lack of data related to the industrial inputs of PCDD/Fs, M_{ind} was not included in computations. Computations were performed for PCDD/F concentrations in bottom sediments and the model results were compared to the observed levels.

Results: Fig. 2 shows modeled and observed PCDD/F concentrations in the sediments of Izmit Bay. It shows that there is a good agreement between estimated and measured PCDD/F concentrations except for three highly-chlorinated furans: 1,2,3,4,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF and OCDF. The model explains nearly all the OCDD presence in the sediments, suggesting that OCDD levels are related to atmospheric deposition (97%), erosion of contaminated soils (2%) and municipal wastewater discharge (1%). On the other hand, the high differences between observed and modeled concentrations of 1,2,3,4,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF and OCDF are obvious (observed values are 10-20 times higher than the modeled ones), which may be attributed to the industrial discharges not included in the model. On the contrary, model overestimates the level of 1,2,3,4,6,7,8-HpCDD, which was measured in substantial levels both in the air and the soil samples collected in the area [3]. The dominance of OCDF in some sediment samples taken from the central section was related to the production of VCM in the past, while that of 1,2,3,4,6,7,8-HpCDF was attributed to the unknown use of a chlorophenol-based fungicide in the region. Additionally, the sediments with a congener profile characterized by the dominance of OCDD were explained by the effect of pentachlorophenol releases and their subsequent transfer to the sediments as the final sinks, through different processes took place after the deposition of airborne PCDD/Fs to water and soil surfaces. The results show that the atmospheric deposition is the main contributor of the PCDD/F pollution in the bay, with an average contribution about 98% both in total concentration of toxic PCDD/Fs and in WHO-TEQ basis, while the rest is related mainly to the erosion of contaminated soils. The contribution of municipal wastewaters is estimated as very low (lower than 1%). Total PCDD/F inputs by atmospheric deposition, soil erosion and municipal wastewater discharges are computed as 3.88 g WHO-TEQ per year, 0.05 g WHO-TEQ per year, and 0.005 g WHO-TEQ per year, respectively.

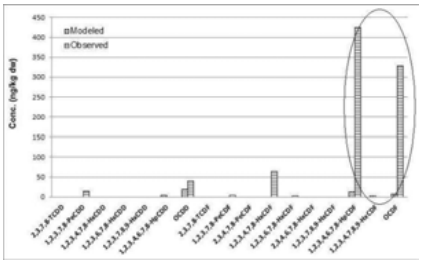

Fig. 2. Modeled and observed PCDD/F concentrations

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LEVELS AND DISTRIBUTION OF CHLORINATED PESTICIDES AND PCBS IN WILD MUSSELS COLLECTED ALONG THE ADRIATIC COAST OF CROATIA

Vesna Milun [1]*
[1] Institute of Oceanography and Fisheries - milun@izor.hr

Abstract
Levels and distribution of chlorinated pesticides and PCBs were investigated in wild mussels *Mytilus galloprovincialis* collected from the Adriatic coast of Croatia in 2003 and 2011. The accumulation pattern of organic contaminants in mussels was characterized by much higher PCBs levels in relation to chlorinated pesticides. Moreover, the most contaminated mussels were collected from the areas where industrial, harbour and urban wastewaters have been released.

Keywords: Bivalves, Bio-accumulation, Monitoring, Pcb, Central Adriatic Sea

Introduction
Mussels have been successfully used for decades as indicators of chemical contamination in coastal areas [1]. As filter feeders, mussels bioaccumulate contaminants through their food revealing essentially the fraction that is available in the environment. This study presents the results of monitoring levels and distribution of PCBs and chlorinated pesticides in the Croatian coastal area using *M. galloprovincialis* as indicator species in 2003 and 2011. The data was expected to indicate temporal differences in organic contamination level.

Materials and Methods
Wild mussels were collected at 12 sites in the pre-spawning period (during March) from the coast in 2003 and 2011 (Fig. 1). Freeze-dried samples were Soxhlet extracted, cleaned-up and passed through a florisil column for OCs separation. Concentrated fractions were analyzed for CPs (HCB, lindane, aldrin, dieldrin), DDTs (p,p'-DDE, -DDD,-DDT) and PCBs (IUPAC No. 28, 52, 101, 118, 138, 153, 180) by Agilent GC-μECD using HP 5 capillary column. Internal standards and reference material IAEA-432 were used to assure data quality.

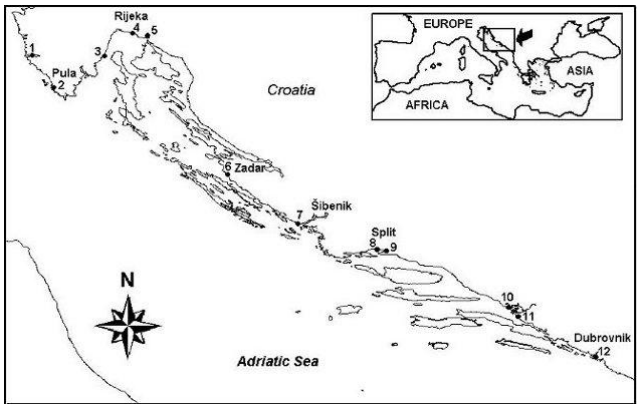

Fig. 1. Study area with sampling locations.

Results and Discussion
The accumulation pattern of OCs in mussel tissue indicated a decreasing concentration trend in the order of PCBs>DDTs>CPs at all locations both in 2003 and 2011 (Fig. 2). PCBs values varied spatially in range of 6.1-99 ng g^{-1} dw (2003) and 4.6-75 ng g^{-1} dw (2011). Elevated concentrations were found in areas with high discharge of wastewaters from on shore local sources. Mussels revealed spatially and temporally similar PCB congener accumulation profile (PCB 153>138>101>118>52>28) with predominant PCB 153 and PCB 138 contribution. The content of DDTs varied in the range of 4.8-18.8 ng g^{-1} dw (2003) and 2.0-11.2 ng g^{-1} dw (2011). The accumulation profile of DDTs indicated a decreasing concentration trend in order of DDE>DDD>DDT. High percentage of more stable and accumulative DDE metabolite reflected a decreased use of DDTs in the study area. The low levels of CPs (HCB, lindan, aldrin, dieldrin) with 52% data below DL reflected low exposure to these compounds, probably as result of their prohibition in the Mediterranean region.

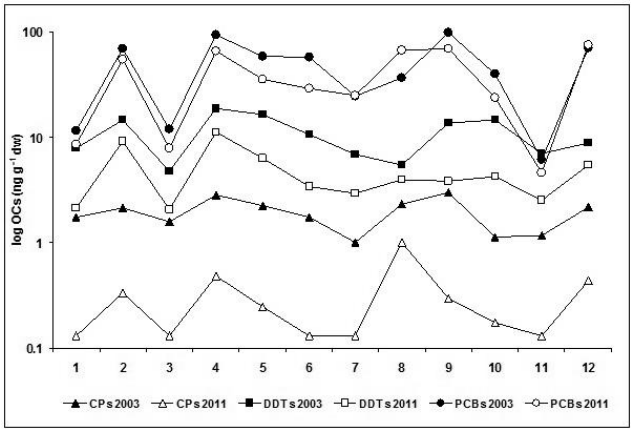

Fig. 2. Levels and spatial distribution of organochlorine compounds.

Statistical comparison of OCs concentrations found in mussels in 2003 and 2011 showed significant difference for lindane and DDTs but no difference for PCBs. Furthermore, anthropogenically impacted sites were separated by PCA factor scores analysis from sites away from known source of pollution. Due to the low statistical correlation between environmental (temperature, salinity) and biological (condition index, lipids) parameters and contaminants level, OCs differences found in mussels were primarily influenced by local pollution sources. However, values obtained for the eastern Adriatic coast are within the range (or even lower) of values published for the Mediterranean coast [2]. Evaluation of the potential risks to human health associated with consumption of analysed mussels indicated that measured OCs concentrations are less likely to pose a significant health risk (RQ<1) for shellfish consumers in Croatia [3].

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COPPER IN MARINE SEDIMENTS AND *MYTILUS GALLOPROVINCIALIS* FROM THE COASTS OF FOÇA (AEGEAN SEA, TURKEY)

Fatma Koçbas [1], Meral Öztürk [2], Hüseyin Güner [3] and Rahime Oral [4]*
[1] Faculty of Arts and Science, Muradiye, Manisa,TURKEY
[2] Celal Bayar University, Faculty of Education, Demirci, Manisa, Turkey
[3] Ege University, Faculty of Science, Bornova,Izmir, Turkey
[4] Ege University Faculty of Fisheries ,Bornova Izmir, Turkey - rahime.oral@ege.edu.tr

Abstract
The copper pollution in the marine environment is determined by measuring its concentration in sediment and mussel. This study performed between May 2008 and August 2009 in the *Mytilus galloprovincialis* and sediment from Foça (Aegean Sea).The coasts of Foça remain heavily impacted by a number of pollutants originating from different sources such as shipping activity, tourism activities, municipal wastewaters, population growth and unplanned urbanization,sewage etc. The Cu levels in the sediment and mussel samples are not higher in the coast of Foça (Aegean Sea). On the other hand, the Cu concentration in mussel and sediment will be significantly higher in the present results than other coast. The construction of the new port and the increase in tourism activities will consist of coastal pollution.

Keywords: Bio-indicators, Mollusca, Metals, Sediments, Aegean Sea

Introduction
From an environmental point of view, the coastal zone can be considered as the geographic space of interaction between terrestrial and marine ecosystems that is of great importance for the survival of a large variety of plants, animals and marine species (1). The pollution of the marine ecosystem by heavy metals is a world-wide problem. Heavy metals can be classified as potentially toxic (cadmium, lead, mercury, etc.), probably essential (nickel, vanadium, cobalt) and essential (iron, manganese, copper, zinc). The essential metals can also produce toxic effects when the metal intake is excessively elevated (2). Bivalves, a marine organism, have been used as a kind of metal concentration ''detector'', as metal concentrations found in their soft tissue are known to reflect the concentrations of the same metals in the aquatic these mussels could be exposed to sub-lethal or even lethal levels of specific toxins (3).

Materials and Methods
The copper pollution in the marine environment is determined by measuring its concentration in sediment and mussel. The common Mediterranean mussels *Mytilus galloprovincialis* were collected from the coasts of Foça (Aegean Sea) from May 2008 and August 2009. Immediately after collection, the samples put into an ice compartment and transported to the laboratory, and then the samples were frozen at −21ºC for metal analysis. Before dissection, the mussel samples were thawed at room temperature (27ºC) with the posterior margin facing downwards in order to allow excess water to drain away. The total soft tissues were dried in an oven at 105ºC to constant dry weight. The surface sediment samples were taken by using a Van Veen type grab from the Foça coast stations (6 stations), respectively. The collected sediment samples were homogenized and stored in plastic cups that were cleaned by 1:1 HCl and 1:1 HNO_3 before analysis. About 100 g of sediment samples were dried at 85 ºC for 48 h, crushed and homogenized prior to the analysis. The mussel samples (0.5 g) were digested with 7 ml of HNO_3, (65%), 2 ml of H_2O_2 (30%) and the sediment samples (0.5 g) were digested with 2 ml of HNO_3 (65%), 6 ml HCl (37%) in a microwave digestion system (CEM Corporation, MARS-5) for 30 min and diluted to 25 ml with deionized water and stored in polyethylene bottles until analysis. A blank digest was performed in the same way. The prepared samples were determined for Cu by ICP-OES. The accuracy of the analysis was verified by analyzing the Europeancertified reference material (ERM-C278, mussel tissue), by the same procedure used for the samples.Certified Referrence Materials NCS DC 74301 (marine sediment) was used for calibration. The results showed good agreement between certified and analytical values. Values are expressed as the mean of three analyses for each sample (2,3,4).

Results
A comparison of the metal concentrations for the investigated elements in mussels and sediments at the Foça costal area for sediment and mussels different locations and and six seasons (May 2008 to August 2009) showed differences clearly associated with anthropogenic impact. Cu concentration changed between 0.009-0.112 mg/kg d.w mussel, respectively. The concentrations of the copper ranged from 0.008 to 0.394 (mg/kg dw) in sediment.

Observed seasonal changes due to the increase in population.mussel directly was affected such as rainfall, wind factors. Mussels have been effective uptake of the copper of sexual maturity.

Conclusion
Copper levels in the sediment and mussel samples are not higher in the coast of Foça (Aegean Sea). On the other hand, the Cu concentration in mussel and sediment will be significantly higher in the present results than other coast. the construction of the new port and the increase in tourism activities will consist of coastal pollution.

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HEAVY METAL DISTRIBUTION IN SEDIMENTS FROM PSITTALIA-KERATSINI STRAIT, SARONIKOS GULF, GREECE

A. Gkaragkouni [1], G. Papatheodorou [1]*, H. Papaefthymiou [2], D. Christodoulou [1] and M. Geraga [1]
[1] Laboratory of Marine Geology & Physical Oceanography, Deparment of Geology, University of Patras, Greece - gpapathe@upatras.gr
[2] Department of Chemistry, University of Patras, Greece

Abstract
In Psittalia –Keratsini strait the outfall sewer of Athens discharged untreated sewage for a period of over 40 years. As a result a surface layer of organic mud has been formed covering the seafloor. Copper, Zn, Mo, Ag, Cd, Pb, Cr, As, Ni, Fe and Co are highly enriched in the organic mud layer compared to underlying natural sediments.

Keywords: Sewage pollution, Metals, Sediments, Gulf of Saronikos

Introduction
North Saronikos gulf receiving sewage from the industrial area of Elefsina and Piraeus port is a heavily polluted marine environment. In particular, the area between the island of Psittalia and Keratsini, was receiving the urban and a large part of the industrial waste of the city of Athens through the main sewer (MSA) in Keratsini for many decades. In 1994, a biological treatment plant was installed in Psittalia Island [1]. Until then, the sewage through MSA was flowing without any treatment, directly to the sea through a diversion channel from the Keratsini outlet works. In 2001 an integrated marine remote sensing survey revealed the presence of a surface layer of organic mud covering the natural seabed [2]. The present paper presents the geochemical data from the area aiming to the evaluation of the spatial and temporal distribution of metal contaminants in the seabed. The dataset includes the results of analysis of grain composition, organic carbon content (Corg) and metal concentrations from six sediment cores selected from the area (Fig. 1).

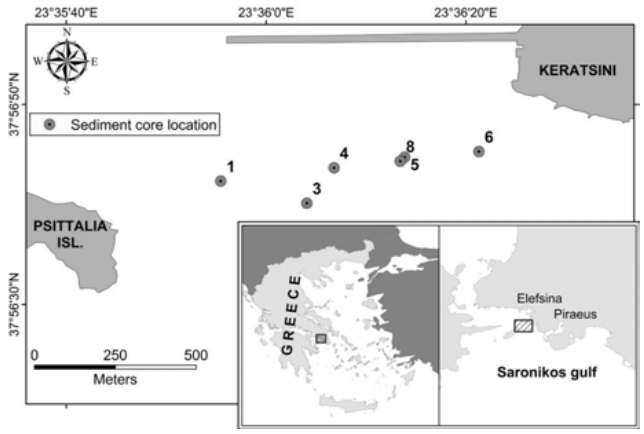

Fig. 1. Map showing the sediment cores locations in Psittalia - Keratsini Strait.

Material and Methods
The collected sediment cores were transferred to the laboratory and stored vertically at 4°C. Prior to analyses, the cores were gently cut longitudinally using a Plexiglas sheet. The sediment of the uppermost 2 cm of all cores together with sediment samples of about 2 cm in thickness taken along the sediment core, were used for the elemental analyses. A quantity of each sediment sample was digested using a mixture of acids (HNO_3, $HClO_4$, HF, HCl) (conventional method - open system) for elemental total concentration measurements by ICP-MS [3]. Grain size analysis was carried out by dry and wet (pipette method) sieving methods.

Results and Discussion
The organic mud surface layer which is associated with the untreated sewage discharges has a thickness ranging from 0.6 to 2.0m. Macroscopic and granulometric study of the sediment cores showed that the thickness of the organic mud layer decreases with increasing distance from the sewage outfall. In all the examined sediments the surface layer consists of high percentages of Corg and silt/clay size particles (Table 1). On the contrary, the underlying natural sediments are characterized by increased percentages of sandy particles and low organic carbon content (Table 1). The mean metal concentrations in the organic mud layer are among the higher reported in marine sediments collected from other harbours, gulfs and coastal areas in Greece and Mediterranean Sea [3, and references within]. Enrichment factors obtained from the results follow the order: Cu>Zn>Mo>Ag>Cd>Pb>Cr>As>Ni>Fe>Co>Mn. Metal concentrations are positively correlated with the fine fractions of organic mud and their spatial distribution presents a clear decreasing trend with increasing distance from the sewage outfall. The natural seabed sediments just beneath the organic mud appear to be affected by the metalliferous organic mud. These elevated metal concentrations are probably attributed to the effect of fine-grained organic mud soaking on the underlying coarse-grained natural sediments. Moreover, the metal concentrations present a general downcore decreasing trend. This probably reflects the gradual growth of urban population and thus the increase of urban and industrial pollution in Athens metropolitan area and accordingly in the seabed of north Saronikos gulf.

Tab. 1. Gravel, sand, silt, clay, organic carbon (%) and metal concentration (ppm) in organic mud and natural sediments in the study area.

	Organic mud	Natural sediments		Organic mud	Natural sediments
	Mean	Mean		Mean	Mean
Gravel	4.6	7.7	**Co**	19.0	8.8
Sand	22.6	54.4	**Mn**	178.6	76.2
Silt	56.4	25.8	**Ni**	85.0	14.5
Clay	16.4	12.1	**As**	63. 4	21. 7
Corg	5.70	0.93	**Ag**	12.0	0.4
Ca	2024.9	1631.3	**Cd**	3.8	0.2
Cu	206.0	3.7	**Cr**	677.9	51.3
Zn	1525.8	44.0	**Mo**	6.0	0.2
Pb	308.0	28.1	**Fe (mg/g)**	12.60	3.97

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ENVIRONMENTAL IMPACT OF COSTA CONCORDIA WRECK ASSESSED THROUGH AN INTEGRATED, MULTIDISCIPLINARY APPROACH: PRELIMINARY RESULTS ON SEDIMENTS AND MUSSEL WATCH

G. Romanelli [1]*, A. M. Cicero [1], M. Amici [1], D. Berto [1], B. Catalano [1], M. Formalewicz [1], A. Gaion [1], S. Giuliani [1], G. Martuccio [1], G. Moltedo [1], R. Parravano [1], D. Pellegrini [1], V. Perini [1], F. Rampazzo [1], A. Scuderi [1], A. Tornambè [1], B. Trabucco [1] and F. Regoli [2]

[1] ISPRA - Institute for Environmental Protection and Research, Italy - giulia.romanelli@isprambiente.it

[2] UNIVPM - Department of Life and Environmental Sciences, Polytechnic University of Marche, Italy

Abstract

On the night of 13 January 2012, the cruise ship "Costa Concordia", collided with a submerged rock close to the Giglio island harbour (Tuscany, Italy) causing 32 victims and a potential environmental disaster, the extent of which is still to be evaluated. After the emergency on the research and passengers safety, a monitoring plan to assess the environmental status in the environment affected by the wreck has been implemented. As part of a more complex and articulated monitoring plan, the preliminary results obtained from the analyses of sediments and biota (*Mytilus galloprovincialis*) are described.

Keywords: Chemical analysis, Bio-indicators, Monitoring, Pollution, Tyrrhenian Sea

Introduction

Immediately after the Costa Concordia wreck, a plan to avoid a more severe environmental impact and to monitor the impact of substances spilled from the boat, has been activated. First of all, the ship tanks were emptied for preventing fuel spill at sea. The Department of the Italian Civil Protection commissioned to ISPRA (National Institute for the Environmental Protection and Research) and ARPAT (Regional Agency for the Tuscan Environmental Protection) the development of a multidisciplinary monitoring plan, in accordance with current legislation [1,2,3]. According to this plan, an integrated approach was followed, examining chemical, biological and ecotoxicological parameters. Among planned activities, chemicals released from the boat have been monitored through active mussel watch methodology and sediment analysis. Concentrations of PAHs, aliphatic hydrocarbons, PCBs and halogenated pesticides, organotin compounds were measured in mussel tissues and sediments. These data were further complemented with ecotoxicological responses measured as both biomarkers and toxicity bioassays.

Results and discussion

Sediment The analyses on sediments sampled during the two campaigns (February and October 2012) showed low levels of contamination from organics xenobiotics (organotins under limit of quantification; low concentration of aliphatic hydrocarbons, PAHs and some PCB congeners; pesticides mostly absent except for traces of DDT and its metabolites). Levels of organic compounds were under the values fixed as EQS [2] and in accordance with literature data [4,5]. Metals (As, Cd, Cr, Cu, Hg, Ni Pb) concentrations were found below the EQS, except for lead measured in two sites of the second sampling campaign; however, concentration are in accordance with monitoring data for the region [5]. Biological responses (biomarkers) were measured on the polychaete *Hediste diversicolor* exposed to sediment collected on April 2012 in proximity of the ship. Results did not evidence any relevant toxicity and organisms maintained a "good physiological condition": beside the high survival rate (> 80%), no effects were detected in terms of oxidative stress biomarkers, damages to structural integrity of DNA, or specific responses to metals, organophosphorus and carbamates pesticides).

Mussel watch Water column contamination has been assessed through an active mussel watch approach with translocated *Mytilus galloprovincialis* as organism bioindicator of the bioavailable contaminant fraction. This strategy has been successfully applied in national monitoring plans to assess level of chemical contamination of marine coastal water [6]. Six cages containing mussels were placed in each of the three sites at two different depths, approximately 2 m from the surface and 1m from the bottom; one site was selected far from contamination source as blank, one in proximity of the poop and one between the prow of the wreck and the harbor. After a period of 4-6 weeks, mussels have been recovered and replaced, for a total of 8 translocation experiments carried out between February and December 2012. Results from the first four campaigns, showed low concentrations of organotins compounds, organics xenobiotics (PCBs, pesticides, PAHs and aliphatic hydrocarbons) and metals in tissues of translocated mussels. Bioaccumulation levels were almost comparable to those found in the reference area. Slightly higher values have been seldom found in mussels near the harbor.

Conclusion

Preliminary results did not highlight particularly critical conditions in terms of chemical and toxicological disturbance due to the shipwreck. Further investigations are still in progress and will continue during 2013 for a better and comprehensive evaluation, which will also consider the possible impact caused by the activities related to the wreck removal. This work, as well as the ISPRA monitoring Plan was financially supported by the Civil Protection Department.

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FINGERPRINTING STUDY OF AN OIL SPILL CASE ALONG THE SARDINIAN COAST (MEDITERRANEAN SEA)

G. Romanelli [1]*, M. Matiddi [1], M. Amici [1], S. Di Muccio [1], P. Giordano [1], M. Mannozzi [1], R. Parravano [1], V. Perini [1] and L. Alcaro [1]

[1] ISPRA - Institute for Environmental Protection and Research, Italy - giulia.romanelli@isprambiente.it

Abstract

A contamination coastal survey was conducted to assess the environmental impact of oil spillages from a submerged pipeline of the E.on power plant of Porto Torres (North west Sardinia) during the draining operation of the France tanker M/C Emerald.Samples taken from different coastal areas and offshore stations were analyzed on GC/FID and GC/MSD for aliphatic and polycyclic aromatic hydrocarbons, terpanes and steranes (fingerprinting). Results were compared with profiles of the spilled oil (IFO 380), of which it was estimated that a total of approximately 50 tons was lost at sea. The comparison of the oil fingerprint revealed a different type of oil beached in close proximity to the power plant and confirmed the same source of oil beached in an area far from the spill point.

Keywords: Chemical analysis, Coastal systems, Petroleum, Pollution, Tyrrhenian Sea

Introduction

In January 2012 the tanker "M/C Emerald" was transferring fuel through a submerged pipeline to the electric power plant in the mainland at Porto Torres, North-West Sardinian coast. Few hours later, a petroleum slick was seen at sea off the harbor, and along the nearest coast. The event was caused by the weld's breakage of a pipeline in the submerged side along thebreakwater,during the draining activity from the tanker to the Power plant. In the following days, the marine current and winds brought the product along the east coast with a patchy distribution, at different areas. Weathering factors affecting petroleum and the occurrence of previous spills on involved coasts, mixed with chronic anthropogenic sources of oil at sea, makes very difficult to identify the origin of contamination. Fingerprinting analysis has been conducted to verify the source of the pollution, in this specific case.

Materials and methods

Samples were taken from the pipeline inside the Power plant, from the tanker and from several beaches involved from the pollution event. Oil samples were analyzed applying the CEN methodology. According to this methodology, the identification of an oil spill has to be proved, by fingerprinting analysis of some "diagnostic" substances (biomarker, PAHs, alkanes, etc.) in the samples to be compared. At this purpose, the two samples to be compared are first analyzed by GC chromatography with FID detector and results are critically evaluated. In fact, if the chromatographic pattern shows differences that cannot be explained by chemical weathering, then the samples cannot have the same origin. On the contrary, if the two chromatograms obtained by GC FID are similar or differences can be explained by weathering, further analysis by GC MSD need to be performed. The GC/MSD analysis allows to compare the chemical composition by fingerprinting of a selected "diagnostic" set of compounds indicative of type and origin of the oil. If there are not significant differences between the diagnostic compounds of the two samples compared, then the conclusion is that the two samples have the same origin (Positive Match). If there are few differences that can be explained by weathering, it can be assumed that the two samples have probably the same origin (Probable Match). If the differences are more evident and cannot be explained by chemical weathering, then the conclusion is that the two samples have different origin (Non-Match).

Results

In this case, the source causing the pollution event was corresponding to the point of the rupture of the pipeline. Oil samples to be compared were taken along the shoreline east and west of Porto Torres, where according to the forecasting models the product would have been beached. In the first campaign conducted in February 2011 five sites were selected for sampling: the beach of Stintino "la Pelosa", the beaches of Santa Teresa di Gallura "Santa Reparata" and "Santa Teresa", the beaches of Marina di Sorso "Eden beach" and "Marritza". Samples treated were first analyzed by GC/FID. The sample from "la Pelosa" showed chromatographic differences so clear that was excluded by further analysis. For the other samples the GC/FID results showed that further analysis on GC/MSD were necessary. Conclusion based on the fingerprinting analysis of these samples showed that the sample from "Santa Reparata" and that from the pipeline have the same origin. For the other three samples results suggest that one ("Eden" beach) is clearly different, whereas "S. Teresa" and "Marritza" are probably derived from the suspected source. The analytical approach has been supported by field observations on the features and appearance of the petroleum product found on the coast line inspected. Fingerprinting analysis showed to be a necessary technique to the identification of oil spill source, also in this case.

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THE USE OF MULTIVARIATE AND GEOSTATISTICAL ANALYSES FOR THE EVALUATION OF QUALITY OF COASTAL MARINE ENVIRONMENT

Fani Sakellariadou [1]*
[1] University of Piraeus, Dept of Maritime Studies - fsakelar@unipi.gr

Abstract
Marine sediments from the Elefsis bay (West Attica, Greece) were analyzed for the determination of metal content. Results were treated with multivariate statistical analyses, such as cluster analysis and principal component analysis to facilitate data interpretation. It was found that metal groups are associated mainly with industrial activities and to a lesser extent with local geological features. Inter-element correlation coefficients were produced, indicating a common metal origin at the inner part of the bay. Also, the spatial distribution of sediment contaminants was constructed applying the Simple Kriging interpolation method. Spatial distribution patterns showed the significant influence of anthropogenic pollutant sources.

Keywords: Coastal systems, Metals, Pollution, Sediments, Saronikos Bay

Introduction Environmental status is influenced by man-made and natural disturbances. As seabed sediments are physical traps for many environment pollutants [1, 2], the evaluation of sediment quality gives significant information related to the consequences of the contamination of marine systems. As chemical analysis of sediment samples provides a large data set, multivariate statistics are considered as powerful tools making easier the interpretation task. Hierarchical cluster analysis forms dendograms that provide a relative percentage measure of the magnitude of difference between clusters. The PCA technique enables data reduction and description of a given multidimensional system by means of a smaller number of new variables. It is used to detect sample patterns, groupings, similarities or differences, to identify metal sources and to distinguish between natural and anthropogenic inputs. Furthermore, the production of inter-element correlation coefficients gives useful information on metal similarities and sources. In addition, the construction of spatial distribution patterns for sediment contaminants shows the pollution trend. The generation of pollution dispersion surface needs the application of a data interpolation method, like the Simple Kriging approach that predicts unknown values from data observed at known locations using variograms [3, 4].

Material and Methods Thirteen sediment samples were collected from various sites of the Elefsis bay (Fig.1), located in west Attica, in Greece. The bay is connected to the Saronikos gulf via two natural channels. Elefsis is characterised by the presence of important heavy industries at the north-eastern coastline and the use of its ports for transportation of raw material and goods.

Fig. 1. Elefsis bay with sampling sites.

Samples were digested with a mixture of concentrated HNO_3, $HClO_4$ and HF in screw capped Teflon beakers, on a hot plate [5]. Metal contents were measured by AAS; the relative standard deviation of the measurements was <5%. Data set was treated with cluster analysis, principal component analysis and the Simple Kriging geostatistical method. Inter-element correlation coefficients were produced.

Results A metal enrichment occurs at the inner part of the Elefsis Bay while lower metal values correspond to its western edge. The dendogram resulted from the metal cluster analysis gives the (Mn, Ni, Cr, Cu, Pb, Zn) and (Fe, Al) groups. Principal component analysis (Fig. 2) shows that sediments collected close to the industrial activities have high positive scores for (Cu, Zn, Pb) and (Al, Mn, Sn). Inter-element correlation coefficients correspond to values greater than 0.65 for the pairs (Mn, Al) and (Sn, Mn), greater than 0.75 for the pairs (Pb, Mn) and (Cu, Pb) and greater than 0.85 for the pairs (Cu, Zn) and (Zn, Pb). All anthropogenic metals correspond to higher correlation coefficients for the sediments collected from the inner part of the bay. Spatial patterns of sediment contaminants show enrichment in anthropogenic metals close to industrial activities while areas of lower pollutant content occur at the western edge of the bay.

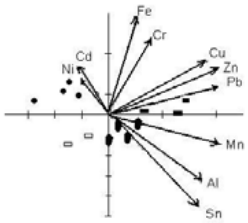

Fig. 2. PCA analysis: sediment samples and relative metal contents.

Discussion Metal clusters correspond mainly to man-made (industrial) activities and to a lesser extent to the local geology characterised by the presence of feldspars, clays and ophiolites. The lower metal content at the western edge is attributed to the drop in anthropogenic pollution sources, the presence of strong subsea currents, the calcareous type of the seabed and the grain size (coarse) of the material covering it. Correlation coefficient values at the inner part of the bay indicate a common metal origin.

Conclusion Industrial activities have strongly influenced the sediment contamination at the Elefsis bay. It is concluded that Elefsis bay seabed acts as physical metal trap and secondary pollution source.

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HEAVY METAL LEVELS IN MARINE ALGAE FROM THE BLACK SEA, MARMARA SEA AND MEDITERRANEAN SEA

Saniye Turk Culha [1]*, Fatma Kocbas [2], Ayse Gundogdu [3] and Mehmet Culha [1]
[1] IKCU, Fisheries Fac., Depart., of Hydrobiology - trksanye@gmail.com
[2] CBU, Faculty of Arts and Sciences,Muradiye, Manisa
[3] SU, Fisheries fac., Akliman, Sinop

Abstract
Concentrations of Cd, Co, Cu, Fe, Ni, Pb and Zn were determined in the marine algae. Certain macroalgae species were chosen among the green, brown and red algae species at 7 stations in the Turkish coasts of the Black Sea, Marmara Sea and Mediterranean Sea in 2009. The concentrations of the heavy metals Fe, Zn and Cu in the present study are higher, but Ni and Co are lower when compared with previous studies in the same region. Also, The highest Fe accumulation was determined in red algae *Ceramium rubrum* (Black Sea) and *Corallina officinalis* (Mediterranean Sea).

Keywords: Algae, Trace elements, Black Sea, Aegean Sea, Marmara Sea

INTRODUCTION
The Black Sea, Marmara Sea and Mediterranean Sea have been subject to very high levels of pollution due to industrial activity, municipal waste waters, agricultural chemicals, oil pollution and airborne particles(1,2). Marine algae species are usually used to indicate heavy metal levels in both estuary and coastal waters throughout the world (3). 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 (3). Some papers have been published concerning heavy metal concentrations measured in macroalgae species collected from Turkish Seas (1,2,4,5,6). The objectives of this paper are to examine the concentration selected heavy metals in marine algae at different stations of Turkey coasts in the year of 2009.

MATERIALS AND METHODS
To determine the concentration of Cd, Co, Cu, Fe, Ni, Pb and Zn in the marine algae, samples were collected from 7 different stations of the Black Sea, Marmara Sea and Mediterranean Sea during the year of 2009. The marine algae species were in Black Sea; Enteromorpha intestinalis, Enteromorpha linza, Ulva lactuca (green algae) Corallina officinalis, Ceramium rubrum (red algae), Cystoseira barbata (brown algae) in Marmara Sea; U. lactuca, C.officinalis, C.barbata and in Mediterranean Sea; Corallina elongata (red algae). About 500 g of the fresh weight were harvested at low tide. The samples were rinsed to remove sand and epiphytal materials in the sea water and then with top water and distilled water. They then were dried at 85 oC and homogenized. All procedure of the method was similar to that previously described (1). The concentration of the heavy metals were determined by ICP-MS. Certified Reference Material BCR-279 sea lactuca (Ulva lactuca, powder) was used for calibration. The results showed good agreement between certified and analytical values (recovery rates 90-110 %).

Station	Species	Co	Cu	Fe	Ni	Cd	Pb	Zn
Samsun (Black Sea)	Cystoseira barbata	0.38	6.53	534.43	4.60	<0.01	<0.01	0.20
	Enteromorpha linza	<0.01	26.69	1099.92	34.89	<0.01	<0.01	28.88
	Enteromorpha intestinalis	<0.01	22.73	1505.64	9.91	<0.01	<0.01	24.15
	Ceramicium rubrum	2.86	13.20	1470.40	10.81	<0.01	<0.01	13.56
Kastamonu (Black Sea)	C. barbata	<0.01	16.33	283.67	14.30	<0.01	<0.01	15.30
Ordu (Black Sea)	C. barbata	1.28	5.06	632.55	3.37	<0.01	<0.01	5.83
	E. linza	2.40	14.20	2577.87	3.03	<0.01	<0.01	13.21
	E. intestinalis	2.16	9.46	753.18	2.01	<0.01	<0.01	<0.01
	Corallina officinalis	1.26	7.55	1483.68	2.88	<0.01	<0.01	14.04
	C. rubrum	<0.01	17.19	3178.92	2.34	<0.01	<0.01	12.12
	Ulva lactuca	2.66	11.23	1053.36	3.69	<0.01	<0.01	<0.01
Trabzon (Black Sea)	C. rubrum	<0.01	11.65	1898.88	3.31	<0.01	<0.01	20.80
	E. linza	2.63	8.89	511.16	1.33	<0.01	<0.01	12.01
	E. intestinalis	<0.01	13.26	1137.30	2.80	<0.01	<0.01	7.89
	U. lactuca	<0.01	10.91	550.72	2.30	<0.01	<0.01	4.58
Istanbul (Black Sea)	E. intestinalis	1.73	7.60	1051.94	3.86	<0.01	<0.01	<0.01
	C. rubrum	1.86	32.57	2717.82	6.06	<0.01	<0.01	41.94
	U. lactuca	0.80	44.87	1621.73	2.97	<0.01	<0.01	66.00
	E. linza	0.04	5.38	297.83	<0.01	<0.01	<0.01	<0.01
Yalova (Marmara Sea)	U. lactuca	<0.01	12.44	358.36	1.25	<0.01	<0.01	5.99
	C. officinalis	2.05	3.81	1495.74	8.59	<0.01	<0.01	39.17
	C. barbata	0.50	7.27	310.75	<0.01	<0.01	<0.01	21.12
Antalya (Mediterranean Sea)	Corallina elongata	0.84	21.26	172.40	3.44	<0.01	<0.01	22.97

Fig. 1. Average heavy metal concentrations (mg kg^{-1} dry weight) in marine algae samples of all sampling stations in Black Sea, Marmara Sea and Mediterranean Sea

RESULTS
The heavy metal concentrations in marine algae are shown in Table 1. Accumulation levels of heavy metals in marine algae have been detected in the order Fe> Cu> Zn> Ni > Co at all stations respectively. The highest uptake in marine algae species at the sampling sites were as follows: Fe and Co in C. rubrum and C. officinalis, Cu in U. lactuca and C. elongata, Zn in U. lactuca and C. officinalis, Ni in E. linza and C. officinalis. The heavy metals accumulated in different algal taxa were: in green algae Cu, Zn and Ni; in red algae Fe and Co. The Cd and Pb concentrations in tested marine algae samples were found to be below the lower limit detection (<0.01). Heavy metal levels of C. rubrum and C. officinalis were significantly higher than those in other marine algae species.

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Session

Pollution hotspots, large cities

Modérateur : **Bruno Andral**

CONTAMINANT INPUTS FROM LARGE COASTAL CITIES INTO THE SEA : THE CASE OF MARSEILLE

B. Andral [1]*, M. Zebracki [2], C. Jany [1], I. Pairaud [1], C. Garnier [3], J. F. Chiffoleau [4] and P. Boissery [5]
[1] IFREMER - LERPAC - bruno.andral@ifremer.fr
[2] IRSN - CEN - Cadarache
[3] PROTEE - Université Toulon
[4] IFREMER- LBCM - Nantes
[5] Agence de l'Eau RMC

Abstract
This study aims to assess the inputs of chemical contaminants to the coastal environment from direct urban discharges of Marseille area. The measurements allow to rank the various sources (sewage network, urban watercourses,...) both in concentrations and fluxes and to compare to similar values available for big rivers like the Rhône.

Keywords: Monitoring, Trace elements, Sewage pollution, Pcb, North-Western Mediterranean

Marine pollution is one of the priority issues of the Mediterranean environment. The Mediterranean Action Plan has shown that few large cities were responsible for a major fraction of the inputs from urban areas and should be considered as hot spots. Pollutant inputs to the sea come form different sources; besides sewage treatment plants and industrial effluents, it is important to consider intermittent flows from rivers and diffuse runoff from the coastal urban areas.

The present study aims to assess the inputs of chemical contaminants to the coastal and marine environments derived from direct urban discharges (sewage network, urban watercourses) of Marseille area (France). The contaminants of interest are metallic (Cd, Pb, Hg) and organics (PAHs, PCBs, PBDEs), distinguishing the dissolved and the particulate fractions. The method for the fluxes determination is based on (i) the determination of contaminant concentrations by collecting water samples in Marseille study area, and (ii) the hydrological (water discharge) data provided by the territorial managers. The collection of water and particles samples started in 2009 and finished in 2011 under various weather conditions (dry/rain periods) and different sampling sites : outfall of water plant, coastal rivers, torrents (rain period), overflow (storm). Data were compared to those available for rivers [1,2,3].

The results show that urban water displays relatively high concentrations for metallic contaminants, both for the dissolved fraction (Hg: 0.04-62.35 ng.L^{-1}) and the particulate fraction (Hg: 4-6235 ng.g^{-1}). These concentrations are 10 to 20 times higher than the concentrations measured in the Rhône river. For organic contaminants, concentrations are particularly high for PAH (eg fluoranthène : 0.21 – 156 ng.L^{-1} dissolved fraction, 4.2 –2256 ng.g^{-1} particulates fraction) and PBDE (0.01- 21 ng/L dissolved fraction, 1.4 – 674 ng/g^{-1} particulate fraction). These concentrations are 50 to100 times higher than measured values in the Rhône river (fig 1).

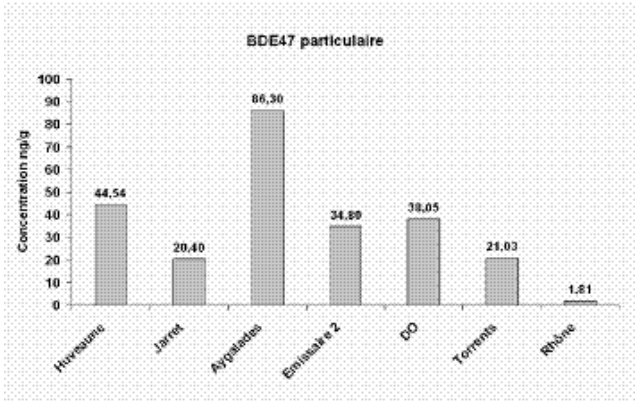

Fig. 1. Figure 1 : Mean concentrations of PBDE particulate fraction. Coastal river (Huveaune , Jarret, Aygalades) – waste water treatment plant (emissaire2), overflow (DO).

Results show that concentrations of pollutants are greater in coastal rivers (Hg and PCBs) and overflow (Pb, PBDE and PAH). By dry weather, variability of concentrations is generally strong. By rain period, concentrations are constant with lower values (dilution by run off water).

The estimation of fluxes shows that the first contributor is the waste water treatment plant of the city (due to the amount of water discharge) by dry or rain period. The second contributor are the coastal rivers. The small coastal rivers are not relevant, neither the sewer outflows. Estimated fluxes for Hg and Pb are 100 to 1000 times lower than in the Rhône river. For PAH, the fluxes are 10 000 times lower. Finally for PCBs and PBDE, the values are 100 to 5000 times and 300 to 10000 times higher in the Rhone and in the Saint Laurent rivers than in this study (fig 2).

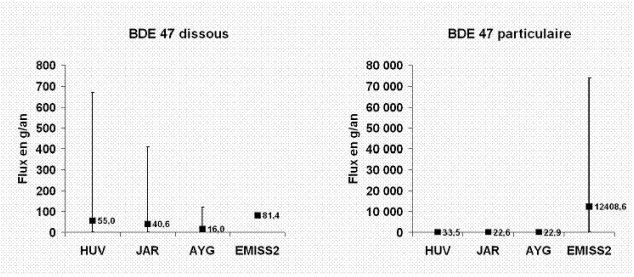

Fig. 2. Figure 2 : BDE 47 fluxes in coastal rivers(HUV, JAR, AYG) and waste water treatment plant (EMISS2). Mean (¦), maximum and minimum values (I).

To optimise the estimation of the polluting flows, a better understanding of factors influencing the variability of the concentrations, longer sampled periods and larger number of sampled floods are necessary. The fate of dissolved and chemicals from the coastal area to the open sea can be further assessed using dedicated numerical models.

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PRELIMINARY STUDIES ON THE EFFECTS OF HEAT PUMP DISCHARGES ON SHALLOW BENTHIC LITTORAL COMMUNITIES IN MONACO

F. Bartolini [1]*, F. Gianni [1], C. Lafargue [1], J. Cottalorda [1], P. Francour [1], T. Thibaut [1] and L. Mangialajo [1]
[1] ECOMERS University of Nice - fabrizio.bartolini@unice.fr

Abstract
Among renewable energies, seawater heat pumps (HP) represent useful technology which uses oceans thermal energy needed for air conditioning and heating systems. However, the outflow of these systems consist of thermally altered brackish or seawater which is discharged directly into the sea, thus potentially impacting local benthic communities.
We measured the effects of HP discharge along spatial gradients east- and westward of an outflow in the Ligurian Sea, assessing the composition of upper sublittoral benthic assemblages. The combined effect of temperature and salinity alteration did not seem to affect the structure of macrolaglal assemblages, while *C. compressa* was absent close the outflow.
These preliminary results showed a limited effect of HP in artificial zones characterized by tolerant species-dominated assemblages.

Keywords: Thermal pollution, North-Western Mediterranean

Heat pumps (HP) represent relatively new technology based on a renewable source of energy, namely ocean's heat, and have potential for future energy supply in coastal developed areas. HP are thermodynamic plants which, based on the differences of surface and deep seawater temperature, extract the energy necessary for domestic cooling or warming [1]. However HP outflow consist of thermally altered brackish or seawater discharges, which could impact the local meso- and sublittoral benthic communities.
Thermal pollution has mainly been studied at the outflows of nuclear or thermal power plants in the past, showing alteration of seaweeds communities and pattern of invertebrate recruitments ([2], [3]).
The project OPTIMA-PAC (OPTImisation des performances énergétiques et MAitrise des impacts sur le milieu marin des PAC eau de mer : vers une nouvelle filière industrielle compétitive), aimed at evaluating the impacts of such discharge is being carried out in the North-Western Mediterranean along the coast of the Principality of Monaco, where HP are utilized since more than 30 years.
In an early stage of the project, the impact of a brackish HP outflow was studied in Summer 2012. Temperature dataloggers were placed at the discharge point and 5, 10 20 40 and 60/80 m east- and westward, respectively, to quantify the entity of thermal disturbance due to the HP on such spatial gradient. Salinity measurements along the gradient were carried out as well. Photographic sampling quadrates were carried out at each station to analyse possible differences in benthic communities' structure and composition and the distribution of the mesolittoral brown alga *Cystoseira compressa* was mapped along the two spatial gradients.
The largest thermal effects were recorded mainly within the first 5-10 m apart from the outflow. The main effect seems to be a widening of the daily temperature range compared to extreme positions (Fig.1). Salinity alteration followed a similar spatial pattern to temperature, with a minimum average value of 29‰ at the outflow.
A preliminary analysis of the benthic assemblages, strongly dominated by coralline and turfs of filamentous algae, revealed significant differences among stations in the gradient, however without any clear relation with the distance to the discharge point. Other environmental factors are potentially affecting the structure of artificial reefs assemblages more that the combined effect of temperature and salinity alteration recorded. The strong anthropization of the study area, chracterized by algal communities dominated by relatively tolerant species, could account for the lack of a clear effect of HP discharge on assemblages structure. On the contrary, *C. compressa* patches were distributed only starting from 27 and 40 m from the outflow, westward and eastward respectively.
These preliminary results suggest that the effects of HP rejects may be limited in highly impacted artificial zones, but the response of benthic communities may be very different on natural substratum, where sensitive species (i.e. *Cystoseira* species) are thriving. Future investigations should consider biological indicators potentially more sensitive to the observed alteration of the environmental parameters, like early life stages, reproduction and physiological traits of benthic organisms.

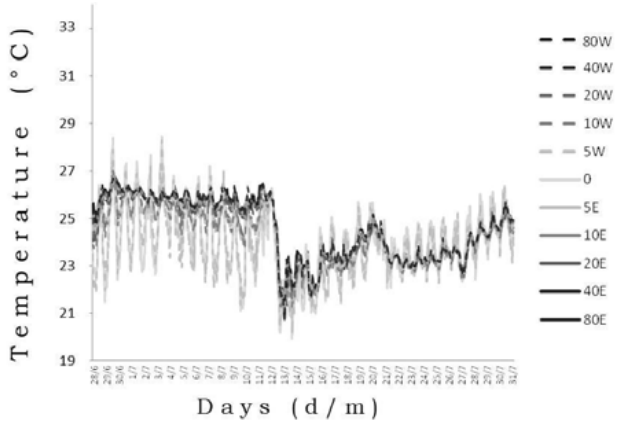

Fig. 1. Recorded temperature from 28/06 to 01/08/2012 along spatial gradients (0-80, E-W) from the HP discharge.

Acknowledgements
The present work was funded by the project Otpima-PAC, supported by the PACA marine competitivness cluster and selected by DGCIS under the 11th FUI (Fonds unique Interministériel) call for proposal. Authors wish to thank the other partners of the project for the constructive discussions during the meetings and in particular the Environment Direction and the Maritime Affairs of Monaco Principality that supported the field activities.

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MODELING THE FATE OF FAECAL BACTERIA IN NEAR-SHORE COASTAL WATERS

S. Bonamano [1]*, A. Madonia [1], C. Stefanì [1], C. Borsellino [1], G. Caruso [2], G. Zappalà [2] and M. Marcelli [1]
[1] Tuscia University - simo_bonamano@unitus.it
[2] IAMC-CNR

Abstract
This work describes the fate of coliform bacteria in the near-shore coastal waters of Civitavecchia and S. Marinella bathing areas (Latium, Italy) integrating mathematical models and in situ data. The modeling approach was used to determine the accumulation and the dynamics of spreading and transport of potentially infectious microorganisms coming from input loads.

Keywords: Bacteria, Pollution, Models, Tyrrhenian Sea

Most of coastal areas are affected by high population density, mainly in the summer season, and by industrial activities which can cause the uncontrolled discharge of polluted waters into the sea. The investigated area is characterized by the presence of several local inputs which produce a surplus of wastewater when the sewage overflow condition is reached. The use of mathematical models plays a key role to analyse the dispersion of potentially dangerous substances to human health and marine ecosystems.In summer 2012, four intensive field surveys were undertaken to measure bacteria load concentration in two selected areas (Civitavecchia and S. Marinella beaches) according to the following criteria: (a) presence of sewage effluents, (b) large number of bathers and (c) low hydrodynamism (e.g. due to the presence of coastal protection barriers). In each bathing area samples were collected every three hours (from 7 a.m. to 8 p.m.) at local inputs and control stations to validate mathematical model results.

