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Ce volume rassemble sous la forme d'articles synthétiques toutes les communications scientifiques présentées lors du 41ème Congrès de la CIESM. Cet ensemble qui regroupe les articles de centaines de chercheurs ainsi que les synthèses des modérateurs des nombreuses sessions tenues à Kiel en septembre 2016, 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 à Kiel par leur auteur 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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COMITÉ 1

Géosciences marines

Président : Silvia Ceramicola

CIESM Congress Session : Marine Tectonics, Geodynamics

Moderator : Sebastian Krastel, Inst. of Geosciences, CAU, Kiel, Germany

Moderator's Synthesis

This session was attended by about 30 scientists. The six presentations, covered a wide variety of topics from shallow to deep targets, were followed by a general discussion aimed at identifying major knowledge gaps. There were no presentations on the western Mediterranean Sea.

The flash presentations in the Mediterranean region and that there are plenty of knowledge gaps due to the complexity of the Mediterranean region. The presentations clearly showed the need for local studies for understanding the broader picture. Thus the presentations discussing local features in the Aegean Sea showed that this area is not an extensional regime but controlled by transtension and in part by transpression. In addition, features can only be understood when conducting multiscale investigations, i.e. both shallow investigations including morphometric data as well as deep –penetrating data are essential for understanding the geodynamic setting.

More specific questions brought up during the discussion were

i) One of the most complex areas in the Mediterranean Sea is the region between north Africa and Sicily. This is a poorly investigated area and needs more attention.
ii) The Messinian Salt is a unique feature in the Mediterranean Sea. It is a complex task to differentiate between regional tectonics and salt tectonics (e.g. formation of the Mediterranean Ridge). In addition, the effect of salt on subduction can be studied in the Mediterranean Region.
iii) Several earthquakes in the Mediterranean region cannot be linked to known faults.

A STUDY ON LATE QUATERNARY SEDIMENTATION OF GÖKOVA BAY, SOUTHWESTERN TURKEY

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Abstract
The late Quaternary sedimentation of Gökova Bay continental shelf has been analysed based on high resolution seismic reflection profiles. The development of the sediment accumulation on the shelf is controlled by the glacio-eustatic sea level changes and tectonic movements.

Keywords: Aegean Sea, Sedimentation, Sea level, Tectonics

Introduction
The Gökova Bay is located in the southwestern Turkey that surrounded by Bodrum Peninsula to the north and Datça Peninsula to the south. Due to the N-S oriented tectonic opening in the western Anatolia, large graben structures have been originated. Aegean graben system generally consists of a large number of blocks limited to E-W oriented normal faults. Evolution of the east–west-trending Gökova Graben structure is related to the north–south extension of the Aegean segment of the Aegean–Anatolian Microplate. The region in general is under the influence of a NNE-SSW oriented shrinkage regime [1, 2]. During the Early–Middle Miocene period thick volcano sedimentary associations were formed within approximately NS trending fault-bounded continental basins under an E–W extensional regime [1].

Fig. 1. (a) Tectonic map of the Aegean and western Turkey showing the major tectonic structures (modified from [2]- [3] (b) The location of the study area, (c) Geological map of Gökova and Hisarönü region [4].

Material and Methods
This study is based on high-resolution single channel airgun and 3,5 kHz seismic reflection profiles acquired during the cruise performed at Gökova Bay by the RV K.Piri Reis. The late Quaternary sedimentary and tectonic framework of continental shelf was recognized by analysis of seismic data.

Results
The location of the paleo-shoreline in the last glacial maximum was determined on the seismic reflection profiles using the principles of sequence stratigraphy. A marine transgression occurred and the shoreline moves toward to the east at least 30 km since the last glacial period. The Holocene sediment thickness is up to 50 m on the continental shelf. The sedimentation rate varies between 0.3 and 0.46 g $cm^{-2}yr^{-1}$ in the eastern Gökova Bay [3]. This high sedimentation rate is primarily caused by terrestrial inputs from Azmak River that discharges into the eastern part of the Bay.

Discussion
The previous sea-level studies indicate that the Gökova Basin is subsiding at 0.3–0.4 mm/year by determining the sedimentary sequences [4]. The active faults recognised in the seismic sections support the tectonic movement in the region. The stratigraphic analysis and the observed tectonic features indicate that the deltaic sedimentation is mainly controlled by glacio-eustatic sea level changes and vertical tectonic movement in the Gökova Bay.

References
1 - Yilmaz Y., Genç S.C., Gürer O.F., Bozcu M., Yilmaz K., Karacik Z., Altunkaynak S. and Elmas A., 2000. When did the western Anatolian grabens begin to develop? *In*: Bozkurt, E., Winchester, J.A., Piper, J.D.A. (eds.), Geological Society, London, Special Publications 173, pp. 353–384.
2 - Bozkurt E., 2003. Origin of NE-trending basins in western Turkey, *GeodinActa,*16: 61–81.
3 - Ugur A. and Yener G., 2001. Accumulation rates and sediment deposition in the Gökova Bay in Aegean Sea Turkish Coast, *Applied Radiation and Isotopes*, 55: 581-588.
4 - Ulug A., Duman M., Ersoy S., Ozel E. and Avci M., 2005. Late Pleistocenesea level change, sedimentation and neotectonics of the Gulf of Gokova:Southeastern Aegean Sea. *Mar. Geo.* 221: 381-395.

AMPHIBIOUS SEISMIC STUDY ON THE CRUSTAL STRUCTURE OF THE ADRIA

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Abstract
The present-day structure of the southern Adriatic area is controlled by two oppositely-vergent fold-and-thrust belt systems. The Adriatic basin offers the unique opportunity to image a segment of Mesozoic crustal structure within the Mediterranean. Seismic refraction and wide-angle reflection data were acquired including stations off- and on-shore. Two different approaches of travel time tomography were applied.

Keywords: South Adriatic Sea, Seismics, Crust structure

The present-day structure of the southern Adriatic area is controlled by two oppositely-vergent fold-and-thrust belt systems (Apennine and Dinaride-Albanide). The Adriatic continental domain is one of the most enigmatic segments of the Alpine-Mediterranean collision zone. It was separated from the African plate during the Permian-Mesozoic extensional phase that led to the opening of the Ionian Sea, with carbonate sediments that were deposited throughout the Mesozoic. The maximum basin widening and deepening occurred during the Late Triassic-Liassic extension, which resulted in the formation of the southern Adriatic basin, bounded on either side by the Dinaric and Apulian shallow water carbonate platforms. A thick succession of shallow water sediments was deposited on the platforms throughout the remaining of the Mesozoic and part off the Cenozoic, whereas a thin succession of hemipelagic sediments were deposited within the basins. Following the Eocene-Oligocene collision of Adria into the European plate, and the ensuing formation of the Alps and Dinarides, clastic sediments were shed into the Adriatic domain. In the southern Adriatic basin, in particular, clastic sediments , mainly Miocene-Quaternary in age, fill the present day foredeep basin of the Dinaride-Albanide thrust-and-fold belt, reaching a thickness up to 7 km, that decreases dramatically northward, offshore Montenegro, where the foredeep basin is resting onto the shallow water Dinaric carbonate platform. Because of its present foreland position with respect to the Alpine s.l. fold-and-thrust belts, the southern Adriatic basin represents the only remain of the Tethys' southern margin and offers the unique opportunity to image a segment of Mesozoic crustal structure within the Mediterranean.

The shallow part of the Adriatic region and its sedimentary evolution in particular have been extensively studied, mostly for hydrocarbon exploration purpose; however, little is known about the deep crustal structure, the upper mantle and the shape of the plate margin. To shed light on these structures, the German research vessel Meteor (cruise M86-3 supported by the Deutsche Forschungsgemeinschaft DFG) acquired 2D seismic refraction and wide-angle reflection data during an off- and on-shore experiment. Three profiles, each consisting of up to 36 ocean bottom hydrophones (OBH) and up to 25 land stations where shot. Two of the profiles crossed Adria from the Italian Peninsula into Montenegro and Albania (P02 and P03). The third profile (P01) was shot parallel to the coastlines, extending from the southern Adriatic basin to a proposed mid-Adriatic decoupling zone. A cluster of 6 G-guns with a combined volume of 84 l was used as source to shoot with ~190 bar every 60 s. This resulted in a shot spacing of ~ 200 m over the densely spaced OBH stations. A short streamer was towed behind the vessel to resolve the shallow part beneath the seafloor.

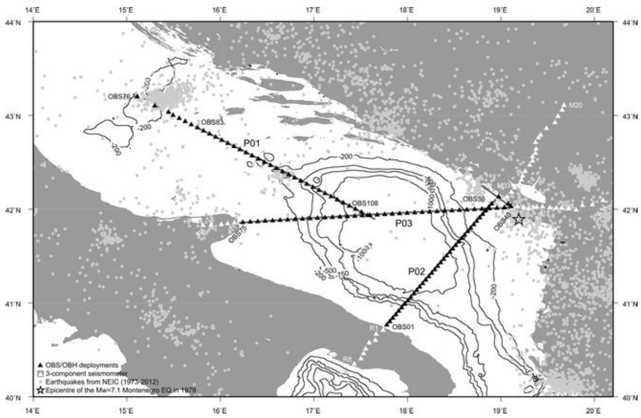

Fig. 1. Overview map of the eastern Adriatic Sea showing the experiment setup of M86-3 cruise on RV Meteor.

Two different approaches of travel time tomography are applied to the data set: A non-linear tomographic approach [*Improta et al., 2002*] is used for the shorter profile P01 that is situated in the middle of the Adriatic Sea. A well-established linear tomographic approach [*Korenaga et al., 2000*] is applied to profile P03 and allows for the integration of OBH and land stations. This profile has a length of 360 km and reaches from the Gargano Promontory into Albania. The instruments partly recorded good data quality up to large offsets. The land stations even recorded arrivals from the opposite end of the shot line. First results show a good resolution of the sedimentary part of the Adriatic region. The depth of the basement as well as the depth of the Moho discontinuity vary laterally and deepen towards the North-East.

References
1 - Improta, L, A. Zollo, A. Herrero, R. Frattini, J. Virieux, and P. Dell'Aversana, 2002. Seismic imaging of complex structures by non-linear traveltime inversion of dense wide-angle data: application to thrust-belt. Geophys. J. Int. 151, 264-278, doi:10.1046/j.1365-246X.2002.01768.x .
2 - Korenaga, J., Holbrook, S., Kent, G., Kelemen, P, Detrick, R. S., Larsen, H.-C., Hopper, J. R., and Dahl-Jensen, T., 2000. Crustal structure of the southeast Greenland margin from joint refraction and reflection seismic tomography, J. Geophys. Res., 105, doi:10.1029/2000JB900188.

SEISMIC WIDE-ANGLE REFLECTION AND REFRACTION STUDY IN THE IONIAN SEA

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Abstract

The collision between Africa and Eurasia resulted in a complex tectonic setting in the Mediterranean. In the area of the Ionian Sea, subduction is still active, and there is an ongoing debate among scientists about the nature of the crust. Seismic wide-angle reflection and refraction data were used to construct a velocity model of the structure of the sub-seafloor.

Keywords: Active margins, Ionian Sea

The complex tectonic setting of the Mediterranean is the result of the collision between the African and the Eurasian plate. This collision slowed down Africa's northward movement and the system changed from subduction-dominated to collision-dominated. Subduction still continues below a large part of the Mediterranean, e.g. the Ionian Sea. It is unresolved to date if the crust in this area is of oceanic origin, as the Mediterranean is a remnant of the Tethys ocean, or if thinned continental crust is subducted. Locked between the Malta escarpment and the Apulia escarpment, the Calabrian wedge is build by sediments that are scraped off the subducting plate, and sediments are also piled up by Calabria's movement to the SE. The development of the wedge was influenced by the Messinian Salinity Crisis (MSC), and the wedge can be divided into a pre- and post-Messinian part. During the MSC, evaporites were deposited in the Mediterranean and these were detected in the Ionian Sea (e.g. Polonia et al. (2011)). R/V Meteor cruise M111 (funded by the Deutsche Forschungsgemeinschaft (DFG)) was the first time a modern ocean bottom seismometer (OBS) survey was undertaken to investigate the deep structure of the Ionian Sea subduction zone. Five seismic refraction and wide-angle reflection profiles cover the area of the Calabrian accretionary wedge and the Ionian Abyssal Plain (IAP). This presentation focuses on profile DY-P04 that crosses the wedge from the IAP to the coast of Sicily. The aim of this profile is to shed light on the debate about the nature of the crust and to image the sub-seafloor structure. A G-gun array was used as source with a total volume of 84 l to shoot with 190 bar with an interval of 60 s. The resulting shot spacing was ~110 m. A multichannel streamer (65 m) was used to resolve the shallow part beneath the seafloor. Wide-angle reflection and refraction data were recorded by 62 ocean bottom hydrophones (OBH) and OBS in a dense spacing of 5 km. The model for profile DY-P04 was constructed by using forward and inverse traveltime modelling (Zelt et al., 1999 and Korenaga et al., 2000). The seafloor consists of a thin layer of Plio-Quaternary sediments (Gallais et al., 2012). In the southern part of the profile, these sediments overlay a layer of salt that is resolved in the OBH data. While its velocities are highest in the IAP, they decrease slowly up the wedge. This indicates a mixture of Messinian evaporites with sediments along the wedge. Another indication for this is the base of the evaporitic layer, which is manifested as a reversed polarised reflector in the IAP. This implies a negative velocity contrast underneath the salt layer. This phase reversal disappears towards the North. The OBS/H data show a second strong reflector within the sediments, indicating an increase in the seismic P-wave velocities. To fit the reflected phases of the basement, a thin layer of ~1.5 km above the basement was introduced. The basement is located at a depth of ~10 km beneath the IAP. Its depth increases along the profile to about 17 km (Dellong, 2015) at the northern end. Seismic energy from the deeper crust, the Moho discontinuity, and the upper mantle was observed on most of the stations. The depth of the Moho was determined at 15 km in the IAP, deepening towards the NW to 21 km beneath the upper slope of the wedge in the centre of the profile. At the northern end of DY-P04, the crust-mantle boundary has a depth of 28 km (Dellong, 2015).

References

1 - Korenaga, J., Holbrook, W. S., Kent, G. M., Kelemen, P. B., Detrick, R. S., Larsen, H. C., Hopper, J. R. & Dahl-Jensen, T. (2000). Crustal structure of the southeast Greenland margin from joint refraction and reflection seismic tomography. Journal of Geophysical Research: Solid Earth, 105 (B9), 21591-21614.

2 - Zelt, C. A., & Smith, R. B. (1992). Seismic traveltime inversion for 2-D crustal velocity structure. Geophysical journal international, 108(1), 16-34.

3 - Polonia, A., Torelli, L., Mussoni, P., Gasperini, L., Artoni, A., & Klaeschen, D. (2011). The Calabrian Arc subduction complex in the Ionian Sea: Regional architecture, active deformation, and seismic hazard. Tectonics, 30(5).

4 - Gallais, F., Gutscher, M. A., Klaeschen, D., & Graindorge, D. (2012). Two-stage growth of the Calabrian accretionary wedge in the Ionian Sea (Central Mediterranean): Constraints from depth-migrated multichannel seismic data. Marine Geology, 326, 28-45.

5 - Dellong, D. (2015). Structure profonde la marge Est-Sicilienne et la subduction Calabraise : données sismiques profondes de la campagne DIONYSUS. Master's thesis. Université de Bretagne Occidentale.

FIRST SEISMIC SURVEY ON WESTERN PALINURO SEAMOUNT, TYRRHENIAN SEA

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Abstract
The Palinuro volcanic complex in the Tyrrhenian Sea, a hydrothermally active area with observed massive sulfide deposits, has been target of the 2015 R/V Poseidon cruise POS484. Being the first seismic survey carried out on the western part of the complex, it reveals the structure of Palinuro and gives insight on its formation history . Combination of surface and deep-towed seismic and borehole leads to a redefined geological model of the complex.

Keywords: Tyrrhenian Sea, Geophysics, Seismics

Palinuro Seamount (PS) is a volcanic complex in the Tyrrhenian Sea and represents the northern part of the Aeolian Volcanic arc. The whole complex has an E-W orientation and an extent of about 55 km, the shallowest peaks lay at less than 500 mbsl while depth reaches 3500 mbsl in the Marsili basin south of PS.

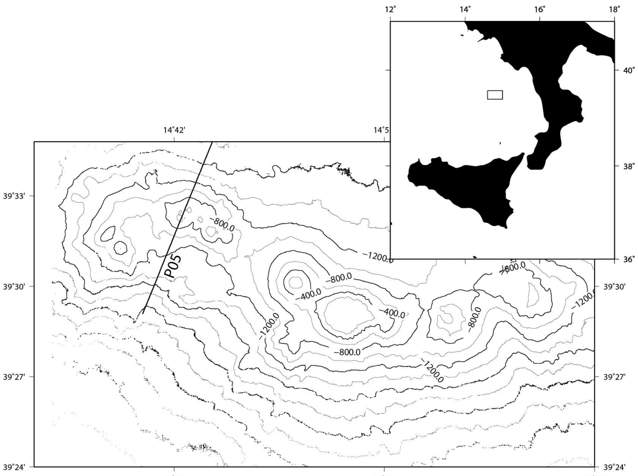

Fig. 1. Overview Map of the Tyrrhenian Sea with target area, Bathymetry of Palinuro Seamount with seismic line P05

Its formation is related to the opening of the Tyrrhenian Sea about 11 million years ago. Back-arc spreading followed the rollback of the Ionian slab and caused the development of back-arc volcanism around the Marsili basin [1]. At present day, PS shows no more active volcanism, but the presence of hydrothermal activity as well as the deposition of [extinct] seafloor massive sulfides ([e]SMS) have been observed in the past [2].
Until cruise POS484, no seismic data have been acquired on Palinuro except one seismic line crossing the east of the complex. Therefore, existing geological models of the Palinuro massive sulfide bodies are based merely on drilling results. Combination of seismic and borehole data should lead to a much more detailed model of west PS, which should give a better insight on the evolution of the complex itself as well as on the processes involved in forming a hydrothermal system and a [e]SMS deposit in general. The geological model of PS should then be used in a synthetic modelling to correlate real and synthetic data to improve both procedures.
To reach these aims, different seismic systems were used to identify the structure of the eSMS deposit as well as the shallower sedimentary structure of the western complex during cruise POS484-2 in April/ May 2015. In total, 22 seismic profiles were acquired using a 312.5 m long surface towed 2D streamer with 160 channels. Furthermore, 7 profiles using a 50 m deep towed (about 100 m above seafloor) streamer with 25 channels (DTMCS) were shot. The deployment of 6 Ocean Bottom Seismometers adds refraction data and allows to obtain seismic velocity information. All systems recorded the shots from a Mini-GI airgun (15 / 15 in³ @ ~180 bars) with a shotrate of 5 sec. Throughout the cruise, the ship´s multibeam system L3-ELAC Nautik SBE 3050 was used to collect bathymetric data to complete existing datasets [3].

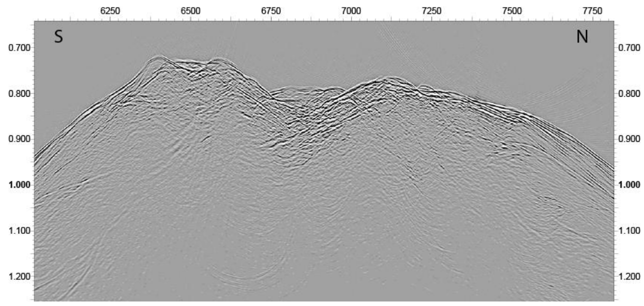

Fig. 2. Time section of seismic line P05 (surface towed streamer) showing the peak of western Palinuro Seamount, x-axis in meters

The seismic data have been processed afterwards using mainly geometry correction, frequency as well as dip-filtering and a multiple suppression. Post-stack time migration has then been carried out for the surface-towed data while the deep-towed data required a pre-stack depth migration.
After the processing, a main focus besides redefining the geological model was to compare the standard surface-towed streamer data with the deep-towed data. In theory, a deep-towed configuration allows a better seismic resolution and due to the larger offset an undershooting of, for example, strong reflecting cap rock formations.
Based on seismic images, velocity depth information and geological sampling, a geological depth model will be developed for PS. Synthetic seismograms based on such a model will be tested against the acquired data to confirm the sediment layers and [e]SMS deposit distribution. Furthermore the capabilities of the deep towed system in terms of mapping [e]SMS deposits will be evaluated.
This work has been supported by the EU Blue Mining project under grant 604500.

References
1 - Milano, G., Passaro, S., and Sprovieri, M., 2012, *Present-day knowledge on the Palinuro seamount (south-eastern Tyrrhenian Sea)*, Bollettino di Geofisica Teorica e Applicata, doi:10.4430/bgta0042.
2 - Petersen et al, 2014, *Drilling shallow water massive sulfides at the Palinuro Volcanic Complex, Aeolian Island Arc, Italy,* Economic Geology, 109 (8). pp. 2129-2157. DOI 10.2113/econgeo.109.8.2129.
3 - Bialas, Jörg, ed., 2015, POS484/2, RV POSEIDON - MARSITE: *Seismic investigations at the Palinuro volcanic complex*, Cruise Report, 27th April 2015 - 09th May 2015 . GEOMAR Helmholtz-Center for Ocean Research, Kiel, 18 pp. DOI 10.3289/CR_POS_484/2.

ACTIVE TECTONICS IN THE CENTRAL PART OF THE HELLENIC VOLCANIC ARC, SOUTH AEGEAN SEA.

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Abstract
Santorini volcanic group is part of the Aegean Volcanic Arc and comprises of three distinct, NE-SW aligned, volcanic centers: Christiana Islets to the southwest, Santorini-Kameni in the middle and Kolumbo volcanic chain to the northeast. Old, analogue seismic profiles, acquired between 1986-1992, recent seismic profiles, acquired in 2006, and swath bathymetry data, have been used to study the tectonic and volcano-sedimentary processes, unravel the geodynamic evolution of the central Aegean Volcanic Arc and understand if and how active tectonics controls the spatial distribution of volcanism in the Santorini volcanic province.

Keywords: Tectonics, Sedimentation, Back-arc, Geophysics, Hellenic Arc

Christiana and Anhydros Basins are the two adjoining basins of Santorini Island. Christiana Basin is located west of Santorini, east of Milos Island and north of the Cretan Basin, while Anhydros Basin is located NE of Santorini, between Ios (north) and Anhydros and Amorgos islands (south). The interpretation of the acquired seismic data that cover those two basins, gives us the opportunity to examine the prevailing geological and sedimentological regime in each basin separately and then to correlate the obtained results in order to draw conclusions for the main tectonic processes that dominate and affect the whole Santorini volcanic province.

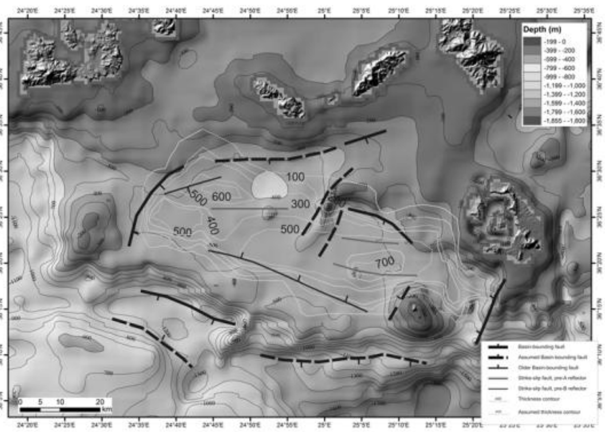

Fig. 1. Tectonic map of the Christiana Basin with major faults and fault zones and the thickness contours that define the sediments' thickness above the alpine basement

Christiana Basin is a W-E elongated basin. Extensional and strike-slip faulting, has played a dominant role in the formation of the basin during Plio-Quaternary. The western and northern boundaries of the basin are defined by apparently normal faults while the southern boundary has been controlled by a series of older blind faults. The eastern margin of the basin and the formation of Christiana volcanic center are controlled by NE-SW trending, active normal faults. The fault network with the older inactive faults and the active, apparently normal faults indicate that the post-Miocene evolution of the basin displays two main stages: A first stage which lasts until the Lower or Middle Pleistocene with three distinct depocenters and a second stagewhere older faults are deactivated, new faults shift the northern and western margins north- and westwards respectively, and the basin becomes unified.

The stratigraphy of Christiana Basin holds evidence for the activity of Santorini volcanic center. At least three different pyroclastic flows have been recognized within the basin's sedimentary infill. Volcanic material related to the Minoan eruption has been deposited on the sea floor of Christiana Basin covering a distance of more than 50 km^2. A second, older pyroclastic flow, probably related with Peristeria volcano, has been mapped 50 msec below the seafloor and can be indirectly dated to about 0,42 Ma while a third, up to 90 msec thick pyroclastic flow has been mapped in the central and eastern part of Christiana Basin. Its age, estimated between 0,42 and 1,25 Ma, strongly suggests that it is generated from one of the early eruptive centers of Santorini.

Anydhros basin is a N45^{o}E trending, elongate basin [1]. More than 20 volcanic cones, with Kolumbo being the largest among them, have been mapped on the basin's seafloor [2], aligned on a N30^{o}E trending zone. The Santorini–Amorgos zone is presently in the state of right-lateral transtension while the seismicity observed underneath Kolumbo is associated with the Kameni – Kolumbo Fracture Zone, which corresponds to the western termination of the major ENE-WSW Santorini – Amorgos Fault Zone ([3], [4], and [1]).

The interpretation of seismic profiles across Anhydros Basin shows that the latter has developed between the Ios (to the north) and Anhydros (to the south) fault zones. They diverge towards SW and display normal to dextral oblique slip character as postulated by the intra-basin deformation and the linear distribution of the volcanic cones along vertical to high-angle faults within the basin. Hemi-pelagic sediments alternating with volcanic material constitute the infill of the basin. A pyroclastic flow with an average thickness of 50 msec, probably related with the Minoan and Kolumbo eruptions, lies on the seafloor. A thicker pyroclastic flow has been recognized at about 800 msec depth and is probably equivalent to the thick (third) pyroclastic flow mapped in Christiana Basin.

Preliminary results of our ongoing research indicate that the NE-SW linear distribution of the volcanic centers of Santorini volcanic province (Christiana, Kameni and Kolumbo chain) in the Anhydros basin derives from the transtensional regime developed between the dextral oblique Ios and Anhydros fault zones. The WNW-ESE trending Christiana Basin, located at the southwestern end of Anhydros Basin may have developed as an extensional feature at the termination of the major Santorini – Amorgos Fault Zone.

References
1 - Sakellariou, D., Sigurdsson, H., Alexandri, M., Carey, S., Rousakis, G., Nomikou, P., Georgiou, P. & Ballas, D. (2010): Active tectonics in the Hellenic Volcanic Arc: the Kolumbo submarine volcanic zone. Bulletin of the Geological Society of Greece, XLIII, No 2: 1056-1063.
2 - Nomikou, P., Carey, S., Papanikolaou, D., Croff Bell, K., Sakellariou, D., Alexandri, M., Bejelou, K., 2012. Submarine volcanoes of the Kolumbo volcanic zone NE of Santorini Caldera, Greece. Global and Planetary Change 90–91 (2012) 135–151
3 - Bohnhoff, M., M. Rische, T. Meier, D. Becker, G. Stavrakakis, and H.-P. Harjes 2006. Microseismic activity in the Hellenic Volcanic Arc, Greece, with emphasis on the seismotectonic setting in the Santorini-Amorgos zone. Tectonophysics, 423 (2006) 17–33.
4 - Dimitriadis, I., Karagianni, E., Panagiotopoulos, D., Papazachos, C., Hatzidimitriou, P., Bohnhoff, M., Rische, and M., Meier, T., 2009. Seismicity and active tectonics at Coloumbo Reef (Aegean Sea, Greece): Monitoring an active volcano at Santorini Volcanic Center using a temporary seismic network. Tectonophysics, in press (doi: 10.1016/j.tecto.2008.11.005)

TECTONIC ARCHITECTURE AND SEDIMENTOLOGY OF EDREMIT BAY BASED ON SINGLE CHANNEL SEISMIC IMAGING

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Abstract

Seismostructural charactersitics of Edremit Bay, northeast Aegean Sea were investigated by 350 km of single channel Airgun reflection survey. Preliminary interpretation of shallow seismic data indicates that Edremit Bay is bounded with normal faults with strike slip components. General direction of this fault system is NE-SW and this complex transtensional regime may be seen as a transfer zone between the extensional regime of the Aegean region and strike-slip regime of the North Anatolian Fault System. This tectonic pattern can also be traced from GPS and seismicity measurements. The components between the faults can be moved downward and westward due to normal and transform fault activities respectively. The presence of left lateral movement component at NE-SW trending faults is not clear and needs to be confirmed.

Keywords: Tectonics, Seismics, Sea level, Aegean Sea, Edremit Bay

Introduction

Single channel airgun reflection seismic survey were conducted on Edremit Bay. This study presents the late Quaternary stratigraphic and tectonic evolution of the Edremit bay at northeastern Aegean Sea (Fig. 1) using high-resolution seismic-reflection profiles. A history of deltaic deposition is recognized from 130 ka to the present, under the influence of active transtensional tectonics and high-frequency sea-level fluctuations. The study area is part of a string of transtensional basins that developed along the western seaward extension of the North Anatolian Transform Fault.

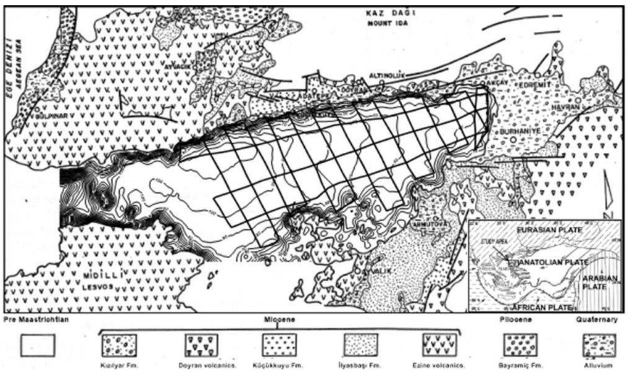

Fig. 1. Map showing location of the study area with bathymetry and location of seismic profiles. Geologic data modified from Siyako et al., [2].

Material and Methods

This study is based on acoustic and seismic data acquired during the cruise performed at Edremit Bay. Seismic surveys carried out on board the RV "K.Piri Reis", (Fig. 1). Areal sedimentary and tectonic framework for water depths of more than 100m have been recognized by analysis of reflection configuration in airgun profiles using the technique that described in Allen and Posamentier [1].

Discussion and Conclusions

Sequence stratigraphic analysis of Edremit Gulf establishes some general principles regarding the relationships of margin sedimentation to sea level changes. Sea level history determined from seismic stratigraphy links with the global eustatic sea level record based on oxygen isotopic curveys (Shackleton and Opdyke [3]). Edremit Bay basin correlates with lowstands of sea level in 2 to 6 whereas basin wide transgression surfaces correspond to the stages 5 to 1 transitions, when main deglaciations occurred. Present bathymetry shows that, when the sea level is lower than 100 m during the last glacial stage lacustrine or less saline conditions prevailing in the Gulf of Edremit. Seismic reflection profiles shows that, Pleistocene depositions and deltaic sedimentation in the Edremit bay largely controlled by mainly sea level changes and tectonic movements of North Anatolian Fault (NAF) system. Edremit Bay also has an asymmetric structure like other Western Anatolian grabens. NE-SW directed young faults are located in the Edremit Bay that parallel to southern branch of the North Anatolian Fault and these faults are associated with earthquakes occurred in the last hundred years tectonic formation of bay is thought to be still continuing. The blocks between the faults can be moved westward and downward due to transform and normal fault activities. The presence of left lateral movement component at NE-SW trending faults needs to be well defined. Faults may develop in any direction with the condition of appropriate Geometry. The westward movement of fault blocks is modelling the western coast of Anatolia and Aegean Sea bathymetry. Investigated data and other observations on coastal areas of eastern Aegean Sea indicate that the Edremit Bay is affected by westward movements rather than N-S openings.

References

1 - Allen, G.P., Posamentier, H.W., 1993. Sequence stratigraphy and facies model of an incised valley fill: the Gironde estuary, France. J. Sed. Petrol. 63: 378–391.
2 - Siyako,M,. Bürkan, K.A., Okay, A.I., 1989. Tertiary geology and hydrocarbon potential of the Biga and Gelibolu Peninsulas. TAPG Bulletin. 1/3: 183-199
3 - Shackleton, N.J., Opdyke, N.D, 1973. Oxygen isotope and paleo-magnetic stratigraphy of the equatorial Pacific core V28-238: oxygen isotope temperatures and ice volumes on a 10,000 year and 100,000 year scale: Quaternary Research. 3: 39-55.

CIESM Congress Session : Underwater archaeology

Moderator : Dimitris Sakellariou, Inst. of Oceanography, HCMR, Anavyssos, Greece

Moderator's Synthesis

The Archaeology Underwater session started with an introduction on the main research interests and challenges for the marine geoscientists in the fields of Deep water geoarchaeology (shipwrecks), Shallow water geoarchaeology (shallow submerged sites) and Continental Shelf Prehistoric Archaeology (Submerged landscapes).

Four presentations were delivered, three of them on submerged landscapes in the Aegean Sea and the fourth on ancient shipwrecks in shallow waters of the southern Black Sea. Here are the points emerging from the discussion that followed:

There is a large potential for deep water geoarchaeological survey in the Mediterranean and Black Sea, especially for ancient shipwrecks dating to the Roman, Hellenistic and Classic periods or even older. This differentiates the Mediterranean & Black Seas from the other European Seas where shipwreck archaeology is mostly concerned by medieval or younger shipwrecks. The involvement and contribution of marine geoscientists in the shipwreck survey and documentation can be very significant.

The reconstruction of the submerged prehistoric landscapes provides a new ground for marine geological research in close collaboration with archaeologists. It is a new, multidisciplinary field, across the boundaries between geosciences and archaeology. It also embraces the fields of sea-level changes and paleoenvironmental reconstruction, while the involvement of underwater technology and the need for science-driven technological progress is of great importance too.

The participants of the session on Underwater Archaeology agreed on the necessity to promote activities in this field and include Underwater (Geo)Archaeology among the interests of CIESM.

MARINE GEOARCHAEOLOGICAL RESEARCH ALONG THE SOUTHWESTERN ANATOLIAN COASTS

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Abstract
Marine archaeological and geophysical surveys were performed on submerged archaeological remains along the southwestern Anatolian coastline in order to determine the Late Holocene sea level changes. High-resolution acoustic data were acquired, and archaeological and geomorphological observations were carried out on the coastal archaeological sites and their surroundings. Submerged archaeological and biological remains provided significant evidence of vertical tectonic subsidence in the region. The results show that the observed changes are produced by the vertical tectonic movement for this coastline since the Hellenistic period.

Keywords: Sea level, Aegean Sea, Geomorphology, Tectonics

In antiquity, humans generally preferred coastal living in order to take advantage of seafood resources and marine transportation. However, since prehistoric times humans have been affected by sea level changes. Numerous ancient coastal settlements can be found along the southwestern Anatolian coastline. Their coastal installations (e.g. moles, quays, public buildings) are now submerged due to relative sea level rise.

Southwestern Anatolia region is a seismically active part of the Aegean–Anatolian microplate. The eastern Mediterranean lithosphere subducts under the Aegean microplate resulting in the generation of serious earthquakes and volcanic activity along the Hellenic – Pliny Strabo arcs and Aegean volcanic arc [1, 2] (figure 1a). This tectonic regime has an impact on the submergence of ancient harbour structures.

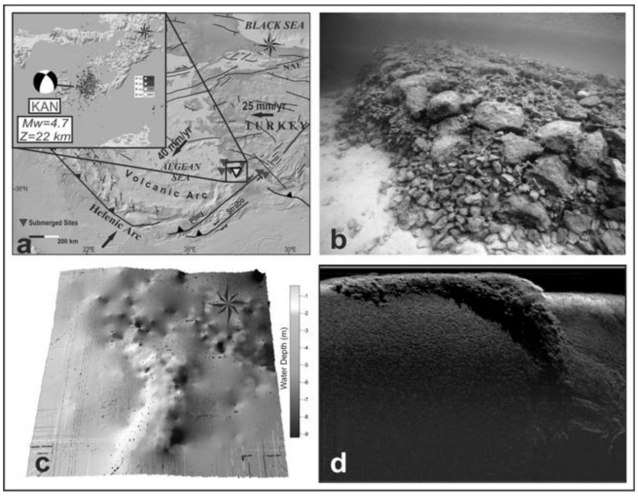

Fig. 1. (a) Location and tectonic structure around the study area (modified [2]; http://www.geomapapp.org). The inset map shows the earthquakes in the Yesilova Gulf in 2002 (http://www.koeri.boun.edu.tr/sismo). (b) Submerged breakwater remains in the southern Yesilova Gulf. (c) Multibeam bathymetric data and (d) side scan sonar images of breakwater.

Late Holocene sea level changes along the coast of southwestern Anatolia were investigated based on the correlation of archaeological and geophysical data. The positions of submerged archaeological structures, dating from Hellenistic to late Roman / early Byzantine periods, were measured with respect to the present sea level. Side scan sonar and multibeam bathymetric data were obtained to provide acoustic images and a high-resolution digital elevation model of submerged remains (figure 1c, d). In addition to archaeological data, geomorphological observations were also made of the ancient harbour sites. On the limestone coast, measurements were made of submerged tidal notch traces, which indicate the sea level change [3].

In Yesilova Gulf, a submerged breakwater is located in a small ancient harbor, which has onshore building remains dated to Hellenistic Period (figure 1b). The upper surface of the breakwater lies 1.5 m below present sea level (figure 1c). Besides this, submerged tidal notches have also been observed in the region at approximately 0.5 m below sea level, indicating vertical tectonic movement. Recent earthquake activity that occurred in Yesilova Gulf in 2012 contributed to tectonic movement in the region. This activity lasted for one-week, generating more than 100 earthquakes (figure 1a), which support the active seismicity of the region.

Eustatic–isostatic sea-level change related to the melting glaciers did not exceed 0.5 m during the last 2000 years [4]. Considering the eustatic–isostatic sea level change, period of construction, and the present positions of archaeological remains, we were able to calculate the tectonic subsidence rate of 0.65 m±0.05. We suggest that tectonic movement has been the dominant cause since the Hellenistic period for the submersion of the southwestern Anatolian coastline, rather than eustatic sea level rise.

References
1 - McKenzie D.P., 1972. Active tectonics of the Mediterranean region. *Geophys. J.R. Astr. Soc.*, 30: 109–185.
2 - Barka A., and Reilinger R., 1997. Active tectonics of the Eastern Mediterranean region: Deduced from GPS, neotectonic and seismicity data. *Ann. Geophys.*, 40: 587–610.
3 - Pirazzoli P.A., 1986. Marine notches. *In*: Plassche O. (ed.), Sea-level research: A manual for the collection and evaluation of data. Norwich: Geo Books, pp 61–400.
4 - Flemming N.C., 1972. Eustatic and tectonics factors in the relative displacement of the Aegean coast. *In*: Stanley D.J. (ed.), The Mediterranean Sea: A Natural Sedimentation Laboratory Stroudsburg: Dowden, Hutchinson and Ross Inc. pp 189-201.