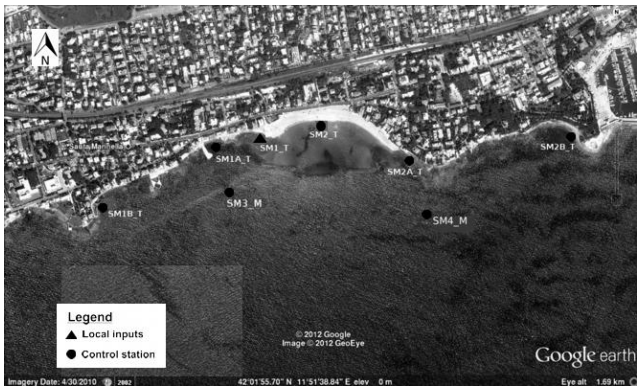

Fig. 1. Sampling stations in Santa Marinella bathing area

Collected samples were analysed according to the standard culture method [1] and the new fluorescent antibody analysis proposed by Caruso et. al, 2000 [2], in order to evaluate the pathogen cells concentration. In addition to the water quality indicator measurements, current speed and direction, temperature and salinity were also measured. Moreover solar radiation and wind speed and direction were available from weather station of Port Authority of Civitavecchia while wave parameters were collected from Capo Linaro wave-buoy of RON (Italian Data Buoy Network).Wind and wave data were used to calculate coastal marine currents by three dimensional models with high spatial-time resolution. The resulting hydrodynamic field was obtained by the steering module that couples the DELFT3D-FLOW [3] and the SWAN models [4]. The dispersion of coliform bacteria was simulated by the Delft3d-WAQ [5] model that takes into account their decay rate (due to solar radiation, salinity and sea temperature) and the flow calculated by the steering process. Predictions for fecal coliform distributions were successfully verified in the study areas, identifying the temporal evolution of potentially pathogenic bacteria in the next 24 hours. The comparison between model and in situ data showed a positive correlation (R2= 0.88) especially at higher concentrations and until a distance of about 200 meters.

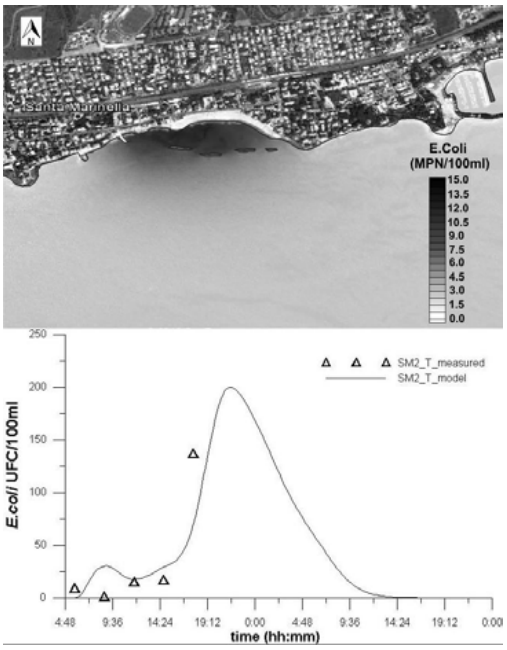

Fig. 2. Faecal coliform (FC) dispersion simulated by Delft3d-WAQ (above) and related comparison between predicted and measured FC concentration at SM2_T station (below).

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LES MÉTAUX TRACES DANS LES SÉDIMENTS DE LA BAIE D'ALGER

M. Boulahdid [1]*, D. Taieb Errahmani [2], A. Noureddine [2], N. Hocini [2] and F. Ounadi [2]
[1] Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement d Littoral - mostefaboulahdid@hotmail.com
[2] Centre de Recherche Nucléaire d'Alger, Algérie.

Abstract
Soumise à la pollution anthropique, la baie d'Alger a fait l'objet d'une étude de contamination par les métaux traces. Deux carottes montrent que les sédiments côtiers sont plus contaminés que ceux profonds et présentent des anomalies pour certains métaux. Des perturbations dans la distribution verticale de certains métaux sont observées. Celle du Mn ne permet de définir la limite entre la couche d'oxydation et la couche de réduction que dans la carotte des sédiments profonds qui est de l'ordre de 3 cm.

Keywords: Pollution, Metals, Sediments, Algerian Sea

1. Introduction : La baie d'Alger est soumise à plusieurs sources de pollution. La zone industrielle d'Alger, via l'oued El Harrach, constitue une source potentielle. Le présent travail, réalisé en mars 2009, a pour objectif de déterminer le niveau de contamination de quelques métaux dans le sédiment et son évolution en fonction de la profondeur du sédiment et de la bathymétrie.

2. Matériels et méthodes : Deux carottes de sédiment ont été prélevées dans la baie d'Alger (fig.1) : l'une de 33 cm de longueur à 30 m de profondeur en face l'oued El Harrach (C-1) et l'autre de 27 cm de longueur à 116 m de profondeur (C-2). Les métaux étudiés sont le Cu, le Zn, le Cr, le Ni, le Mn et le Fe. La détermination des concentrations a été faite par spectrophotométrie d'absorption atomique selon les méthodes décrites par [1], [2], [3] et [4].

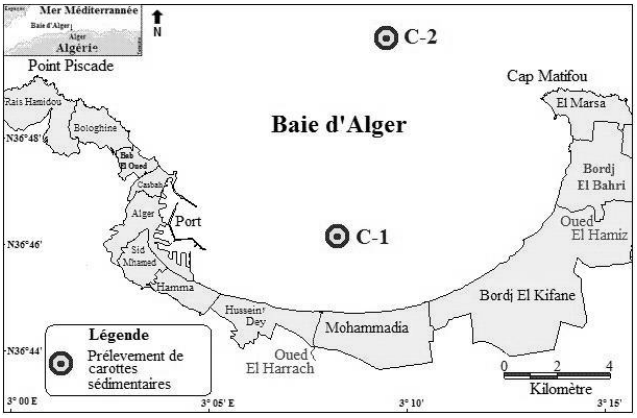

Fig. 1. Positions des deux carottes sédimentaires dans la baie d'Alger.

3. Résultats : Les résultats obtenus montrent des concentrations modérées pour tous les métaux étudiés. En outre, les moyennes des concentrations des métaux de la carotte (C-1) sont relativement plus élevées que celles de la carotte (C-2), sauf pour le nickel où les moyennes sont comparables. Ceci dénote l'influence des apports continentaux, probablement d'origines anthropiques. Dans la distribution verticale des métaux en fonction de la profondeur, la carotte (C-1) manifeste des concentrations anomales pour le Zn, le Cu et le Cr (fig. 2). En effet, les profils verticaux de ces métaux montrent des anomalies qu'on n'observe pas dans la carotte (C-2). Ces anomalies sont entre 0 et 10 cm de profondeur dans le sédiment avec deux pics : le premier avec la concentration maximale se localise à 6 cm de profondeur et le deuxième avec une concentration modérée se situe à une profondeur de 1,5 cm. L'essai de datation évoque que ces anomalies sont assez récentes (années 80). En dehors de ces anomalies, la concentration moyenne (µg/g) le long du profil est de : Zn=124,16; Cu=29,56 et Cr=23,49. Cette moyenne peut correspondre au fond géochimique de l'élément chimique considéré. Dans les deux carottes, à l'exception des anomalies observées, si le Zn, le Cu, le Cr et relativement le Fe de la carotte C-1 montrent une distribution verticale assez stable, le Ni, le Mn et le Fe de la carotte C-2, par contre, présentent des perturbations. Ces dernières peuvent être en rapport avec les conditions de sédimentation, la nature des sédiments et leur évolution diagénétique. La distribution verticale du Mn au niveau de la carotte C-2 permet de définir une épaisseur de l'ordre de 3 cm à la couche d'oxydation (de bioturbation). Cette limite n'est pas définissable au niveau de la carotte (C-1). La moyenne des concentrations relevées pour le Zn et le Cu dans la présente étude sont supérieures à celles du sédiment superficiel de la baie d'Alger au voisinage du site de la carotte C-1 [5]. Cependant, ces auteurs relèvent, pour les mêmes éléments, des concentrations supérieures à celles observées au niveau de la zone de C-2.

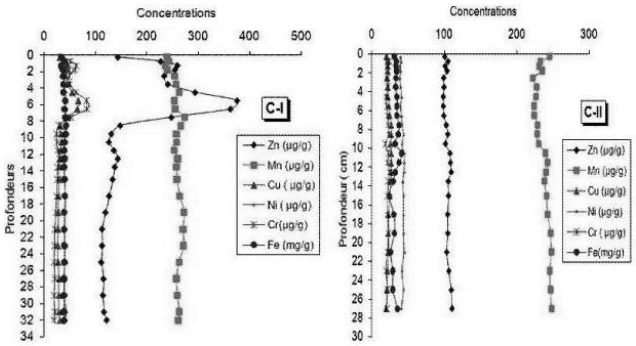

Fig. 2. Profils de distribution verticale des métaux dans les sédiments de la baie d'Alger

4. Conclusion : Les concentrations relevées pour les métaux étudiés ont un niveau modéré. Celles de C-1 sont nettement plus élevées que celles de C-2. Trois éléments (Zn, Cu et Cr) présentent des concentrations anomales dans C-1 entre 0 et 10 cm de profondeur. Ces anomalies sont assez récentes, cependant, l'origine reste à déterminer. La distribution verticale du Mn dans la carotte C-1 ne permet pas de définir l'épaisseur de la couche d'oxydation. Par conséquent, une perturbation dans le comportement du Mn et dans la sédimentation au niveau de la zone de cette carotte peut être évoquée.

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SEASONAL MONITORING OF INORGANIC CONTAMINANT DYNAMICS IN COASTAL SEDIMENTS (TOULON BAY, SE FRANCE)

D. H. Dang [1]*, V. Lenoble [1], G. Durrieu [1], D. Omanovic [2], J. Mullot [3], S. Mounier [1] and C. Garnier [1]
[1] Laboratoire PROTEE, Université du Sud Toulon Var, BP20132, 83957 La Garde, France - dang@univ-tln.fr
[2] Center for Marine and Environmental Research, Ruder Boškovic Institute, P.O. Box 180, 10002 Zagreb, Croatia
[3] LASEM-Toulon, Base Navale de Toulon, BP 61, 83800 Toulon, France

Abstract
The highly contaminated sediments from Toulon bay (NW Mediterranean Sea) were deeply studied to investigate their potential threat toward the seawater quality. A seasonal variation of diagenetic tracers and of inorganic contaminants was then revealed, with high intensity in early autumn and spring (November and March), probably linked to "fresh" organic matter input (e. g. plankton bloom). Within this significant variation, a coupling of contaminants and diagenesis -sensitive carrier phases was demonstrated (As/Fe oxides, Co/Mn oxides...). A similar behaviour was evidenced for oxyanion/oxycation, and also for metals. Theirs dynamics seemed to be closely related to that of the sedimentary organic matter.

Keywords: Sediments, Trace elements, Geochemistry, North-Western Mediterranean

Introduction
The sedimentary dynamic of diagenesis tracers and inorganic contaminants was investigated in Toulon bay (NW Mediterranean Sea), previously demonstrated to be hugely polluted by numerous species (metals/metalloids, PAH …) [1]. Such dynamics influence the role of sediments: only a sink or also a source of contamination for the surrounding ecosystem. Few studies on the diagenesis variations were realized, and they were maily dedicated for some tracers in subsurface sediments [2, 3]. In such context, analytical and modelling approaches were used to better understand the dynamic and fate of diagenesis tracers and inorganic contaminants in coastal sediments.

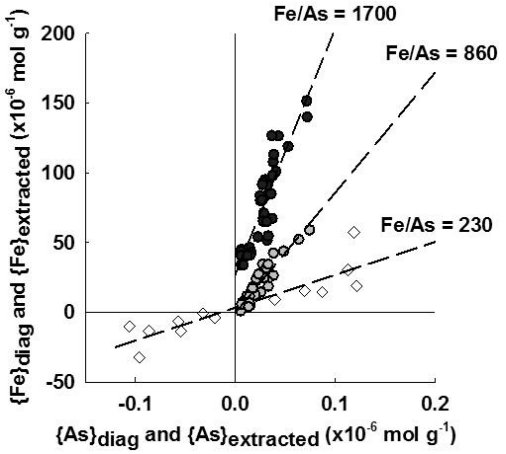

Fig. 1. Fe and As contents gained or lost by diagenesis activity (PROFILE calculations, *open diamond*), and measured on sediment extracts (ascorbate pH 8.2 (*grey circle*) and 1 M HCl (*black circle*)).

Materials and methods
Core sediments were sampled through the bay every 2 months, during 1.5 years to characterize porewater (physical/chemical parameters, diagenesis tracers and major/trace concentrations …) and solid sediments (major/trace contents, selective extractions and carrier phase identification). A 1D steady-state modelling approach (PROFILE [4]) was used to fit the elements' profiles, estimating depth reaction intervals and reaction rates. Thermodynamic simulation (PHREEQC [5]) was also performed to (1) calculate elements' chemical speciation and (2) simulate the dissolved/particulate element fractionation, by implementing in the database the main geochemical reactions and processes occurring in sediments.

Results and discussion
The diagenesis dissolved profiles (C_T (DOC+DIC), N, P, Mn, Fe, S...) showed significant seasonal variations. The highest diagenesis activity was recorded in November and March, suggesting a link with the varying input of "fresh" organic matter (e.g. plankton bloom). Diagenetic products (DIC, NH_4^+, PO_4^{3-}) ratio appeared to be constant through the seasonal variation (C_T/PO_4^{3-} = 280, R^2 = 0.75 (n = 200); C_T/N_T=11, R^2 = 0.90 (n = 200)). Otherwise, the coupling of experimental (selective extractions) and modelling approaches demonstrated the strong link between contaminants and the diagenesis-sensitive phases in subsurface sediments. The most recurrent examples were the coupling of As/Fe oxides and Co/Mn oxides. Precisely, the estimation of the Fe and As quantity lost or gained through different diagenetic processes (mineral dissolution/precipitation or adsorption...) demonstrated a correlation with a Fe/As ratio of 230 (Fig. 1). Selective extractions have also shown that As was mainly linked to amorphous iron oxyhydroxide. The relationship between As and this diagenetic-sensible mineral explained the high As remobilization in subsurface sediment. In the sulfidic sediments, similar profiles were recorded for oxyanion/oxycations (As, Sb, U, V...), apparently following a covariation with the dissolved organic matter profiles. A similar observation was found for different metals (Cu, Pb, Ni ...). It seemed that the organic matter quality (aromaticity) control their dynamics.

Conclusion
The monitoring of the diagenetic activity showed a significant seasonal modification of the behaviour of numerous elements, either diagenetic tracers or inorganic contaminants. Such variation could impact on the diffusive flux of pollutants from sediments to the water column. Numerous diagenetic processes involved in the dynamics of different inorganic contaminants were also identified and the role of sedimentary organic matter needs further investigations.

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DYNAMICS AND FATES OF TRACE METALS INPUT IN MEDITERRANEAN COASTAL ZONE IMPACTED BY MARSEILLE AGGLOMERATION (FRANCE)

B. Oursel [1], Y. Lucas [1], G. Durrieu [1], S. Mounier [1], D. Omanovic [2] and C. Garnier [1]*
[1] Laboratoire PROTEE, Université de Toulon, BP20132 - cgarnier@univ-tln.fr
[2] Ruder Boskovic Institute, Center for Marine and Environmental Research, PO Box 180, 10002 Zagreb, Croatia

Abstract
Quantification and characterization of chronic inputs of trace metals and organic carbon in coastal Mediterranean area (the city of Marseille) during contrasted seasons (dry and raining periods) was carried out. During dry season, the impact of Treated Wastewater (TWW) on trace elements fluxes to the sea was clearly evidenced. In the freshwater/seawater mixing zone, most of the studied elements presented non-conservative behaviors, partly due to a non-equilibrium in the dissolved/particulate metals distribution in the effluents [1].

Keywords: Coastal waters, Geochemistry, Metals, Sewage pollution, North-Western Mediterranean

Study site:
Only a few studies have dealt with the Mediterranean area despite its rapid anthropization due to present-day heliotropism from Northern Europe and despite its climate specificities. Among all the possible sources of marine pollution, large coastal cities are among the most worrying, especially in the Mediterranean Sea. A typical example is Marseille, the largest Mediterranean French city, with over 1.7 million inhabitants. Two small rivers, the Huveaune and the Jarret, run through the agglomeration and join before their outlet to the sea. The uniqueness of this system is that the river waters are mixed with the city waste water treatment plants (WWTP) effluents and then rapidly discharged into the open sea without passing through an estuary, so that the WWTPs' contribution to the water characteristics at the outlet is most likely predominant during baseflow periods. These inputs have a certain impact on the local coastal ecosystem, however, a high number of such anthropized sources along the coast is likely to impact the whole Mediterranean Sea.

Material and methods:
Nine sampling campaigns (2010 to 2012) were conducted during dry and wet periods, under contrasting conditions with regard to season, wind and waves. One of this campaign was performed during an abnormal event, characterized by very high DOC and metal concentrations, probably due to the WWTP dysfunction. Water samples were systhematically collected in rivers, effluents and along the salinity gradient to cover the whole freshwater/ seawater miwing zone. Samples for DOC/POC analyses were filtered through 0.7 µm glass filters. Particulate organic carbon (POC) was quantified using these filters. DOC and POC concentrations were analyzed using a TOC-meter. Samples for dissolved/particulate metal analyses were filtered through 0.45 µm cellulose nitrate filters. The filters were dissolved by microwave digestion in aqua regia for further analysis of particulate metals by HR-ICP/MS. Dissolved trace metals were analyzed after acidification and UV irradiation by DPASV and DPCSV [2]. For a better understanding of the mechanisms that operate in the salinity gradient, remobilization experiments were performed in lab to simulate the outlet effluent/seawater mixing. Unfiltered effluent water was mixed with filtered seawater to cover a range of salinity: 1, 2.5, 5, 10 and 25. At 15 min, 1, 6 and 24h of contact time, water aliquots were filtered and analyzed for DOC and dissolved trace metals. To simulate flood conditions, a second set of experiments was performed after addition to the effluent water of flood deposit particules from the outlet, reaching a final SPM concentration of 800 $mg.L^{-1}$.

Results and discussion:
During baseflow conditions, dissolved and total organic carbon and metal concentrations in the rivers considered were comparable to values observed for other small coastal Mediterranean rivers, surpassing the world average river values. Concerning the trace metal dynamics in the plume salinity gradient (Fig. 1), Cu, Cd, Co, Pb and Zn are desorbed from the SPM, increasing the potentially bioavailable fraction of these metals. It was clearly demonstrated that the release of metal ions can occur at low salinity with fast kinetics followed by partial re-adsorption onto SPM; a behavior especially observed for Cu. Other metals (e.g. Ni) can undergo a fast adsorption onto SPM followed by slower desorption. Such unusual behaviors make mandatory the practice of filtration immediately after sampling to avoid under- or over-estimation of dissolved metal concentrations.

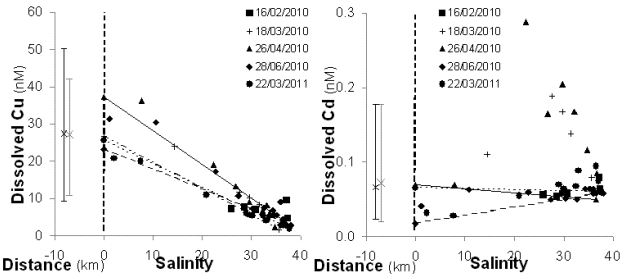

Fig. 1. Variation of dissolved Cu (left) and Cd (right) concentrations, during dry season, in rivers (as a function of the distance until the outlet) and from outlet to seawater (as a function of the salinity).

A second important point of this study is that, at the outlet, the river signatures were hidden by the WWTP anthropogenic input for most elements or compounds. The anthropogenic input was higher than 90% of the total input to the sea for particulate Cd, Pb and Cu and higher than 65% for particulate Zn, Co and dissolved Zn and Pb. The daily variation of these inputs followed the fluctuations of the TWW issued from WWTP. Although most likely not frequent, the observed abnormal event linked to a WWTP malfunction or by-pass can temporally strongly enhance the impact of an urbanized area on the coastal zone. Similar phenomena all around the Mediterranean are more than probable, especially in countries without wastewater treatment plants. This underlines the need for such treatment facilities for an improvement of local coastal water quality, but most likely also at a more global scale. Such chronic fluxes of pollutants require better study in comparison to other main sources (large rivers, aerosols, etc.). During wet conditions, trace metals fluxes increased, with a main contribution from rivers (compared to WWTP). Considering the high anthropogenic organic matter and trace element contents of the output to the sea, a detailed study of their chemical speciations, which are known to be strongly influenced by dissolved organic ligands, must be performed to evaluate their bioavailability for marine biota.

Acknowledgments:
This workwas financially supported by the ''ANR CES MARSECO'' and the ''GIRAC-PACA'' (FUI, TPM, Région PACA). This study was part of the ''MerMex-WP3-C3A'' and international ''IMBER'' projects.

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ORGANOCHLORINE CONTAMINATION (OCPS AND PCBS) IN SEDIMENTS FROM THE CANDARLI GULF (EASTERN AEGEAN)

Idil Pazi [1]*, Filiz Kucuksezgin [1] and Lutfi T. Gonul [1]
[1] Dokuz Eylul University Institute of Marine Science and Technology - idil.erden@deu.edu.tr

Abstract
The residual levels of organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) were determined in surface sediments collected from Candarli Gulf. Total concentrations of OCPs and PCBs in sediments ranged from 10.2 to 57.3 and 2.8 to 205 ngg^{-1} dwt, respectively. DDTs in sediments (8.0 to 37.4 ngg^{-1} dwt) were originated weathered agricultural soils and recent DDT inputs. Their concentrations appeared to be relatively low according to sediment quality guidelines except for Bakircay River estuary and petrochemical industry area.

Keywords: Pesticides, Pcb, Sediments, Aegean Sea

Introduction
Organochlorines (OCs), such as PCBs and OCPs, represent an important group of persistent organic compounds (POPs) that have caused worldwide concern as toxic environmental contaminants. An investigation of the distribution of OCPs and PCBs in sediments can provide valuable data about sediment contamination in a marine environment.Although the production and usage of many organochlorinated compounds were completely banned in Turkey in the 1990s, pesticide usage increased by 270% between the years of 1979-2007 [1]. In this study, OCswere measured in Candarli Gulf sediments to provide a better understanding of recent distribution, possible sources as well as potential biological risk of these compounds in this area.

Materials and Methods
In the framework of MEDPOL Phase IV Project, sediment samples were collected from 18 stations in 2009 covering the entire Candarli Gulf, using box corer to detect organchlorine residues. The sampling sites were shown in Fig.1. Sediment samples were analysed according to [2]. Quantitative analysis was performed with GC–MS. The OCPs and PCBs were analyzed in the sediments. Sediment (IAEA-417) sample was used as a control for the analytical methods.

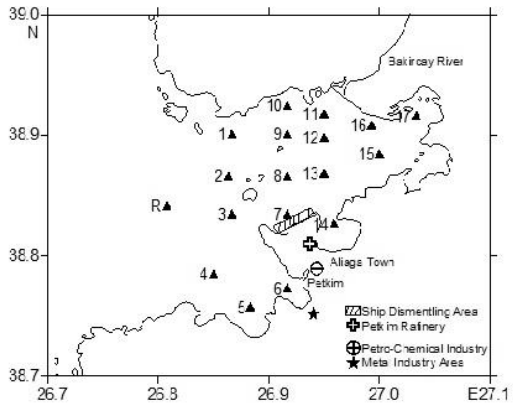

Fig. 1. Location of stations

Results and Discussion
Concentrations of sum nine OCPs in surface sediments from Candarli mean value of 34± 3.03 (Mean±SE) ng g^{-1} (based on dry weight). The highest value was found close to the Bakircay Estuary, while the lowest value of OCPs occurred in the middle part of the Gulf, corresponding to the lowest content of total organic carbon. Aldrin, dieldrin were found below detection limit (bdl) and endrin was found at low concentrations in most of the samples (bdl-2.9 ng g-1). Aroclor 1254 and 1260 in Candarli Gulf sediments ranged from 1.4 to 141 and 1.4 to 64.2 ngg^{-1}, respectively (Fig. 2). The higher levels of PCBs can be attributed to localized source of contaminants from Petkim petro chemical industry. In the Bakircay River estuary reported that OCPs and PCBs in sediments were 3-4 orders of magnitude higher than those in the reference station.

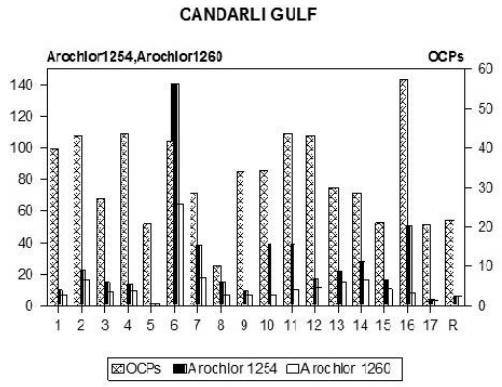

Fig. 2. Total concentrations of OCPs, Arochlor 1254 and Arochlor 1260 (ng g^{-1} dry weight) in the Candarli Gulf

Conclusion
This study first documented the composition and distribution of OCPs and PCBs in sediments collected from the Candarli Gulf. The results indicated that the DDTs were the predominant contaminant in sediments of the Eastern Aegean coasts. The recent DDT inputs in the Candarli Gulf mainly from the agricultural activity. Highest concentrations of PCBs were found in samples collected near the petrochemical industry. Based on the sediment quality guidelines, ΣPCB concentrations of the samples collected for this study did not exceed the ERM (Effect Range-Median value) or PEL (Probable Effect Level) values, other than the station near the petrochemical industry.

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MASSILIA PROJECT - MODELLING OF THE BAY OF MARSEILLE: IMPACT OF THE ANTHROPOGENIC SUPPLY ON THE MARINE COASTAL ECOSYSTEM

C. Pinazo [1]*, A. Doglioli [2], V. Faure [1], M. Fraysse [3], I. Pairaud [3], A. Petrenko [2], B. Thouvenin [4], J. Tronczynski [5], R. Verney [4] and C. Yohia [2]

[1] Aix-Marseille Université, Université du Sud Toulon-Var, CNRS/INSU, IRD, Mediterranean Institute of Oceanography MIO UM110, Station Marine d'Endoume, Chemin de la Batterie des Lions 13007 Marseille - christel.pinazo@univ-amu.fr

[2] Aix-Marseille Université, Université du Sud Toulon-Var, CNRS/INSU, IRD, Mediterranean Institute of Oceanography MIO UM110 13288, Marseille, Cedex 09

[3] Laboratoire Environnement Ressources Provence Azur Corse, IFREMER Méditerranée, Zone portuaire de Brégaillon - BP 330, 83507 La Seyne/Mer Cedex

[4] Laboratoire Physique Hydrodynamique et Sédimentaire, Département Dynamiques de l'Environnement Côtier, Centre de Brest BP 70 29280 Plouzané

[5] Laboratoire Biogéochimie des Contaminants Organiques, IFREMER Département Biogéochimie et Ecotoxicologie, Rue de l'Ile d'Yeu BP 21105 44311 Nantes Cedex 03

Abstract

In the framework of sustainable development, the anthropogenic impact of large coastal cities on the marine ecosystem is a key issue. This project aimed to improve our knowledge in marine ecosystem response to the anthropogenic supplies (from rivers, sewage outflows and atmosphere) from large cities. In particular, the goal is to underline how the physical forcing decreases or increases the anthropogenic impact on the coastal ecosystem and the assessment of the chemical contaminant (PCB) inputs (from city to sea) and exports (from mid-sea to open sea).

Keywords: North-Western Mediterranean, Coastal models, Coastal processes, Eutrophication, Pollution

The density of contaminant-generating industries of the city of Marseille is highly representative of large modern Mediterranean cities. Marseille was thus chosen for the development of numerical tools, based on the coupling of a hydrodynamic model [1], a sedimentary model, a biogeochemical model [2] and a model of chemical contamination (PCB). The coastal area off Marseille is characterized by numerous physical and biogeochemical forcing, as shown on Figure 1. The physical forcing are: wind induced upwelling and downwelling, eddies, intrusion of the Northern Current, wind vertical mixing or stratification by heat fluxes. The biogeochemical inputs come from the Rhone River, the urban rivers in case of rainfall, the Waste Water Treatment Plant (WWTP) inputs, the sediment and atmospheric inputs and the biogeochemical characteristics of large-scale waters surrounding the Marseille area.

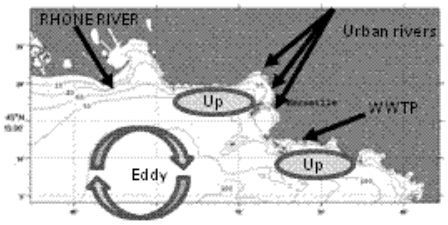

Fig. 1. Study Site of the Massilia Project - Physical processes and Anthropogenic and Natural Inputs

The approach was to study realistic typical and extreme events observed during the years 2007 and 2008. The status of typical or extreme of each event was determined in comparing with statistics on the 2001-2008 period. We used numerical tools to address following questions: i) what are the respective contributions of the physical forcing in the modulation of the oligotrophic level of this coastal ecosystem submitted to strong anthropogenic supplies? ii) What is the influence of extreme events, which frequency increases with global warming (floods, storms, heat events), on the changes in the first trophic level (phytoplankton) in the Bay of Marseille? iii) Are the chemical contaminant (PCB) inputs from the city to the sea off Marseille, stocked inside the coastal marine area or exported to the open sea?

Mistral wind events induced two spots of upwelling with a strong upwards vertical velocity (maximum of 5 $m.s^{-1}$ during an upwelling event in 2008's November) [1]. The area impacted by ascent of deep water was characterized by low temperature and high nutrient concentrations. These nutrient concentrations induced an increase in chlorophyll-a concentrations in the upwelling spot and at the front between the upwelled water and the Rhone River plume water. This phytoplankton production could be potentially associated with chemical contaminant (PCB). In addition, sediment erosion occurred in the South part of the Bay of Marseille, where the fetch for Mistral wind was the largest. The suspended particulate matter and the adsorbed chemical contaminant (PCB) were exported offshore by currents.

South-Easterly wind events induced strong intrusion of large-scale waters inside the domain and a downwelling at the coast, inducing a vertical mixing of the whole water column. This wind was associated with waves, which induced sediment erosion near the WWTP inputs. The suspended particulate matter and the adsorbed chemical contaminant (PCB) were transported nearshore by currents, in the South part of the Bay of Marseille. The end of summer rainfall had a weak impact on hydrodynamics, but induced significant nutrients, suspended matter and PCB inputs in the Bay of Marseille by urban rivers and in the South area by the WWTP. The nutrients did not promote a significant phytoplankton production, which was limited by light and temperature in fall.

The intrusion events of Rhone River diluted water in the Bay of Marseille induced a decrease in salinity and an increase in nutrients, suspended matter and PCB. This nutrient enrichment induced a phytoplankton production and an increase in chlorophyll-a concentrations, potentially associated with PCB adsorption. These events could be associated with an anticyclonic eddy located off the Rhone River mouth [3].

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EXPORT OF CHEMICAL CONTAMINANTS FROM A BIG MEDITERRANEAN CITY: MODELLING OF DISSOLVED AND PARTICULATE TRANSPORT IN THE BAY OF MARSEILLES

B. Thouvenin [1]*, I. Pairaud [2], C. Jany [2], M. Zebracki [3], R. Verney [4], J. F. Chiffoleau [5], C. Garnier [6], J. Tronczynski [5], D. Sauzade [2], D. Cossa [5], C. Pinazo [7], F. Ardhuin [4], M. Fraysse [2] and B. Andral [2]
[1] IFREMER, DYNECO-PHYSED, Brest, France - benedicte.thouvenin@ifremer.fr
[2] IFREMER, LER PAC, France
[3] IRSN/PRP-ENV, Saint Paul Les Durance, France
[4] IFREMER, Brest, France
[5] IFREMER, BE, Nantes, France
[6] USTV, PROTEE, Toulon, France
[7] MIO, Marseille, France

Abstract
Large coastal cities are a significant source of marine pollution in the Mediterranean Sea. Metals and organics are brought to the marine environment through the sewage system and the surrounding catchments. Based on measurements of contaminants concentration in urban rivers and city outflows, a hydrosedimentary model of the bay of Marseilles was applied to study the transport of dissolved and particulate contaminants, their dilution and potential accumulation area for several circulation pattern and weather conditions. Examples are shown for Lead and CB153. This work is part of the METROC, MASSILIA, MERMEX and PERSEUS projects.

Keywords: Coastal models, Metals, Pcb, Pollution, Gulf of Lyon

Studies dealing with monitoring networks [1] and process studies [2] showed environmental disturbances in the coastal zone of the Mediterranean Sea by ecosystem damage, chemical contamination or ecotoxicological effects. The Mediterranean marine system differs from the Atlantic system in its impulsive behaviour triggered by meteorological events. Indeed, events like wind and rain drive both the coastal circulation and the particulate flow.

Inputs from big Mediterranean cities contribute to coastal contamination through urban wastes and leaching of coastal catchment. In the framework of the IFREMER METROC project, a team aimed to assess chemical contaminant raw inputs (from city to sea) and exports (from midsea to open sea) in the bay of Marseilles, a city whose geomorphology and density of contaminant-generating industries is highly representative of large modern Mediterranean cities. A modelling strategy was therefore developed. The hydrodynamical and hydrosedimentary MARS3D model [3,4] coupled to the WW3 wave model were applied to the area of Marseilles to assess the dispersion of chemicals. The potential area of contaminants' accumulation in sediments and their export to the open sea were further studied depending on the meteorological conditions.
The model takes into account the various forcing and hydrodynamical processes (wind, general circulation, waves, vertical mixing, surface heating) as well as hydrosedimentary processes (advection of particles, deposit, resuspension). Inputs from the city have been previously studied [5] and were used to simulate the urban discharges from small rivers and outflows. Sea measurements were used to calibrate and validate the hydrodynamics and the particulate transport reproduced by the model.

In a first approach, the model was applied to reproduce the dynamics of conservative dissolved substances in order to compute residence times and dilution rates encountered in the area during a long period. Floods are totally evacuated from the bay of Marseilles in a few days (<1 to 11 days depending on the flood and meteorological situation). The area of influence for each discharge source is described through its dilution rate.
The model was then applied to particulate substances : local accumulation or export depend on the kind of particles associated with contaminants, and on the discharge. An application to a metal contaminant (Lead) is shown in Figure 1 and the influence of each input (waste water treatment plant, coastal river, storm-water drains, atmospherical input) was investigated. An application to CB153 was also performed in the framework of the MASSILIA EC2CO project [6]. The CB 153 model simulates processes of adsorption/desorption and volatilisation, using results of DOC and detrital and algal POC from the coupled biogeochemistry model ECO3M-MASSILIA.
From this study, the bay of Marseilles appears as a transit area and not as a storage area even if non negligible deposits are found in the northern and southern part of the bay and off the Cortiou outflow. Deposits are more important in the case of contaminants being hydrophobic, less desorbable and associated with high fall velocity particles.

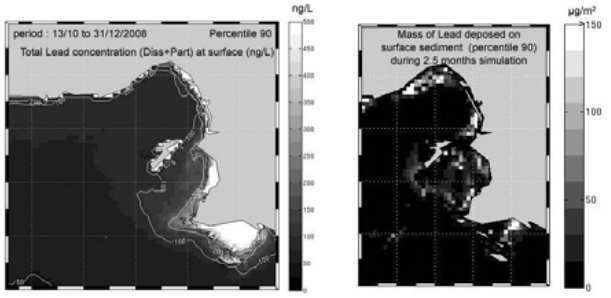

Fig. 1. **Map of total Lead concentration (dissolved plus particulate) at the water surface in the bay of Marseilles, percentile 90 (left panel) and map of lead deposal (µg/m2 - percentile 90) at the surface sediment (right panel) during the period October- December2008.**

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ETUDE SAISONNIÈRE DES CONTENUS EN PCBS ET EN ISOTOPES STABLES (C13, N15) DU PLANCTON DE LA BAIE DE MARSEILLE (SEPTEMBRE 2010 - OCTOBRE 2011)

M. Tiano [1]*, J. Tronczynski [2], C. Tixier [2], M. Harmelin-Vivien [1] and F. Carlotti [1]
[1] Mediterranean Institute of Oceanography (MIO) Université d'Aix-Marseille 13288, Marseille, Cedex 09, France Université du Sud Toulon-Var, MIO, 83957, La Garde cedex, France ; CNRS/INSU, MIO UMR 7294; IRD, MIO UMR235. - marion.tiano@univ-amu.fr
[2] IFREMER / Département Biogéochimie et Ecotoxicologie/ Laboratoires LBCO, 43311 Nantes, Cedex

Abstract
L'objectif de cette étude est d'appréhender les facteurs qui influencent la contamination du réseau planctonique proche d'une grande métropole. Des échantillons de plancton ont été récoltés dans la baie de Marseille à sept dates entre septembre 2010 et octobre 2011 Les résultats montrent l'importance des conditions météorologiques (fort mistral ou forte précipitation) des jours précédant l'échantillonnage sur les teneurs observées.

Keywords: Pcb, North-Western Mediterranean, Plankton, Bio-accumulation

Introduction
Le milieu marin méditerranéen est soumis à de fortes contaminations organiques et métalliques. . Cette étude présente une évolution temporelle de la contamination en PCBs du plancton et identifie les facteurs environnementaux qui favorise les teneurs observées de contamination en PCBs du réseau planctonique de la baie de Marseille, soumise à de forts rejets de polluants attribuables principalement aux activités domestiques et industrielles.

Matériels et Méthodes
Des échantillons de plancton ont été récoltés à l'aide de coups de filets (60µm) horizontaux au maximum de chlorophylle dans la baie de Marseille à sept dates (septembre, novembre, et décembre 2010 et janvier, avril, juin et octobre 2010). Plusieurs paramètres ont été mesurés sur différentes classes de taille (60-200, 200-500, 500-1000 et 1000-2000µm) : pigments chlorophylliens, contenu en isotopes stables du carbone et de l'azote et concentration de 7 congénères des PCBs (CB 18, CB 52, CB 101, CB 118, CB 138, CB 153, CB 180).

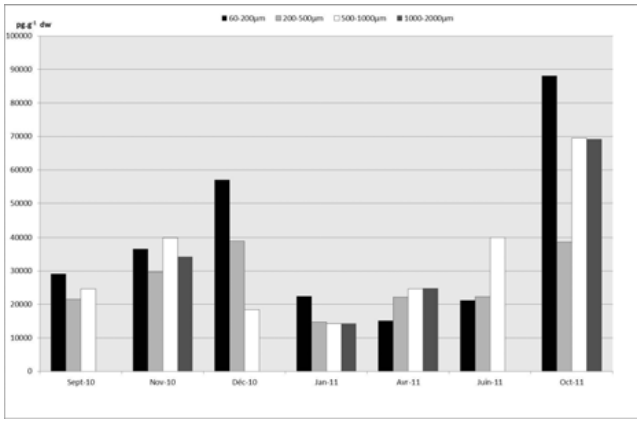

Fig. 1. Somme des concentrations de 7 PCBs (CB28, CB52, CB101, CB118, CB138, CB153, CB180) pour chaque classe de taille à chaque date d'échantillonnage.

Résultats
L'évolution saisonnière des contenus en PCBs (figure 1) et en isotopes stables (^{13}C, ^{15}N) dans les différentes fractions de taille du zoo de la baie de Marseille (septembre 2010 - octobre 2011) seront présentées et analysées. Une analyse de covariance (ANCOVA) à plusieurs facteurs : la force du vent (modérée ou faible), les précipitations, le débit de l'Huveaune, les classes de taille du plancton, et la concentration en chlorophylle a été réalisé pour chaque variables : concentration en PCBs, les ratios des isotopes stables du carbone et de l'azote (tableau 1).

Tab. 1. Résultat des analyses de covariances (ANCOVA) sur la concentration en PCB, δ13C et δ15N des différents facteurs environnementaux : saison, force du vent, débit de l'Huveaune et les précipitations, et facteurs biologique : classe de taille et concentration en chlorophylle. En gras les valeurs significatives.

Facteur	PCB		$\delta^{13}C$		$\delta^{15}N$	
	F	P	F	P	F	P
Saison	5.65	**0.015**	52.41	**<0.001**	1.21	0.325
Vent	14.64	**0.002**	12.19	**0.003**	47.76	**<0.001**
Taille	0.31	0.817	0.67	0.585	1.59	0.234
Débit Huveaune	0.14	0.718	0.80	0.386	16.74	**0.001**
Chlorophylle	0.13	0.723	9.14	**0.009**	0.31	0.586
Précipitation	8.15	**0.012**	3.22	0.093	26.96	**<0.001**

Discussion
Le plancton, premier maillon du réseau trophique, semble être très impacté par les facteurs environnementaux tels que le vent que par l'effet de la bioamplification liée aux interactions trophiques. Les fortes teneurs en contaminants observées après un fort Le Mistral, s'explique par la remise en suspension des sédiments fortement contaminés de la rade nord [1]. Cela est confirmé par les teneurs en δ13C et δ15N des mêmes échantillons présentant une signature proche de celle des sédiments chargé en détritus de Posidonia oceanica [2]. Cette contamination pourrait provenir du transport par le courant sud de la baie de matière du bassin septentrional vers le lieu d'échantillonnage, comme observé par Castelbon [3].

Remerciement
Nous remercions l'aide financière apportée par l' ANR COSTAS (N° 2009 CESA 007 002) et l'aide des équipes de l'Antédon 2 et de l'Europe R/V.

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FINGER PRINT ANALYSIS OF PETROLEUM HYDROCARBONS AND THEIR DERIVATIVES FOR THE IDENTIFICATION OF ILLEGAL DISCHARGES: CASE STUDY TURKISH COASTS

Fatma Telli karkoç [1], Hakan Atabay [1], Leyla G. Tolun [1]* and Ersan Kuzyaka [1]
[1] TUBITAK MAM ENVIRONMENT INS - leyla.tolun@tubitak.gov.tr

Abstract
An increasing traffic of over 55,000 ships a year in Turkish seas are producing an average of 12 illegal oil spills a year. Fingerprint analysis is initiated by comparison of fluorometric spectra of polluted sea water sample and suspected source sample. 'Matching' is confirmed or rejected by subsequent comparison of FTIR, HPLC and GC-FID. In this study, 39 clean sea waters, 41 polluted sea waters and 111 suspected samples were analysed. 76 suspected samples were spectrofluorometrically analysed and categorised as "*Non-match*". Finally, 28 suspected samples were classified as a "Match".

Keywords: Petroleum, Marmara Sea, Pollution

Introduction
Oil is the black blood that runs through the veins of the modern global energy system (Höök, 2009). Oil spills discharges could be "mystery spills" or "known-source spills" (Stout. and Wang, 2007). Normally, determination of the mysterious spill method is based on direct comparison of matching peaks among chromatograms/spectra. The aim of this paper is to identification of the spilled oil pollution source coming from illegal discharges.

Material and Method
Clean sea water, polluted sea water and suspected vessel samples were analysed according to the fingerprint procedures explained in ASTM methods (ASTM, 2011a; ASTM 2011b; ASTM 2006; ASTM, 1996). For each occasion/event, at least three samples were taken from clean water (sea/fresh) as a reference site, polluted waters from polluted site and samples from different tanks/section of suspected sources like sludge, bilge, slope, bunker tanks etc. Collecting samples were scan by using synchronous spektrofluorometer between 200-600 nm. Samples scan patterns were compared between polluted sample and suspected sample. If polluted sample and suspected samples pattern were similar than further analysis were done by using, HPLC, GC-FID and FT-IR methods.

Results and Discussion
For present study, samples were collected from 38 illegal discharges events from Turkish Coasts. 39 clean sea water, 41 polluted sea water and 111 suspected samples were analysed (Table 1). 76 samples of them were syn-spektrofluorometrically analysed and polluted samples spectral results were not similar with suspected samples. They were classified as "*Non-match*", so there were no need for further analysis (Table 1). Other 35 suspected sample were classified as "*Match or Probable Match*", and they were required further analysed by using other methods such as FT-IR, HPLC and GC-FID. Finally, 28 samples were classified as a "Match" .

Case 1; Non match: Samples were compared for the similarities and analysis was started with syn-spectrofluoromety. (Figure 1). Figure 1 showed that polluted samples and suspicious sample were completely different each other (Non-match) and clean sea water spectrum was also behaving differently.
Case 2; Match: In second case, since, syn-spectrofluorometric results were matched with either polluted sample or suspicious samples, finger printing analysis should be continued with other methods by using HPLC, FT-IR and GC-FID

Conclusion
Finger print analysis is a qualitative method and consists of four different methods were used for the comparison of the chromatogram/spectra. In addition to this, expert judgement is another important step for the assessment of the results. Although, achieve the highest success rate in terms of the correct result, sometimes, specific cases, the finger print method could not show one source or sometimes shows more than one sources. If the source sample and polluted sample outputs were not the same, finger print analysis were ended and legal proceedings were completed in a short time.

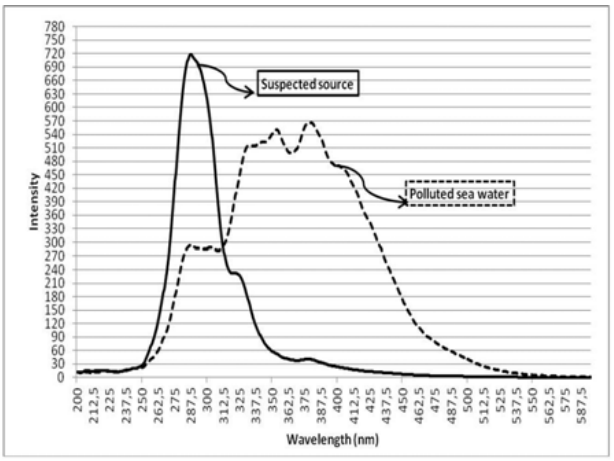

Fig. 1. Comparison of the Synchronous Spectrofluorometer spectra results among clean sea water, polluted sea water and suspected sample (- suspected soures; -clean sea water; -:polluted sea water)

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DISTRIBUTION OF PHTHALATE ACID ESTERS (PAE_S) IN SURFACE SEDIMENTS FROM THE SEA OF MARMARA, TURKEY

Selma Ünlü [1]*, Bedri Alpar [1] and Hülya Özaltin Günday [1]
[1] Istanbul University Institute of Marine Sciences - su@istanbul.edu.tr

Abstract
Surface sediments from 35 sampling sites of the Sea of Marmara were analyzed for 6 phthalate acid esters (PAEs), namely diethyl phthalate (DEP), dimethyl phthalate (DMP) di-n-butyl phthalate (DBP), benzylbutyl phthalate (BBP), di-(2-ethylhexyl) phthalate (DEHP) and di-n-octylphthalate (DnOP). In all samples, concentrations of the DBP and DEHP were found to be higher than the other four PAEs. DBP and DEHP concentrations in sediment samples ranged from <MDL to 1.18 µg/g dry weight (dw), and 0.01 to 4.52µg/g dw, respectively. The analytical results showed a direct relation of PAEs levels with the input of urban and industrial treated waste waters near the sampling point. As compared to the results from other studies, the Sea of Marmara exhibited relatively low pollution by the PAEs.

Keywords: Pollution, Plastics, Sediments, Marmara Sea

Introduction

Phthalate acid esters (PAEs) are widely used as non-reactive additives in plastics, particularly polyvinyl chloride, but also in rubber, cellulose and styrene production, to improve their softness and flexibility. The global production is approximately 6.0 million tones [1]. As PAEs do not chemically bind in the polymeric matrix, they can enter the environment directly and/or indirectly, during the production of plastic and plastic material or after disposal. Because of the large and widespread application, PAEs are ubiquitous in the environment and have been widely detected in air, water, soil and sediment. Since some phthalate esters have low water solubility and high octanol partition coefficient, they can become concentrated in suspended matter and sediment. In the 1980s, only six phthalates (DMP, DEP, DBP, BBP, DnOP and DEHP) have been classified as priority pollutants by the US Environmental Protection Agency (EPA). The main objectives of the present study are to investigate the PAEs concentrations in the sediments from the Sea of Marmara and discussing their possible sources and ecological effects.

Material and Method

The sediments were taken from 35 stations by using a grab sampler on board of R/V ARAR in December 2010. The sampling depths vary between 11 and 150 m. The samples (0-5 cm depth) were collected using a pre-cleaned stainless steel scoop into pre-cleaned aluminium foil envelopes. Then they were stored in a freezer at -20°C until analysis.The methods used in this study have been described in detail [2] and will only be summarized here. Extraction of samples with a Soxhlet apparatus and analyses by a Gas Chromatography/Mass Spectrometry (GC/MS, Finnigan (Thermo) Trace DSQ) were given in detail by Zeng [2]. Background contamination due to various sources in the laboratory constituted a major problem, which was controlled by performing blank analysis with each sample series. All solvents were tested regularly for PAE contaminations. Only glass, teflon and stainless steel were used. All hardware was cleaned with tap water, distilled water and acetonitrile, then stored at 150°C and rinsed with hexane before use. A mixture of six PAEs, including DEP, DMP, DBP, BBP, DEHP and DOP were obtained from Dr. Ehrenstorfer GmbH Inc. (Germany). For the six PAEs standards, the recoveries of spiked blanks (n=3) varied from 78.2 to 108.2% (relative standard deviations <12.7). The organic carbon content of sediment samples were measured by a Carlo Erba NC2500 model CHN analyzer after removing the inorganic carbonate fractions.

Results and Discussion

The $\sum_6$PAEs concentrations ranged from ND to 5.7µg/g-dw, with the median concentration of 0.9µg/g-dw of the 6 PAEs, DEHP and DBP dominated the PAEs, with the maximum concentrations of 1.18 and 4.52µg/g-dw respectively, and accounted for 37 and 59% of the $\sum_6$PAEs concentrations. It has been reported that DBP and DEHP are the most commonly used plasticizers worldwide [3]. The concentrations of PAEs in sediments were substantially lower than most reported in other locations over the world [e.g. 2, 4, 5]. The statistical analyses indicated that ∑PAEs concentrations, especially DEHP concentrations, had a significant positive relationship with TOC in the sediments. The correlation coefficients were 0.72 ($p<0.01$) for total PAEs concentrations, and 0.76 ($p<0.01$) for DEHP. Based on the ecotoxicology and environmental chemistry of DnBP and DEHP, median concentrations of DnBP (0.30 µg/g) and DEHP(0.52 µg/g) measured in sediments of the Sea of Marmara; which were lower 2.5 and 2 times than the ERLs of 0.7µg/g and 1µg/g, respectively [6]. As no data were available representing the past levels of PAEs in the study area no conclusion can be made concerning temporal changes in PAEs levels in the sediments of the Sea of Marmara. These results can be used as reference levels for future monitoring programs of pollution from PAEs.