SUBMERGED LANDSCAPE ARCHAEOLOGICAL FEATURES OF THE CARIA REGION

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Abstract
Submerged ancient harbours and coastal installations were researched along the coast of Caria during underwater surveys undertaken between 2006 and 2010. The current positions of the submerged remains have been measured and compared with eustatic –isostatic sea level data. The results indicate that the primary cause of relative sea level changes is the vertical tectonic movement of Caria coasts.

Keywords: Tectonics, Geophysics, Aegean Sea

Caria is one of the most important regions of the ancient world due, in part, to the geographic relationship of sea trade between east and west (Figure 1a). Several important coastal settlements have been located in Caria demonstrating maritime activity from the Hellenistic to Byzantine periods. A number of coastal settlements can be listed; Iassos, Myndos, Halicarnassus, Cedrai, Cnidus, Caunos, Tymnus, Thyssanous, Lydai, and Crya, which contain, among other features, breakwaters, moles, quays, and public buildings. Some features of these sites are presently submerged as a result of the combination of tectonic subsidence, and eustatic sea level change.

A detailed marine geophysical and archaeological survey was performed during 2006 in the harbour of ancient Halicarnassus, located in southwestern Anatolia (Figure 1a, b). A bathymetric survey was also carried out in order to reveal the current situation of ancient remains (Figure 1c). High resolution seismic data were collected for the harbour in order to determine the level of original seafloor below the ancient remains and the thickness of Holocene deposits. After the acoustic survey, underwater images and mortar samples from remains were taken by SCUBA divers.

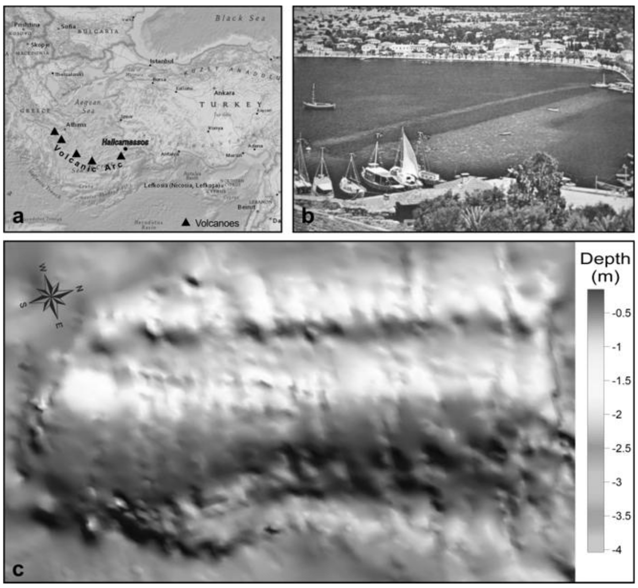

Fig. 1. Submerged harbour remains of Halicarnassus. (a) Location map; (b) a photo from 60’s; (c) multibeam bathymetric map of submerged remains.

A submerged ancient mole, located in Halicarnassus harbour, has two separate parts, lying in a nearly north to south orientation. The highest level of the mole lies only 0.3 m below the present sea level. The maximum water depth is 4 m, near the mole. The larger part of the remain is approximately 120 m in length, 27 m in width, at southern end tapering to 13-14 m width at the northern part. Several local volcanic green stones, cut to rectangular shape, were located at the southern tip of the remain. Hydraulic mortar mixed with ceramic sherds and rubble stone were used to build the mole.

Eustatic–isostatic sea-level change has not exceeded 0.5 m during the last 2000 years [1, 2]. However, over the same period, ongoing tectonic activity has affected the coasts of the southeast Aegean Sea [3]. Frequent earthquakes occurred around the middle of the 6th century, giving rise to vertical tectonic movements of the coastal plain, which make the harbour constructions currently useless. After the harbours were submerged and lost their function, many coastal settlements in the Caria region would not have been used as harbour cities.

References

1 - Flemming, N.C., 1972. Eustatic and tectonic factors in the relative vertical displacement of the Aegean coast. *In*: Stanley, D.J. (ed.) The Mediterranean Sea. Stroudsberg, PA: Dowden, Hutchinson & Ross. pp.189–201.
2 - Pirazzoli, P.A., 1976. Sea level variations in the northwest Mediterranean during Roman times. *Science*, 194: 519–521.
3 - Kizildag , N. Ozdas, A.H. and Ulug, A., 2012. Late Pleistocene and Holocene sea level changes in the Hisaronu Gulf, southeast Aegean Sea. *Geoarchaeology*, 27: 220–236.

RECONSTRUCTION OF THE SUBMERGED LANDSCAPE OF VATIKA BAY, PELOPONNESE, GREECE

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Abstract
Vatika Bay, in SE Peloponnese, Greece, has been the subject of a marine geophysical-geological survey with the aim to reconstruct the submerged prehistoric landscapes. Subsidence of the prehistoric city of Pavlopetri is in mark contrast to the long-term uplift of the area, as postulated the uplifted Late Quaternary terraces. Our scope is to understand the geological processes which led to the drowning off the city within a long-term upliftin region. Preliminary interpretation of the obtained data reveal a complicate tectonic deformation with relative subsiding and uplifting areas controlled by active faulting.

Keywords: Active margins, Tectonics, Seismics, Sea level, Hellenic Arc

Introduction
Vatika Bay, in SE Peloponese, Greece, has been the subject of a marine geological geophysical survey with the aim to reconstruct the submerged prehistoric landscapes. The area belongs to the seismically active Hellenic Arc and is characterized by long term uplift [1]. A series of Late Quaternary marine terraces occur around the Vatika Bay, reaching altitudes of several hundreds of meters. At the northwestern coast of the Bay, the ancient/prehistoric city of Pavlopetri has subsided by about 3-4 m below the present seafloor [2], [3]. Local subsidence is likewise indicated by beachrock formations submerged by 3-4 m. Our scope is to understand the geological processes which led to the drowning off the city within a long- term uplifting region and reconstruct the submerged, Late Quaternary landscape.

Material and Methods
The survey has been conducted on board the 14m RV Alkyon of the HCMR. Single beam and swath bathymetry data, high resolution seismic profiling (3,5kHz Pinger, Boomer, Chirp) and side scan sonar imaging revealed a valley-like morphology, with smooth relief in the northern and eastern part of the gulf while the western part close to Elafonisos island is characterized by steep slopes and terraces.

Results
The interpretation of the seismic profiles indicates a series of submerged riverbeds running off the northern shore of the Bay and buried below the recent, Holocene sediments. Holocene sediment deposition on the shallow seafloor of the Bay is fairly limited, with sediment thickness not exceeding a few meters. In the deeper part and close to the axial valley of the Bay, at about 85-100 m depth, we observe a fairly well developed prodelta prograding sequence, which may have formed in respect to a previous, low sea level. Two prominent, erosional terraces have been mapped systematically on the seafloor of the Bay at depths of 99-107m and 93-108 m. Two more, morphological terraces, at 65-70 and 51-56m depth, have been mapped locally.

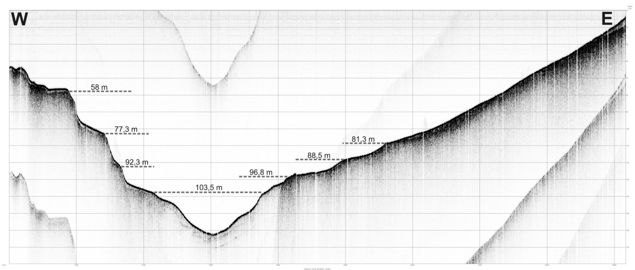

Fig. 1. Dustlines indicate marine terraces. In both western and eastern slope, the terraces seem to exist in different depths.

High resolution seismic profiles across the western steep slope of the Bay provide evidence of E-facing, NW- SE trending, normal faulting, separating the uplifted Elafonisos Island from the subsiding Vatika Bay. The eastern slope of the Bay displays marked differences: it dips smoothly westwards, while the observed submarine terraces do not match with the ones mapped along the western slope.

Conclusions
Preliminary results of the present research indicate that active faulting separates the long-term uplifting parts of the surveyed area from the relative subsiding seafloor of Vatika Bay. The submerged ancient city of Pavlopetri is located on the subsiding, hanging wall of the dominant fault. Submerged, Early Holocene riverbeds have been mapped on the shallow shelf of the Bay. Differential vertical tectonics has led to the occurrence of low sea-level terraces at different depths across the Vatika Bay.

References
1 - Sakellariou D., 2010.Submerged cultural remains in long-term uplifting regions: examples from the Hellenic Arc Proceedings. INQUA 501 - IGCP 521 Six Plenary Meeting and Field Trip, Hydrobiological Station of Rhodes, 27 Sept – 6 Oct 2010, Rhodes
2 - Sakellariou, D., Rousakis, G., Maroulakis, S., Georgiou, P., Kalogirou, S., Henderson, J., Gallou, Ch., Spondylis, I., Pizzaro, O., Hogarth, P., Flemming, N., 2011. The submerged city of Pavlopetri. In Poseidons Reich XVI, (DEGUWA 2011), Heidelberg, February 18-20, 2011
3 - Henderson, J.C., Gallou, C., Flemming, N.C., Spondylis, E., 2011. The Pavlopetri Underwater Archaeology Project: investigating an ancient submerged town. In: Benjamin, J., Bonsall, C., Pickard, C., Fischer, A. (eds.): Submerged Prehistory, p. 207-218. Oxbow Books, Oxford, ISBN 978-1-84217-418-0.

INNER HARBOUR WRECKS OF SINOP

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Abstract
After the research lasting since 1985 in Sinop Inner Harbour, three wooden battle ships ((Nesim-i Zafer, Demirciköy village, 37 meters), Navek-î Bahri (DSI resort, 14 meters) and Avnillah II (mobil beach, 23 meters)), a tomb and a Byzantian wreck loaded with tiles belonging to Crimea War started with Sinop Blitz on 30th November 1853 have been identified.

Keywords: Swath mapping, Black Sea

Sinop is a very rich region of wrecks for having thousand years of history and Maritime traffic. Because it is the only natural harbour in Anatolian Coast, that makes it an area to be reached in heavy weather conditions.

Foundation date of Sinop City which used to be an important site in Hittite Era is still unknown [1]. It is stated that Sinop could develop and became the most significiant city of Black Sea Coast, just because it was on the edge of the road connecting Black Sea to Hattusha [1].

During Ottoman Empire, Sinop was used as a naval base as well as Gallipoli [1].

Sinop Blitz subjected by Russian Navy on 30th November 1853 caused the Crimea War between Russia and Ottoman Empire with its allies.

Method
The wrecks were determined by luck during the tangled fishnets were being scanned by divers and also sportive and trading dives. The research process was started by diver Yasar Tarakçi in 1985 and has lasted till today (fig. 1).

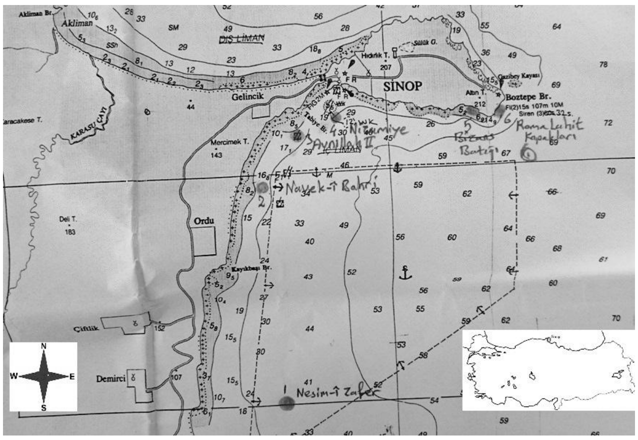

Fig. 1. Location of wrecks of Sinop

Discussion and Suggestions
After the obtained findings, it is not possible to compare the determined wrecks with another wreck, because they are first record and there are not any archaeological sudies on them.

In the future studies, it is suggested to conduct scientific and archaelogical research on the determined wrecks and turn them into national park open to scuba diving tourism.

Conclusion
After the research, an ancient tomb (Adabasi site), a Byzantian wreck loaded with tiles, (Adabasi Site), three wooden battle ships (Nesim-i Zafer, Demirciköy village, 37 meters), Navek-î Bahri (DSI resort, 14 meters) and Avnillah II (mobil beach, 23 meters) belonging to Russian Blitz on 30th November 1853 were identified (fig. 2).

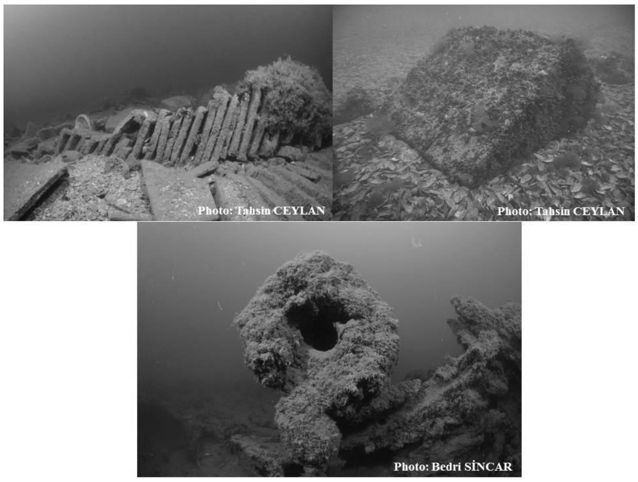

Fig. 2. Inner harbour wrecks of Sinop

During Sinop Blitz, an important part of other ships sank, burned and succumbed to the corrosive effects of sea. Also sunken wooden battle ships washed ashore and are known to have been removed and used as fuel.

References
1 - Http://www.sinopmuzesi.gov.tr/TR,78304/sinopuntarihcesi.html

CIESM Congress Session : Shelf and slope dynamics
Moderator : Dierk Hebbeln, MARUM, Uni. of Bremen, Germany

Moderator's Synthesis

The discussion focused on two main topics: (1) Dense shelf water cascading (DSWC) and (2) Cold-water coral (CWC) ecosystems and mounds. DSWC occurs in the NW Mediterranean, in the Adriatic and in the Aegean Sea. It is driven by very cold and dense water formed on the shelves in winter that often pass through canyons to the deep-sea, basically driven by their density. Such DSWC events can temporarily increase downward particle fluxes by >2 orders of magnitude, result in significantly enhanced current speeds, increase the supply of organic matter to deep-sea ecosystems and can leave clear traces in the sedimentary record. To understand the imprint of such events on the seafloor, an interdisciplinary approach must be followed linking oceanographers, biologists, sedimentologists and others to answer questions like, e.g., if the traces of such events dominate the sedimentary record in specific regions and to what extent well-known, yet not understood, sea floor features can be linked to such events.

By providing high-energy settings and high particle loads, including food particles, DSWC events are also beneficial for CWC, supporting their occurrence in DSWC-affected areas. However, CWC are also found in many other places in the Mediterranean Sea. As ecosystem engineers the CWC form biodiversity hotspots in the deep Mediterranean (~200-1000 m) although they are close to their ecological limit in terms of temperature. These thriving ecosystems attract many organisms and serve as nursery for many species, including commercial ones, explaining that many Mediterranean CWC settings show a clear anthropogenic impact (e.g., lost fishing gear). Over time, the CWC can generate impressive seabed features, so-called coral mounds, that can reach > 100 m above the surrounding sea floor and that form very valuable sedimentary archives. Also the investigation of CWC and of coral mounds requires very broad interdisciplinary approaches to answer questions regarding the distribution of CWC and coral mounds in the Mediterranean and their forcing factors, with many new discoveries to expect in the future. The coral mound records are very complex, consisting of coral fragments in a hemipelagic sediment matrix and our ability to read the coral mound record needs to be further developed. Such records provide temporal resolutions of a few meters per thousand years, bearing a huge potential.

Other issues that were briefly touched during the discussion were canyon systems and the impact of internal waves on the sea floor. Two key points were highlighted during the discussion : (a) our lack of knowledge on most parts of the African margin in the Mediterranean and (b) the need for interdisciplinary approaches in studying specific topics/systems, as only a more holistic approach can really result in a mechanistic understanding/reconstruction of many processes in the Mediterranean and beyond.

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RAPID SEDIMENTARY PROCESSES AT THE SOUTHERN OUTLET OF THE ISTANBUL STRAIT

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Abstract
Using available hydrodynamic field data, swath bathymetry map, seismic sections and radiometric age data from cores, the sedimentary processes occurred during the last glacial - Holocene ages and in the present were described at the southern outlet of the Istanbul Strait, which is a highly dynamic transition zone due to sediment transport processes under a typical two-layer and quasi-steady exchange flow system. Together with the global sea level changes, water and sediment exchange throughout the Istanbul Strait, the initial bathymetry, minor sediment sources and deep water currents along the slopes of the strait's banks, were responsible on the rapid sedimentary processes and structures in this outlet zone.

Keywords: Sediment transport, Bosphorus Strait

Introduction
The southern open boundary of the Istanbul Strait, a narrow and strongly stratified water channel between the Black Sea and Marmara Sea, is a transitional buffer zone that is mainly controlled by sediment load transported from various sediment pathways, sea level changes and hydrodynamic conditions moving sediments from one place to another (Figure 1a). This scope of the present study is to describe the surficial sediments and the sedimentary processes that are active in this outlet zone at the present day, using available geological and geophysical data. The last glacial - Holocene events and processes that contributed to the present day seafloor morphology and sediment distribution are also reviewed.

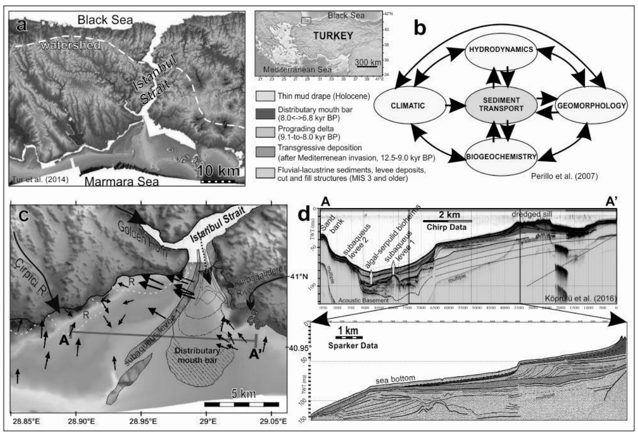

Fig. 1. A) Major morphological landforms and swath bathymetry of the region. b) Major controls that act upon environmental processes and their relations. c) Net sediment transport pathways and distribution of some critical subbottom elements were superimposed on bathymetry. R stands for the low-sediment-quality areas of medium to high priority. d) Distribution of sedimentary units along the cross section A-A'.

Material and Methods
Knowledge of how sediment dynamics in coastal environments is affecting the distribution of sediment [1], especially at shallow and hydrodynamic transition zones, is a very powerful tool for environmental management, civil engineering applications and development of modelling systems (Figure 1b). On the basis of different databases available, such as conductivity-temperature-depth casts, acoustic Doppler current profiler data, multibeam bathymetry maps [2], high-resolution shallow seismic profiles (115-km-line Sparker, 453-km-line boomer [2] and 538-km-line Chirp [3]), and ^{14}C age data from sediment cores [4], the studied area is open to rapid interaction of dominant processes such as climatic and hydrodynamic features, sediment sources, sediment transport and seafloor morphology. The granulometric fingerprints of available sea bottom surface sediments [5] were also used for sediment transport analyses in order to evaluate the actual mobility of the seabed material.

Results and Discussion
Hydrodynamic and sediment transportation models revealed that the modern sediments in the region are brought in through the Bosphorus canyon and partly by the short rivers flowing south. Its transportation over the shelf is mainly under the control of the persistent southerly waves, the Bosphorus jet stream at the outlet and its associated currents. The density-induced circulation movements in the region are able to produce responsible currents for actual sediment transportation. One of the most striking transportation patterns is towards the depression area behind a sand ridge (a subaqueous levee) located at the eastern bank of the strait and the other is over a local distributary mouth bar formation, which is mostly confused with the submarine delta of Kurbagalidere River (Figure 1c). In these places a succession of marine-lacustrine and some riverine sediments overlie the lower to middle Pleistocene age basement rocks (Figure 1d). The distributary mouth bar deposits are represented by aggradational and progradational seismic reflection patterns deposited under the control of rapid sediment input during a flood stage from the Istanbul Strait with friction between the sediment plume and basin bottom. The uppermost thin marine sediments show the Holocene transgression over the shelf and marking the onset of the highstand systems tract over the maximum flooding surface. In conclusion, the southern outlet of the Istanbul Strait is a dynamic depositional environment as it was during the last glaciation and Holocene. The sedimentary processes during the accelerated deglaciation following the Last Glacial Maximum, depend mostly on the water exchange along the Istanbul Strait; the availability of sediment sources to the depositional environments; their input rate and the hydrodynamic conditions during transport and deposition of the sediments. All these rapid sedimentary processes might have potentially significant impacts on the geomorphic, hydrodynamic and biogeochemical processes. Similarly the geomorphic setting of the seafloor, dominant hydrodynamic processes, such as the jet currents at the strait's exit, reverse and bottom currents, and partly biogeochemical processes on the seafloor control sediment input by different sources, its transportation and erosion.

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References
1 - Perillo, G.M.E., Syvistki, J.P.M. Amos, C.L., Depetris, P., Milliman, J., Pejrup, M., Saito, Y., Snoussi, M., Wolanski, E., Zajaczkowski, M., Stallard, R., Hutton, E., Kettner, A., Meade, R., Overeem, I. and Peckham, S., 2007. Estuaries and the sediments: how they deal with each other. *Inprint,* 3, 3-5.
2 - Tur, H., Hoskan, N. and Aktas, G., 2015. Tectonic evolution of the northern shelf of the Marmara Sea (Turkey): interpretation of seismic and bathymetric data. *Mar. Geophys. Res.*, 36: 1-34.
3 - Koprulu, K., Alpar, B. and Vardar, D., 2016. Last Glacial - Holocene stratigraphic development at the Marmara Sea exit of the Bosphorus Strait, Turkey. *Mar Geophys Res.*, DOI: 10.1007/s11001-016-9264-5.
4 - Eris, K.K., Ryan, W.B.F., Cagatay, M.N., Sancar, U., Lericolais, G., Menot, G. and Bard, E., 2007. The timing and evolution of the post-glacial transgression across the Sea of Marmara shelf south of Istanbul. *Mar. Geol.* 243: 57–76.
5 - Unlu, S. and Alpar, B., 2015. An assessment of metal contamination in the shelf sediments at the Southern exit of Bosphorus Strait, Turkey. *Toxicol. Environ. Chem.*, 97(6): 723-740.

THE EAST MELILLA COLD-WATER CORAL PROVINCE IN THE ALBORAN SEA

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Abstract
Impressive seafloor structures formed by cold-water corals (CWC) characterize parts of the seafloor in the Alboran Sea east of the Spanish enclave Melilla forming the East Melilla Cold-Water Coral Province (EMCP). These up to 100 m high structures are composed of a mixture of CWC fragments and hemipelagic sediments, reflecting the growth of CWC and their capacity to baffle sediments resulting in the partly rapid build-up of these structures. Under present-day conditions, CWC still thrive in the EMCP, however, not as strong as in the past.

Keywords: Deep sea corals, Sediments, Paleoceanography, Continental slope, Alboran Sea

The East Melilla Cold-Water Coral Province (EMCP) is located in the Alboran Sea off the Moroccan coast, east of the Spanish enclave Melilla [1, 2]. ROV-based video observations conducted during cruise P385 with the German R/V Poseidon revealed a sparse living cold-water coral (CWC) community with small, patchy distributed, live colonies (15–20 cm) of the common cold-water coral species Lophelia pertusa and Madrepora oculata. These are accompanied by large amounts of fossil coral debris admixed with sediments [3] with especially the fossil coral framework being colonised by a diverse associated fauna comprising sponges, soft corals, echinoderms and many other benthic organisms.
The mixture of coral fragments and hemipelagic sediments forms impressive seabed structures called cold-water coral mounds and ridges, which occur in water depths of between 250 and 450 m. With respect to the distribution of these structures, the EMCP can be divided into three different morphological zones (Figure 1). In the north the so-called Brittlestar Ridges extend seaward from the Banc de Provencaux. These are long-winded, very steep ridges rising 50-150 m above the surrounding sea floor. Video-footage and sediment cores revealed that the upper parts (max. 70 m) of these ridges are made up by the coral-sediment mixture typical for CWC mounds. These ridges are accompanied by very distinct moats.

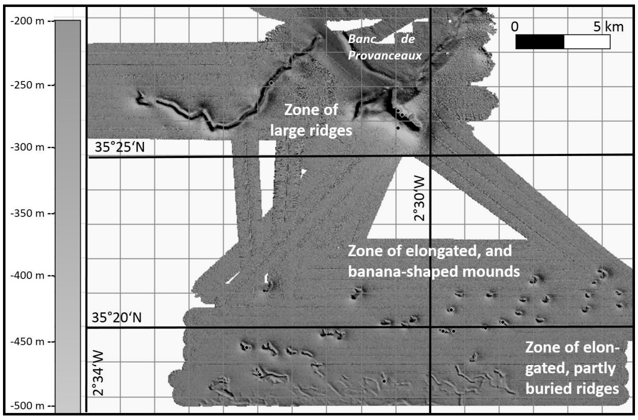

Fig. 1. The East Melilla Cold-Water Coral Province in the Alboran Sea.

Further to the south a gently rising flat sea floor shows for ~5 nm no indications for any mound- or ridge-like structures, neither as a surface expression nor as a subseafloor structure. Landward (i.e. south) of the 300 m isobath, a zone with numerous elongated or banana-shaped single mounds occurs. These mounds are characterized by very steep flanks often reaching slope angles of >30°. The average height of these mounds above the sea floor is 20-40 m, and even more, when considering the depressions of the moats also accompanying these mounds.
Also for the elongated ridges forming the third zone in the south, a distinct amount of CWC in the sedimentary record has been proven. These ridges rise up to 10 m above the surrounding sea floor and appear to get buried further to the south by a veneer of sediments. Nevertheless, in the subsurface, coral fragments can be traced at least to a depth of ~60 m below the seafloor.
Hydroacoustic data reveal that in the subsurface the CWC mounds and ridges are characterized by an acoustic transparence as often found in such structures. Between the ridges in the north and the mounds in the south, as well as in between the mounds, the hydroacoustic profiles provided a penetration of up to 100 m revealing mostly nicely layered hemipelagic sediments. The strongest dynamics in the sedimentary setting are displayed by clearly contouritic sediments close to the mounds, where various erosional phases of moat formation and depositional phases of moat filling are observed.
Short sediment cores revealed that the CWC colonized the area during most of the Holocene since ~14 ka BP [2]. During expedition MSM 36 with the German R/V Maria S. Merian, up to 70 m long sediment cores have been taken from these structures with the MeBo, the Bremen Seafloor Drill Rig [4].

References
1 - Comas, M. and Pinheiro, L.M., 2007. Discovery of carbonate mounds in the Alboran Sea: the Melilla mound field. Abstract for the First MAPG International Convention, Conference & Exhibition Marrakech Convention Center, October 28–31 2007.
2 - Fink, H. G., Wienberg, C., De Pol-Holz, R., Wintersteller, P. and Hebbeln, D., 2013 Cold-water coral growth in the Alboran Sea related to high productivity during the Late Pleistocene and Holocene: Marine Geology, 339, 71-82.
3 - Hebbeln, D., C. Wienberg and cruise participants, 2009. Report and preliminary results of RV POSEIDON Cruise POS 385 "Cold-Water Corals of the Alboran Sea (western Mediterranean Sea)", Faro - Toulon, May 29 - June 16, 2009: Berichte, Fachbereich Geowissenschaften, Universität Bremen, 273, urn:nbn:de:gbv:46-ep000106508.
4 - Hebbeln, D., Wienberg, C. and cruise participants, 2015.Climate-driven development of Moroccan cold-water coral mounds revealed by MeBo-drilling: Atlantic vs. Mediterranean settings - Cruise report to R/V Maria S. Merian expedition MSM 36, doi:10.2312/cr_msm36.

INFLUENCE OF NATURALLY OCCURRING ORGANIC AND INORGANIC COATINGS ON SURFACE PROPERTIES OF MINERAL PHASES IN RECENT MARINE SEDIMENTS (ADRIATIC SEA)

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Abstract

The influence of naturally occurring organic and inorganic compounds existing on the surfaces of mineral particles in marine sediments was investigated with respect to their surface physico-chemical and electrochemical properties. Bulk sediment and the clay fraction were investigated before and after removal of organic matter and Fe and Mn oxides/oxyhydroxides. It was found that organic matter induced aggregation of particles into larger organo-mineral aggregates and lowered their specific surface area (SSA) and cation exchange capacity (CEC). The role of organic coatings in the formation of surface charge of mineral particles was established. The influence of Fe and Mn oxides/oxyhydroxides on the surface reactivity of mineral particles was not consistent. Their presence increased SSA and reduced CEC of mineral particles.

Keywords: Sediments, Organic matter, North Adriatic Sea, Central Adriatic Sea, South Adriatic Sea

Introduction

Submicron sized mineral particles are omnipresent particulates in natural environments that comprise most of the potentially reactive surfaces responsible for the transfer and removal of organic and inorganic contaminants [1]. These solids are regularly associated with different organic and inorganic compounds that are attached to mineral surfaces in the form of coatings. In consequence, surface properties of mineral particles are modified to various extents. This influences particle reactivity and stability, but also the fate of contaminants bound to surfaces of mineral particles. The aim of this study was to investigate the influence of naturally present organic matter and Fe and Mn oxides/oxyhydroxides on surface reactivity of mineral particles. This was approached by determination of surface physico-chemical properties (specific surface area, SSA; cation exchange capacity, CEC) and surface charge (electrophoretic mobility) of bulk sediment and the clay fraction before and after removal of organic matter and Fe and Mn oxides/oxyhydroxides.

Materials and Methods

Recent marine sediments were collected in distinct sedimentological environments along the eastern Adriatic coast. Sediments were retrieved using Uwitec gravity corer or Van Veen grab sampler. Organic matter was removed by the NaOCl-treatment after [2]. Clay fraction (<2 μm) was collected by gravitational settling, confirmed by laser-based granulometry and freeze-dried. Fe and Mn oxides/oxyhydroxides were removed by dithionite-citrate-bicarbonate (DCB) method modified after [3]. Samples were mineralogically (XRD) and morphologically (FE-SEM) characterized and their physico-chemical properties (SSA, CEC) and surface charge (electrophoretic mobility) determined.

Results and Discussion

The physico-chemical characterization of samples revealed an increase in CEC and SSA after organic matter removal, regardless of mineral composition. The NaOCl-treatment caused disintegration of macroaggregates, an increase in clay fraction and significant exposure of mineral surfaces, rendering them more available for interactions with the environment. The main role of organic matter was mostly in gluing particles in macroagreggates, thus limiting access to the mineral surfaces. The determination of electrophoretic mobility showed that organic matter, even when present in minor amounts, has a prevailing role on charge formation of mineral surfaces in natural environments. It was found that while Fe and Mn oxides/oxyhydroxides increased the overall SSA, their presence decreased CEC and lowered the negativity of surface charge of mineral particles.

Conclusion

This investigation showed that the surface reactivity of mineral particles in natural environments is strongly influenced by the presence of organic and inorganic coatings on their surfaces. This causes aggregation of particles in larger micron-sized mineral-organic aggregates and affects interactions of mineral particles with contaminants and pollutants.

References

1 - Hochella M.F., Lower S.K., Maurice P.A., Penn R.L., Sahai N., Sparks D.L. and Twining B.S., 2008. Nanominerals, mineral nanoparticles, and Earth systems. *Science*, 319, 1631-1634.
2 - Kaiser K. and Guggenberger G., 2003. Mineral surfaces and soil organic matter. *Eur. J. Soil Sci.*, 54, 219-236.
3 - Mehra O.P. and Jackson M.L., 1960. Iron oxides removal from soils and clays by a dithionite-citrate-bicarbonate system buffered with sodium carbonate. *7th National Conference on Clays and Clay Minerals*, 7, 312-327.

EVIDENCE OF BOTTOM CURRENT-CONTROLLED QUATERNARY SEDIMENTATION ON THE EASTERN SICILY MARGIN (IONIAN SEA)

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Abstract
There is still little knowledge concerning the depositional transitional environment located between the continental escarpment and the abyssal plain in the Eastern Sicily margin. Currently, the sedimentary processes that take place in deep sea are not fully understood. Integrated geological and geophysical investigation methods allow us to study these particular deposits, which form under conditions still to be fully understood. In this study we present the identification of large up-slope and up-current sediment waves of contouritic origin never observed before. We infer the current dominated deposits to have started to develop since about 650 ka in response to an increase of bottom current velocity associated to the Mid Pleistocene Transition.

Keywords: Deep sea sediments, Waves, Currents, Continental margin, Ionian Sea

We here present results from geophysical data acquired in the Ionian Sea aboard the OGS-Explora research vessel, during the third phase of the "Canyon processes in sediment-undersupplied margins: A geomorphometric investigation of the Malta Escarpment submarine canyons (Cumecs3)" campaign. The survey succeeded in gathering new information regarding the sedimentary processes that develop at the base of the Malta Escarpment. The geophysical data collected with the multibeam echosounder and the sub bottom profilers integrated with the multichannel seismic reflection imaging highlighted evidence of peculiar sedimentary deposits forming at a depth of about 2400 mbsf, which we interpreted as current-controlled sediment waves [1]. These sedimentary structures have considerable size with a height of 50 m and a wavelength of 2500 m. They cover a large area at the base of the escarpment (figure1-2).

Fig. 1. Multibeam bathymetric data.

The analysis of these geophysical data integrated with oceanographic data allowed the definition of the features of the transport agent of the sediment. It is very likely that these structures were formed by a bottom current that moves from north to south along the base of the escarpment with speeds greater than 10 cm/s, according to data recorded at the mooring station KC2, [2][3]. The stratigraphic correlation between the seismic section CU15_001 and the DSDP 374 well enabled to estimate the age of the onset of contouritic deposits to be ca.650 ka. The main outcome the preliminary analyses of the available data suggests that the contouritic sedimentary process began during the Mid Pleistocene Transition (MPT), a paleoclimate event that consists of a transition of the glacial cyclicly from 40 to 100 ky.
The comparison of our sedimentary features with similar contouritic sediments identified in the Tyrrhenian Sea suggests that the MPT was an important paleoclimate event that developed during the Quaternary and perturbed the sedimentary deposition at a regional scale [4]. It is most likely that the MPT led to the increase of the bottom currents' velocities, promoting the formation of contouritic deposits in the Mediterranean Sea.

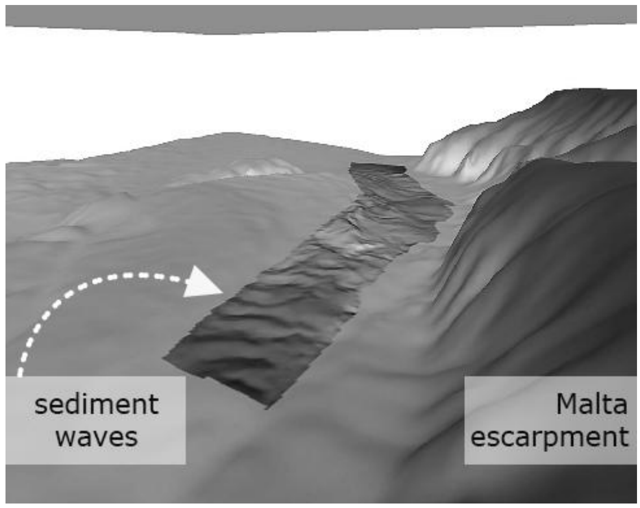

Fig. 2. In the illustration multibeam bathymetric map superimposed to cartography of EMODNET dataset. Processing made with PDS2000 and global Mapper software.

References
1 - Wynn R.B, Stow D.A.V. 2002. Classification and characterization of deep-water sediment waves. Marine Geology 192, (1-3), 7-22.
2 - Sparnocchia S. , Gasperino G.P., Schroeder K., Borghini M. 2011. Oceanographic conditions in the NEMO region during the KM3NeT project (April 2006 May 2009). Nuclear Instruments and Methods in Physics Research, A , 626-627, s87-s90, 2011. Doi:10.1016/j.nima.2010.06.231.
3 - Manca B., Budillon G., Scarzato P., Ursella L. 2003. Ecolution of dynamics in the eastern Mediterranean affecting water mass structures and properties in the ionian and Adriatic Seas, Journal of Geophysical Research, vol. 108.
4 - Miramontes E., Cattaneo A., Jouet G., Thereau E., Thomas Y., Rovere M., Cauquil E., Trincardi F. 2015. The Pianosa Contourite Depositional System (Northern Tyrrhenian Sea): Drift morphology and Plio-Quaternary stratigraphic evolution. Marine Geology (2015).

SEDIMENTARY GEOCHEMISTRY OF MUD VOLCANOES IN THE ANAXIMANDER MOUNTAINS REGION (EASTERN MEDITERRANEAN SEA)

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Abstract

Investigations including sedimentary and geochemical properties were carried out on the surface sediments sampled by E/V Nautilus from the Anaximander mud volcanoes in the Eastern Mediterranean Sea. The sediment grain size distribution and geochemical contents were determined by grain size, organic and inorganic carbon content and element analysis. The results were evaluated according to Enrichment and Contamination Factor Analysis. These index analyses can also be used to evaluate of deep sea environmental and source parameters. The factor analysis results were interpreted as the biological and cold seep effects are the main factors of surface sediment characteristics from the Anaximander mud volcanoes.

Keywords: Mud volcanoes, Sediments, Geochemistry, Anaximander Seamount, Mediterranean Sea

Introduction

Anaximander Mountains contains a high number of deep marine mud volcanoes and mud domes. The methane fluxes are associated with the mud volcanoes, cold vents and cold seeps at deep marine mud volcano areas [1]. The aim of this study is to investigate the characters of geochemical effects in the deep-sea mud volcano sediments and determine the mud volcanism effects on environments of the Anaximander Sea Mountains using grain size, geochemical element and numerical factor analysis data.

Material and Methods

This study is based on nine ROV push core sediment samples taken from the Anaxagoras and Anaximenes regions during the 2012 The E/V Nautilus exploratory cruises. The particle size analysis carried on based Folk classification [2], carbonate-organic carbon content was determined by using a gasometric method modified from 'Scheibler' gasometer system [3] and multi element analyzes were performed by ICP-MS. The Contamination Factor, Enrichment factor and Principal Component Factor Analysis calculated according to grain size, carbonate - organic carbon and ICP results.

Conclusions

Investigations were carried out on surface sediments taken from Anaximander mud volcanoes in the Eastern Mediterranean Sea. The grain size distribution of surface sediments ranged between sand to sandy silt in the study area. The contamination degree values showed low contamination in the area and factor analysis revealed that there was no anthropogenic or any other pollution sources around the searched area. The highest values of these parameters evaluated that observed enrichment of elements caused by environmental conditions together with mud volcano process. Six main factors were determined effecting of the study area. Those are identified as biogenic, carbonate, cold seep and ophiolite, lithogenic, ferromanganese concretion and organic matter factors. Effects of cold seeps were clearly observed at the area and the benthic community linked to methane-rich fluid expulsion is the main factor of the surface sediments from Anaximander mud volcanoes interpreted as biogenic factor. The biogenic and carbonate factor more intense around the Thessaloniki, Amsterdam and Kazan mud volcanoes, pointing these regions probably have more active ecosystems in the study area and biological process in progress. The cold seep factor determined more intense around the Kula, Thessaloniki and partly Amsterdam suggesting that these areas have more active cold seep expulsions in the study area.

References

1 - Charlou, J.L., Donval, J.P., Zitter, T., Roy, N., Jean-Baptiste, P., Foucher, J.P., Woodside, J. MEDINAUT Scientific Party, 2003. Evidence of methane venting and geochemistry of brines on mud volcanoes of the eastern Mediterranean Sea. Deep-Sea Res. PT 1 50 (8), 941-958.

2 - Folk, R.L., 1980. Petrology of Sedimentary Rocks. Hemphill Publishing Company, Austin, Texas, 26–27.

3 - Muller, G., 1967. Methods in Sedimentary Petrology. Schweizerban, Stuttgart, 283.

CIESM Congress Session : Cold seeps and gas hydrates

Moderator : Gerhard Bohrmann, MARUM, Univ. of Bremen, Germany

Moderator's Synthesis

Methane and other low-molecular-weight gases, such as ethane and carbon dioxide, can combine with water to form ice-like substances at high pressure or low temperature in what are known as gas hydrates. The stability of these compounds is controlled by several factors including pressure, temperature, salinity, and gas concentrations. On a global scale a lot of methane is stored in methane hydrate of the ocean sediments there some principle questions all of global aspects are under discussion: What is the contribution of methane from hydrates as a greenhouse gas to climate? Can we use the methane from the ocean for energy? What is the influence of hydrate dynamics to seafloor stability and landslides at continental margins? How important is the role of methane hydrate for chemosynthetic life?

Gas hydrates have been recovered from shallow sediment cores whose locations are cold seep environments. Typical cold seeps are characterized by chemosynthetic macro-fauna like bivalves (Mytilids, Vesicomyds, Lucinids and Thyasirids), bacterial mats, and or vestimentiferan tube worms as well as by mineral authigenic precipitates (calcite, aragonite and barite). Methane in form of methane hydrate or free gas is oxidized by sulfate through AOM processes. Although larger amounts of chemosynthetic animals are associated in many cases with shallow gas hydrate deposits, gas hydrates in the Mediterranean are only known from mud volcanoes of the Anaximander area. The deep water of the Mediterranean has a temperature of ca. 14°C and high salinity (>38 PSU) which both push the stability of the methane hydrates to much greater water depth than in other oceans of the world. The reason why gas hydrates occur in mud volcanoes of the Anaximander area is probably because water of reduced salinity from deep sources is used for hydrate formation in the chimneys of the mud volcanoes. The stability zone for methane hydrate occurs shallower in the Black Sea because of lower water temperature (ca. 9°C) and lower salinity (ca. 22 PSU). The presentations during the session contributed both to the lower stability boundary of methane hydrates in sediments from the Black Sea. This can be shown by the presence of a bottom simulating reflector in the seismic records or by 3D-seismic images from local areas in the ocean, which are important tools for detecting hydrates in the seabed.

HIGH RESOLUTION SHEAR WAVE MODELLING OF OBS DATA IN A GAS HYDRATE ENVIRONMENT IN THE DANUBE DEEP-SEA FAN, BLACK SEA

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Abstract
The Danube deep-sea fan, with his ancient and recent meandering canyon systems, hosts multiple bottom-simulating reflections (BSRs) observed in high-resolution reflection data, indicating the occurrence of gas hydrates and free gas. To image the distribution of submarine gas hydrates and the occurrence of free gas in a channel-levee system, fifteen ocean bottom seismometers (OBS) were deployed. The OBS data in particular reveal information about seismic P- and S-wave velocities of the subsurface. They record wavefields of a wide range of incidence angles, thus, allowing for an estimation of density and porosity of the sediment layers.

Keywords: Seismics, Danube Fan, Black Sea

With his ancient and recent meandering canyon systems, the Danube deep-sea fan mainly controls the slope at the Bulgarian and Romanian margin of the western Black Sea. This channel-levee system hosts multiple bottom-simulating reflections (BSRs) observed in high-resolution reflection data [*Popescu et al., 2006*], indicating the occurrence of gas hydrates and free gas. In the scope of the multidisciplinary research projects "SUGAR" and "MIDAS" the German research vessel Maria S. Merian (cruise MSM34-2) conducted high-resolution 2D and 3D multichannel seismic reflection data and ocean bottom seismometer (OBS) data, along with acoustic and heat flow measurements, as well as gravity coring for geochemical analysis. The goal of the active seismic experiment is to image the distribution of submarine gas hydrates and the occurrence of free gas in the Danube deep-sea fan. The OBS data in particular reveal information about seismic P- and S-wave velocities of the subsurface. They record wavefields of a wide range of incidence angles, thus, allowing for an estimation of density and porosity of the sediment layers.

Fifteen OBS stations equipped with hydrophones and three-component seismometers were deployed in a grid distribution and recorded source signals from a 45/45 cinch Generator Injector (GI) airgun. Eight 2D lines (11 km to 14 km length) that extend beyond the area of the 3D P-Cable acquisition were shot. For the 2D lines the shot interval of 5 s resulted in a shot distance of ~10 m. Frequencies up to 300 Hz with the main energy at about 100 Hz were recorded. All fifteen instruments show good data quality. The hydrophone data were used to determine a seismic P-wave velocity image of the subsurface. As a result of overamplification the direct wave is clipped in the near-offset and thus not suitable for an amplitude analysis. However, ten seismometers had good coupling to the seafloor and the recorded converted shear waves could be used for S-wave traveltime analysis and provide amplitude information. The frequencies of the S-waves are much lower than the P-wave reflection signals. This is characteristic for shear waves in unconsolidated sediments where the S-wave attenuation is high [*Zillmer et al., 2005*]. The first S-wave appears at ~0.7 s after the direct wave. Some of the S-phases can be traced up to 3.5 km in offset to the station.

Both, P- and S-wave traveltime modelling cover a depth down to 1.5 km below the seafloor; thus, providing seismic velocity information far below the BSR. The seismic P-wave velocities increase with depth from ~1600 m/s beneath the seafloor up to ~2400 m/s at 1.5 km depth. In OBS data, the BSR shows up with inverse polarity compared to the direct wave. Within the seismic multi-channel data, locally, the reflector of the BSR cuts the reflecting phases of the sediment layers. This could be partly observed in the 2D OBS data as a phase separation between the BSR reflector and the reflectors of the sediment layers. In order to fit the refracted and reflected phases and match the inverse polarity of the BSR reflector a negative velocity jump below the BSR was introduced. This is interpreted as occurrence of free gas below gas hydrate at the lower limit of the hydrate stability zone. It is not possible to detect the top of the gas hydrate zone and the bottom of the free gas zone using seismic P-waves only.

The observed shear wave phases did not resolve the above described phase separations. Shear waves in general are not sensitive to changes in the pore fill; however, gas hydrate can increase the sediment shear stiffness, causing an increase in seismic S-wave velocity [*Yun et al., 2005*]. The seismic S-wave velocities increase from ~240 m/s beneath the seafloor up to ~1100 m/s at a depth of 1.5 km below the seafloor. From these observations the P-to-S ratio can be derived and densities and porosities can be estimated. The P-to-S ratio might also help to estimate the thickness of the zones with gas hydrates and free gas, while there will be a limited capability to constrain their concentrations.

This work was completed in the course of the SUGAR-III project funded by the German BMBF (grant 03G0856A).

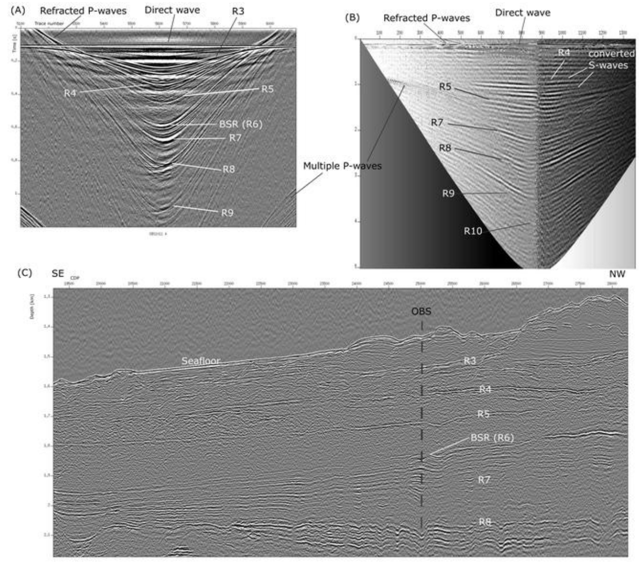

Fig. 1. Data example of OBS1011 along P1103: (A) Hydrophone, showing a wavefield mainly consisting of P-wave energy. (B) Radial component from the Seismometer, showing S-wave energy, while P-wave energy is suppressed. (C) Multi channel seismic data of P1103. Interpreted reflectors are marked in all three seismic sections.

References
1 - Popescu, I., M. De Batist, G. Lericolais, H. Nouzé, J. Poort, N. Panin, W. Versteeg, and H. Gillet, 2006. Multiple bottom-simulating reflections in the Black Sea: Potential proxies of past climate conditions. Marine Geology 227, 163-176, doi: 10.1016/j.margeo.2005.12.006 .
2 - Yun, T. S., F. M. Francisca, J. C. Santamarina, and C. Ruppel, 2005. Compressional and shear wave velocities in uncemented sediment containing gas hydrate. Geophys. Res. Lett. 32, L10609, doi:10.1029/2005GL022607.
3 - Zillmer, M., E.R. Flueh, and J. Petersen, 2005. Seismic investigation of a bottom simulating reflector and quantification of gas hydrate in the Black Sea. Geophys. J.Int. 161, 662-678, doi: 10.1111/j.1365-246X.2005.02635.x.

DISTRIBUTION OF FREE GAS AND IMAGE STRUCTURES BENEATH SEVASTOPOL MUD VOLCANO, BLACK SEA, FROM A 3D STUDY OF A HIGH RESOLUTION WIDE-ANGLE SEISMIC DATASET

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Abstract

Combined geophysical, geological, and geochemical analyses were conducted to investigate gas-hydrate occurrence in the Sorokin Trough, Black Sea. This study concentrates on a 3D high resolution seismic grid recorded with 13 ocean bottom stations on Sevastopol mud volcano. The 3D nature of the experiment results from the geometry of densely spaced profiles as well as the cubical configuration of the densely spaced receivers on the seafloor (~300 m station spacing). Correlation of a 3D mirror image of the seismic records in addition with 2D velocity-depth inversions of several seismic profiles gives a quasi 3D image of the subsurface. The Kirchhoff mirror image time migration reveals the reflective structure of the sub-seafloor beneath the ocean bottom stations. The traveltime inversion reveals the seismic velocities along the profiles.

Keywords: Geophysics, Black Sea, Sorokin Trough, Seismics, Mud volcanoes

The goal of this study is to image the sub-seafloor structure beneath the Sevastopol mud volcano (SMV) with the focus on structures of/within the feeder channel, the distribution of gas and gas hydrates and their relation to fluid migration zones in sediments. SMV lies in the Sorokin Trough and is located southeast of the Crimean peninsula in the Black Sea.

To achieve the goals, the main focus of this study lies in the interpretation of seismic data recorded with ocean bottom stations. Four ocean bottom hydrophones (OBH) [1] and 9 ocean bottom seismometers (OBS) [2] were deployed in a 3D grid for high resolution wide-angle seismic measurements. The high density of the seismic profiles is the pre-requisite of the 3D investigation of the dataset. Two 1.7 l GI-guns generated the seismic signal at a shooting rate of 10 s. The extent of the 3D study area is 7 km x 2.5 km, comprising 113 profiles, recorded at a distance of 25 m in the central region and 50 m distance in the peripheral region. The seismic profiles are typically longer than 6 km which results in large offsets for the reflections of the OBH/S section. This enables the study of the seismic velocities of the sub-seafloor sediments and additionally large offset incident analysis.

Seismic data quality is improved by frequency-wavenumber and bandpass-frequency filters with the main frequencies lying between 16 Hz and 400 Hz. This means i.e. to reduce the low frequency content of the strong bubble signal from the direct wave, which interferes with the uppermost sediment reflections, and therefore allow for a better identification of reflections originating from the uppermost sediment reflectors.

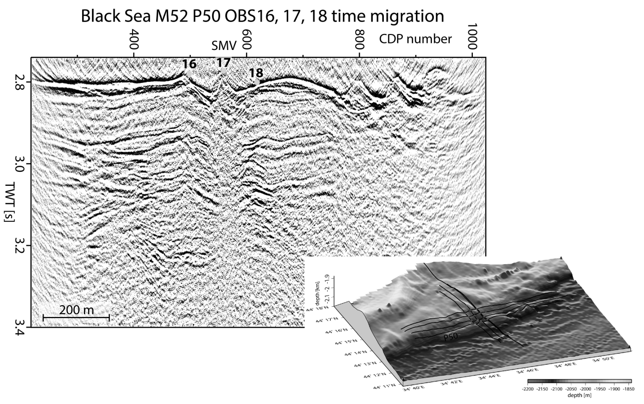

Fig. 1. Bathymetry of region of SMV showing major seismic lines and OBH/S positions. Mirror image of OBH 16, 17, and 18 on profile 50 across SMV.

The 3D Kirchhoff mirror image [3] time migration, applied to all OBH/S sections including all shots from all profiles, leads to a spatial image of the sub-seafloor. Here, the migration was applied with the velocity distribution of 1.49 km/s in the water column and 1.5 km/s below the seafloor (bsf) increasing to 2 km/s for the deeper sedimentary layers at ~2 s bsf. Acoustic blanking occurs beneath the south-easterly located OBH/S and is associated with the feeder channel of the mud volcano. There, gas from depth can vertically migrate to the seafloor and on its way to the surface horizontally distribute patchily within sedimentary layers. High amplitude reflections are not observed as continuous reflections, but in a patchy distribution. They are associated with accumulations of gas. Also structures exist within the feeder channel of the SMV.

The velocity depth structures for the seismic profiles of the 2D traveltime inversion (RayInvr [4]), show reduced seismic velocity zones correlating with the zones where gas is indicated from the time migration and assumed fluid-migration paths.

Mirror imaging proves to be a good tool to seismically image structures, especially steep dipping reflectors and structures which are otherwise obscured by signal scattering, i.e structures associated with fluid migration paths.

References

1 - Flueh, E.R. & Bialas, J., A digital, high data capacity ocean bottom recorder for seismic investigations, Int. Underwater Syst. Design, 18, 18–20, 1996.
2 - Bialas, J. and Flueh, E.R., A new Ocean Bottom Seismometer (with a new type of data logger), Sea Technology, 40, 1999.
3 - Grion, S., Exley, R., Manin, M., Miao, X.-G., Pica, A., Wang, Y., Granger, P.-Y., and Ronen, S., Mirror imaging of OBS data, First Break, 25, 2007.
4 - Zelt, C., and R. Smith, Seismic traveltime inversion for 2D crustal velocity structure, Geophys. J. Int., 108, 16-34, 1992.

CIESM Congress Session : Metal distribution in sediments

Moderator : Luca Zaggia, Inst. of Marine Sciences, CNR-ISMAR, Venice, Italy

Moderator's Synthesis

The main points of the discussion were as follows:

- Studies on metal contamination are generally focused on hotspots located in coastal areas (urban and industrial districts, estuaries, mine tailings etc.) or offshore discharge sites. Research approaches have been developed for these point-based investigations and widely tested by scientists. Are the current research methodologies suitable to assess the impacts of large-scale contamination related to anthropic activities like, for instance, the increasing ship traffic in the open sea? Ship traffic is an important stress factor for the sea and has to be taken into account in the Mediterranean as well as in the Baltic Sea-North Sea regions. It is probably too early to observe evidence of these impacts on offshore sediments, and future scientific efforts for marine scientists should be focused on the development of new strategies to investigate these processes in the water column (i.e. inputs of particulate-bound metals along main ship routes) or in the topmost sediment.

- From the contributions presented in this session and in other parallel sessions of CIESM 2016 (sessions 11, 18, 21, 25), it seems that the practice of discharging contaminated materials in coastal and open waters is still widely used, surprisingly also by countries where strict EU regulations or other international conventions apply. Even buried deposits from the past (some date back to historic times and not just the industrial era) are still a threat the marine ecosystems as materials can be eroded and contaminants transported in contiguous or remote areas by natural processes like wave action, currents, cascading, submarine groundwater discharge. In some cases we are not fully aware of the risk associated to this secondary transport processes which can only be understood by integrating contamination studies with knowledge on water circulation both on local and basin scale.

TRACE ELEMENTS IN SUSPENDED PARTICULATE MATTER IN SUBOXIC AND ANOXIC WATER COLUMN OF SOUTH EASTERN BLACK SEA (TURKEY)

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Abstract

In this study, some major, minor and trace elements concentrations (Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Mo, Ag, Cd, Sb, and Pb) were determined in particulate suspended matter of suboxic and anoxic layers of the water column of the southeastern Black Sea. Water sampling was made seasonally with rosette sampler. Co, Mn and Ni concentrations of the suspended matter in suboxic layer were found higher than concentrations of anoxic layer as 4; 3 and 2 times respectively. Cu, As, Cr and Pb concentrations of suspended matter in anoxic layer were determined higher than suboxic layer's.

Keywords: Metals, Black Sea, Anoxic basin

Particulate trace elements in aquatic systems has important role in the biogeochemical cycles of many elements of the water column and they distributed over different compartments[1].The suspended particulate matter which contain biotic or abiotic suspended particulate matter, higher organisms such as zooplankton, and the colloidal state has been recognized both as carrier and as possible source of contaminants in aquatic systems affecting their transport, fate, biogeochemistry, bioavailability and toxicity[1, 2]. Because of the biogeochemical cycles of many trace elements are controlled by redox reactions permanently anoxic basins offer unique opportunities to study basic redox geochemistry and the interactions between pelagic processes and sedimentary diagenetic processes [3, 4].

The Black Sea is a semi-enclosed sea and it has a suboxic zone at the interface between the oxic and anoxic sulfidic layers. Althougt there have been several studies of metal distributions of water and sediment sample different part of the Black Sea, trace metal data for suspended particulate matter are still rare [4].

Total suspended matter samples from the suboxic and anoxic layer were collected by rosette sampler. Concentration of measured by ICP-MS (Varian 820) after digestion with microwave digestion procedure of filter. The aim of this study was to determine concentrations of the major, minor and trace elements in the suspended matter of suboxic and anoxic layer of the Black Sea (Coast of Rize, Turkey). The averarage concentrations of particulate trace metals are presented in Figures1 and 2.

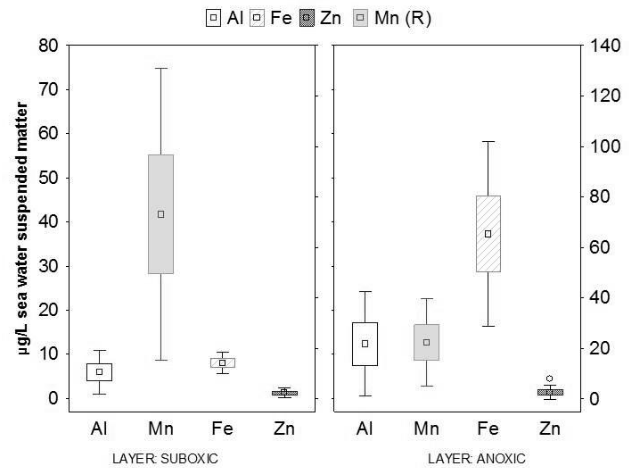

Fig. 1. Al, Mn, Fe and Zn concentrations in suspended particulate matter of the suboxic and anoxic layer of the Black Sea water column.

Metal cycling between dissolved and particulate phases in suboxic zone and metal sulfide formation in the anoxic zone are important processes for metal variabilities in the Black Sea water column. In this study significant correlations were found between metal concentrations in suspended particulate matter especially in anoxic layer.

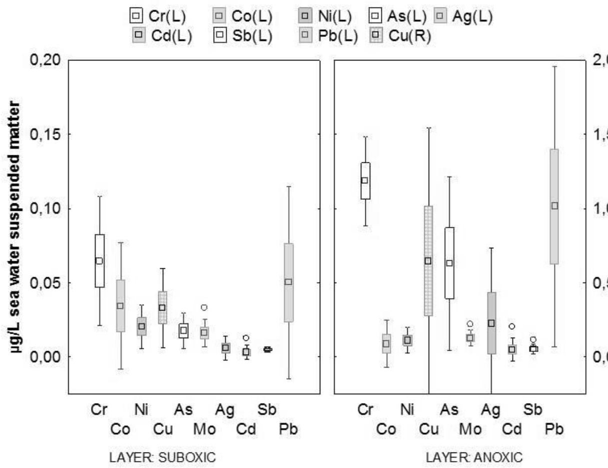

Fig. 2. Cr, Ni, As, Ag, Sb, Co, Cu, Mo and Pb concentrations in suspended particulate matter of the suboxic and anoxic layer of the Black Sea water column.

References

1 - Helmers, E., Trace metals in suspended particulate matter of Atlantic Ocean surface water (40°N to 20'S). Marine Chemistry, 1996. 53: p. 51-67.

2 - Violintzis, C., A. Arditsoglou, and D. Voutsa, Elemental composition of suspended particulate matter and sediments in the coastal environment of Thermaikos Bay, Greece: delineating the impact of inland waters and wastewaters. J Hazard Mater, 2009. 166(2-3): p. 1250-60.

3 - Skei, J.M., D.H. Loring, and R.T.T. Rantala, Trace Metals in Suspended Particulate Matter and in Sediment Trap Material from a Permanently Anoxic Fjord- Framvaren, South Norway. Aquatic Geochemistry, 1996. 2: p. 131-147.

4 - Yigiterhan, O., J.W. Murray, and S. Tugrul, Trace metal composition of suspended particulate matter in the water column of the Black Sea. Marine Chemistry, 2011. 126(1-4): p. 207-228.

MULTI-PROXY CHARACTERIZATION OF THE SUBMERGED MINE TAILINGS DEPOSIT OF PORTMÁN BAY, SE SPAIN

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Abstract

The Portmán Bay represents one of the most extreme cases in Europe of the impact of mine tailings dumping on the marine ecosystem. During a period of 33 years, the mining activity in this region generated about 57 million tons of tailings that were disposed directly into the sea, infilling the bay and extending offshore along the continental shelf. In this work, we present a multi-proxy characterization of the mine tailings deposit carried out through fifty-eight sediment cores recovered from the submerged deposit, using high resolution micro X-ray computed tomography, elemental chemical composition X-ray fluorescence and laser diffraction particle size analysis. Bulk density and grain size along with the content of metals have allowed investigating the physical properties and composition of the deposit's upper layers.

Keywords: South-Western Mediterranean, Metals, Sediments, Coastal systems, Pollution

The Sierra de Cartagena mining district was exploited since the 3rd century B.C. due to its high density of Pb-Zn ore deposits. However, intensive exploitation occurred during 1957-1990 when started the open-pit mining activities. During this period, large volumes of ores were transported to the Lavadero Roberto plant where Pb and Zn minerals were selectively separated and concentrated. A large volume of tailings (57 million tones) were generated and pumped directly into the sea leaving behind hazardous (metal-rich) artificial soils and sands, moving the shoreline 500–600 m into the sea [1]. At present, sediments from the filled bay are enriched in Zn, Pb and As, but there is not any record that could confirm the metals concentration in the submerged deposit. The aim of the present study is to characterize the distribution of the submerged mine tailings deposit in the inner continental shelf in front of the Portmán Bay.

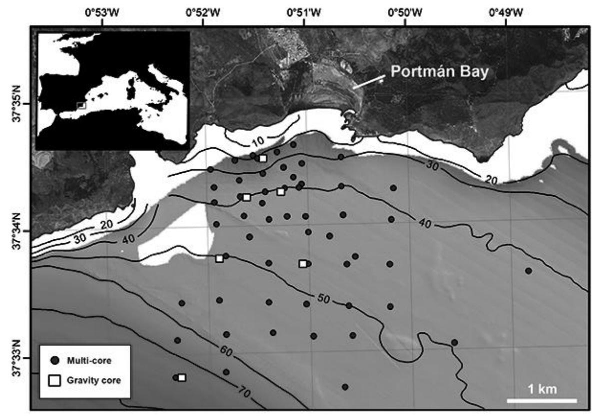

Fig. 1. General bathymetric map of the study area with contours every 10 m and location of multicore and gravity core stations.

Fifty-two short (up to 45 cm) sediment cores were collected with a multicorer system in August 2014, and six gravity cores (up to 300 cm) were collected in March 2015 within the framework of the MIDAS and NUREIEV projects (Fig. 1). All sediment cores were analyzed by two non-destructive techniques, the X-ray micro Computed Tomography (µCT MultiTom Core, X-Ray Engineering) for high-resolution analysis of 3D density changes and X-ray fluorescence core scanner (XRF, Avaatech) for determining the elemental chemical composition. Furthermore, grain size analyses were performed using a laser diffraction particle size analysis (Beckman Coulter LS230). Two depositional periods can be distinguished from the detailed sedimentary profiles of most of the sediment cores. Taking a reference core, the uppermost 20 cm layer shows quite homogeneous black sediments, with abundant bioturbation,

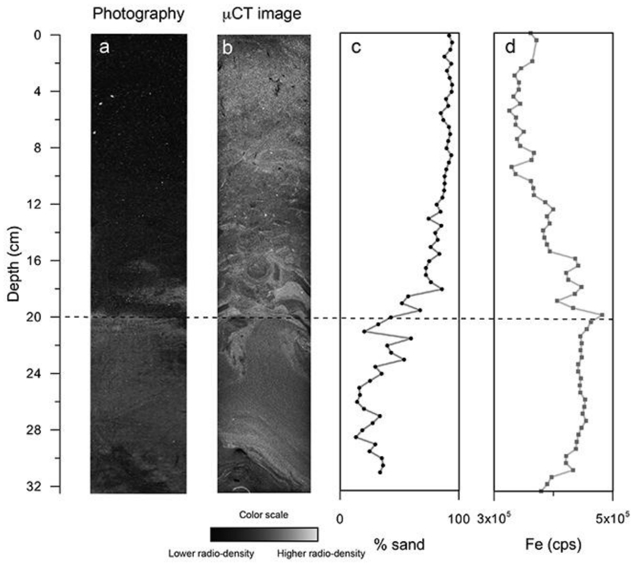

Fig. 2. Data from reference core MP-MC-05. (a) Photography; (b) µCT image; (c) Sand percentages; (d) XRF core scanner Fe content distribution (cps). Dashed line indicates the limit between the two depositional periods.

characterized by high percentages of sand, and relatively low, but highly variable, radio-density values (Fig. 2). The bottom layer, in our referece core from 20 - 32.5 cm, shows homogenous dark greenish grey sediments, with no bioturbation, reduced percentage of sands and much more constant radio-density values. Accordingly, these two units are characterized by different elemental composition. Of especial interest is the observed inverse correlation between the Fe content and sand percentages, which both show an abrupt change associated with the two layers limit around 20 cm core depth. Subsequently, and considering the preliminary dating information obtained by ^{210}Pb, our results suggest that the abrupt geochemical and physical changes observed in our sedimentary record could be related to the ceasing of the mining activity.

References

1 - Manteca, J.I., García, J. Á.L., Oyarzun, R., Carmona, C., 2014. The beach placer iron deposit of Portman Bay, Murcia, SE Spain: The result of 33 years of tailings disposal (1957-1990) to the Mediterranean seaside. Mineralium Deposita, 49 : 777–783.

REGIONAL GEOCHEMISTRY OF SURFACE SEDIMENTS FROM THE NORTH AEGEAN SEA

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Abstract
The composition of surface sediments from the North Aegean Sea is characterized by variable admixtures of terrigenous aluminosilicates and autocthonous biogenic carbonates. Element spatial distribution is controlled mainly by riverine inputs, domestic/industrial sources and water depth. On the outer continental shelves, relict, rich in quartz, coarse-grained sediments predominate. Sediments of a few coastal areas and semi-enclosed gulfs exhibit high heavy metal contents. The determination of enrichment factors (EF) revealed that sediment contamination related to human activities is recorded for Thessaloniki Bay and Gulf, and Ierissos Gulf, whilst the other areas are influenced by natural metal enrichment processes. High Mn contents observed at slopes and deep waters are initially attributed to in situ formation of Mn oxides.

Keywords: Geochemistry, Sediments, Continental margin, Aegean Sea, Pollution

The North Aegean Sea (NAS) extends from the Greek mainland (Thessaly, Macedonia) to the west, up to Thrace, the Gulf of Saros and W. Turkey to the east, covering an area of ~280x170 km. The NAS exhibits fairly complex morphology, comprising extensive continental shelves, deep basins, and island complexes, whilst it receives freshwater from numerous rivers draining the Balkan Peninsula. Scope of the present work is to bring together previous and recently acquired data on surface sediment geochemistry, thus presenting, for the first time a unified assessment of their chemical composition.

A total of 417 surface sediments were collected between 1996 and 2015 and were analyzed for major and minor elements by wavelength-dispersive X-ray fluorescence [1, 2]. The main sediment constituents are Si and Al, representing terrigenous clay minerals and aluminosilicates, and Ca, chiefly representing biogenic carbonates. A ternary plot with end members Al_2O_3, SiO_2 and CaO shows that most samples exhibit similar composition to the average shale (AS) or the average crust (UC) (figure 1). A significant number of samples, however, show progressively higher carbonate contents and plot along a mixing line stretching from AS/UC towards the carbonate end member.

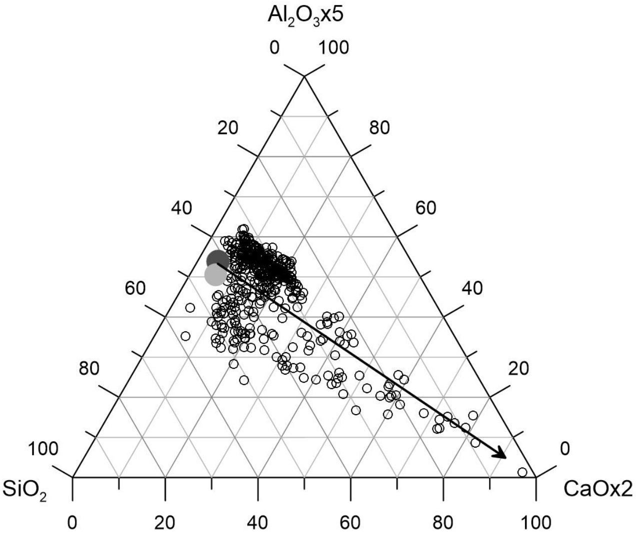

Fig. 1. Major components of North Aegean Sea surface sediments in comparison with average shale (dark grey filled circle) and upper crust (grey filled circle).

Fe, Ti, K and Na are significantly correlated with Al, corroborating for terrigenous origin. Terrigenous aluminosilicates originate in the rivers discharging into the Aegean Sea, as they exhibit higher values in front of the river mouths, whereas their dispersal is controlled by longshore transport processes and local circulation patterns. Silicon, however, displays different distribution patterns, as high Si contents are recorded offshore at deeper waters, up to 120-m depth. Such features are associated with quartz-rich relict and/or palimpsest sediments that were deposited during the last sea transgression, and remained uncovered or partly mixed with modern sediments. Sediments of a few coastal areas and semi-enclosed gulfs exhibit high heavy metals content: i) Thessaloniki Bay and Gulf (Cu, Pb, Zn); ii) Axios and Aliakmon deltas (Co, Cr, Cu, Ni, Pb, V, Zn); iii) Pinios delta (Co, Cr, Cu, Ni, V); iv) Ierissos Gulf (As, Cr, Ni, Pb, V, Zn); v) Strymon delta (Cu, Pb, Zn); vi) Evros delta (Cr, Cu, Pb, Zn). Enrichment factors (EF) were determined for a suite of heavy metals, using Al as normalizer and local pre-industrial sediment as background. The highest EFs were obtained for Pb (72), As (37), Zn (12), occurring in the Ierissos Gulf and are attributed to the combination of natural weathering of sulfide ores and mine tailings. The Thessaloniki Bay also exhibits high EFs related to anthropogenic activities (Pb: 16, Zn: 6, Cu: 3). Manganese shows high EF values up to 16 in slope sediments (water depths 368-857 m; figure 2). Scanning electron microscope analysis revealed the presence of sizable aggregates (~100 µm) composed of clay minerals and biogenic fragments, joined and/or coated by Mn (hydr)oxides. Additional work is required to fully-explain the observed Mn distribution patterns and associated accumulation processes.

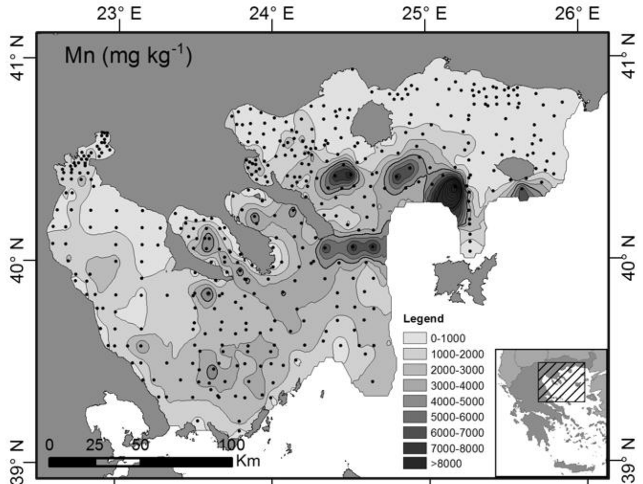

Fig. 2. Spatial distribution of Mn contents in surface sediments from the N. Aegean Sea.

References
1 - Karageorgis, A.P., Anagnostou, C.L. and Kaberi, H., 2005. Geochemistry and mineralogy of the NW Aegean Sea surface sediments: implications for river runoff and anthropogenic impact, Appl. Geochem, 20(1), 69–88.
2 - Karageorgis, A.P., Katsanevakis, S. and Kaberi, H., 2009. Use of enrichment factors for the assessment of heavy metal contamination in the sediments of Koumoundourou Lake, Greece, Water Air Soil Poll, 204, 243–258.

LEVELS AND PARTITIONING OF CHROMIUM IN SURFACE SEDIMENTS ENRICHED WITH METALLURGICAL SLAG

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Abstract

The geochemical fractions of Cr were investigated in the surface sediments of the Evoikos Gulf, as well as in metallurgical slag originating from a Fe-Ni smelter which dispose it, daily, into the gulf. The surface sediments in the areas affected by the smelter were highly enriched in Cr that was allocated in the residual and relatively inert fraction. However, Cr leachability was increased from the slag to the surface sediments, implying the occurrence of labile Cr-bearing phases that could potentially be mobilized and released to the environment.

Keywords: Geochemistry, Metals, Pollution, Sediments, Aegean Sea

Introduction

Since 1960's metallurgical slag originating from a Fe-Ni smelter located in the Larymna Bay (Evoikos gulf, Greece) is daily discharged in a designated marine area of about 80 m depth [1] and contributes to heavy metal enrichment of the surface sediments. In this study, we determined the geochemical fractions of Cr in surface sediments from the Evoikos Gulf and in the slag discharged by the smelter in order to detect potential changes that occur in the deposition area. The sampling network of surface sediments in the Northern Evoikos Gulf is shown in Fig.1. Additionally, a slag sample was collected directly from the smelter right before its discharge. The geochemical fractions of Cr were investigated through sequential extractions according to the BCR protocol (EUR report 19502EN) and a weak-acid digestion with 0.5N HCl [2]. Total Cr contents were determined by ultrasonic assisted digestion with a mixture of concentrated acids, including HF. Analysis of Cr in all extracts was carried out by GF AAS.

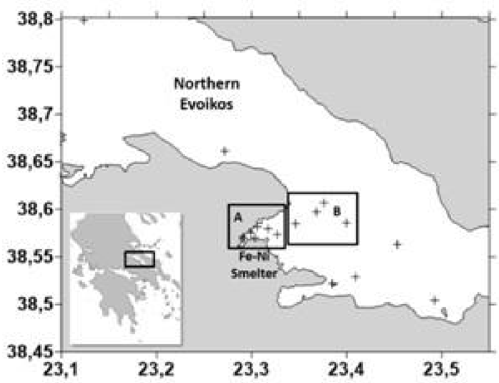

Fig. 1. Sampling stations in the Northern Evoikos Gulf: A) Larymna Bay, B) Slag deposition area, C) unaffected area.

Results

Chromium values were increased in the surface sediments affected by the Fe-Ni smelter while decreasing in the open and unaffected stations (Table1). Grain size distribution showed that Cr was allocated in the sand fraction (63 μm< f<1 mm) of the surface sediments that were enriched with metallurgical slag. The percentage of 0.5 N HCl extractable Cr of the pure slag was 16.4%, giving an estimation of the more labile Cr-bearing phases. Mineralogical analysis of the slag showed that chromite - $FeCr_2O_4$ was the major crystalline phase containing Cr, while other Fe-Cr spinels were also identified which explains the low leachability. For the surface sediments these percentages ranged from 3 to 49% for the silt/clay fraction and from 5 to 53% for the sand fraction for all samples analyzed, and maximum values were determined for the underwater slag deposit. The leachability of Cr increased from the slag to the sediments associated with the smelter, implying a potential transformation of Cr-bearing phases from the sources to the deposition area. Sequential extractions showed that Cr was primarily distributed in the residual fraction which accounted from 79 to 99% for the silt/clay fraction and from 91 to 99% for the sand fraction of all the samples analyzed. Therefore, the majority of Cr is inert under common environmental conditions. However, significant amounts of Cr were detected in fractions F1, F2 and F3 representing the amount of Cr that could potentially be released to the environment. Additionally, the percentage of the sum F1+F2+F3 to total Cr for the pure slag accounted for 4%, and increased to 6–21% in the surface sediments affected by the smelter. This difference is attributed to an increase in the oxidizable fraction F3 and to a slight increase in the F2 fraction. The positive correlation of Cr in the F2-reducible fraction with Mn and Fe in both silt/clay and sand fractions of the surface sediments associated with the smelter implies that Cr is possibly bound to Fe-Mn oxy-hydroxides.

Tab. 1. Chromium contents of sediments in various extracts (in mg/kg).

Samples	Fraction	Total Cr	HCl extr.Cr
Slag	f<1 mm	17577	2772
Area A	f<63 μm	1728-10299	142-3422
	f>63 μm	72.8-18282	38.7-3908
Area B	f<63 μm	4017-8131	1438 - 3553
	f>63 μm	10158 - 21938	5315-7182
Open Stations	f<63 μm	447-733	17.8-70.5

Samples	Fraction	BCR - sequential Extraction F1	F2	F3	F4
Slag	f<1 mm	113	223	410	14555
Area A	f<63 μm	0.07-10.7	3.8 - 173	135 - 1140	1587-8978
	f>63 μm	0.12 - 3.5	8.2 -191	117 - 336	2251 - 18068
Area B	f<63 μm	1.1-21.3	27.7 - 277	428-792	3227-7142
	f>63 μm	5.4-144	383 - 747	153-1035	14731 - 20705
Open Stations	f<63 μm	0-0.11	0.23 - 1.8	11.5-57.8	411 - 718

F1= Acid Soluble, F2 = Reducible, F3= Oxidizable, F4= Residual

Conclusions

The surface sediments near the Fe-Ni smelter and inside underwater slag deposit were highly enriched in Cr and the grain size distribution showed the contribution of the slag in the total Cr-content of the sediments. Although Cr was distributed mainly in the residual fraction, it was observed that the Cr-leachability increased in the surface sediments enriched with slag compared to pure slag, implying a transformation in more mobile Cr-bearing phases. Increase in fractions F2 and F3 of these sediments confirmed this assumption.