Acknowledgment: This study was financially supported by the Research Fund of Istanbul University (Project No: 15387).

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COMPARATIVE STUDY OF HEAVY METALS AND SELENIUM ACCUMULATION IN THE DIGESTIVE GLAND AND GILLS OF *M. GALLOPROVINCIALIS* (LAMARCK 1819) CAUGHT IN IZMIR BAY TURKEY.

Selma Katalay [1], Murat Yabanli [2], Aykut Yozukmaz [2]* and Burak E. Inanan [3]
[1] Deparment of Biology, Faculty of Science and Art, Celal Bayar University, Muradiye, Turkey
[2] Faculty of Fisheries, Mugla University, Kotekli 48000, Turkey - aykutyoz@gmail.com
[3] Department of Biology, Faculty of Science, Mugla University, Kotekli 48000, Turkey

Abstract
The aim of this study was to evaluate heavy metal (Cr, Fe, Ni, Cu, Zn, As, Cd, Hg, Pb) and selenium levels in digestive gland and gill tissues of wild Mediterranean mussel *Mytilus galloprovincialis* (Lamarck, 1819) collected from Izmir Bay. The highest values (mg kg^{-1} dry weight) of these metals for digestive gland and gills were revealed. Statistically significant differences ($p<0.05$) between digestive gland and gills were found for Cr, Ni, Zn, As, Se and Cd. The low levels of toxic metals (Cd, Hg, Pb, Cr, Ni) found in tissues of *M. galloprovincialis*, comparing with the other studies including taken place in the Inner of Izmir Bay. *M. galloprovincialis* can be used as a sensitive biomonitor for the availabilities of studied elements in the Inner Bay of Izmir, Turkey.

Keywords: Bio-accumulation, Izmir Bay, Metals, Bivalves

Introduction
Mussels are sedentary organisms filtrating large amounts of water allowing them to accumulate the substances from the environment. This characteristic makes it possible to use them as "bioindicators" in an aquatic environment. *M. galloprovincialis* is a very sensitive 'early warning' tool for heavy metals contamination of a marine environment [1, 2, 3]. The aim of this study was to quantify and compare heavy metals and selenium in digestive glands and gill tissues of *M. galloprovincialis* caught four locations in Izmir Bay.

Material and Method
Izmir Bay is located in the eastern Aegean Sea between latitudes of 38°20' and 38°42' N and longitudes of 29°25' - 27°10' E. A total of 180 samples of the wild mussel *M. galloprovincialis* with shell length of 50-60 mm were collected from four locations in the Izmir Bay in early spring 2010 (Fig. 1). Drying and digestion processes of the samples were carried out with the procedure used by Licata et al., (2004) [3]. Inductively coupled plasma-mass spectroscopy (ICP-MS) was used to determine heavy metals in mussel samples. Statistics were performed using SPSS software version 15.0. The data obtained by the values of studied elements were subjected to one-way analysis of variance (ANOVA) followed by *post-hoc* test analyses based on the Tukey test.

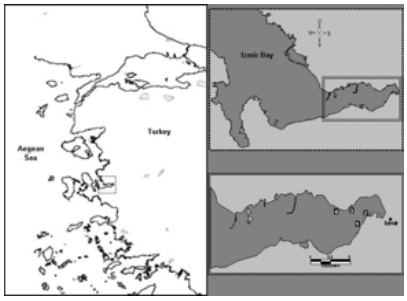

Fig. 1. The study area and sampling stations (1: Pasaport, 2: Alsancak, 3: Karsiyaka, 4: Bostanli).

Results and Discussion
Fe has the highest concentrations both in the gill and digestive gland while Cd and Hg have the lowest values. Generally, content of concentrations in the digestive gland were lower than concentrations in the gill. The magnitude of element concentrations in digestive gland was determined as Fe>Zn>Cu>As>Se>Ni>Cr>Pb>Cd>Hg. The data obtained showed that accumulated metal concentrations in gills in the following sequences: Fe>Zn>As>Cu>Se>Ni>Cr>Pb>Cd≈Hg. Considering all data, there is a statistically positive significant correlation between Cu-Pb, Ni-Cd, Se-Cd, Ni-Se, Fe-Cu, Cr-Cd, Ni-Cu, Ni-Pb, Fe-Ni, Cr-Se, Zn-Pb, Zn-Cd, and Zn-Se (from higher to lesser), while negative relationships were found As-Se, Ni-Hg, Fe-Hg, Zn-Hg, Ni-As, Cu-Hg, As-Cd, and Hg-Pb. Especially, Hg and Ag showed negative relationships with the other heavy metals and Se. Among the correlations of measured elements in gill, the correlations between Ni-Cu, Cu-Pb, Ni-Pb, Fe-As were significant. In the same tissue, the negative significant relationships between Cr-Cu, Cr-Ni, Cr-Pb, Ni-Hg, Fe-Hg were found. The significant correlations between Fe-Cu, Fe-Ni, Cu-Pb, Ni-Cu, Zn-Pb, Zn-Cd, Cu-Zn, Cd-Pb, Cu-Cd, Cr-Pb, Ni-Zn, Cr-Cu, Fe-Zn, Fe-Pb, Ni-Cd, Ni-Pb, Cr-Cd, Fe-Cd, Cr-Ni, Cr-Fe, Cu-Se, Se-Pb, Ni-Se, Fe-Se, Cr-Zn, Zn-Se were determined in the digestive gland, while Hg showed the strongly negative relationships with Cu, Fe, Ni, Zn, Pb, Cd, Cr, Se. Among the three correlation matrices, the correlation matrix obtained from the digestive gland has stronger and significant relationships relatively. According to ANOVA, there were no statistical significant differences between the studied tissues in terms of Fe, Cu and Hg but Cr, Ni, Zn, As, Se, Cd, Pb. The results of ANOVA also indicated that the significant differences weren't found among sampling stations in terms of Cr, As, Se, Cd. However, the other elements have shown significant differences in the stations. Tukey *post-hoc* analysis separated station 1 and 3 in terms of these elements. Also, no significant differences were found between station 1 and 2, except for Zn. Finally, in comparison to data reported in other studies, our findings for in *M. galloprovincialis* indicated that most of the data were lower in the literature.

Conclusions
As a conclusion, with a detailed statistical analysis we obtained following results; •*M. galloprovincialis* samples collected from different locations have significantly different heavy metal concentrations. •Gills had higher concentrations for Cr, Fe, Ni, Zn, Cd, Pb, and Se compared to digestive gland. •Fe and Zn contents are high both digestive gland and gills at all sites. •Se shown a significant negative correlation with Hg, and a weak negative correlation with As but the other measured heavy metals. •The low levels of toxic metals (Cd, Hg, Pb, Cr, Ni) found in tissues of *M. galloprovincialis*, despite urbanization and vessel traffic in the Izmir Bay, comparing with the other studies done in the Inner of Izmir Bay. This situation might be a consequence of waste water treatment activities during the last decade in the bay.

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Session

Remote sensing

Modérateur : **Patrick Bonhomme**

THE CALYPSO HF RADAR DATA INTERFACE

Joel Azzopardi [1]*, Raisa Tarasova [1], Adam P. Gauci [1] and Aldo Drago [1]
[1] Physical Oceanography Unit, University of Malta - joel.azzopardi@um.edu.mt

Abstract

Within the ambit of the CALYPSO project, a network of HF-radars with installations on the northern coast of the Maltese Islands, and on the southern Sicilian coast is intended to provide real-time sea surface currents in the Malta Channel. This paper describes the web interface developed to provide users with viewing, selection and downloading of the measured data. Value-added services targeting the general public as well as specialised professional users provide a means to maximise benefits through the use of the data for different applications.

Keywords: Remote sensing, Currents, Malta Channel

The HF radar network set up within the CALYPSO project [1] provides synoptic maps of currents in real-time every hour and with a high resolution and coverage in space. It consists of multiple radars at different locations and with an overlapping beam pattern; the same patch of water can be viewed from different angles, and the surface current radial velocity components can be summed to determine the total surface current velocity vector. Data measured simultaneously at the different points can be combined to produce hourly maps of current vectors within a regular grid.

The real-time data produced by the HF-radar network is of interest not only to researchers but is also useful to national authorities during the undertaking of crucial activities such as Search-and-Rescue and Oil Spill Response. However, such users would require the data to be in an enhanced format that is readable and understandable to them and their systems. For this reason the CALYPSO web data interface was developed to provide such users with the required value-added services derived from the original data gathered by the radars.

The data interface is composed of two main sections, namely: the Public Interface – targeting the public users by showing plots and statistics over nine different sub-regions in the Malta Channel; and the Professional Interface – targeting the professional users by the presentation of quick-view plots, and allowing the download of data, and the handling of special data requests.

The products available on the CALYPSO Data Interface are derived from nowcast sea surface currents data generated by the HF-radar system, and forecast currents data generated by the ROSARIO-6420 [2] Malta shelf forecast. The domain of data coverage has a spatial resolution of 0.03° (approx. 3Km) in the case of the observation nowcasts, and 0.0163° (approx. 1.6 Km) for the forecast fields. Data is provided with a temporal resolution of 1 hour.

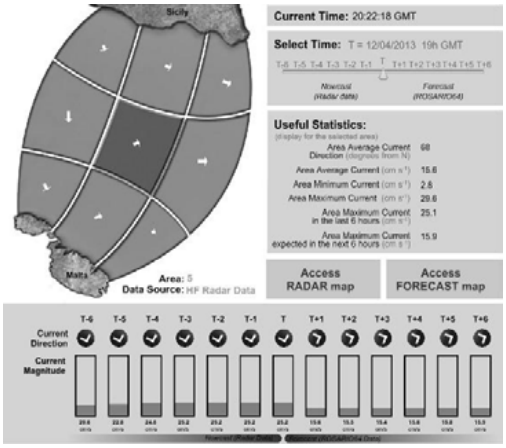

Fig. 1. A screen-shot of the Calypso Public Data Interface

The Public Data Interface synthesises the hourly data fields by spatial averaging over 9 sub-regions and presenting the information on sea surface currents averaged for each sub-region for a time span of 13 hours, namely: the present hour conditions; the previous 6 hours generated from HF radar observations; and the next 6 hours generated by ROSARIO 6420 forecast. The information displayed for each selected sub-region includes: the average current magnitude and direction in that sub region; the maximum and minimum current magnitude; the maximum current magnitude over the last 6 hours; and the maximum current magnitude expected in the coming 6 hours.

The Calypso Professional Data Interface consists of four main components. It allows the viewing and downloading of data for the entire domain. The user selects the date and time of interest, and is presented with an image of the currents for the selected date-time, along with the necessary links to download the data in ASCII or in NetCDF formats. The user can also submit a request to aggregate the data over a period of interest. The system performs the required aggregation and 'pushes' the user-selected aggregated dataset in the pre-selected format. The user can alternatively select a point and period of interest, and the system prepares a time series of the sea surface currents hourly data at the selected geographical location and time span; apart from the data time series, the system also presents the user with an interactive plot of the time series using Google Charts [3]. The user has also the option to select an area of interest, and the system outputs to the user time series of the mean, minimum and maximum currents within the selected area. The online interface further allows the user to submit a special data request; the user requests an area and period of interest, and the system returns a pdf report describing the evolving sea surface circulation conditions. This reporting function is especially relevant for oil spill emergencies where such a report can then be uploaded to the European CECIS Emergency Response system [4] in case of an oil spill emergency.

Acknowledgements:
This work was accomplished within the CALYPSO project partly financed by the EU under the Operational Programme Italia-Malta 2007-2013, and co-ordinated by Prof. Aldo Drago from the Physical Oceanography Unit of the IOI-Malta Operational Centre of the University of Malta.

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A METHOD FOR ASSESSING ANCHORING PRESSURE

P. Bonhomme [1]*, D. Bonhomme [1], N. Frachon [1], C. F. Boudouresque [2], S. Borocco [1], R. Bricout [1], T. Schohn [1], M. Imbert [3] and S. Ruitton [2]

[1] GIS Posidonie, Groupement d'Intérêt Scientifique pour l'Etude de l'Environnement Marin, Aix-Marseille University, Campus Universitaire de Luminy, Case 901, 13288 Marseille Cedex 09, France - patrick.bonhomme@univ-amu.fr

[2] Aix-Marseille University, Mediterranean Institute of Océanography (MIO), Université du Sud Toulon-Var, CNRS/INSU, IRD, UM 110, Campus Universitaire de Luminy, Case 901, 13288 Marseille Cedex 09, France

[3] CEN PACA / Parc Maritime des Îles du Frioul, Sémaphore de Pomègues, Le Frioul, 13001 Marseille, France

Abstract

A new method for assessing anchoring pressure is proposed. It is based upon an automatic high frequency digital photography (AP-AP system). The autonomous equipment is working from sunset to sunrise.

Keywords: Posidonia, North-Western Mediterranean, Monitoring, Mapping, Marine parks

Introduction

Leisure boating is an activity in the increase in the Mediterranean. Anchoring of boats on e.g. *Posidonia ocenica* meadows and the coralligenous assemblages is a source of bottom degradation and an issue of growing concern [1, 2]. Up until now, leisure boat frequentation, anchoring and carrying capacity were tackled on the basis of inaccurate data, e.g. a few aerial photographs and boat counts. Within the framework of the research program 'Liteau III FHUVEL', the anchoring pressure issue was addressed through automatic high frequency digital photography (AP-AP System: Anchoring Pressure by Automatic Photography).

Material and methods

The method was successfully implemented in Sormiou and Frioul-Crine Coves, two sites of the recently established 'Parc national des Calanques' (Calanques National Park, Marseille-Cassis, Provence, France), during respectively 19 months and 7 months.

The camera was installed in a waterproof shelter, 200 m and 60 m respectively, above the sea level, depending on the site and programmed to take a picture every 10 min from sunrise to sunset (Figure 1).

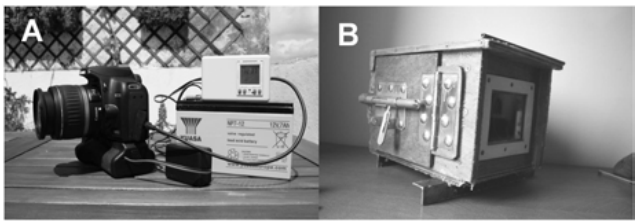

Fig. 1. AP-AP system: A - Camera with electronic dispositive; B - protective case.

The battery and memory card of the camera ensured an autonomy of 15 to 21 days. Photos, which were taken at an oblique angle, were transformed to a vertical format (Figure 2), in order to match the maps, using a set of 150 GPS marks. Spatial data analysis was performed under GIS Arc View 10.2®. The exact anchoring location of every boat, every day, every 10-min, was manually geo-referenced.

Photo analysis makes it possible to assess the pressure location within the site, the time of arrival, the departure and the anchoring duration, the day of the week (weekday vs weekend), the month, the boat category (e.g. sailing boat, motor boat) and the weather.

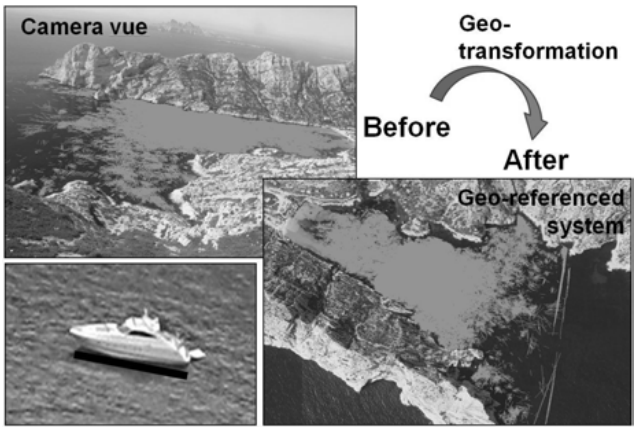

Fig. 2. Geo-transformation of identified anchored boats from the camera vue to a georeferenced system. The gray area is the enveloppe area of the position of boats every 10 min, over the study period. In the vignette, the black line plotted from the prow to the stern of the boat allows to get the size and the orientation of the boat.

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PLEASURE BOAT ANCHORING PRESSURE IN A PROVENCE COVE

N. Frachon [1], P. Bonhomme [1]*, C. F. Boudouresque [2], D. Bonhomme [1], D. Nerini [2], L. Le Mire Pecheux [3], P. Astruch [1], E. Rouanet [1], A. Accornero-Picon [3] and M. Harmelin-Vivien [2]

[1] GIS Posidonie, Groupement d'Intérêt Scientifique pour l'Etude de l'Environnement Marin, Aix-Marseille University, Campus Universitaire de Luminy, Case 901, 13288 Marseille Cedex 09, France - patrick.bonhomme@univ-amu.fr

[2] Aix-Marseille University, Mediterranean Institute of Océanography (MIO), Université du Sud Toulon-Var, CNRS/INSU, IRD, UM 110, Campus Universitaire de Luminy, Case 901, 13288 Marseille Cedex 09, France

[3] Parc national des Calanques, Bât A4 Parc Valad, Impasse Paradou, 13009 Marseille, France

Abstract

Anchoring pressure was precisely evaluated with the AP-AP system in Sormiou Cove (Provence, France, NW Mediterranean Sea). The image analysis (30 000 pictures) under GIS allowed to georeference anchored boat position and determinate the anchoring density per hectare and per day, during an annual cycle.

Keywords: Posidonia, North-Western Mediterranean, Monitoring, Mapping, Marine parks

Introduction

Ecological importance of *Posidonia oceanica* meadows makes their decline particularly worrying [1]. The regression of *P. oceanica* meadows in the NW Mediterranean is therefore an issue of growing concern. A variety of human activities threaten *P. oceanica* meadows, e.g. pollution, water turbidity, trawling, invasive species and anchoring. Beyond a given level of anchoring pressure (number per hectare, frequency), the rhizome growth cannot compensate for shoot and rhizome losses. Breaks then develop within the matte. The anchoring pressure was assessed by the AP-AP system (Anchoring Pressure by Automatic Photography) developed during the research program 'Liteau III FHUVEL' [2]. The goal was to compare spatialized maps of the anchoring pressure and of the status of the *P. oceanica* meadow.

Material and methods

The study site was Sormiou Cove, a popular site for leisure boating and anchoring, mostly covered by *P. oceanica* [3], close to the city of Marseilles. Sormiou Cove is included within the recently established 'Parc national des Calanques'. 30 000 pictures taken by the AP-AP system (May 2010 through April 2011) were georeferenced under GIS.

Results and discussion

During the one-year study period, 5 920 boats anchored over the 25.5-ha surface area where anchoring is authorized. Anchoring occurred mostly (95%) during the high season (May through September). The highest recorded daily frequentation was 255 boats (July 11th) while the highest recorded simultaneous frequentation was 101 boats (August 22nd, 15:14). Sailing boats constituted the dominant category (44%), followed by motor boats less than 10 m long (30%), with conspicuous fluctuations according to the day of the week, the month and the wind strength (Figure 1).

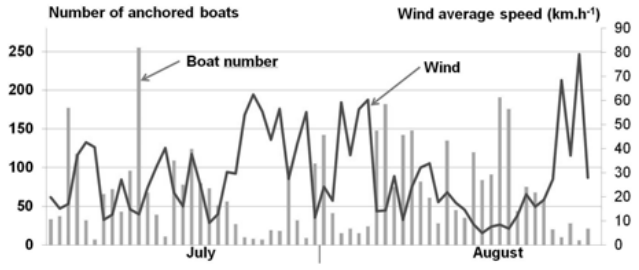

Fig. 1. Number of anchored boats per day according to wind strength (July and August 2010).

The anchoring process began at 9:00 and peaked from 12:00 to 14:00. The mean duration of the stay at anchor was 6 h 18 min, the record being 9 days. The sailing boats were concentrated in the centre of the cove, close to the line of marker buoys delimiting the area of unauthorized anchoring. The highest local density of anchored boats was observed in the centre of the cove, 6 boats/ha/d (annual average) and 22 boats/ha/d (August average) (Figure 2).

The thresholds of maximum sustainable anchoring pressure on *P. oceanica* meadows are 2 boats/ha/d (annual average) and 10 boats/ha/d (at peak periods) [4]. Though the validity of these recommendations requires confirmation, it is worth noting that the Sormiou Cove anchoring pressure locally exceeds the above mentioned thresholds (upon 2 ha of meadow). The monitoring of the *P. oceanica* meadow will allow to confirm, to invalidate or to adjust the thresholds proposed by the authors above mentioned.

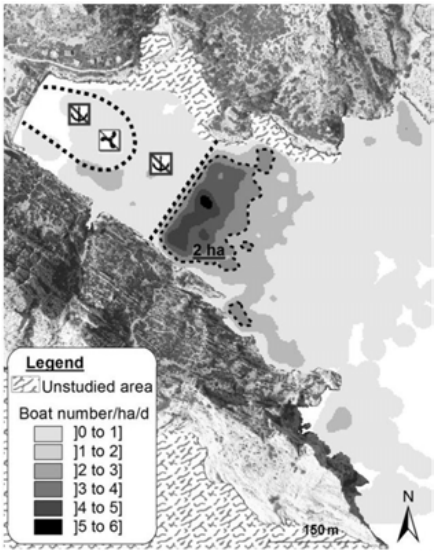

Fig. 2. Anchoring pressure (boat number/ha/d)(May 2010 through April 2011).

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MAPPING NATURAL AND CULTURAL MARINE HERITAGE SITES IN LEROS ISLAND GREECE

M. Geraga [1], E. Katsou [1], D. Christodoulou [1], M. Iatrou [1]*, S. Kordella [1], G. Papatheodorou [1], V. Mentogiannis [2] and K. Kouvas [3]

[1] Laboratory of Marine Geology & Physical Oceanography, University of Patras, Greece - oceanus@upatras.gr
[2] UFR-TEAM, Athens, Greece
[3] Hydrovius Dive Center, Leros, Greece

Abstract

Mapping of natural and cultural marine heritage sites is substantial to national and regional inventories aiming to conservation and protection and the management of coastal and offshore resources. Within this concept this study presents the results of a marine geophysical survey in conjunction with visual inspection, conducted at Leros Island, Greece. The acquired data designated wrecks of the World War II (WW II) and mapped in detail the marine protected habitats of the studied area.

Keywords: Aegean Sea, Coastal management, Posidonia, Remote sensing

Introduction

The battle of Leros island, located in the south-eastern Aegean Sea marked the history of the island during the second world war [1]. The island was occupied by British forces since 15th September 1943, after the surrender of Italy on 8 September 1943. The location of the island and the coastal geomorphology revealed Leros as strategically vital for Allied and German forces. The battle began with German air attacks on 26 September. All forces involved suffered heavy casualties during the battle which lasted 52 days and ended with the capitulation of the Allied forces. Today wrecks lay on the seabed keeping the memory of that battle. Furthermore, the island of Leros hosts ecosystems which are of great importance in marine environments. A marine remote sensing survey was carried out in the coastal zone (up to depth of 100m) of Leros Island between 10 and 18 June 2011. The objective of this survey was twofold: (i) to map *P. oceanica* meadows and coralligene formations and (ii) to detect and identify targets which are probably related to Leros Battle during the WW II.

Methods and Results

The remote sensing survey of Leros Island was organized into two phases. First a systematic survey of the sea floor was carried out using side-scan sonar. The second phase consisted of visual inspection based on the results of the first phase. This methodological approach provides a cost-effective tool to rapidly survey areas of ecological and historical interest [2,3]. A total area of 54.1 km^2 around the island insonified by a side scan sonar system consisting of a dual frequency (100 and 500 kHz) towfish 272TD, following standard methods for relative studies [2,3]. Visual inspection and confirmation of sites of interest achieved by dropping and towing of digital camera and scuba diving by experts. All the acquired data were imported and georeferenced into the GIS environment (Fig 1).

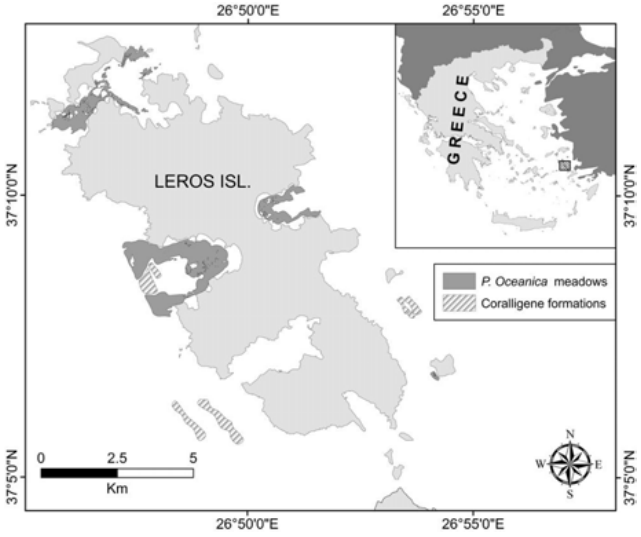

Fig. 1. Map showing the area of the marine protected habitats around Leros island.

The analysis and interpretation of the results showed that a total area of 5.5 km^2 and 1.5 km^2 is covered by prairies of *Posidonia oceanica* and coralligene formations, respectively (Fig. 1).

According to European Union regulations, both of them are included in the list of marine protected habitats. Furthermore the study detected several targets as potential wreck sites. Selective visual inspection among the targets confirmed the existence of debris of two barges (in Lakki and Partheni bays), one landing ship (in Lakki bay), two aircrafts (close to Blefoutis bay and at the entrance of Lakki bay) and anti-submarine nets (in Lakki and Partheni bays). One of the targets was the debris of the flagship *Queen Olga* (Fig. 2).

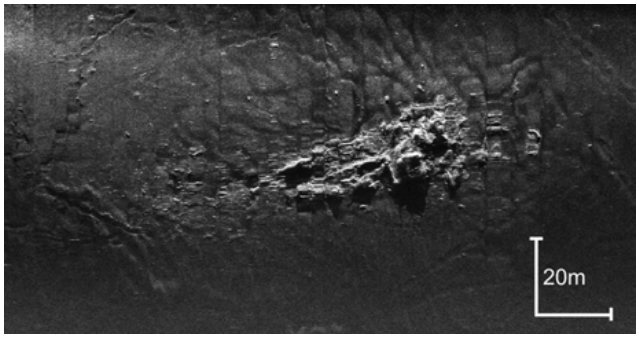

Fig. 2. Sonograph from Lakki Bay, presenting the remains of the flagship *Queen Olga.*

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SIDE-SCAN SONAR MAPPING OF COASTAL SEABED HABITATS. A CASE STUDY ON ROMANIAN SCI NATURA 2000 SITES

V. Lazar [1]*, A. Balahura [1], R. Lazar [1], G. Ungureanu [2], A. Ionescu [1] and V. Nita [3]
[1] SC Marine Research SRL - vlad.lazar@marine-research.ro
[2] University of Bucharest, Faculty of Geology and Geophysics
[3] National Institute for Marine Research and Development "Grigore Antipa", Constanta

Abstract
This paper presents the acoustic image of various types of habitats identified during the scanning performed for seabed habitat mapping, and emphasizes the correlation between the type of habitat, its relation to the sediments on the seafloor, and the corresponding acoustic facies.

Keywords: Black Sea, Acoustics, Instruments and techniques, Swath mapping, Sediments

There are six Natura 2000 sites on the Romanian Black Sea coast. Mapping of seafloor habitats was performed using an IXSEA Elics 400-1250 side-scan sonar, coupled with ground truthing by sampling and diving. Similar approaches were done by [1], [2] and [3].

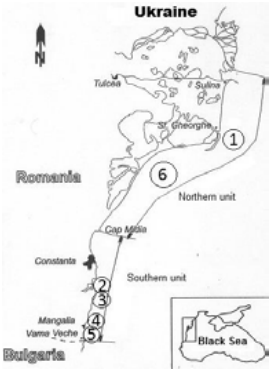

Fig. 1. The Romanian coast with locations of Natura 2000 site: 1- "The submarine metanogenic structures Sf. Gheorghe", 2- "Eforie N-S submerged beach", 3- "Cape Tuzla marine area", 4- "Mangalia submarine sulphurous springs", 5- "Vama Veche- 2 Mai" and 6- "Danube Delta- marine area"

The sonograms were processed and into a mosaic. Seabed classification using backscatter properties was done and helped in the identification of acoustic facies and corresponding sedimentary facies. An exemple is in Figure 2 for Mangalia site. Four main types of habitat were identified, according to the European Commission's Directive [4], divided into subtypes according to their particularities. We have analyzed them and characterized them based on their acoustic features:

Sandbanks which are slightly covered by sea water all the time (1110) are characterized by a relatively intense backscatter and, as the sand grains are smaller than the resolution of the sonograms, they are seen as plain light gray. They show typical sedimentological features such as current ripples. They appear in all Natura 2000 sites.

Reefs (1170). There are two acoustic facies identified that belong to this main type of habitat. The first is represented by mussel beds, Mytilus galloprovincialis reefs, and the second by various types of rocks. The mussel beds show intense backscatter, the sonar facing clams powerfully reflecting the sound. They look like low mounds or blankets of shells on the seafloor, appearing in a linear orientation transverse to the nutrient bearing currents. They appear in the deeper areas of the Vama Veche- 2 Mai, Tuzla, Sfantu Gheorghe and Danube Delta- marine area sites. Also, on Mangalia, Tuzla and Eforie sites, areas containing a large amount of broken, disarticulated shells and shell debris were found. The acoustic facies resembles the mussel beds but show a different morphology, their architecture being controlled by water movement and not by the living and development of the organisms that produce them.

The rocks show distinctive characteristics on the sonograms. Some of their features are large enough to be seen, like the orientation of fissures. The level of backscatter varies as sonar-facing surfaces and boulders reflect very well the sound, returning the signal with great amplitude, and cast shadows, from where the returned amplitude is close to zero. They appear in the southern unit.

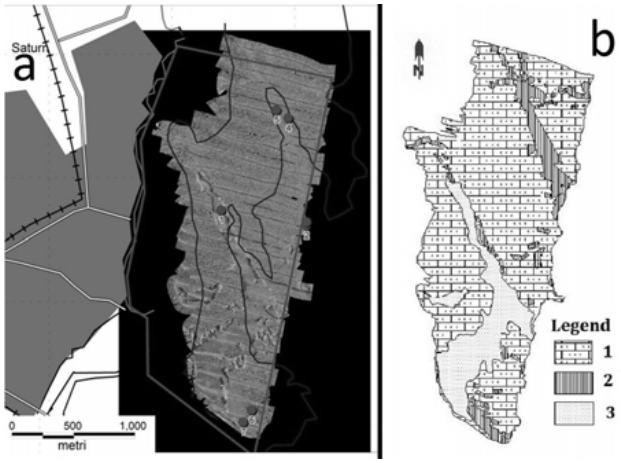

Fig. 2. A) Mosaic of the Mangalia Natura 2000 site; the dots mark ground truthing location; B) The distribution of habitats associated to the main acoustic facies: 1- habitat 1170, rocks; 2- broken, 3- habitat 1110, sand;

Submarine structures made by leaking gases (1180). Carbonate chimneys are seen on sonograms in the muddy areas in front of Sfantu Gheorghe, but do not appear on habitat maps due to their small size.

The mud with Mellina, although not assigned to a specific type of habitat according to the Habitat Directive covers important areas in Vama Veche and Sfantu Gheorghe sites. It shows a small level of backscatter and appears dark gray on sonograms.

The Mudflats and Sandflats not covered by water at low tides (1140) was identified near the shore in areas where sonar scanning was not appropriate because low water depth.

A clear correlation can be done between the acoustic and sedimentary facies. Based on the relation between the type of seabed and living organism, sonar scanning is a valuable tool for assessing habitat distribution. However, the level of details regarding the types of species living on the seafloor is limited.

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IMPACT OF ATMOSPHERIC CYCLONES ON THE PRODUCTIVITY OF THE MEDITERRANEAN AND ARABIAN SEAS

Sergey Piontkovski [1]* and Saud Al-Jufaili [1]
[1] Sultan Qaboos University - spiontkovski@mail.ru

Abstract
Remotely sensed parameters of 7 atmospheric cyclones were analyzed to estimate the range of fluctuations of chlorophyll-*a* concentrations induced by the passage of these cyclones through waters with different biological productivity (the low productivity of Mediterranean Sea versus the highly productive Arabian Sea). The annual mean of chlorophyll concentration in the western Arabian Sea exceeded the Mediterranean concentrations by ten times. Amplitudes of chlorophyll peaks initiated by propagating cyclones were associated with the phase of the chlorophyll seasonal cycle.

Keywords: Remote sensing, North-Eastern Mediterranean

Phytoplankton communities of the upper layer of the ocean respond to propagating atmospheric cyclones by increasing biological productivity (Subrahmanyam et al., 2002). The variety of this response in waters with different biological productivity is poorly understood however. The goal of this study was to compare biological footprints of cyclones in poorly productive versus highly productive waters, exemplified by the Mediterranean and Arabian Sea correspondently.

Satellite-derived (4-km spatial resolution SeaWIFS and MODIS-Aqua) daily and weekly chlorophyll-a concentrations (Level-2 and Level-3 products) available from the NASA Ocean Color Group (http://oceancolor.gsfc.nasa.gov) were used to retrieve time series for the Arabian Sea and the Mediterranean Sea for the period of 1997-2013. Data on seasonal concentrations of nitrates were retrieved from the WOD database (http://www.nodc.noaa.gov/OC5/indprod.html). Characteristics of cyclones were retrieved from global and regional databases (the PO-DAAC ftp site- ftp://podaac.jpl.nasa.gov/ocean_wind/quikscat/NRT/; http://hurricane.accuweather.com;
http://iridl.ldeo.columbia.edu/docfind/databrief/, and others).

Seasonal cycles of nitrates and chlorophyll-a concentration may be treated as the background processes mediating potential response of the phytoplankton community to propagating cyclones (Figure 1).

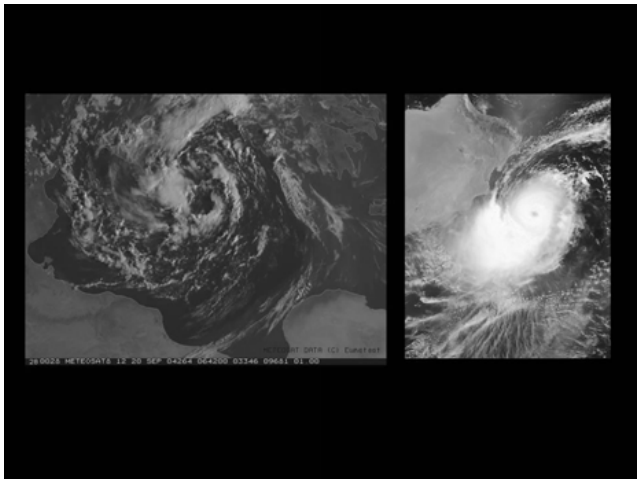

Fig. 1. Cyclone # 040920 in the Mediterranean Sea (left panel) and cyclone "Phet" in the Arabian Sea (http://in.reuters.com/article/idINIndia-49106920100607).

In the western Arabian Sea, seasonal amplitudes of chlorophyll-a exceeded the eastern Mediterranean amplitudes tenfold (Figure 2). In terms of development and duration, seasonal peaks of the Arabian Sea time series have a sharp (pulse-type) form versus a smoothed sinusoidal type typical for oligotrophic Mediterranean waters. In the western Arabian Sea, in 2002-2013, the annually averaged chlorophyll-a concentration exceeded the eastern Mediterranean one by 10 times.

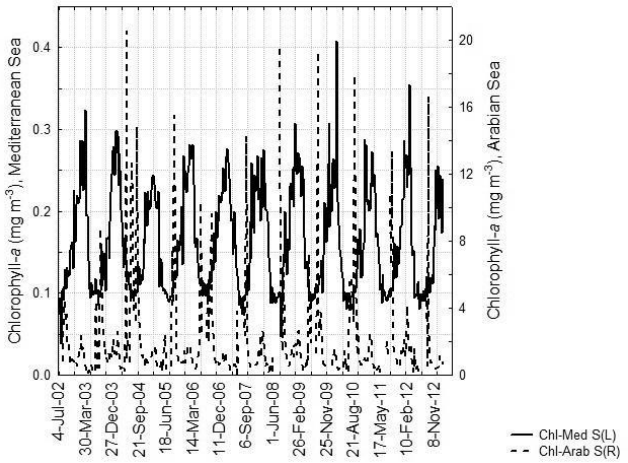

Fig. 2. Seasonal cycles of chlorophyll-*a* concentration in the Mediterranean and the Arabian Seas.

The concentration of nitrates at 100m depth at the time of seasonal chlorophyll peaks was twice as high in the western Arabian Sea compared to the eastern Mediterranean waters. In the Arabian Sea, tropical cyclone #01A has induced gradual amplification of the chlorophyll concentration, with up to a twentyfold increase. This cyclone matched the time of low chlorophyll concentration observed in May. ??The other two cyclones ("Gonu" and "Phet") matched the time of maximal chlorophyll concentrations of the seasonal cycle (in June). The response of the phytoplankton community to these two cyclones was much less pronounced (with about a 1.5 fold chlorophyll increase). In the Mediterranean Sea, the passage of cyclones #071018 and #040920 matched the time of low concentrations (in September-October). The phytoplankton community has responded to propagating cyclones by about a 1.6 fold increase in chlorophyll-a concentration. The cyclone which hit the Gulf of Lyons on March 26 1999, matched the time of high seasonal concentration of chlorophyll. A minor (1.3 fold) chlorophyll increase was observed during the cyclone's passage. The above cases pointed out that presumably, the phase of the chlorophyll seasonal cycle might be one of the important factors mediating the phytoplankton community's response to propagating cyclones. In terms of chlorophyll peaks induced by cyclones, the response might be minimal when cyclones match the time of seasonal chlorophyll peaks in the region, because these peaks reflect the maximal response to the physical-chemical environment the community is capable of producing.

Acknowledgment: This work is funded by the SQU grant # IG/AGR/Fish/13/01.

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COMBINATION OF *POSIDONIA OCEANICA* DISTRIBUTION MODELING AND REMOTE SENSING DATA THROUGH GEOSS FOR COASTAL ECOSYSTEMS EVALUATION.

M. Zucchetta [1]*, L. Bigagli [2], E. Boldrini [2], G. C. Malvárez García [3], A. Mangin [4], S. Nativi [2], M. Santoro [2], M. A. Taji [4], C. Venier [1] and R. Pastes [1]
[1] University Ca' Foscari, Venice - Italy - matzuc@unive.it
[2] CNR-IIA, National Research Council of Italy, Monterotondo (RM) - Italy
[3] Universidad Pablo de Olavide, Sevilla - Spain
[4] ACRI-EC, Casablanca - Morocco

Abstract
This work presents the integration of the *Posidonia oceanica* distribution model (PoDM) for the North African coasts, developed within the MEDINA FP7 Project, in GEOSS (Global Earth Observation System of Systems). It is shown how this implementation represents a contribution in facilitating the use of remote sensing data and ecological models for coastal ecosystem evaluations and monitoring.

Keywords: Posidonia, South-Central Mediterranean, Remote sensing, Models

Posidonia oceanica (L.) Delile is an endemic seagrass species of the Mediterranean sea and the most-widespread and most important species in this region. Moreover, the distribution and population conditions of this species are considered important biological indicators of coastal water quality and coastal ecosystem status [1]. Considering the importance of *P. oceanica*, and the regression of its distribution recorded in recent years [2], the management and conservation of its sensitive habitats is required. The aim of this work is to present the integration of the *P. oceanica* distribution model (PoDM), developed within the MEDINA FP7 Project, in GEOSS (Global Earth Observation System of Systems) – a public infrastructure which connects tools of Earth Observation with monitoring and global changes information systems. Species distribution models are tools that allow relating species distribution to environmental conditions. The model developed within MEDINA, a project aimed at enhancing Northern African Countries capabilities of monitoring coastal areas, was developed using *P. oceanica* distribution data from 5 Mediterranean areas on one side, and bathymetry and chemical-physical data (SST, Chlorophyll, Organic Matter, light *Kd*, Irradiance), derived from satellite observations (AVHRR/MODIS and MERIS) on the other side. The user, after connecting to the server (*http://medina.dais.unive.it:3838/PoDM/*; fig. 1) should take care of gathering the necessary data and all variables need to meet certain characteristics in terms of formats, time and space resolution and extent. All input data should be raster layers and share homogeneous cartographic characteristics. Moreover, all variables, with the exception of bathymetry must be supplied as yearly average, in order to meet model assumptions.

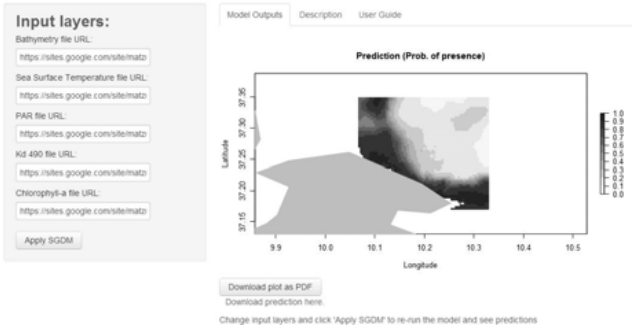

Fig. 1. Screenshot of the web application interface.

In order to override these drawbacks, the integration between the PoDM web application and GEOSS has been developed. In this way, the required input data can be searched, accessed and ingested into the model leveraging the brokering framework of the GEOSS Common Infrastructure (GCI). This framework is comprised of a set of middle-ware components (Brokers) that are in charge of implementing the needed interoperability arrangements to interconnect the heterogeneous and distributed capacities contributing to GEOSS [3, 4]. Figure 2 depicts the architecture of the integration. The MEDINA Spatial Data Infrastructure is integrated with the GEO Discovery and Access Broker (DAB) of the GCI. This allows to transparently discover and access the resources (data and model implementation) which are required to run the model. A high-level description of the steps needed to execute the model is provided using a Business Process Modeling Notation (BPMN) v. 2.0 document. This will be transformed to an executable workflow by a new experimental component, the BP Broker [5], and submitted for execution to a workflow engine. The BP Broker is linked to the GEO DAB for the discovery and access of data. The generated forecasts are then published back on GEOSS through the service bus of the MEDINA SDI which is brokered by the GEO DAB.

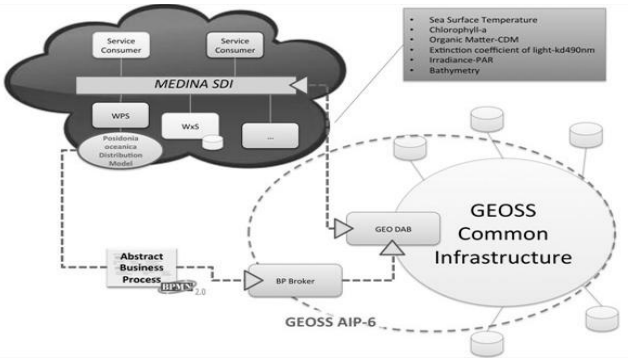

Fig. 2. PoMD web application and GEOSS integration architecture.

The integration between a remote sensing-based species distribution model and GEOSS represents a potentially useful tool open and easily accessible to every users for mapping and evaluating the potential distribution of *P. oceanica* by using satellite data. This could represent an important contribution in support, ease and enhance capabilities of using and integrating remote sensing products and numerical models for coastal ecosystem evaluations and monitoring.

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Session

Divers

ETUDE DES MACROPHYTES DU GOLF D'ANNABA

Mounia Aouissi [1]*, Hocine Frehi [1] and Farid Derbal [1]
[1] Université Badji Mokhtar Annaba, Laboratoire Bioressources Marines, Algérie - aouissi_m@yahoo.fr

Abstract
Selon l'étude des macrophytes du golfe d'Annaba, on a pu enregistrer la présence de trois groupes d'algues: les Chlorophycées (avec 15 espèces), les Rhodophycées (avec 33 espèces), les Phéophycées (avec 20 espèces) et une Phanérogame représentée par une espèce: *Posidonia oceanica*. Parmi ces espèces, deux sont invasives pour la méditerranée :*Caulerpa racimosa et Asparagopsis armata*.

Keywords: Phanerogams, Posidonia, Infralittoral, Algerian Sea, Supralittoral

Introduction

Les algues jouent un rôle primordial dans le maintien de l'équilibre écologique du milieu aquatique et sont un indicateur de l'état des milieux marins [1]. Leur étude est donc un enjeu majeur et c'est dans ce cadre que s'insère la présente étude. Notre travail consistera à établir un recensement de la flore algale qui se développe dans le golfe d'Annaba (Cap de Garde) et d'essayer de les identifier en établissant un alguier. Elle tend à contribuer à la connaissance des algues marines benthiques (Chlorophycée, Phéophycées et Rhodophycées) du golf d'Annaba et de recenser les différentes espèces qui y vivent [2]. Mais nous n'avons pas la prétention d'établir un inventaire précis car de nouvelles algues sont régulièrement découvertes.

Matériel et Méthodes

Pour nos sorties, nous avons utilisé une embarcation, du matériel de plongée (vêtements de terrain, bouteilles de plongée, lestes, palmes, masque, tuba, gilet stabilisateur) un système GPS ainsi que d'un appareil photographique numérique avec caisson pour les prises de vues. Un quadrat carré en métal galvanisé de côté de 25cm a été utilisé pour délimiter les zones d'échantillonage, des récipients divers, sachets, grattoir. Un multiparamètre type HANA pour mesurer les différents paramètres physiques (Température, salinité, oxygène dissous, pH).

Résultats et Discussion

L'étude des algues marines benthiques (Macrophytobenthos) a mis en exergue une richesse spécifique de 69 espèces: ** 15 *Chlorophyceae* (Algues vertes) ** 33 *Rhodophyceae* (Algues rouges) ** 20 *Phaeophyceae* (Algues brunes) **01 *Phanérogam : Posidonia oceanica* (Tableau 1)

Tab. 1. Liste des macrophytes inventoriés dans le golfe d'annaba.

Chlorophycées (15 espèces)	Rhodophycées (33 espèces)	Phéophycées (20 espèces)
Ulva compressa	*Chrysymenia ventricosa*	*Cutleria multifida*
Ulva rigida	*Hypnea spinella*	*Fucus virsoides*
Ulva linza	*Liagora viscida*	*Sargassum vulgare*
Ulva lactuca	*Laurencia hybrida*	*Sargassum muticum*
Codium fragile	***Asparagopsis armata***	*Hydroclathrus clathratus*
Codium bursa	*Liagora distenta*	*Colpomenia sinuosa*
Codium vermilara	*Amphiroa rigida*	*Cladostephus verticillatus*
Palmophyllum crassum	*Amphiroa cryptarthrodia*	*Leathesia difformis*
Valonia macrophysa	*Jania rubens*	*Stypocaulon scoparium*
Halimeda tuna	*Corallina elongata*	*Dictyota dichotoma*
Acetabularia acetabulum	*Peyssonnelia*	*Dictyopteris membranacea*
Chaetomorpha linum	*Laurencia obtusa*	*Dilophus fasciola*
Udotea petiolata	*Plocamium cartilagineum*	*Zanardinia prototypus*
Dasycladus vermicularis	*Bonnemaisonia asaragoides*	*Cystoseira compressa*
Caulerpa racemosa	*Pseudolithophyllum cabiochea*	*Cystoseira zosteroides*
	Phymatolithon calcareum	*Padina pavonica*
	Gigartina acicularis	*Phyllariopsis brevipes*
	Lithophyllum incrustans	*Dictyopa sp*
	Chondracanthus teedii	*Aspercoccus bullosus*
	Tricleocarpa fragilis	*Cystoseira mediterranea*
	Sphaerococcus coronopifolius	
	Alsidium corallinum	
	Kallymenia lacerate	
	Osmundea pinnatifida	
	Corallina officinalis	
	Mesophyllum lichenoides	
	Schottera nicaeensis	
	Sebdenia rodriguezlana	
	Hypnea musciformis	
	Rissoella verruculosa	
	Bornetia secundiflora	
	Gelidium bipectinatum	
	Rytiphlaea tinctoria	

Conclusion

On peut dire que dans le golfe d'Annaba, on a enregistré des proliférations importantes des deux espèces invasives *Caulerpa racemosa*: observée à 15 et à 27m de profondeur sur substrat meuble et/ou rocheux. Récemment introduite en méditerranée, *Asparagopsis armata*: observée jusqu'à 25m de profondeur sur substrat rocheux.

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DINOFLAGELLATE CYSTS IN RECENT MARINE SEDIMENTS FROM GULF OF GEMLIK (TURKEY)

N. Balkis [1]*, M. Balci [2], A. Giannakourou [3], A. Venetsanopoulou [3] and P. Mudie [4]
[1] Istanbul University Faculty of Science Department of Biology - neslbalk@istanbul.edu.tr
[2] Istanbul University, Institute of Science 34134 Vezneciler, Istanbul-Turkey
[3] Hellenic Centre for Marine Research (HCMR) 46km Athinon Souniou, Mavro Lithari, Anavissos, Athens-Greece
[4] Geological Survey Canada Atlantic, Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada

Abstract
In coastal waters, many planktonic organisms produce resting cysts and they have an important ecological role in semi-enclosed areas such as bays and gulfs where they can be a source of algal blooms. The accumulation of harmful algal cysts in the sediments can explain the frequent outbreaks of HABs. The aim of the study is to describe recent dinoflagellate cysts in surface sediments from the Gulf of Gemlik, in eastern Marmara Sea. Approximately 25 different dinoflagellate cyst types were found in sediment samples, collected between August 2010 and May 2011, from 5 stations in the Gulf. These 25 dinoflagellate cyst types were transferred to f/2 culture medium for germination in laboratory studies. This is the first study on cultivation of recent dinoflagellate cysts in Turkish marine waters and this work is ongoing.