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References

1 - Simboura, N., Papathanassiou, E. and Sakellariou, D. 2007. The use of a biotic index (Bentix) in assessing long-term effects of dumping coarse metalliferous waste on soft bottom benthic communities. Ecological Indicators, 7(1), 164-180.
2 - Agemian, H. and Chau, A.S.Y. 1976. Evaluation of extraction techniques for the determination of metals in aquatic sediments. Analyst, 101, 761-767.

GEOCHEMISTRY OF TRACE ELEMENTS IN SEDIMENTS OFF THE SOUTHERN MEDITERRANEAN COASTAL ZONE: AN ASSESSMENT OF POTENTIAL RISKS

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Abstract

The present study provides an initial assessment of nine heavy metals (Cd, Cr, Co, Cu, Fe, Mn, Ni, Pb and Zn) distribution in 34 sampling sites from Egypt and Libya representing special Mediterranean seaside areas that cover contrasting topography, geology, sediments and human impacts. The ecological risks were assessed, and the pollution sources were identified to provide valuable information for environmental impact assessment and pollution control. Both the ecotoxicological index method and the potential ecological risk index (RI) suggested that the combined ecological risk of the studied metals may be low in the Egyptian Mediterranean coast, while the Libyan Mediterranean coast was at medium ecological risks. Multivariate analysis (Principal component analysis, cluster analysis) and correlation matrix were used in this study.

Keywords: South-Eastern Mediterranean, Geochemistry, Trace elements, Sediments

Introduction

Rapid industrialisation and uncontrolled urbanisation around many cities and coastal areas have brought alarming levels of pollution to aquatic environments because of their anthropogenic inputs. Trace metals are considered as serious inorganic pollutants because of their toxic effects on life in aquatic system, having a high enrichment factor and slow removal rate [1]. To date, many methodologies have been developed to assess ecological risks of trace elements. However, most of them are suitable only for ecological assessment of a single contaminant (e.g. Geoaccumulation index method and Enrichment factor). In reality, trace elements usually accumulate simultaneously and cause combined pollution. To address this, Hakanson (1980) [2] developed the potential ecological risk index, which introduced a toxic-response factor for a given substance and thus can be used to evaluate the combined pollution risk to an ecological system [2]. On the other hand, mean Sediment Quality Guidelines quotient (mSQGQs) has been developed for assessing the potential effects of contaminant mixtures in sediments. The aim of the present study was to: (1) characterize the concentration and distribution of some trace elemnts in the Southern Mediterranean Sea sediments. (2) provide a better understanding of the potential ecological risk levels of some heavy metals by applying the Potential Risk Index Method. (3) investigate the biological effects of some heavy metals concentrations using available Sediment Quality Guidelines (SQGs); and (4) identify the sources of the heavy metals using multivariate statistical analyses.

Study area

Thirty four surfacial sediment samples (0–5 cm depth) were collected from different selected stations along the Southern Mediterranean Sea from Egypt and Libya using Peterson grab sampler (Figure 1). Sampling sites were selected to cover the expected polluted area due to industrial and other activities.

Fig. 1. Study area

Materials and Methods

A concentrated acid digestion protocol according to Oregioni and Aston [4] 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. 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%.

Results and Discussion

Risk assessment showed that Cd had the highest ecological risk (Er=21.52) and (Er=835), followed by Pb (Er=3.01) and (Er=9.09) for Egyptian and Libyan Mediterranean coastal sediments, respectively. While Zn and Mn had the lowest ecological risk (Er=0.23) and (Er=0.03). Both the ecotoxicological index method and the potential ecological risk index (RI) suggested that the combined ecological risk of the studied metals may be low in the Egyptian Mediterranean coast, while the Libyan Mediterranean coast was at medium ecological risks. Multivariate analysis (Principal component analysis, cluster analysis) and correlation matrix were used in this study. Highly significant correlations were found between the concentrations of Cd, Co, Cu, Mn, Ni and Zn in the sediments of the Libyan Mediterranean coast suggesting similar sources and/or similar geochemical processes controlling the occurrence of these metals in the sediments. On the other hand, highly significant correlations were found between Fe, Mn, Co, Cr, and Ni in the Egyptian Mediterranean coastal sediments. This study supports metal pollution monitoring and control for the Egyptian and Libyan Mediterranean coastal environment. It will be a useful tool to authorities in charge of sustainable marine management.

References

1 - Alloway J, Ayres DC., 1997. Chemical principles of environmental pollution. London: Chapman and Hall.
2 - Hakanson, L., 1980. An ecological risk index for aquatic pollution control: a sedimentological Approach, Water Res.,14, 975-1001
3 - Yang, Z., Wang, Y., Shen, Z., Niu,J., Tang, Z., 2009. Distribution and speciation of heavy metals from the mainstream, tributaries, and lakes of the Yangtz River catchment of Wuhan, China, J Hazard. Mater., 166, 1186-1194.
4 - Oregioni, B. Aston, S.R., 1984, The determination of selected trace metals in marine sediments by flame atomic absorption spectrophotometry, IAEA Monaco Laboratory Internal Report 1.

CIESM Congress Session : Marine geo-hazards

Moderator : Namik Çagatay, Dept. Of Geological Engineering, Istanbul Technical Univ., Turkey

Moderator's Synthesis

Geohazard is defined as a geological event that can lead to damage or disaster, causing loss of life and property. In marine areas such as the Mediterranean Sea, located on or near plate boundaries, the common geohazards are: earthquakes, submarine landslides, tsunamis, and volcanic explosions and collapses. The session theme was briefly introduced by the moderator, underlining the importance of risk assessment and mitigation for marine areas with potential geohazards by high resolution mapping, characterization and seafloor monitoring.

Discussion followed the introductory talk and the five presentations, covering various scientific problems and issues. They included the role of fluids in submarine geohazard dynamics, links between geological triggers and preconditioning factors, identification and dating of sedimentary geohazard records, parameters that could be precursory signs of geohazard events, and communication of the results to public, government and industry. Within the allocated time, the participants mainly discussed the importance of marine geohazard risk assessment methodology, and in particular the long-term multiparameter seafloor measurements and long term geological earthquake records.

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EMBAYMENT CHARACTERISTICS AND SHORELINE ATTRIBUTES OF POCKET BEACHES IN CRETE

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Abstract
The formation of pocket beaches is a complex process being the result of a large number of processes and mechanisms that vary on space and time scales. The aim of this study is to define evolution processes dominating the Cretan pocket beaches, and to determine their vulnerabilities and risks. Thus, data from 46 pocket beaches along the coastline of Crete were collected. The pocket beaches under investigation are characterized by different geomorphological and hydrodynamical setting.

Keywords: Coastal processes, North-Eastern Mediterranean, Geomorphology, Shoreline evolution

Introduction
Pocket beaches are constrained coastal morphological cells nested between rocky headlands. Embayed beaches are often rather singular environments with great variability in terms of wave exposure, geomorphology and sedimentology and can be extremely sensitive to storm events. Pocket beach embayments have often been described and typified by geometric indices that include the planform parameters. Planform parameters represent the geometric characteristics of a beach. Previous studies [1] suggest that the geometric indices approach provides a useful first step in the study of embayed coasts. Geometric indices can make an important contribution in estimating the exposure of the coastal segments to incident waves, beach response to big storms, and the longshore migration of hotspots of erosion and accumulation, beach and nearshore morphological changes and shoreline progradation or recession. At regional scales, geometric indices, can used before detailed dynamic field experiments are undertaken. The aims of the present study are to assess the significance of planform parameters, to the formation and evolution of pocket beaches and to estimate the vulnerability and risks under climate change.

Study area
Crete coastline totals 1300 km, and consists from various landforms that include rocky coasts and coastal cliffs, while 15% of coastline consists of sandy beaches [2]. The wave climate is primarily wind-driven with average offshore wave heights <1.5 m, which may exceed 6 m during storms. The Cretan coast can be subdivided into 8 sections, based on the wave conditions and 3 tectonic sections based on Holocene crustal movements. Western and eastern tectonic sections of Crete are subjected to uplift movements, while the central section is subjected to subsidence.

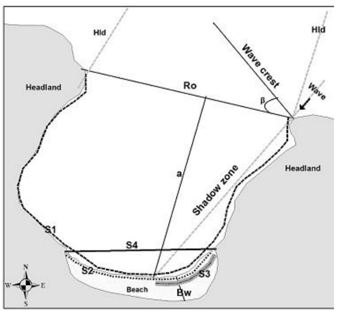

Fig. 1. Pocket beach planform parameters.

Methodology
Planform parameters and geometric indexes from the bibliography [3] were applied. Planform parameters used are: Headland spacing (R_o); Bay indentation (a); (S_1): Embayed shoreline length(S_1); Embayed beach length (S_2); Length of a beach segment located at the shadow of a headland (S_3); Linear distance and orientation between the edges of the embayed beach (S_4); f: Direction of the incident wave (f); Wave crest obliquity to the headland spacing (ß); Beach area (A_r); Maximum beach width (B_w); Headland orientation (H_{ld}) (Fig. 1). The planview Indices used include: two beach embaymentization indices (a/R_o and S_1/R_o). Stability (relation between a/Ro and the angle of wave incidence *(ß)* compared to a theoretical equilibrium curve. Sheltering index (S_3/S_2); Sediment availability index (S_2/S_1) and the Embayment scaling parameter $\delta'=S_1^2/(100RoH_b)$. For the vulnerability estimations the BVI (4) index was used.

Results and Conclusions
Five classes of indentation were recognized. The first class includes the least indented, shorelines with the smaller sheltered segments. The second class consists of a larger headland spacing and shorter shorelines and beaches. Third class included similar bays indentation characteristics with the previous, but less sheltered beaches. In the fourth class, indentation (a) almost equals the headland spacing (R_o) and the bays are more circular-shaped. Finally the fifth class include the most sheltered beaches. The small range of indentation suggests that similar factors may control their morphology. Tectonism is an important factor that controls pocket beach formation in Crete. Statistically high correlations was found between beach embaymentization indices, a) ratio between bay indentation and headland spacing a/R_o, and the ratio between embayed shoreline and headland spacing (S_1/R_o). Also between headland spacing Ro with beach length (S_2) and Beach area A_r and Beach length S_2 and sheltered beach length S_3. Related to the stability of beaches, the majority of the beaches present that are in equilibrium with natural processes. The few beaches that fall below the stability curve, belong to the North coast of the central tectonic section, which is subjected to subsistence. Beaches under the stability curve also host man-made structures. Low embayment scaling values ($\delta'>10$) indicate wide beach exposure (R_o) and high H_b per relative short shoreline (S_1). As the scaling class increases the beach exposure (R_o) and the wave breaking height H_b decrease. Finally, low scaling beaches receive more energy. Cretan pocket beaches display a small range of indentation index values. Beaches become shorter with increasing bay indentation, while wider exposure seems to be related to an increase beach length. More than half of the Cretan pocket beaches are lacking of "sediment supply" in their embayment. The most indented class has the highest values for S_1/R_o and low S_2/S_1, indicating the best shore protection. The least indented pocket beaches show the opposite values (high S_1/R_o, low S_2/S_1). Based on the equilibrium status, most of the beaches are currently in a stable mode. Exception are a few beaches which are mainly influenced by man-made structures. The majority of beaches in central tectonic section are in low indented class, this may be related to landmass subsidence. Beaches with low scaling parameter, are those confronted by high wave energy. Based on their erosion vulnerability most of the beaches are classified as medium vulnerable.

References
1 - Bowman, D., Rosas, V., Pranzini, E., 2014, Pocket beaches of Elba Island (Italy) - Planview geometry, depth of closure and sediment dispersal Estuarine, Coastal and Shelf Science, 138, 37 – 46.
2 - Alexandrakis, G., Ghionis, G., Poulos, S.E., and Kampanis N.A., 2013. Greece, in Coastal erosion and Protection *In* Europe: A Comprehensive Overview, E. Pranzini, A. T. Williams (Eds.), Earthscan Ltd, London, UK, 355-377
3 - Klein, A.H.F., Menezes, J.T., 2001. Beach morphodynamics and profile sequences for a Headland Bay Coast. J. Coast. Res. 17, 812-835.
4 - Alexandrakis, G., and Poulos, S.E., 2014. An holistic approach to beach erosion vulnerability assessment. Sci. Rep. 4, 6078.

SHALLOW FAULT DISTRIBUTION AND DEFORMATION PATTERN IN THE STRAIT OF MESSINA, SOUTHERN ITALY

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Abstract
Newly collected high-resolution seismic data allowed mapping fault patterns in the Strait of Messina. Several transtensional faults were identified in the inner Strait but these faults seem to be too short for generating large earthquakes, such as the Messina earthquake of Dec. 28, 1908 (Mw=7.1). A prominent E-W-trending transtensional fault zone was identified in the outer Strait. It is the only fault system with a clear surface expression. We consider this fault zone as potential source for tsunamis.

Keywords: Geophysics, Messina Strait, Geohazards

The continental margins of southern Italy are located along converging plate boundaries, which are affected by intense seismicity and volcanic activity. Most of the coastal areas experienced severe earthquakes, landslides, and tsunamis in historical and/or modern times. The most prominent example is the Messina earthquake of Dec. 28, 1908 (Mw=7.1; 80,000 casualties), which was characterized by the worst tsunami Italy experienced in historical times (~2000 casualties). However, no general agreement has been archived on the seismogenic/tsunamigenic faults, mainly because the tectonics of the Messina Strait is still unclear.

New hydroacoustic and high-resolution 2D-reflection seismic data were collected during RV Meteor Cruise M86/2 in the Strait of Messina in Dec 2011/Jan 2012 in order to investigate the fault pattern in the Strait of Messina. The data suggest that the inner Messina Strait is a triangular graben. Surface faults in the graben strike in N-S and E-W directions. The N-S-trending surface faults are right-lateral transtensional faults distributed along the Messina Canyon and the coastline off southern Calabria, dipping toward the Messina Canyon. E-W-trending surface faults are left-lateral transtensional faults and located in the northern inner Messina Strait off Calabria. Most of them dip toward the south. Several surface faults fit to the suggested focal mechanisms of the 1908 Messina earthquake, but we were not able to identify the master fault of this event because the superficial expression of all mapped faults was too short for generation a magnitude 7.1 earthquake.

A prominent fault zone has been discovered in the outer Strait (Fig. 1), which is located in the area supposed to be the source of the 1908 Messina tsunami. It is a 30 km long E-W-trending left-lateral transtensional fault zone. The master fault of this system has a clear surface expression, which is marked by a 60 m-high morphological step (SF21 in Fig. 1). We consider this fault as being active. Tsunami modelling showed that this fault would produce significant tsunamis with assumed vertical slip rates of 5 m. A vertical slip of up to 15 m could generate a tsunami comparable to the 1908 Messina tsunami, but we discard this fault zone as a source for the 1908 Messina tsunami, because an E-W-trending fault is not in agreement with levelling and microseismic data of the 1908 Messina earthquake; moreover a 15 m slip event is highly unlikely. However, we still consider this fault as a hazard source in Southern Italy, because it shows the most obvious vertical displacement in the entire Messina Strait and seems to be active.

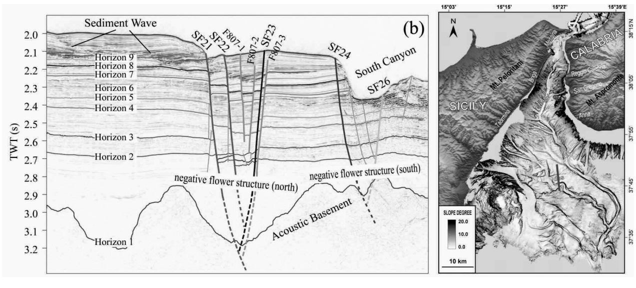

Fig. 1. Seismic profile almost perpendicular to the described fault zone in the outer Strait of Messina. SF21 is the master fault showing a clear surface expression. Map shows location of profile

References

1 - No references

MONITORING OF MEDITERRANEAN VOLCANOES ACTIVITY THROUGH SEAFLOOR MULTIPARAMETRIC MEASUREMENTS

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Abstract
The presence of a wide variety of volcanoes in the central Mediterranean Sea is such that this is considered a particularly active and dangerous area. The objects of this study are three main volcano systems in this area: Etna , Stromboli and Marsili Seamount. The first two are sub-aerial volcanoes but have significant parts of their structures under the sea, while the Marsili Seamount is completely submerged. This work presents an overview that shows how multiparametric measurements performed through seafloor observatories of EMSO, can bring a real benefit volcano hazard assessment.

Keywords: Geohazards, Mediterranean Sea

Seafloor fixed-point multidisciplinary observatories offer new possibilities in the detection of signals associated with volcanos on different time-scales. They allow for extensive and long-term synchronous measurements of signals from different sensors (multi-parameter), including instruments that are less commonly used for volcano monitoring, such as gravimeters, magnetometers, and Acoustic Doppler Current Profilers (ADCPs). Gravimetric on-land volcano monitoring is not routinely performed and is even more rare at the seafloor due to the technological challenges related to the marine environment. Nevertheless, density variations inferred from gravity observations can be used to better understand processes such as magma and fluid mass redistribution within the volcano apparatus [1]. Gravity signal variations can also be linked to degassing processes in hydrothermal systems [2] and, together with seismological and magnetometric data, provide helpful information on these systems. Magnetic measurements give important information on sub-seafloor magnetic and electrical properties, in terms of magnetization and conductivity. The resistivity structure underneath the observation area can be deduced from the observed geomagnetic field. Magnetic field variations can be caused by transport of conductive fluids in a hydrothermal system [3]. Oceanographic parameters, such as the echo intensity measured by ADCP, can supply information on volcanic ash dynamics in seawater. Actually, this data is mostly used to monitor sediment and turbidity fluxes in rivers and coastal areas [4], but it was applied to the detection of ash fallout in seawater during the 2013 Etna explosive activity. Thanks to a multiparameter approach we were able to document the whole chain of events, from the explosion, the ash emission, to the fallout in the water column, and finally to its sedimentation at the benthic layer. In cases where the volcanoes have part of their structure under the sea, observation from the seafloor is necessary to complement land and satellite observations, as in the case of Stromboli and Etna volcanoes. By contrast, remote sensing from the seafloor is an obvious necessity in the case of a submerged volcano that has activity undetected from land, such as the Marsili Seamount. Seismological and gravimetric data acquired by seafloor observatory, suggested that the Marsili Seamount shows signals that are typically associated to hydrothermal activity. In particular, Short Duration Events were observed during a variation in gravity and an increase of high frequency seismic noise. Although these gravimetric variations have been observed only a few times at Marsili during the recording period, similar signals have been detected at other volcanoes, including Etna and Stromboli, and have been linked to mass rearrangement within the volcano.

References
1 - Battaglia, M.; Gottsmann, J.; Carbone, D.; Fernández, J. 4D volcano gravimetry. Geophysics 2008, 73, WA3–WA18.
Gottsmann, J.; Carniel, R.; Coppo, N.; Wooller, L.; Hautmann, S.; Rymer, H. Oscillations in hydrothermal systems as a source of periodic unrest at caldera volcanoes: Multiparameter insights from Nisyros, Greece. Geophysical Research Letters 2007, 34. Johnston, M.J. Volcano-Electromagnetic Effects. In Encyclopedia of Geomagnetism and Paleomagnetism; Springer, 2007; pp. 984–987. Gostiaux, L.; Van Haren, H. Extracting meaningful information from uncalibrated backscattered echo intensity data. Journal of Atmospheric and Oceanic Technology 2010, 27, 943–949.

COUPLED VOLCANO EDIFICE- AND CONTINENTAL MARGIN DEFORMATION AND INSTABILITY AT MT ETNA, ITALY

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Abstract

Mt Etna's volcano edifice, known as Europe's largest volcano, reveals a large-scale instability at its eastern flank. In order to investigate the extension of this deformation and coherent instability, a new high-resolution 2D/3D reflection seismic dataset was acquired during research cruise M86/2. The dataset shows in high detail the deformation pattern at the submerged continental margin offshore Mt Etna. The limits of the continental margin's deformation were identified by transpressional and compressive tectonic structures. Based on the new dataset and available onshore data, we propose a coupled volcano edifice and continental margin deformation, leading to a large-scale on- and offshore instability.

Keywords: Geohazards, Ionian Sea, Tectonics, Volcanology

Mt Etna is Europe's largest volcano (3323 m a.s.l.), which was established on the eastern coast of Sicily ~500 ka ago. Gravitational instability on Mt Etna's volcano edifice was first described by Borgia et al. (1992). Due to a lack of marine geological and geophysical data, the extension of this instability in the direction of the submerged volcano flank and continental margin was only recently considered and investigated. Chiocci et al. (2011) presented the first multi-beam bathymetry map of the submerged continental margin offshore Mt Etna, showing a complex morphology that differs significantly from Sicily's continental margin not affected by the volcano buildup. Chiocci et al. (2011) proposed a large-scale continental margin instability, linked to an ancient large-scale slope failure. Based on 2D reflection seismic profiles, Argnani et al. (2013) presented deep and shallow seated extensional deformation patterns at the continental margin. Nevertheless, Argnani et al. (2013) did not observe any clear evidence for the limits of this deformation.

In order to investigate the deformation of the continental margin in detail, a high-resolution 2D/3D seismic dataset was acquired during research cruise M86/2 (December 2011 - January 2012).

The 2D seismic profiles reveal a complex tectonic setting, dominated by extensional faulting on the continental margin. The eastern limit of the deformation is characterised by two major N-S trending anticlines (Fig. 1), revealing syn-tectonic activity. The northern boundary of the deformed margin is marked by a stratigraphic disconformity at Riposto Ridge (Fig. 1). The southern boundary of the system is displayed by a positive flower structure, indicating a deep-seated transpressional fault. This fault system can be traced by a prominent morphological lineament from the continental margin towards the onshore observed southern fault system. A high-resolution 3D P-Cable seismic dataset reveals the deformation of the boundary between Valle di Archirafi and a prominent amphitheater-like structure (Fig. 1).

The data suggest a strong link between the tectonic system of the Timpe Fault System onshore and the head of the amphitheater-like structure offshore. As most of the faults are traceable to the seafloor, we suggest that this system is highly active. Furthermore, a domino-style fault system, dipping towards the headwall of the amphitheater, was identified. This implies high activity of this tectonically-controlled system. As tectonic lineaments and structures can be traced from the volcano edifice to the continental margin, we propose a coupled volcano edifice and continental margin instability.

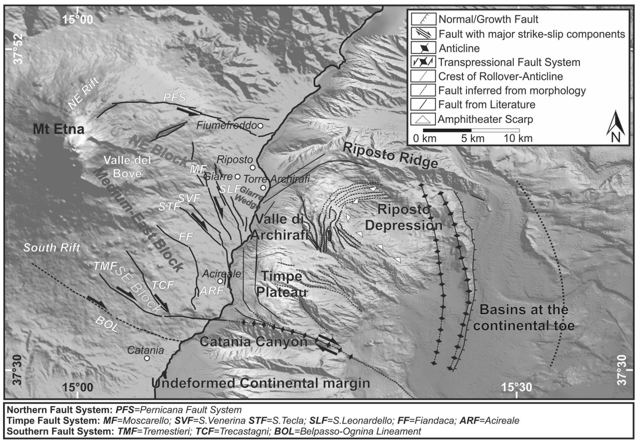

Fig. 1. New morpho-tectonic map of the onshore volcano edifice and the submerged continental margin.

References

1 - Argnani, A., Mazzarini, F., Bonazzi, C., Bisson, M., Isola, I., 2013. The deformation offshore of Mount Etna as imaged by multichannel seismic reflection profiles. Journal of Volcanology and Geothermal Research 251, 50–64.

2 - Borgia, A., Ferrari, L., Pasquarè, G., 1992. Importance of gravitational spreading in the tectonic and volcanic evolution of Mount Etna. Nature 357, 231–235.

3 - Chiocci, F. L., Coltelli, M., Bosman, A., Cavallaro, D., 2011. Continental margin large-scale instability controlling the flank sliding of Etna volcano. Earth and Planetary Science Letters 305, 57–64.

SUBMARINE CANYONS OF THE SEA OF MARMARA

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Abstract
Numerous canyons are distributed on the steep slopes (>10º) of the ~1250 m-deep transtensional Marmara basins, which are developed between the splays of the North Anatolian Fault. The canyons are commonly short (1-3 km), except for a few canyons which are up to 50 km long. The canyons started forming by tectonic and erosional processes mainly during the Plio-Quaternary, but their subsequent evolution was strongly influenced by climatically controlled Quaternary cyclic sea (lake) level changes.

Keywords: Marmara Sea, Canyons, North Anatolian Fault, Sea level

The Sea of Marmara, located on a continental transform-fault plate boundary between the Eurasian and Anatolian-Aegean plates, is a tectonically very active basin (figure 1). As in the case of all the active tectonic continental margins around the world, the Sea of Marmara margins are incised by a number of submarine canyons. East of the Sea of Marmara, the North Anatolian Fault (NAF) forming the transform plate boundary splays into branches and accommodates a total of ~2.5 cm/year dextral motion.

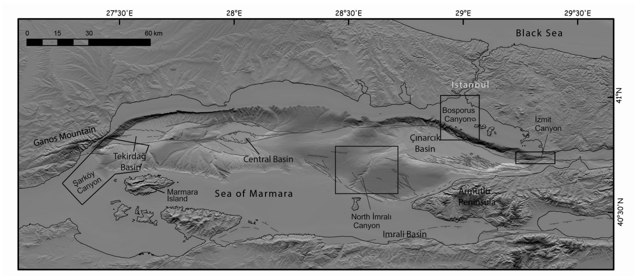

Fig. 1. Morphotectonic map of Sea of Marmara showing the submarine canyons and active faults (red lines). EM300 bathymetry from [1] and active faults modified after [2].

The Sea of Marmara continental margins are marked by numerous submarine canyons. Their length is mostly limited by the width of the continental slope, which varies from 1 to 3 km [3, 4], except for the Izmit, North Imrali Sarköy canyons which are 36, 33.5 and 50 km long (figure 1). The southern slopes of the Tekirdag and Central basins with low slope angles have the longest, widest (1-3 km) and deepest (up to 400 m) submarine canyons, whereas the northern continental slope of the Çinarcik Basin and northwestern slope of the Tekirdag Basin with steep slopes (up to 29º), are short (1-2 km long) and narrow (few hundred metres) [3].

Most of the Sea of Marmara canyons have a straight course, extending from the shelf edge to the base of the continental slope. The only exception is the North Imrali Canyon on the southern slope of the Çinarcik Basin, which is sinuous (figure 1). All the canyons are associated with erosional gullies. Some canyons show branching towards the shelf edge. Others are characterized by arcuate head scars near the upper slope-shelf edge area in the north and on southern slope of the Tekirdag Basin (figure 1). Some large canyons are located on the faults and are associated with submarine landslides near their junctions with the deep basins (e.g., Izmit and Sarköy Canyons) (figure 2). The Sarköy and the Istanbul (Bosporus) canyons are connected with the outlets of the Çanakkale (Dardanelles) and Bosporus straits on the shelf. They evidenced the passage of large water masses between the Mediterranean Sea and Black Sea and their morphology was strongly modified by erosional and *depositio*nal processes, especially during interstadials and melt water pulses, when one-way flow regime operated from the Black Sea through the straits and the Sea of Marmara.

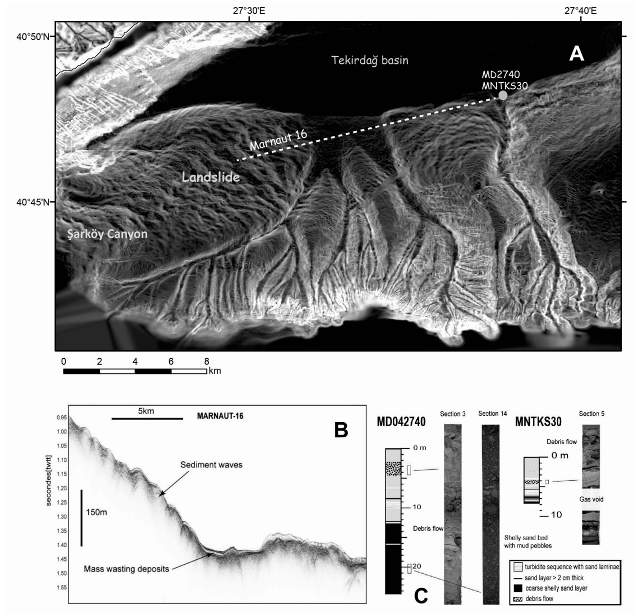

Fig. 2. (A) Slope gradient map of north of Marmara Island, southern slope of Tekirdag Basin, showing the canyons including the lower course of the Sarköy Canyon. The canyons appear to merge and open to Tekirdag Basin. Also seen is Ganos Landslide Complex to the west overlying strike slip Ganos Fault. (B) Chirp subbottom profile across the slope of the landslide and mouths of canyons, showing the transparent mass-wasting deposits. (C) Cores located at the mouth of canyons containing debris flow deposits (modified after [3]).

The sinuous North Imrali Canyon most probably developed at the shelf extension of the Kocasu River by erosive activity of the turbidity currents (figure 1). Mass wasting and turbidity current activity in the canyons were more frequent and effective during the periods of low sea level and transition from lacustrine to marine conditions in the Sea of Marmara.

References
1 - Le Pichon, X. et al. (2001). The active main Marmara fault: Comparative anatomy of a continental transform fault in a marine setting. *Earth Planet. Sci. Lett.*, 192: 595-616.
2 - Armijo, R et al. (2005). Submarine fault scarps in the Sea of Marmara pull-apart (North Anatolian Fault): implications for seismic hazard in Istanbul. *Geochem., Geophys., Geosyst.*, 6: 1-29.
3 - Zitter et al. (2012). Distribution, morphology and triggers of submarine mass wasting in the Sea of Marmara. *Mar. Geol.*, 329–331:58–74.
4 - Cagatay et al. (2015). Submarine canyons of the Sea of Marmara. *In*: Submarine Canyon Dynamics. CIESM Workshop Monographs no.47, pp. 123-135.

CIESM Congress Session : High-Resolution seabed mapping
Moderator : Jean Mascle, GeoAzur, France

Moderator's Synthesis

This session was attended by about 25 scientists, but due to ongoing, important swath mapping activities still going on in same period in the Mediterranean, only four communications could be presented. As moderator I decided to switch my own presentation and dedicate it to stress the interests and benefits to conduct systematic swath mapping and to share the results with the community in the form of syntheses, as promoted and supported by CIESM in the past decade.

Up to now the Mediterranean Sea is the only regional sea to be the subject of morphological syntheses based on the use of this tool. Even if EC efforts now attempt to better share this type of data (see www.emodnet.eu/), the efforts conducted in the framework of CIESM should continue. We recommend the following sequence:

1. Complete swath mapping of the Mediterranean Sea as far as possible in order to produce a map at the best resolution (100 m DTM?) including the continental shelf in the frame of cooperation (CIESM)
2. Select specific target areas to illustrate and study various active processes such as sedimentary, tectonic, salt tectonic, brines, mud volcanoes and seeps, coral mounds, magmatic sites, archeological sites, etc..
3. Perform near bottom swath mapping to produce maps at very high resolution (up to 50 cm if possible)
4. Initiate dedicated and focused programs
5. In certain cases (geohazards) repeat near bottom swath mapping during several years.

MICRO-REEF MORPHOLOGY IN THE SEMI-ENCLOSED SHALLOW EMBAYMENTS OF LESVOS ISLAND, NE AEGEAN SEA, GREECE

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Abstract
Unique morphological features have been detected in Kalloni and Gera embayments in Lesvos Island. The observed micro-reefs consist of benthic assemblages over a very soft mounded substrate and their comparison in both study areas show similarities as well as few contrasts. Their peculiar relief probably results from the combination of the regional oceanographic conditions, slow fluid seepage, surrounding tectonics and nutrient inputs from the adjacent drainage systems.

Keywords: Aegean Sea, Acoustics, Coastal systems, Geomorphology, Mollusca

Introduction - Methodology
The Gulfs of Kalloni (~110 km^2) and Gera (~42 km^2) are two semi-enclosed shallow (< 20 m depth) embayments located in the SW and SSE sides of Lesvos Island (Fig. 1), which is characterized by intense tectonic and hydrothermal activity. Both gulfs are connected with the Aegean Sea through elongated channels (Kalloni having the deepest but shortest channel) and they receive discharges from seasonal streams/small rivers. Currents have been found to be more intense close to the gulfs entrances [1,2]. Bathymetric (echo-sounder) and high resolution geophysical (side scan sonar and subbottom profiler) surveys were conducted for the detection of the regional geomorphology. Scuba diving, a drop down camera system and sediment sampling were also employed to ground-truth the geophysical results.

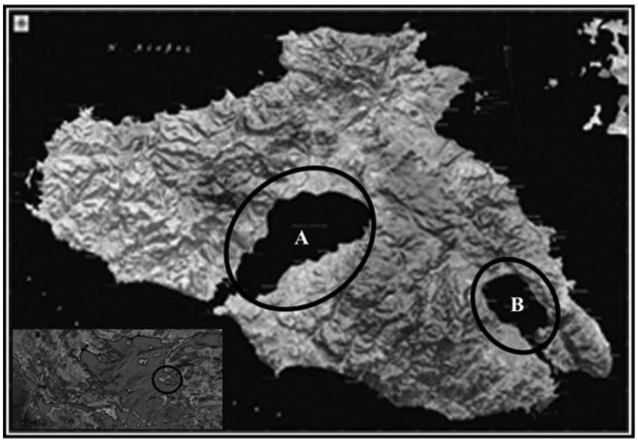

Fig. 1. Location of Lesvos island and of Kalloni (A) and Gera (B) Gulfs.

Results and Discussion
The main morphological features identified are numerous small reef structures that populate the seafloor (Fig. 2). They generally appear in water depths deeper than ~12 m and occur individually or coalesce, locally forming elongated features. Their height is < 6 m in Kalloni, occurring mainly at the centre of the Gulf, whereas in Gera they are < 2.5 m having a more expanded distribution, with the highest occurring near the Gulf entrance. Based on their morphological characteristics, they appear to have either symmetric or asymmetric structure, locally being more composite, and in Kalloni they are often followed from small and shallow (0.5-1 m) depressions around their base. Small pockmarks are also randomly observed. Subbottom profiles in both gulfs show the presence of an almost homogeneous surficial layer (Holocene) that overlies almost concordantly earlier sedimentary units. The bottom-echo becomes more intense at the top of the hummocks. Acoustic anomalies such as enhanced reflectors, turbid zones and small plumes, mainly within the surficial layer, imply the potential presence of fluids in the sediments. Of great interest is the detection of similar buried micro-relief structures in the surficial layer (Fig. 2), located at the boundary of the transgressive and highstant system tracts, implying physical conditions favouring their growth the last ~5500y. Camera images and seabed sampling in both Gulfs revealed that the reefs consist of assemblages of molluscs (mainly) of various sizes in a fine muddy sediment matrix. Scuba diving along the two highest observed reefs in Kalloni revealed holes, being ~ 30 cm in diameter. Conditions that favour the micro-reef formation in both gulfs are probably related to the (a) local hydrodynamics [1,2], (b) slow seepage of fluids (gas, water, hydrothermal fluids) that has been reported elsewhere to be connected with high concentration of bivalves and other benthic life [3], (c) local geology and tectonics (fault-controlled gulfs) [4] and (d) nutrients supply from the surrounding land areas [5].

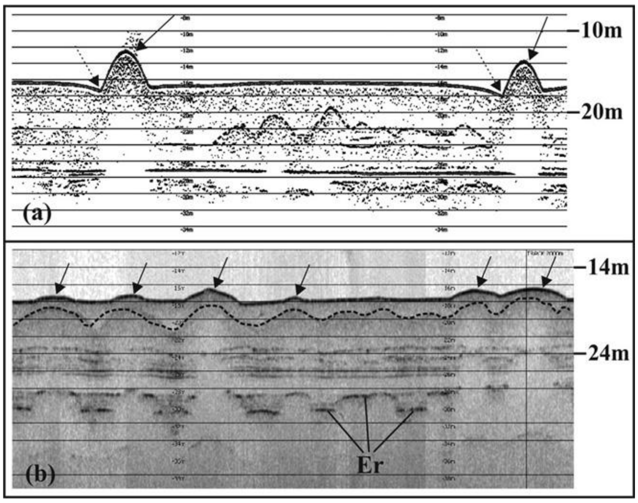

Fig. 2. High resolution subbottom profiles in Kalloni (a) and Gera (b) Gulfs showing the micro-reef morphology (arrows), shallow depressions (dashed arrows) and buried micro-relief structures (dashed lines). Er: enhanced reflectors due to fluid presence in the sediment pores.

References
1 - Kolovoyiannis, V. and Tsirtsis, G., 2005. Implementation of a high resolution, 3 dimensional, hydrodynamic model to a shallow, semi – enclosed water body, Gulf of Gera – Lesvos. *Proceedings of the 9th International Conference on Environmental Science and Technology*, pp. 791-797.
2 - Millet, B. and Lamy, N. (2002). Spartial patterns and seasonal strategy of macrobenthic species relating to hydrodynamics in a coastal bay. *Rech. Océanographique*, vol 27(1): 30-42.
3 - Judd, A. and Hovland, M., 2007. Seabed Fluid flow. Cambridge University Press, pp. 492.
4 - Anagnostou, C. and Sioulas, A., 1989. A sedimentological study of the gulf of Gera (Lesvos) and the possible anthropogenic influence in the geochemical cycle of the region. *Bull. Geol. Soc. Greece*, vol. XXIII, pp.193-207.
5 - Arhonditsis G., Tsirtsis G., Karydis, M. 2002. The effects of episodic rainfall events to the dynamics of coastal marine ecosystems: applications to a semi-enclosed gulf in the Med. Sea. *Journal of Marine Systems*, 35, 183-205.

A NEW MORPHO-BATHYMETRIC MAP OF THE EASTERN MEDITERRANEAN SEA

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Abstract
We present a new morpho-bathymetric compilation of the Eastern Mediterranean Sea basins. This map, based on DTMs at 100m from different swath bathymetric surveys, allows to illustrate, and discuss, most of the active geological processes actually operating within the various basins and particularly well expressed on the sea floor. Moreover the map may be used as a bathymetric background to better constraint deep current circulation and gyres as well as various physical modeling (tsunamis for example); the document could be also very useful for planning detailed oceanographic surveys (such as fluid systems, deep sea ecosystems, etc.…).

Keywords: Mapping, Bathymetry, Geomorphology, Levantine Basin, Mediterranean Sea

Following previous morpho-bathymetric syntheses of the Mediterranean Sea at a 500- meter grid [1, 2], we have compiled a new morpho-bathymetric synthesis of the Eastern Mediterranean using digital terrain models (DTMs) based on a 100-meter grid. The various DTMs have been generated using data provided by several Mediterranean Institutes, and collected using different swath bathymetry systems. One may estimate that 90% of the seabed, extending by water depths higher than 2000m, have now been mapped using these swath systems despite difficulties issued from EEZ claims.