Keywords: Dinoflagellates, Sediments, Toxic blooms, Marmara Sea

Ocurrence of HABs influence the marine ecosystem in several ways as they cause structural changes in natural food webs and their effect on aquaculture is of primary economic concern in terms of availability of healthy stocks and in maintaining the local economy [1]. In the last decade, scientific papers have highlighted the use of cyst signals as indicators of eutrophication and industrial pollution. Cysts can rest in the the surface sediments for decades [2], being a reservoir of potential biodiversity. The study of dinoflagellate cysts is one of the important subjects for understanding blooming mechanisms and the oceanographic conditions associated with harmful algal blooms. Cyst banks are not only the witness of past blooms, but also show the potential of what a given basin can produce in the future and are of strategic importance for prediction of red tide events [3,4]. There are very few studies about microalgae resting cysts in recent marine sediments from the Marmara Sea [4]. The Gulf of Gemlik which is located in the south-eastern part of Marmara Sea is a 15 km wide and 35 km long semi-enclosed basin. The maximum depth is 110 m in the middle of a small northwest-trending elliptical central trough which is a fault-controlled depositional area.

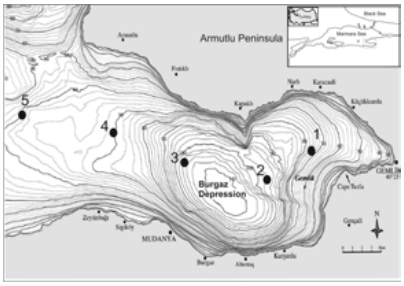

Fig. 1. Sampling stations in the Gulf of Gemlik

Twenty-five different dinoflagellate cyst types were found in sediment samples collected between August 2011 and May 2012 from 5 stations at the Gulf. The study will be an attempt to answer a question of practical interest: could the presence of cysts in the sediments eventually provide an inoculum, leading to the appearance (or initiation) of blooms. The information that will be gained would be a highly valuable contribution to the study of HAB development. Cyst cultures also germinate benthic resting cysts and link them with thecate plankton species, contributing to knowledge of theca-cyst taxonomy.

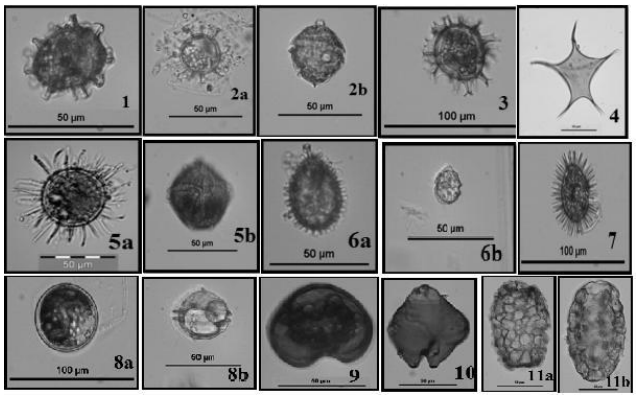

Fig. 2. **Plate 1. (1)**-*Scrippsiella trifida* **(2a,b)**-*Spiniferites bentorii=(Gonyaulax digitalis)* **(3)**-*Spiniferites mirabilis***(4)**-*Stelladinium stellatum=(Protoperidinium compressum)* **(5a,b)**-*Lingulodinium polyedrum=(Lingulodinium machaerophorum)* **(6a,b)**-*Scrippsiella trochoidea***(7)**-*Scrippsiella precaria* **(8a,b)**- *Diplopsalis lenticula***(9)**- *Votadinium calvum=(Protoperidinium oblongum)* **(10)**-*Quinquecuspis concreta =(Protoperidinium leonis)***(11a,b)**-*Polykrikos schwartzii*.

Acknowledgements This work was supported by the Joint Research and Technology Program Greece-Turkey 2011-2013 (TÜBITAK Research Project 109Y385).

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SUMMER PICOEUKARYOTIC DIVERSITY IN THE GULF OF GABES

A. Bellaaj zouari [1]*, M. Bel Hassen [1], B. Baccouch [1], F. Akrout [1] and A. Hamza [1]
[1] INSTM Salammbô, Tunisie. - amel.zouari@instm.rnrt.tn

Abstract
The investigations of picoeukaryotic diversity, hydrographical water properties and nutrient contents were carried out during June 2008 in the Gulf of Gabes (south-western Mediterranean Sea). Denaturing gradient gel electrophoresis (DGGE) analysis revealed a spatial and vertical diversity of the eukaryotic picoplankton community. The diversity is more important in offshore stations than in coastal area, notably at the thermocline. The vertical distribution of nutrients is almost homogeneous whereas an increasing surface gradient toward the offshore area was detected for both temperature and salinity. Eukaryotic sequences affiliated to picoeukaryotic organisms and to Metazoans were obtained and results suggest that the picoeukaryotic assemblages in the Gulf of Gabes were influenced by the hydrographical water structure.

Keywords: Plankton, Gulf of Gabes, Biodiversity

Introduction

Eukaryotic picoplankton organisms are important players in global carbon cycling. They contribute significantly to both phytoplankton biomass and primary production. Exploration of picoeukaryotic diversity is essential to understand their community structure and distribution patterns. In recent years, the introduction of molecular biology methods, such as Denaturing Gradient Gel Electrophoresis (DGGE), provided a new insight on the genetic diversity of the picoplankton [1]. The DGGE approach offered a reasonably detailed view of marine picoeukaryotic assemblages and allowed a direct analysis of gene sequences in natural samples leading to the phylogenetic identification of the dominant members [2,3]. In the Gulf of Gabes, different studies on the composition and the variability of phytoplankton organisms in relation to hydrographical properties and water masses nutrient contents have been conducted using CHEMTAX analysis of HPLC pigment data [4,5,6]. However, composition of picoeukaryotic community has not yet been examined with molecular biology approaches. The object of this study is to investigate the diversity of picoeukaryotic organisms in the Gulf of Gabes using DGGE approach; and to analyze the physico-chemical water properties and the availability of nutrients to determine their effect on the structure and distribution of picoeukaryotic community.

Material and methods

Sampling was conducted in the Gluf of Gabes (33-35°N and 10-11°E) at different depths of 15 stations with Niskin bottles attached to a rosette and a conductivity, temperature and depth probe (Seabird 9). To collect the picoplankton biomass, seawater was pre-filtered through a GF/D membrane (whatman) and then filtered on a 47 mm diameter membrane filter with a 0.45µm pore size; which is transferred immediately into a cryovial tube containing 3 ml of DNA lysis buffer [7]. Cryovials were then stored in liquid nitrogen. DNA extraction was achieved by a phenol chlorophorm protocol [8]. DNA yield was quantified by NanoDrop (Thermo). PCR amplification with the primers Euk1A and Euk 516r-GC and DGGE analyses were carried out according to Dièz et al. [2]. DNA bands were cut and transferred to microcentrifuge tubes that contained 80 µl of MQ water. They are incubated firstly at 37°C for 4h with stirring and secondly at 4°C overnight. A sample of 20µl was used as PCR template for PCR reamplification with Euk1A and Euk 516r primers. PCR products were purified and then subjected to sequencing. For nutrient analysis, seawater was stored at -20°C and then analyzed with an automatic analyzer type 3 (BRAN + LUEBBE).

Results and Discussion

The vertical temperature distribution exhibited a decreasing gradient with depth. Whereas, the density, particularly influenced by the temperature gradient, showed a high surface to bottom increasing. Both the surface temperature and salinity surface increased toward the offshore area. The vertical distribution of nutrients is almost homogeneous throughout the water column. The low detected concentrations of phosphorus suggested that this nutrient could be the first limiting factor for phytoplankton growth. This finding is consistent with reports of P limitation in the Mediterranean Sea [9]. The Comparison of the obtained DGGE fingerprints revealed that the diversity of picoeukaryotic community in offshore stations is more important than that in coastal water. At offshore stations, an important diversity is distinguished at the thermocline. The important diversity detected at the offshore stations could be related to distinct water masses described in the Gulf of Gabes [5]. The dendrogram analysis showed that the samples are grouped according to their positions in the water column. These results are similar to those of Diez et *al*., [2]. Sequences obtained from extracted gel bands were affiliated to Metazoans and to picoeukaryotic organisms. Metazoa sequences corresponding to Crustacea, Mollusca and Cnidaires groups could originate from sperm cells [3]. Our results revealed a spatial and vertical diversity of the picoeukaryotic community in the Gulf of Gabes and suggested that the environmental factors control their composition and distribution.

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RELATIONSHIPS BETWEEN OTOLITH SIZE AND MASS VERSUS FISH SIZE AND WEIGHT IN *GNATHOPHIS MYSTAX* (DELAROCHE, 1809) FROM THE SIGACIK BAY (SOUTHERN AEGEAN SEA)

Gökçen Bilge [1]*, Halit Filiz [1] and Anil Gülsahin [1]
[1] Mugla Sitki Kocman University Faculty of Fisheries - gbilge@mu.edu.tr

Abstract
Length, height and weight of the sagittal otoliths versus fish length and weight relationships of the *Gnathophis mystax* specimens were investigated. Fish specimens were collected during the period July-September 2007 throughout off the Sigacik Bay using bottom trawls. Calculated regressions were displayed a high coefficient of determinations ranging between 0.910 - 0.986. The linear and non-linear functions provided the best fit for %44 and %56, respectively.

Keywords: Deep sea ecology, Fishes, Aegean Sea

Introduction
Gnathophis mystax (Thinlip conger) is a demersal fish species living on the shelf and on upper slope, on muddy bottoms between 80 - 800 m and it's distributed in eastern Atlantic and Mediterranean [1]. *G. mystax* is also known from the Aegean Sea and the Mediterranean coasts of Turkey [2]. The otoliths are one of the most important tools for understanding the life of fish and fish populations for the fisheries biologists [3]. They are widely used in stomach content analysis because they are one of the last species-specific features to be digested in the digestive systems of piscivorous predators and they are important tool for prey classification. The aim of this study is to fill in the missing data concerning otolith and fish size relationships of the species in the Aegean Sea, thereby providing researchers studying food habits of top predators to determine the size and weight of prey fish from length or weight of recovered otoliths.

Material and Methods
Specimens (n= 205) were collected via commercial bottom trawl vessels from the upper slope of the Sigacik Bay at depths between 296-603 meters during the year of 2007. Fishes were weighted (W in g) and measured (TL, in mm). Sagittae (Fig. 1) were removed to expose them then cleaned and stored dry in glass vials and left and right otolith were considered separately. Each sagitta was placed with the sulcus acusticus oriented through the observer and otolith length (OL, in mm) was determined [4]. Otolith height (OH, in mm) was measured. Individual otolith weight (OW-in mg) was determined. The paired t-test was used to check any differences between left and right otolith pairs. When significant differences ($p<0.05$) were not found, a single regression was used for each parameter (OL, OW and OH). Linear ($Y = ax+b$) and exponential ($Y = ax^b$) regression equations were fitted to determine what equations (TL-OL, TL–OH, TL–OW, W–OL, W–OH, W–OW, OW–OL, OH-OL and OW-OH) best described various relationships between otolith and fish size [5].

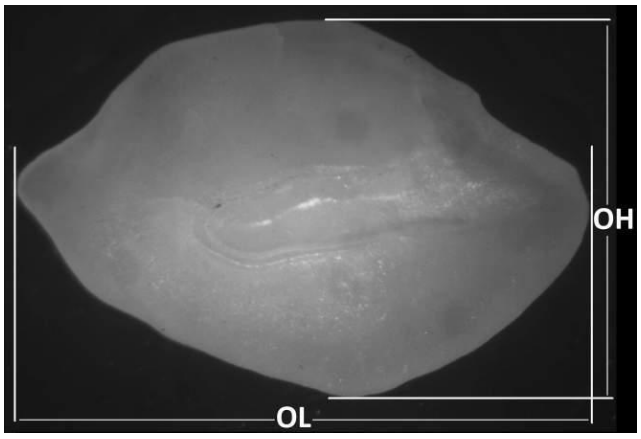

Fig. 1. Sagittal otolith and measurements of *Gnathophis mystax* (342 mm TL, 7.8 mm OL).

Results and Discussion
Minimum, maximum, average (± SD) values were found for total length as 191, 349, 269.4 (± 40.3) mm; for fish weight as 5.79, 53.77, 22.89 (± 11.27) g; for otolith length as 4.92, 8.01, 6.47 (± 0.71) mm; for otolith height as 3.12, 5.23, 4.23 (±0.52) mm and for otolith weight as 0.0228, 0.1405, 0.0700 (± 0.0300) g, respectively. No significant differences (t-test for paired comparisons, $P>0.05$) were found between left and right otolith size and weight data. Left sagittae measurements were used for the calculation of equations. Relationships between fish and otolith measurements were given in Table 1. Although, there are some identification guides for western Mediterranean and Atlantic Ocean, data about sagittal otolith morphometrics are limited with some species specific papers for eastern Mediterranean. Morphometric data of the sagittal otoliths of two *G. mystax* specimens (TL= 270 and 380 mm) were reported (in ratio of OL/TL= 2.3-2.8 and OH/OL= 62.1-64.2) from the western Mediterranean [6]. In the present study, these ratios were calculated between 2.1-2.8 and 58.0-79.2, respectively. Larger sample size and length intervals samplings may affect the results.

Tab. 1. Intercept values (a), regression slope (b) and coefficients of determination (r^2) for linear (L) and exponential (E) relationships between otolith morphometric parameters, fish length and weight of *Gnathophis mystax*.

	Relationship	Regression	a	b	r^2
Fish Length	TL vs. OL	L	54.33	- 81.851	0.922
	TL vs. OH	L	76.778	- 55.679	0.967
	TL vs. OW	E	721.39	0.3567	0.941
Fish Weight	W vs. OL	E	0.0068	4.2976	0.910
	W vs. OH	E	0.0672	3.9769	0.956
	W vs. OW	L	410.74	- 4.4178	0.986
Otolith	OW vs. OL	E	9E-05	3.5345	0.923
	OH vs. OL	L	0.6993	- 0.2871	0.931
	OW vs. OH	E	0.0006	3.2609	0.963

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DIFFÉRENCIATION MORPHOLOGIQUE ET OTOLITHOMÉTRIQUE D'*ATHERINA BOYERI* (RISSO, 1810) DANS TROIS HABITATS CÔTIERS DE L'EST DE L'ALGÉRIE.

Ahmed Sofiane Boudinar [1]*, Lamya Chaoui [1] and Mohamed Hichem Kara [1]
[1] Laboratoire Bioressources Marines, Université Badji Mokhtar-Annaba, BP 12, 23000 Annaba, Algérie. - boudinar-2009@live.fr

Abstract
L'analyse de la morphologie somatique et de la forme des otolithes (sagittae) de l'athérine *Atherina boyeri*, issue de 3 habitats des côtes Est de l'Algérie, permet d'identifier 3 groupes distincts. Ces résultats vont dans le même sens que les connaissances antérieures qui montrent l'existence de 2 ou 3 espèces au sein de ce complexe et permettent, en plus, d'identifier un autre morphe rattaché à l'Oued Ziama.

Keywords: Biometrics, Algerian Sea, Lagoons, Fishes, Estuaries

Introduction
Atherina boyeri (Risso, 1810) est un petit poisson euryhalin vivant dans les eaux côtières, les estuaires et les lagunes et peut former des populations denses dans les eaux douces. Il est commun en Méditerranée et dans l'Atlantique Nord-Est. *A. boyeri* constitue un complexe subdivisé en 3 espèces, une lagunaire (*A. lagunae*) et deux marines (ponctuée *A. punctata* et non ponctuée *A. boyeri*) (Trabelsi, 2002a et 2002b). Cette étude utilise la morphologie somatique et la forme des otolithes pour comparer les athérines issues de 3 sites de nature différents dans l'Est algérien: la lagune Mellah, le golfe d'Annaba et l'embouchure de l'Oued Ziama.

Matériels et méthodes
La morphologie de 754 spécimens appartenant à quatre populations d'*Atherina boyeri* provenant de trois sites est décrite en utilisant 14 paramètres métriques et 9 autres numériques: lagune Mellah (n = 269; 2,0 ≤ Lt ≤ 8,3 cm), Golfe d'Annaba (n = 194 individus non ponctuée; 4,6 ≤ Lt ≤ 13,1 cm et 144 individus ponctués; 5,4 ≤ Lt ≤ 10,7 cm), embouchure Oued Ziama (n = 147; 2,9 ≤ Lt ≤ 10,2 cm). Une analyse factor discriminante est appliquée pour différencier les 4 échantillons. La forme des otolithes a aussi été utilisée comme outil de différentiation de ces populations. Les contours de 452 otolithes (sagittae) (69 lagunaires, 51 marins non ponctués, 40 marins ponctués, 66 estuariens) ont été numérisés et analysés en utilisant le programme TNPC (5.0). Une analyse factorielle discriminante a été également appliquée en utilisant les descripteurs de Fourier (Shape V 1.3). La comparaison des caractères numériques est basée sur l'utilisation du coefficient de différence CD de Mayr-Lynsley-Usinger qui permet de déterminer le niveau taxonomique des échantillons.

Résultats
Un test du succès de la classification de la discrimination indique un bon taux de reclassification en utilisant les caractères métriques (71,9%) ou les descripteurs de Fourier (84,3%). Les résultats de l'analyse discriminante, basés sur les caractères métriques, montrent que ces populations ne sont pas homogènes (Wilk's lambda = 0,194, p < 0.001) et peuvent être séparées en trois groupes distincts (fig. 1).

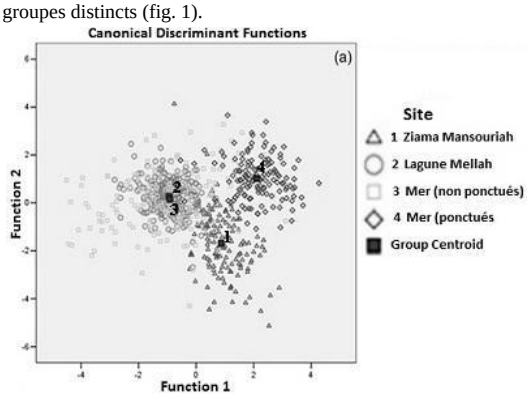

Fig. 1. Représentation graphique de l'analyse factorielle discriminante utilisant les caractères métriques.

Le premier contient les individus de la lagune Mellah et ceux non ponctués du golfe d'Annaba, le second contient les poissons ponctués du golfe d'Annaba et le troisième est formé des athérines de l'oued Ziama.L'analyse de la forme des otolithes confirme cette structure en trois groupes (Wilk's lambda = 0.062, p < 0.001) (fig. 2), exprimée en particulier par la différence de rondeur des otolithes. Enfin, l'analyse des caractères numériques distingue 4 groupes en séparant, en plus, les individus de la lagune Mellah de ceux non ponctués de la mer adjacente.

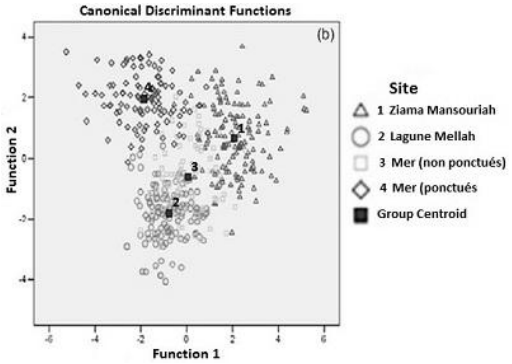

Fig. 2. Représentation graphique de l'analyse factorielle discriminante utilisant les descripteurs de fourrier.

Discussion
Les caractères somatiques, métriques et numériques, associés à la forme de l'otolithe sagittae d'*Atherina boyeri* des côtes de l'Est algérien nous ont permis de reconnaitre trois groupes distincts. Ces différences peuvent être attribuées à la grande plasticité morphologique reconnue de cette espèce en fonction de son environnement, mais pourrait aussi correspondre aux résultats des travaux de Trabelsi *et al*. (2002a et 2002b)et Klossa-Kilia *et al*. (2007) qui reconnaissent la complexité du taxon *Atherina boyeri* et son organisation en 2 ou 3 espèces. Cependant, l'occurrence d'un autre groupe issu de l'embouchure de l'Oued Ziama mérite notre attention. Les analyses génétiques en cours sur ces populations nous permettraient d'en savoir davantage.

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MORPHOLOGIE ET CROISSANCE RELATIVE DE QUELQUES LABRIDAE (TÉLÉOSTÉENS) DES CÔTES EST ALGÉRIENNES

Naima Boughamou [1]*, Farid Derbal [1] and Mohamed Hichem Kara [1]
[1] Laboratoire Bioressources Marines, Université Badji-Mokhtar, Annaba, Algérie. - boughamounaima@gmail.com

Abstract
Cette étude fournit les premiers résultats sur la morphologie et la croissance relative de quelques Labridae communs sur les côtes est algériennes. Chez *Symphodus tinca*, l'allométrie majorante concerne 13/14 paramètres. Seul le diamètre orbitaire (Do) présente une allométrie minorante. Chez *Xyrichthys novacula*, un total de 11/14 paramètres présentent une isométrie de croissance seulement 2/14 paramètres montrent une allométrie majorante et un seul paramètre présente une allométrie minorante (Ls). La croissance relative est isométrique chez *S. tinca*, *Labrus merula* et *X. novacula* et majorante chez *S. ocellatus*.

Keywords: Fishes, Biometrics, Growth, Algerian Sea

Introduction
Les Labridae sont des téléostéens côtiers qui habitent les herbiers à Zostère et à Posidonie ainsi que les fonds mixtes (rochers-algues) [1, 2]. *Symphodus tinca, S. ocellatus, L. merula* et *X. novacula* sont des espèces assez communes sur les côtes orientales d'Algérie [3] mais qui ne sont pas connues. Nous fournissons ici les premiers résultats sur la morphologie de *S. tinca* et *X. novacula* et la relation longueur-masse de *S. tinca, S. ocellatus, L. merula* et *X. novacula* des côtes est d'Algérie.

Matériel et méthodes
Les échantillons de Labridae (245 *S. tinca* pour la biométrie et 556 pour l'étude de la relation longueur-masse, 74 *S. ocellatus*, 61 *L. merula*, 147 *X. novacula*) proviennent de la pêche artisanale et expérimentale pratiquée dans le golfe d'Annaba (est, Algérie). La caractérisation morphologique s'est effectuée à partir de 8 paramètres numériques et 15 paramètres métriques. La longueur et la masse totales ont été respectivement exprimées en centimètre et en gramme.

Résultats et discussion
Les nageoires dorsales et anales de *S. tinca* comportent respectivement 14 à 16 et 3 rayons durs, et 11 à 12 rayons mous. Le nombre d'écailles de la ligne latérale est compris entre 33 et 38. Le nombre de branchiospines inférieures et supérieures varie respectivement entre 9 et 13 et entre 0 et 3. Le nombre de vertèbres est égal à 34. Chez *X. novacula*, les nageoires dorsales et anales comportent respectivement 9 et 3 rayons durs, et entre 12 et 13 rayons mous avec un nombre de 25 vertèbres. Le nombre d'écailles à la ligne latérale varie 24 et 29. Le nombre de branchiospines inférieures et supérieures varie respectivement entre11 et 12, et entre 6 et 7. Ces valeurs des caractères numériques observées chez *S. tinca* et *X. novacula* des côtes est algériennes sont proches ou égales de celles rapportées en Méditerranée [4].Une corrélation très hautement significative a été observée chez *S. tinca* ($0,832 \leq r \leq 0,997$; $P \leq 0,001$) et *X. novacula* ($0,579 \leq r \leq 0,988$; $P \leq 0,001$) pour l'ensemble des paramètres morphométriques examinés en fonction de la longueur totale ou celle de la tête. Chez *S. tinca*, l'allométrie majorante concerne 13 paramètres métriques et elle est minorante pour le diamètre orbitaire. Chez *X. novacula* les paramètres suivants : longueur pré-dorsale, diamètre orbitaire, longueur pré-orbitaire, longueur post-orbitaire, longueur pré-pectorale, longueur post-pectorale, longueur pré-anale, hauteur du corps, épaisseur du corps, diamètre inter-orbitaire et hauteur du pédoncule caudal, présentent une isométrie de croissance, alors que les longueurs céphalique et du maxillaire supérieur montrent une allométrie majorante. La longueur standard présente une allométrie minorante. La croissance relative est isométrique chez *S. tinca* (r = 0,956 ; b = 2,97 ; tobs = 0,791 ; N = 556), *L. merula* (r = 0,924 ; b = 3,082 ; tobs = 0,547 ; N = 61) et *X. novacula* (r = 0,923 ; b = 2,945 ; tobs = 1,504 ; N = 147), alors qu'elle est majorante chez *S. ocellatus* (r = 0,948 ; b = 3,251 ; b = 2,159 ; N = 74). La croissance relative est respectivement minorante, isométrique et rapide chez *S. tinca* (b = 2,875), *S. ocellatus* (b = 2,966) et *L. merula* (b = 3,186) dans les zones ouest de la Méditerranée [5], tandis que la masse croit au même rythme que la taille chez *X. novacula* dans les zones centrales du même bassin [6]. Ce changement des valeurs de b dépend de plusieurs facteurs, aussi bien biotiques (forme du poisson, quantités de graisse stockées, nourriture, sexe, stade de maturité) qu'abiotiques (température, salinité) [7, 8, 9].

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SHELL SHAPE DIFFERENTIATION IN THE THREE MORPHOTYPES OF THE MEDITERRANEAN LIMPET *PATELLA CAERULEA* (LINNAEUS, 1758)

Jihen Boukhicha [1]*, Oum Kalthoum Ben Hassine [1] and Sabiha Tlig-Zouari [1]
[1] Faculty of sciences of Tunis University of Tunis El Manar, Tunis,Tunisia - boukhicha.jihen73@gmail.com

Abstract
Shell shape differentiation in the three *Patella caerulea* morphotypes was studied along the Tunisian coastline. Statistical analysis revealed morphometric variability mainly associated to shell height and radula length. Both var. *subplana cognata* and var. *subplana stellata* showed a partial morphometric overlap.The study indicated that in addition to external shell architecture, the three *P. caerulea* morphs also exhibited different shell shapes. Therefore, morphometrics seems to be efficient to distinguish different *P. caerulea* morphotypes with enough precision.

Keywords: Gastropods, Biometrics, Mediolittoral, Mediterranean Ridge

Introduction
Patella caerulea (Linnaeus, 1758) is endemic to the Mediterranean. It has a wide vertical distribution and colonizes different types of micro-habitats, this feature results in high morphological diversity. Two forms were reported for this species ([1]): the classic morphotype with regular thin ribs and smooth edge and *subplana* morph with large protruding ribs and irregular angular edge. The latter presents two forms: *cognata* characterized by slightly vertically curved ribs around the peristome (*P. caerulea* var. *subplana cognata*) and *stellata* characterized by a flat star-shaped shell due to the angular extensions of the ribs (*P. caerulea* var. *subplana stellata*). In order to highlight the possible shell shape variations between these three morphs, a comparative morphometric study was performed.

Material and methods
A total of 391 specimes of *P. caerulea* was collected from 10 rocky stations covering the entire Tunisian coastline (from Algero-Tunisian (Tabarka) to Tuniso-Libyan (Zarzis) frontiers). The classification adopted by [1] was used to identify each specimen's morph. Shell length (SL), shell width (SW), shell height (SH), shell length from apex to anterior end (SAA) and from apex to posterior end (SAP) and radula length (RL) were measured to the nearest 0.01mm using a digital caliper.
All parameters were Log transformed in order to increase linearity and multivariate normality ([2]). Size dependent variation was removed using an allometric approach ([3]). Data were transformed using the following formula: Mtrans = logM – β (log SL - log SLmean), where Mtrans is the transformed measurement, M the original measurement, β the within-group slope regressions of the log M vs. log SL, SL the shell length, and SLmean the overall mean of the shell length.
A discriminant function analysis (DFA) on transformed data was performed to estimate the contribution of each shell character to group separation and illustrate the spatial separation between the centroids of the three morphs. Wilks' lambda was subsequently estimated to test the significance of the difference between the identified groups means. In order to discern the possible overlap between the morphology of the three studied morphs, percent classification success (PCS) was evaluated, for each morph, as the percentage of correct re-classification of individuals in discriminant analysis.

Results and discussion
Based on the observation of the external shell architecture, 149 individuals of the classic form, 122 *P. caerulea* var. *subplana cognata* and 120 *P. caerulea* var. *subplana stellata* were identified.
The contributions of the morphometric variables to group separation are shown in Fig.1. The two first discriminant functions explained 79% of inter-group variability. The DFA plot (Fig.2) showed discrimination between the three studied morphs which was proved by wilks' lambda (Wilks' lambda = 0.0526, F=6.4165, p<0.001). Morphometric differences were mainly related to shell height and radula length which were more important in the classic morph. However, a partial overlap between the two morphs of the var. *subplana* was observed.
91% of the classic form, 64% of var. *cognata* and 67% of var. *stellata* were cross-validated correctly into their putative groups, confirming the classic morph distinction and the overlap between var. *cognata* and var. *stellata*. Morphometric differentiation between the two latter morphs was mainly associated to shell width and the anteroposterior position of the apex.

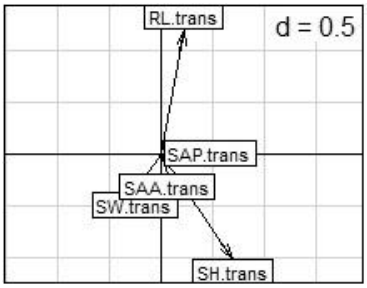

Fig. 1. Transformed variable contribution in the discrimination of groups.

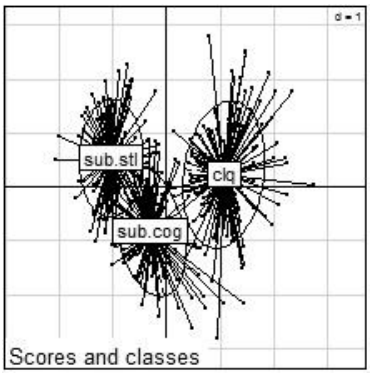

Fig. 2. Discriminant function scores for the three morphs.

The results suggest that in addition to the variations in the shell radial ribs architecture ([1]), the three morphotypes of *P. caerulea*, also exhibit shell shape differences. Therefore, morphometrics seems to be efficient to distinguish different *P. caerulea* morphs with enough precision. Shape variability in these three morphotypes can be considered as an expression of phenotypic adaptation to the extremely diverse intertidal rocky shore environments and reinforces the morphological plasticity reported in limpets. These morph specific phenotypic traits seem to confer physical advantages for the survival of each morphotype in its respective niche.

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ETUDE SYSTÉMATIQUE, PHYLOGÉNÉTIQUE ET PHYLOGÉOGRAPHIQUE DE QUELQUES ESPÈCES DE PATELLES

Zoheir Bouzaza [1]* and Karim Mezali [1]
[1] Faculté des sciences Exactes et Sciences de la Nature et de la Vie - riskemall@yahoo.fr

Abstract
Une étude phylogénétique et phylogéographique sur quelques espèces de Gastéropodes prosobranches a été réalisée sur la côte algérienne afin de comprendre le patron de connectivité entre leurs populations, en expliquant par les données paléontologiques les causes de leur divergence. Ceci nous a donné une idée sur la plasticité morphologique des patelles étudiées puisque l'aspect morphologique ne pouvait pas toujours être un critère de raprochement intraspécifique. Aussi, nous avons pu constater que la divergence et la répartition géographique entre les espèces de patelles étudiées concordait avec certains bouleversements paléontologiques, ce qui pourrait être la cause des divergences des espèces étudiées.

Keywords: Biogeography, Algerian Sea

Introduction: le but de ce travail est d'étudier la phylogénie et la phylogéographie de deux gastéropodes Prosobranches [*Patella rustica* (Pr) et *Patella ferruginea* (Pf)] pour comprendre les models de connectivité entre leurs populations, en expliquant, par les données paléontologiques , les causes de leurs différences, leur répartition et leurs réponses aux changements environnementaux.
Matériel et méthodes: l'échantillonnage a été fait dans quelques stations de la côte Algérienne. Après avoir identifié les espèces morphologiquement, nous avons effectué le travail moléculaire (extraction d'ADN, PCR, séquençage de l'ADN ...) en utilisant le marqueur mitochondrial « COI ». Les résultats de séquences de l'ADN mitochondrial obtenus ont été traités à l'aide de quelques logiciels telque « codon code Aligner 3.7.1 » disponible en (http://www.codoncode.com/aligner) pour l'alignement de séquence, "MEGA 5.03" (Tamura et al., 2011) pour la construction d'un arbre phylogénétique suivant la méthode du maximum de vraisemblance "ML" en utilisant le modèle de "Juke-Cantor (1969)" et «Network 4.6 » (Polzin & Daneschmand, 2011) pour la construction d'un réseau d'haplotypes en utilisant le procédé « Median Joining». Nous avons utilisé le modèle de «l'horloge détendue » avec une distribution log-normale du taux de substitution en utilisant deux valeurs différentes (0,6% et 1,2% par million d'années "MA") Hellberg & Vacquier (1999).
Résultats et discussion: les données génétiques nous ont montré que certains individus morphologiquement identifiées autant que *Patella rustica* appartiennent en fait à l'espèce *Patella caerulea* (Pc) (Fig. 1).

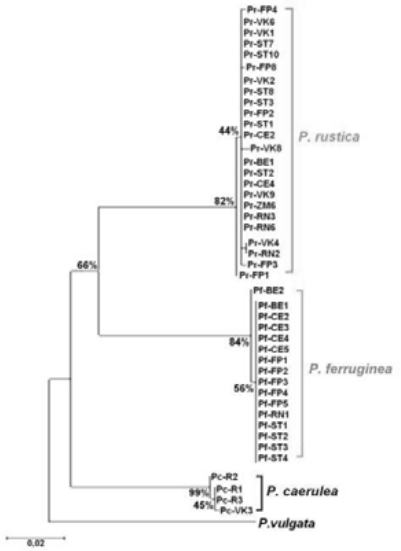

Fig. 1. Arbre phylogénétique des espèces étudiées établi par la méthode « ML » avec un nombre de réplicas bootstrap de 100.

L'arbre phylogénétique (Fig. 1) nous montre que les deux formes de *Patella ferruginea* (Rouxii et Lamarkii)
(J. Christiaens, 1973) sont situées dans un même clade avec des morphotypes appartenant à la même espèce. Le réseau d'haplotypes (Fig. 2) montre qu'il existe une distribution en étoile des espèces étudiées qui peut être expliqué par une récente explosion démographique après le dernier maximum glaciaire.

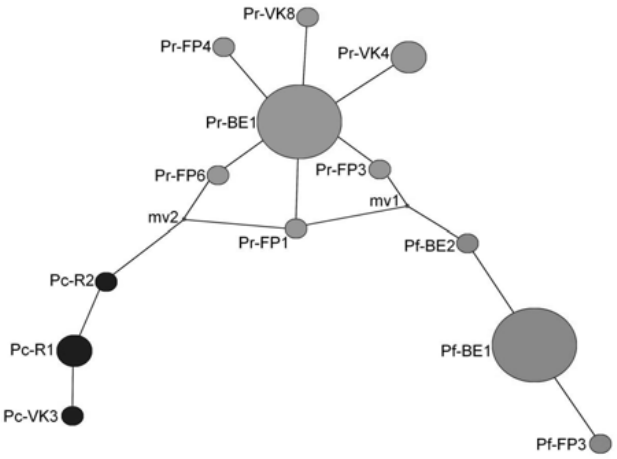

Fig. 2. Réseaux d'haplotypes représentant les espèces de patelles étudiées. Pf, *Patella ferruginea* ; Pr, *Patella rustica* ; Pc, *Patella caerulea*.

La divergence entre les espèces *Patella ferruginea* et *Patella rustica* étudiées se situe entre 8. 25 et 4,125 MA, cela aurait pu être produit pendant l'ère Messinien où le niveau de la mer avait diminué considérablement, ce qui a donné lieu à un isolement génétique créant une spéciation allopatrique.

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THE ROLE OF FISHERY IN THE ENERGY BUDGET OF BURULLUS LAKE: INSIGHTS FROM A FOOD WEB MODEL AND LINKS WITH ECOSYSTEM STATUS MONITORING AND ASSESSMENT

Daniele Brigolin [1]*, Fabio Pranovi [1] and Roberto Pastres [1]
[1] Università Ca' Foscari Venezia - brigo@unive.it

Abstract
This work aims at investigating the role played by fishery in the energy budget of the Burullus lake (Nile Delta, Egypt). The food web was reconstructed by means of an inverse methodology of linear estimation, based on an extensive review of published field studies performed during the early 2000s. A subsequent network analysis allowed to derive a set of measures which could be of interest in the context of the implementation of the UNEP-MAP approach for ecosystem status monitoring and assessment. Results pointed out that the detrital path can play a significant role in sustaining catches, and the relevant export of organic matter associated to fishery is important for maintaining the system around its equilibrium.

Keywords: Food webs, Fisheries, Models, Nile Delta

Introduction: Burullus, located in the Kafr El-Sheikh Governorate, is the most central of the Nile delta lakes. The wetland, which extends for about 410 km^2, is an important spot for breeding and wintering of different waterfowl populations, and was designated as a Ramsar site in 1988. After the Aswan high dam completion the lake became subjected to strong inputs of drainage waters, experiencing very few exchange with the sea, limited in time, and restricted to the area nearby the Bughaz canal. The constant load of inorganic nutrients from the drainage basin stimulated an elevated trophism of the site, and was capable to sustain a relevant increase in fishery landings, mostly Mugilidae and Cichlidae, which started in the eighties and peaked in the early 2000s, at about 60000 tons (GAFRD statistics; Rahman, 2011). The estimation of mass and energy fluxes in fishery exploited systems is a topic of high applied interest, since these fluxes are the basis to calculate integrated measures, which can contribute to the monitoring and assessment of the ecosystem status. In particular, in the framework of the Ecosystem Approach implementation proposed by the Mediterranean Action Plan of the United Nations Environment Program (http://www.unepmap.org), these indexes could contribute to Ecological Objective 4 ("Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability"). The model study here presented was carried out in the framework of the MEDINA project "Marine Ecosystem Dynamics and Indicators for North Africa" (EU 282977). A steady-state model for lake Burullus was balanced by means of an inverse methodology of linear estimation. Model application was specifically focused on the role played by fishery in the energy budget of the lake food web, and compares the energy resources provided by primary producers and organic detritus for sustaining consumers and fishery.

Methods: species were aggregated in compartments on the basis of the similarity in size and feeding ecology. The resulting lake food web included 15 living compartments, and 1 dead dissolved and/or particulate organic matter, see Table 1. Data, which main references are summarized in Table 1, were collected between 2000 and 2004. The resulting linear system of 16 mass-balance equations was under-determined, and was therefore solved using the inverse methodology by van Oevelen et al. (2009). Model constraints were set on the basis of general eco-physiological knowledge of system functioning (growth, assimilation and ecotrophic efficiencies), and site-specific information on fishery landings, primary productivity and gut contents.

Preliminary results:results suggest that a relevant fraction of the synthesized organic matter is not directly conveyed to higher trophic levels through grazing, but first accumulates in detritus. This detrital path seems to play a significant role also for sustaining the declared catches. In such a situation, the high export from TL2 (on an integer scale representation), associated to fishery, could induce a positive feedback on the system, preventing from a potentially dangerous accumulation of organic matter which could lead to dystrophic crises. This could represents an interesting case study within the context of the ecosystem based management, in which typical negative effects due to the exploitation activities are in some way counterbalanced by positive feedbacks. The set of ecosystem functioning indexes, derived by estimated fluxes, could provide an useful basis to assess the Burullus lake status in the early 2000s, constituting also a base for future comparison with different states reached by the system as a consequence of changes in the human induced pressures.

Tab. 1. Compartments of the lake Burullus food web model

Compartment	References
Phytoplankton	Radwan (2005); Okbah & Hussein (2006)
Phytobenthos (s.l.)	Shaltout & Khalil (2005)
Zooplankton	Dumont & El Shabrawy (2008)
Meiobenthos	Mitwally & Abada (2008)
Macrobenthos detritivorous	Shaltout & Khalil (2005); Mitwally & Abada (2008)
Macrobenthos herbivorous	Shaltout & Khalil (2005); Mitwally & Abada (2008)
Macrobenthic filter-feeders	Shaltout & Khalil (2005); Mitwally & Abada (2008)
Macrobenthic mixed-feeders	Shaltout & Khalil (2005); Mitwally & Abada (2008)
Macrobenthos carnivorous	Shaltout & Khalil (2005); Mitwally & Abada (2008)
Nekton hyperbenthivores-zooplanktivores	Shaltout & Khalil (2005); GAFRD
Nekton microbenthivores	Shaltout & Khalil (2005); GAFRD
Nekton macrobenthivores	Shaltout & Khalil (2005); GAFRD
Nekton detritivores	Shaltout & Khalil (2005); GAFRD
Nekton hyperbenthivores-piscivores	Shaltout & Khalil (2005); GAFRD
Birds	Tarwat & Hamied (2000)
Organic detritus	Mitwally & Abada (2008); Shaltout & Khalil (2005)

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INFESTATION STATUS OF GNATHIID ISOPOD JUVENILES PARASITIC ON *MULLUS BARBATUS* (L. 1758) OFF THE NORTHERN SICILIAN COAST (MEDITERRANEAN SEA)

B. Busalacchi [1]*, T. Bottari [1], R. Forzano [1], E. Armeli Minicante [1] and P. Rinelli [1]
[1] Istituto per l'Ambiente Marino Costiero - CNR - barbara.busalacchi@iamc.cnr.it

Abstract
The host-parasite relationship between the gnathiid isopods and the red mullet (*Mullus barbatus*) was studied off the northern Sicily coast. The relationships between parasitic prevalence and sex and age of host have been evaluated.

Keywords: Fishes, Parasitism, Tyrrhenian Sea

Introduction
Gnathiid isopods are temporal parasites of teleosts and elasmobranchs as well. The larvae are hematophagous feeding on the blood of the host through attaching to their fins, nostrils, lips, eye rims, oral cavity, and especially gills. Adults live freely on sandy-muddy bottom. Recently gnathiid larvae on *Mullus barbatus* gills in the Southern Tyrrhenian Sea have been reported (1). The aim of the present study is to describe the relationships between parasitic prevalence and sex and age of *M. barbatus.*

Methods
Three experimental trawl surveys were conducted on May 2011 and 2012 and October 2011 along the northern Sicily coast. A total of 308 specimens of *M. barbatus* were caught, frozen on board and sent to laboratory. Fish were measured (mm) and dissected to identify their sex. The sagittal otoliths were extracted, cleaned and stored dry. The entire gills were removed and examined under a stereomicroscope for the presence of ectoparasites. Two readers aged the otoliths twice using a stereomicroscope under reflected light (2). The prevalence of infestation, mean intensity and mean abundance, with relative 95% confidence intervals, were calculated using the software 'Quantitative Parasitology 3.0' (3).

Results and discussion
Gnathiid larvae with full and empty stomach were observed on *M. barbatus* at the same time. The parasite prevalence was 19.3 and 9.1 in host males and females, respectively. This difference was statistically significant (Fisher's exact test, $p < 0.05$). The prevalence by age class ranged from 0 to 26.3% (Table 1). The III age class showed the highest prevalence (26.3%). Prevalence and abundance were higher in October than in May (Table 2; Fisher's exact test, $p<0.01$; Bootstrap 2-sample t-test, $p<0.01$). Apparently the gnathiid isopods are not host specific being described in a large number of species. The values of prevalence and intensity reported in this study are lower than reported for *Dentex dentex, Epinephelus aeneus* and *E. marginatus* (4, 5). No relationship between age and prevalence and intensity was revealed.

Tab. 1. Prevalence (P), mean intensity (I) and mean abundance (A) of gnathiid larvae by age class of *Mullus barbatus*. N: number of specimens; TL: total length. () 95% confidence limits.

Age class	N	range TL (mm)	P (%)	I	A
II	41	95-170	0	0	0
III	99	120-189	26.3 (18.3-35.8)	3.88 (2.85-5.12)	1.2 (0.66-1.56)
IV	97	140-190	15.5 (9.21-24.1)	3.53 (2.60-5.93)	0.55 (0.3-1)
V	40	160-230	12.5 (5.06-26.1)	3 (2.2-4)	0.38 (0.10-0.8)
≥VI	30	225-265	3.3 (0.18-17.7)	4	0.13

Tab. 2. Prevalence (P), mean intensity (I) and mean abundance (A) of gnathiid larvae by sampling period. N: number of specimens; TL: total length. ()95% confidence limits.

	May	October
N	271	37
range LT (mm)	95-265	140-258
P	7.7 (5.03-11.57)	70.3 (54.1-82.8)
I	4.14 (3.10-5.67)	3.31 (2.50-4.23)
A	0.32 (0.19-0.51)	2.32 (1.59-3.16)

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RP-HPLC DETERMINATION OF CAFFEIC ACID IN *ZOSTERA NOLTII* FROM TURKISH COASTLINES

Levent Cavas [1]*, Hakan Alyuruk [2] and Gamze Topcam [1]
[1] Dokuz Eylül University, Faculty of Science Department of Chemistry - levent.cavas@deu.edu.tr
[2] Dokuz Eylül University, Institute of Marine Sciences and Technology, Izmir, Turkey

Abstract
Zostera noltii biosynthesizes important bioactive compounds such as caffeic, zosteric and rosmarinic acid.In the present work, seasonal variation of caffeic acid in *Zostera noltii* detritus from Turkish coastlines was determined by reverse phase HPLC.

Keywords: Biotechnologies, Chemical analysis, Detritus, Aegean Sea

Introduction:
Zostera noltii (Hornemann, 1832) is a dwarf eelgrass species widely distributed along Turkish coastlines. This species is generally located at the shallow coastal waters and at the entrances of the estuaries. Biosynthesis of protective and defensive bioactive metabolites, especially antioxidant compounds like caffeic acid (CA), zosteric acid and rosmarinic acid, could be altered due to the variability of different environmental stress factors like temperature, salinity and epiphytic grazers [1]. On the other hand, these regions also affected from tides that result in loss of bioactive compound resources. Caffeic acid is one of the greatly studied natural compound for its hepatoprotective effects against t-BHP-induced oxidative liver damage [2], suppression of UV-B induced skin carcinogenesis [3], suppression of COX-2 expression [3], antioxidant activity [4], anti-hepatitis B virus activity [5], peripheral analgesic effect in mice and rats [6], inhibition of cancer cell metastasis [7], anti-inflammatory and anti-coagulatory activity [8] in the literature. In this study, it was aimed to determine seasonal variation of caffeic acid levels in *Zostera noltii* detritus from Turkish coastlines by reverse phase HPLC.

Materials and Methods:
Zostera noltii detritus were collected from Dikili coastlines, Turkey. The samples were washed by using tap water to remove epiphytes and then they were allowed to dry at room temperature. The samples were powdered and 20 g of dried sample was extracted with HPLC methanol by soxhlet extraction for 8 h. The chromatographic separations were performed with Shimadzu LC-20 HPLC system connected to SPD-20A UV detector. Separation of caffeic acid was obtained on Inertsil C8 HPLC column (GL Sciences), (250 mm x 4.6 mm, 5 µm). The analytes were eluted by using linear gradient of 0.1% TFA (v/v) in water (A) and 0.1% TFA (v/v) in methanol (B) (0 min, 1% B; 20 min 99% B) at a flow rate of 1 mL/min. Caffeic acid concentration was determined by using calibration curve of a caffeic acid standard at 360 nm. Statistical analysis of results was performed with one-way Anova followed by Tukey's test in Minitab 16.

Results:
HPLC chromatogram of *Z. noltii* detritus was given in Figure 1.

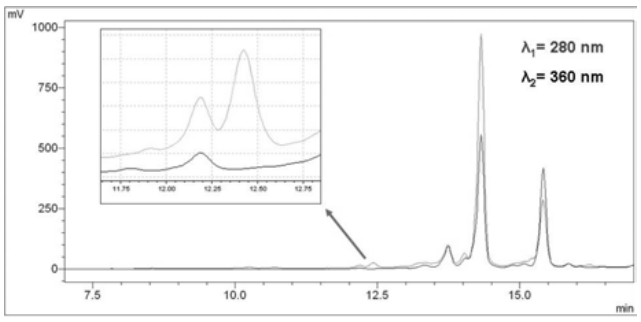

Fig. 1. A sample HPLC chromatogram of *Z. noltii* detritus at 360 nm (λ_1: grey, λ_2: black).

According to the results, caffeic acid was clearly separated from other eluents by simultaneous detection at two wavelengths, 280 and 360 nm. The concentration of caffeic acid was determined from a five point calibration curve (R^2=0.9916) at 360 nm. The seasonal variation of caffeic acid content in *Z. noltii* detritus was given in Table 1.

Tab. 1. Seasonal change of caffeic acid levels in *Z. noltii* detritus from Turkish coastlines. Small letters indicate seasonal changes for each sampling area at significance level of $p<0.05$ according to One-Way Anova.

Season	Caffeic acid concentration (µg CA/g DW)
Spring	275 ± 15^{b}
Summer	161 ± 14^{c}
Autumn	19 ± 1^{d}
Winter	332 ± 17^{a}

According to the Table 1, highest caffeic acid contents in detritus samples from Dikili was determined as 332 ± 17 CA/g dry weight (DW) and it was maximum in winter season.

Conclusion:
Caffeic acid is an important bioactive metabolite that has so far been shown as one of the strongest drug candidate against cancer in the literature. Therefore, *Z. noltii* detritus from Turkish coastlines could be potential bioresource for isolation of caffeic acid.

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RÉGIME ALIMENTAIRE DE L'ANGUILLE *ANGUILLA ANGUILLA* DANS LES EAUX DE TRANSITIO DE L'EST DE L'ALGÉRIE.

F. Derbal [1], S. Hamdi [1], L. Rouag-Laouira [1], L. Chaoui [1]* and M. Kara [1]
[1] Université d'Annaba, Algérie - chaouilamya@hotmail.com

Abstract
Le régime alimentaire est étudié chez l'anguille européenne *Anguilla anguilla* de l'embouchure de l'oued El-Kébir et de la lagune du Mellah, dans le nord-Est de l'Algérie. Les valeurs moyennes annuelles de la vacuité digestive sont respectivement de 38,1% et de 53,1%. Elles fluctuent sensiblement en fonction des saisons, du sexe et du stade de développement. Dans les deux sites, *A. anguilla* est opportuniste et se nourrit préférentiellement de crustacés (%IRIOEK = 95,38, %IRILM = 89,86).