The aim of this scientific synthesis is chiefly to illustrate, in details, the various morphological features resulting from the different (sedimentary, tectonic, geochemical, magmatic, etc.) active geological processes operating on the major physiographic domains, which characterize the Eastern Mediterranean Sea: the Calabria outer arc (Ionian Sea), the Mediterranean Ridge [3] (most of the central Eastern Mediterranean basin), the Nile sedimentary cone and the Eratosthenes seamount (south of Cyprus) [4].

For areas not yet mapped by swath bathymetry the synthesis has been completed by data extracted from the GEBCO and the EMODNET Project DTM files.

A few artifacts, introduced by the use of these large scale files, can be detected along most of the continental slopes not yet mapped in details, as well as for example in the southern domain of the Adriatic Sea. Similarly it has not been possible to systematically adjust a few, but non-linear, discrepancies in Z values between various DTM files. Such differences result from the use of data collected by swath systems operating at different frequencies and/or from minor differences in seawater sound velocity corrections. This map of the Eastern Mediterranean Sea illustrates, despite a few artifacts, the results of active geological processes at levels of details never reached so far.

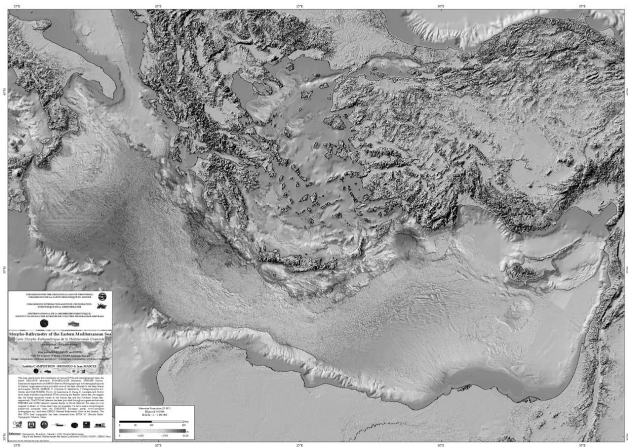

Fig. 1. Morpho-bathymetric synthesis of the Eastern Mediterranean Sea (DTM at 100 meter). This detailed synthesis allows the observation of seabed images of many active geological processes participating to the present-day shaping of the seafloor of the Eastern Mediterranean basins and margins.

References
1 - Loubrieu, B., Mascle, J., and MediMap group, 2005, Morphobathymetry of the Mediterranean Sea. Two sheets: the Western Mediterranean sea, the Eastern Mediterranean sea, CIESM/Ifremer special publication.
2 - Brosolo, L., Mascle, J., Loubrieu, 2012, Morpho-bathymetry of the Mediyerranean Sea, CCGM/UNESCO, publisher Monaco.
3 - Huguen C., Chamot-Rooke N. , Loubrieu B. , Mascle J., 2006, Morphology of a pre-collision, salt-bearing, accretionary complex: The Mediterranean Ridge (Eastern Mediterranean), Marine Geophys. Research, 27, 61-75.
4 - Sardou, O. et Mascle, J., 2003, Cartographie par sondeur multifaisceaux du delta sous marin profond du Nil et des domaines voisins. Deux cartes (Morphobathymétrie et mosaiques d'images acoustiques, CIESM Publisher, Monaco .

MORPHOLOGICAL DESCRIPTION OF THE SOUTH EASTERN CYPRUS OUTER SHELF AND SLOPE REGIONS (EASTERN MEDITERRANEAN)

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Abstract
We present here the first results of the analysis and interpretation of the swath bathymetry and side scan sonar data collected along the southeastern outer shelf and upper slope regions of the Cyprus insular margin (offshore Cape Greco). The resultant bathymetric model and the derivatives (e.g.: slope, aspect, benthic position index) are presented and analyzed in order to describe the morphology of the seabed and the main geomorphological features through quantitative indicators including morphometric indexes and statistical descriptors. The presence of deep sea coral communities (*Dendrophylia ramea*) in a particular location of the surveyed area is also discussed and tentatively related to the landscape morphology where the colonies are settled.

Keywords: Canyons, Deep sea corals, Geomorphology, Swath mapping, Cyprus Arc

Introduction
Although the complex geological setting of the Cyprus Island has been the subject of numerous studies inshore, most of them focused on Troodos massif and its singular ophiolite complex, the corresponding insular margin has been barely surveyed. Most of the Cyprus insular shelf and upper slope regions still remain to be mapped through modern acoustic methodologies like multibeam echosounder and side scan sonar.

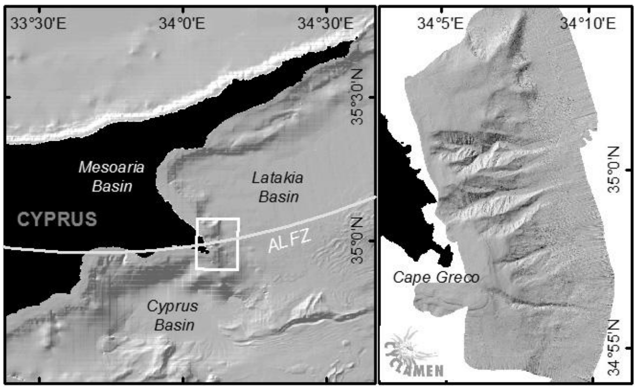

Fig. 1. **Surveyed area and location Map**. Amanos-Larnaka Fault Zone (ALFZ). Bathimetric data in the location map are from EDMONET [5].

We present here the first results of a multibeam survey conducted along the outer shelf and slope sectors of the southeastern insular margin offshore Cape Greco. The study area is located among three basins; the Latakia Basin to the East, the Mesaoria Basin to the West (currently emerged) and the Cyprus Basin to the South. This margin is crossed in an East-West direction by the Amanos-Larnaca Fault zone [1] extending from the Amanos mountains in Turkey to the Troodos ophiolitic complex in Cyprus and presenting a remarkable graben structure offshore Cape Greco. The resulting Digital Elevation Model (DEM) shows the Cyprus southeastern insular margin from 60 to 800 m depth (Fig 1).

The continental shelf is narrow (up to 3 km) and the shelf break is around 100 m deep. The average slope of the surveyed shelf is 1º and it varies from 0.5º to 2º along the surveyed area. The shelf break along the northern part of the surveyed region is diffuse whereas it becomes sharper towards the south, where at least two terraces at the depths of 110 m and 160 m are evident. Four main submarine canyons, interpreted as controlled by a retrograding evolution, are present along the mapped slope, displaying an 8 º steep average gradient. Retrograding canyons generally start to develop along the lower slope regions and migrate towards shallow depths through punctual turbiditc flows and stacked mass wasting events [2]. In the surveyed area some of the canyons reach the shelf edge, demonstrating a relatively mature stage whereas some other are poorly developed [3]. A general evolutionary trend shows the northernmost canyons as more developed features. The two canyons located at the upper latitude are wider, more incised, and present three tributaries and a rather sinuous axis. Few small landslide scars were also observed in this area. The southern canyons present a single strait axis (Fig 1). The surveyed insular glacis slope is about 2º and no remarkable features are present on it.

As the Amanos-Larnaca Fault zone crosses the study area in the same direction of the canyon axis, it is reasonable to infer a tectonic control of the canyon orientation [4]. High densities of deep sea corals *D. ramea* are present in a particular area of the slope with a priori no significance differences to other areas in terms of water composition, light availability or exposure to hydrodynamics. Slope, orientation and depth threshold, among other morphometric parameters have been analyzed in order to find any singularity.

Acknowledgements
This work has been supported by the TOTAL foundation (CYCLAMEN project, reference: BIO_2014_091_Juin_CS-8). The CYCLAMEN partners are: Instituto Español de Oceanografía, and Universitat de Barcelona both in Spain; The Cyprus Institute, and Enalia Physis Environmental Research Centre, both in Cyprus; Aix Marseille Université; Institut Méditerranéen de Biodiversité et d'Ecologie marine et continentale; France; Centre Scientifique de Monaco, MONACO; National Oceanography Centre, United Kingdom; Hellenic Centre for Marine Research, Greece. Special thanks to Captain, officers and crew of the RV AEGAEO for their valuable work and comradeship during the survey.

References
1 - Hall J, Aksu AE, Calon TJ, Yasar D. Varying tectonic control on basin development at an active microplate margin: Latakia Basin, Eastern Mediterranean. Mar Geol. 2005 Oct;221(1-4):15–60.
2 - Pratson LF, Coakley BJ. A model for the headward erosion of submarine canyons induced by downslope-eroding sediment flows. Geol Soc Am Bull. 1996 Feb 1;108(2):225–34.
3 - Harris PT, Whiteway T. Global distribution of large submarine canyons: Geomorphic differences between active and passive continental margins. Mar Geol. 2011 Jul 1;285(1–4):69–86.
4 - Follows E, Robertson A. Sedimentology and structural setting of Miocene reefal limestones in Cyprus. Ophiolites Ocean Crustal Analog Nicos Cyprus Geol Surv Dep Minist Agric Nat Resour. 1990;207–16.
5 - EMODnet Bathymetry portal - http://www.emodnet-bathymetry.eu.

CASE STUDY OF HABITAT MAPPING FOR ENVIROMENTAL ASSESSMENT IN CIVIL ENGINEERING

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Abstract
This is an example of coastal management and environmental surveillance where geophysical, biological and oceanographic disciplines are geographically linked through Geographic Information Systems in order to evaluate and minimize the environmental impact of civil engineering. Operational needs of the harbor of Maó force the recurring dredge of the harbor what means a potential environmental impact of the seabed, not only in the harbor area where seafloor is already altered by human activity, but in the spoils dumping site as well.

Keywords: Gis, Coastal management, Mapping, Geomorphology, Balearic Islands

Introduction
The Instituto Español de Oceanografía was commissioned to assist in the environmental observation of civil engineering operations related to the Maó harbor refurbishment that took place during spring and summer of year 2014. Among other working groups focused on the monitoring of seagrass meadows, intertidal zone, costal circulation and the presence of pollutants in fisheries and aquaculture, a working group concerning insular shelf habitat mapping and monitoring was established [1].

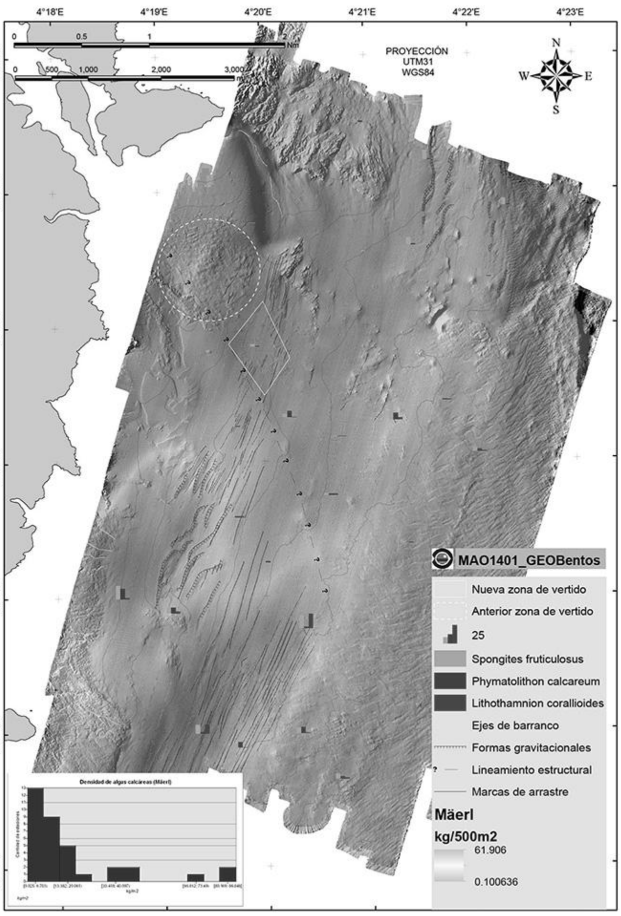

Fig. 1. **Map of the study area.** Digital elevation model from mutibeam bathymetry data. Seabed colour show mäerl densities in kg / m^2. Histograms show densities of Spongites fruticulosus, Phymatolithon calcareum, Lithothamnion corallioides in each sampling location.

Two surveys were planned in order to assist in the environmental monitoring of the seabed were the dumping site was considered. First one with the aim of determine the previous conditions of the seabed, and suggest the best location of the precise dumping site within the considered area. The second survey, after the dredging works, was needed to evaluate the impact of the spoils.

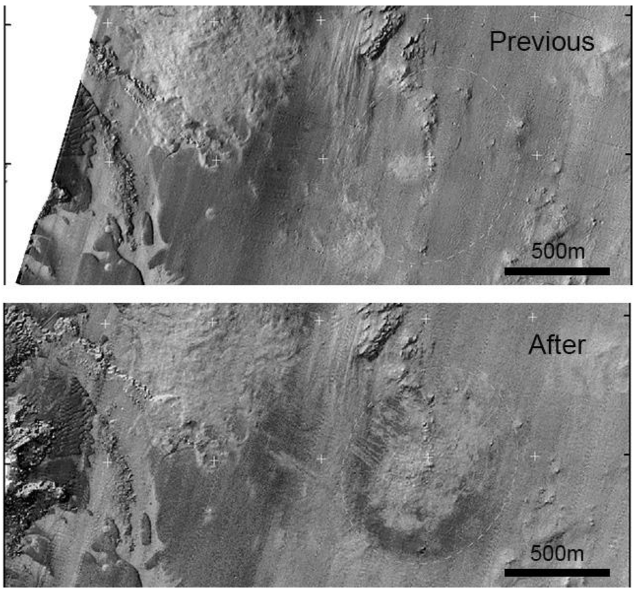

Fig. 2. **Disposal site.** Backscatter of the same area before and after the disposal of dredge spoils.

The two swath bathymetry data sets show previous dredge spoils and trawl marks and allow us to determine the volume and extension of the current spoils. Sediment sampling using a Van-Veen dredge, and benthic fauna sampling using a beam-trawl lead us to map the middle and inner shelf maërl community through geostatistical tools. The methods and resultant maps are discussed in detail through this work.

Acknowledgements
Data sets shown and discussed throughout the text and figures were obtained in two surveys conducted by the Instituto Español de Oceanografia (IEO) on board the R/V F. de Paula Navarro (“IEO Fleet”, 2015); we thank the crew for their help and comradeship during both surveys. Special thanks to the Port Authority of the Balearic Islands for their permission to use this material.

References
1 - Massutí, E., Santaella-Álvarez, E., et al. 2014. Revisión y Control del Plan de Vigilancia Ambiental de las obras de dragado del Puerto de Maó.

CIESM Congress Session : Paleoceanography

Moderator : Wolf-Christian Dullo, GEOMAR, Kiel, Germany

Moderator's Synthesis

Paleoceanography needs more interdisciplinarity. After global data and observations, we need to strengthen regional observations in order to better validate models and redefine models. Models are still too „rough“. Chemical paleoceanography will certainly improve our understanding, but still better proxies are needed, e.g. paleotemperature for ocean volume, or any proxy for paleo-alkalinity and paleo-salinity. The present tools are a rough approximation and leave room for much speculation. the calibration of existing and new proxy tools has a high priority.

New perspectives arise from the physics of the ocean, such as internal waves and cascading processes of dense water masses. How can we prove the existence of theses processes in the paleo record?

Lead and lag problems. Globally we know such phenomena. A leading Arctic and a lagging Antarctic and vice versa. However, what is the leading process to form sapropels in the Med. Biology or chemistry or physics and what lags physics or biology. In other words what is driving the system.

Final point: What is a pristine state of the Mediterranean ? Is there a time in the paleo record, to which we can ascribe what would be a pristine state for the modern Mediterranean as an equivalent What is the natural state of the Mediterranean and when was that? After the LGM? Early Holocene? Mid Holocene?

MO AND U ISOTOPES IN A FERRUGINOUS LAKE: AN ANALOGUE FOR THE PROTEROZOIC OCEAN

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Abstract

Authigenic trace metal enrichments, as well as Mo and U isotope systematics, have attracted attention as a tool for reconstruction of ocean redox structure through Earth's history [1]. However, the main controls on such redox proxies need to be verified in modern analogues of past ocean environments. Due to the highly oxygenated modern atmosphere, analogues for ancient anoxic oceans are rare, particularly for times when conditions were likely to be enriched in dissolved iron [2]. We have measured the Mo and U isotopic composition in tributaries, sediments, water column and sinking particles in a meromictic and ferruginous lake (Lake Pavin, France) to understand the behaviour of U, Mo and their isotopes in an environment akin to the Precambrian ocean.

Keywords: Anoxia, Ocean history, Anoxic basin, Black Sea

Results and Discussion

The lake is characterised by low Mo and U concentrations in the water column compared to the open ocean, exhibiting Mo and U depletion below the redox/chemocline down to approx. 75 to 80 m depth, and increasing dissolved Mo and U concentrations towards the bottom of the lake (max. 90 m depth). Molybdenum isotopes (δ^{98}Mo) show large and systematic variations within the stratified water column.

The upper oxic lake layer is characterised by δ^{98}Mo in the range of +1.20 to +1.52‰. These isotope compositions are significantly heavier than δ^{98}Mo in tributaries (0.5‰), the source of Mo to the lake, demonstrating that dissolved Mo is isotopically fractionated in oxic waters. The likely cause is adsorption of Mo to Mn and/or Fe (oxyhydr)oxide particlulates, which involves preferential uptake of light Mo isotopes, thereby leaving the remaining dissolved Mo pool isotopically heavy.

In the anoxic part of the lake, the dissolved Mo pool has δ^{98}Mo in the range of +0.71 to +0.27‰. The difference between the oxic surface and the anoxic deep lake is most likely due to Fe-Mn cycling across the chemocline. Dissolved, reduced Fe and Mn diffuse upwards from the anoxic waters and are oxidised in the upper oxic portion. Consequently, the Lake Pavin chemocline is characterised by high concentrations of Mn and Fe (oxyhydr) oxides that preferentially sorb the light Mo isotopes.

Sinking and dissolution of these Mn and Fe (oxyhydr)oxides in the anoxic part of the lake is most probably responsible for low δ^{98}Mo in the anoxic bottom of Lake Pavin. Due to very low U concentrations the ^{238}U/^{235}U (δ^{238}U) could not be determined in oxygenated waters. However, dissolved U in the anoxic water column below 75 meters depth has δ^{238}U in the range of +0.2 to -0.28‰, averaging -0.2‰. This isotopic composition is similar to δ^{238}U measured in the tributaries, indicating little net U isotope fractionation in this part of the water column.

Anoxic Lake Pavin sediments show contrasting behaviour with depth beneath the sediment-water interface. In the top ~10 cm both U (~4 ppm) and Mo (~20 ppm) concentrations are higher than below (~2 and ~10 ppm, respectively). This abundance variation is accompanied by shifts in U and Mo isotopic composition: δ^{98}Mo and δ^{238}U are around +0.15‰ and 0.0‰, respectively, in the upper sediments, and -0.5‰ and -0.2‰, further down.

The changes in δ^{98}Mo and δ^{238}U, as well as the Mo and U concentrations in anoxic Lake Pavin sediment, imply significant changes in redox conditions during the deposition of the investigated sediments. Mo and U concentration and isotope systematics in the deeper sediments suggest little authigenic enrichment and more oxic conditions during deposition, whereas the top 10 cm show both authigenic U and Mo enrichment and isotope fractionation. The upper sediments also suggest that Mo and U incorporation into sediments under ferruginous ocean conditions may lead to lower δ^{98}Mo and higher δ^{238}U compositions compared to the overlying waters.

References

1 - Asael D., François L.H.T., Reinhard C.T., Rouxel O., Dauphas N., Lyons T.W., Ponzevera E., Liorzou C. and Chéron S., 2013. Coupled molybdenum, iron and uranium stable isotopes as oceanic paleoredox proxies during the Paleoproterozoic Shunga Event. *Chem. Geol.*, 362: 193-210.

2 - Planavsky N.J., McGoldrick P., Scot C.T., Li C., Reinhard C.T., Kelly A.E., Chu X., Bekker, A., Love G.D. Lyons T.W., 2011. Widespread iron-rich conditions in the mid-Proterozoic ocean. *Nature*, 477: 448-451.

DEEPWATER-/ REDOX-CONTROLED FORMATION, PRESERVATION, AND INTERRUPTION OF ORGANIC-RICH SAPROPEL S1

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Abstract
The synchronous initial deposition and preservation at a basin-wide scale of the most recent sapropel S1 appears mainly controlled by redox-conditions. The latter are determined by a complex interplay between S-borderland-related precipitation and N-borderland-related cooling episodes. The continuing deep-water ventilation after its deposition & initial reventilation event resulted in a downward progressing oxidation front that degraded the upper part of S1. Pronounced double Manganese peaks in the sediment are clear markers for this reventilation and the subsequent downward oxidation. In addition, even during S1 deposition, initially thought to be continuously anoxic, distinct re-ventilation events appear to have taken place. The 8.2 ka event is the most noticeable of these, but others, probably of more reduced duration, also occurred.

Keywords: Sapropel, Mediterranean Sea, Anoxia, Sediments, Paleoceanography

In Mediterranean marine deposits, distinct organic-rich units (sapropels) occur in a repetitive, climate-controled way. Their deposition is precession-related and associated with humid climate conditions [1] The most recent sapropel S1 formed between 9.8 and 5.7 14C ky BP, thus simultaneously with a circum-Mediterranean humid period. (11 - 5 kyr 14C) [2]. S1 deposition occurred synchronously at all water depths greater than a few 100m. The effect of such 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. This resulted in a differential basin-wide preservation of S1 determined by water depth, as a result of different ventilation/climate-related redox conditions above and below 1.8 km. A sedimentary,basin-wide, MnO_2-peak marks the abrupt re-ventilation of deep-water at 5.7 kyr. The subsequent oxic conditions resulted in a downward progressing oxidation-front that is not only marked by degradation of organic matter over its active pathway, but also by the built-up of a secondary Mn-peak below the first, ventilation Mn-peak [3] (Fig.1).

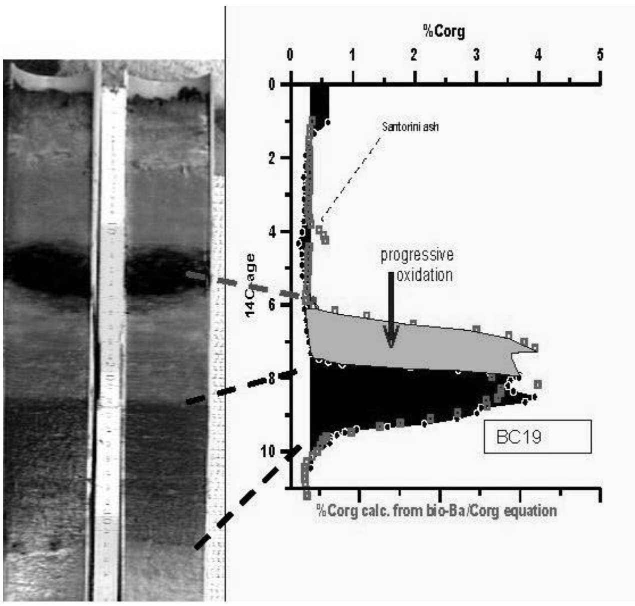

Fig. 1. Sapropel S1: Left: manganese-rich Marker-Bed (black-unit), remaining S1 (darkgreen); Right: initial %Corg (green), upper oxidized (blue), and lower un-oxidized, remaining S1 unit (black)

Apart from the major re-ventilation event at the end of sapropel S1 formation, also other, short-term ventilation events have occurred, notably the 8.2 ka event. [4] This basin-wide event is particularly noticeable at relatively shallow near-coastal sites of high sedimentation rates. It marks a brief episode of not only re-oxygenated deep water thus reduced preservation, but also decreased primary productivity thus nutrient supply. Similar but potentially shorter water-column ventilation events during S1 deposition have been demonstrated [5], thus pointing to a subtle hydrological balance governed by northern and southern borderland related climate variability. The 8.2 ka event is the most outspoken example for this. The 8.2 cal ka BP interruption event is related to enhanced deep-water formation in the Aegean or Adriatic due to a period of sustained cold air fluxes from Polar regions. The amount of precipitation thus stratified water-column conditions is associated with N.African monsoonal system, whereas deep-water formation, thus disrupture of a stratified water column is related to the N-borderland climate system. Sapropel formation mechanisms, therefore, are related to a sensitive interplay between S- and N- borderland climate systems. Assessing distinct, sub-Milankovitch climate variability is vital for understanding and forecasting future climate change.

References
1 - Rossignol-Strick et al. ,1982. After the deluge Mediterranean stagnation and sapropel formation. Nature 295, 105-110; Emeis et al., 2000. The sapropel record of the eastern Mediterranean –results of Ocean Drilling Program Leg 160.Palaeogeog. Palaeoclimatol. Palaeoecol. 158 371-395.
2 - Reitz et al., 2006. Source and development of large manganese enrichments above eastern Mediterranean sapropel S1. Paleoceanogr, 21, PA3007, doi:10.1029/2005PA001169;.De Lange et al., 2008. Synchronous basin-wide formation and redox-controlled preservation of a Mediterranean sapropel. Nature Geo 1, 606-610
3 - Van Santvoort et al., 1996. Active post-depositional oxidation of the most recent sapropel (S1) in sediments of the E.Mediterranean. Geochim. Cosmochim. Acta 60, 4007-4024; Thomson et al., 1999. Review of recent advances in the interpretation of E.Mediterranean sapropel S1 from geochemical evidence Mar. Geol. 153, 77-89.
4 - Rohling, 1994. Review and new aspects concerning the formation of eastern Mediterranean sapropels. Mar. Geol. 122 1-28; Rohling et al.1997. 200 Year Interruption of Holocene sapropel formation in the Adriatic Sea. J. Micropal.16, 97–108; De Rijk et al., 1999. E.Mediterranean sapropel S1 interruption: an expression of the onset of climatic deterioration around 7 ka BP. Mar. Geol. 153, 337–343.
5 - Jilbert et al., 2010.Short-time-scale variability in ventilation and export productivity during the formation of Mediterranean sapropel S1 Paleoceanogr. 25, PA4232, doi:10.1029/2010PA001955 ;Jilbert et al., 2008. Fluid displacive resin embedding of laminated sediments: preserving trace metals for high-resolution paleoclimate investigations. Limnol. Oceanogr Methods 6, 2008, 16–22.

PALEO-SEAWATER DENSITY RECONSTRUCTION AND ITS IMPLICATION FOR COLD-WATER CORAL CARBONATE MOUNDS IN THE NORTHEAST ATLANTIC THROUGH TIME

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Abstract
Cold-water coral build-ups in the NE Atlantic are bound to distinct water mass characteristics. A key parameter is seawater density. Based on gravity cores and ODP piston cores we demonstrate this relationship for the geological past and the onset of carbonate mound growth on the NW European continental margin.

Keywords: Cnidaria, North Atlantic

Carbonate buildups and mounds are impressive biogenic structures throughout Earth history. In the recent NE Atlantic, cold-water coral (CWC) reefs form giant carbonate mounds of up to 300 m of elevation. The expansion of these coral carbonate mounds is paced by climatic changes during the past 2.7 Myr. Environmental control on their development is directly linked to controls on its main constructors, the reef-building CWCs. Seawater density has been identified as one of the main controlling parameter of CWC growth in the NE Atlantic. One possibility is the formation of a pycnocline above the carbonate mounds, which is increasing the hydrodynamic regime, supporting elevated food supply, and possibly facilitating the distribution of coral larvae. The potential to reconstruct past seawater densities from stable oxygen isotopes of benthic foraminifera has been further developed: a regional equation gives reliable results for three different settings, peak interglacials (e.g., Holocene), peak glacials (e.g., Last Glacial Maximum), and intermediate setting (between the two extremes). Seawater densities are reconstructed for two different NE Atlantic CWC carbonate mounds in the Porcupine Seabight indicating that the development of carbonate mounds is predominantly found at a seawater density range between 27.3 and 27.7 kg m−3 (σΘ notation). Comparable to recent conditions, we interpret the reconstructed density range as a pycnocline serving as boundary layer, on which currents develop, carrying nutrition and possibly coral larvae. The close correlation of CWC reef growth with reconstructed seawater densities through the Pleistocene highlights the importance of pycnoclines and intermediate water mass dynamics (Fig. 1).

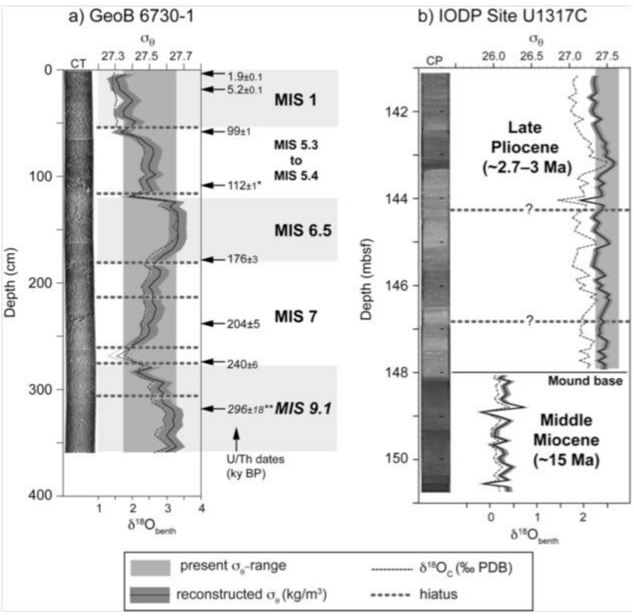

Fig. 1. Figure 1: (a) Downcore record of core GeoB6730-1 of the past ~300 kyr for Propeller Mound. U/Th age data are in thousand years before present (kyr B.P.); corresponding Marine Isotope Stages (MIS) are indicated. The vertical gray bar highlights the present-day density range of σΘ = 27.35–27.65 kg m−3 for living cold-water corals reefs of the NE Atlantic [Dullo et al.,2008]. Reconstructed paleoseawater densities are shown by black line; dark grey envelope indicates the error bar. Computer tomographic (CT) images indicate occurrence of corals throughout the core with varying densities. An asterisk denotes mean value of three age determinations (see Table S1), and two asterisks denote large error comprising MIS 8.3 to MIS 9.2 (see supporting information). (b) Sedimentary record of IODP Site U1317C between 151 m and 141 m below the seafloor (mbsf). The vertical grey bar corresponds to the present-day density envelope.

Overall, CWC carbonate mound growth portrays prolific marine benthic ecosystem development and is linked to small changes in ambient bottom water characteristics (i.e., density). These results show that marine benthic ecosystems occupy very narrow and specific ecological niches, which are very sensitive and even at risk to the actual global environmental changes, such as bottom water warming and acidification. As a consequence, our findings have lead to a robust diagnostic key tool for the interpretation of basin-wide sudden onset or shutdown of carbonate mound growth during Earth history.

References
1 - Dullo, W.-C., S. Flögel, and A. Rüggeberg (2008), Cold-water coral growth in relation to the hydrography of the Celtic and Nordic European continental margin, Mar. Ecol. Prog. Ser., 371, 165–176.
2 - Haug, G. H., and R. Tiedemann (1998), Effect of the formation of the Isthmus of Panama on Atlantic Ocean thermohaline circulation, Nature, 393, 673–676.

MIS 5 COASTAL CARBONATE DIAGENESIS IN THE NORTHERN AND SOUTHERN MEDITERRANEAN SEA

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Abstract

Sea level changes influenced the diagenetic processes of the MIS 5 Mediterranean coastal carbonate deposits of both Sardinia (Italy) and Alexandria (Egypt). Diagenesis in Sardinia took place in two phases. The first occurred during the MIS 5e in shallow marine phreatic environment, while the second took place between MIS 4 and MIS 2 in a meteoric phreatic environment. In Alexandria, diagenesis followed three phases. The first occurred during MIS 5c in a vadose, active phreatic zone, the second, between MIS 4 and MIS 2 in a meteoric phreatic environment; and the final phase took place during the early and middle Holocene MIS 1 in a marine phreatic environment.

Keywords: Mediterranean Sea, Sea level, Paleoceanography, Rocky shores

Marine Isotope Stage 5 (MIS 5) carbonates, outcropping along the western of Sardinia (Italy - Central Mediterranean) and all along the city of Alexandria (Egypt - South Mediterranean), deposited and underwent diagenetic cycles because of sea level fluctuations related to the last 125 ka glacial and interglacial cycles.

In Sardinia (locality Porto Alabe), the shallow water carbonates are biogenic rims mostly made of the red coralline algae *Lithophyllum byssoides* with intertidal invertebrates encrusted the biggest cobbles and boulders of the lower conglomerates. They have been OSL dated at 125 Ka; thus related to MIS 5e. The diagenetic processes in Porto Alabe followed two phases. The first took place directly after their deposition in the shallow marine phreatic environment during MIS 5e. This assumption is supported by the presence of microcrystalline high-Mg calcite isopachous rims and the crusts of fibrous aragonite cements. The second phase occurred in a period of sea level lowstand, during which subaerial exposure of carbonates allowed fresh water to replace sea water in the pores. Consequently, a meteoric phreatic environment was created, and equant or granular calcite cement were developed. This phase most probably occurred during the glacial period between MIS 4 and MIS 2 when sea level regressed of several kilometers and carbonates were exposed (figure 1).

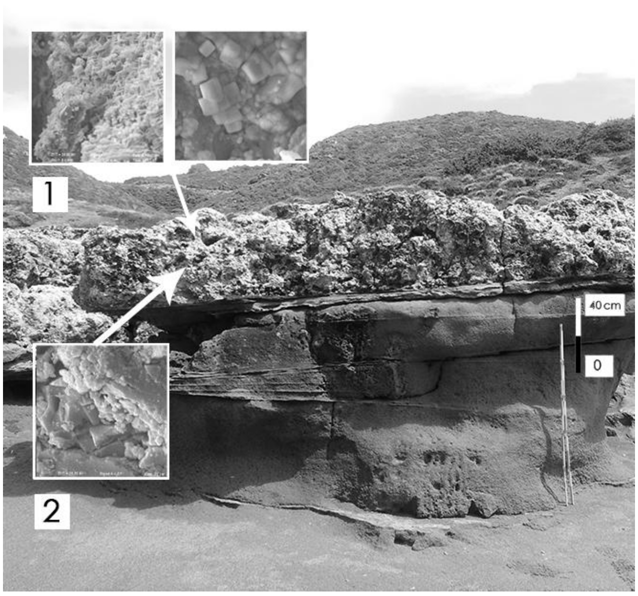

Fig. 1. Phases of carbonate diagenesis represented by two stages of cementation, Porto Alabe, Sardinia.

In Alexandria (Gabal El-Kor formation), shallow marine carbonate made up of ooids, skeletal grains, quartz and others. They have been OSL dated at 104 ± 17 ka [1]; and is therefore related to MIS 5c. These deposits have been subjected to three phases of diagenetic processes [2]. The first took place directly after their deposition during the MIS 5c. The early stage of cementaion occurred in a vadose, active phreatic zone. This is proved by the presence of micritic low Mg-Calcite cements . The second phase started during a marine regression period and with subaerial exposure of the formation. The deposits in the phreatic marine zone started to leach out. This reflects the instability of the earlier formed low Mg-calcite and the partial dissolution of the micrite envelope. Rims of isopachous bladed microcrystalline calcite cement formed representing a stage of meteoric phreatic cementation. This phase of diagenesis most likely occurred during the glacial period between MIS 4 and MIS 2. The last phase has been formed during the post Late Glacial Maximum transgression (MIS 1). In this phase, sea reached the lowermost part of the outcrop affecting it by seawater splash and spray. Fibrous aragonite cements grew on the previously formed low Mg-calcite rhombs in the marine phreatic zone. (figure 2).

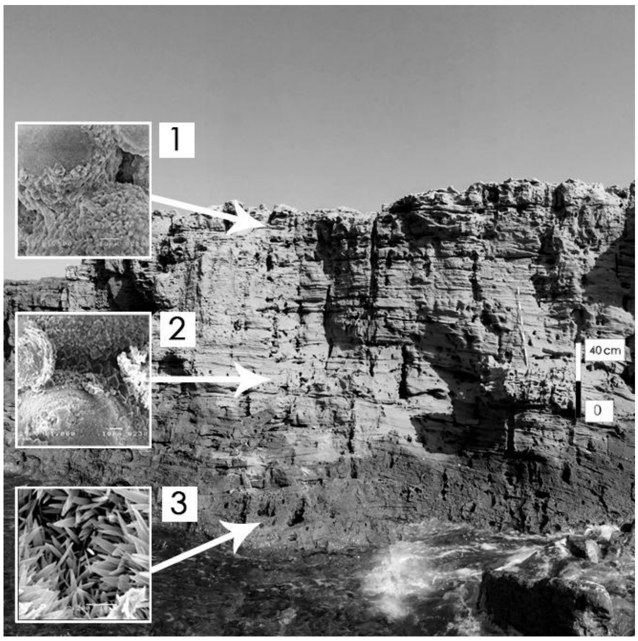

Fig. 2. Phases of carbonate diagenesis represented by three stages of cementation, Gabal El-Kor, Alexandria.

References

1 - El-Asmar, H.M. and Wood, P., 2000. Quaternary shoreline development: the Northwestern coast of Egypt. Quat.Sci. Rev., V. 19, P. 1137-1149, UK.

2 - El-Sayed, M.Kh., 1988. Progressive cementation in Pleistocene carbonate sediments along the coastal area of Alexandria, Egypt. J. C. R., 4: 289-299.

UPPER WATER COLUMN VARIATIONS IN THE SOUTH AEGEAN SEA DURING CLIMATE CHANGE EVENTS IN THE LAST 19.000 YEARS

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Abstract

The Late Quaternary palaeoenvironmental evolution and the main palaeoceanographic changes of the south Aegean Sea was reconstructed using high resolution micropalaeontologic and geochemical data ($\delta^{18}O$ and $\delta^{13}C$ isotopes, AMS ^{14}C datings, C_{org} content) obtained from the sediments of a high sedimentation rate gravity core north of Kimolos Island.

Keywords: Aegean Sea, Stable isotopes, Sapropel, Sea level

An integrated high resolution study based on a high sedimentation rate gravity core (KIM 2A, length 197 cm collected from a submarine depression located north of Kimolos Island, south Aegean, 640-m water depth), was carried out in the frame of "YPOTHER" project, funded by the National Strategic Development Program EE. New data concerning climatic, eustatic and paleoenvironmental changes during the late Quaternary are provided. The stratigraphic framework, based on a combination of Accelerator Mass Spectrometry (AMS) radiocarbon (^{14}C) datings, additional control points of planktonic foraminiferal bioevents and the oxygen isotope record, spans from the last deglaciation to the Holocene. Herein we focus on findings from the last glacial to interglacial transition and the sapropel S1 deposition. The results based on high-resolution micropalaeontological data (planktonic and benthic foraminiferal assemblages, pteropods), stable isotopes ($\delta^{18}O$, $\delta^{13}C$) and other indicators of sea-surface hydrology (stratification and productivity indices), allowed the recognition of palaeoceanographic/sea-level changes of the last 19 kyr.

Marking the transition from glacial to present-day interglacial conditions, the late Pleniglacial/Late Glacial interval (coeval with late Marine Isotope 2; MIS2) was characterized by a series of millennial-scale climate oscillations that affected the ocean-atmosphere system. During the glacial period (19.0–14.8 kyr; Fig. 1), the heaviest $\delta^{18}O$ values, accompanied with low values of Planktonic Palaeoclimatic Curve (PPC), the highest values of the stratification index (S-index) and the absence of oligotrophic species, suggest low SST and high eutrophication levels. An abrupt shift to warmer conditions connected to the Bølling-Allerød (B-A) interstadial is indicative by all records (e.g. abrupt high percentages up to 60% of the PPC, lighter $\delta^{18}O$ values, Fig. 1C, B) representative of temporal climatic amelioration (Termination T1a).

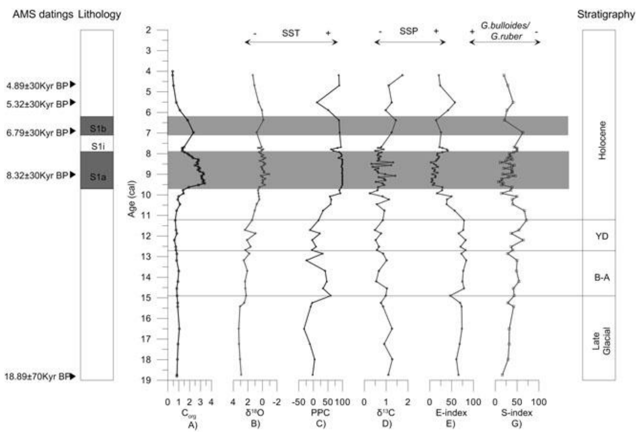

Fig. 1. Results of the GC KIM2A showing the downcore variation of the: A) Total Organic Carbon (C_{org}), B) $\delta^{18}O$ isotope values, C) Sea Surface Temperature, D) $\delta^{13}C$ isotope values, E) Sea Surface Productivity (E-index), G) *G. bulloides/G. ruber* ratio (S-index).

This short deglacial event (14.8-12.7 kyr) also played an important role in the sea-level rise that produced changes in benthic foraminiferal assemblages, favoring the proliferation of shallow water species of the inner shelf. The abrupt rise of the palaeoclimatic curve during this time period is characterized by the higher abundances of *G. ruber alba*, *G. bulloides*, and *G. inflata*, which are indicative of changing conditions of deposition, suggesting temperate and mesotrophic waters, with strong seasonal mixing and local upwelling. An abrupt switch to cool, arid climatic event of Younger Dryas (YD) suggests a strengthening of winter convection around 12.7 kyr. This climate response of south Aegean depression to the YD event (12.7-11.2 kyr) seems to be in accordance with relevant signals from the north and central Aegean sub-basins [1-3]. The latter oscillation precedes the final transition to the interglacial conditions of the Early Holocene (Termination T1b).

The Holocene started with a sharp warming of sea surface water, reaching present-day levels and probably associated with a reduction in salinity. The most warm and humid Holocene conditions coupled with a relatively productive and stratified water column enabled the deposition of the two sapropel sub-layers: S1a (9.7-7.9 kyr) and S1b (7.1-6.2 kyr) as witnessed by their high organic carbon (C_{org}) content (1.8-3.3%). During S1 deposition, depleted values of $\delta^{18}O$ are recorded (-0.9‰ to 0.6‰), warm water species domain, and oligotrophic conditions are observed. The sapropel interruption (S1i; 7.9-7.1 kyr) is marked by the decreasing content in C_{org} (1.3%) and in heavier $\delta^{18}O$ and $\delta^{13}C$ values (Fig. 1A, B, D). In this interval a brief cooling event at 7.8 kyr can be recognized mostly by the negative peak of PPC. This brief cooling event has also been recorded in other Aegean cores [1-6]. From 6.2 kyr to the top of the core, slightly heavier $\delta^{18}O$ values are recorded and represent the modern water column of central Aegean Sea.

References

1 - Kontakiotis, G., 2015. Late Quaternary paleoenvironmental reconstruction and paleoclimatic implications of the Aegean Sea (eastern Mediterranean) based on paleoceanographic indexes and stable isotopes. *Quat. Internat*. 1-15.

2 - Geraga, M., Tsaila-Monopolis, St., Ioakim, Chr., Papatheodorou, G., Ferentinos, G., 2005. Short-term climate changes in the southern Aegean Sea over the last 48000 years. *Palaeogeogr. Palaeoclimatol. Palaeoecol*., 220: 311-332.

3 - Geraga, M., Ioakim, Chr., Lykousis, V., Tsaila-Monopolis, St., Mylona, G., 2010. The high resolution palaeoclimatic and palaeoceanographic history of the last 24,000 years in the central Aegean Sea, Greece. *Palaeogeogr. Palaeoclimatol. Palaeoecol*., 287: 101-115.

4 - Triantaphyllou, M.V., Antonarakou, A., Kouli, K., Dimiza, M., Kontakiotis, G., Papanikolaou, M.D., Ziveri, P., Mortyn, P.G., Lianou, V., Lykousis, V., Dermitzakis, M.D., 2009. Late Glacial-Holocene ecostratigraphy of the south-eastern Aegean Sea, based on plankton and pollen assemblages. *Geo-Mar. Lett*. 29(4): 249–267.

5 - Marino, G., Rohling, E.J.,Sangiorgi, F., Hayes, A.,Casford, J.L.,Lotter, A.F.,Kucera, M.,Brinkhuis, H.,2009. Early and middle Holocene in the Aegean Sea: interplay between high and low latitude climate variability, *Quat. Sci. Rev*., 28: 3246-3262.

6 - Fhlaithearta, Ní S., Reichart, G.-J.,Jorissen, F.J., Fontanier, C., Rohling, E.J., Thomson, J., G.J. De Lange, 2010. Reconstructing the seafloor environment during sapropel formation using benthic foraminiferal trace metals, stable isotopes, and sediment composition. *Paleoceanography*, 25, PA4225.

EASTERN MEDITERRANEAN MARINE ECOSYSTEM MONITORING THROUGH MORPHOLOGICALLY ABNORMAL BIO-INDICATORS

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Abstract

We investigate morphological abnormalities of recent planktonic foraminiferal tests in coastal (Aegean Sea) and open marine (Levantine Sea) environments of the eastern Mediterranean Sea. The occurrence of "twinned" *Globigerinoides ruber* specimens may be linked to stressful environmental conditions, mostly associated with the hypersaline, oligotrophic and oxygen-depleted nature of the Mediterranean water column. Therefore their relative abundance can be a useful proxy for the reconstruction of paleoecological changes in stressed environments, and furthermore as an alternative to population dynamics in studying and monitoring natural population ecology.

Keywords: Bio-indicators, Paleoceanography, Salinity, Temperature, Mediterranean Sea

Morphological abnormalities of both benthic and planktonic (less frequent) foraminiferal tests have long been documented and various hypotheses relating to either natural ecological causes (wide salinity fluctuations, water acidification, oxygen depletion, increased terrigenous input, nutrification, and high energy hydrodynamics) or human activities (pollution by heavy metals, and organic matter produced by eutrophication) have been proposed to explain their occurrence [1-4]. Especially the particular type of abnormality manifested by the so-called "double tests" usually arise due to abnormal growth originating mainly from twinning, but may also be caused by irregularities in the early chambers and by regeneration after test injury that modifies the direction of growth. Application of this information to a suite of modern core-top samples in the eastern Mediterranean Sea [5] spanning strong sea surface environmental (temperature, salinity, dissolved oxygen and productivity) gradients, along a North-South transect shows the presence of twinned *Globigerinoides ruber* specimens for the first time, and furthermore highlights the possible connection between this mode of deformation and environmental parameters. Scanning Electron Microscopy (SEM) observations on *G. ruber* tests indicate a range of malformations and aberrant morphologies from slight deformity with smaller or overdeveloped chambers to more severe deformity with misplaced chambers, distorted spirals, irregular sutures, double apertures, or double tests forming twinned individuals. The test abnormalities, carried out on total assemblages, show that the Foraminiferal Abnormality Index (FAI) values range from 0% to 5%. In the North Aegean no abnormality events were found, while in the Central Aegean they were relatively rare, with percentages not exceeding 1% of the total assemblage. The highest percentage of abnormal tests occurred in the South Aegean and Levantine regions and reached ~5%. Although it is difficult to distinguish between the effect of natural stress and anthropogenic impact, their similar occurrence in both the coastal environment of the South Aegean and the open Levantine Sea lead us to carefully look at different aspects of the environment (e.g. salinity, eutrophication, oxygen levels) before concluding that anthropogenic pollution is the only cause of deformations of both benthic and planktonic foraminifera. The combined interplay of local environmental stressors acting on this oligotrophic, oxygen-depleted and hypersaline sector of the Mediterranean Sea is the most likely explanation for the observed morphological abnormalities. Regardless of the exact mechanism producing test abnormalities, our results clearly support the current use of the relative abundance of abnormal tests as a bio-indicator for monitoring natural stress, and further illustrate the necessity to map both their spatial and temporal distribution for accurate paleoenvironmental reconstructions. However, further investigations should extend this approach to test the robustness of our findings in a number of similar oceanic settings.

References

1 - Stouff V., Debenay J.P., Lesourd M., 1999. Origin of double and multiple shells in benthic foraminifera: observations in laboratory cultures. *Mar. Micropal*. 36 (4): 189–204.

2 - Geslin E., Stouff V., Debenay J.P., Lesourd M., 2000. In: Martin, R.E. (Ed.), Environmental variation and foraminiferal test abnormalities. Environmental Micropaleontology, vol. 15 of Topics in Geobiology. Kluer Academic, pp 191–215.

3 - Frontalini F. and Coccioni R., 2008. Benthic foraminifera for heavy metal pollution monitoring: a case study from the central Adriatic Sea coast of Italy. *Estuar. Coast. Shelf Sci*. 76: 404–417.

4 - Mancin N. and Darling K., 2015. Morphological abnormalities of planktonic foraminiferal tests in the SW Pacific Ocean over the last 550 ky. *Mar. Micropal*. 120: 1-19.

5 - Kontakiotis G., Mortyn P.G., Antonarakou A., Martínez-Botí M.À., Triantaphyllou M.V., 2011. Field-based validation of a diagenetic effect on *G. ruber* Mg/Ca paleothermometry: Core top results from the Aegean Sea (eastern Mediterranean). *Geochem. Geophys. Geosyst.* 12 (9), Q09004. doi:10.1029/2011GC003692.

PAST COLD-WATER CORAL GROWTH IN THE WEST MELILLA COLD-WATER CORAL PROVINCE, ALBORAN SEA, RELATED TO HIGH PRODUCTIVITY AND CURRENT VELOCITY

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Abstract

The West Melilla Cold-Water Coral Province (WMCP) in the Alboran Sea is characterized by coral carbonate mounds, which presently lack a living cold-water coral ecosystem. Sediment cores from the WMCP have been analyzed to unravel the palaeo-environmental conditions that controlled the growth of cold-water corals in this region in the past. Results show three periods with enhanced bottom currents, productivity and aeolian input characterized by coarser grain sizes, higher Br/Al and Ca/(Ca+Fe) ratios, and Si/(Si+Al) and Zr/Al ratios, respectively. With a stratigraphic framework still lacking, it is hypothesized that improved food supply to the corals, triggered by productivity and bottom current strength, was the dominant forcing factor controlling the vitality of cold-water corals in this region.

Keywords: Alboran Sea, Paleoceanography

Recent investigations in the eastern Alboran Sea (Western Mediterranean), found two different cold-water coral (CWC) mound provinces, with some living CWCs in the East Melilla Cold-Water Coral Province (EMCP) (e.g. Hebbeln et al., 2009) and no living CWCs observed in the West Melilla Cold-Water Coral Province (WMCP) (Lo Iacono et al., 2014). In the EMCP, productivity is thought to be the main factor controlling the thriving of CWCs (Fink et al., 2013), while little is known about the development of CWC mounds in WMCP, which at least under present-day conditions differ significantly from the EMCP by the lack of any living CWC. In order to unravel the development of CWC mounds in WMCP, on-mound and off-mound sediment cores were collected during R/V Maria S. Merian cruise MSM 36 (Fig.1). First results of XRF core scanner and grain size analyses on the off-mound core GeoB 18131, used to assess the regional paleoceanographic setting, show four core sections characterized by high Zr/Al, Br/Al, Ca/(Ca+Fe), and Si/(Si+Al) ratios in core depths of 35 ~ 70 cm, 188 ~ 223 cm, 528 ~ 610 cm and 752 ~ 812 cm (Fig.2), respectively. High values of Zr/Al and Si/(Si+Al) ratios indicate a high content of aeolian input and dry conditions in the area, while high Br/Al and Ca/(Ca+Fe) ratios suggest a high productivity which actually might be triggered by an enhanced aeolian input. The median grain size and the mean grain size curves show three peaks at the same depth levels. This sediment coarsening indicates strong bottom currents, which most likely contribute to the food supply to the filter-feeding corals and, thus, to improve their living conditions. Indeed, food availability and variables such as temperature, dissolved oxygen concentrations, etc. also earlier have been recognized as factors controlling the development of CWCs in the Mediterranean Sea (e.g. Freiwald et al., 2009; Fink et al., 2012; 2013). Although by the time of writing this abstract, the stratigraphic framework in terms of absolute age datings is still missing, we hypothesize that the periods with enhanced productivity and stronger bottom currents provided a proper environment for the growth of CWCs in the WMCP. In contrast, at present productivity appears to be high, shown by Br/Al and Ca/(Ca+Fe) ratios, but bottom current velocities are comparatively low (as shown by the grain size data). The latter fact might explain, why nowadays no living CWCs occur in the WMCP. By the time of the conference, absolute age datings will allow to put these observations into a stratigraphical framework.

References

1 - Fink, H.G., Wienberg, C., Hebbeln, D., McGregor, H.V., Schmiedl, G., Taviani, M., and Freiwald, A., 2012, Oxygen control on Holocene cold-water coral development in the eastern Mediterranean Sea. Deep-Sea Research I, 62, 89-96.

2 - Fink, H. G., Wienberg, C., De Pol-Holz, R., Wintersteller, P., and Hebbeln, D., 2013, Cold-water coral growth in the Alboran Sea related to high productivity during the Late Pleistocene and Holocene: Marine Geology, 339, 71-82.

3 - Freiwald, A., Beuck, L., Rüggeberg, A., Taviani, M., Hebbeln, D. and R/V Meteor M70-1 participants, 2009, The white coral community in the Central Mediterranean Sea - Revealed by ROV surveys. Oceanography, 22, 36-52.

4 - Hebbeln, D., C. Wienberg, L. B., A. Freiwald, P. Wintersteller, and participants, c., Report and preliminary results of RV POSEIDON Cruise POS 385 "Cold-Water Corals of the Alboran Sea (western Mediterranean Sea)", Faro - Toulon, May 29 - June 16, 2009: Berichte, Fachbereich Geowissenschaften, Universität Bremen, 273.

5 - Lo Iacono, C., Gràcia, E., Ranero, C. R., Emelianov, M., Huvenne, V. A., Bartolomé, R., Booth-Rea, G., and Prades, J., 2014, The West Melilla cold water coral mounds, Eastern Alboran Sea: Morphological characterization and environmental context: Deep Sea Research Part II: Topical Studies in Oceanography, 99, 316-326.

SENSITIVITY OF PLANKTONIC FORAMINIFER SHELL MASS TO AMBIENT SEA WATER DENSITY: ATLANTIC AND MEDITERRANEAN PERSPECTIVES

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Abstract
Foraminifera shell thinning due to the ongoing surface ocean acidification is a topic of increasing interest in paleoceanographic research. As CO_2 invades the surface ocean, carbonate ion concentrations [$CO_3^{=}$] and pH are lowered. Since it was first shown that the calcification capability of foraminifera is related to changes in ambient seawater [$CO_3^{=}$] [1] their shell weight has been used in paleoceanographic reconstructions as a [$CO_3^{=}$] proxy [2]. Although glacial-interglacial shell weight variations are well correlated with the atmospheric $p$$CO_2$ record [3] this is not always the case [4]. Based on new investigations carried out in selected foraminifera species, shell weight measurements suggest that glacial – interglacial ocean density oscillations may also account for the observed shell weight variations.

Keywords: Density, Foraminifera, Paleoceanography, Pelagic, Mediterranean Sea

Downcore results from the North East Atlantic, core NEAP 8K , revealed a good correlation between the shell mass of *G. bulloides* tests and density values reconstructed from combined Mg/Ca and δ^{18}O measurements on the same weighed tests (Fig.1). Mg/Ca in the same carrier were used to subtract the temperature effect on δ^{18}O in order to gain information on past sea water δ^{18}O, which is directly related to variables like salinity and continental ice volume [5].

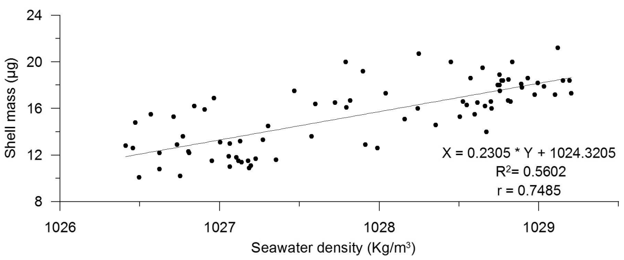

Fig. 1. *G. bulloides* shell mass relation to water paleodensities estimates from core NEAP 8K from the North East Atlantic. Heavier tests are found to precipitate in denser waters.

We further tested the link by investigating modern foraminifera and in-situ T-S data from core top samples from different Mediterranean localities. The Mediterranean Sea is a particularly sensitive area to global environmental change and it has been suggested that its rate of acidification has been higher than in the open oceans [6].

In order to assess the effect of dissolution on shell weight variations the preservation of the samples was checked using the fragmentation index [7]. Weight measurements were performed on different abundant surface and deep-dwelling planktonic foraminifera species such as *O. universa*, *G. ruber* s.s., s.l both white (*G. ruber alba*) and (*G. ruber rosea*) pink variety, *G. inflata*, *G. trilobus* etc. The different *G. ruber* alba morphotypes were measured as they have been found to calcify in different depths [8]. Furthermore, benthic foraminifera species such as *Cibicidoides kullenbergi* and *Planulina ariminensis* are also examined in order to investigate the role of shell mass to exceed buoyancy and sink to the sea floor.

The tests were picked from the 300 – 355 μm size fraction and a mean sieve based weight [9] was calculated for each species. SEM examination of test ultrastructure [10] was performed on the weighed *G. ruber* pink tests to crosscheck their dissolution and exclude any increase in fragmentation due to extremely delicate and thin test secretions.

References
1 - Spero, H. J., et al. 1997. Effect of seawater carbonate concentration on foraminiferal carbon and oxygen isotopes. *Nature* 390(6659): 497-500.
2 - Broecker, W. and E. Clark 2001. Glacial-to-Holocene Redistribution of Carbonate Ion in the Deep Sea. *Science* 294(5549): 2152-2155.
3 - Barker, S. and H. Elderfield 2002. Foraminiferal calcification response to glacial-interglacial changes in atmospheric CO_2. *Science* 297(5582): 833-836.
4 - de Villiers, S. 2004. Optimum growth conditions as opposed to calcite saturation as a control on the calcification rate and shell-weight of marine foraminifera. *Marine Biology* 144(1): 45-49.
5 - Rosenthal, Y., et al. 2000. Incorporation and preservation of Mg in Globigerinoides sacculifer: implications for reconstructing the temperature and ^{18}O/^{16}O of seawater. *Paleoceanography* 15(1): 135-145.
6 - Touratier F. and G. C. 2011. "Impact of Eastern Mediterranean transient on the distribution of anthropogenic CO_2 and first estimate of acidification for the Mediterranean Sea." *Deep Sea Research* Pt I(58): 1-15.
7 - Berger, W. H., et al. 1982. "Foraminifera on the deep-sea floor: Lysocline and dissolution rate." *Oceanologica Acta* 5: 249-258.
8 - Antonarakou A., et al. 2015. "Biotic and geochemical (δ^{18}O, δ^{13}C, Mg/Ca, Ba/Ca) responses of *Globigerinoides ruber* morphotypes to upper water column variation during the last deglatiation, Gulf of Mexico." *Geochimica et Cosmochimica Acta* 170: 69-93.
9 - Beer, C. J., et al. 2010. "Technical Note: On methodologies for determining the size-normalised weight of planktic foraminifera." *Biogeosciences* 7(7): 2193-2198.
10 - Henrich, R. and G. Wefer 1986. "Dissolution of biogenic carbonates: Effects of skeletal structure." *Marine Geology* 71(3–4): 341-362.

COMITÉ 2

Physique et climat de l'océan

Président : Miroslav Gacic

CIESM Congress Session : Coastal / open-sea exchanges
Moderator : Mirko Orlic, Dpt of Geophysics, Univ. of Zagreb, Croatia

Moderator's Synthesis

The simplest model addressing dynamics in the shelf-break area is based on the assumption that the flow is steady, linear and inviscid and it results in currents paralleling the isobaths. The result, first obtained by G. I. Taylor and J. Proudman a century ago, implies that the exchange between the coastal area and the open sea is minimal. Therefore, the basic question is which processes break the Taylor-Proudman constraint and therefore enable the exchange to occur. A number of these processes have been detected over the years in various basins all around the world and have usually been found to belong to one of the three types: time-dependent, nonlinear or viscous.

This session showed that many of these processes are at work also in the Mediterranean Sea and that therefore the exchange between the coastal area and the open sea, often enhanced by topographic constraints, is of considerable importance there. The phenomena documented in the oral and poster presentations included barotropic tides (J. Sanchez-Garrido), barotropic-to-baroclinic tidal conversion (J. Abdennadher), dense-water formation and related buoyancy-driven flows (C. Eronat), current instability resulting in eddies (J. Isern-Fontanet) and wind-driven currents (J. Abdennadher, G. Mikolajczak). The resulting advection and turbulence support an exchange of momentum, energy, mass and various properties between the coastal area and the open sea, with the transport of organic matter receiving a particular attention during the session (A. Gogou).

The debate following the oral presentations revealed that the model improvements are rarely accompanied by the prompt use of state-of-the-art instruments in the Mediterranean area, which renders the verification of the modeling results difficult. As for the neglected processes, it turned out that the dependence of general circulation on turbulent exchange of heat and salt is seldom considered. Also rarely addressed is the origin of turbulence itself, with most attention being up to now paid to the instability of internal waves – particularly those of tidal origin. It may therefore be expected that in the future the generation of turbulence in the Mediterranean Sea will be explored in more detail, by allowing not only for the breaking internal waves but also for the buoyancy and wind forcing, and that the control the turbulence exerts on the residual flow will receive the attention it deserves.

INTERNAL TIDES STRUCTURE IN THE STRAIT OF SICILY AND MALTA PLATEAU

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Abstract

The structure of internal tides (ITs) in the Sicily strait and Malta plateau is investigated by using a very high model resolution (ROMS). Barotropic to barolinic energy conversion is highest over near and super-critical slopes of the Adventure shelf's break, the Malta plateau and in the surrounding of the Pantelleria isle. Our simulated currents compare favorably to those of ship board and radar measurements. The converted energy feeding the ITs is estimated to be 124 MW, 60 % of which is within the semidiurnal frequencies. The most energetic semi-diurnal tide, namely M_2, propagates with strong dissipation occurring close to its generation sites. In contrast, the energy of diurnal ITs is totally dissipated in the vicinity of the shelf break where they are topographically-trapped.

Keywords: Tides, Adventure Bank, Malta Channel, Continental slope, Coastal models

1. Introduction

The region covered by the present study includes the Sicily strait and the Malta plateau, a dynamically active area connecting the eastern and western Mediterrenean sub-basins. This area is characterized by important dynamical processes occurring over a large spectrum of temporal and spatial scales. Even this area has been extensively studied during the last years [1-2], very few is known about the generation and the internal tides energetics. In fact, except sparse observations [3-5], the vertical structure has not been sufficiently addressed and very few is known about the generation of the internal tides (ITs) in this region based on sparse observations. In this study we try to quantify the ITs enregetics and to clarify the vertical modes structure associated to the diurnal and semidiurnal frequencies.

2. Model setup

The model used in this study is based on the Regional Oceanic Modelling System (ROMS), a three dimensional primitive equations, finite difference, hydrodynamic model. The bahymetry used is deduced from gebco 1' resolution. Realistic summer stratification is used [6]. Tidal forcing is appended at the four open boundaries by setting M_2, S_2, K_1 and O_1 elevations deduced fom 2D gravity model (MOG2D).

3. Results

In order to well investigate the distribution of the ITs in the area of study and for a better representation of the mesoscale eddy activity, we carried out two numerical simulations in which the grid resolution is chosen to be 1/32° and 1/60°, respectively. The spatial resolution significantly affects the converted energy feeding the internal tides. The finer spatial resolution the higher the converted energy. Indeed, the converted energy is 10 % higher with the finest resolution (1/60°) but the ratio between flux divergence and the converted energy remains almost the same.

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 are the main generation sites for M_2. Three sites are identified for K_1, namely, the eastern edge of the Adventure Bank, the surrounding of Malta plateau and the Messina strait.

In the Sicilian Channel, the converted energy feeding the internal tides is estimated to be 124 MW, 60 % of which is within the semidiurnal band (M_2 and S_2). The K_1 converted energy is 80 % of that of M_2 but is entirely lost in the vicinity of the shelf break. The K_1 internal energy is topographically-trapped near its generation regions. The M2 internal tide propagates namely toward the north from the western sill of the Adventure Bank where the second baroclinic mode is exicted. Far from this generation site the first baroclinic mode dominates as suggest the wavelet orthogonal functions decompositions (WEOF) of the baroclinic velocity.

The modeled currents compare favorably to ship board [4] and radar data [5]. The finest resolution gives the best results namely in the C01 station located in the western sill of the Adventure Bank. Increasing the horizontal resolution improves the magnitude of the major semiaxis in the surface layers for the semi-diurnal constituents and the diurnal ellipses estimation in the bottom layers. The improvement of the simulated surface currents in the Malta channel is confirmed by their comparsion to those deduced from radar measurements.

Vertical thermocline displacement induced by the internal tides in the Adventure Bank over a neap cycle is estimated to be between 10 m and 15 m in the thermistor station [4] and it is in good agreement with previous estimations [4]. Besides, the power spectra of the vertical displacement amplitude in this location shows that K_1 prevails M_2 below the mixed layer (~20 m) which is also in agreement with measurement estimations [4]. Finally, the EOF decomposition of the temperature at this location shows that almost 90 % of the total temperature variance is contained in the first three modes.

References

1 - Omrani H., Arsouze T., Béranger K., Boukthir M., Drobinski P., Lebeaupin-Brossier C., Mairech H, 2016. Sensitivity of the sea circulation to the atmospheric forcing in the Sicily Channel. Progress in Oceanography 140 , 54–68.

2 - Bernager K., Mortier L., Gasparini G.P.,Gervasio L., Astraldi M., and Crépon M.,2004. The dynamics of the Sicily strait : A comprehensive study from observations and models, Deep-Sea Research I, 51, 411-440.

3 - Artale V, Provenzale A, and Santoleri R, 1989. Analysis of internal oscillations of tidal period on the Sicilian continental shelf. Cont. Shelf Res., 9, 867-868.

4 - Gasparini, G.P., Smeed,D., Alderson,S., Spanocchia,S.,Vetrano,A., and Mazzola,S, 2004. Tidal and subtidal currents in the Strait of Sicily, J. Geopys. Res.,109,p 1-19.

5 - Cosoli S , Aldo Drago A., Ciraolo G, Capodici F, 2015. Tidal currents in the Malta – Sicily Channel from high-frequency radar observations. Cont. Shelf Res., 109 , 10–23.

6 - MEDAR/MEDATLAS Group, MEDAR/MEDATLS 2002. Cruise inventory, observed and analysed data of temperature and bio-chemical parameters (4CD- ROMs).

ON THE EFFECT OF WIND AND TIDES ON THE HYDRODYNAMICS OF THE TUNISIAN CONTINENTAL SHELF

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Abstract
The combined effect of tides and wind on the hydrodynamics of the Tunisian continental shelf is investigated by using a two-dimensional configuration of ROMS Model. The induced circulation is characterized by a strong current flowing the eastern Tunisian coast and by an anticyclonic structure in the gulf of Gabes. Meteorologically currents first follow the Tunisian coast and are detached to flow between 100 and 200m isobaths and from 13°E, they flow as a strong coastal current. Autumn and summer are mainly characterized by low eddy activity related primarily to the wind.

Keywords: Circulation, Wind, Tides, Tunisian Plateau, Adventure Bank

1. Introduction

Numerical models allow isolation of the tidal forcing influence on the generation of specific features associated to the water exchange between the gulfs of Gabes and Hammamet and the open sea. Previous investigations [1-3] demonstrate that eddies generated in tidal flows are transient and their spatial structure may vary considerably through the tidal cycle. In this work, we will study the combined effect of tides and wind on the hydrodynamics of the Tunisian continental shelf and we will quantify the contribution of each forcing in the circulation. In order to achieve these goals, a 2D, finite-difference hydrodynamic numerical model was applied to the eastern Tunisian coast. However we assume that the sea is homogeneous, which is physically realistic over most of the shelf during the winter periods but not during the summer months where regions of the shelf are stratified.

2. Modelling approach

We used the barotropic version of the Regional Ocean Modelling System (ROMS). It solves the primitive equations in an earth centred rotating environment, based on the Boussinesq approximation and hydrostatic vertical momentum balance. ROMS uses stretched, terrain-following coordinates in the vertical and orthogonal curvilinear coordinates in the horizontal. ROMS is a split-explicit, free-surface oceanic model, where short time steps are used to advance the surface elevation and barotropic momentum equations [4]. The horizontal grid selected for this study consists of 241×193 grid elements with a spacing of 1/32° in both longitudinal and latitudinal directions, which corresponds to 2,7 km in the latitude and 2,7–2,8 km in the longitude. The model bathymetry is deduced from Smith and Sandwell topography database [5] by a bilinear interpolation of the depth data onto the model grid. Annual and seasonal wind stress data based on satellite observations (**QUIKSCAT**) are used to calculate the meteorologically induced circulation on the shelf. Tidal forcing was implemented by setting the elevations of the major constituents in the region, M_2, S_2, N_2, K_1 and O_1 [6] along the four open boundaries, with the coefficients taken from a two-dimensional gravity-waves model of the Mediterranean [7].

3. Results

In order to determine the meteorologically induced circulation on the shelf, five separate simulations were performed, one for each season, and one using annual meteorological input. In each simulation, the model was run from a state of rest to a steady state with the appropriate meteorological forcing, and with the most important tidal components in the region along its open boundaries. The pure tidal simulation was also performed, from a state of rest for an identical period of time. The meteorologically induced circulation on the shelf was computed for the five simulations by removing the tidal signal. The basic data used in the calibration/validation of the model results comes mainly from the tide gauge measurements. The model results agreed well with existing tidal elevation and phase observations for all simulated constituents. Indeed, the rms amplitude error does not exceed 2 cm and the rms discrepancy of phase-lag is about 17.5°. The combined action of tides and wind does not significantly enhance the quality of the simulated tidal characteristics. Currents flow southward along the Tunisian coast and become more intense, mainly in the Gulf of Gabes which is filled by the east and west. The maximum current occurs during the winter period, and the minimum in summer, a period of weak wind. The wind has a fairly limited impact on the direction of the currents in the Gulf of Gabes. However, the direction of the currents in the Adventure Bank and Malta plateau changes from season to season due to the change of wind direction. The Gulf of Gabes, the Adventure Bank and the Malta plateau are the only zones with relatively strong currents. Residual (meteorologically) currents directly flow the Tunisian coast between 100 and 200m isobaths, becoming stronger southward and reach the Libyan coast where they are intensified. The eddy activity generated during summer and fall is mainly induced by wind. The circulation in the Gulf of Gabes is relatively weak throughout the year with an anticyclonic circulation in winter and autumn, while the Sfax-Kerkennah channel is subject to strong currents along the coast except in summer. The only areas of strong interaction between wind and tide are the Gulf of Gabes and the Adventure BanK.

References

1 - Imasato, N., 1983. What is tide-induced residual current? Journal of Physical Oceanography, 13, 1307–1317.
2 - Geyer, W.R., Signell, R.P., 1990. Measurements of tidal flow around ahead-land with a ship board acoustic Doppler current profiler, Journal of Geophysical Research 95, 3189–3197.
3 - Geyer, W.R., Signell, R.P., 1992. A reassessment of tidal dispersion. Estuaries, 15(2), 97–108.
4 - Shchepetkin, A., McWilliams, J., The regional oceanic modeling system (ROMS): a split-explicit, free-surface, topography-following-coordinate oceanic model. Ocean Model. 9, 347–404, 2005.
5 - Smith, W.H.F., and Sandwell, D.T., 1997: Global sea floor topography from satellite altimetry and ship depth soundings, Sciences, 277, 1956-1962.
6 - Carrère, L. and Lyard, F., 2003: Modeling the barotropic response of the global ocean to atmospheric wind and pressure forcing-comparisons with observations: Geophys. Let., Vol.30,NO.6,1275.
7 - Abdennadher, J., and Boukthir, M, 2006, "Numerical simulation of the barotropic tides in the Tunisian shelf and the Strait of Sicily", *J. Mar. Syst.*, 63, pp. 162-182.

CHANGING OF THE DENSITY LEVELS OF IZMIR BAY, EASTERN AEGEAN SEA

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Abstract

The temporal variability of the density is studied by analyzing last decadal CTD data of the Izmir bay, Eastern Aegean Sea. The data show the period of rising isopycnals due to cooling in 2007, 2008 and 2012 as seen in literature about Aegean Sea. As a result, the Izmir Outer Bay area where Aegean origin surface water enters the bay, show similar interanual variability with Aegean Sea according to the water characteristics.

Keywords: Aegean Sea, Izmir Bay, Time series, Density

Izmir Bay, which is situated at the eastern part of the Central Aegean Sea, exchange water with Aegean Sea in the northern part of the bay (Figure 1). It is an "L" shaped geometry with the leg of the "L" about 20 km wide and 40 km long, It is divided into three areas according to their physical characteristics: Outer, Middle and Inner Bays. More than 50 hydrographic cruises have been conducted in the bay for last 30 years. The air sea interactions are more effective over the Izmir Bay area because of the shallowness (max. 70 m). Especially the local wind force is the main mechanism influencing the water characteristics of the bay.

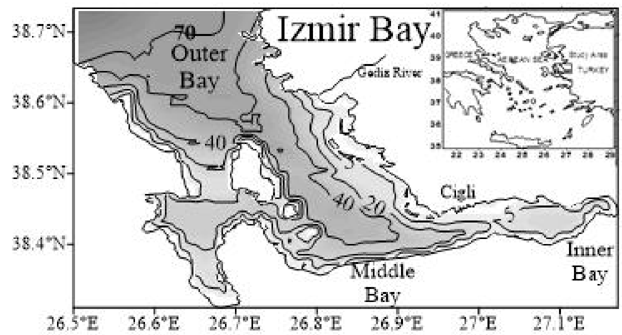

Fig. 1. The location and bathymetry of the Izmir bay.

In the Izmir Bay area, rising of the isopycnals could be resolved with the data collected during many cruises in the Outer Bay area. In this study after anlysis data, covering last 10 years, the increasing densities can be traced from the isopycnal level σ_θ = 29 kg/m^3 easily in the Izmir Outer Bay (Figure 2). This level reached up to surface in 2007, 2008, 2009 and 2012. These periods can be characterized by cooling events which are shown in Figure 2 for the same years.

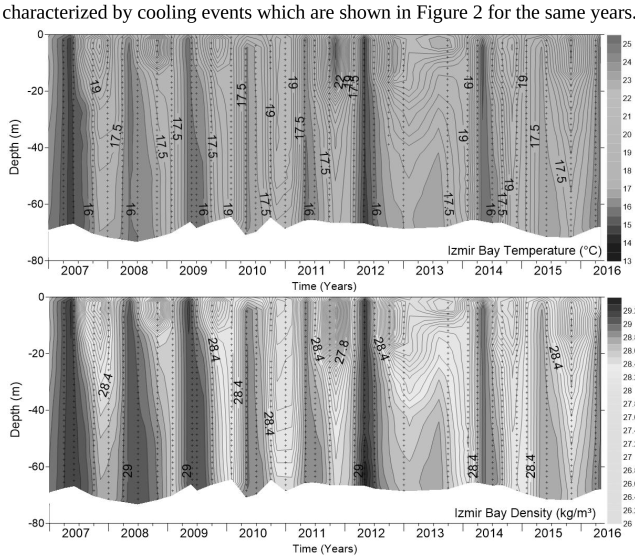

Fig. 2. Temporal evaluations of temperature and density fields of Izmir Bay Area

Eronat and Sayin, 2014 [1], emphasize that 2007 is the first time after 1993 (EMT Period) there have been a new severe deep–water producing episodes in the Aegean. Velaoras et al. 2014 [3] find that the dense Cretan Sea outflow occurs during 2007, 2008, and 2009 as called "EMT-like" event. Georgiou et al. (2014) [2] showed that the period of 2006–2012 is characterized by two strong cooling events (2008–2009 and 2012) in the south Aegean Sea and by a significant increase (2010–2011). These information obtained from the Aegean Sea and the present study of Izmir Bay is complementary to each other to explain the density levels in the last decade.

References

1 - Eronat, C., Sayin, E. (2014) "Temporal evolution of the water characteristics in the bays along the eastern coast of the Aegean Sea: Saros, Izmir, and Gökova bays" Turkish J. Earth Sci., 23, 53-66, 2014.
2 - Georgiou, S., Mantziafou, A., Sofianos, S., Gertman, I., Özsoy, E., Somot, S., & Vervatis, V. (2015). Climate variability and deep water mass characteristics in the Aegean Sea. Atmospheric Research, 152, 146-158.
3 - Velaoras, D., G. Krokos, K. Nittis, and A. Theocharis (2014), Dense intermediate water outflow from the Cretan Sea: A salinity driven, recurrent phenomenon, connected to thermohaline circulation changes, J. Geophys. Res. Oceans, 119, doi:10.1002/2014JC009937.

RECONSTRUCTION OF OCEAN CURRENTS AT SCALES SHORTER THAN 30 KM FROM EXISTING SATELLITE OBSERVATIONS: EDDIES ALONG THE IBERIAN COAST

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Abstract

Along-track altimetric measurements of Sea Surface Heights (SSH) are very well suited to quantify across-track currents. However, the spatial resolution of derived 2D velocities is restricted to scales above 100-150 km and the limited number of altimeters can lead to errors in the location of currents. On the contrary, infrared measurements of Sea Surface Temperature (SST) are well suited to locate flow patterns but it is difficult to extract quantitative estimations of ocean currents.To overcome the previous constrains we have developed a methodology able to provide enhanced 2D surface currents. Our approach opens the door to retrieve the velocity field associated to structures smaller than 30 km, not accessible through the standard SSH maps. Results are compared with drifting buoy trajectories showing good agreement.

Keywords: Remote sensing, North-Western Mediterranean, Coastal processes, Mesoscale phenomena

Data

We used infrared measurements provided by AVHRR downloaded from the Coastal Ocean Observatory hosted at the Institut de Ciències del Mar (CSIC). Due to their lower levels of noise we used Brightness Temperature (BT) from the Channel 4 instead of SST. Infrared data were processed according to [1]. In situ measurements consisted on a set of surface and CODE drifters released close to the coast of the Iberian Peninsula.