Keywords: Fishes, Lagoons, Brackish water, Diet, North-Western Mediterranean

Introduction
En Méditerranée, l'anguille européenne *A. anguilla* est en danger critique d'extinction [1]. Malgré ce statut, sa biologie et son écologie restent très peu connues, tant en Algérie que sur les côtes nord-africaines [2]. Cette étude vise à fournir les premières données sur le régime alimentaire de deux populations d'A. anguilla vivant dans l'oued El-Kébir et la lagune du Mellah, deux hydrosystèmes en communication directe et permanente avec la mer.

Matériel et méthodes
La composition taxonomique et les variations du régime alimentaire de 1120 anguilles, pêchées à l'embouchure de l'oued El-Kébir (position géographique : 07°15'E - 36°59'N, effectif : 495, Lt = 23,5 - 83 cm, Wt = 23 - 1470 g) et dans la lagune Mellah (position géographique : 08°20'E - 36° 53'N, effectif : 625, Lt = 24,3 - 75,8 cm, Wt = 23 - 842 g) au moyen de verveux, ont été étudiées entre décembre 2008 et novembre 2009. Chez chacune des 2 populations étudiées, les coefficients de vacuité digestive (CV%) ont été déterminés en fonction des saisons, du sexe et du stade d'argenture (jaunes, argentés, intermédiaires). Le statut des proies ingérées (préférentielles, secondaires, accidentelles) a été aussi recherché en utilisant le pourcentage indiciaire du IRI [3].

Résultats
Les valeurs moyennes annuelles respectives de la vacuité digestive chez *A. anguilla* de la lagune du Mellah et de l'oued El-Kébir sont de 53,1% et de 42,9%. Il en est de même pour la vacuité digestive des mâles (CvLM = 44,6% ; CvOEK = 37,6%) et des femelles (CvLM = 24,5% ; CvOEK = 28,6%), les individus indéterminés étant absents dans l'oued El-Kébir (CvLM = 60,2%). Dans les deux sites, les valeurs du coefficient de vacuité chez les anguilles jaunes et intermédiaires sont inférieures à 50% alors que celles des anguilles argentées est presque de 90% dans le Mellah et nulle dans l'oued El-Kébir. L'anguille du Mellah se nourrit principalement de crustacés décapodes (%IRI = 89,86) et accidentellement d'ostéichtyens, de mollusques et de macrophytes (%IRI < 10). Les principales proies identifiées dans les contenus digestifs appartiennent à 12 espèces : *Palaemon adspersus*, *Penaeus kerathurus*, *Carcinus aestuarii*, *Microdeutopus gryllotalpa*, *Aphanius fasciatus*, *Atherina boyeri*, *Gobius niger*, *Abra ovata*, *Cardium glaucum*, *Mytilus galloprovincialis* et Ruppia sp. Nous avons identifié un total de 464 proies pesant 633 g, soit un nombre et un poids moyens par tube digestif plein de 1,6 et 2,1 g, respectivement. Dans l'oued El Kébir, les crustacés décapodes constituent aussi la base de son alimentation (%IRI = 90,48) avec une préférence pour la petite crevette P. adspersus (%IRI = 66,48). Les ostéichtyens, les mollusques et les macrophytes sont faiblement représentés (%IRI < 5). Au total, 12 taxons entrent dans la composition de son alimentation dont : 3 crustacés (*P. adspersus*, *C. aestuarii*, *Sphaeroma* sp.), 1 insecte (*Libellula quadrimaculata*), 5 ostéichtyens (*Mugil cephalus*, *Liza saliens*, *L. ramada*, *Chelon labrosus* , *Atherina sp.*), 1 phanérogame (*Ruppia* sp.) et 1 mollusque (*Hydrobia* sp.). Chaque anguille échantillonnée ingère en moyenne 2 proies pour un poids total de 4,4 g.

Discussion
Les variations de la vacuité digestive dans la lagune du Mellah et dans l'oued El-Kébir seraient dues non seulement à l'effet de la température [4], mais à la conjugaison avec d'autres facteurs environnementaux, comme la photopériode et la pluviosité [5], ainsi que la turbidité (facteur causant les crises dystrophiques en milieux confinés) [6]. L'importance des crustacés dans leur alimentation de base, notamment de *P. adspersus* et de *C. aestuarii*, s'expliquerait par la disponibilité de ces proies dans ces milieux. Ce régime à base de crustacés est décrit aussi dans les estuaires de la Severn [7] et du Tage [8] ainsi que dans la lagune de Mauguio [6]. Dans les 2 sites étudiés, les petits poissons, notamment les muges et les athérines, sont consommés accessoirement, alors qu'en milieu dulcicole la tendance alimentaire des anguilles est plutôt l'ichtyophagie [9], avec un spectre alimentaire qui peut s'étendre à d'autres proies, comme les crustacés, les mollusques, les annélides et les larves d'insecte [4]. Nous pouvons ainsi supposer que cette hétérogénéité alimentaire aussi bien qualitative que quantitative observée dans les 2 hydrosystèmes étudiés est attribuée probablement à l'adaptation exceptionnelle de l'anguille à coloniser divers biotopes, ce qui leur permettrait d'acquérir ce comportement nutritionnel de type opportuniste.

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ETUDE DES MYXOSPORIDIES ET DES MICROSPORIDIES DES POISSONS DES CÔTES NORD-EST DE LA TUNISIE

Kalthoum Chourabi [1]*, Lamjed Mansour [1] and Oum Kalthoum Ben Hassine [1]
[1] Faculté des Sciences de Tunis - chourabi.kalthoum@gmail.com

Abstract
Les poissons sont fréquemment les hôtes de divers protozoaires parasites, en particulier les Myxosporidies et les Microsporidies. Nous avons consacré nos investigations à certaines espèces de poissons des côtes Nord Est de la Tunisie pour la recherche de ces parasites. Sur l'ensemble des poissons examinés nous avons récolté deux Myxosporidies sur *Trachurus trachurus* et sur *Symphodus tinca* et une Microsporidie sur *Sardinella aurita*.

Keywords: Fishes, Parasitism, Tunisian Plateau

Introduction
Les poissons constituent un biotope extrêmement favorable au développement d'un grand nombre de protozoaires parasites, notamment les Myxosporidies et les Microsporidies. L'impact de ces parasites dans les élevages de poissons a relancé l'intérêt de leur étude. Ces parasites sont caractérisés par la formation de kystes et la présence d'une forme de propagation: la spore.

Matériel et Méthodes
La recherche des Myxosporidies et des Microsporidies a été réalisée sur des poissons frais: *Trachurus trachurus*, *Sardinella aurita* et *Symphodus tinca*, provenant des côtes Nord-Est de la Tunisie. L'observation à la loupe binoculaire intéresse toutes les parties du corps du poisson afin de détecter la présence éventuelle de kystes et de caractériser les spores en microscopie photonique.

Résultats et Discussion
Sur l'ensemble des poissons examinés, nous avons récolté une Myxosporidie du genre *Kudoa* repérée chez *Trachurus trachurus.* Elle est signalée pour la première fois dans les ovules. Nous notons que deux autres espèces de *Kudo*a ont été déjà décrites chez ce poisson au niveau des muscles et la vésicule biliaire [1].

Chez *Symphodus tinca*, nous avons rencontré une Myxosporidie du genre *Henneguya*. Cette dernière a déjà été retrouvée sur ce Crénilabre [2]. Récemment une nouvelle espèce *Henneguya tunisiensis* a été mentionnée sur les branchies de ce même poisson en provenance des îles Kerkennah [3].
Sardinella aurita est parasitée, pour la première fois, par une Microsporidie appartenant au groupe Microsporidium.

Conclusion
Les données préliminaires supportent l'idée qu'il s'agisse d'une nouvelle espèce de *Kudoa*.
L'analyse moléculaire comparative d'*Henneguya* sp. et *Henneguya tunisiensis* permettra de confirmer s'il s'agit ou non de la même espèce.
Nous avons placé la microsporidie dans le groupe polyphylétique de *Microsporidium* sp. en attendant la caractérisation ultrastructurale et éventuellement moléculaire.

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SEASONAL VARIATIONS OF THE LEVELS OF TOTAL AND CULTURABLE HETEROTROPHIC BACTERIA AROUND GOKCEADA ISLAND (THE NORTHERN AEGEAN SEA), TURKEY

Pelin Saliha Çiftçi Türetken [1]* and Gulsen Altug [1]
[1] Istanbul University Fisheries Faculty - pciftci@istanbul.edu.tr

Abstract
The aim of this study was to investigate total and culturable heterotrophic bacteria levels at the sea water samples taken from 19 stations determined around Gökçeada Island, Northern Aegean Sea. The highest total and culturable heterotrophic bacteria level was recorded at St-10 (Cape of Kömür) in summer sampling survey.

Keywords: Bacteria, Coastal waters, Surface waters, Temperature, Aegean Sea

Introduction
Heterotrophic bacteria which have important roles on the food chain and live as a part of marine ecosystem. Determination of their levels has an importance to use as alarm symptoms for the environmental pollution and sudden changes in the marine environmet, understanding of the marine ecosystem functioning [1]. Gökçeada which is situated in the North Aegean Sea is the largest island of Turkey. In this study, the variations of heterotrophic bacteria levels were investigated seasonally around Gökçeada Island coastal and off shore areas.

Materials and Methods
Seawater surface samples were taken seasonally from 19 stations that selected open sea stations, Gökçeada coastal area stations and referance station during February 2012- September 2012. The samples were taken to the sterile bottles under aseptic conditions and have been analysed at Istanbul University Fisheries Faculty Aquatic Microbial Ecology Laboratory. Marine agar and spread culture method was used in order to determine total culturable bacteria levels [2]. Then the bacteria colonies were counted and recorded. DAPI and CTC staining method was used to determinate total (living and dead) bacteria count. Epifluorescent microscope was used to estimate abundance of heterotrophic bacteria [3].

Results and Discussion
The changes of bacteria levels at 19 stations have shown in Figure 1. Maksimum culturable heterotrophic bacteria level has recorded as $11x10^{10}$ CFU/100 ml at St 10 (Cape of Komur) in summer sampling period. Maksimum total bacteria level was found $27x10^{12}$ CFU/100 ml at the same station and the same sampling period. While maximum values of heterotrophic bacteria haver reported in summer period, minimum values have recorded in winter sampling period. According to the results shown above bacteria levels were all positively correlated with seasonal sea water temperature changes.

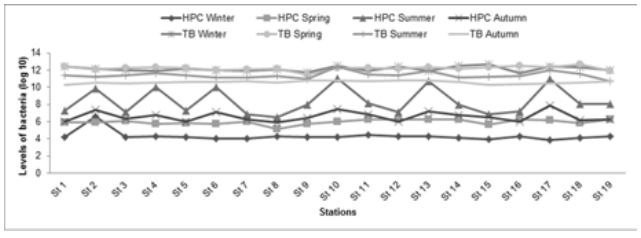

Fig. 1. Levels of total and culturable heterotrophic bacteria (Log_{10})

Acknowledgements This work was supported by Research Fund of the Istanbul University (Project no 17653).

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ÉTUDE BIOCHIMIQUE DE CINQ SOUCHES ALGÉRIENNES D'ARTEMIA (CRUSTACÉ : BRANCHIOPODE)

Abdelkader Amorouayeche [1], Mounia Amarouayache [1], Farid Derbal [1]* and Mohamed H. Kara [1]
[1] Laboratoire Bioressources Marines, Université Badji-Mokhtar d'Annaba - mfderbal@yahoo.fr

Abstract
Nous comparons ici la biochimie (lipides, protéines et glucides totaux) de cinq souches algériennes d'*Artemia*, petit crustacé d'intérêt aquacole, (*A. salina* et populations parthénogénétiques) et une américaine (*A. franciscana*). La souche américaine et la souche parthénogénétique d'El-Bahira sont les plus riches en lipides. La souche d'Ez-Zemoul (*A. salina*) est particulièrement riche en glucides. *Artemia* de Bathioua est la plus riche en protéines. Les populations parthénogénétique et mixte d'El-Bahira et de Bathioua respectivement ont une composition globale proche de la souche commerciale américaine *A. franciscana*.

Keywords: Crustacea, Biotechnologies, Aquaculture, South-Western Mediterranean, Algerian Basin

Introduction
En Algérie, l'*Artemia* (Leach, 1819) existe dans au moins 10 sites, dont certains ont fait l'objet d'études éco-biologiques [1]. Les travaux sur la biochimie ne concernent que le Chott Marouane et portent sur l'analyse des acides gras [2]. Ce travail est complémentaire et a pour objectif la connaissance de la qualité nutritionnelle des souches algériennes d'*Artemia*, en vue de leur exploitation en aquaculture.

Matériel et méthodes
Les souches étudiées appartiennent à 5 populations algériennes d'Artemia et une américaine: *A. salina* (Chott Marouane, Sebkha Ez-Zemoul), population parthénogénétique (Lac El-Bahira), populations mixtes parthénogénétique + *A. salina* (salines de Bathioua et Rélizane) et *A. franciscana* (Grand Lac Salé, Utah). L'extraction des métabolites a été réalisée sur des cystes décapsulés. Nous avons dosé les protéines [3], les lipides [4] et les glucides totaux [5] et recherché d'éventuels groupes de populations analogues (Minitab 16).

Résultats et discussion
Les résultats des taux de protéines, de lipides et de glucides sont présentés dans la figure 1. La souche la plus riche en lipides est celle d'*A. franciscana* d'Amérique (14,32%), suivie de celle d'El-Bahira (12,16%). Le taux le plus élevé de protéines est observé chez *Artemia* de Bathioua (58%), suivi de celle du Chott Marouane (51,65%). Le taux le plus bas est observé chez *A. salina* de la Sebkha Ez-Zemoul (35,14%) qui est particulièrement riche en glucides (31%).

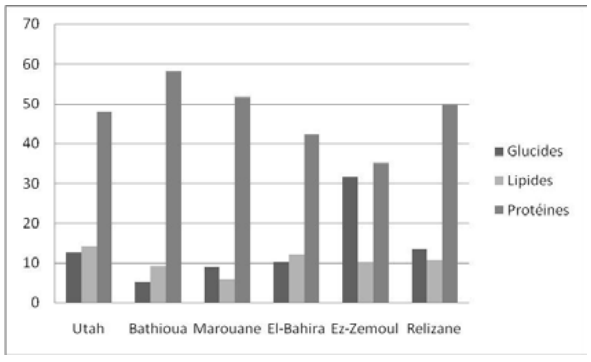

Fig. 1. Concentration des différents métabolites (% du poids sec) dans les six souches étudiées.

Dans le monde, les études portant sur la biochimie des cystes et des nauplii d'*Artemia* concernent essentiellement les acides gras [2, 6] pour leur intérêt en aquaculture. Les métabolites totaux ont été moins étudiés, particulièrement chez les cystes décapsulés, bien que cette forme soit fréquemment utilisée en larviculture [7]. L'analyse hiérarchique comparant les six souches étudiées met en évidence trois grands groupes distincts (Fig. 2): le premier groupe englobe les souches d'*A. franciscana*, parthénogénétique d'El-Bahira et mixte de Bathioua, le second groupe est composé de la population mixte de Rélizane et d'*A. salina* du Chott Marouane. La souche d'*A. salina* d'Ez-Zemoul est très différente des autres et forme un groupe à part. Du point de vue de la composition biochimique totale, les populations algériennes les plus proches de la souche américaine, la plus utilisée en aquaculture, sont celles parthénogénétiques ou mixtes.

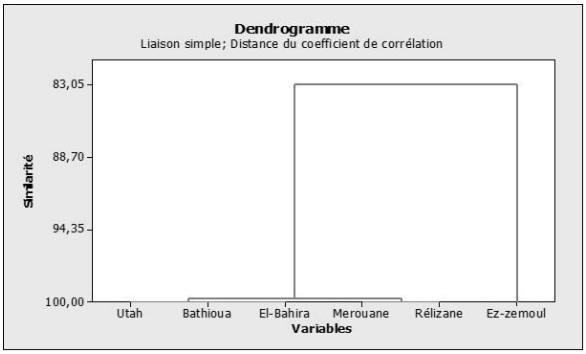

Fig. 2. Résultats de l'analyse de similarité entre les six souches étudiées.

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SETTLEMENT FEATURES OF JUVENILE STAGES OF YELLOWMOUTH BARRACUDA (*SPHYRAENA VIRIDENSIS*) IN THE LIGURIAN SEA

D. Di Blasi [1]*, E. Carlig [1], M. Chiantore [1], A. Molinari [2] and M. Vacchi [3]
[1] DISTAV, University of Genoa, Genoa, Italy - dibdavide@gmail.com
[2] RSTA scrl, Genoa, Italy
[3] ISPRA, c/o ISMAR CNR, UOS Genoa, Italy

Abstract
The yellowmouth barracuda *Sphyraena viridensis* is a termophilic fish species, now very common in the Ligurian Sea. In the available literature, information on this species is very scanty. In particular the early stages of the life cycle (e.g. settlement) are virtually unknown. An analysis of this crucial phase can be very important to understand the dynamics of the species, since the study of the characteristics of the settlement, post-settlement and recruitment is crucial to obtain information on the supply of the local population. A Visual Census survey was carried out in some locations of western Ligurian coasts between April and November 2011. Uni and multivariate analyses were used in order to evaluate the preferential habitat types and other information on these early life stages of the species.

Keywords: Fish behaviour, Ligurian Sea, Fishes

Introduction
Yellowmouth barracuda, *Sphyraena viridensis* is one of the two species reported in the waters of the north-western Mediterranean Sea (the other is *Sphyraena sphyraena*) [1, 2]. Visual Census has allowed us to collect the necessary data for the analysis of the habits and distribution, during the important stages of settlement, post-settlement and recruitment, so far little known.

Materials and methods
To investigate the habits and distribution of juveniles of *S. viridensis*, we applied a sampling design with four habitats (semi artificial pier, gravel beach, artificial ballast, semi submerged cliff), replicated in two areas along the western Ligurian coast. 3-way ANOVA, with the factors time (orthogonal and random), area (orthogonal and random) and habitat (fixed and orthogonal), and 2-way with the factors time (orthogonal and random) and habitat (orthogonal and fixed), incorporating the two areas in a single series of replicates, were used to determine whether the juveniles of *S. viridensis* show a preference for specific habitat types among those taken into consideration and to show how their abundance varied over time. Further investigations on the differences among habitats and among times were made taking into account also the species that have are known to be preyed upon by juveniles of *S. viridensis* and could affected their distribution (juveniles of *Diplodus sargus*, *Oblada melanura* and *Atherina sp*.). An MDS plot was produced using the Bray-Curtis index to measure the similarity between the different visual transects collected at different times and in different habitats. PERMANOVA was used to assess the differences between the tested factors**.**

Results
Boyh 3-way and 2-way ANOVA results have shown that the factor habitat does not influence significantly the settlement of juveniles, whose density varies rather significantly in time. This result is confirmed by the MDS plot and PERMANOVA, for which also those fish species preyed upon by *S. viridensis* have been taken into account. Furthermore, these species seems not to affect the distribution of juveniles of this species, as demonstrated by the low correlations obtained with correlation plots.

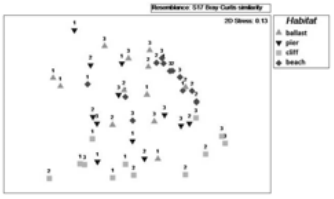

Fig. 1. MDS plot developed to investigate the differences among habitats and among times taking into account the distribution of juveniles of *S. viridensis* and their main preys

Other studies have been done in this framework regarding the mortality of small *S. viridensis* and their growth rate, that were never conducted earlier for this species. In particular, growth seems quite rapid (almost 2 mm per day, achieveing recruitment at a length of about 20 cm).

Discussion
From all the results we can affirm that *S. viridensis* can establish without distinction in all the considered habitat types, when their length is 5 or 6 cm, showing a variation of abundance that, after an initial period of settlement, which occurs in early summer, is decreasing to settle on values rather constant during the remaining summer months. The fact of not having spotted juveniles of *S. sphyraena* leads us to think that probably the settlement for this species occurs in habitats different than those used by juveniles of *S. viridensis*. This could be an example of segregation between juveniles of congeneric species [3], in this case spatial. The information obtained from the literature [4] could reinforce this conclusion: it is shown that the habitats suitable for settlement of juveniles of *S. sphyraena* are mainly sandy bottoms, an habitat type that is not between those sampled in the study. Finally, the high growth rate recorded, which allows to reach a larger size before winter, makes it possible to accumulate a good amount of lipids and to face more successfully the cold season [5].

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ORGANISATION FONCTIONNELLE ET VARIABILITÉ SPATIALE DE LA MACROFAUNE BENTHIQUE DE LA LAGUNE D'ELBIBAN ET DU PORT DE ZARZIS (SUD-EST TUNISIEN)

Hanem Djabou [1]* and Ahmed Afli [1]
[1] INSTM salammbo, tunis - hanem.djabou@laposte.net

Abstract
Deux zones côtières tunisiennes, la lagune d'El Biban et le port de pêche de Zarzis plus ou moins exposés aux activités anthropiques, ont été étudiées. Le sédiment a été prélevé par plongée autonome, les descripteurs statistiques et les indices de diversité ont été déterminés. Les résultats montrent que les deux écosystèmes présentent des signes d'eutrophisation. L'organisation trophique révèle une dominance des organismes déposivores dans le port, alors que la lagune est dominée par les herbivores. Une analyse des correspondances effectuée sur les valeurs des paramètres physico-chimiques enregistrées montre des différences notables entre les deux sites étudiés, et aussi entre les stations du même site.

Keywords: Coastal systems, Eutrophication, Trophic relations, Zoobenthos, South-Western Mediterranean

Très productifs, les écosystèmes paraliques subissent des perturbations fréquentes et brusques pouvant provoquer des variations considérables dans les facteurs physico-chimiques ainsi que dans l'organisation fonctionnelle de la macrofaune benthique [1]. Elément clé des écosystèmes côtiers, les communautés benthiques jouent un rôle essentiel dans la décomposition des détritus, le cycle des nutriments et le flux d'énergie vers les niveaux trophiques supérieurs [2]. Elles représentent également un outil biologique important pour l'évaluation de l'état écologique des écosystèmes puisqu'elles montrent des réponses différentes en fonction de la nature et de l'ampleur des perturbations naturelles et anthropiques [3]. Les travaux sur la macrofaune benthique du sud de la Tunisie sont rares et se limitent généralement à l'étude d'une ou de quelques espèces seulement sans évoquer l'état général des communautés [4]. Dans ce travail, on se propose d'étudier l'état écologique de deux milieux du Sud-Est tunisien, la lagune d'El Biban et le port de pêche de Zarzis. Il s'agit d'étudier la structure et l'organisation fonctionnelle des communautés en réponse aux principaux facteurs anthropiques et environnementaux. Au total, 21 stations ont été échantillonnées, quatorze lagunaires et sept portuaires. L'échantillonnage a été réalisé par plongée et un total de 0,50 m² a été prélevé à raison de deux prélèvements par station. Les échantillons ont été tamisés sur une toile de 1 mm² de vide de maille et les macro-invertébrés ont été prélevés et identifiés. Les données de base considérées sont le nombre d'espèces ou richesse spécifique S, l'abondance A qui peut être exprimée en densité moyenne ou totale par unité de surface (N/m²), l'indice de diversité de Shannon-Wiener H' (Shannon & Weaver 1963) et l'indice d'équitabilité J' (Pielou 1966). Les principaux paramètres physico-chimiques ont été étudiés. Il s'agit de la température, de la salinité, de l'oxygène dissous, de la granulométrie et des éléments nutritifs, à savoir les nitrites, les nitrates, l'azote ammoniacal et les ortho-phosphates. Une analyse des Correspondances (CA) a été établie sur les valeurs de similarité de Bray-Curtis entre les groupes trophiques et les principaux paramètres physico-chimiques. Au total, 53 espèces ont été identifiées dans la lagune d'El Biban dont plus de 32% sont communes avec le port de pêche de Zarzis. La richesse spécifique moyenne ***S*** dans la lagune est deux fois celle du port, et l'abondance ***A*** est en moyenne douze fois plus importante dans la lagune. Ces paramètres ne présentent pas de forte variation spatiale. L'organisation trophique révèle une dominance des organismes déposivores dans le port, alors que la lagune est dominée par les espèces herbivores. L'analyse (Figure 1) montre des différences notables entre les deux milieux ainsi qu'au sein des stations lagunaires. Trois groupes peuvent être identifiés par cette analyse.Le premier regroupe les stations portuaires (les SDF et l'élément PO^3). Le deuxième groupe est composé des groupes trophiques SF, DF, NSDF, C et µB et la plupart des stations lagunaires, hormis la station BIB13 qui forme un groupe à part ayant une forte corrélation avec la fraction sédimentaire fine. Les autres paramètres physico-chimiques sont situés au milieu du graphique et semblent avoir presque la même influence sur les différentes stations.

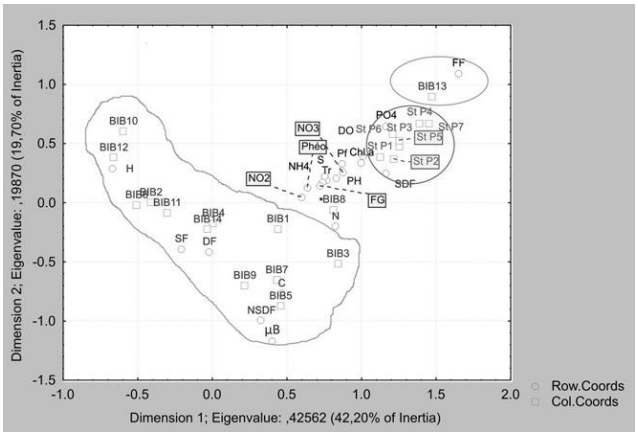

Fig. 1. Analyse des correspondances établie entre les groupes trophiques et les paramètres physico-chimiques

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LEVELS OF BACTERIAL POLLUTION IN SURFACE WATERS OF MARMARIS BAY IN TURKEY

M. Didem Ercan [1]*, Canan Ontas [1] and Nedim Ozdemir [1]
[1] Mugla Sitki Kocman University, Fisheries Faculty, Kotekli, Turkey - dican@mu.edu.tr

Abstract
Indicator bacteria and V. cholerae levels were investigated in water samples from 18 stations in the Marmaris Bay, Mugla, between May 2011 and April 2012. As a result total and fecal coliform contamination in the water was found over the limit.

Keywords: Bacteria, Aegean Sea

Introduction
Marine pollution is an event of mixing the water with concentrate of unwanted harmful substances that may impair the quality of water can be measured. Logarithmic growths of microorganisms in nature occur rarely. In this way for a rapid reproduction and abundant presence of nutrients as well as the physicochemical conditions must be optimal. If pollution reaches serious level, environment can become toxic that aquatic life is limited [1]. Also, changes in the natural levels of bacteria, depending on environmental pollution factors, affect adversely the ecosystem and public health [2]. In this study, indicator coliform bacteria and *V. cholerae* levels were investigated in water samples in the Marmaris Bay. This is the first study about investigation of bacterial pollution of the Marmaris Bay that place is touristic.

Materials and Methods
Surface (0-30 cm) sea water was sampled in to the sterile bottles monthly, between May 2011 and April 2012. Membrane filtration and streak plate method were used for bacterial analysis. In streak plate method, ENDO agar for coliforms and TCBS for *V. cholerae* were used. Determination of indicator bacteria were carried out according to described method [3]. For *V. cholerae* identification, biochemical tests [4] and API20E kits were used. Nitrite, nitrate, phosphate and Cl-a levels were measured by spectrophotometrically [5].

Results and Discussion
Monthly results of coliforms analysis were given in figure 1 and 2. Our findings were evaluated according to European Union Blue Flag Project Standards; total coliform limit value is 500 cfu/100 mL (base on log10 is 2,7/100 mL), fecal coliform limit value is 100 cfu/100 mL (base on log10 is 2/100 mL).V. cholerae suspected colonies, growth on TCBS, was identified non V. cholerae by biochemically tests. In the summer, total and fecal coliform levels were high in the beach and marina. Mugla city has increased the number of tourists every year more and more. Marmaris, town of Mugla, covers about 40% of the foreign tourists. According to the findings, in the stations 1,4,6,8,9,11,13,15,16,17 were polluted with fecal contaminant in the summer. But, number 6 and 8 were found below the limit values. Also, open water stations affected by sea shore with currents and sea vessels. All this results were observed in the tourism season, it exceeds the limit values to be associated with the input of organic matter revealed by analysis of the nutrients. The areas which exceeds the limits were not suitable for use recreational aims. The Marmaris Bay is under the effects of biological pollution due to the fact that heavily populated with dwelling and hotel guests, and blue cruises. If measured bacterial contamination in the summer increase in the coming years that is expected to be led to the emergence of infectious diseases.

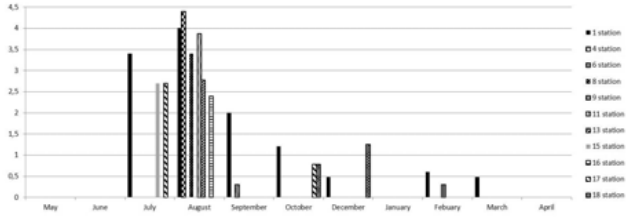

Fig. 1. Levels of Fecal Coliform in water samples collected from Marmaris Bay, Turkey, during one year(2011)

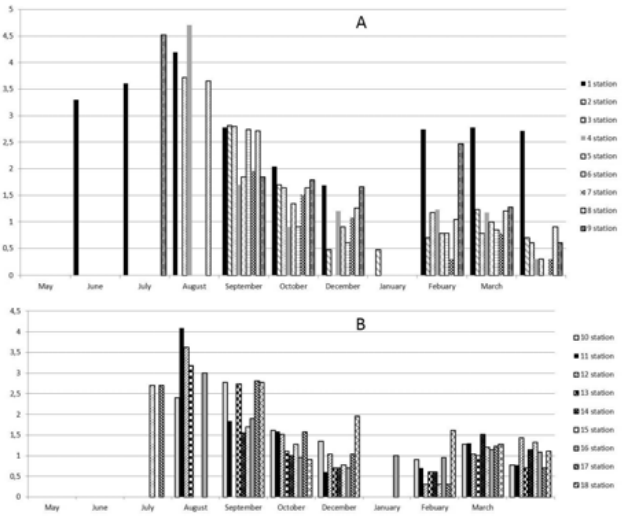

Fig. 2. Levels of Total Coliforms, in water samples collected in Marmaris Bay, TURKEY. log10 CFU/100mL A.1st sampling, B. 2nd sampling.

Acknowledgements
The authors would thank Prof. Gulsen Altug and Pelin S. Ciftci, Istanbul University, Faculty of Fisheries, for their valuable advices and contribution.

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GROWTH PERFORMANCE OF SEA BREAM (*S. AURATA*) JUVENILES AFTER WINTERING PERIOD

Ertan Ercan [1]*, Murat C. Sunar [1] and Lütfi Kömez [1]
[1] MUGLA SITKI KOCMAN UNIVERSITY FISHERIES FACULTY - ertanercan@mu.edu.tr

Abstract
Earthen pond aquaculture is one of the parts of marine aquaculture of Turkey. Wintering the juveniles of the marine fish in the earthen ponds is the general trend for fish farmers in Mugla region. In this study, we would like to determine the effects of salinity to the growth performance after wintering conditions on sea bream fry. Three different salinity rates (‰10-18-24) used in thisstudy which were produced by reverse osmosis system. The best growth performance is found at ‰ 18 salinity.

Keywords: Aquaculture, Aegean Sea

Introduction
Sea bream is one of the benthic species, which lives at 5-50 ‰ salinity and between 5-32 ° C temperatures [1]. Having this kind of a big tolerance to the environmental conditions, sea bream have a very good market for many years. Today, many studies are continuing on this species. Because of the rapid development of the aquaculture, we need larger number of studies for wider spectrum of economic fishes [2, 3]. Physiological and biological studies on sea bream are relatively less than other aquaculture species. Difficulties in culture of this species make the studies on the species difficult and the main challenges are to acclimatize the species to laboratory and culture conditions [2, 4, 5 ,6]. In Turkey, most of the studies accomplished on the larval stage of this species aimed to increase the survival rate, growth performance, artificial feeds, larval rearing protocols and treatment of diseases of the species. Salinity is one of the most important environmental factors affecting growth rate. The relationship between salinity and growth has substantial effect on the cultivation methods of many important fish species. The osmoregulation mechanism in fish is for osmotic balance and balanced energy required for growth. For example, osmotic balance on energy consumption for marine fish, cultured water is considered to be the most suitable in the iso-osmotic salinity (12 ‰) for the growth [7]. In this study, we aim to find the wintering effects on the growth performance of sea bream fries in three different salinity levels (‰ 10, ‰ 18, ‰ 24).

Material and Methods
Three different salinity levels (‰ 10 ‰ 18 ‰ 24) were generated by using reverse osmosis system. Paralleled groups were placed with 15 individuals. Each fish was anesthetized with 0.5 mL/L ratio phenoxyethanol to take the biometric measures then they were placed into the tanks. The system was heated by aquarium heaters, aerated with aquarium pumps. The volume of the each tank was 70 L. Each day, half of the system water was renewed. Fish were fed twice in a day with ad libitum. At the end of 15-day trial growth of sea bream, weight and length were examined and the growth rate, specific growth rate (SGR), feed conversion rate (FCR) and condition factor (CF) values were calculated and the results are given in Table 1. Also water quality parameters were measured during the study (Table 2).

Results and Discussion
The results of this study suggested that the best growth rate, weight gain, SGR, FCR and CF were in the group of 18‰. As it is well known, water quality is the most important factor affecting fish growth. The results of this study also showed that the water quality in 18‰ salinity level had the best as is the growth rate.

Tab. 1. The growth parameters of the groups.

Salinity	Time		Inital	Final	Mean Gain	SGR	CF Initial	CF Final	FCR
‰10	15 days	L(cm)	9,26	9,55	0,29	0,21	1,42	1,31	3,5
		W(g)	11,24	11,7	0,45	0,26			
‰18	15 days	L(cm)	8,44	8,68	0,24	0,19	1,34	1,31	3
		W(g)	8,05	8,6	0,55	0,44			
‰24	15 days	L(cm)	8,6	8,77	0,17	0,13	1,4	1,34	4,6
		W(g)	8,9	9,01	0,11	0,08			

Tab. 2. The water quality parameters of the study.

Water Quality Parameters			
Salinity	‰9	‰18	‰24
O_2(mg/lt)	5	5.3	5
pH	8	8.07	8.17
NH_4(mg/lt)	0.09	0.07	0.1
NO_2(mg/lt)	0.41	0.20	0.91
NO_3(mg/lt)	3.89	3.06	14.4
PO_4(mg/lt)	0.65	0.51	0.55
Temperature(°C)	20.6	20.6	20.6

Our findings on weight gain, specific growth rate, condition factor values overlapped with the results found in other studies on sea bream [8,9,10]. However, our study indicated higher feed conversion ratio compared to other studies. This result is important for the earthen pond farmers that prefer to take their sea bream larvae before the winter time. This kind of a value of FCR rate means loss of money for the farmers.

Acknowledgements
Authors would like to thank May-Su Sanayi Pazarlama Ithalat Ihracat A.S. for giving this opportunity. This study supported by TUBITAK(Project number: 709O218).

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UTILISATION DES PARASITES COMME MARQUEURS BIOLOGIQUES POUR LA DISCRIMINATION DE STOCK DE *SCOMBER JAPONICUS*

Mariam Feki [1]*, Lobna Boudaya [1] and Lassad Neifar [1]
[1] faculté de sciences de sfax - feki_mariam@yahoo.fr

Abstract
Des analyses discriminantes non paramétriques, utilisant neuf taxons parasites comme marqueurs biologiques de Scomber japonicus, ont permis de séparer les maquereaux en provenant de quatre localités des côtes tunisiennes (Bizerte au Nord, Kélibia et Mahdia à l'Est et Zarzis au Sud) en trois stocks. Les parasites, essentiellement les Monogenea seraient de bons marqueurs biologiques pour discriminer les stocks.

Keywords: Fishes, Parasitism, Stock assessment, Tunisian Plateau

La production de *Scomber japonicus* en Tunisie a atteint 4725 tonnes en 2011 [1]. Ce poisson, pêché le long de la côte tunisienne, présente une biomasse variable selon les localités [2]. Pour une gestion durable de cette ressource, l'identification d'éventuels stocks est indispensable. Dans ce travail, les parasites sont utilisés comme marqueurs biologiques pour la discrimination des stocks. Ils présentent l'avantage d'être plus faciles à manipuler que les marqueurs artificiels et plus efficaces pour l'étude des petites et délicates espèces comme les Scombridae [3]. 369 individus de *S. japonicus* ont été échantillonnés aux des points de débarquement de 4 localités, Bizerte, Kélibia, Mahdia et Zarzis. Les coordonnées de pêche ont été soigneusement prélevées avec la collaboration des pêcheurs.

Fig. 1. Localisation des stations d'échantillonnage

Chaque poisson a été examiné afin de rechercher tous les macroparasites. Pour chaque espèce parasite, la prévalence et l'abondance moyenne ont été calculées [4]. Les variations géographiques de ces paramètres ont été testées par les tests statistiques X^2 et ANOVA. Une analyse discriminante a été réalisée pour séparer les maquereaux des différentes régions. Trois Monogenea *Grubea cochlear*, *Kuhnia scombri* et *Kuhnia minor* ont été récoltés au niveau des branchies. Six endoparasites : 4 Digenea, *Prodistomum orientalis*, *Opechona bacillaris*, *Monascus filiformis* et *Lecithocladium excisum*, un Acanthocephala *Rhadinorhynchus* sp. et un Nematoda Anisakidae ont été identifiés au niveau du tube digestif. Les 3 Monogenea et deux Digenea *M. filiformis* et *O. bacillaris* sont totalement absents au niveau de Bizerte. La comparaison de la prévalence et de l'abondance moyenne entre chaque deux régions a montré des différences significatives entre Kélibia et Bizerte pour *P. orientalis* (χ^2=8,51 ; d.d.l=1; p<0.05), (F=14,94 ; d.d.l=1 ; p<0.05) et *L. excisum* (χ^2=20,06 ; d.d.l=1 ; p<0.05), (F=36,82 ; d.d.l=1 ; p<0.05). La prévalence et l'abondance des 3 Monogenea ne présentent aucune différence significative entre Kélibia et Mahdia (p>0,05). *O. bacillaris* (χ^2=4,55 ; d.d.l=1 ; p<0.05), (F=6,42 ; d.d.l=1 ; p<0.05), et *Rhadinorhynchus* sp. (χ^2=5,36 ; d.d.l=1 ; p<0.05), (F=6,25 ; d.d.l=1 ; p<0.05) sont plus prévalents et abondants à Mahdia. *G. cochlear* (χ^2=17,05 ; d.d.l=1 ; p<0.05), (F=21,73 ; d.d.l=1 ; p<0.05) est plus prévalent et abondant à Mahdia qu'à Zarzis. L'analyse discriminante a pu séparer les *S. japonicus* des 4 régions en trois stocks (lambda de Wilks=9,34 ; p<0,01).

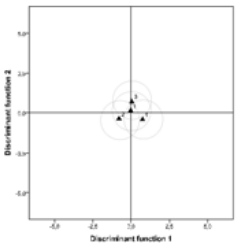

Fig. 2. Analyse discriminante séparant les maquereaux des différentes localités 1Kélibia, 2 Bizerte, 3 MAhdia et 4 Zarzis

Un au niveau de Bizerte (Nord de la Tunisie), un rassemblant les individus de Kélibia et Mahdia (Est de la Tunisie) et un au niveau de Zarzis (Sud de la Tunisie). Les parasites, essentiellement les Monogenea à cycle direct et spécifiques de leurs hôtes seraient de bons marqueurs biologiques pour discriminer les stocks.

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OPTIMISATION ET CARACTÉRISATION DE L'ACTIVITÉ PROTÉOLYTIQUE CHEZ LA SOUCHE *SALICOLA* SP. ISOLÉE DE LA SALINE DE SFAX EN TUNISIE

D. Frikha [1]*, S. Masmoudi [1], H. Trigui [1], F. Ghanmi [1] and S. Maalej [1]
[1] Faculté des sciences de Sfax - fdonyez@yahoo.com

Abstract
Salicola sp. (Souche ETR14) est une bactérie halophile extrême isolée des eaux de la saline de Sfax en Tunisieau niveaude la table de cristallisation du sel. Cette souche, identifiée par la méthode polyphasique a été criblée en termes d'activités hydrolases. Nos résultats montrent cette souche dispose d'une forte activité protéolytique. L'activité protéase a été optimale en présence de 4% de glucose, 1% de tryptone et 1% de $MgSO_4$. De plus, elle était optimale à une température de 60°C et à un pH de 9, alors que la dénaturation thermique à 70°C, n'affecte que 13 % de cette activité après 1 h d'exposition.

Keywords: Bacteria, Tunisian Plateau

Introduction
Les bactéries et les archées halophiles ont émergé en tant que sources possibles et importantes d'hydrolases résistantes à la salinité et à la dénaturation thermique [1]. Parmi ces hydrolases, les protéases produites par des bactéries halophiles extrêmes présentent un intérêt biotechnologique considérable [2]. Quelques travaux sur la saline de Sfax en Tunisie ont montrés que les bactéries du genre *Salicola* dominent dans les eaux des tables de crsitallisation du sel [3]. Dans ce travail, l'activité protéase de la souche ETR14 a été optimisée et caractérisée.

Matériel et méthodes
ETR14 a été isolée sur milieu R2A à pH 7,4 et à une température de 37°C puis identifiée par amplification et séquençage du gène codant pour l'ARNr16S. L'activité protéolytique a été détectée sur milieu solide DSC additionné de 20% de lait écrémé [4] et l'activité a été dosée selon la méthode de Kembhavi en 1993 [5]**.** Pour améliorer l'activité protéase, différentes sources de carbone (glucose, maltose, amidon, sucrose et xylose) et d'azotes (urée; peptone; tryptone; NH_4Cl) ont été testées à une concentration finale de 1 % (w/v). De plus, d'autres cations comme le Ca^{2+} ; Mg^{2+} ; Mn^{2+} ; Zn^{2+} ont été testés en ce qui concerne leur aptitude à améliorer l'activité protéase. La stabilité de l'activité protéolytique a été testée vis à vis du pH en utilisant un tampon phosphate (0,1M) pH 6 ; 6,4 ; 7,4 et 8, un tampon Tris-HCl (0,2M) pH 8,5 et un tampon Glycine-NaOH (0,1M) pH 9 et 10. Pour déterminer la stabilité face à la dénaturation thermique, l'extrait enzymatique a été exposé 15 min à 30, 40, 45, 50, 55 et 60°C et l'activité protéolytique résiduelle a été estimée par rapport à un contrôle non traité.

Résultats
La souche ETR14 isolées des eaux de la table de cristallisation du sel TS18 est capable de supporter des concentrations en sel comprises entre 100 et 250 g/l, avec une vitesse spécifique de croissance maximale en présence de 200 g/l de sel. Ces résultats suggèrent que ETR14 est une souche halophile extrême. L'identification de cette souche par l'analyse de l'ARNr 16S montre qu'elle est affiliée au genre Salicola, famille des *Halomonadaceae*, classe des *Gamma-Proteobacteria*, phylum des *Protobacteria* et domaine des *Bacteria*. Salicola sp. montre une activité protéolytique importante sur milieu solide DSC-97 contenant 20 % de lait écrème alors qu'elle est protéasenégative sur le milieu R2A. Le meilleur halo de l'activité protéolytique a été détecté sur milieu solide à 200g /l de sel ce qui nous a permis de classer cette protéase parmi les halophile extrêmes.La production enzymatique a été optimale en présence de 4% de glucose en tant que source de carbone, 1% de tryptone comme source d'azote et 1% de $MgSO_4$. De plus, l'activité protéolytique était optimale à une température de 60°C et à un pH de 9, alors que la dénaturation thermique à 70°C, n'affecte que 13 % de l'activité protéolytique après 1 h d'exposition.

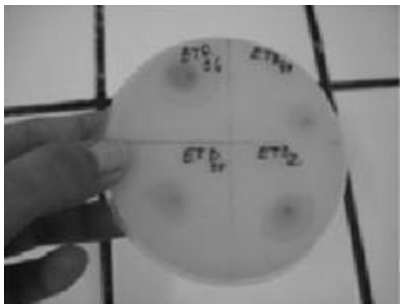

Fig. 1. Mise en évidence des activités protéase chez *Salicola sp*.sur milieu solide (DSC-97)

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BIOMASS DISTRIBUTION OF NORWAY LOBSTER, NEPHROPS NORVEGICUS, OFF CATALANO-LEVANTINE MEDITERRANEAN COAST OF SPAIN (CGPM-GSA 06).

Mariano Garcia Rodriguez [1]* and Jose luis Perez Gil [1]
[1] INSTITUTO ESPAÑOL DE OCEANOGRAFIA - mariano.garcia@md.ieo.es

Abstract
The Norway lobster, a demersal species found on muddy bottoms, is a sedentary lobster that inhabits borrows built in the mud, and is present at depths ranging from 20 to 800 m. We analysed its biomass distribution in the Mediterranean coast of Spain (GSA06), and the influence of some abiotic factors in such distribution, using survey data from 2006 to 2012. Our results reveal that, during this time interval, Norway lobster biomass distribution was shaped by the temperature and, more clearly the salinity of the water masses. Depth was the most important factor, negatively affecting the species biomass, which decreased dramatically below 500 m depth.

Keywords: Decapoda, Biomass, South-Western Mediterranean

Introduction
The Norway lobster (*Nephrops norvegicus*) is a demersal species found on muddy bottoms in the North-Eastern Atlantic and the Mediterranean, being common in the coasts of the Iberian Peninsula. It is a sedentary lobster that inhabits borrows built in the mud and is found at depths ranging from 20 to 800 m. This species is among the most valuable resources for the trawl fleets in the studied area (GSA06), with landings reaching an average of 470 t per year (2007-2012) and showing some stability along time. Patchiness of the species populations seems to be related to both heterogeneity in the characteristics of the sediments [1] and variations in fishing effort [2]. In addition, it is often argued that marine organisms may respond to a combination of depth-related factors such as availability of food, light, temperature and pressure [3]. Here we present an exploratory study on the influence of some of these abiotic factors on the biomass distribution of the Norway lobster.

Material and Methods
Sampling took place in the Catalano-Levantine coast of Spain (FAO-GFCM Geographic Sub Area 06, GSA 6). All samples were collected during the course of seven consecutive MEDITS_ES International Spring Trawl Surveys (from 2006 to 2012) according to the international standard methodology [4]. Depth, temperature and salinity were recorded with a CTD SBE-37 probe located in the mouth of the gear. For each of these variables, 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 (from 2006 to 2012) and latitude were also considered as factors. Species biomass per haul was calculated as the catch in weight per swept area and expressed as kg/km^2. G.I.S. was used to generate a distribution map by kriging. Data were normalised by logarithmic transformation, and the relationship between the different factors and species biomass was analysed by linear and multiple regressions (GLM), applying a simple model without interactions. Analyses comprised data from 145 hauls.

Results and Discussion
Nephrops norvegicus biomass values ranged from 0.113 to 230.0 kg/km^2, with an average of 16.22 kg/km^2. The average biomass of the species seemed to be stable along time, showing overall lower abundances in Southern (Levante) than in Northern (Catalonian coasts) latitudes, with the highest biomass values found in some locations (Gerona, Barcelona, and Ibiza channel). The species was present in almost all the depth range studied, occurring from 76 m to 819 m, although the maximum biomass values were concentrated in the 200-500 m depth interval. Average length of individuals was significantly smaller in Catalonian coasts, being related with a more intensive exploitation [5]. In the area of study, both salinity and temperature are positively correlated with depth, showing a gradient on both the continental shelf and the upper slope. These gradients correspond to the Modified Atlantic Water (MAW) and to the Levantine Intermediate Water (LIW), in the shelf and the slope respectively, and to the Western Mediterranean Deep Water (WMDW) in the Ibiza channel [7]. In this sense, the species biomass appeared distributed in ranges of temperature and salinity 1.241 C^o and 0.618 psu wide, respectively, with averages of 13.180 C^o (±0.166 S.D.) for temperature and 38.423 psu (±0.133 S.D.) for salinity. These values are closely related to the LIW. Overall, our model explained 26% of the observed deviance. Biomass increased, although not significantly, with temperature, which explained 1.8% of the deviance (F=3.3257; p= 0.070). It also increased, in this case significantly (F=16.397; p= 0.0000865), with salinity, which coped with 9.1% of the deviance. On the other hand, bathymetric distribution (depth) explained 12.3% of the deviance, being negatively correlated (F=22.149; p= 0.0000062) with biomass, which decreased as depth increased, especially below 500 m depth.

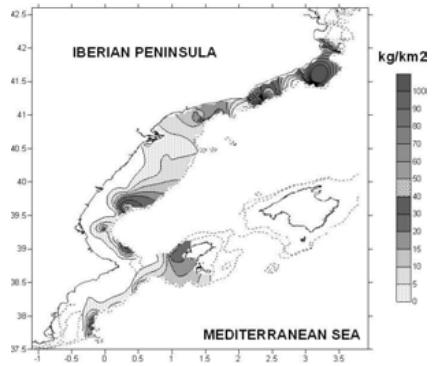

Fig. 1. Representation of the biomass distribution of *Nephrops norvegicus* in the studied area

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EVALUATING QUALITY OF CORALLIGENOUS ASSEMBLAGES: PRELIMINARY RESULTS OF THE RAPID VISUAL ASSESSMENT METHOD

Giulia Gatti [1]* and Stéphane Sartoretto [2]
[1] Department of Hearth, Evironmental and Life Sciences, University of Genoa, corso Europa 26 - 16132 Genoa, Italy - giulia.gatti@unige.it
[2] Ifremer - Centre de Méditerranée, Zone Portuaire de Brégaillon - BP 330 - 83507 La Seyne sur Mer cedex, France

Abstract
The Rapid Visual Assessment (RVA) method, proposed for the evaluation of coralligenous quality, was applied on assemblages differently affected by human pressures. Result showed that RVA is able to reveal the health status of the assemblages. Future activities will compare the RVA with an index under development (INDEX-COR).

Keywords: Coastal systems, Monitoring, Sampling methods, North-Western Mediterranean

Introduction
Despite the great importance of coralligenous habitat [1], due to its large distribution and specific richness, standardised methods for its study are still lack. Thus, the health status of coralligenous remains scarcely broached. Since the European Marine Strategy Framework Directive (MSFD, 2008/56/EEC) required to reach a good environmental status of coastal ecosystems, different approaches aimed to assess the health status of coralligenous assemblages started to be developed [2, 3]. Here we present the preliminary results obtained by the application of the Rapid Visual Assessment (RVA) method proposed by Gatti *et al*. [4] and based on a seascape approach. The final aims of this study are the improvement of the methodology and the intercalibration with another index under development (INDEX-COR).

Materials and Methods
The RVA was applied between Marseilles and Toulon (France). Six sites differently affected by human pressures were selected:
· Marseilles - Low pressure: Cap Caveau (Frioul Island); reference: Moyade; high pressure: Northern Plane Island (sewage outfall)
· La Ciotat - Low pressure: Bec de L'Aigle; high pressure:Figuerolle (sewage outfall)
· Toulon - Reference: Eastern "Sêche des pêcheurs".
We considered three layers to describe the structure of assemblages [5]: Basal layer (0-1 cm height), Intermediate layer (1-10 cm) and Upper layer (> 10 cm). Several descriptors were considered to characterise the geomorphology and to evaluate the quality of the coralligenous. A score comprised between 1 (low quality) and 3 (high quality) was given for each layer and finally a mean global score was computed in order to obtain the quality value of each site.

Results and Discussions

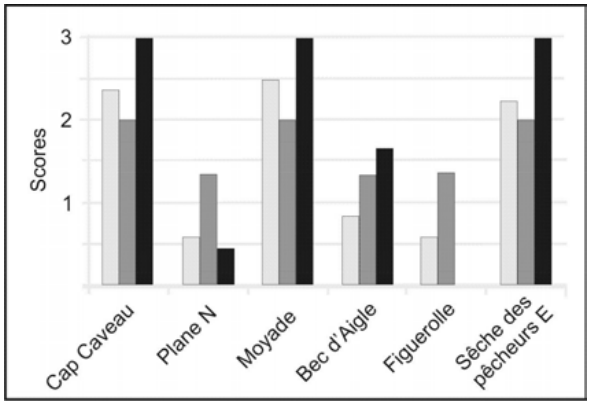

Fig. 1. Quality Scores per layer. Light gray: Basal layer; dark gray: Intermediate layer; black: Upper layer.

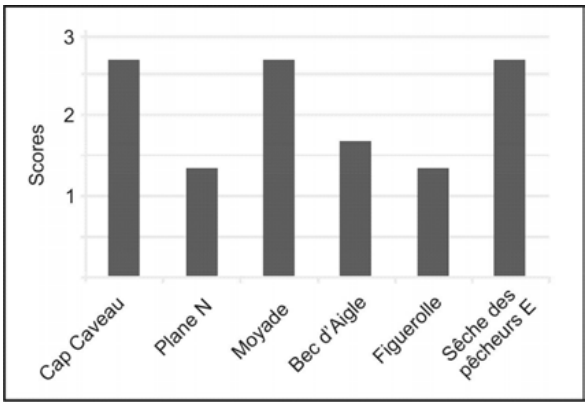

Fig. 2. Global Quality Scores (= mean value of layers Quality Scores).

The RVA approach revealed that, even in the same site, the three layers can show different dynamics. Anyway, global scores disclosed that RVA distinguished well the lower quality of high impacted sites from low or non-impacted ones. The next step will complete these preliminary results and will compare the RVA method with the INDEX-COR approach.

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UNEXPECTED BEHAVIOR OF THE SHARK

B. Gul [1]*, K. Sato [2], T. Mori [2], I. Nakamura [2] and S. Durna [1]
[1] Ege University Faculty of Fisheries - benalgul@yahoo.com
[2] The University of Tokyo Atmosphere and Ocean Research Institute

Abstract
We conducted research of the movements and behavior of the smooth hound shark (*Mustelus mustelus*) using biologging method in the Edremit Bay, Turkey. During the pool experiments two sharks were attached with accelerometer, and it was observed that one of the sharks was trying to remove the accelerometer by swimming on its back and rubbing it to the pool bottom. The behavior of sharks were identified by acceleration data and video records. This paper, aims to report the unexpected reactions of the shark, and to present the importance of monitoring experiments at captive conditions.

Keywords: Fish behaviour, Edremit Bay

Introduction: Assessing animal behavior is essential to understand life history (1). Using the animal-borne devices is crucial for marine and fisheries studies. Bio-logging methods are being used for a wide variety of species such as sea birds, fishes, marine mammals, and sea turtles. To obtain behavioral data of the animal, or to proper analyze the information contained by loggers, not only the effect of attaching logger on animal, but also reaction of the animal to the attaching logger should be investigated. Sharks are the target species for the fisheries in Turkey. Although not being used as food, the extended amount of export and selling of the smooth hound shark to aquariums.. Therefore the smooth hound shark is being caught by fisherman in the Edremit Bay. In this region, there is less information regarding the movements and behavior of this species. Bio-logging study on the *Mustelus mustelus* to understand the movements and behavior has started in in August 2012. In this study, we are explaining that how the shark has tried to remove the logger during pool experiments.

Material and Methods: We caught two female Smooth hound sharks (113cm and 4 kg, 105 cm and 4.3 kg, respectively) by demersal longline in Edremit Bay and kept in 19 tons pool. We attached the accelerometer W190-PD3GT (21 mm in diameter, 116 mm in length, 60 g in air; Little Leonardo, Japan) between 18 and 21 August 2012. Sampling rates were 32 Hz for acceleration. After anesthesia the accelerometer were attached on the back front side of the first dorsal fin using plastic cable ties through two tiny holes. The sharks were put back into the pools and left for them to come out from the anesthesia. After 17 hours, we placed video camera (550HDRX, Sony) with waterproof housing was placed into the corner of the pool, and audio-visual recordings obtained during day time in 2 different periods (around between 10:00 -12:00 and 14:00-16:00). Total 9 hours footage were recorded during 3 days. Acceleration data were analyzed using Igor Pro 6.2. To identify the specific behaviour, we used dorsoventral and lateral acceleration data throuth 0,59 Hz low pass filter and extracted the specific events automatically with these acceleration data (Mask analysis). Finally we make sure the time wen extracted events occured and checked shark behavior when occured in same time by observing video records.

Results: Video records show 4 rolling and rubbing events. Analysis of acceleration of behaviors determined 13 rolling events which includes rolling events observed by video record (Fig 1). All events occured at daytime and in the first 36 hours. After detach the accelerometer, the attachment points had become even more injured, probably because of rubbing. Additionally, video records showed one more different type of rolling and rubbing behavior of the sharks. The shark changed its body position upside down and hit accelerometer to bottom twice with half rolling at the same side of the body.

Discussion: Pool experiment helped us to determine that reaction of shark and leads us to think about alternative attachment place and technique. That kind of behavior can be harmful for animal and also for devices, and can affect success of logger recovery. Similar behavior of shortnose sturgeon (*Acipenser brevirostrum*) that rubbed external transmitters along tank sides and bottom were reported. According to the reports express that, externally attached transmitter loss began at second day because rubbing (1,3). By using video records, we could identify that unexpected behavior more easily. The use of video is a good means of capturing uncommon or previously unknown behavior of captive animals (2). In conclusion, before release animal attached logger, pool experiments is important. During that period, continuously audio-video recordings can help to identify unexpected behavior of animals.

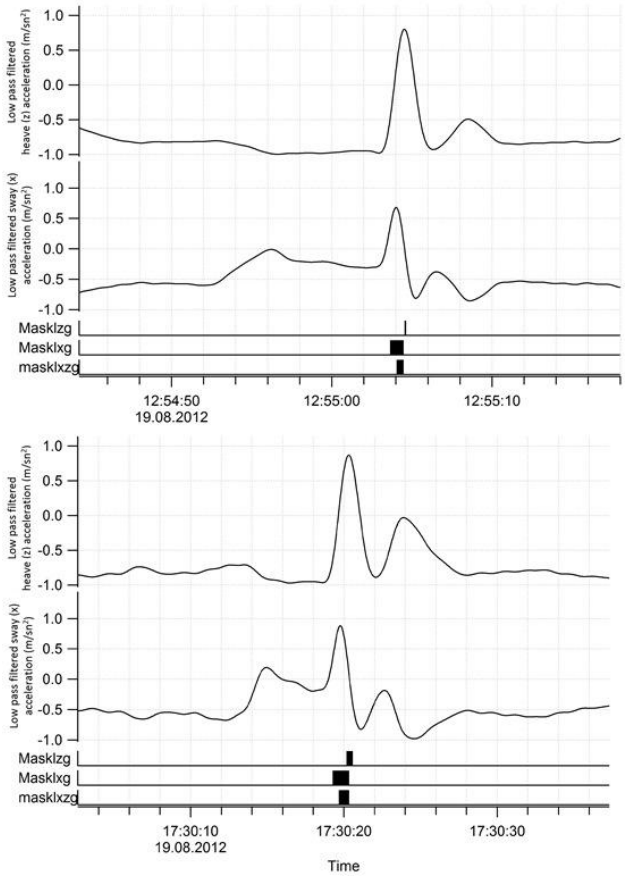

Fig. 1. Low pass filtered heave (z) and sway (x) acceleration waves and masks of two rolling-rubbing events

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IMPACT DU COPÉPODE PARASITE *PERODERMA CYLINDRICUM* SUR LA QUALITÉ LIPIDIQUE ET LA COMPOSITION EN ACIDES GRAS DE LA SARDINE *SARDINA PILCHARDUS*

T. Hajji [1]*, S. Bennour [2], K. Telahigue [2], I. Rabeh [2] and M. El Cafsi [2]
[1] Université de la Manouba, Institut Supérieur de Biotechnologie de Sidi Thabet, Biotechpole Sidi Thabet 2020 Ariana, Tunisie - tarekhaj@gmail.com
[2] Université Tunis El Manar, Faculté des Sciences de Tunis, UR de Physiologie et Environnement Aquatique, El Manar, 2092 Tunis, Tunisie

Abstract
L'impact du copépode parasite *Peroderma cylindricum* sur la composition lipidique et la qualité nutritionnelle de la sardine a été étudié. Les résultats obtenus ont montré que le parasite détourne un pourcentage non négligeable d'acides gras notamment polyinsaturés à son profit. En outre, il entraîne une élévation de la teneur en acides gras saturés et en acides gras monoinsaturés et détériore de ce fait la qualité nutritionnelle de la sardine.

Keywords: Parasitism, Fishes, Tunisian Plateau, Copepoda

Introduction
La sardine héberge de nombreux parasites dont le plus pathogène est le crustacé copépode *Peroderma cylindricum* [1]. Ce parasite inflige à son hôte des dégâts considérables sur les plans morpho-anatomique, physiologique et comportemental [1-3]. Dans le présent travail, nous avons abordé l'effet de la copépodose sur la qualité lipidique du poisson-hôte.

Matériel et méthodes
Les sardines ont été prélevées sur les débarquements de pêche au feu du port de Kélibia (Nord-Est de la Tunisie). Au total, 48 spécimens de sardines de longueur totale comprise entre 16 et 18 cm ont été collectés. L'extraction des lipides a été effectuée selon la méthode de Folch [4]. Les esters méthyliques des acides gras ont été obtenus par une trans-estérification selon la méthode de Cecchi et al. [5].

Résultats et discussion
Les résultats de l'analyse de la composition lipidique ont révélé que le copépode *P. cylindricum* entraîne (I) une élévation da la teneur en acides gras saturés (AGS) suite à l'augmentation de celles du C14:0, du C15:0 et du C17:0, (II) une élévation de la teneur en acides gras monoinsaturés (AGMI) touchant le C16:1n-9, le C18:1n-9 et le C20:1n-9 et (III) une réduction de la teneur en acides gras polyinsaturés (AGPI) surtout le DHA (C22:6n-3). Le calcul de paramètres lipidiques a permis d'étudier la qualité nutritionnelle du gras du poisson parasité. Les résultats ont révélé que le parasite entraîne une élévation des rapports AGS/AGPI et EPA/DHA et une réduction du rapport oméga-3/oméga-6. Le parasite induit également une élévation de la valeur de l'indice d'athérogénicité et de thrombogénicité. L'élévation de ces indices témoigne de la détérioration de la qualité nutritionnelle bénéfique pour la santé humaine. La modification de la composition lipidique des sardines parasitées témoigne du détournement sélectif de certains acides gras au détriment du parasite. Des résultats similaires ont été enregistrés chez le copépode *Lepeophtheirus salmonis* parasite du saumon atlantique *Salmo salar* [6]. L'impact très sévère des parasites sur leurs hôtes caractérise certaines espèces de copépodes de la même famille (Pennellidés) de *P. cylindricum* telle que *Lernaeocera branchialis* [7].

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BIOLOGICAL PRESSURES IN THE IONIAN SEA (GREECE) AND ROMANIAN COAST OF THE BLACK SEA: PRELIMINARY RESULTS

K. Kapiris [1]*, G. Radu [2], A. Palialexis [1], T. Zaharia [2], E. Anton [2] and K. Tsagarakis [1]
[1] Hellenic Centre for Marine Research, Athens, Greece - kkapir@hcmr.gr
[2] NIRDEP-National Institute for Marine Research and Development "Grigore Antipa", Constantza, Romania

Abstract
The most common important biological pressures in the Ionian Sea and Romanian Black Sea coast (presence of alien species, fishery, relationships between fishery and cetaceans) are studied, among others, in the frame of the project "Investigation and application study of the ecosystemic approach to fishery in the Ionian Sea and Black Sea (Romania)"

Keywords: Ionian Sea, Black Sea, Alien species, Fisheries, Cetacea

Introduction
The goals of ecosystemic approach to fishery (EAF) are ''to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic, and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries'' [1]. The biotic compartment, including the most important biological pressures (target fish resources, other species associated and dependent species – alien, cetaceans - the living habitat) could actually offer a valuable assistance for the description of the fishery interaction within the ecosystem.

Material and Methods.
In the frame of the project all the needed data-indicators will be collected (a) describing the state of the marine environment in the two research areas as well as (b) all the human activities will be reported in details (for example fisheries, aquaculture and pollution) that can affect environment (pressure indicators). The indicators which describe the state of the environment in areas relating to the abiotic and biotic parameters (e.g. marine organisms, marine protected areas), fisheries (e.g. fleet, fishing effort, spawning and nursery areas) and the legislative framework related to the environment. Regarding the record of anthropogenic impacts on the environment (pressure indicators) will be analyzed the impact of the fishery in the marine environment (e.g. impact to the fishery resources, interactions between cetaceans-fishery), the climatic changes, as the alien species, the aquaculture data in both areas and all the recorded cases of marine pollution from land and water resources. Finally we provide the first guidelines for the application and future use of the Ecological Approach to Fisheries in both regions. The above data will be processed in a comparative manner for both regions, taking into account differences in geomorphology, oceanography, fisheries and social synthesis. Very useful results to be exported will be used in the future as useful tools for the implementation of the Ecological Approach to Fisheries in both regions. The aim of the present study is to present some of the most important anthropogenic pressures (the situation of the fishery sector, the interactions between cetacean-fishery and the alien species) in both marine ecosystems of the study areas (Ionian and Romanian Black Sea coast .

Results and Discussion
Most of the alien species (60 species) found in the Ionian have an Indo-Pacific origin and belong to fishes, phyto- zoobenthos plankton. Their mode of introduction is mainly by shipping and via Suez [2]. Most invasive species at Romanian coasts (totally 70 species) were accidentally introduced from ships' hulls, ballast water, aquaculture. These species are mainly cosmopolite planktonic (43%), Atlantic and Indo Pacific species [3]. The monitoring of alien species in both areas, which does not exist, should be one of the priorities of any strategy to protect biodiversity. The number of fishery vessels during the period 2000-2012 (mean number: 4432) in the Ionian has decreased and the main gears used are trawlers, purse seines, beach seines, nets. The most common species in the landings are: anchovy, pilchard, anchovy, picarel, bogue, hake. The small size of the fleet and the traditional fishing techniques are the most important characteristics of the Romanian fishery. There are different types of fishing gears in this country (like trawls, point net, gillnets, long and bottom lines, specific gillnets, sea pound nets, other). During the period 2000-2011, the level of total catches declining from 2476 tons to 258 tons. In general, values of Good Environmental Status (GES), in the frame of the MSFD 2008/56/EC, concerning some of the assessed fishing stocks in the Ionian are within safe limits (deep waters rose shrimp, red and striped red mullets)having acceptable values of fishing pressure and biomass indicators. Other species (hake, anchovy and sardine) present slight departures from the safe limits [4]. In the last years (2005-2011) the stock biomass for the main Romanian fishes (sprat, whiting, turbot, dogfish) presented some variations comparing the period 2005-2008. The fishing effort continues the trend of reduction reported since 2000. Resource overlap between common dolphins and fisheries in the Inner Ionian differed, being higher for purse and beach seiners [5]. The illegal fishery and the specific use of the turbot gill nets cause often the dolphin's death in the Romanian coasts [6]. Since fisheries can have often several by-catch problems with other vulnerable species (turtles, birds, elasmobranches, cetaceans) would be advisable to adopt a multi taxon strategy of mitigation in both countries.

Conclusions
Concluding, the deep knowledge of the most important biological pressures in the environment, alien species, target fishery species and interaction between fishery-cetacean, will absolutely contribute to the fishery management in both countries taking into consideration all the ecosystem's characteristics for the application of the ecosystemic approach to fishery

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EFFECT OF HYDROGEN PEROXIDE TREATMENT ON GOLDFISH (*CARASSIUS AURATUS AURATUS*, L.) EGGS

Muge A. Hekimoglu [1], Ulviye Karacalar [1]*, Gulcin Akcan [1] and Sirma Yavuz [1]
[1] Ege University Fisheries Faculty Aquaculture Department - ukaracalar@yahoo.com

Abstract
In this study, the effectiveness of hydrogen peroxide as a treatment for disinfecting goldfish (*Carassius auratus auratus, L.*) eggs were investigated, considering hatching success and embryo survival in various hydrogen peroxide treatment regimes ranging in concentration from 300 ppm at a water temperature of 26°C. We searched 5, 10, 20-min bath in hydrogen peroxide (H_2O_2) at this dose that hatching success and embryo survival.

Keywords: Aquaculture, Izmir Bay, Bacteria, Fishes

Introduction Many researchers were investigate about the effects of various disinfectants of intensive egg incubation of marine and freshwater fish for prevent to the growth of bacteria and reduce the transfer a disease with them [1,2,3]. However, while goldfish having an important place within the ornamental fish sector, few studies on the effect and mode of application are some type of disinfectant which used during breeding time. After hatched during goldfish larvae period are seen high mortality problems caused by bacteria, such as *Flexibacter columnaris* [4], *Flavobacterium columnare [5], Aeromonas hydrophila [6]*. Hydrogen peroxide has since been investigated as an alternative treatment to control bacterial or fungal infections of eggs of several additional fish species [3,7]. Although hydrogen peroxide has long been used for external treatment of fish [8],its use for treatment of fish eggs has only recently been examined. It is considered to be a therapeutant of Low Regulatory Priority (LRP) by the U.S. Food and Drug Administration's (FDA's) Center for Veterinary Medicine (CVM) to control fungal on fish and fish eggs (R. E. Geyer, CVM, personal communication). Although hydrogen peroxide is not an approved drug, the LRP status allows hatchery personnel to administer treatments on fish and fish eggs to control or prevent fungus at 500 ppm or less with little concern for regulatory action. At the same time, evaluating the efficacy of hydrogen peroxide to treat ectoparasites of Atlantic salmon *Salmo salar*, found a linear relationship between hydrogen peroxide efficacy and temperature [9]. In the present study, goldfish eggs incubated at 26 °C were treated with increasing bath time in same concentrations of hydrogen peroxide to determine what time yielded the greatest hatching success.

Materials & Methods Hydrogen peroxide (30% active ingredient)was obtained from Sigma- Aldrich and its test solution were prepared from a stock solution of 30% hydrogen peroxide. Egg-full kakabans taken from the tank where 10 brood fish that mated randomly. The eggs were disinfected in 5 min, 10 min and 20 min with 300 ppm dose of hydrogen peroxide. Any treatment were not done in control group. Three replicates were conducted for each treatment; For each replicate, as an average 1g eggs were removed from the kakabans, and transferred to 500 mL of the test disinfectant solution in a beaker. After trial of disinfection , the solution was poured off and the eggs were rinsed three times with sterile water (about 10–20 mL).The bacteriological examination were done after disinfection treatment . Trypticase soy agar (TSA) were used to test for bacterial growth. The trypticase soy agar (TSA) medium was used to discern prevalence and abundance for all other culturable bacteria and fungi.For each treatment were inoculated per replicate to infect three agar plates.Plates were incubated at 25°C and examined 24,32 and 48 hours after inoculation.Counts were made of all colony-forming units (CFU) when possible,but many plates were classified as too numerous to count.Than the eggs were placed into 10 glass container of 5 liter volume with the same water temperature with breeding tank (which was 26 °C). An airstone was put in the middle of the each experiment container. Every day, the dead eggs were counted in their containers during hatching time. This study were made in triplicate.

Results After surface disinfection of goldfish eggs with hydrogen peroxide (30%, Sigma-Aldrich), bacterial growth in trypticase soy agar (TSA) culture media studied at 5, 10, and 20 minutes; after cultivation on the groups were counted respectively $4.94(\pm0.02)\times10^5$cfu/ml, $1.55(\pm0.34)\times10^5$cfu/ml, $9.89(\pm0.54)\times10^4$cfu/ml and $5.51(\pm0.21)\times10^5$cfu/ml were determined in the control. Accordingly, 5, 10, 20-minute disinfections and in the control group results were not found statistical important in the formation of colonies of those stored ($p> 0.05$). The survival rate of goldfish egg groups in the incubators which disinfected with 300 ppm hydrogen peroxide in 5, 10, 20 minute applications was found respectively 76 ± 17.2%, 79.11 ± 4.12% and 72.88 ± 6.99%. The survival rate was determined 84.66±3.33% in the control group.

Discussion Treatment of goldfish eggs with hydrogen peroxide (H_2O_2) result that the 300 ppm is not effective on bacteriological control and survival rate when we compared with the control group. They have not statistically importance between the time treatments.

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CONTRIBUTION A L'ETUDE SYSTEMATIQUE DES FORAMINIFERES DU LITTORAL TUNISIEN

Samia Khabouchi [1]* and Atf Azzouna [1]
[1] université de Tunis El Manar: Fac. Sciences - khab.sami@yahoo.fr

Abstract
L'étude systématique préliminaire des échantillons de Foraminifères de 7 stations des côtes tunisiennes (Sidi Rayes, Borj Cedria, Radès, La Goulette et La Marsa dans le Golfe de Tunis, Mahdia et Skanès dans le Golfe de Hammamet) a permis d'identifier 60 espèces (49 + 11 non déterminées) qui appartiennent à 29 genres et 21 familles. Mots clés : Foraminifères, systématique, Golfe de Tunis, Golfe de Hammamet.

Keywords: Biodiversity, Tunisian Plateau

Introduction
Les Foraminifères sont des Eucaryotes, Protistes, essentiellement marins et benthiques. La cellule est enveloppée par le test muni de pseudopodes réticulés, la taille est comprise entre 0.1 et quelques mm, parfois moins. Le cycle de reproduction haplodiplophasique. [1], [2]. La systématique de ces protistes est basée sur : *Des critères génériques du test : nature, forme générale, nombre et arrangement des loges, microstructure de la paroi, absence ou présence de perforations, structure interne, forme et position des ouvertures. *Des critères spécifiques du test : caractère des sutures, ornementation, dimensions des loges.

Matériel et méthodes
Le choix des stations s'est basé essentiellement sur les facteurs suivant : (*) qualité des eaux: propre ou polluée, (*) température: eau froide/ eau chaude, (*) salinité. Deux types de carotte de 2cm de diamètre, de profondeur respectives 6 et 10cm ont été utilisés. Le tri s'est effectué à l'aide de pinces très fines. Les espèces sont observées directement sous la loupe biloculaire puis conservées à sec ou occasionnellement congelées.

Résultats et discussion
Le présent travail nous a permis de recenser 60 espèces appartenant à 29 genres et 21 familles ; parmi cet effectif nous avons déterminé 11 espèces signalées pour la première fois en Tunisie (*Quinqueloculina sp1, Quinqueloculina sp3, Quinqueloculina sp4, Triloculina sp, Lagena sp1, Lagena sp2, Lagena gibbera sp, Lobatula sp, Elphidium sp, Bolivina sp et Lenticulina sp*). (Figure 1)

Fig. 1. Espèces signalées pour la première fois en Tunisie

Composition taxonomique des familles (Tab 1) Les familles identifiées au cours du présent travail se divisent en trois groupes : A- Familles hautement diversifiées et qui renferment presque la moitié des espèces recensées (27 espèces parmi 60) ; trois familles qui sont : Famille des MILIOLIDAE : 14 espèces. Famille des HAUERINIDAE : 7 espèces. Famille des GLOBIGERINIDAE : 6 espèces. B- Familles à diversité moyenne : 13 espèces appartenant à 4 familles. Famille des LAGENIDAE : 3 espèces. Famille des VAGINULINIDAE : 4 espèces. Famille des UVIGERINIDAE : 3 espèces. Famille des BOLIVINIDAE : 3 espèces. C- Familles presque mono-spécifiques : 20 espèces représentées dans 14 familles. Famille des SPIROLOCULINIDAE : 2 espèces. Famille des OPHTHALMIDIIDAE : 1 espèce. Famille des PENEROPLIDAE : 1 espèce. Famille des SORITIDAE : 1 espèce. Famille des NODOSARIIDAE : 1 espèce. Famille des STILOSTOMELLIDAE : 1 espèce. Famille des AMPHISTEGINIDAE : 1 espèce. Famille des ALFREDINIDAE : 1 espèce. Famille des GAVELINELLIDAE : 1 espèce. Famille des CIBICIDIDAE : 2 espèces. Famille des ROTALIIDAE : 2 espèces. Famille des ROSALINIDAE : 2 espèces. Famille des ELPHIDIIDAE : 2 espèces. Famille des HETEROHELICIDAE : 2 espèces. Leur répartition est fonction de nombreux facteurs abiotiques, dont le stress anthropique joue un rôle primordial.

Tab. 1. **Composition taxonomique des familles identifiées.** sp : spécimen non identifié

N°	FAMILLES	Nombre des genres déterminés	Nombre des espèces déterminées
1	MILIOLIDAE	3	14 (10 + 4 sp)
2	HAUERINIDAE	3	7
3	SPIROLOCULINIDAE	1	2
4	OPHTHALMIDIIDAE	1	1
5	PENEROPLIDAE	1	1
6	SORITIDAE	1	1 sp
7	NODOSARIIDAE	1	1
8	LAGENIDAE	1	3
9	VAGINULINIDAE	2	4 (3 + 1 sp)
10	STILOSTOMELLIDAE	1	1
11	AMPHISTEGINIDAE	1	1
12	UVIGERINIDAE	1	3
13	BOLIVINIDAE	1	3 (2 + 1 sp)
14	ALFREDINIDAE	1	1
15	GAVELINELLIDAE	1	1 sp
16	CIBICIDIDAE	1	2 (1 + 1 sp)
17	ROTALIIDAE	2	2 (1 + 1 sp)
18	ROSALINIDAE	1	2
19	ELPHIDIIDAE	1	2 (1 + 1 sp)
20	GLOBIGERINIDAE	3	6
21	HETEROHELICIDAE	1	2
TOTAL	21	29	60(49+11 sp)

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SPATIAL HETEROGENEITY OF SESSILE BENTHOS IN A SUBMERGED CAVE OF THE EASTERN MEDITERRANEAN

Vasilis Gerovasileiou [1], Dimitris Vafidis [2], Drosos Koutsoubas [3]* and Eleni Voultsiadou [1]
[1] School of Biology, Aristotle University of Thessaloniki, Thessaloniki, Greece
[2] Department of Ichthyology and Aquatic Environment, University of Thessaly, Nea Ionia, Magnesia, Greece
[3] Department of Marine Sciences, University of the Aegean, University Hill, Mytilene, Greece - drosos@aegean.gr

Abstract
Despite their scientific interest and high conservation value, marine caves of the eastern Mediterranean are poorly explored. Herein, a submerged cave from the Aegean Sea was surveyed through SCUBA diving and photoquadrats. A rich fauna of 65 taxa and 4 distinct benthic assemblages were identified. The biotic spatial heterogeneity observed was associated with the unique topography of the different cave sectors.

Keywords: Biodiversity, Rocky shores, Aegean Sea

Introduction
Marine caves constitute characteristic habitats of the Mediterranean rocky coastline. They harbour rare and protected species and have been characterized as 'biodiversity reservoirs' for particular groups of sessile animals [1]. Their topographic complexity generates abiotic gradients reflected in a marked spatial variability of their biota [2], [3]. Partially and totally submerged cave systems are protected by the EC (92/43/EEC). Recent evidence of temperature-induced alterations in Mediterranean cave-dwelling communities [4] highlights the criticality for their monitoring and conservation. However, quantitative data on the biodiversity and community structure of marine caves from the eastern basin do not practically exist.

Material and Methods
Fará cave, a submerged cave from the Aegean Sea (Lesvos Island: 38°58′11.64′ N, 26°28′39.54″ E), was mapped in detail and its benthic communities were investigated through the use of a non-destructive photographic method. The cave is 32 m long and is located at an average depth of 14 m. Fieldwork was carried out with SCUBA diving. The sampling scheme included 9 photoquadrats (3 from the ceiling, right and left walls of the cave) at 5 meters intervals, from the cave exterior to the inner dark zone. In total 72 photoquadrats were taken and the percent coverage of each species was calculated with photoQuad. Multivariate analysis was undertaken with Primer.

Results and Discussion
Sample analysis revealed a rich sessile fauna of 65 taxa belonging to 8 taxonomic groups. As previously shown [1], [3] for marine caves, Porifera were the dominant animal group in terms of species richness (45), followed by Anthozoa (8). Concerning the biotic coverage throughout the cave, Porifera had the highest percentage (41.9%), followed by Rhodophyta (12.6%), Anthozoa (11.3%), Polychaeta (9.9%), and Bryozoa (4.5%). The remaining 1.6% was covered by Chlorophyta, Foraminifera, Hydrozoa, Bivalvia, Brachiopoda, and Tunicata, while 18.6% was characterized as unidentified biogenic substrate.
Multivariate resemblance analysis revealed four distinct groups of stations (Fig. 1). The first group comprised the sciaphilic algal dominated (e.g. *Peyssonnelia rosa-marina*, *Mesophyllum* sp.) community of the exterior and entrance wall stations. The second included the two left wall stations, located 5 and 10 m from the entrance, where the locally higher sedimentation rate favored a differentiated fauna (e.g. *Axinella* spp., *Penares euastrum*). The third group constituted a typical semidark cave community dominated by sponges (e.g. *Dendroxea lenis*, *Spirastrella cunctatrix*, *Phorbas tenacior*, *Agelas oroides*). The scleractinian *Madracis pharensis* prevailed on the ceilings and overhanging walls. The last group included the inner totally dark stations, dominated by encrusting sponges (e.g. *Diplastrella bistellata* and *Hexadella pruvoti*) and serpulid polychaetes. Encrusting and cushion shaped growth forms dominated within the cave while erected forms had much lower coverage. In the middle and inner cave sectors, the encrusting bryozoans *Hippaliosina depressa* and *Onychocella marioni* formed nodules, while serpulid polychaetes formed bio-constructions.
The ceiling stations of the entrance (0C) and middle cave zones (15C) were grouped with the semidark and totally dark stations respectively, probably due to the sharper decrease of light in relation to the corresponding walls, as a result of the substrate inclination.

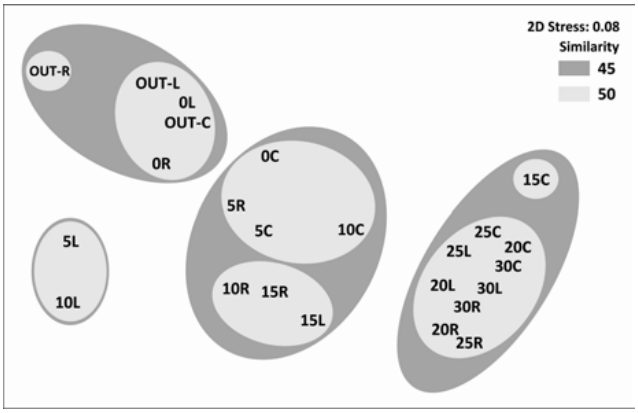

Fig. 1. Resemblance of cave assemblages demonstrated in MDS plot. C: ceiling, L: left wall; R: right wall. Numbers indicate distance from cave entrance.

The unique geomorphology of the different cave sectors can induce spatial heterogeneity of cave assemblages presumably through the modification of abiotic features [2], [3], which deserves further study in this geographic area. The creation of a digital photographic database depicting the current status of marine cave communities enables their future monitoring. This is crucial for caves frequently visited by divers and for those located in Mediterranean sub-areas which are highly subjected to alterations attributed to global climate change.

Acknowledgments
The authors thank Maria Sini for her precious help during the fieldwork. This research has been co-financed (01/2011 up to date) by the EU and Greek national funds through the Research Funding Program: Heracleitus II Investing in knowledge society through the European Social Fund. The first author also benefited from "Alexander S. Onassis Public Benefit Foundation" fellowship for postgraduate studies (10/2009-12/2010).

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ACID DNASE ACTIVITY IN MUSSEL *MYTILUS GALLOPROVINCIALIS*: TEMPORAL VARIATIONS AND POLLUTION EFFECT

Ines Kovacic [1]* and Maja Fafandel [2]
[1] Juraj Dobrila University of Pula - ikovacic@unipu.hr
[2] Center for Marine Research, Ruder Boškovic Institute

Abstract
Temporal variation in the level of acid DNase activity in gills and digestive glands of the mussels *Mytilus galloprovincialis* from pristine and polluted area were determined. Acid DNase activity is tissue specific and responsive to physiological requirements and environmental conditions. Preliminary data indicated acid DNase activity in mussel gills as promising biomarker of pollution.

Keywords: Pollution, North Adriatic Sea, Enzymes, Mollusca

Introduction
New biomarkers of high sensitivity and low cost are widely investigated for marine biomonitoring purposes. Acid DNase activity has been demonstrated to be a useful biomarker for the assessment of toxic industrial pollutants in the freshwater snail [1] and in mussels from contaminated areas [2]. Our previous investigations showed that the exposure of mussels to model marine pollutants causes the increase of acid DNase activity in mussel hematocytes and hepatocytes indicating acid DNase activity as a promising biomarker [3]. In an attempt to better understand the natural and environmental changes in patterns on the acid DNase activity of *Mytilus galloprovincialis*, mussels are being collected on year basis. Preliminary results are presented.

Material and Methods
During the one year, beginning August 2012, mussels (5-6 cm in length) were collected from two sites (reference – Crveni otok and one affected by pollution – ACI marina) located in the Rovinj area, Istrian coast, Northern Adriatic. Acid DNase activity was measured in digestive gland and gills according to Fafandel et al. [3].

Results and Discussion
Acid DNase activity was detected in both tissues studied. The enzyme activity patterns in digestive glands and gills were not similar. In general, acid DNase activity was higher in gills than in digestive gland. In digestive gland maximal level occurs in October (Fig 1) while in gills maximal acid DNase activity was observed in January with no prominent peak in October (Fig 2). DNase activity increases in the period December - January in gills tissue but did not vary significantly in digestive gland where levels of enzyme activity during this period were consistently lower.

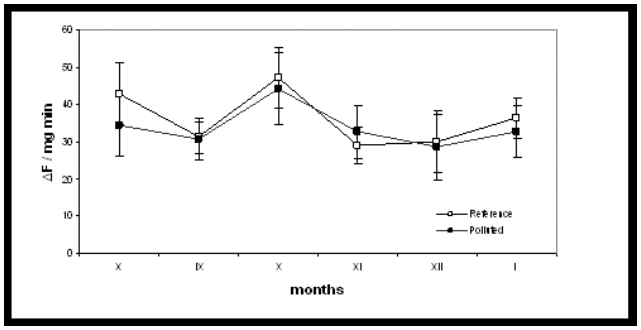

Fig. 1. Temporal variation of acid DNase activity in digestive gland of Mytilus galloprovincialis sampled from Crveni otok – reference (empty square) and ACI marina Rovinj – polluted (black square) in Adriatic sea, Croatia. (N=10)

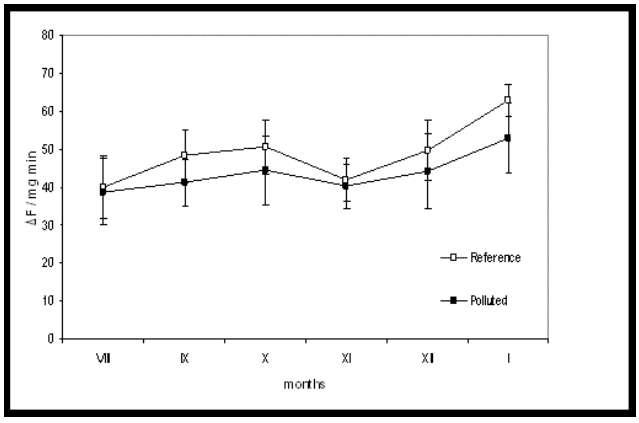

Fig. 2. Temporal variation of acid DNase activity in gill of Mytilus galloprovincialis sampled from Crveni otok – reference (empty square) and ACI marina Rovinj - polluted (black square) in Adriatic sea, Croatia. (N=10)

Difference in acid DNase activity due to the pollution impact in digestive gland was not as great as in gill tissue where enzyme activity was lower in mussels from polluted site. The highest difference in DNase activity in gills between reference and polluted site was in January.
Seasonal variations arise from a complex interaction between exogenous factors such as food availability, temperature and pollution and endogenous factors such as spawning. Spawning period was detected as significant increase of acid DNase activity in digestive gland in October due to the intense nucleic acid metabolism during gamete formation. Increase in acid DNase activity in gills during the December – January period reflects tissue-specific requirements probably due to lower temperatures during winter period. From the preliminary data presented in this work it can be concluded that DNase activity in gills can be promising biomarker of marine environmental contamination.

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AQUACULTURE MÉDITERRANÉEENNE MAROCAINE : SITUATION ACTUELLE ET PERSPECTIVES DE DÉVELOPPEMENT

Abdeljaouad Lamrini [1]*
[1] Institut Agronomique et Vétérinaire Hassan II - jlamrini@gmail.com

Abstract
L'aquaculture en Méditerranée marocaine se heurte à des difficultés et ne cesse de régresser. Sa situation actuelle et ses contraintes sont passées en revue. Pour faire face à une telle situation, un réaménagement des sites actuels et la création d'autres sites sont nécessaires. Une proposition de nouveaux sites est avancée en tenant compte de leurs caractéristiques physico chimiques et des exigences aquacoles; mais l'évaluation d'une future production est complexe et nécessite une approche globale.

Keywords: Aquaculture, South-Western Mediterranean, Fishes, Bivalves

L'aquaculture a connu au niveau mondial un essor considérable passant de moins de 1 million de tonnes en 1950 à 60 millions de tonnes en 2010 (1). Elle évolue plus rapidement que les autres productions d'origine animale. Cependant, cette branche d'activité maritime n'a pas connu la même tendance au Maroc, elle a chuté de 1467 tonnes en 2005 à 332 tonnes en 2010 (2). Les sites naturels restent limités en raison des caractéristiques des côtes ; de plus, ils sont concurrencés par des projets touristiques côtiers.

La côte méditerranéenne marocaine (512 Km) est surtout rocheuse entrecoupée de baies et de fonds sédimentaires. Elle présente peu de sites protégés ; certains sont déclassés (lagunes) , d'autres sont menacés (baies).

Quant à la lagune de Nador, une des plus grandes de la rive sud de la Méditerranée (115 Km^2), elle dispose d'atouts clés liés à la richesse et à la diversité de son écosystème (3) ; elle est favorable à l'aquaculture.

MAROST, initialement installée dans cette lagune en 1985 pour élever l'huître et la palourde, a du réorganiser ses activités pour produire le bar et la daurade (4). La SAM, établie dans les années 90 sur l'estuaire de Moulouya, s'est spécialisée également dans la production de ces poissons (5).

A part ces deux sites dont les activités sont suspendues depuis 2006 pour des raisons stratégiques et de rentabilité, deux autres zones permettent l' aquaculture : baie de M'diq et baie de Ben Younech (Fig.1). Les productions ont subi une chute entre 2005 et 2010 passant de 1223 à 49 tonnes (2).

Outre les sites précités méritant d'être aménagés pour relancer des activités aquacoles, d'autres sont tout à fait indiqués pour de telles activités (Fig.1).

La lagune de Nador était dépendante du point de vue hydrodynamique d'une seule passe de 250 m de largeur (Bokhana) pour ses échanges avec la mer. Depuis 2010, un nouveau chenal de 300 m de largeur et de 6,5 m de profondeur a été établi (6). Il permet de renouveler les eaux et de restaurer la qualité du milieu. De plus, il contribue à la préservation des ressources et à la mise en place de nouvelles unités d'élevage.

Pour déterminer d'autres sites aquacoles, les conditions physicochimiques et bioécologiques du littoral méditerranéen marocains ont été examinées (7), ce qui a permis de sélectionner certains sites répondant aux exigences d'élevage. Ces sites ont été soumis à une confirmation ponctuelle de leurs caractéristiques environnementales (juillet 2009).

Quatre petites baies ont une protection partielle et des potentialités aquacoles limitées : Ras kebdana, Al Hoceima, Cala Iris et Jebha (Fig. 1)

Ras Kebdana est une réserve naturelle abritée, elle est à 6 Km à l'ouest de la Moulouya. La baie d'Al Hoceima est la partie maritime du Parc National d'Al Hoceima, elle englobe les sites côtiers les mieux préservés, l'eau y est limpide favorisant une grande biodiversité, elle offre un abri à des espèces rares. Cala Iris, située à 50 Km à l'ouest d'Al Hoceima, est une zone très abritée. La baie de Jebha survit de la pêche artisanale et de l'agriculture vivrière, une activité aquacole viendrait en complément.

Deux estuaires présentent de grands avantages du fait de leur basse situation facile à aménager : Kaa srass et Martil, mais les dangers de crues sont réels. Kaa srass, au sud de l'oued Laou, fait partie d'une aire marine protégée aux fins des pêches dont les activités peuvent être substituées par la création d'une zone aquacole. Martil, à l'embouchure de l'oued Amssa, permet aussi cette activité d'aquaculture.

Par ailleurs, étant donné les conditions climatiques clémentes du littoral méditerranéen marocain, l'aquaculture en offshore est prometteuse (8).

La production de ces sites reste à déterminer. Son évaluation est complexe et nécessite une approche globale basée sur les aspects environnementaux, technologiques, socio-économiques et stratégiques.

Fig. 1. Situation des sites d'aquaculture en Méditerranée marocaine

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SULINA CASE STUDY EXPERIENCE IN PUBLIC PARTICIPATION ON ICZM PROTOCOL WITHIN PEGASO PROJECT

E. Marin [1]*, I. Nichersu [1], C. Trifanov [1], M. Mierla [1] and I. Nichersu [1]
[1] Danube Delta National Institute - jenica@indd.tim.ro

Abstract
This paper presents the experience in public participation approach carried out for Romanian case study in the frame of the PEGASO project funded by the European Union within FP7. The purpose of this research was to actively involve a wide range of stakeholders in a two day planning session, focused on issues and potentials of Sulina coastal area, with the aim to work out possible solutions for integrated coastal spatial planning within the context of ICZM protocol implementation for Black Sea. The possible solutions drawn by the participants during the session according to their point of view and interest were integrated into a final sketch and then transposed in GIS map

Keywords: Coastal management, Black Sea

INTRODUCTION
One of the objectives of PEGASO is to use the model of the existing ICZM Protocol for the Mediterranean and adjust it to the needs of the Black Sea through innovative actions. Thus, one of the tools for making sustainability assessments in the coastal zone pilots was participatory process. For the Romanian case study was selected Sulina town which is located in the South-East part of the country, on the Black Sea coast.

METHODS
For a good approach of the participatory process it was necessary to develop four thematic maps of the studied area (area location, infrastructure map, flood hazard map, map of elements vulnerable to floods) which were further used for sketching and drawing the ideas expressed by stakeholders during the session. For the public participatory approach was selected the "Sketch Match method" which is a workshop method developed by Netherlands Government Service for Land and Water Management (DLG) [1]. The interactive public participation took place in Sulina town during 2 days of work in November 2012. Participants were representatives of a wide range of stakeholders varying from local population, fishermen and NGO's to representatives of Local and County Council. The workshop consisted in forming two parallel thematic groups with following topics: spatial planning and socio-economic development.

RESULTS
The stakeholders analysed, with the help of thematic maps, the area's characteristics in two different groups. This gave them insight in the area's main problems, qualities and potentials (Fig.1):

Problems	Qualities	Potentials
• Land property issues and cadastre of Sulina coastal area	• Status of Sulina as fluvial and maritime port	• Updating the action plans and national legislation in conformity with ICZM protocol
• Lack of coastal area delineation	• Coastal biodiversity	• Potential for touristic development
• Uncontrolled development of touristic coastal activities	• Existence of wetlands and Natura 2000 sites	• Potential for public- private investments
• Decreasing fish stock and lack of a fish market Institutional conflicts	• Cultural diversity and heritage buildings	• Potential of renewable energy development
• Poor basic infrastructure in the town and coastal area	• Touristic attraction of the area	

Fig. 1. Examples of area characteristics as defined by participants

Having these starting points in mind, there were defined the main possible solutions by two categories: **(i) non structural solutions and (ii) structural solutions.**

i) it was observed that all the issues from both groups could be tackled by same **non-structural solutions**: raise public awareness which can be achieved through education, trainings, courses among population on ICZM topic as well as institutional collaboration by organizing regularly meetings at local, regional, national level.

ii) the structural possible solutions were grouped in 5 categories:

1. Infrastructure category by modernisation and enhancing accessibility. Using the "thematic maps" was identified the need of an integrated infrastructure approach and infrastructure quality improving. This refers to Garlita channel reactivation that will offer perspectives for navigation by small boats.

2. Agri-economic category which involves the necessity of reopening the canning factory and shipyard rehabilitation. Development of craft construction industry and ship repair industry were mentioned as solutions for Sulina economical revival. The reintroduction of fresh water in the southern embankment may restore opportunities for fishery in the area, enhance ecological and landscape development and offer new perspectives for local economy (developing a fish market in the area). Channel dredging was designed as a solution to improve soil quality properties of pastures for cattle breeding.

3. Within the **Social category** the main vital solution is to reopen the Hospital in Sulina in order to assure the medical care for the community. Further, creating jobs through new investments in tourism and establishment of small crafts workshops using the natural resources were other solutions sketched by the participants. Enhancement of the cultural and historical heritage and necessity of architectural building rehabilitation through legislation was also raised.

4. Tourism category which includes the delineation of camping and recreational areas as well as Sulina touristic beach in order to avoid conflicts between stakeholders. Change the functionality of a part of the deactivated shipyard for tourism purposes and job creation.

5. Environment category involves Integrated Waste Management solution in order to reduce the environment contamination hazard and waste overload.

These solutions build up the integrated final sketch for Sulina case study in which all the efforts and ideas of two days' hard work brought together (Fig.2).

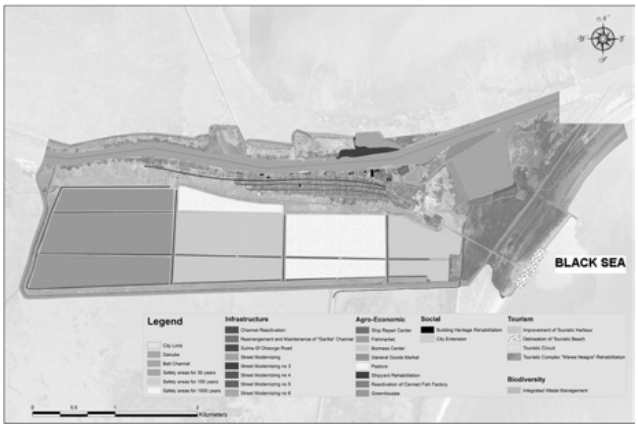

Fig. 2. The integrated final sketch with possible solutions for Sulina case study

EXPERIENCES AND LESSONS LEARNED
The results presented above emphasize a future possibility of socio-economic development of Sulina town and coastal area in accordance with ICZM protocol. The participatory session proved to be a success for Sulina case study, assuring a good cooperation process within different stakeholders, raising awareness among them.

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THE EFFECT OF WATER FLOW ON NORWAY LOBSTER BURROW EMERGENCE

V. Sbragaglia [1], J. Aguzzi [1], J. García [1], D. Sarriá [2], S. Gomariz [2], C. Costa [3], P. Menesatti [3], A. Manuel [2], A. Mecho [1]* and F. Sardà [1]

[1] Marine Science Institute (ICM-CSIC)-Passeig Marítim de la Barceloneta 37-49, 08003 Barcelona, Spain - mecho@icm.csic.es

[2] Technological center of Vilanova i la Geltrú (SARTI-UPC) - Rambla de l'exposició s/n, 08800, Vilanova i la Geltrú, Spain

[3] Consiglio per la Ricerca e la sperimentazione in Agricoltura, (Unità di ricerca per l'ingegneria agraria) - Via della Pascolare 16, 00015 Monterotondo Scalo, Italy

Abstract

The Norway lobster is a burrowing decapod of elevated commercial importance for the European fishery. Understand which factors affect its diel (24-h based) catchability is of importance for its stock assessment. Here we presented preliminary results on burrow emergence modulation on lobsters exposed to water flow cycles in the laboratory simulating internal tides.