Results

First, the trajectories of surface drifters were compared to infrared images to identify those drifters that were captured by structures smaller than 30 km. Then, surface currents were estimated from infrared measurements using the transfer function approach described in [2]. In this study, it was also shown that the SQG approach was reasonable good at wavelengths below 100 km (see [3] and references therein for more details about SQG and [2] for its application to the Mediterranean). Therefore, we used the SQG transfer function for this study. The resulting fields were compared to the trajectories of drifters showing a good agreement (see figure 1). A more quantitative comparison was obtained by interpolating the velocities derived from thermal images onto drifter trajectories. Results for the example shown in figure 1 exhibited a linear correlation of 0.9.

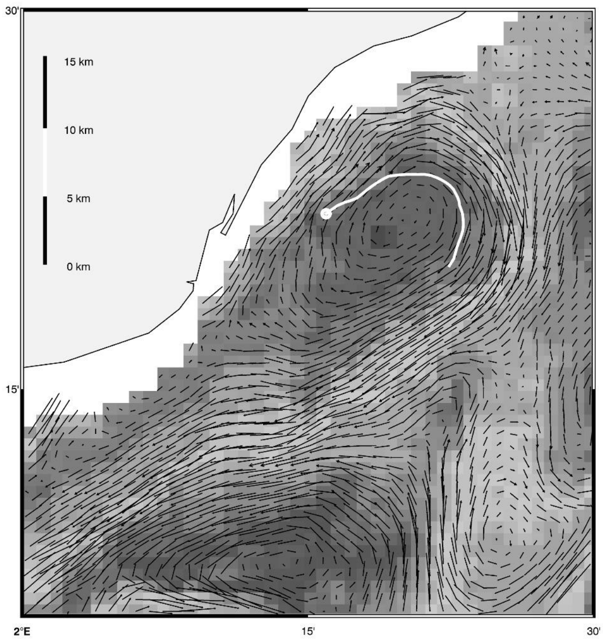

Fig. 1. Brightness temperature with the velocity field derived from it overplotted. The white line corresponds to the trajectory of a surface drifter. The White dot indicates its starting position

References

1 - Isern-Fontanet, J. and E. Hascoet (2014) Diagnosis of high resolution upper ocean dynamics from noisy sea surface temperatura *J. Geopys. Res.* 118 1—12
2 - Isern-Fontanet, J., M. Shinde, and C. Gonzalez-Haro, 2014: On the transfer function between surface fields and the geostrophic stream function in the mediterranean sea. J. Phys. Ocean, 44, 1406–1423, doi:10.1175/JPO-D-13-0186.1
3 - Isern-Fontanet, J., B. Chapron, P. Klein, and G. Lapeyre, 2006: Potential use of microwave SST for the estimation of surface ocean currents. Geophys. Res. Lett., 33, L24608, doi:10.1029/2006GL027801.

HIGH RESOLUTION MODELLING OF THE IMPACT OF A STORM ON THE COUPLING OF SEA STATE AND OCEANIC CIRCULATION IN THE GULF OF LION (NW MEDITERRANEAN SEA).

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Abstract
The Gulf of Lion (GoL, NW Mediterranean sea) is known to be the place of East-Southeastern winter storms. These extreme events induce energetic sea states, with significant wave height close to 5 m, and oceanic currents, which could reach 0.80 $cm.s^{-1}$ at the surface.These conditions are at the origin of large amounts of sediment resuspension and transport. Data obtained during a winter storm in March 2013 have been used to validate a coupled wave-current model. This high spatial resolution model permitted to study the impact of the storm on sea state and oceanic currents.

Keywords: Circulation models, Gulf of Lyon, Coastal processes, Waves, Continental shelf

The residual cyclonic circulation in the Gulf of Lion (GoL) is mainly induced by the Northern Current which is part of the Western Mediterranean circulation [1]. A study has shown that GoL sea state is generally quiet with significant wave height lower than 1.5 m [2]. This study also highlighted a specific period, from October to March, during which short events with more than 5 m wave height can be related to the passage of winter storms.

In the past ten years, the NW Mediterranean sea has been the place of several of these East-Southeastern (E-SE) storms. In the Gulf of Aigues-Mortes (NW GoL), waves with significant height greater than 5 m have been seen during the winter storm of 18 February 2007 [3]. The same study noticed strong surface currents that reached 0.8 $m.s^{-1}$ while near bottom current presented maximum value of 0.5 $m.s^{-1}$ close to 30 m depth. Similar observations have been made during 2011 winter storms offshore the Cap de Creus (SW GoL) [4]. Significant wave heights higher than 4 m have been observed and at the same time, maximum current speed of 0.55 $cm.s^{-1}$ have been measured.

Since the 2011 winter events, a major E-SE sea storm has been detected during the month of March 2013. Waves characteristics and currents have been measured off the coast of Sète (France) at the BESsète station (position : 43°20,035' N, 3°38,377'E).
These in situ observations have been used to validate a numerical model based on the coupling of the three dimensional ocean circulation model SYMPHONIE [5] and the generation and propagation wave model WAVEWATCH III [6]. To reproduce the effect of the storms on the circulation and the sea level on the Gulf of Lion continental shelf including the vicinity of the coastline, a bipolar numerical grid with a spatial resolution lower than 300 m along the coast has been used. The impact of the storm on the intensity of currents and turbulence on the whole continental shelf is discussed .

The energetics inputs in the water column induced by storms increases sediment resuspension. Consequently, the better the storms are simulated, the better the estimation of sediment transport will be reproduced. This work is therefore the first step in order to well represent the erosion and dispersal of sediment.

References
1 - Millot, C., 1990. The Gulf of Lion's hydrodynamics. Cont. Shelf Res. 10 (9-11) 885-894.
2 - Guizien, K., 2009. Spatial variability of wave conditions in the Gulf of Lions (NW Mediterranean Sea), Vie Milieu, 59, 261–270.
3 - Michaud, H., Leredde, Y., Estournel, C. and Berthebaud, E., 2013. Modelling and in-situ measurements of intense currents during a winter storm in the Gulf of Aigues-Mortes (NW Mediterranean Sea). Comptes Rendus Geoscience, 345, 361-372.
4 - Martin, J., Durrieu de Madron, X., Puig, P., Bourrin, F., Palanques, A., Houpert, L., Higueras, M., Sanchez-Vidal, A., Calafat, A. M., Canals, M., Heussner, S., Delsaut, N. and C. Sotin, 2013. Sediment transport along the Cap de Creus Canyon flank during a mild, wet winter. Biogeosciences, 10, 3221-3239.
5 - Marsaleix, P., Auclair, F., Estournel, C., 2009. Low-order pressure gradient schemes in sigma coordinate models: The seamount test revisited. Ocean Modelling 30, 169–177.
6 - Tolman, H., 2015. User manual and system documentation of WAVEWATCH-III version 5.08,Tech. rep. NOAA/NWS/NCEP/MMAB.
7 - Ulses, C., Estournel, C., Durrieu de Madron, X., Palanques, A., 2008. Suspended sediment transport in the Gulf of Lions (NW Mediterranean): Impact of extreme storms and floods. Cont. Shelf Res. 28, 2048–2070 doi:10.1016/j.csr.2008.01.015.

WATER RENEWAL MECHANISMS OF THE BAY OF ALGECIRAS IN THE STRAIT OF GIBRALTAR

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Abstract
The Bay of Algeciras (BA) is a marine environment subject to high levels of anthropogenic pressure. Here we analyze a number of ADCP observations collected at the bay and the results of an ocean circulation model to investigate its circulation, variability, and the mechanisms involved in the water exchange with the adjacent Strait of Gibraltar. It is found that the flushing of the bay, and therefore also its water quality, is largely dependent on the strength of tidal flows.

Keywords: Coastal processes, Coastal models, Gibraltar Strait

The BA is located at the north-eastern end of the Strait of Gibraltar (Fig.1). Covering an area of about 9x11 km and with a maximum depth of nearly 400 m, features by far the mildest surface currents of the strait, a circumstance that has made of this spot the ideal location for the settlement of harbors from the times of early civilizations. Today, the bay is a strategic point within one of the busiest shipping routes in the world and not for nothing holds two major ports in both Algeciras and Gibraltar, along with numerous industrial plants distributed all along its shoreline. Marine pollution is therefore a serious problem in the bay itself and in the surrounding areas.

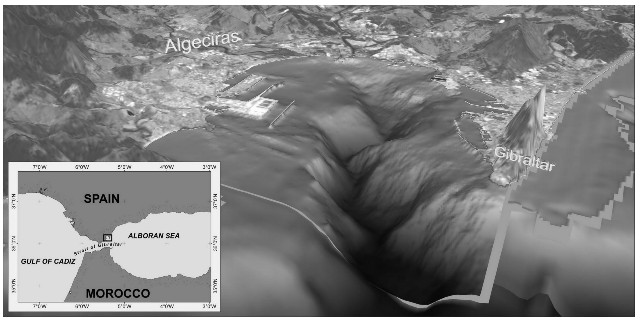

Fig. 1. Location and bathymetry of the Bay of Algeciras.

In order to understanding the circulatory system of the BA and the physical mechanisms involved in its water renewal, water quality, and exchange with the strait's main channel, three mooring lines equipped with autonomous CTs at around 10m above the seafloor and uplooking ADCPs were deployed at different locations of the bay during the Spring and the Fall of 2011. Moreover, with the aim to get a more comprehensible time-spatial data coverage, a high-resolution primitive equation model was used to conduct a hind-cast simulation for the mentioned period, whose results compared very satisfactorily with observations [1, 2].

Model and observations reveal that the mean surface circulation of the BA is characterized by an anti-cyclonic cell fed by a coastal current flowing in opposite direction to the jet of Atlantic Water offshore. The coastal current in question encompasses a narrow stripe along the north coast of the strait of Gibraltar and is within the lateral boundary layer. This circulation pattern is subject to substantial variability and its negative vorticity can be enhanced or diminish, even revert sign, depending upon meridional displacements of the referred jet. These displacements are shown to be linked to atmospheric-pressure driven flows that accelerate or slow down the jet. The second source of variability is due to winds and fulfills the expectations of Ekman dynamics, with surface currents entirely pointing offshore or inshore during westerly or easterly winds, respectively. The third source of variability, though no less important, are tides, able to revert the flow direction with semidiurnal periodicity.

A series of additional model runs tracking the evolution of passive tracers (dye) released in the BA were carried out in order to gain an insight into the mechanisms involved in the water renewal of the BA and discern the most favorable/unfavorable scenario for the flushing of the Bay. The dye was released within both the Atlantic (S<37.5) and the Mediterranean (S>37.5) layers in order to obtain a more complete picture of the process. For each release of the dye the corresponding *e*-flashing time was computed by the exponential fitting the dye concentration curve. The results are shown in Fig.2a and reflect substantial time variability.

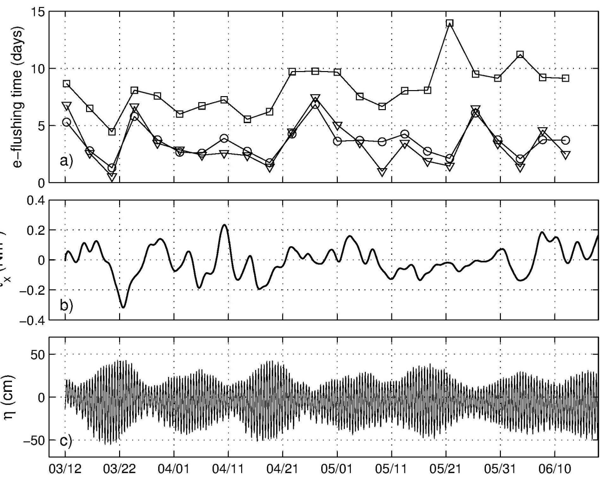

Fig. 2. A) Temporal dependence of the Atlantic (circles), Mediterranean (squares), and surface ($-5 < z < 0$ m; triangles) layer e-flushing times. The marks are located at the time of the passive tracer release. b) Horizontal component of wind stress over BA. c) Mean sea surface height.

The most direct outcome is that minimum (maximum) flushing times of the Atlantic (circles) and the very surface layers (triangles) are obtained for releases of the dye during spring (neap) tides (Fig. 2c), which suggests that tidal flows play a major role in the dispersal of the tracer therein. This does not apply, however, to the bottom Mediterranean layer (squares) in which tidal currents are weak, and ventilation of this layer appears to be connected with the variability of the wind forcing that is stronger during the first half of the simulation (Fig. 2b). These results suggest that the marine environment of the BA benefits from the relatively strong tides of the strait, and that its water quality would be significantly worse if it were located just few kilometers eastwards (within the Alboran Sea), where tides are practically absent.

References

1 - Sammartino et al., 2014, Cont. Shelf Res., 72, 34-46.
2 - Sánchez-Garrido et al., 2013, Prog. Oceanog., 116, 142-153.

BIOTIC VS. ABIOTIC PROCESSES SHAPING ORGANIC MATTER DYNAMICS IN THE NE AEGEAN FRONTAL SYSTEM

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Abstract
In the present study we discuss organic matter (OM) seasonal dynamics in coastal shelf waters of the Dardanelles Straits – North Aegean Sea frontal area. Our main goal was to understand organic matter dynamics taking into account the particle size continuum. We traced the particulate organic matter using inherent optical properties (IOPs), the macromolecular organic carbon fractions by measuring TEPs (Transparent Exopolymer Particles) and the dissolved organic matter using absorbance and fluorescence properties (CDOM). For the latter we used also the indices of absorption spectral slope S275-295 and the fluorescence ratio HIX (i.e. the ratio of the emission spectrum areas between 300-345nm and 435-480nm at 254nm excitation wavelength).

Keywords: Organic matter, Phytoplankton, Sedimentation, Fronts, Aegean Sea

The North Aegean Sea is a highly dynamic coastal area of the eastern Mediterranean Sea, where the low salinity, rich in dissolved organic matter (DOM) Black Sea Waters (BSW) mix with the highly saline and poor in DOM oligotrophic Levantine Waters (LW). In addition, the eutrophic environment of the Marmara Sea, with elevated rates of both primary and bacterial production is known to enrich the incoming BSW with particulate organic matter [1]. At the same time the NE Aegean Sea represents a shelf environment where particle dynamics and in situ processes should be taken into consideration. The study of OM in this environment is of particular importance since it represents the area where highly eutrophic continental waters are transferred to the oligotrophic Mediterranean Sea. Within the framework of the AegeanMarTech project we studied a north south transect from 39.6 oS to 40. 3 oN and from 25.4 oW to 25.7 oE (Figure 1) during October 2013, March 2014 and July 2014. The topography of this region includes the Limnos plateau, a shallow area (<100m) located east of Limnos isl., as well as the Limnos deep basin (~1600m) located between Limnos and Samothraki islands. A strong stratification of the water column (upper 30-40m) throughout the study area, caused by the increased outflow rates of brackish BSW and the higher surface temperatures was evident in October 2013 and July 2014. In addition, during these months, the prevailing strong NE winds (Etesians) spread the surface brackish layer towards the south. In March 2014, BSW waters were confined to the north part of the section and a less pronounced stratification was observed, favored by the lower surface temperatures and the limited Dardanelles outflow during winter. The frontal zone was confined between stations 5 and 6. The northern part of the sampled section is clearly affected by the presence of the Samothraki anticyclone. According to the spatial distribution of the backscattering ratio and the bulk particulate refractive index three water layers could be identified, associated with different particle composition: (a) BSW (~0-30 m) appears to be dominated by material with moderate index of refraction 1.141-1.159; (b) mid-waters (30-65 m) characterized by maximum fluorescence and lower index of refraction (1.120-1.135); and (c) the near-bottom layer which exhibits high n, up to 1.26. During March and July 2014 fluorometric chlorophyll-a concentrations indicate a period of enhanced productivity. TEP concentrations distribution is positively associated to diatoms distribution with high concentrations being recorded into surface waters of Black Sea origin. During March 2014 the elevated TEP concentrations in the top 100 m of the water column in station 2 is probably related to the high levels of extracellular release observed for this station [2]. During stratified conditions (October 2013 and July 2014) TEP distribution patterns in the subsurface layer, display relatively lower values (around 50 m depth), the lowest observed for October 2013. The spatiotemporal variability in the hydrography was depicted in CDOM distribution. Highest CDOM were always associated with low salinity waters. Nevertheless the three campaigns conducted during the present study allowed us to trace several in situ transformations of DOM taking place. A strong conservative character and coupling was established only during March 2014. It becomes clear that all BSW samples fall to the high a300 –low S275-295 terrestrial pool, and all LW samples to the low a300 – high S275-295 marine pool. The inflowing waters are rich in CDOM of high molecular weight and of aromatic character and mix with Levantine waters poor in DOC and CDOM of low molecular weight. During the summer months, the decrease in the CDOM absorption coefficient at 300nm observed for the surface layer during summer and autumn and the parallel increase in the spectral slope S275-295 is indicative of photodegradation processes [3]. Under the strong pycnocline conditions and the limited exchange between the two water layers during summer and autumn, it is expected that the subsurface LW waters (S>38) retain their optical properties i.e. low a300, high S275-295. Instead, our results showed low a300, but also low S275-295values. This could be due to impacts of microbial processes [3], but it could also be due to the influence of particles and sedimentary processes. Under stratified conditions, the Samothraki anticyclone is expected to be attenuated and particle export becomes less intense. We suspect that macromolecular compounds that otherwise will tend to flocculate and adsorb onto particles now remain in solution and may explain the decrease in S275-295 values. This is in accordance with the TEPs distribution discussed previously, and shows that when the vortex effect is attenuated the macromolecular compounds do not coagulate and can be traced in the dissolved rather than the particulate fraction (TEPs are filter retained macromolecules). Another feature, which differentiates bottom waters under stratified conditions, is the existence of different sources of OM at the Limnos plateau, as inferred by the relatively high HIX values, i.e. relatively increased visible fluorescence. Resuspension of sediments has been recorded for the October 2013 and July 2014 samplings at the Limnos plateau exactly at the same sites were HIX was found elevated as traced by the bulk refractive index n. Moreover, the generation and release of visible fluorescent FDOM from sediments has been reported [4] and provides strong evidence that the site specific increases observed in the visible fluorescent CDOM are linked to sedimentary organic material.

References
1 - Polat, S.C., Tugrul, S., 1995. Nutrient and carbon exchanges between the Black and Marmara Seas through the Bosporus Strait. Continental Shelf Research, 15(9), 1115-1132.
2 - Lagaria A., Mandalakis M., Mara P., Frangoulis C., Karatsolis B-Th., Pitta P., Triantaphyllou M., Tsiola A., Psarra S., 2016, Phytoplankton dynamics and community structure in relation to hydrographic features in the NE Aegean frontal area (NE Mediterranean). Submitted to Continental Shelf Research.
3 - Helms, J.R., Stubbins, A., Ritchie, J.D., Minor, E. C., Kieber, D.J., Mopper K., 2008. Absorption spectral slopes and slope ratios as indicators of molecular weight, source and photobleaching of chromophoric dissolved organic matter. Limnology and Oceanography, 53 (3), 955-969.
4 - Skoog, A., Wedborg, M., Fogelqvist, E., 1996. Photobleaching of fluorescence and organic carbon concentration in a coastal environment. Marine Chemistry, 55, 333-345.

CIESM Congress Session : Open ocean processes

Moderator : Birgit Klein, Federal Maritime and Hydrographic Agency, Hamburg, Germany

Moderator's Synthesis

The complex multi-scale dynamics of the Mediterranean Sea makes it a challenging task to provide sufficient in-situ observations that will further our understanding of the physical processes and enable predictions of the short and long-term behavior. Multi-disciplinary and multi-scale sampling in the Mediterranean basins should be guided by the synthesis of existing knowledge combined with theoretical considerations in order to avoid incomplete sampling so as to close knowledge gaps in time and space. The observation strategies should make use of the present technological progress and increase cross-basin coordination of experiments for systematic exploration. In recent decades, research in the Mediterranean did yield advanced knowledge of deep water formation processes, the hydrographic property changes and the eddy component of the circulation.
The communications covered a variety of physical and biogeochemical processes in the deep basins of the Mediterranean, including new results on:

- Observations of mesoscale eddies from SMOS data
- Climatologies of eddies in the Mediterranean
- Convection studies in the Gulf of Lions
- Progress made in installing an integrated marine monitoring system
- Glider missions in the Adriatic
- Quantification of eddies from altimetry including centrifugal accelerations
- Salinity measurements based on SMOS data
- Monitoring of the circulation in the Levantine Basin

The general debate which followed the presentations highlighted the fact that the observational data base in the Mediterranean is still sparse and often limited by the length of available time series and/or the spatial coverage. It was suggested to intensify the comparison to model output to help the analysis of the observational data, to identify key processes and areas where additional data would be needed. The discussion also highlighted that a model inter-comparison study and a thorough validation of models based on robust indices derived from data would be of much interest.

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CAN SMOS OBSERVE MESOSCALE EDDIES IN THE ALGERIAN BASIN?

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Abstract
The circulation of the Mediterranean Sea is dominated by the spread of fresh waters incoming from the Atlantic Ocean. Algerian eddies are accountable for the mixing between these newly entered waters and the saltier resident Mediterranean ones. New improvements in the processing of Soil Moisture and Ocean Salinity (SMOS) Level 2 (L2) data have allowed to produce new satellite-derived Sea Surface Salinity (SSS) maps able to capture, for the first time, the signature of Algerian eddies and track them in time. It has been shown that the capability to detect such vortices is stronger during winter.

Keywords: Remote sensing, Algerian Basin, Salinity

Data
Three years (2011-2013) of SSS were derived from Brightness Temperatures (BT) measured by SMOS and provided by the European Space Agency (ESA). SMOS data were processed according to [1] and used to generate an SSS map by means of a classical scheme of objective analysis applied over time periods of 9-days. Besides, numerical simulations of the circulation in the Mediterranean Sea have confirmed the strong tendency of the Sea Surface Temperature (SST) and SSS gradients to align [2]. This property has been exploited to improve SSS maps using the methodology proposed by [3], that combines information from SSS and SST. For this study, satellite-derived SSS were merged with Reynolds SST downloaded from NOAA. In addition, Absolute Dynamic Topography (ADT) maps provided by AVISO have been used to assess the capabilities of SSS maps.

Results
First, the vorticity field derived from altimetric maps and the SSS anomaly were compared. Here, the SSS anomaly has been computed as the band-pass filter of SSS using cut-off wavelengths of 100 and 200 km. As it is evident from the example in figure 1, there is a good agreement between the patterns seen in vorticity and SSS anomalies. Besides, anticyclonic vortices were identified in altimetric SSH measurement using the procedure proposed by [4]: a vortex core is the simply connected region with values of the Okubo-Weiss (W) parameter smaller than $-0.2\sigma_W$ and the same sign of vorticity. This definition does not capture the whole vortex but its core [4]. Once anticyclonic vortices were identified in SSH fields, the probability of having negative SSS anomalies inside anticyclonic eddies was evaluated. Results showed that, it is of the order of 0.7 in winter (December-March), which contrasts with the probability of having negative anomalies outside eddies (less than 0.5). On the contrary, the probabilities during other periods of the year are of the order of 0.5 in both cases.

Conclusion
Yes, for the first time it has been possible to detect Algerian eddies in satellite-derived SSS maps derived from SMOS measurements. It has been also shown that the capability to detect such vortices is stronger during winter.

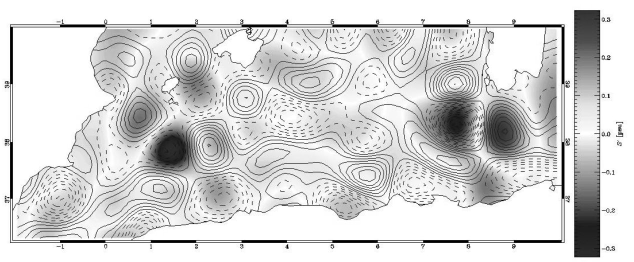

Fig. 1. Figure 1: SSS anomaly with vorticity contours overplotted. Solid (dashed) lines correspond to positive (negative) vorticity.

References
1 - Olmedo, E., J. Martinez, A. Turiel, and M. Ballabrera-Poy, J. and Portabella, 2016: Enhanced retrieval of the geophysical signature of smos sss maps. Remote Sensing of Environment, (in press).
2 - Isern-Fontanet, J., M. Shinde, and C. Gonzalez-Haro, 2014: On the transfer function between surface fields and the geostrophic stream function in the mediterranean sea. J. Phys. Ocean, 44, 1406–1423, doi:10.1175/JPO-D-13-0186.1.
3 - Olmedo, E., J. Martinez, M. Umbert, N. Hoareau, M. Porta- bella, J. Ballabrera-Poy, and A. Turiel, 2016b: Improv- ing time and space resolution of smos salinity maps using multifractal fusion. Remote Sensing of Enviroment, doi: 10.1016/j.rse.2016.02.038.
4 - Isern-Fontanet, J., Garcia-Ladona, and J. Font, 2006b: The vortices of the Mediterranean sea: an altimetric perspective. J. Phys. Oceanogr., 36 (1), 87–103

ATLAS OF EDDIES IN MEDITERRANEAN SEA FROM SATELLITE IMAGERY

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Abstract
We present an atlas of surface eddies in Mediterranean sea from 2000 to 2015 with their features: trajectory, size and intensity and also the main area of formation for long-lived eddies. The atlas is build from the Absolute Dynamical Topography (ADT) satellite imagery (AVISO 1/8°) thanks to a new automated eddy detection and tracking algorithm based on the computation of the LNAM (Local and Normalized Angular Momentum).

Keywords: Remote sensing, Mesoscale phenomena, Mediterranean Sea

Introduction

The increasing of resolution in regional model configurations allows to improve mesoscale processes which need to be evaluated at the basin scale. In this context we have developed an automated algorithm able to detect and track eddies from a wide diversity of oceanic velocity with distinct spatial resolution like satellite imagery and numerical models. Thanks to AVISO products[1], providing for the whole Mediterranean sea a time series of ADT at relatively high resolution (1/8°), the main eddies typical features and also formation areas from 2000 to 2015 are computed using the method.

Data

We use the geostrophic velocity fields distributed regional product for the mediterrannean sea derived from the Absolute Dynamical Topography (ADT). This regional product for the mediterrannean sea combines satellite altimetry up-to-date datasets with up to four satellites at a given time, using all missions available at a given time (Topex/ Poseidon, ERS-1 and -2, Jason-1 and -2, Saral, Cryosat-2 and Envisat missions). This merged product is projected on a 1/8° Mercator grid, in time intervals of 24 hours. The horizontal resolution of the 1/8° gridded velocity fields (13km) cannot fully resolve the internal deformation radius which is around $R_d = 8 - 12$km in the Mediterannean sea but is still less coarse than the 1/4° global product.

Method

The method is an improvement of the method by Mkhinini et al.[2], where we remove any geometric parameters. The principle of the method is to avoid the tuning of criteria as usually done in other methods which use the Okubo-Weiss parameter[3] or geometric parameter[4]. To fix parameters we performed several sensitivity test[5] on different velocity fields (satelitte imagery, idealized model, experimental cylindric tank). The only necessary condition is to provide the grid resolution of the velocity field and the typical deformation radius for the regional oceanic area or the experimental field.

3 consecutive steps compose the algorithm:

1) LNAM computation from velocity field to detect centers. This is a key step describe in Mkhinini et al. [2] to identify the centers of rotation in any velocity field and differenciate hyperbolic and elliptic point.

2) Eddy shapes with features computation for eddy centers surrounded by closed streamlines. This is a more classical step. The eddy's edge is the streamline with the higher mean velocity. This is arbitrary but has the advantage to directly provide the Rossby number.

3) Finally eddy tracking is performed by minimizing a coast function depending on difference between centers and features at different time steps [6].

Results

The algorithm applied to the 15 years ADT time serie point out 18900 eddies with 65% are less than 1 month life length. The number of cyclones dominate (60%) but for eddies older than 8 months the proportion between cyclone and anticyclone is equilibrated. Even if the averaged age for cyclones and anticyclones are identical (40 days) the older are antycyclones (11 anticyclones are more than 2 years old but only one cyclone). Also the mean size is similar for cyclones and anticyclone (20km) as well as the rotating speed (10cm/s).

The spatial distribution of the formation area for long-lived anticyclones more than 6 months (figure 1) confirms where the well known anticyclone usually take place (Iera Petra, Lybia, Cyprus, Alboran). Whereas the formation area for long-live cyclones (not shown) is often located at the deep sea water convecting area (Gulf of Lion,...).

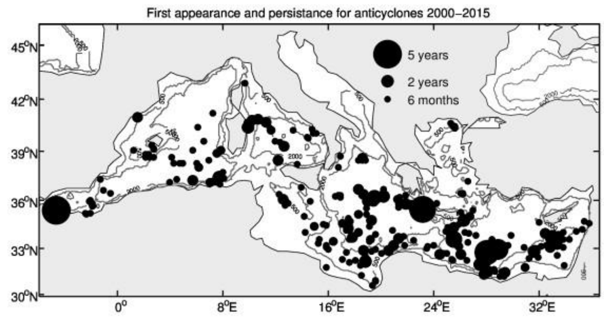

Fig. 1. First detection between january 2000 and december 2015 of long-life anticyclones.

Acknowledgements

The altimeter products were produced by Ssalto/Duacs and distributed by Aviso, with support from Cnes (http://www.aviso.altimetry.fr/duacs/)

References

1 - Http://www.aviso.altimetry.fr/en/data/products/sea-surface-height-products/regional/madt-mediterranean-sea.html#c5156

2 - Mkhinini et al. Long-lived mesoscale eddies in the eastern Mediterranean Sea: Analysis of 20 years of AVISO geostrophic velocities. JGR:O, 2014, doi:10.1002/2014JC010176.

3 - Chelton, D. B., M. G. Schlax, R. M. Samelson, and R. A. de Szoeke (2007), Global observations of large oceanic eddies, Geophys. Res. Lett., 34, L15606, doi:10.1029/2007GL030812.

4 - Faghmous, J. H. et al. A daily global mesoscale ocean eddy dataset from satellite altimetry. Sci. Data 2:150028 doi: 10.1038/sdata.2015.28 (2015)

5 - Tegner A. and B. Le Vu. Angular Momentum Eddy Detection and tracking Algorithm (AMEDA) and its application to coastal eddy formation. Part I:Methodology. In prep.

6 - Penven, P., V. Echevin, J. Pasapera, F. Colas, and J. Tam (2005), Average circulation, seasonal cycle, and mesoscale dynamics of the Peru Current System: A modeling approach, J. Geophys. Res., 110, C10021, doi:10.1029/2005JC002945.

OBSERVING SYSTEM SIMULATION EXPERIMENT OF HYMEX'S SOP2 TO STUDY THE WINTER 2013 CONVECTION EVENT IN THE GULF OF LION.

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Abstract
In winter 2013, deep convection events in the Gulf of Lion have been extensively sampled by a glider network in the HyMeX's SOP2 experiment. OSSE reproducing the real glider missions have been performed with the glider simulator SIGLID in a high-resolution hindcast simulation of the Western Mediterranean Sea during winter 2013. Characteristics of the deep convection events estimated from the simulated gliders are compared with those of the model simulation to validate the methodology and to assess the capabilities of the glider network to sample in time and space this extreme oceanic proccess. Finally, the methodology is used to quantify the renewal of the deep waters using the in-situ glider network observations sampled during SOP2.

Keywords: Gulf of Lyon, Deep waters, Sampling methods, Water convection

Over the last decade, underwater gliders have been increasingly operated to observe the ocean. They are particularly adapted for the study of meso to sub-mesoscale processes as deep convection, as they sample the ocean interior from the surface to a depth of 1 000 m with a high vertical resolution of a few meters, associated to an horizontal resolution of about 2 to 4 km.
In the framework of HyMeX's SOP2, a network of gliders has been deployed in the Western Mediterranean Sea during winter 2013 (Fig. 1). This experiment provided a substantial sampling of the ocean interior at the time when an intense deep ocean convection event occurred. The understanding of the processes involved is particularly important from dynamical, hydrological, biogeochemical and climatological perspectives.

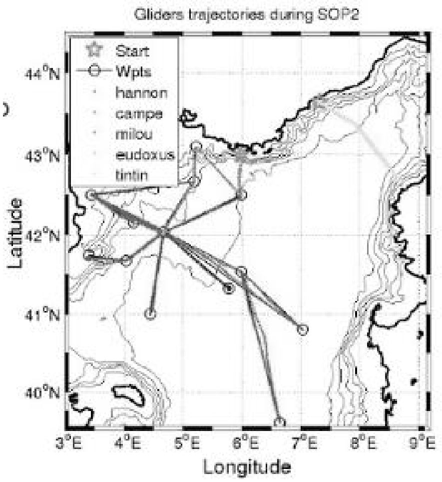

Fig. 1. Trajectories of the 5 gliders during the SOP2 experiment, from January to March 2013.

The dense in-situ dataset provided by the glider network has been used to evaluate the characteristics of the deep convection events [1]. With a multi-scale objective analysis method, the gliders data have been interpolated over the Gulf of Lion on a 10km by 10km horizontal grid, for different time periods ranging from 10 days to the season. An analysis of the interpolated fields has been undertaken to characterize the deep convection event. The convection area has first been estimated from the surface temperature and salinity fields for successive time periods (Fig. 2). The temperature of the intermediate waters (LIW, from 400 to 600 m depth) and the mixed-layer depth have also been estimated as indicators of vertical mixing. The temporal evolution of the energy content has been examined and a first estimate of the newly formed deep waters volume is provided.

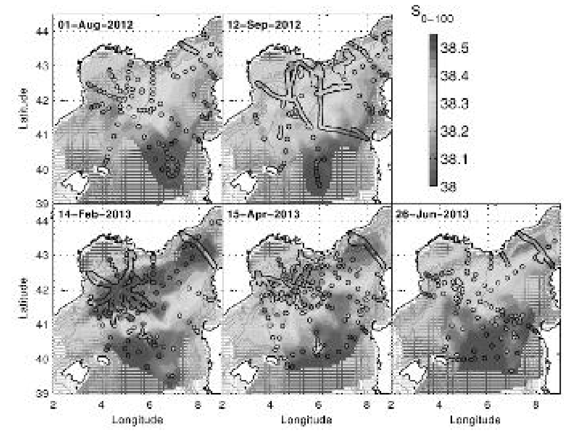

Fig. 2. Surface salinity in the Gulf of Lion constructed from the objective analysis of the in-situ data (gliders and CTD) collected between 08-2012 and 06-2013.

An Observing System Simulation Experiment (OSSE) has been performed, that simulates the SOP2 glider data sampling with the numerical glider simulator SIGLID [2] in a high resolution hindcast ocean simulation of the Mediterranean Sea. The glider simulator samples the 4D dynamical fields provided by the ocean numerical model along sawtooth trajectories reproducing those of the real gliders during their deployments at sea. The numerical simulation used is an hindcast of the Mediterranean sea during the winter 2013, performed with NEMO-MED36v75 model configuration (horizontal resolution of 2-3 km) forced by ARPERA atmospheric data set. The simulated glider data set has then been processed in the same way as the real glider data set, providing the characteristics of the deep convection event in the model simulation (deep convection area, volume of deep water formed,...). A comparison between estimates from simulated gliders and the ones based on the full simulation fields allows to test the performance of the methodology and to quantify the errors associated with the glider network undersampling in time and space.

References
1 - Bosse A., 2015. General circulation and physics-biogeochemistry coupling at sub-mesoscale in Northwestern Mediterranean Sea from in-situ data. PhD Thesis, UPMC, France.
2 - L'Hévéder B., L. Mortier, P. Testor and F. Lekien, 2013. A glider network design for a synoptic view of the oceanic mesoscale variability, JAOT, Vol 30, 1472-1493, DOI: 10.1175/JTECH-D-12-00053.1.

DEVELOPMENT OF AN AUTONOMOUS SYSTEM FOR INTEGRATED MARINE MONITORING

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Abstract

Increasing our understanding of the complex exchange among processes throughout ocean basins is severely limited by the paucity of infrastructures able to support sustained and interactive observations of the biological, chemical, physical, atmospheric and geological processes. Because all these processes interact in the ocean in complex ways, promoting a more fundamental scientific understanding of these relationships requires new and transformational approaches to ocean observation. In this work we are developing an autonomous system for integrated marine chemical, physical and biological monitoring – MarinEye. This system combine high-resolution imaging, acoustic, sonar, fraction filtration systems and sensors technologies in a modular, compact system that can be deployed on fixed and mobile platforms.

Keywords: Biodiversity, Chemical analysis, Bacteria, Monitoring, Mediterranean Sea

Marine organisms exert tremendous power over the planet, and linking the organisms to their environments by monitoring biological variables with contextualized environmental data (physical-chemical variables) is essential to evaluate the environmental status of marine ecosystems. While ocean observation technologies and programs have made considerable progress in advancing physical and chemical observing systems, bio-geochemical and biological monitoring is still under-represented and poorly implemented on ocean observatories (Barnes et al. 2007, Moloney et al. 2012). Thus, the present work addresses the urgent needs to provide regular monitoring of oceanic ecosystem function at the biological level, by developing an autonomous system for integrated marine chemical and biological monitoring. This device will provide key data to respond to time sensitive environmental issues. This is fundamental for accurately assess the health of marine ecosystems, necessary to protect more efficiently and promote sustainable management of marine resources. Also, such integrated data will promote the implementation of adaptative management approaches, as the EU Marine Strategy Framework Directive (MSFD, European Commission 2008), allowing the development of marine strategies for the continuous assessment of the environmental status of marine waters and the achievement and maintenance of the good environmental status (GES). The autonomous monitoring system consists of several modules, each particularly conceived to a specific oceanic compartment. One of the modules is a multi-sensor system that composed by different physico-chemical sensors, to measure temperature, salinity, dissolved oxygen and pH. This module also includes a novel optoelectronic sensor platform adapted and validated with dissolved CO_2 sensing layers envisaging further development and a new self-referencing mechanism for external light and biofouling. This modular multi-sensor system allows the collection of essential environmental physical and chemical data. MarinEye also integrates an underwater high-resolution imaging system to record plankton organisms targeting the main groups of phyto- and zooplankton. A third module is equipped with an active sonar system and an hydrophone for hydroacoustic surveys, to provide information about the presence of marine mammals as well as an estimation of fish abundance and schooling behavior. In addition, MarinEye harbours a forth module, an autonomous biological sampling device, specially designed for filtering and preserving two distinct biological size-classes of plankton species (including unicellular Eukaryotes and Prokaryotes). The genomes of these communities will be further examined (at DNA and/or RNA level) generating a multitude of data on species occurrence and function, providing an in deep understanding on the players of fundamental ocean processes responsible for maintenance of the global ocean balance. Thus, the autonomous monitoring system that is being developed combines a range of technologies capable of providing data that gives an integrated view of the different compartments of the ocean (physical, chemical, biological) at different levels of knowledge (from genomics to biogeochemistry and from micro to macro community dynamics) but synchronized in time and space. The capability to simultaneously monitor biological, chemical and physical data provides the ability to answer questions about how organisms interact with their environment and with each other, and how these interactions influence the overall ecosystem stability. MarinEye also includes a centralized data base infra-structure that will aggregate all the diverse data sources (physical, chemical, biological) collected by the different modules. This data base feeds a platform of data visualization and summarization that can provide synthetic summaries of the main events of the system in order to simplify data analysis. Moreover, the platform also implements several modelling tools that have as main goal to uncover unsuspected and useful patterns that may exist on the physico-chemical and biological data sets generated. The development of the proposed autonomous monitoring system capable of acquiring biological, physical and chemical data at the same spatio-temporal resolution will represent a great advance in integrated ocean data generation with an important impact in monitoring and measurements programs, which will certainly contribute to the maintenance of the Long Term Ecological Research (Caroppo et al. 2013), deepen the knowledge of the community response and helping deriving accurate multimetric indicators to assess the environmental status of marine ecosystems (Racault et al. 2014).