Keywords: Behaviour, North-Western Mediterranean

The Norway lobster, *Nephrops norvegicus* (L.), is a burrowing decapod distributed in the European Atlantic Ocean and in the Mediterranean Sea from 10-800 m. It is an important resource for European fishery and great attention is devoted to its stock assessment [1]. Animals can be captured only during burrow emergence and 24-h catch patterns show markedly different daily rhythms on shelves and slopes. Little is known about other ecological factors that may modulate this behavior (e.g. social interactions, hydrodynamic regimes) creating great uncertainties in stock assessment [2, 3]. Periodical sea bed currents (internal tides and inertial motion) are detected in *Nephrops* Atlantic and Mediterranean areal of distribution but their effect on burrow emergence is still unknown. Here, we presented preliminary results on the modulation of burrow emergence behavior by interplaying water currents and day-night cycles, as usually experienced by Atlantic shelf and slope populations. The burrow emergence behavior of 8 adult males of carapace length (CL; Mean ± SD) equals to 35.34±3.04 mm, was investigated in a 10-days experiment. Experiment was performed in a novel and automated multi flume actograph equipped with artificial burrows. Individual behavior was tracked by video image analysis at 10s frequency. Infrared illumination (not detectable by *Nephrops*) was always ON to track also at darkness. The trial was carried out according to the following conditions: current flow at approximately 10 $cm \cdot s^{-1}$ with a duration of 2 hours and a periodicity of 12.4-h mimicking internal tides and 15-9 monochromatic blue Light-Darkness (LD) cycles at $4 \cdot 10^{-3}$ $\mu E/m^2/s$ intensity simulating shelf conditions. Preliminary results showed that current flow have an inhibiting effect on animals' out of burrow displacement (Fig. 1), especially pronounced when occurring at darkness hours (i.e. when animals are engaged in emergence). When current started during burrow concealment (at light hours), animals retreated deeper into the burrow or scanned the outside environment with second pairs of antennae, to immediately emerge few minutes after the water flow offset.

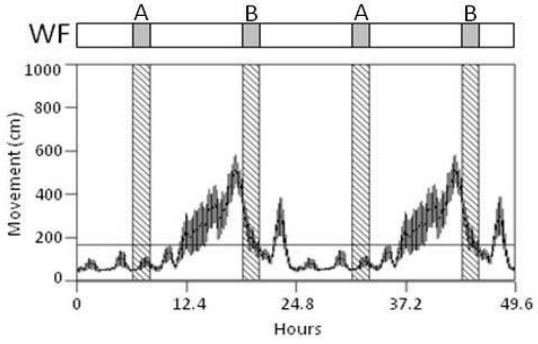

Fig. 1. Fig. 1. Double plotted waveform (24.8 h based) of one representative animal. Vertical lines represent the Standard Error of the Mean (SEM). White-grey bars represent Water Flow ON or OFF and also water flow of two hours are represented by shadowed areas. The horizontal line represents the MESOR. Water flow occurring during light hours are represented by **A** and during dark hours by **B**.

Image inspection at current flow onset showed that animals blocked themselves with a downstream orientation or immediately retired into the burrow. Blind *N. norvegicus* orientated itself downstream when exposed to water currents in laboratory [4]. Such an orientation could allow individuals to check for predators arrival, which in the case of fishes is usually performed upstream [5]. Moreover, we observed that lobsters also scanned the outside of the burrow with second antenna when current flow increases during their concealment. In this case, a speculative interpretation could relate this behavioural response to the searching for food odors bring by the current. Mechanoreceptors and chemoreceptors are present on Norway lobster's second antenna [6] and they could bring information to *Nephrops* even if it is hidden inside the burrow. No one reported before the reaction of *N. norvegicus* to water currents in presence of an important habitat feature as the burrow in presence of a LD cycle. Future research will focus on the effect of inertial motion (18h periodicity) simulating a Mediterranean scenario. These observations could be of importance when extrapolating laboratory results to the field context to obtain reliable information for fishery management of the species both in the Atlantic and in the Mediterranean.

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COMMON DOLPHIN (*DELPHINUS DELPHIS*) PHOTO IDENTIFICATION IN THE REGION OF THE NE. AEGEAN SEA, GREECE

Adam King [1], Thodoris Tsimpidis [1], Anastasia Miliou [1]* and Hazel Thornton [1]
[1] Archipelagos, Institute of Marine Conservation - anastasia@archipelago.gr

Abstract
Capture-recapture analysis using photo identification was applied to the Common Dolphin *(Delphinus delphis*) population in the region of the north east Aegean Sea. The few studies which have applied photo identification techniques to this delphiniid species have used distinct pigmentation patterns and long-term natural markings on the dorsal fin to identify individuals. This study successfully identified 35 individuals from photographs obtained between 2004 and 2011, with 5 individuals sited on multiple occasions.

Keywords: Aegean Sea, Cetacea, Population Dynamics

Introduction
The Common dolphin was once one of the most common cetacean species in the Mediterranean Sea [1]. During the last decade, this species was classified as endangered based on the IUCN Red List criteria, due to a decline of 50% over the last 3 generations, the reasons behind which remain poorly understood [2], [3]. There is currently no reliable time series of abundance of common dolphins in the Mediterranean Sea, with the most recent estimate by Forcada and Hammond in 1998 [4]. For this reason, IUCN/Species Survival Commission Cetacean Specialist Group has integrated common dolphin studies among their priorities and recommended the escalation of studies focusing on common dolphin distribution abundance, population structure and factors threatening their conservation status [5], [2]. Thus with this thought in mind, we aim to estimate and photo-identify individuals of the common dolphin population frequenting in the region of the north eastern Aegean Sea, Greece.

Researchers have primarily used distinct pigmentation patterns and long-term natural markings on the dorsal fins to identify individuals [9]. Although the non-intrusive method of photo-identification of cetaceans is well established [6], only a few areas around the world, including New Zealand [7], [8], the eastern Ionian Sea [9] and the Gulf of Corinth [1], have studied common dolphins using photo-identification. Analyses of capture-recapture technique provides data on group structure, site fidelity, movement patterns [6], and yield estimates of relative and total abundance of common dolphin, essential for management and conservation planning [1].

Material and Methods
A total of 166 photographs of common dolphin obtained between September 2004 and July 2011 were examined, looking at pigmentation patterns and other markings on the dorsal fins, resulting in the identification of 35 individuals. Five individuals were frequently observed on more than one occasion (Fig. 1).

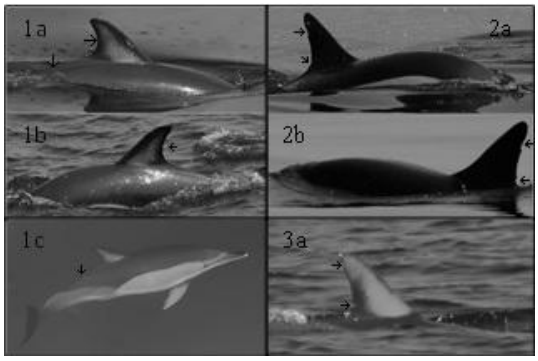

Fig. 1. Example of dorsal fin differences on three common dolphin individuals. Arrows indicate identifying features. First individual (1a,1b,1c) with distinct notch half way up the trailing edge of the dorsal fin and scar on body;, second individual (2a,2b) with two distinct notches on the trailing edge of the dorsal fin;, third individual (3a) with notch near the top and base of the trailing edge of the dorsal fin

Results and Discussion
The results of this study suggest that photo identification can be successfully applied to common dolphin population in the region of the north eastern Aegean. However, further research and photographic material are required to identify the total common dolphinpopulation in the region. As the volume of photographic material increases, the need for photographic software which can identify individuals via the analysis of pigmentation patterns is highlighted, consequently reducing potential human error.

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MORPHOMETRIC SEX DIFERENCES OF THE ROUND SARDINELLA, *SARDINELLA AURITA* (VALENCIENNES, 1847), IN THE MIDDLE EASTERN ADRIATIC SEA

Bosiljka Mustac [1]* and Gorenka Sinovcic [2]
[1] University of Zadar - bmustac@unizd.hr
[2] Institute of oceanography and fisheries

Abstract
A total of 2,004 round sardinella, *Sardinella aurita* (Valenciennes, 1847) specimens were caught between November 2007 and January 2009 to analyse their nine morphometric characteristics. Monthly sampling was done from the purse seine catches in the middle eastern Adriatic Sea. The total length of males (*N*=983) varied from 11.5 to 28.0 cm (mean±*SD* =21.8 ± 3.21 cm), while it ranged from 11.0 to 32.5 cm (mean±*SD*=22.5 ± 3.67 cm) for females (*N*=1,021). A significant difference between the mean lengths of males and females was observed.

Keywords: Biometrics, Fishes, Central Adriatic Sea

Introduction : Biometry is one of the most important biological characteristics in fish population dynamics and management purposes. Since data on morphometric characteristics of round sardinella from the Adriatic Sea are sporadic, the aim of this study was to analyse its various length amounts in order to gain a better understanding of this species. Round sardinella is not an autochthonous species in the Adriatic Sea. However, nowadays due to climate change**,** round sardinella specimens are becoming more numerous and have widened their habitat (1,2,3,4).

Material and methods : Round sardinella specimens were collected from November 2007 to January 2009 by monthly random sampling of commercial purse seine catches in the middle eastern Adriatic Sea. The total length (*LT*) of the fish was measured to the nearest millimetre. Sex was determined macroscopically on the basis of the shape, appearance and structure of gonads (5). Nine morphometric (*LT, LS, LF, LA, LH, LF, H, PE, ED*; Tab. 1) characteristics were used for biometrical analysis. To analyse sex differences, variability (*V*) and two sampled *t*-test was used.

Results : Mean values of all analysed meristic characteristics for both sexes of round sardinella (*N*=2,004) are shown in Table 1. Total length of males (*N*=983) varied from 11.5 to 28.0 cm ($\bar{x} \pm SD$ =21.8 ± 3.21 cm,) while it ranged from 11.0 to 32.5 cm ($\bar{x} \pm SD$=22.5 ± 3.67 cm) for females (*N*=1,021). As presented in Table 1, females had significantly greater mean values of all analysed morphometric characteristics than males, except the eye diameter (*t*=1.59). Variability was high for all length parameters, within both sexes. The greatest variability coefficient (*V*) was observed in males length of dorsal fin base (*LA*=16.48%), while the head length of males (*LH*=13.45 %) slightly varied.

In general, mean monthly length values of females were greater than those of males, although during the February smallest total length values for both sexes were noticed (Fig.1).

Tab. 1. Morphometric characteristics of male and female round sardinella caught in the middle eastern Adriatic Sea during the period November 2007 - January 2009

Sex:	Male		Female		
Morphometric:	$\bar{x} \pm SD$	*V*(%)	$\bar{x} \pm SD$	*V*(%)	*t*
Total length (*LT*)	21.8 ± 3.2	14.71	22.5 ± 3.7	16.31	4.41
Fork length (*LF*)	19.1 ± 2.8	14.72	19.7 ± 3.1	15.76	4.38
Standard length (*LS*)	18.2 ± 2.7	14.67	18.8 ± 3.1	16.28	4.59
Anal length (*LA*)	13.3 ± 1.9	14.65	13.8 ± 2.3	16.36	4.67
Head length (*LH*)	4.09 ± 0.5	13.45	4.17 ± 0.6	14.38	3.11
Length of dorsal fin base (*DF*)	2.67 ± 0.4	16.48	2.77 ± 0.5	17.33	4.85
Maximum body height (*H*)	3.73 ± 0.6	16.08	3.87 ± 0.7	17.31	4.92
Preorbital length (*PE*)	1.29 ± 0.2	13.95	1.32 ± 0.2	15.15	3.52
Eye diameter (*ED*)	0.95 ± 0.1	14.73	0.96 ± 0.1	14.58	1.59

p<0.0001

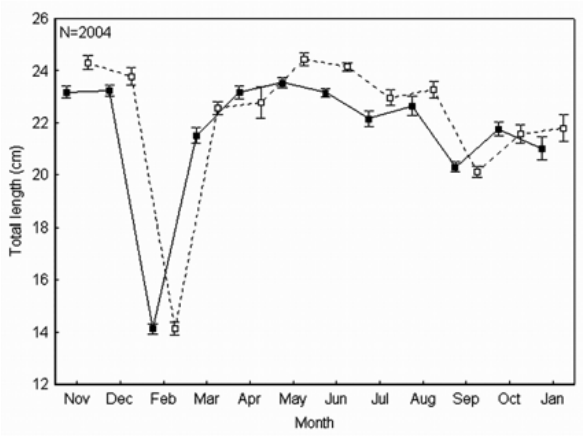

Fig. 1. Mean total length distribution (±SE) of male (plain black square : N=983) and female (empty white square : N=1,021) round sardinella from catches realized in the middle eastern Adriatic Sea during the period November 2007 - January 2009.

Discussion : The presented analyses showed that females (*N*=1,021) had significantly greater values of all analysed body lengths than males (*N*=983), except the eye diameter. Observed significant differences between sexes of the analysed mean lengths are in accordance with the results previously reported by for this species from the other seas (6). To reveal round sardinella sexual dimorphism, further and more detailed investigations, especially of genetic ones should be done.

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RECENT ADDITIONS TO THE ALIEN MARINE BIOTA ALONG ITALIAN COASTS

Agnese Marchini [1], Jasmine Ferrario [1] and Anna Occhipinti-Ambrogi [1]*
[1] Department of Earth and Environmental Sciences, University of Pavia, Via S. Epifanio 14, 27100 Pavia (Italy) - occhipin@unipv.it

Abstract
New records of non-indigenous species along the Italian coasts have been reported, amounting to a total of 176, which includes suspected cryptogenic species. Many species have shown range expansion especially in the lagoon of Venice and the area surrounding Olbia (NE Sardinia).

Keywords: Tyrrhenian Sea, North Adriatic Sea, Ionian Sea, Alien species

Introduction - Target 5 of the EU Biodiversity Strategy (2011) [1] states that European countries are committed to identifying Invasive Alien Species (IAS) and their pathways by 2020, in order to develop management strategies able to control and prevent introduction and establishment of new IAS. Furthermore, in 2008 the Marine Strategy Framework Directive [2] included the presence and relative abundance of non-indigenous species (NIS) as one of the main descriptors in assessing Good Environmental Status (GES) in European marine waters. The production of validated lists of alien species and their continuous updating is therefore a crucial instrument for member states to meet the commitments towards the EU. As regards Italian coasts, a comprehensive report of multicellular NIS introduced in the period 1945-2009 was published in 2011 [3], and a focus on the hotspots of introduction and pathways was also presented [4]. Since then, new literature records have shown the presence of additional NIS or suspected cryptogenic species, as well as the range expansion of previously recorded ones. This paper offers a summary of the new records, providing an update of the presence of NIS along the Italian coast and indicating the main hotspots of introduction.

Methods - Data were extracted from AquaNIS (Information system on Aquatic non-Indigenous species)
Version: 2.0 (http://www.corpi.ku.lt/databases/index.php/aquanis).

Results - Twelve NIS, which are new to the Italian fauna, have been recorded since the publication of the list in 2011 [3] (in brackets the year of first Italian record): the macroalgae *Caulerpa taxifolia* var *distichophylla* (2008), *Gracilaria vermiculophylla* (2008), *Heterosyphonia japonica* (1999), *Hypnea flexicaulis* (2009), *Solieria filiformis* (2005), the digenean parasite *Allolepidapedon fistulariae* (2005), the polychaetes *Branchiomma bairdi* (2004), *Hesionura serrata* (2010), the crustaceans *Artemia franciscana* (2003), *Charybdis japonica* (2006), *Pseudodiaptomus marinus* (2011), and the ascidian *Didemnum vexillum* (2007). Conversely, we have not considered several recent literature records that might refer to cryptogenic species: the macroalga *Palisada maris-rubri* (1991), the deep-sea polychaete *Harmothoë vesiculosa* (2000), the ascidian *Botrylloides pizoni* n.sp., recently reported from Mar Piccolo, Taranto (2003) but likely to have originated outside the Mediterranean area. These species would require evidence from genetic analyses in order to clarify their native origin. Other species that had previously been reported in Italy have reached new regions of the Italian coastline. Most of the recent range expansions involve the lagoon of Venice (V), the Mar Piccolo of Taranto (T) and the NE coast of Sardinia, namely around Olbia (O), whereas a number of other records occurred elsewhere in Italy (E): the macroalgae *Agardhiella subulata* (V), *Aglaothamnion feldmanniae* (V), *Grateloupia turuturu* (T), the molluscs *Anadara transversa* (O), *Brachidontes pharaonis* (O), *Bursatella leachii* (O), *Crassostrea gigas* (O), *Fulvia (Fulvia) fragilis* (O), *Haminoea japonica* (E), *Polycera hedgpethi* (V), the peracarid *Caprella scaura* (T), and the bryozoans *Electra tenella* (E), *Tricellaria inopinata* (O).

Discussion & Conclusions - A former analysis of the geographical distribution of introduction events in Italy [4] had highlighted the lagoon of Venice as the main hotspot of alien species introduction, with 40 alien species introduced since 1945. The number of aliens has now increased, reaching 48, and confirms that the lagoon of Venice is an optimal site for the introduction and establishment of alien organisms. Venice also represents an important source of secondary spread of alien species by means of shipping and aquaculture activities. In particular, the transfer from Venice of live molluscs for farming has been suggested as the most likely vector, explaining the recent appearance of several alien species in the harbour of Olbia [6]. Olbia is now to be added to the list of Italian hotspots of introduction (Fig.1), displaying 12 introduced species. The updated total number of marine NIS introduced to Italy now stands at 176, but it is currently under verification as it is suspected to include a number of cryptogenic species. Eventually, the total number of NIS along the Italian coast is likely to be lower.

Acknowledgements - Support for this research was provided by the European Community's Seventh Framework Programme (FP7/2007-2013) for the project *Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors* (VECTORS).

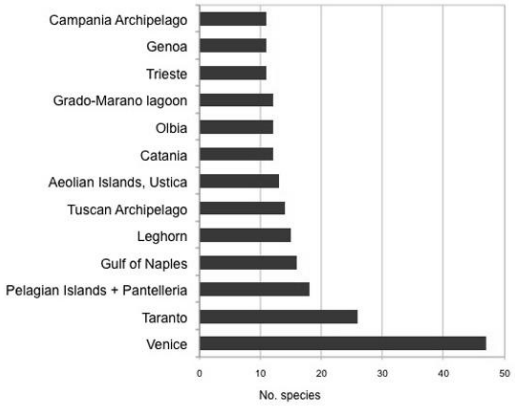

Fig. 1. Hotspots of introduction along the Italian coasts (only localities with more than 10 alien species recorded).

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DETERMINING THE NITRITE STRESS ON GREEN ALGAE *CHLORELLA VULGARIS* CHLOROPLAST

Isil Ezgi Eryilmaz [1], Dilek Unal Ozakca [1]*, Aysegul Kozak [2] and Inci Tuney [2]
[1] Bilecik Seyh Edebali Univetsity, Faculty of Science and Art, Department of Molecular Biology and Genetics, Bilecik-TURKEY - dilek.unal@bilecik.edu.tr
[2] Ege University, Faculty of Science, Department of Biology, Izmir-TURKEY

Abstract
Chlorella vulgaris is a single-celled green algae with a spherical shape, about 2 to 10 μm in diameter without flagella. Ammonium (NH4+), nitrite (NO2–) and nitrate (NO3–) are the most common ionic (reactive) forms of dissolved inorganic nitrogen in aquatic ecosystems. Excessive nitrogen fertilization causes osmotic stress, in which reactive oxygen species (ROS), hydrogen peroxide (H2O2) and hydroxyl radical (•OH) are produced. reductase (NitR), rubisco large subunit (rbcL) and ascorbate peroxidase (APX) genes in Chlorella sp. were investigated in this study. There is no distinctive changes observed in chlorophyll integrity after NaNO2 treatment on the Chlorella sp. cultures. But there are variations determined on expression of APX, NitR and rbcL genes depending on nitrite stress.

Keywords: Algae, Aegean Sea

Introduction: *C. vulgaris*is a single-celled green algae with a spherical shape, about 2 to 10 μm in diameter without flagella. It contains the green photosynthetic pigments chlorophyll-a and -b in its chloroplast. Phytoplankton need nitrogen sources which are considerably important for their growth and also it is a constituent element of amino acids and thus of protein, and nucleic acids (DNA and RNA). Nitrate occurs naturally in mineral sources and animal wastes, and anthropogenically as a by product of agriculture and human wastes. Ammonium (NH_4^+), nitrite (NO_2^-) and nitrate (NO_3^-) are the most common ionic (reactive) forms of dissolved inorganic nitrogen in aquatic ecosystems. Excessive nitrogen fertilization causes osmotic stress, in which reactive oxygen species (ROS), hydrogen peroxide (H_2O_2) and hydroxyl radical (•OH) are produced. ROS are highly toxic and can cause serious damages on lipid, protein and nucleic acid metabolisms and then inhibit plant and algae growth.

Materials and Method: *C. vulgaris* was obtained from EGEMAC culture collection, University of Ege, Izmir, Turkey. Five flasks of 100 ml Chlorella sp. were used for the experiment. *C. vulgaris*culture was grown photoautotrophiclly in Bold's Basal Medium(BBM) at 27°C in under continuous illumination. Illumination provided by daylight fluorescence tubes at 20 μmol photons $m^{-2}s^{-1}$. Air was supplied to the culture. Continuous aeration was provided by bubbling air using a blower. Three different doses (0.5mM, 1mM, 2.5mM, 5 mM) of $NaNO_2$ applied to the culture flasks. Cells harvested at 24, 48, 72 and 96th hours for the analysis. For the assesment of chlorophyll integrity, DMSO added to the cell pellet and incubated at 65°C for an hour. Absorbance of the extracts was read at 665.1 nm, 649.1 nm, 435 nm and 415 nm by spectrophotometer. Chlorophyll a, chlorophyll b, and chlorophyll a/b were calculated using equations derived from specific absorption coefficients. Reverse Transcriptase-PCR was performed by using Intron he High Capacity cDNA Reverse Transcription Kit. Obtained cDNAs used for PCR analysis to determine the expression of NitR, rbcL and APX genes.

Results: The expression of *APX* encoding genes is modulated by various environmental stress including drought, salt, high light, pathogen attacks, and low temperature. In the present study, the *APX* mRNA transcript level increased after 48 h $NaNO_2$ exposure.

Fig. 1. PCR results of APX gene

Fig. 2. PCR results of NitR gene

The effects of high nitrite concentrations on alterations in chlorophll integrity and expression rates of nitrite reductase (NitR), rubisco large subunit (rbcL) and ascorbate peroxidase (APX) genes in *C. vulgaris*were investigated in this study. There is no distinctive changes observed in chlorophyll integrity after $NaNO_2$ treatment on the *C.vulgaris* cultures. But there are variations determined on expression of APX, NitR and rbcL genes depending on nitrite stress.

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THE EFFECTS OF SEASON AND GENDER ON THE PROXIMATE AND FATTY ACID PROFILE OF RED MULLET (MULLUS BARBATUS) AND HORSE MACKEREL (TRACHURUS TRACHURUS)

Y. Ozogul [1]*, M. Durmus [1], M. Aydin [2], F. Ozogul [1], E. Balikci [1], S. Gokdogan [1], H. Yazgan [1] and N. Toy [1]
[1] Cukurova University Faculty of Fisheries - yozogul@cu.edu.tr
[2] Fatsa Faculty of Marine Science, Ordu

Abstract

The effects of the seasonal and gender on the proximate and fatty acid compositions in the flesh of two commercially important fish species from Black Sea were evaluated. Significant differences were found in proximate and fatty acid compositions for all seasons and gender. The major fatty acids were myristic acid (C14:0), palmitic acid (C16:0), palmitoleic acid (C16:1), stearic acid (C18:0), oleic acid (C18:1*n*9), linoleic acid (C18:2*n*6,), *cis*-5, 8, 11, 14, 17-eicosapentaenoic acid (EPA, C20:5*n*3,) and *cis*-4, 7, 10, 13, 16, 19-docosahexaenoic acid (DHA, C22:6*n*3). EPA and DHA contents were high in both fish species, increasing the value of these fish species.

Keywords: Fisheries, Black Sea

Introduction

Fish is regarded as the best source of polyunsaturated fatty acids (PUFA), especially eicosapentaenoic acid (EPA, C20:5n3) and docosahexaenoic acid (DHA, C22:6n3). Fish is one of animal protein sources as it includes amino acids, essential fatty acids, and vitamins and minerals in sufficient amounts for healthy living [1]. Fatty acids are very important nutritional elements for human health. The beneficial effect of fish consumption on human health has been related to the high content of n-3 fatty acids (PUFA). In addition, fish oil is a rich source of vitamins including vitamin A, D, E, and K, which are soluble in oil and must be taken on a regular basis because of their key roles in human health and metabolism [2]. Red mullet belonging to Mullidae family has high economic value, was widely spread in East Atlantic, Dakar, Senegal, Canary Islands, Mediterrian and Black Seas and Asor Islands [3]. Horse mackerel belonging to Carangidae family is a pelagic fish species and spread in Turkey. The total amounts of red mullet and horse mackerel caught in the Turkish coasts were 1861.4 tons per year and 18072.7 tons per year, respectively [4]. These fish species are generally consumed domestically and imported to European countries. Studies have been conducted on proximate and fatty acids content of fish species [5,6,7,8,9,10]. The aim of this research was to determine the proximate content and fatty acid compositions of two different marine water fish species from the Black Sea.

Materials and methods

Red mullet and horse mackerel were caught by a gill net for each season (autumn, winter, spring and summer) from Black Sea. Fish were then transported to the laboratory in ice for analysis. At least nine individuals from each species were gutted, filleted and minced for analyses. Lipid content was measured by the method of Bligh & Dyer [11]. Ash and moisture contents were determined as described by AOAC [12] and protein was determined by the Kjeldahl procedure using a Buchi Digestion System, Model K-424 (BÜCHI Labortechnic AG, Flawil, Switzerland) and a Kjeltec Distillation Unit B-324 (BÜCHI Labortechnic AG). Percent protein was calculated as % Nx6.25. Methyl esters were prepared by transmethylation using 2 M KOH in methanol and *n*-hexane according to the method described by Ichihara et al [13] with minor modification; 10 mg of extracted oil were dissolved in 2 ml hexane, followed by 4 ml of 2 M methanolic KOH. The tube was then vortexed for 2 min at room temperature. After centrifugation at 4000 rpm for 10 min, the hexane layer was taken for GC analyses. ***Gas chromatographic conditions*** The fatty acid composition was analysed by a GC Clarus 500 with autosampler (Perkin–Elmer, USA) equipped with a flame ionization detector and a fused silica capillary SGE column (30m×0.32mm ID×0.25µm BP20 0.25 UM, USA). The oven temperature was 140^{o}C, held 5 min, raised to 200^{o}C at the rate 4^{o}C/min and held at 220^{o}C at 1^{o}C/min, while the injector and the detector temperatures were set at 220 and 280^{o}C, respectively. The sample size was 1µl and the carrier gas was controlled at 16ps. The split used was 1:50. Fatty acids were identified by comparing the retention times of FAME with the standard 37 component FAME mixture. Two replicate GC analyses were performed and the results were expressed in GC area % as mean values±standard deviation.

Results and discussion

Determination of the effects of different fishing seasons and gender on the fatty acid composition of these species will provide valuable information on the nutrient value for both the consumers and the dieticians. In this research, significant differences ($P<0.05$) were found in proximate and fatty acid compositions among seasons and gender. The main fatty acids were myristic acid (C14:0), palmitic acid (C16:0), palmitoleic acid (C16:1), stearic acid (C18:0), oleic acid (C18:1*n*9), linoleic acid (C18:2*n*6,), *cis*-5, 8, 11, 14, 17-eicosapentaenoic acid (EPA, C20:5*n*3,) and *cis*-4, 7, 10, 13, 16, 19-docosahexaenoic acid (DHA, C22:6*n*3). EPA and DHA contents were observed to be high in both fish species, increasing the value of these fish species.

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COMPARISON OF DIFFERENT WAYS TO DETERMINE AGE FOR WHOLE OTOLITH.

P. Pesci [1]*, P. Altea [1], S. Cabiddu [1], F. Palmas [1], C. Porcu [1] and S. Vittori [1]
[1] Department of Life Science and Environment, University of Cagliari, Italy. - ppesci@unica.it

Abstract
Age determination in *Mullus barbatus* Linnaeus, 1758 is generally made reading annuli in whole otoliths. They are usually seen against a black background, immersed in clear liquids. The aim of this paper is to compare the age estimation obtained with otoliths immersed in six different means (water, ethanol, glycerin, solutions of glycerin and ethanol) and dry, to understand which is the best way to read them. Coefficient of Variation (CV), Percentage of agreement (PA) and Relative Bias were calculated to evaluate the precision and accuracy. The analysis showed that age determination is more reliable when otoliths are immersed in a clear liquid (preferably a solution of glycerol and ethanol 2:1).

Keywords: North-Western Mediterranean, Growth, Teleostei, Instruments and techniques

Introduction
Age determination in *M. barbatus* is often made through the reading of otoliths. They are usually seen "*in toto*" against a black background, generally immersed in clear liquids [1, 2]. The purpose of this work is to compare and evaluate the use of different liquids, in order to indicate the more precise and accurate mean for age determination of *M. barbatus*.

Materials and Methods
40 otoliths of *M. barbatus*, collected during the MEDITS survey 2012 along the Sardinian coast (central - western Mediterranean), were selected for age reading. The individuals sampled had a total length (LT) comprised between 10 and 21.7 cm. Several pictures of each otolith have been acquired under a binocular microscope at 10 x 2 magnification with reflected light against a black background. Each otolith was firstly photographed dry, then immersed in six different liquids: water, ethanol, glycerol, 2:1 dilution with two parts of glycerol and one of ethanol (2:1 g-e), 1:1 dilution of glycerol and ethanol (1:1 g-e); 1:2 diluition with one part of glycerol and two of ethanol (1:2 g-e). At each step, otoliths were carefully rinsed in water and dried thoroughly to avoid the mixture of the different liquids and preserve the next steps. Each photo was read by three operators which did not have any information about fish length, sex and liquid used. A modal age has been estimated for each otolith, considering the average readings made by the operators with the different means. Methods were compared using the Coefficient of Variation (CV), Percentage of Agreement (PA) and Relative Bias [3]. To choose the best way of make annuli counts, we used the rank method. A rank between 1 to 7 was given to each values of CV, PA and relative bias, for each method. Then the average rank allowed to choose the most adequate method.

Results and Discussion
The age classes assigned to the sampled individuals ranged between 1 and 4 years. Each operator agreed that otoliths immersed in liquid appeared much clearer and easier to read than dry ones. The precision in the age readings has been evaluated with the CV. Water is the liquid which gave the lowest CV (6.9%) whereas the highest was obtained with dry otoliths (24.3%). High CV were also obtained using ethanol (18.5%). Accuracy has been investigated through analysis of PA. The highest values of PA were obtained immersing the otoliths in 1:1 dilution of glycerin and ethyl alcohol (PA 97.5%). The other two glycerin solutions as well gave high PA values (95% both). The less accurate reading method resulted with dry otolith (PA 60%) followed by ethanol 75%. The Relative bias analysis confirmed that the reading of dry otoliths gave the worst results (underestimation of -0.38). A certain underestimation on annuli counts came as well from the use of water (-0.10). According to this analysis, the most accurate way of reading otoliths was using glycerol (0.00) (Fig. 1). An overall average ranking was then obtained. According to it, the best way to read otoliths of *M. barbatus* was by immerging them in a solution 1:2 glycerin-ethanol. Among liquids, ethanol, which is one of the more used means, resulted the worst. However, it is clear the importance of immersing the otoliths in a clear liquid, since reading them dry always resulted the worst method.

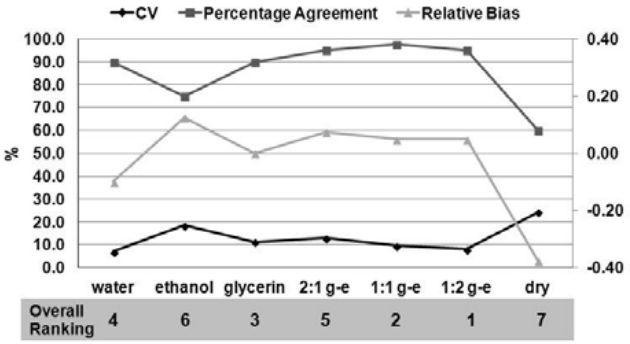

Fig. 1. Coefficient of Variation (CV), Percentage of Agreement (PA), Relative Bias and Overall Ranking.

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A FRESHWATER IN?OW EVENT IN THE BIZERTE LAGOON (TUNISIA SW MEDITERRANEAN) AND A RELATED BLOOM OF *CHAETOCEROS* SPP.

S. Melliti [1], I. Sahraoui [1]*, M. Chalghaf [2], J. Ksouri [2], H. Hadj Mabrouk [1] and A. Sakka Hlaili [1]
[1] Faculté des Sciences de Bizerte - ineskalif@yahoo.fr
[2] Institur supérieur de Pêche et d'Aquaculture de Bizerte

Abstract
On March 2012, a red tide was observed in Bizerte Lagoon. The water column was characterized by a sharp pycnocline, after abundant freshwater runoff and release from dams. It was sampled at 9 depths to determine salinity, temperature, chlorophyll *a* (Chl *a*) concentration and phytoplankton abundance and composition. Water temperature (13.7 – 17.3 °C) and salinity (16 – 31.9 ° C) exhibited strong vertical gradients. Chl *a* concentration varied also vertically from 13.1 to 19.5 µg l^{-1}. Diatoms formed a pronounced bloom, which was dominated by *Chaetoceros holsaticus* (8 x 10^6 cells l^{-1}) and *C. constrictus* (7 x 10^6 cells l^{-1}). These harmful species do not produce toxins, but have long setae armed with short secondary spines and may kill fish at fairly low concentrations (<10^4 cells l^{-1}).

Keywords: Blooms, Diatoms, Lagoons, South-Western Mediterranean

Introduction
Harmful algal blooms (HABs) are increasingly reported throughout the coastal areas of all continents [1]. These events can discolour the water giving rise to red, brown, or green tides, and deplete oxygen levels through excessive respiration or decomposition. HABs negatively impact organisms in a variety of ways that can range from cell and tissue damage to organism death [1]. Increased stability of the water column due to stratification is generally favourable to HABs [1]. Here we report the incidence of a large diatom bloom which occurred after a significant winter storm event and high water stratification in Bizerte Lagoon.

Materials and Methods
Sampling was carried out on March 2012 at one station located near a shellfish farm in Bizerte Lagoon. Samples were taken from 9 depths using a HYDRO-BIOS (Kiel-Holtenau, Germany) water sampler. Water temperature and salinity were recorded *in situ* using a microprocessor conductivity meter (WTW-LF-197, Brives B.V., Germany). Chl *a* concentrations were determined using the standard spectrophotometric method of Parsons et al. [2]. Sub-samples for identification and enumeration of phytoplankton were fixed with 3 % acidLugol'ssolution and than analysed following the Utermöhl method [3].

Results and discussion
The results showed that the water column was characterised by strong vertical gradients in both temperature (13.7 – 17.3 °C) and salinity (16 – 31.9 °C) (Fig. 1) with less dense warmer surface waters floating on top of denser colder waters.

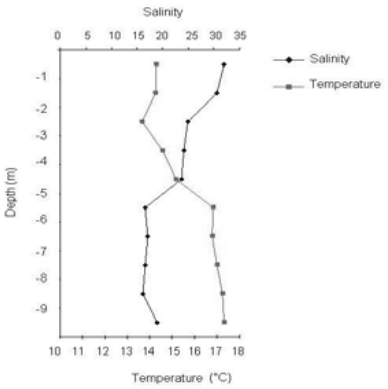

Fig. 1. Vertical profiles of water temperature and salinity in Bizerte Lagoon during the diatom bloom (17 March 2012)

Chl *a* concentration varied vertically from 13.1 to 19.5 µg l^{-1} (Fig 2), which was much higher than values generally reported for Bizerte lagoon [4].

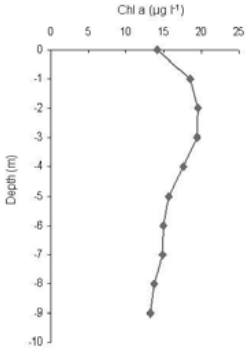

Fig. 2. Vertical profile of chlorophyll *a* in Bizerte Lagoon during the diatom bloom (17 March 2012)

Microscopic analysis of phytoplankton showed abnormally high concentrations of diatoms (Max: ~2.5 x 10^7 cells l^{-1}) dominated by *Chaetoceros holsaticus* (Max: ~8 x 10^6 cells l^{-1}) and *C. constrictus* (Max: ~7 x 10^6 cells l^{-1}). These species are non-toxic to humans, but harmful to fish and invertebrates, especially in intensive aquaculture systems, by damaging or clogging their gills [1].

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POPULATION AGE STRUCTURE OF THE LONG-LIVED, SLOW GROWING PRECIOUS MEDITERRANEAN RED CORAL.

G. Santangelo [1]*, L. Bramanti [2], C. Priori [1], M. Angiolillo [3], S. Canese [3], S. Rossi [4], G. Tsounis [5] and M. Iannelli [6]
[1] Dep.Biology University of Pisa - gsantangelo@biologia.unipi.it
[2] California State Univ. at Northridge
[3] ISPRA - Roma
[4] UAB Barcelona
[5] AWI Bremerhaven
[6] Dep. Mathematics Trento University

Abstract
Matching exploitation to population growth rate in long lived, slow growing species is one of the more difficult tasks of conservation biology. Gorgonians are long lived species as their life-span can exceed a full century . The high valuable red coral *Corallium rubrum* is a precious Mediterranean gorgonian which populations have been subject to a selective long-lasting exploitation. Here we present our findings on colony growth rate and population age structure based on annual growth ring counts in a mesophotic population. The average colony growth rate of the basal diameter of colonies is higher in the early colony life, than decreases slowly during the following years. The aim of this research is to set out demographic models based on colony growth and transition algebraic matrixes, suitable to project population trends over time.

Keywords: Growth, Life cycles, Population Dynamics, Deep sea corals, Tyrrhenian Sea

Introduction

Age determination is a basic step in the study of population dynamics; knowing growth rates allows to estimate population age structure and to attribute a precise timing to the passage from one year to the following of each *cohort* thus setting out reliable, time explicit demographic models [1]. As red coral develops annual growth rings, an age determination method based on staining of organic matter [2] was applied to estimate the age of colonies of mesophotic "deep populations". Although our knowledge on the demographic features of red coral populations living between 10 and 50 meter depth increased considerably in recent years [3, 4 and references herein], the basic life-history traits of deep populations (the main target of harvesting nowadays), are still largely unknown (5). The aim of this study is to investigate the demography of deep *Corallium rubrum* populations [6] and to compare these findings with those obtained in the "shallow populations" of this species [7, 8, 9, 10] .

Material and Methods

To increase the demographic knowledge on deep-dwelling populations an *ad hoc* cruise was carried out during early Summer 2010 in the North and Central-East Tyrrhenian Sea (Tuscany Archipelago and Campania, between 62 and 130 m depth. [6]. A subsample of colonies from Tuscany Archipelago was sectioned and the thin-sections were stained to highlight the annual growth rings [2] . The variability in age determination between 3 different observers and that between groups of colonies of similar size (5 classes) was checked by a two factor orthogonal ANOVA which factors were: age (5 levels) and observers (3 observers). The relationship between age and basal diameter was fitted on a smaller sample of colonies, then the relation thus obtained wasapplied to estimate the age of a larger sample of colonies on the basis of their size (diameter). The growth rate and the population age structure thus obtained were compared with those previously described in shallow populations [7, 8, 9].

Results and Discussion

On the basis of a 2-way ANOVA, , no significant difference was found between the age estimated by the three independent observers. The relationship between age and basal diameter was well fitted by a power curve which was applied to share all the colonies in different size/age classes on the basis of their diameter. Thirty-height % of the overall colonies were larger than 7 mm in diameter (the minimum harvesting size in several countries), corresponding to the age of 30-35 years. The majority of colonies (97.7%) fell within the 6 – 55 years range; about half of them (51.1 %) were in the 21-25 and 26-30 age classes. Only two colonies have an estimated age of 93 and 69 years. The shallow populations previously studied at Portofino (Italy) and Cap de Creus (Spain), revealing a slightly lower average colony growth rate (0.24 vs 0,26 mm y^{-1}), less skewed age structures, shorter life-span and a several fold lower percentage of colonies below the commercial size [8].

The average colony growth rate, expressed as basal diameter of colonies, was 2-3 fold higher in the early colony life and then decreases slowly with colony age [6, 8, 10], suggesting that a larger error can be made if a linear correlation beteen the two parameters will be applied to estimate the age of larger colonies . The knowledge of these life-history descriptors, together with that of the reproductive parameters of the populations and the spatial data obtained by ROV recordings [5, 6], will greatly foster our understanding of deep dwelling red coral population structure and complex dynamics. Moreover they will allow to develop demographic models suitable to simulate population trends over time and to match harvesting to population growth rate.

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PROVISION OF PREPARATORY GUIDELINES FOR THE PROPER SITING OF MARICULTURE FISHFARMS ALONG THE ITALIAN COASTS

S. Scanu [1]*, V. Piermattei [1], S. Bonamano [1], A. Madonia [1] and M. Marcelli [1]
[1] Lab of Experimental Oceanology and Marine Ecology Tuscia University - sergioscanu@unitus.it

Abstract
The offshore fish farming, in Italy, is rapidly expanding and becoming the most popular way the product reaches maturity. These systems use an immediately available resource, sea water, which provides the best conditions necessary to the fish growth. The mariculture coastal and offshore plants has increased almost tenfold, parallel to the increase of the production capacity of the single fish farms. These events generated a growing interest of scientific community to the alterations produced in the marine environment by these activities, mainly explicable by the placing of large quantities of wastewater with high organic content. This work shows the first results of a study aimed at the plan of the proper guidelines for mariculture siting.

Keywords: Monitoring, Aquaculture, Coastal models, Tyrrhenian Sea

Introduction and purpose of the work
The expansion of mariculture activities in the areas of interest allowed to define the 'Best Environmental Practice' to limit the impact of such activities. Within the framework of national (D.lgs152/06) and international regulations, the purpose is the environmental quality conservation related to production activities in the area that houses systems.Therefore it is necessary to provide to the administrations useful tools to assess the environmental compatibility of the sites used for mariculture. In this context the Lab. Of Experimental Oceanology and Marine Ecology (University of Tuscia) together with the Directorate for Nature Protection of the Italian Ministry of the Environment, Land and Sea, conducted a preliminary study to plan a series of guidelines for the proper siting of fishfarms in coastal areas.

Material and methods
The drafting of guidelines for mariculture plants siting has been developed through the application of a protocol for studying and monitoring a pilot area located in the Oristano Gulf in Sardinia where there is already an active mariculture plant. The review and analysis of International Standards and of the bibliography of mariculture impacts indicators and the review of offshore fishfarms in Italy (type and location) allowed to identify four groups of criteria, necessary to be assessed in order to elaborate sinoptic guidelines for the siting and to reduce the potential impacts.These criteria are: ecological/primary criteria;sanitary criteria;productive criteria; management criteria. The research activities applied to the pilot area of Oristano Gulf focused on the first criterion (ecological/primary criteria) in particular, in this first phase, the following aspects were considered: 1) development of predictive models of physical and ecological dynamics, and application of hydrodynmical models in order to simulate the diffusion of organic matter ; 2) study of integrated phytoplankton primary production in the water column; 3) water column characterization (physical-chemical-biooptical parameters) of the pilot area. The study of phytoplancton primary production and the water column characterization were carried out in two separate campaigns representative of winter and summer. The sampling plan includes 8 radial transects for a total of 29 stations, plus a further control transect composed of three 3 stations. This work shows the first results of the application of the ecological and primary criteria on a the pilot site of Oristano which allowed to verify and estimate the area of potential impacts of a fishfarm.

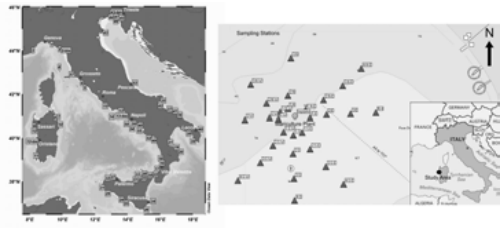

Fig. 1. Italian mariculture plants (left) and Oristano study area (right)

Results
The study area is characterized by low concentrations of the major dissolved nutrients and phytoplankton biomass. This condition of general oligotrophy is confirmed by the values of the concentration of dissolved nitrogen compounds and phosphates as well as of chlorophyll a related to the summer season and reported by IAMC-CNR of Oristano. Regarding the load of suspended solids is recognized instead an average value greater than that expected (7.54 mg/L vs 3.57 ± 1.34 mg/L). In order to acquire more information on the trophic status of the area surrounding the plant site, the concentrations of the main trophic parameters were compared with those reported by La Rosa et al. (2001) measured at a station located inside a mariculture plant in the Gaeta Gulf, and Karakassis et al. at 4 mariculture plants located in different areas of the Mediterranean Sea, respectively in Cyprus, Sicily (Italy), in Sounio (Greece) and Alicante (Spain). On the Gulf of Gaeta, in September, the concentrations of DIN (Dissolved Inorganic Nitrogen) and DIP (Dissolved Inorganic Phosphorus) are considerably higher than those reported in the present study (0.25 μmDIN / L and 0.36 μmDIP/L vs 0.08 μmDIN/L and 0.07 μmDIP/L), probably because of the different position of the monitoring stations with respect to the cages. The comparison with the data reported by Karakassis et al. showed a higher amount of phytoplankton biomass in Oristano Gulf compared to all 4 sites studied (chl a concentration is 4-5 times higher) and an average concentration of dissolved phosphates comparable to those found in Cyprus and Greece. The areas monitored in Sicily showed higher values (0.1-0.4 μm/L) whereas the areas monitored in Spain showed lower values (0.02-0.05 μm/L). The analysis of the concentrations of chlorophyll a and dissolved phosphate has also allowed to identify a spatial gradient of gradual decrease with the increasing of the distance from the cage. This gradient could be related to the enrichment of nutrients caused by mariculture activities. As for the nitrates and suspended particulate matter, instead, this decreasing trend was not detected at the distances monitored. For what concerns the modeling results, the particle size distribution of suspended particulate matter, is indicative of the hydrodynamic field of Oristano Gulf. Greater particle sizes deposited in a short time along a shorter distance from the cages, (with a minimum values measured at 245 m from the cages). The maximum values measured at 540 m form the cages shows that, at this distance, the he finer suspended component has not yet fallen on sea bottom. The increased turbidity of the water column in the stations placed at 540 m also explains the lower growth of phytoplankton organisms and dissolved inorganic nitrogen concentration.

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CONDITIONS DU MILIEU ET BIOMASSE D'*ALTHENIA FILIFORMIS* PETIT (ZANNICHELLIACEAE) DANS UNE LAGUNE MÉDITERRANÉENNE (NORD-EST TUNISIE)

Abdessalem Shili [1]*, Besma Chaouachi [2], Naceur Ben Maiz [3] and Charles F. Boudouresque [4]
[1] Institut National Agronomique de Tunisie. Université de Carthage. - shili.abdessalem@inat.agrinet.tn
[2] Faculté des Sciences de Tunis. Université Tunis El Manar.
[3] Société de Promotion du Lac de Tunis
[4] Mediterranean Institute of Oceanography (MIO), Aix-Marseille University.

Abstract
Le présent travail décrit les conditions du milieu et la variabilité saisonnière de la Magnoliophyte aquatique *Althenia filiformis* Petit var. *barrandonii* (Zannichelliaceae) dans la lagune de Korba. C'est le secteur Nord de la lagune qui semble présenter les conditions les plus favorables à la constitution d'herbiers pouvant être homogènes ou mixtes avec *Ruppia maritima* L. (Ruppiaceae). Dans cette zone, le développement d'*A. filiformis* s'est étendu sur 5 mois avec une biomasse variant entre 0 et 73 g MS/m^2 (Ecart-type = 17). Il s'agit d'une espèce menacée en Tunisie, comme c'est le cas dans plusieurs pays du bassin méditerranéen, étant donné sa rareté et la fragilité des écosystèmes qui l'abritent.

Keywords: Phanerogams, Gulf of Tunis, Lagoons, Phytobenthos, Hydrology

Introduction
La lagune de Korba est située dans la région du Cap-Bon au Nord-Est de la Tunisie (Fig. 1). Dans ce milieu, les peuplements phytobenthiques sont exposés aux contraintes de l'eutrophisation, au confinement et au risque d'assèchement. Les deux Magnoliophytes aquatiques *Ruppia maritima* s.s (Ruppiaceae) et *Althenia filiformis* Petit var. *barrandonii*(Zannichelliaceae) peuplant cet écosystème sont des opportunistes capables d'achever leur cycle de vie durant une courte période (un à cinq mois) avec une forte production de graines [1].

Matériel et Méthodes
Nous avons réalisé les mesures et les prélèvements durant deux cycles d'étude allant du mois de janvier 1996 au mois de décembre 1997. Nous avons mesuré la phytomasse dans trois stations réparties au Nord de la lagune, lieu de prolifération des Magnoliophytes aquatiques (Fig. 1).

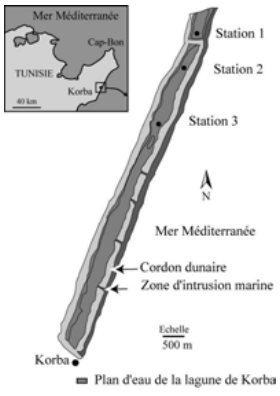

Fig. 1. Position géographique et localisation des stations d'échantillonnage dans la lagune de Korba (Nord-Est Tunisie).

Résultats et discussion
L'herbier d'*Althenia* se développe essentiellement au niveau de la station 1 du Nord de la lagune de Korba. Son extension est moins importante dans les stations 2 et 3. Les niveaux d'eau les plus faibles sont relevés à la station 1 qui passe par des périodes d'assèchement pendant la saison estivale. La hauteur de l'eau est comprise entre 0,2 à 0,4 m dans les stations 2 et 3. La salinité a varié entre 22 et 86, avec des fluctuations assez proches dans les 3 stations. L'évolution mensuelle du pH montre des valeurs comprises entre 7,5 et 9,5.
L'apparition d'*A. filiformis* s'est limitée à 5 mois/an depuis l'hiver jusqu'à la fin du printemps ou le début de l'été. La biomasse moyenne a varié de 0 à 73 g MS/m^2 (Ecart-type = 17) dans la station 1, de 0 à 15 g MS/m^2 dans la station 2 (Ecart-type = 13) et de 0 à 104 g MS/m^2 dans la station 3 (Ecart-type = 22). La production de biomasse a varié entre des valeurs <0,1 g MS/m^2/j (station 2) et 0,4 g MS/m^2/j (station 3). La production annuelle de biomasse la plus importante a été relevée à la station 3 avec 155,7 g MS/m^2 en 1996 et 69,8 g MS/m^2 en 1997 (Tab. 1)

Tab. 1. Productions de biomasses annuelles et journalières par unité de surface (g MS/m^2) de la Magnoliophyte *Althenia filiformis* dans la lagune de Korba.

Stations/Année	1996		1997	
	Production annuelle	Production journalière	Production annuelle	Production journalière
Station 1	95,49	0,26	68,66	0,19
Station 2	14,80	< 0,10	0,16	< 0,10
Station 3	155,75	0,43	69,84	0,19

A. filiformis, plante annuelle à reproduction sexuée, est inféodée aux zones humides du littoral méditerranéen [2]. Dans la lagune de Korba, elle se développe dans le secteur Nord dans des eaux relativement peu profondes (< 0,4 m) et souvent en association avec *R. maritima* comme c'est le cas dans d'autres lagunes méditerranéennes ([1] ; [3]). La salinité du milieu montre une grande variabilité, vu l'instabilité des apports en eaux douces et des échanges avec la mer. La lagune est souvent exposée à des périodes d'assèchement plus ou moins longues dans le secteur Nord. Dans ce milieu, *A. filiformis* a germé dans des conditions où les salinités sont proches de 25, dépassant largement les valeurs indiquées dans des conditions expérimentales rapportant le maximum de germination à une salinité de 13 et l'optimum de croissance à des salinités comprises entre 6 et 13 [3]. Dans notre cas, la plante arrive à supporter des salinités allant jusqu'à 78. Elle disparait suite à des changements rapides de salinité. En un mois, on a relevé la disparition de la plante suite à une baisse brusque de salinité (écart de 34,8) et le même phénomène a été observé suite à une augmentation rapide de salinité (écart de 17,7). Il est à noter que le pH est généralement alcalin durant la période de croissance d'*A. filiformis*. Dans l'ensemble, les caractéristiques hydrologiques du milieu confirment les tendances eutrophes de la lagune de Korba. Après déviation des rejets des eaux usées vers la station de traitement de Korba et déversement des eaux traitées au Nord de la lagune (depuis 2002), des transformations notables ont affecté la diversité et la répartition des Magnoliophytes, notamment l'apparition au Nord de la lagune de *Potamogeton pectinatus L.* (Potamogetonaceae), espèce à affinité d'eau douce. Plusieurs projets d'assainissement et d'aménagement des zones côtières du Cap-Bon sont en cours de réalisation et ces écosystèmes lagunaires relativement sensibles sont menacés. De ce fait, des mesures de protection sont recommandées pour la sauvegarde de ces biotopes très importants pour la survie de la Magnoliophyte *A. filiformis*, protégée dans certains pays du bassin Méditerranéen.

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ETUDE DE LA COMPOSITION BIOCHIMIQUE DE L'HOLOTHURIE *HOLOTHURIA POLII DE TUNISIE*

Y. Skandrani [1]*, S. Ghouaiel [2], N. Bouriga [2], M. Chalghaf [1] and H. Missaoui [1]
[1] Unité Exploitation des Milieux Aquatiques. Institut Supérieur de Pêche et d'Aquaculture de Bizerte, BP 15, 7080 Menzel Jemil, Tunisie. - skandraniyassine@yahoo.fr
[2] Université de Tunis El-Manar, Faculté des Sciences de Tunis, Unité de Biologie Marine, 2092 Campus Universitaire, Tunisie

Abstract
L'holothurie est un animal marin qui ne fait pas partie des traditions culinaires Tunisiennes. Ce travail vise l'étude de la composition biochimique de *Holothuria polii* en vue d'une éventuelle présentation aux consommateurs. Les résultats des analyses biochimiques ont montrés que la teneur en lipides est de 10%, les protéines présentent un taux de 8%. Le profil lipidique des acides gras AG de la chair de *Holothuria polii* étudiée à l'état frais, révèle que la fraction des AG polyinsaturé AGPI est la plus dominante. Elle est représentée essentiellement par la famille des omégas 3 par le C20 :5 n-3 (EPA). Les acides gras saturés représentent la fraction intermédiaire des acides gras totaux. Les acides gras saturés représentent la fraction la plus faible des lipides totaux. <\/div>

Keywords: Biotechnologies, Chemical analysis, Echinodermata, Tunisian Plateau

Introduction
L'holothurie ou concombre de mer est un animal marin appartenant à l'embranchement des échinodermes. Parmi les 11 espèces inventoriées en Tunisie, *Holothuria polii* et *Holothuria tubulosa* sont à la fois fréquentes et abondantes le long du littoral Tunisien. Les holothuries sont des espèces de haute valeur nutritionnelle. Elles sont très appréciées par les consommateurs asiatiques. En Tunisie, ces organismes marins constituent une faune méconnue sur le plan biologique, écologique et nutritionnel. Ce travail vise l'étude de la composition biochimique et la qualité nutritionnelle de *Holothuria polii* afin de promouvoir la commercialisation de ce produit en Tunisie.

Méthodes
L'échantillonnage des Holothuries a été effectué au niveau de la baie de Bizerte. Deux méthodes analytiques d'extraction des lipides (Folch et *al*, 1957) et de méthylation des acides gras (Cecchi et *al*, 1985) ont été utilisées.

Résultats
Les résultats issus de la présente étude mettent en évidence la haute valeur nutritionnelle de cette espèce vue sa richesse en protéines et en lipides. La teneur en cendre est très importante en raison de la nature calcaire de l'endosquelette. Les teneurs en lipides et en protéines sont respectivement de 10g/100g de 8g/100g de matière fraîche (tableau 1).

Tab. 1. Composition biochimique de la chair de *Holothuria polii*

	Eau %	Protéines%	Lipides %	Cendres %
***Holothuria Polii* à l'état frais**	83.81	8	10	46.43

Selon les analyses effectuées par la chromatographie en phase gazeuse, une vingtaine d'acides gras ont été identifiés dans les lipides totaux de la chair des holothuries (tableau 2).
Le profil lipidique des AG de cette espèce, révèle que la fraction des AG saturés (A.G.P.I.) est la plus dominante avec un taux de 50,06%. Ce sont essentiellement des AG de la famille des omega 3 et omega 6. Il s'agit de l'acide docosahexaénoïque DHA C22:6 n-3, l'acide éicosapentaénoïque EPA C20:5 n-3 et l'acide linoléique C18:2 n-6. Les acides gras saturés représentent la fraction intermédiaire des acides gras totaux. Ce sont en majorité l'acide myristique C14:0, l'acide palmitique C16:0 et l'acide stéarique C18:0. Cependant, les acides gras monoinsaturés AGMI présentent les taux les plus faibles. Le taux est évalué à environ 20,98%. Ils sont représentés par les acides gras C16:1 n-7, C18:1 n-9.

Tab. 2. Composition en acides gras (g/100g acides gras totaux) chez *Holothuria polii*

Acides Gras	Chair
C14:0	3.14±1.00
C15:0	0.49± 0,05
C16:0	8.96 ± 1.9
C17 :0	0.20 ± 1.08
C18 :0	9.28 ± 1.63
C16:1	9.44 ± 2.85
C17:1	2.20 ± 1.08
C18 :1	2.86 ± 0,14
C20 :1n-9	2.52 ± 0.66
C22 :1n-9	1.76 ± 0.68
C24 :1 n-9	2.20 ± 0.42
C18 :2 n-6	1.27 ± 0.17
C18 :3 n-6	2.47 ± 0.94
C18 :3 n-3	0.54± 0,02
C20:2	1.38 ± 0,13
C20:3 n-6	2.99 ± 0,24
C20 :3 n-3	20.55 ± 4.22
C20 :5 n-3	15.43±3.85
C22 :6 n-3	5.43± 0.74

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RAPD ANALYSIS OF THE GENETIC VARIABILITY IN THE POPULATION OF THE SEA CUCUMBER *HOLOTHURIA POLII* AROUND THE MALTESE ISLANDS, CENTRAL MEDITERRANEAN

David Spiteri [1]* and Adriana Vella [1]
[1] University of Malta - davids@vol.net.mt

Abstract
Randomly amplified polymorphic DNA (RAPD) analysis was used to assess the genetic variation of the sea cucumber *Holothuria polii* population. A total of 33 loci were chosen from the 7 primers used. The study revealed that there is divergence between sub-populations found on the east coast and the west coast of Malta, especially at the Anchor Bay site (I = 0.7; D = 0.3). On the other hand, Delimara's sub-population showed a high homozygozity and less effective alleles (H = 0.214, N_e = 1.295), possibly due to a decline in numbers, as a result to new selection pressures. The UPGMA dendrogram obtained of the entire Maltese population shows that *H. polii* is sub-divided into two distinct populations, the north-westerly sub-populations and the south-eastern sub-populations.

Keywords: Mediterranean Ridge, Malta Trough, Malta Channel, Coastal waters

Introduction
Studies carried out on species similar to H. polii were carried out in different environments, some consisting of large geographical areas, and in protected reefs (Uthicke & Benzie, 2001). Here, "no apparent restrictions to gene flow" (Uthicke & Benzie, 2001) were noticed, meaning that no genetic differences were present. The Maltese Islands are small and situated in the middle of the Mediterranean, making the sea currents in the area highly erratic. In fact, due to the shallow bathymetry and the proximity of the two major islands in the Maltese archipelago, a complex system of mesoscale eddies and gyres forms close to the islands (Drago et al., 2003).

Material and Methods
In this study, the RAPD primers, shown in table 1 below, were selected at random from other studies carried out on other echinoderm species.

Tab. 1. RAPD primers utilised in this study

Name	Sequences 5'-3'	TA	Reference
Primer 104	GGG CAA TGA T	36°C	Karako *et al.*, 2002
Primer 148	TGT CCA CCA G	36°C	Karako *et al.*, 2002
Primer 159	GAG CCC GTA G	36°C	Karako *et al.*, 2002
Primer 2	GTT TCG CTC C	36°C	Chenuil *et al.*, 2004
Primer OPI-07	CAG CGA CAA G	41°C	Dupont *et al.*, 2000
Primer OPF-13	GGC TGC AGA A	41°C	Dupont *et al.*, 2000
Primer OPA-11	CAA TCG CCG T	41°C	Dupont *et al.*, 2000

A total of 15 primers were screened, and 7 were selected to produce 33 loci. A statistical correction in accordance with Lynch and Milligan (1994) was applied, in order to result in 6 highly polymorphic loci. Gene diversity within the three islands was found to be at an average of 43%. Overall, the Maltese Island sub-populations were found to be closely related except for the locations of Anchor Bay and Delimara.

Results
The average heterozygozity obtained in this study is higher than that found in a previous study carried out by Spiteri (2007). In this previous study the average heterozygozity was found to be 0.13. The higher value of expected heterozygozity should not be at all surprising since in this present study the population had a greater amount of alleles and a much larger distribution, than the previous study, due to the use of more loci. In fact once the grouping of closely related sites was carried out, the expected heterozygozity increased drastically, as the possibility of a small sample size was removed.

The Delimara sub-population revealed a lower effective number of alleles and therefore lower heterozygozity, which could be due to biological factors such as inbreeding, possibly due to a decline in numbers, and the Wahlund effect. The sub-population could also have passed through a recent bottleneck. In fact Freeland, 2008 describes that "allelic diversity usually decreases after a bottleneck because rare alleles are lost". A study on the same population (Spiteri, 2007) using allozymes, also resulted in an observation of a high level of inbreeding within the same site. Inbreeding can also lead to homogeneity, the effect of which can be made worse in a small population due to breeding with closely related individuals. This inbreeding can eventually lead to a reduction in genetic diversity. Although inbreeding may cause problems in future generations because of the existence of deleterious recessive alleles, there might still be a genetic advantage by preventing recombination between adaptive loci (Primack, 1998).

Once the analysis was carried out, in order for the Maltese islands to be studied as an entire population it was observed that the sub-populations at Anchor Bay (pop. 6) and Delimara Creek (pop. 1) were the most divergent from the rest of the sub-populations. A test was carried out using UPGMA (Unweighted Pair-Group Method using an Arithmetic average), which defines the "intercluster distance as the average of all the pair-wise distances for members of two clusters" (Weir, 1996). The estimated distances of the branch length refer to the likeliness ratio, meaning that the further away the branching is, the more divergent the sub-population is.

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ALLOZYME GENETIC VARIABILITY IN THE SEA CUCUMBER (*HOLOTHURIA POLII)* AROUND THE MALTESE ISLANDS

David Spiteri [1]* and Adriana Vella [1]
[1] University of Malta - davids@vol.net.mt

Abstract
Allozyme electrophoresis was carried out over 7 loci that were selected from a maximum of fourteen enzymes. These 7 loci showed an average polymorphism, over the entire population, of 23%. Genetic index and distance showed that a genetic variation is present in the sub-populations surveyed, with a significant difference within the sub-populations of Delimara and Anchor Bay. 54% of the specimens sampled show that they are coming from the same population. Another 12%, mainly specimens collected from Anchor Bay, show that they are genetically different. In both these sites, different sub-populations may have been in contact with different environmental conditions allowing for changes to occur. Differences in allelic frequencies between *Holothuria polii* from different sites were also detected.

Keywords: Mediterranean Ridge, Malta Channel, Coastal waters

Introduction

Information on the biology and ecology of the sea cucumber *Holothuria polii* is sparse, since unlike most of its close relatives, it does not hold any economic value. However, being a relatively abundant species in the Mediterranean Sea, genetic studies on this species would have been expected, especially due to its unique characteristic organs' evisceration reflex on predatory-like stimulation. This allows for easy tissue collection, preventing any harm to the local population, as the organism can be put back in its natural habitat. Being filter-feeders, and relatively sedentary, holothurians are highly dependent on their environment (Ocana *et al.* 2005, Purwati & Luong-van 2003), allowing for behavioural changes to occur if any slight change in the environment occurs.

Materials and Methods

Allozyme electrophoresis

Approximately 300mg of frozen (-80^{o}C) gut tissue was mixed with the same amount of volume of extraction buffer (100mM Tris adjusted to pH 8.0 with HCl). Electrophoresis of all enzymes was carried out on 12% horizontal starch gels. In an initial screening process, 14 enzyme systems were used in order to select the best enzyme loci. The seven enzyme loci surveyed were: Phosphoglucomutase (E.C. 2.7.5.1, PGM*), Malate Dehydrogenase (E.C. 1.1.1.37, MDH*), Malate Dehydrogenase Phosphate (E.C. 1.1.1.40, MDHP*), Superoxide Dismutase (E.C. 1.15.1.1, SOD*) and Alcohol Dehydrogenase (E.C. 1.1.1.1, ADH*) as described in May 1992 These were analysed on R-Buffer (Gel Buffer: 0.03M Tris, 0.005M Citric acid, 2.5% Tray Buffer, pH 8.5; Tray Buffer: 0.06M Lithium Hydroxide, 0.3M Boric Acid, pH 8.1; electrophoresis for 7 hours at 200V and 38±2mA). Isocitrate Dehydrogenase (E.C. 1.1.1.42, IDH*) and Glucose-Phosphate Isomerase (E.C. 5.3.1.9, GPI*) as described in Murphy *et al.* 1996, were analysed on Tris-Citrate Buffer (Tray: 0.687M Tris, 0.157M Citric, pH 8.0; Gel: 1:25 Tray buffer diluted with water; electrophoresis for 5 hours at 100V and 34±4mA).

Results

Polymorphism in this investigation was found to be 23%. When compared to the value of 44% given by Bader (1998), it can be interpreted that polymorphism was low in the individuals sampled in the Maltese Islands. On the other hand in this study the mean heterozygozity was 0.13, while that reported in Bader (1998) was 0.124. These results agree with the statement that Bader made, "that the calculation of polymorphism is much more prone to statistical tests due to small sample sizes". The expected heterozygozity is not affected by this.

A statistical difference that was observed in this study was on the locus of PGM. There was no significant difference between the F_{IS} index of the other loci, and also in the mean F_{IS}. McDonald (1991) mentioned that there is evidence for temperature selection to occur at the PGM locus in certain organisms. In fact one should note that 1.3km north from Kalanka (sampling site), Hofra IZ-Zghira, the Enemalta power station is located, which releases hot water into the surrounding environment. This electricity generating plant is thus allowing for higher than average sea temperatures along the Delimara creek (Axiak and Sammut.2002; Borg, 2002). This is because the power plant, discharges its coolant water directly into the marine environment (Marsaxlokk and Delimara), at a temperature of 120°C (Borg, 2002).

Another prominent observation was at Anchor Bay sub-populations, were values for the genetic distance were found to be above 0.2. These indicate that a divergent sub-population is present. This can be related due to the fact that, one of the major outfalls is located in this area.

However to further critically assess the genetic variation around the Maltese islands, the sampling sites were grouped according to their vicinity and aspect.

The results show that although, the values, including the site for Anchor Bay, do not fit in the index range for sub-population divergence, they do not fit in the values for closely related sub-populations either. Thus the sub-populations found in the region, consisting of Anchor Bay, Ghajn Tuffieha and Ghar Lapsi (West) were still indicating divergence from the rest of the entire population.

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COMPARATIVE STUDY OF SOME ENVIRONMENTAL PARAMETERS ALONG THE MEDITERRANEAN EGYPTIAN WESTERN COAST, WINTER 2009&2010

A. Tadros [1]*, A. Radwan [1], H. Hemaida [1], M. S. Guerguess [1], M. Mahmoud [1] and F. Asaad [1]
[1] National Institute of Oceanography and Fisheries - Bt_aida@yahoo.Com

Abstract
The present study aims to evaluate and compare the environmental parameters; temperature, salinity, dissolved oxygen (DO), oxidizable organic matter (OOM) and total alkalinity during winter 2009 and 2010 of the western Mediterranean coast of Alexandria, Egypt. The data revealed that, the averages of temperature (except El Mex area) and DO during winter 2009 in the studied marine sectors are higher than their corresponding values during winter 2010. Opposite trend is obtained with salinity and total alkalinity. The maximum average concentration of OOM was found at El Hammam sector and the minimum at Sidi Kerir, winter 2010. The surface distribution of both temperature and salinity decrease westwards during both winter seasons.

Keywords: Coastal waters, Hydrography, South-Eastern Mediterranean

Introduction: The northwestern coast of Egypt is extending 510 km from Alexandria to El-Saloum. The coast of this area is covered with fine and white carbonate sands [1]. The coastal zone is distinct by clear blue water; mild weather and sun prevailing most of the year which made this coast an attractive site to be developed rapidly for tourist. The previous study revealed that, during the last three decades, many touristic cities were constructed along the western coastal area exhibiting signs of stress, population pressure which cause impact to the area [2]. In this study, seawater samples were collected at sites distributed along the western coast of Alexandria, Egypt lying between longitudes 25.25ºE to 29.88ºE during winter seasons of 2009 and 2010 for studding the above mentined parameters. The distribution of the parameters was investigated and the comparison of their values during winter 2009 and 2010 were discussed.

Material and methods: Ten marine sectors during winter 2009; El Mex, Sidi Kerir, El Hammam, El Alamaen, El Dabaa, Foka, Alam El Room, Marsa Matrouh, Sidi Barani, El Saloum and six marine sectors; El Mex, Sidi Kerir, El Hammam, Marsa Matrouh, Sidi Barani and El Saloum during the winter of 2010 were studied for the above parameters (Fig1).

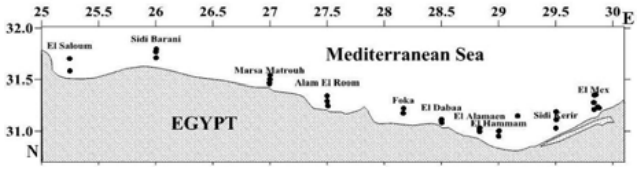

Fig. 1. Sampling locations of sectors, Med. western coast, Egypt.

The seawater samples were collected at depths ranging from 0-200m. The temperature and salinity were measured in situ using CTD. DO of seawater samples were determined according to Winkler modified method [3], oxydizable organic matter according to Calberg [4] and total alkalinity was measured according to the method described by Strickland and Parsons[5].

Results and discussion: The temperature and salinity of the studied marine sectors during 2009 lie in the ranges (16.47ºC, El Salum,-17.52ºC, El Mex) & (38.54, Sidi Barani & El Saloum- 38.79, El Almaen) respectivly. These ranges are slightly increase in their range values during 2010 (except the temperature at El Mex sector) and found to be (16.27, Sidi Barani & El Saloum-18.47ºC, El Mex) & (38.56, El Saloum-38.88,El Hammam).The surface distribution of temperature and salinity during both winter seasons decreased westwards of the Mediterranean coast, Alexandria, Egypt. The maximum temperature during 2009 and 2010 was recorded at El Mex with values (17.42ºC and 17.79ºC) and its minimum value (16.73ºC) measured at Marsa Matrouh and Sidi Barani. Also the highest surface salinity was measured at Sidi Kerir (39.9&39.93) during both winter seasons while the minimum (38.55) measured at Marsa Matrouh and Sidi Brani in winter 2009 and 38.64 measured at Sidi Barani, winter 2010. The minimum average temperature of seawater was 16.2ºC (El Dabaa, 2009) and 16.76ºC (Sidi Kerir, 2010) while El Mex sector recorded the maximum average water temperature during both winter seasons (20.05ºC and 17.89ºC) respectively.The difference in the averages of temperature measured during the winter seasons 2009 and 2010 in the marine sectors; Marsa Matrouh, Sidi Brani and El Saloum indicate the decrease in seawater temperature westward of Alexandria coast, Egypt with values 0.01, 0.03 and 0.08°C. The maximum average of salinity found at Sidi Kerir (38.902) and at El Hammam for 2009 and 2010 respectively while the minimum salinity value (38.55 and 38.65) was found at El Saloum and Sidi Barani. Dissolved oxygen concentration in the studied marine sectors; winter 2009 lie in the range (5.6ml/l, Sidi kerir) to (12.99ml/l, Sidi Barani) and decrease during winter 2010 to the range (4.9ml/l, El Saloum) to (11.5ml/l, El Hammam). During winter 2009, the average DO values are nearly similar at El Alamaen, El Dabaa, Marsa Matrouh and El Saloum sectors and found to be (11 ml/l) and the lowest average recorded at Foka sector (6.051 ml/l). It is clear that the maximum average concentration of dissolved oxygen recorded in El Alamaen sector (11 ml/l) recorded the lowest average of oxidizable organic matter concentration (1,615 $mg0_2/l$) and the highest value of OOM calculated at Foka (4.272$mg0_2/l$) met with the minimum DO concentration in comparison with its values of the rest of the marine sectors. Dissolved oxygen average values of the studied marine sectors during winter 2010 is lower than their corresponding values during 2009 and ranged between a maximum of 8.8m/l (El Mex) and a minimum of 5.8m/l (El Saloum). The previous date recorded lower DO and OOM content during winter 2006 and their average values reported in the range (4.23ml/l-5.32ml/l) and (0.17$mg0_2/l$-0.42$mg0_2/l$) in the marine sectors from El Dabaa-El Salouml[2]. The total alkalinity was measured at surface water and at selected depth of each station. Generally the total alkalinity measured in the seawater samples during winter 2009 in all marine sectors lie in the range (2.016meq/l, El Salum to2.784meq/l, El Hammam) is lower than their corresponding total alkalinity values during the winter season 2010 (2.727meq/l, Sidi Barani to 3.333meq/l ,El Saloum). The lowest average total alkalinity during 2009 and 2010 was measured at El Mex sector with value 2.66meq/l and the highest average total alkalinity values (2.72meq/l) was measured at El Hammam marine sector (2009). The maximum average of total alkalinity during 2010 (2.98meq/l) was recorded at the four marine sectors (Sidi kerir, El Hammam, Sidi Barani and El Saloum). The study of environmental parameters during winter 2009 and 2010 revealed the decrease of temperature and salinity westwards. The averages of DO and temperature during winter 2009 are higher than their corresponding values during winter 2010 and the opposite obtained with salinity and total alkalinity. The highest temperature and salinity recorded at El Mex and Sidi Kerir, while their minimum value was found at marine sectors located westwards.

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FIRST DOCUMENTED REPORT OF TWO SPONGE SPECIES IN THE BLACK SEA COAST OF TURKEY

B. Topaloglu [1]*, M. Sezgin [2], L. Bat [2], M. Zengin [3] and S. Karakulak [4]
[1] Istanbul University Fisheries Faculty Istanbul; Turkish Marine Research Foundation Istanbul/ Turkey - topalbl@istanbul.edu.tr
[2] Sinop University, Fisheries Faculty
[3] Central Fisheries Research Institute Trabzon/ Turkey
[4] Istanbul University Fisheries Faculty Istanbul/ Turkey

Abstract
No sponge species has been reported from the Black Sea coast of Turkey so far. This study is the first attempt on sponges of the Black Sea coast of Turkey with two new reports: *Suberites domuncula* (Olivi, 1792) and *Dysidea fragilis* (Montagu, 1818).

Keywords: Porifera, Black Sea, Zoobenthos

Introduction
Sponges are the most primitive members of multicellular animals and play important role as habitats in the marine environment. The studies about the sponge species and especially taxonomic studies are very limited in the Turkish Coasts. According to Saritas [1] the earliest information on the sponges was reported by Forbes (1844) and first report was published by Deveciyan [2] in Turkey. Beside this, several studies were published on the sponge populations of Aegean Sea by Saritas [1; 3] and Ergüven et. al. [4]. Topaloglu studied the sponge populations of the Marmara sea [5]. Katagan reported a faunistic study about the sponge species of Turkey without any taxonomic description [6]. The latest study was realized by Evcen and Çinar [7] on the sponge species from the Mediterranean coast of Turkey and the authors gave a checklist of sponges for the coasts of Turkey and reported 115 sponge species for the sponge fauna of Turkey. Some information was given on the sponge species of the Black sea coast for Romania by Müller [8] and for Bulgaria by Konsulov [9] and Marinov and Golemansky [10]. According to the previous study [7], no sponge species have been reported from the Black Sea coast of Turkey. Therefore, this is the first report on the sponges of the Black Sea coast of Turkey.

Material and Method
Samples were compiled from several studies realized between 2008 – 2013 by trawl and SCUBA diving (see Fig.1). The samples were taken between 20-100 m depths by trawl and 5-8 m by SCUBA diving. Materials were fixed by 70 % ethanol and histological preparation for spicules and sponging skeletons were made following the Rützler method.

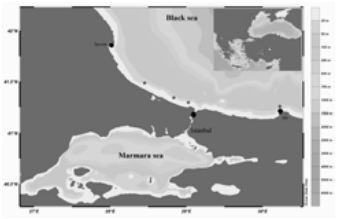

Fig. 1. Sampling Stations (* Trawl stations • SCUBA Diving stations)

Results and Discussion
Two sponge species were identified. Specimens of *Suberites domuncula* (Olivi, 1792) were collected by trawling and *Dysidea fragilis* (Montagu, 1818) by SCUBA diving. Marine species identification portal was used for identification and taxonomic description of the species (http://species-identification.org). *D. fragilis* has blue-grey color, lobate, elastic and without spicule skeleton, instead it has a network of fibres loaded with sand grains, broken spicules and other foreign material. Sometimes foreign spicules which are contaminated from other sponges can be observed in microscopic examination. The species is common in shallow waters of the Black Sea coast of Turkey. Mostly found on hard substrates, on rocks or on organisms like *Mytilus galloprovincialis* (see Fig.2.). *S. domuncula* changes from orange to brown color depending on its surrounding habitat. The collected samples in this study were mostly brown due to the muddy characteristic of the habitat. The shape is elongated globular, inhabited by a hermit crab or gastropod shell, the size up to 10 cm in diameter. The surface is smooth and velvety. Apart from the opening used by the hermit crab, there are no clearly developed oscules. Spicules are consisting tylostyles up to 250-350 x 3-5 µm. and 180-350 x 3-5 µm styles (see. Fig.2). The number of the sponge species was given as seven by Müller [8] on the Black sea coast for Romania; 22 by Konsulov [9] and 29 by Marinov and Golemansky [10] for Bulgarian coasts. There is no documented record for The Black Sea coast of Turkey. This study is the first attempt on the sponge species in the area. We actually assume that the Black Sea coasts of Turkey are more diverse. Future studies will demonstrate real numbers and the ecological roles of the sponge species in the area.

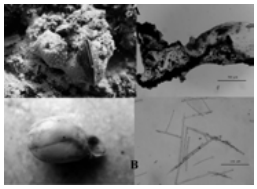

Fig. 2. The *Dysidea fragilis* in living habitat and foreign material in fibre (A) and *Suberites domuncula* and spicules (B).

Acknowledgements: Authors thanks to Prof. Dr. Bayram ÖZTÜRK (COCONET Poroject) for great support and guiding; to I.Ü BAP (Project No:5381), TAGEM/HAYSÜD (Project No: 2011/09/02/06) for material support off Sile and MISIS Project for material support from Igneada Coast.

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LONG TERM VARIATIONS OF NUTRIENTS AND CHLOROHYLL *A* IN THE COASTAL WATERS OF THE SEA OF MARMARA

Muhammet Turkoglu [1]* and Suleyman Tugrul [2]
[1] C.Kale Onsekiz Mart Univ., Marine Scien.&Techn.Fac. - mturkoglu@comu.edu.tr
[2] METU, Institute of Marine Sciences, 33731 Erdemli, Mersin, Turkey

Abstract
Temporal variations of nutrients and chlorophyll *a* (Chla) in the Sea of Marmara were investigated in relation to the eutrophication between March 2002 and December 2005. Average nutrient levels in Tekirdag were higher (NO^-_2+NO^-_3, PO^{-3}_4 and SiO_4 were 0.65±0.86, 0.19±0.37 and 3.91±5.56 mM, respectively) than the average concentrations in Çanakkale (NO^-_2+NO^-_3, PO^{-3}_4 and SiO_4 were 0.51±0.54, 0.08±0.08 and 2.41±1.69 mM, respectively). While average elemental ratios of N/P, Si/N and Si/P were 7.10±10.7, 27.7±107.6 and 62.3±110.7, respectively in Tekirdag, they were 12.3±23.1, 8.57±7.87 and 51.6±46.6 respectively in Çanakkale. In light of these ratios, the system was limited by nitrate than phosphate. Annual average chla concentration was over the 2.50 µg L^{-1} (average: 2.78±3.21 µg L^{-1}). Chla reached to 20.0 µg L^{-1} in some productive periods.

Keywords: Marmara Sea, Nutrients, Chlorophyll-A, Eutrophication, Time series

Introduction: the Sea of Marmara is located between the Aegean Sea and the Black Sea and has two flow systems reverse to each other [1]. The surface waters of the system are originated from the Black Sea surface waters. However, the surface layer waters of south west area of the Dardanelles (St. D) are largely affected by under layer waters due to the topographic upwelling [2].

To determine eutrophic situation of the surface waters in coastal stations of the Sea of Marmara, long temporal variations of nutrients and chlorophyll *a* (chla) were carried out connected with the CTD parameters in the period of March 2002 and December 2005.

Materials and Methods: the data was collected during cruises in the period of March 2002 and December 2005, in the framework of a National project of DIE (TUIK) - DPT, Turkey. It was collected 184 surface samples for each variable during the four years sampling period in the Dardanelles (Fig. 1). While CTD parameters were measured by using YSI 6600 MPS, nutrients and chla were analyzed according to the method of Strickland and Parsons (1972) [3].

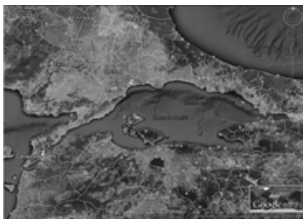

Fig. 1. The Sea of Marmara and sampling stations.

Results and Discussion: findings showed that while surface temperature varied between 5.83 and 29.80 °C (average: 17.33±6.94 °C) in the costal waters of Tekirdag (Sea of Marmara: St.M), it varied between 5.83 and 26.6 °C (average: 16.1±6.37 °C) in the costal waters of Çanakkale (Dardanelles: St.D). Due to different water layers, surface salinity values varied between 21.08 and 28.76 ppt (average: 23.83±1.79 ppt) in the Sea of Marmara, whereas the salinity varied between 21.9 and 37.1 ppt (average: 25.3±2.71 ppt) in the Dardanelles. Average level of dissolved oxygen was generally close to saturation limit (8.79±1.69 mg L^{-1}). Moreover, pH levels were in limit values and varied between 7.68 and 8.67 (average: 8.26±0.18).

Nutrient levels in the study area were dramatically higher than oligotrophic waters. On the other hand, the concentrations in the Dardanelles (St.D) were lower (NO^-_2+NO^-_3 = 0.51±0.54 µM; PO^{-3}_4 = 0.08±0.08 µM; SiO_4 = 2.41±1.69 µM) than the concentrations in the Sea of Marmara (St.M) (NO^-_2+NO^-_3 = 0.65±0.86; PO^{-3}_4 = 0.19±0.37; SiO_4 = 3.91±5.56 µM) (Fig. 2). It is known that the high nutrient concentrations in the Sea of Marmara decrease considerably as far as the Dardanelles during the Marmara surface flow due to high photosynthetic processes in the Sea of Marmara. Additionally, nutrients are partly exported to the Marmara lower layer. Ultimately, the brackish Black Sea waters reach the Dardanelles Strait with modified biochemical properties [4].

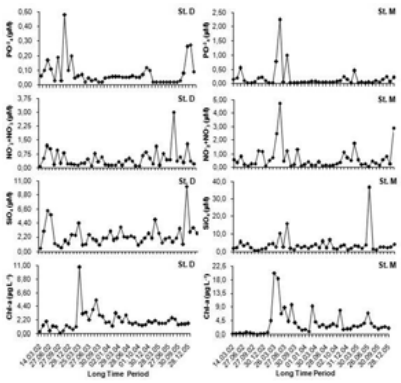

Fig. 2. Long term variations of nutrients and chlorohyll *a* in the coastal waters of the Dardanelles (St.D) and Sea of Marmara (St.M).

Average elemental ratios of N/P, Si/N and Si/P in the Sea of Marmara (St.M) were 7.10±10.7, 27.7±107.6 and 62.3±110.7, respectively, whereas average elemental ratios of N/P, Si/N and Si/P in the Dardanelles (St.D) were 12.3±23.1, 8.57±7.87 and 51.6±46.6, respectively. In light of these ratios, the system was exposed to hypereutrophication and so nitrate was more limiting nutrient than phosphate and silicate. The system was so productive that annual average phytoplankton chla level was 2.78±3.21 µg L^{-1}. On the other hand, chla levels reached to 20.0 µg L^{-1} in some spring and late summer periods (Fig. 2).

In light of the high levels of nutrients and chla, the Sea of Marmara and the Dardanelles are underneath all the heavy pollution due to the urban waste waters of Istanbul and North West Black Sea surface waters more polluted by Danube.

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HETEROTROPHIC MICROBIAL ACTIVITY IN THE CILICIAN BASIN (NORTH EASTERN MEDITERRANEAN)

Nebil Yücel [1]*, Zahit Uysal [1] and Süleyman Tugrul [1]
[1] Institute of Marine Sciences Middle East Technical University - nebil@ims.metu.edu.tr

Abstract
Bacterial Carbon Production (BCP) and Heterotrophic Bacterial Abundance (HBA) were studied monthly from May 2010 to October 2011 at two stations in the Cilician basin. BCP varied between 0.002 and 0.270 mgC.m^{-3} h^{-1} in the coastal and 0.001 and 0.1 mgC.m^{-3} h^{-1} in offshore waters at the shelf break. Mean BCP rates were calculated as 0.05 and 0.015 mgC.m^{-3} h^{-1} for the coastal and offshore waters, respectively. Annual BCP was estimated as 14.6 g C.m^{-2} y^{-1} for the coastal and 12.9 g C.m^{-2} y^{-1} for the offshore zone of the Cilician basin. Our findings also support the suggestion of eastward decrease in BCP rates in the Mediterranean. BCP data provided with this study may be considered preliminary for the Cilician basin.

Keywords: Bacteria, Secondary production, Mersin Bay, North-Eastern Mediterranean, Carbon

Introduction
Eastern Med is known as one of the least productive seas in the world [1]. There exists a gradual decrease in bacterial production from west to east in the Mediterranean. Rates of BCP vary between 1 and 468 mg C m^{-2} d^{-1} for the western and between 7 and 131 mg C m^{-2} d^{-1} for the eastern Mediterranean [2].

Material and Methods
Two stations (the shallow one: 50 m deep; the offshore: 200 m), located in the Cilician basin (Fig. 1) were visited monthly from May 2010 to October 2011. BCP was measured by ^{3}H-Leucine incorporation. Samples were incubated in situ during midday for about 3 hours. HBA was measured by epifluorescence microscopy.

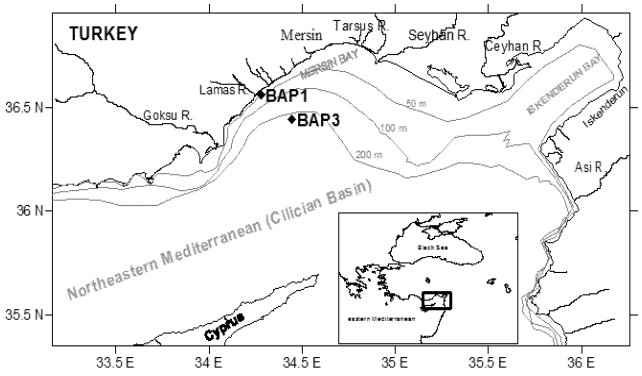

Fig. 1. Location of stations in the Cilician basin.

Results
Daily BCP rates varied between 7.4 - 39.7 at top 50 m in the shelf and 8.9 - 35.4 mg C m^{-2} d^{-1} for the 200 m water column in the offshore. BCP decreased with depth in the offshore. HBA varied in the range of 29686 and 1397129 cells ml^{-1} in the shelf and between 11989 and 886253 cells ml^{-1} in the offshore throughout the study period. Highly significant positive correlations were seen between BCP and BA (n:60, r:0.691, P<0.01) in shelf waters and similarly between BCP and temperature & salinity in the offshore ((n:60, r:0.338, P<0.01)& n:60, r:0.247, P<0.01)). Nutrient concentrations were low in the euphotic zone (nitrite+nitrate: 0.05-3.06 µM; Phosphate: 0.02-0.07 µM) in offshore waters.

Acknowledgements: This study was supported by METU BAP-07-01-2009-01 and BAP-07-01-2011-001 projects.

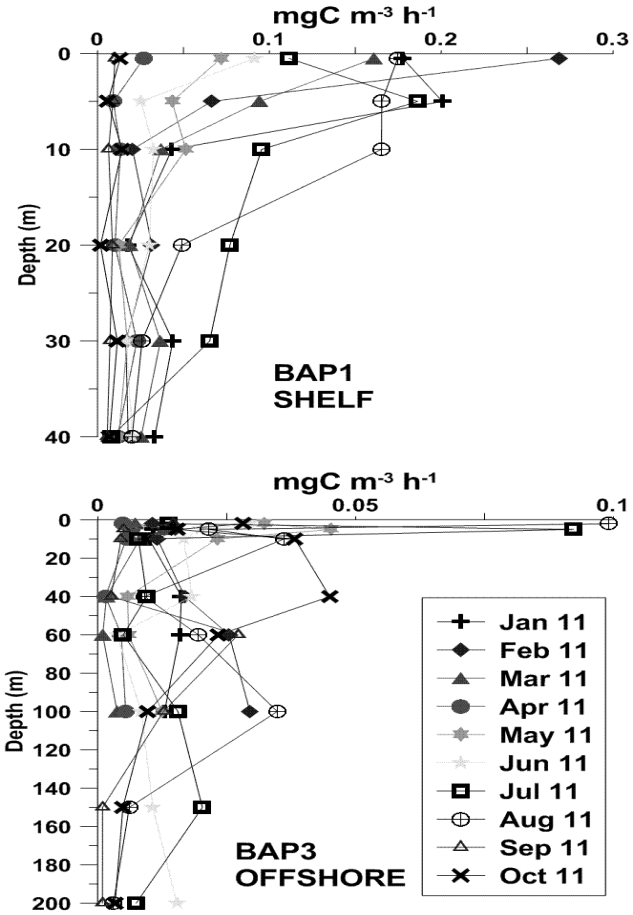

Fig. 2. Monthly variations of Bacterial Carbon Production at the coastal and offshore stations.

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RÉGIME ALIMENTAIRE D'*EPINEPHELUS COSTAE* (SERRANIDAE) DES COTES EST DE L'ALGÉRIE

Raouf Zaidi [1]*, Farid Derbal [1] and Mohamed Hichem Kara [1]
[1] Laboratoire Bioressources Marines, Université Badji Mokhtar, Annaba, Algérie. - raoufrfm@hotmail.fr

Abstract
Le régime alimentaire de la badéche *Epinephelus costae* (Heemstra, 1991) des côtes Est de l'Algérie a été analysé, qualitativement et quantitativement, entre mars 2011 et mars 2012. La vacuité digestive moyenne annuelle de 259 individus est de 18,14%. Elle ne varie pas en fonction des saisons. Cette espèce se nourrit principalement d'ostéichtyens (%IRI = 76,67) et secondairement de crustacés (%IRI = 15,46). Les autres proies (crustacés, mollusques, annélides, végétaux) sont accidentelles (% IRI < 3).

Keywords: Diet, Fishes, Algerian Sea, South-Western Mediterranean

Introduction
La badèche *Epinephelus costae* (Heemstra, 1991) a le statut d'espèce ''Data Deficient'' dans la liste rouge des poissons marins de Méditerranée [1] et très peu de recherches qui lui ont été consacrées sur les côtes nord-africaines [2]. Un travail sur son régime alimentaire a été précédemment abordé sur les côtes algériennes, mais de manière incomplète [3]. Cette étude est plus précise et donne des informations complémentaires sur la composition et les variations de l'alimentation de cette espèce au cours d'un cycle annuel.

Matériel et méthodes
Le régime alimentaire de 259 badèches *E. costae* (Lt: 20,1 – 79,9 cm; Wt: 189,32 - 5661 g) a été étudié, qualitativement et quantitativement, entre mars 2011 et mars 2012. Tous les poissons proviennent de la pêche artisanale (arbalète et palangre). Les coefficients de vacuité digestive (CV%) ont été déterminés globalement et en fonction des saisons. Le statut des proies ingérées (préférentielles, secondaires, accidentelles) a été déterminé en utilisant le pourcentage indiciaire du IRI [4].

Résultats
Le coefficient de vacuité digestive moyen est égal à 18,14%. Quelque soit la saison de pêche, la vacuité reste faible (printemps: 6,56%, été: 2,7%, automne: 7,72%, hiver: 1,16%). La figure 1 classe les principaux taxons zoologiques ingérés par *E. costae* selon les pourcentages indiciaires du IRI. Ce prédateur se nourrit principalement d'ostéichtyens (%IRI = 76,67), représentés par 11 familles et 16 espèces: 5 Sparidae, 2 Labridae, 2 Mugilidae et une seule espèce pour les autres familles (Mullidae, Atherinidae, Pomacentridae, Gobiidae, Blennidae, Trachinidae, Carangidae, Clupeidae). Les autres proies (crustacés décapodes, mollusques, annélides, végétaux) sont ingérées accidentellement (%IRI < 3). Chaque individu consomme en moyenne 1,5 proie pour un poids moyen de 3 g.

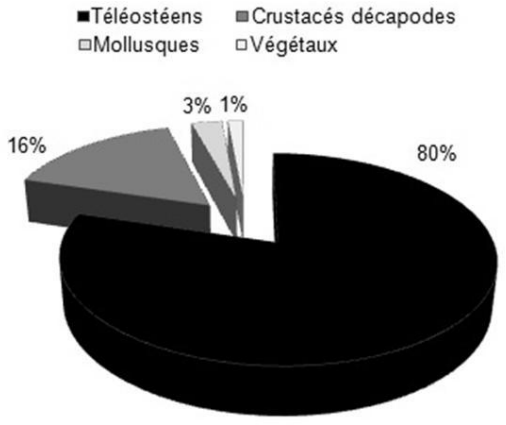

Fig. 1. Pourcentages indiciaires du IRI des principales proies ingérés par *Epinephelus costae* des côtes Est algériennes.

Discussion
Les faibles valeurs de la vacuité digestive, aussi bien chez la population globale qu'en fonction des saisons, mettent en évidence la voracité de ce prédateur. Comme la majorité des *Epinephelus* de Méditerranée, *E. costae* est un poisson carnivore, au niveau trophique élevé, comme c'est le cas d'*E. aeneus* (Troph. = 4,1), d'*E. caninus* (Troph. = 3,8) ou d'*E. marginatus* (3,7 <Troph. < 4,13) [5]. Sur les côtes de l'est de l'Algérie, la badèche se nourrit principalement de poissons téléostéens, avec une préférence pour les Sparidae, ce qui n'est pas le cas sur les côtes sénégalaises où cette espèce cible les sardinelles *Sardinella aurita* en période froide et les crevettes *Penaeus notialis* en période chaude [6]. Dans notre région, la sardinelle *S. aurita* n'est ciblée que par les petites badèches et celles de taille moyenne; les plus âgées préfèrent la sardine *S. pilchardus* [3].

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THE ANALYSIS OF THE MAIN SOURCES OF VARIABILITY FOR THE ESTIMATION OF THE RED MULLET (*MULLUS SURMULETUS*, L.1758) AGE STRUCTURE AT THE STRAIT OF GIBRALTAR

Abdelaziz Zoubai [1]*, Abdeljaouad Lamrini [2] and Allal Hamouda [2]
[1] Institut National de Recherche Halieutique - a.zoubai@gmail.com
[2] Institut Agronomique et Vétérinaire Hassan II

Abstract
This paper focused on the analysis of the major sources of variability for the estimation of the red mullet age structure at the strait of Gibraltar. The results showed that the variability of the species age proportions is much higher between the landing days. Thus, for better estimates of the species demography, a further effort of sampling in number of days is required especially for the market categories composed by small fish.

Keywords: Fishes, Population Dynamics, Gibraltar Strait

Introduction

The red mullet, *Mullus surmuletus, L., 1758* (Mullidae) constitutes the main target stock of the trawl fishery and longliners at the Moroccan Mediterranean. The area of study extends from the Gibraltar Strait to Larache region over about 150 km. The present study aims to analyse the sources of variability in the estimation of red mullet age structure by sampling trawlers and longliners landings.

Material and methods

The present study was based upon monthly samples of red mullet collected in 2009 by the use of a two-stage sampling plan. A total sample of 3304 red mullet individuals, ranging in size between 10 to 30 cm, was collected. 5 specimens by length class of 1 cm and by market category were taken and measured by their fork length to the nearest centimetre then a sub-sample of 847 specimens was kept for ageing purpose. In the laboratory, scales from the shoulder between the head and the dorsal fin [5], were removed from each fish and were washed and then were illuminated with a reflected light and examined under a dissecting microscope with a dark background [1]. The age readings were done without knowledge of scales reference (length). Guidelines for pattern interpretation were based upon standardized interpretation presented in the CARE Age Reading Manual [3]. The estimate of the age proportions is done according to the principle of double sampling [8], which determines an age-length key (ALK) per month and by market category. The species ages proportions by market category and by quarter and its associated variance were then computed by the combination of the ALK's on a quarterly basis and the corresponding sample length distributions [6]. The total variance for each age and for each market category is composed by the inter-days and the intra-days variances related to the measurement and the aging of fish [7].

Results

The results showed that the red mullet age structure varies from one quarter to another ; the landings consist of fish of age varying from 0 to 9 years; the fish which are 5 years old and more are slightly represented in the landings. Moreover, for quarters 3 and 4, we noted a peak of abundance for the age groups 0, 1 and 2. Regarding the sources of variability of the species demography, we observed for all quarters that the total variance related to the estimation of the species age proportions by market category is explained to more than 80 % by the variance between the days of landings; inside each day of sampling, the ageing variance is lower (< 7 %) for fish of small and medium sizes, and higher (> 13 %), for fish of large size ; this latter increased with the fish size, as age determined for older fish is generally less precise [2].

Discussion and conclusions

The study permitted to note that the species age composition is highly variable and depends mainly on the landing days, especially for fish of age groups composing very small and small market categories. Thus, to suitably estimate the proportions of these age groups, it would be necessary to multiply further the effort of sampling in number of days for these age groups especially for the market categories composed of small fish. Previous papers [4], underlined that the age structure precision is mostly driven by the precision of the age-length-key (ALK). Similar studies recommended that prior to the estimation of the species age proportions, the ALK's should be established at each operation of sampling and be applied to the corresponding length data in order to take account of the variability of the species demography with the landing days [9].

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