References

1 - C. R. Barnes, "Building the World's First Regional Cabled Ocean Observatory (NEPTUNE): Realities, Challenges and Opportunities," in *Oceans 2007*, 2007, pp. 1–8.

2 - C. Caroppo, I. Buttino, E. Camatti, G. Caruso, R. De Angelis, C. Facca, F. Giovanardi, L. Lazzara, O. Mangoni, E. Magaletti. 2013. State of the art and perspectives on the use of planktonic communities as indicators of environmental status in relation to the EU marine strategy framework directive. Biologia Marina Mediterranea, 20: 65-73.

3 - European Commission, 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, establishing a framework for community action in the ?eld of marine environmental policy (Marine Strategy Framework Directive). Of?cial Journal of the European Union L164, 19–40.

4 - J. Moloney, C. Hillis, X. Mouy, I. Urazghildiiev, and T. Dakin, "Autonomous Multichannel Acoustic Recorders on the VENUS Ocean Observatory," in *2014 Oceans - St. John's*, 2014, pp. 1–6.

5 - M.-F. Racault, T. Platt, S. Sathyendranath, E. Agirbas, V. M. Vicente, R. Brewin. 2014. Plankton indicators ocean observing systems: support to the marine ecosystem state assessment. Journal of Plankton Research, 36: 621–629.

SOUTH ADRIATIC GLIDER MEASUREMENT DURING NOVEMBER 2015

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Abstract
A glider operated in the South Adriatic Pit (SAP) in November 2015, revealed a salinity structure along the water column with two maximum: a subsurface layer with salinity larger than 38.9 and a deeper one between 400 and 600 m with salinity around 38.8. The origin of the salinity double maxima, not seen in previous years, seems to be due to the deepening of the Levantine Intermediate Water (LIW) in the last 3 years and to an intrusion of saltier water mass in a shallower layer whose origin might be found in the Eastern Ionian Sea area.

Keywords: Salinity, Adriatic Sea

Introduction
The SAP is influenced by the general Adriatic circulation carrying water masses with different characteristics: the modified LIW is the saltiest water entering from the South through the Otranto Strait; the Western Adriatic Current (WAC) brings less salty waters originated from the Po River in the North-East [1]. The SAP is also affected by both coastal and open sea winter convection processes. The coastal convection in the North Adriatic Sea produces the Northern Adriatic Dense Water (NAdDW) that sinks to the bottom flowing to the South along the Italian shelf break [2]. The open water convection can annually vary significantly [3]. In some years the vertical mixing affects only the shallowest surface layers, in others, the mixing can be much deeper reaching 800 m. In the last 3-4 years, floats and gliders have been deployed in the South Adriatic Sea to better study the physical and biogeochemical characteristics and their changes and evolution. We hereby focus on the November 2015 measurements which happen to show interesting and novel structures.

Material and Methods
Gliders are autonomous underwater vehicles with no propulsion; their motion is due to buoyancy change. They follow an up-and-down, sawtooth-like profile through the water from the surface to a maximum depth of about 1000 m, collecting data at a selected frequency. The 2-way Iridium satellite communication allows sending new commands to the gliders and receiving the collected data each time they are at surface. Gliders can reach a forward horizontal velocity of about 30 km/day and they have autonomy of up to four months. The glider used for this work is a Teledyne deep Slocum glider equipped with a Sea-Bird pumped CTD, an AAnderaa Optode 4831 oxygen sensor, a WetLab ECO Triplet FLBBCD-SLK. The glider route followed the Bari-Dubrovnik transect (and back) recording data during downcast and upcast reaching a maximum depth of 950 m. The full dataset were edited in order to eliminate outliers. Oxygen concentration must be interpreted with caution due to possible problems with sensor calibration. Ancillary temperature and salinity data were provided by 3 Argo floats in the South Adriatic and other floats in the Ionian.

Results
The glider operated in the SAP in November 2015, sampled a typical late fall stratified condition with maximal temperature of 17 ºC at the surface and a minimum of about 13 ºC at depth. The salinity structure along the water column exhibits two maxima: a subsurface layer with salinity larger than 38.9 and a deeper layer between 400 and 600 m with salinity around 38.8 (Fig. 1). The oxygen concentration maximum layer is located on top of the salinity maximum layer (Fig. 1). The temporal evolution of the salinity captured by floats, deployed in the SAP in 2013 and lasting for over 3 years shows the evolution the deepest maximum salinity layer. At the end of summer 2013, the salinity maximum of about 38.9 was around 250 m, in the 2014 a deepening of the core was detected at around 300 m and in 2015 the core moved to 500 m with a slightly lower salinity. In fall 2015 a layer of higher salinity values (over 38.9) was measured at about 100 m. The glider missions conducted in the SAP in late spring 2013, spring 2014 and 2015 give coherent snapshots of the salinity structure and confirm its evolution.

Conclusions
The double layer of salinity maximum observed in November 2015 in the SAP seems to be due to the deepening of the LIW in the last 3 years and to an intrusion of saltier water mass in a shallow layer whose origin might be found in the Eastern Ionian Sea area.

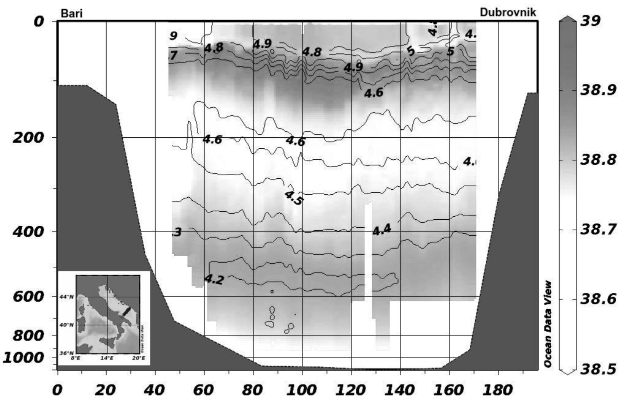

Fig. 1. Colour coded salinity distribution along the Bari-Dubrovnik glider track on top. In the left, oxygen concentration (ml/l) contours are overlaid on top. On the left bottom corner the map of the investigated area with the glider transect.

References
1 - Poulain, P.-M. (2001), Adriatic Sea surface circulation as derived from drifter data between 1990 and 1999. Journal of Marine Systems, 29, 3-32.
2 - Bignami, F., E. Salusti and S. Schiarini (1990), Observation on a bottom vein of dense water in the Southern Adriatic and Ionian Seas. J Geophys Res 95(C5), 7249–7259.
3 - Ovchinnikov IM, Zats VI, Krivosheya VG, and Udodov AL. 1985. A forming of deep eastern Mediterranean water in the Adriatic Sea. Okeanologyja **25**(6): 911–917.

MEDITERRANEAN SEA SURFACE SALINITY MEASURED FROM SMOS

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Abstract
The Soil Moisture and Ocean Salinity (SMOS) mission is an innovative Earth Observation satellite launched on November 2009 to remotely sense soil moisture over land and sea surface salinity over the oceans [1,2]. Due to some limitations with the processing technology, SMOS SSS maps still displayed significant artifacts and biases that until now prevented to retrieve SSS in the Mediterranean. In this work new techniques (calibration techniques [3]; image reconstruction methods [4, 5]; SSS retrieval algorithms [6]; and fusion schemes [7]) have been applied, allowing us to compute SMOS SSS maps in the Mediterranean for the first time. In this work we present these new SMOS SSS maps and we provide an assessment of their quality by means of their comparison with Argo buoys and SSS measurements obtained in several campaigns [8].

Keywords: Mediterranean Sea, Salinity, Remote sensing

After more than six years of mission, the retrieval of the Mediterranean Sea Surface Salinity (SSS) using the measurements by the satellite Soil Moisture and Ocean Salinity (SMOS) mission had not been possible. Many instrumental error patterns, as Land-Sea Contamination (LSC), seasonal biases, differences between ascending and descending orbits, systematic sources of Radio Frequency Interference (RFI), etc. [7,8], made impossible the computation of SSS in the Mediterranean. Recently, a study on LSC has shown that the correlator efficiency errors are the main driver of this contamination and a simple correction scheme has been proposed to mitigate it [1]. On the other hand, a novel image reconstruction technique, the Nodal Sampling [2], has been introduced to reduce tails and ripples (the so-called Gibbs-like contaminationm produced by land/sea/ice transitions and RFI sources). In this work we have used these two techniques together. So, the correction proposed in [1] has been applied prior to the image reconstruction by nodal sampling technique. The resulting Brightness Temperatures (TB) are in better agreement with the modeled ones [3].

A non-Bayesian approach is used for retrieving SSS from the improved TB [4]. In this approach, one SSS is directly retrieved for each TB measurement. On one hand, this retrieval methodology allows a better characterization of the systematic biases and therefore a proper correction of such patterns. On the other hand, new filtering criteria based on the statistical properties of sets of SSS that have been retrieved under the same orbital conditions along six years of SMOS mission, allow us providing measurements in areas where SMOS could not provide information until now. Finally, the time and space resolution of the SSS maps have been improved by using the Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA) Sea Surface Temperature (SST) maps [9]. We have used the methodology proposed in [5], which starting from some established principles of horizontal turbulence shows that the gradients of both SSS and SST can be related by a smooth matrix (a composition of a rotation and a scale factor), and that matrix can be estimated from the data themselves.

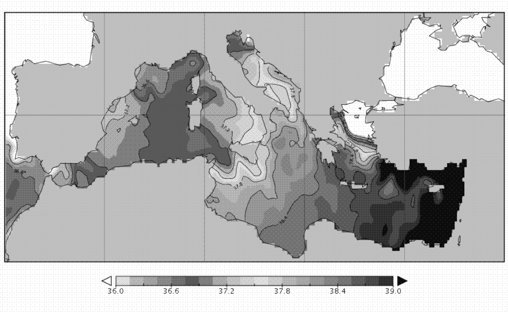

Fig. 1. SMOS Salinity map for the 10th of September of 2012

We have generated five years (2011-2015) of daily maps. Figure 1 shows the SMOS SSS map for the 10th of September of 2012. Three different sources of data have been used for assessing the quality of these new maps. First, the SMOS salinity maps have been compared with the Mediterranean Sea Physics Analysis and forecast provided by Copernicus [10]. Second, in situ data from close-to-surface acquisitions by Argo floats (freely distributed by the CORIOLIS data center, http://www.coriolis.eu.org) have been used for computing statistical information of the differences between the remote sensed and in situ measured salinities. Third, measurements of the thermosalinometers (TRANSMED [6]) and opportunity ships have been used for assessing the capability of SMOS for monitoring the salinity dynamics and capturing the mesoscale in the Mediterranean.

Although there are some pending issues, the new SMOS salinity maps in the Mediterranean attain a reasonable quality and are able of capturing the main SSS signature.

References

1 - I. Corbella, I. Durán, L. Wu, F. Torres, N. Duffo, A. Khazaal, M. Martin-Neira, in Geoscience and Remote Sensing Letters, IEEE , vol.12, no.9, pp.1813-1817, Sept. 2015, doi: 10.1109/LGRS.2015.2428653.
2 - V. González-Gambau, A. Turiel, J. Martinez, E. Olmedo, and I. Corbella, in Microwave Radiometry and Remote Sensing of the Environment (MicroRad), 2014 13th Specialist Meeting on, 124-127, 24-27 March 2014, doi: 10.1109/MicroRad.2014.6878922.
3 - V. González-Gambau, E. Olmedo, A. Turiel, J. Martínez, J. Ballabrera, M. Portabella, and M. Piles, Remote Sensing of Environment, DOI: 10.1016/j.rse.2015.12.032.
4 - E. Olmedo, J. Martínez, A. Turiel, J. Ballabrera-Poy and M. Portabella, “Enhanced retrieval of the geophysical signature of SMOS SSS maps. Remote Sensing of Environment, (Submitted).
5 - E. Olmedo, J. Martínez, M. Umbert, N. Hoareau, M. Portabella, J. Ballabrera-Poy, and A. Turiel. Remote Sensing of Enviroment, DOI:10.1016/j.rse.2016.02.038.
6 - Taupier-letage Isabelle; Bachelier Celine; Rougier Gilles; (2014): Thermosalinometer TRANSMED, Marfret Niolon, definitive data set; SEDOO OMP. http://dx.doi.org/10.6096/MISTRALS-HyMeX.1127
7 - Daganzo-Eusebio, E., Oliva, R., Kerr, Y. H., Nieto, S., Richaume, P., and 574 Mecklenburg, S. M. (2013). Geoscience and Remote Sensing, IEEE Transactions, 51 (10):4999-5007.
8 - Oliva, R., Daganzo-Eusebio, E., Kerr, Y., Mecklenburg, S., Nieto, S., Richaume, P., and Gruhier, C. (2012). IEEE Transactions on Geoscience and Remote Sensing, 50(5):1427-1440.
9 - C. J. Donlon, M. Martin, J. Stark, J. Roberts-Jones, E. Fiedler and W. Wimmer (2012). Remote Sensing and Enviroment, 116 (0), 140-158.
10 - A. Grandi, M. Tonani, E. Clementi, D. Damiano and J. Pistoia, (2015) “Quality information document for the Mediterranean Sea Physical Analysis and Forecasting Product”, Technical Note.

CYCLOGEOSTROPHIC CORRECTION OF THE AVISO SURFACE VELOCITIES FOR INTENSE SURFACE EDDIES AND ITS APPLICATION TO THE MEDITERRANEAN SEA.

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Abstract
The surface geostrophic velocities derived from the satellite altimetry allows to quantify surface eddies. However, the neglect of centrifugal accelerations results in an over estimation (underestimation) of the velocities in the cyclonic (anticyclonic) eddies. . The main goal of this study was to identify the range of parameters where the cyclogeostrophic correction is needed. Iterative and perturbative methods were both studied to provide a robust algorithm able to converge for a wide range of parameters. This ageostrophic correction was tested on the 1/8° AVISO regional product available for the Mediterranean Sea and correction up to 50% or 120% were accounted.

Keywords: Mesoscale phenomena, Remote sensing, Water transport, Algerian Basin, North-Eastern Mediterranean

The recent progress in automated eddy detection algorithms enables to identify coherent structures at the ocean surface. Several algorithms [1,2] use the surface geostrophic velocities derived from the satellite altimetry to quantify the size and the intensity surface eddies. However, neglecting the centrifugal accelerations results in an over estimation (underestimation) of the velocities in the cyclonic (anticyclonic) eddies. Errors up to 50cm/s were found for the intense eddies of the Mozambique chanel when centrifugal accelerations is neglected [3]. For an horizontal, stationary and non-dissipative flow, the momentum equation that rely the sea surface deviation *h* with the horizontal velocity ***u*** is given by:

$$\mathbf{u}.\nabla\mathbf{u} + f\mathbf{k}\times\mathbf{u} = -g\nabla h$$

Solving this non-linear equation leads to a complex inversion problem that may not always converge. Exact solution exists only for a circular eddy but the wide majority of oceanic structures are not axisymmetrical. The geostrophic assumption allows a simple linear inversion for all cases but its validity is restricted to small Rossby numbers. The main goal of this study was to identify the range of parameters where the cyclogeostrophic correction is needed to quantify accurately the vortex Rossby number of surface eddies:

$$Ro = \frac{V_{max}}{f\,R_{max}}$$

where V_{max} is the maximal azimuthal velocity and R_{max} the corresponding radius. The perturbative and iterative methods were both tested to calculate the ageostrophic terms. We found that combining the iterative method with a quintic interpolation provides the best accuracy when the vortex Rossby number do not exceed 0.3. We then apply this algorithm on the AVISO ADT geostrophic velocities, gridded at 1/8°, in the Mediterranean Sea. We first select the intense surface eddies, having a vortex Rossby number larger than 0.12, detected by the angular momentum eddy detection algorithm [2] during the 15 year period between 2000 and 2015. We consider only meso scale eddies having a typical radius equal or larger than the local deformation radius and exclude smaller vortices. Then we compute the ageostrophic corrections of the velocity component in a restricted area centered on the detected eddy.

An example of corrected velocity profile is given in Figure 1 for the Ierapetra anticyclone. The amplitude of the maximal cyclogeostrophic velocity is 30% higher than the geostrophic one while the characteristic eddy radius is reduced by 10%. The global analysis for the various eddies show an asymmetry between cyclonic and anticyclonic structures. The ageostrophic correction is much weaker for the intense cyclones than for the anticyclones. Moreover, we found that anticyclones with an initial geostrophic Rossby number of 0.2 need a significant ageostrophic correction up to 30% or 40% (120% when Ro was around 0.26). The amplitude of this correction depends on the Rossby number but also on the ellipticity and the shape parameter of the velocity profile. Circular anticyclones with a steep velocity gradient will lead to the strongest ageostrophic correction. Our analysis shows that the geostrophic velocities of anticyclones derived from the satellite altimetry should be corrected even for relatively weak geostrophic Rossby number of 0.1

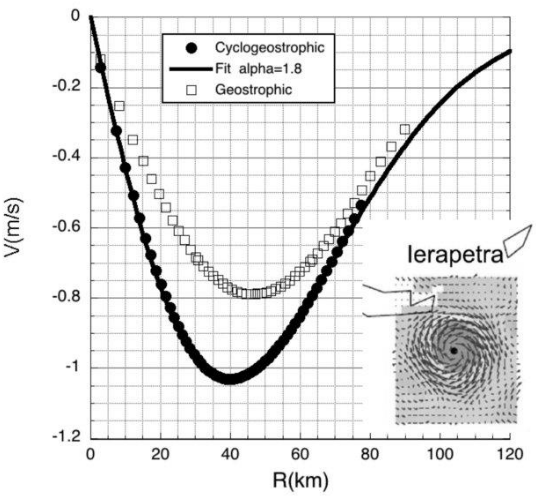

Fig. 1. Geostrophic (open square) and cyclogeostrophic (filled circle) velocity profile computed from the AVISO absolute dynamical topography for the Ierapetra eddy August 12, 2014.

Hence, in the Mediterranean Sea the intensity of a large number of meso scale eddies are underestimated by the standard AVISO geostrophic velocties and a optimized algorithm is proposed to compute these ageostrophic component of motion.

References

1 - Nencioli, F., C. Dong, T. Dickey, L. Washburn, and J. C. McWilliams, 2010. A vector geometry-based eddy detection algorithm and its application to a high-resolution numerical model product and high-frequency radar surface velocities in the Southern California Bight, J.Atmos. Oceanic Technol., 27(3), 564–579
2 - N.Mkhinini, A.L. Santi-Coimbra, A.Stegner, T. Arsouze, I. Taupier-Letage and K. Béranger. 2014. Long-lived meso-scale eddies in the Eastern Mediterranean Sea: analysis of 20 years of AVISO geostrophic velocities. J. Geophys. Res. Oceans, 119, 8603–8626, doi:10.1002/ 2014JC010176.
3 - P. Penven, I. Halo, S. Pous, and L. Marié, 2014. Cyclogeostrophic balance in the Mozambique Channel, J. Geophys. Res. Oceans, 119. doi:10.1002/ 2013JC009528.

TWO DECADES OF MONITORING AND FORECASTING OF THE CIRCULATION IN THE LEVANTINE (1995-2016)

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Abstract

The in-situ data gathered the last two decades in the Levantine Basin from several hydrographic campaigns (CYBO, CYCLOPS, MSM/14, Haifa-Sec), the Argo floats, the drifter deployments (NEMED project) and several gliders missions, along with data provided by the well established operational numerical modeling systems of ALERMO, CYCOFOS and SELIP, nested in MFS (nowadays in Copernicus marine service), have all provided insight on the dominating meso-scale coherent circulation features of the basin and their variability. The above long term in-situ monitoring and forecasting provides also extend of the main waters masses characterizing the area and demonstrates the increase of the temperature and salinity not only at the surface and subsurface layers, but also in deep waters, through these twenty years.

Keywords: Levantine Basin, Mesoscale phenomena, Salinity, Temperature

Preface. In the 1980s, during the mutli-national POEM cruises [1], a detailed pattern of the meso-scale circulation in the Levantine Basin was defined, and consisted of several alternative cyclonic and anticyclonic eddies and gyres, an offshore cross basin jet, the Mid Mediterranean-MMJ, as well as the anticlockwise current along the coasts of the basin. The dominant flow feature in the open part of the Levantine was identified to be a non-permanent multi-pole gyre, the Shikmona that consisted of few eddies, of which the most northern one, the Cyprus warm eddy is the most well pronounced. The present work aims to provide an overview of the meso-scale hydrodynamical features of the Eastern Mediterranean - Levantine Basin, based on synoptic in-situ data obtained the last 20 years, after the POEM cruises, from various observing platforms, as well as from the well established operational numerical models in the basin, assimilating satellite and in-situ data.

Discussion and Results. The new data sets obtained from in-situ investigations in the Levantine Basin, in the frame of CYBO, CYCLOPS, MSM/14, Haifa-Sec (Figure 1) and NEMED research projects made possible to provide, after some years of scientific disputes on the circulation pattern of the basin, as presented in [2], strong evidences about the seasonal and inter-annual variability of the main hydrodynamical features of the basin, such as the MMJ, the Cyprus warm eddy, the Shikmona eddy generation and the periodical re-establishment of the Shikmona gyre [3,4]. Based on these new in-situ data sets, it is evident that the Cyprus warm core eddy is the dominant feature in the area, with significant fluctuations in time and space. The generation of the Shikmona gyre as a non permanent eddy, was observed as a result of the fluctuation of the northward current along the eastern coastline of the Mediterranean. The latter is also evident in the drifter trajectories, gathered by the NEMED project that showed that this eddy is detached from the northward current towards the area of the secondary eddy, as observed by CYBO cruises and the CYCOFOS forecasts. Initially, the secondary warm eddy observed at the SE end of the Levantine was found during periods when the Cyprus warm eddy became weaker and shifted westward or southward from Eratosthenes SM. During theses long term observing campaigns it was found periodically the re-establishment of the Shikmona gyre, when the co-existence of the Cyprus and Shikmona warm eddies were observed. 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]. Similarly, the higher resolution numerical datasets from ALERMO, CYCOFOS and SELIPS forecasting systems, all nested in MFS, reveal that the dominant flow features in the SE Levantine is the Cyprus warm core eddy. The Shikmona eddy, which is generated during periods when the Cyprus eddy becomes weaker and/or shifted westward or southward from Eratosthenes SM, and when the strong northward current flowing along the Israel-Lebanese coast becomes unstable. The latter is also evidently in drifter trajectories, deployed during the NEMED project. The drifter trajectories show an anticyclonic eddy to be detached from the prevailed northward current along the coast. Synthesis of circulation patterns derived from the in-situ and numerical data sets obtained in the Levantine during 1995-2016, provide a typical picture of the meso-scale circulation, where: a)the Cyprus and Shikmona eddies, as well as the MMJ are the dominant flow features; b)the Cyprus warm eddy presents strong spatial and temporal variability; c)the variability of the displacement of the Cyprus warm eddy affects the MMJ and the eastward transfer of the AW; d)The Shikmona eddy was found to be established for certain periods, when the Cyprus eddy shifts to the west, south-west; e) the MMJ flows along the northern periphery of the Cyprus eddy and is the major current transferring the AW in the area.

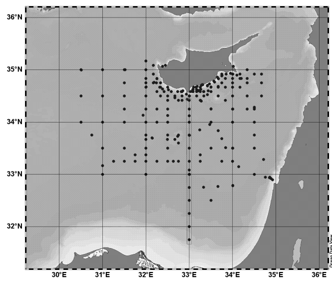

Fig. 1. Figure 1 : Maps with CTD stations in the Levantine during CYBO cruises from 1995-2010, CYCLOPS, MSM/14, Haifa-Sec and during the PERSEUS project, in the frame of the CYBO-HaiSec cruises in October and December 2012 and March 2013.

References

1 - POEM group, (1992). General circulation of the eastern Mediterranean, Earth Sci. Rev., 32: 285-309.

2 - The Climate of the Mediterranean Region, from the past to the future (2012) . P. Lionello Editor, 590 p. ISBN 9780124160422. Elsevier. Circulation of the Mediterranean Sea and its variability, 187-256.

3 - Zodiatis G., Drakopoulos P., Brenner S., Groom S., (2005). Variability of the Cyprus warm core Eddy during the CYCLOPS project, DSR- II, 52, 2897–2910.

4 - Menna, M., P.M. Poulain, G. Zodiatis, I. Gertman, 2012, On the surface circulation of the Levantine sub-basin derived from Lagrangian drifters and satellite altimetry data, DSR- I, 65, 46-58.

5 - Pinardi Nadia, et. al.(2015). Mediterranean Sea large-scale low-frequency ocean variability and water mass formation rates from 1987 to 2007: A retrospective analysis. Progress in Oceanography Volume 132, 318–332.

CIESM Congress Session : Open ocean processes in the Mediterranean and Black seas

Moderator : Pierre-Marie Poulain, OGS, Trieste, Italy

Moderator's Synthesis

Most of the processes prevailing in the open ocean can also be found in the Mediterranean and Black Sea (MBS). In fact, the MBS can be considered as a miniature ocean. These processes include deep convection and deep water formation, the mixing due to the meso and sub-mesoscale variability, the exchange of biogeochemical properties between the shelf and deep waters, extreme atmospheric forcing and climate change effects, such as the sea level rise, the increase of the water temperature and salinity, and the seawater acidification. Due to the limited geographical extent of the MBS, observations on these processes might be easier to collect, despite geopolitical restrictions, with respect to the World Ocean. Nevertheless, an international, multiplatform, multivariable (multi-model) approach is necessary, along with an integrated and harmonized monitoring system of systems. The communications presented in this session covered a variety of physical and biogeochemical processes prevailing in the MBS, including new research results on:

- Deep currents in the NW Mediterranean;
- Sinking particles and the biological carbon pump in the Ionian Sea;
- An important sub-surface mesoscale eddy in the Levantine basin;
- The hydrology, circulation, nutrients and carbonate properties in the Algerian basin;
- Simulations of circulation and sea surface temperature in the Black Sea;
- Simulations of deep convection in the NW Mediterranean;
- Organic matter (DOC and FDOM) in the Mediterranean Sea.

The debate which followed the presentations highlighted the fact that all the processes mentioned above are indeed related and that a multidisciplinary approach is preferable to study them thoroughly.

TRACKING THE MEDITERRANEAN ABYSS

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Abstract
The abyssal velocity of the Northern Current, in the north-western Mediterranean has been estimated using for the first time MERMAID instruments, i.e. submarine drifting instruments that record seismic waves. In this study the Northern Current shows an intense activity even in deep layers of the water column. Through pseudo-eulerian statistics different components of the observed variability are described.

Keywords: Abyssal, Mediterranean Sea, Gulf of Lyon, Ibiza Channel, Circulation

The Mediterranean Sea is well known to be a miniature ocean with small enough time-scales to allow the observation of main oceanographic events, e.g. deep water formation and overturning circulation, in a human life time. Therefore the Mediterranean can be considered as a key oceanographic observatory site. The deep sea is challenging to monitor. This work is focused on the north-western Mediterranean basin (figure 1), where deep water formation events often occur in the Gulf of Lion (GoL) [1].

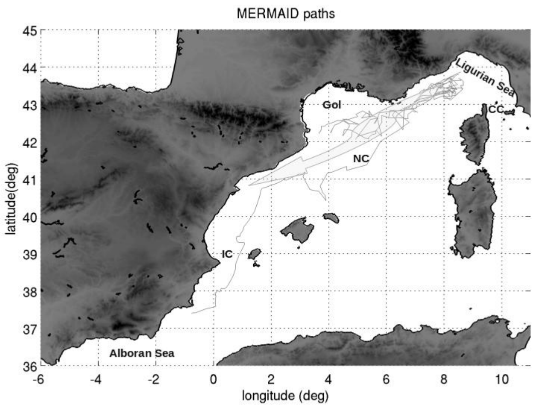

Fig. 1. Paths of the seven MERMAIDs deployed in the Ligurian Sea, some of which followed the deep Northern Current (NC) until the Ibiza Channel (IC).

The north-western Mediterranean circulation is characterised by a marked frontal structure [2] that flows cyclonically along the coast from the Corsica Channel (CC) to the Alboran Sea. This flow constitutes the Northern Current (NC). MERMAIDs are submarine robots designed to observe underwater seismic waves in order to improve ocean tomography, i.e. the imaging by sections through the use of a penetrating wave. The functioning of MERMAID profiling process is illustrated in figure 2. After the deployment the instrument communicates its surface position via GPS and Iridium satellite. When the Iridium transmission stops an internal bladder starts to be filled with oil, the floater begins its descent. At 50 m depth the bladder is full and the profiler sinks until it reaches its park depth where the acquisition starts. The park depth is provided by the instrument measurements and it ranges from 555 m to 2332 m depth. At the end of the acquisition the ascent phase begins until 50 m depth is reached again, the bladder is emptied and the float can reach the surface. The 50 m positions and times, both during the descent and the ascent phase, are known with an uncertainty of 5 minutes. The position at 50 m depth is calculated assuming a linear drift evinced by two consequential GPS communications before the float starts its descent. The time at sea of the profilers goes from 3 to 19 months. Seven MERMAIDS were deployed in the Ligurian Sea, one of them particularly followed the Northern Current until the Ibiza Channel (IC), figure 1, allowing us to estimate the north-western Mediterranean abyssal circulation. We extract MERMAIDs deep velocities, correcting them with geostrophic velocities estimated values, extracted from an historical database of hydrographic stations. The geostrophic velocities are applied to correct the drift that the instruments undergo from 50 m depth, last known position, to their park depth, at which they float following the deep current and from park depth to 50 m during the up-cast. Furthermore pseudo-eulerian calculations, following the methods suggested by [3], have been also applied and interpreted. Eddy Kinetic Energy (EKE) and Mean Kinetic Energy (MKE) values show particularly high values in the GoL and in the IC, meaning that both the kinetic energy given to the mean flow and the kinetic energy ascribable to the flow fluctuations, occur close to the main site of deep water formation, the GoL, and in a choke point like the IC. The importance of the IC is due to its high variability, mostly dictated by the intermittent presence of a cyclonic eddy that prevents the Atlantic Water recently entered in the Mediterranean from crossing the IC [4]. An intense activity in the abyss of the north-western Mediterranean has been depicted, allowing the estimate of deep circulation of the NC and highlighting abyssal velocities that can reach 1 m/s. The NC appears to involve the whole water column and not only the superficial and intermediate layers as it was suggested in the past [5].

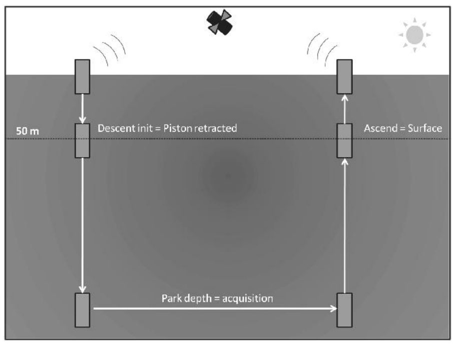

Fig. 2. MERMAID profiling process.

References
1 - Marshall, J. and Schott, F. (1999). Open-Ocean Convection: observations, theory and models. Reviews of Geophysics, 37(98):1–64.
2 - Astraldi, M., Gasparini, G. P. and Sparnocchia, S. (1994). The Seasonal and Interannual Variability in the Ligurian-Provencal Basin. in Seasonal and Interannual Variability of the Western Mediterranean Sea (ed P. E. La Viollette), American Geophysical Union, Washington, D. C.
3 - Poulain, P.-M. (2001). Adriatic Sea surface circulation as derived from drifter data between 1990 and 1999. Journal of Marine Systems, 29:3–32.
4 - Heslop, E., Ruiz, S., Allen, J., López-Jurado, J., Renault, L. and Tintoré, J. (2012). Autonomous underwater gliders monitoring variability at choke points in our ocean system: A case study in the Western Mediterranean Sea. Geophysical Research Letters, 39:L20604.
5 - Bethoux, J., Prieur, L., and Nyffeler, F. (1982). The Water Circulation in the North-Western Mediterranean Sea, its Relations with Wind and Atmospheric Pressure. Elsevier, Amsterdam.

SEASONAL AND INTERANNUAL VARIABILITY OF SINKING PARTICULATE MATTER IN THE DEEP IONIAN SEA: ECOLOGICAL AND BIOGEOCHEMICAL PERSPECTIVES

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Abstract
Aiming to investigate the significant ecological and biogeochemical features and provide new insights on the sources and cycles of sinking particulate matter in the open Ionian Sea, we have examined long-term records of downward fluxes for Corg, N, d13Corg and d15N, along with the associated ballast minerals (opal, lithogenics and CaCO3), selected lipid biomarkers and coccolithophores.

Keywords: Ionian Sea, Particle flux, Organic matter, Coccolithophores, Deep sea basins

Formation and sinking of particulate matter drive the biological carbon pump via export and sedimentation of organic matter from the surface mixed layer to the deep ocean and sediments (reviewed by Honjo et al., 2008). Biotic processes that form, change, transport, and remineralize particulate organic carbon, opal, calcium carbonate, and other minor chemical species in the water column are central to the ocean's biogeochemical cycles and are of fundamental importance to the global carbon cycle. The present work focuses on the study of downward fluxes of Corg, N and their stable isotopes, along with the associated ballast minerals (opal, lithogenics and CaCO3), selected lipid biomarkers and coccolithophores (main calcifying primary producers), as recorded in sinking particulate matter intercepted by time-series sediment traps. A mooring line was deployed from 2006 to 2012 at 5 successive water column depths (700, 1200, 2000, 3200 and 4300 m) in the SE Ionian Sea, where the deepest part of the Mediterranean Sea is located ('NESTOR' site). The time-series dataset is used to identify mechanisms governing particle transport in the study area, and to explain (i) the seasonal, and (ii) the interannual variation of mass and main constituent fluxes, in relation to oceanographic conditions. The temporal distribution of total mass flux exhibited strong seasonal patterns, with higher fluxes recorded mainly in late winter/early spring followed by a second, more pronounced flux maximum period in late spring/summer and significantly lower fluxes in autumn/winter. This oscillation in total mass flux was observed throughout the experiment, although a marked interannual variability in export intensities is observed. Primary productivity in the Ionian Sea, as in most oligotrophic sites of the subtropical Mediterranean Sea, displays high seasonal variability with maximum rates observed during the winter/spring convective mixing period (Bosc et al., 2004; D'Ortenzio and Ribera d'Alcala, 2009). In our time-series, this feature was observed to coincide with relative increases in organic carbon and opal export and increase in the fluxes of planktonic biomarkers at all depths during late winter/early spring, and could be attributed to the development of siliceous blooms in the euphotic zone. In late spring/ summer period, nanophytoplankton species (coccolithophorides) gain more importance as primary producers, as it is witnessed by the increase in the carbonate contents and coccolithophorids' export. A considerable interannual variability in vertical distributions is observed in the total mass flux maxima at various depths, despite some similarities in the seasonal patterns. The main feature of the mass flux variability was the gradual increase of winter mass flux almost at all depths, followed by an evident analogous increase (with some exceptions) in spring and summer mass flux. Such an interannual change in flux patterns could be explained by the reinforcement of processes which produce and/or transfer particulate matter in the area. A plausible reason for the increase of fluxes from 2006 to 2010 could be related to the general circulation patterns at the study site, which exhibit strong interannual variability. During mid-late 1990s the large scale anticyclonic circulation observed during the 1980s and early 1990s was confined in the southern part and replaced by a cyclonic circulation in the northern Ionian (Gacic et al., 2011). In the years following 2006, the salinity and nutrient changes in the south Adriatic suggest that the Ionian circulation was changed back into anticyclonic (Civitarese et al., 2010). This latter circulation regime causes the upwelling of the nutricline in the periphery of the anticyclonic gyre and the weakening or even the absence of the Pelops gyre. The NESTOR site is obviously found at the edge of this anticyclone as revealed from the recurrent shoaling of the isohalines recorded in the nearby observational buoy of the Poseidon system. Furthermore, the remarkable enhancement of the fluxes from 2008 onwards seems to be directly dependent on the intensity of the intrusion in the upper layer of high salinity intermediate waters of Levantine/Cretan origin. The upward movement of these intermediate waters could favor upwelling of nutrients and enrichment of the upper layer, thus triggering surface productivity and the enhancement of downward particle fluxes. In respect to this hypothesis, the increased contribution of all biogenic (OC, carbonate, opal) constituents in late spring/summer of 2008 and 2009, suggests an effective nutrient fueling of the upper layer created by the dynamic conditions prevailing in the vicinity of NESTOR site. Finally, a pronounced increase of all biogenic fluxes was recorded in spring 2012, when atmospheric conditions involving particularly strong cold and dry northerly winds triggered intense winter convection mixing. Our study based on multi-biogeochemical parameters shows that large scale processes and oceanographic changes play a crucial role controling the ecological and biogeochemical functioning of the Ionian Sea on seasonal and interannual scales.

References

1 - Civitarese et al., 2010. Biogeosciences, 7, 3987-3997.
2 - D'Ortenzio, F., and D'Alcalà, M. R., 2009. Biogeosciences, 6, 139-148.
3 - Gacic et al., 2011. Journal of Geophysical Research, 116, C12002.
4 - Stavrakakis et al., 2013. Biogeosciences, 10, 7235–7254.
5 - Triantaphyllou et al., 2010. Geobios, 43, 99–110.

ON THE EVOLUTION OF THE LONG-LIVED SUBSURFACE MESOSCALE EDDY SOUTH OF CYPRUS

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Abstract

Since systematic measurements of ocean temperature and salinity began south of Cyprus in 1995, evidence for the presence of an anti-cyclonic mesoscale Cyprus eddy has been consistently observed. Initially, the Cyprus Basin Oceanography (CYBO) ship-based hydrographic program often found relatively warm, salty water at about 200-500 m depths. While not high enough in spatial resolution to observe the extent of the eddy, it was unmistakably one of the dominant features of the region. Recently, glider-based observations of the Cyprus eddy have shown how it has evolved since 2009. Every year since that intense, multi-platform 2009 study south of Cyprus, the eddy has changed. This descriptive study motivates further study as to the dynamics governing both the formation, evolution of the eddy and its size and position.

Keywords: Levantine Basin, Mesoscale phenomena

Introduction

We investigate a subsurface mesoscale eddy south of Cyprus using ocean gliders. We describe its characteristics, focusing on interannual variability. The glider data is compared with available ship and float observations in other studies [1]. The comparison on one hand highlights the need to use gliders to observe this eddy at adequate temporal, horizontal, and vertical resolution, and on the other hand, supports the reliability of the glider-derived parameters.

The diameter of the eddy, located south of Cyprus (Fig 1.) is usually about 80 km. While it can be seen in dynamic height calculations, in situ observations show that the core of the density anomaly is from 200-500 m depth, at which Levantine Intermediate Water (LIW) is located. Observations since 2009 suggest that this eddy is semi-permanent, and existed all these years [1]. Observed backscatter, oxygen, and fluorescence suggest that this subsurface eddy plays a role in biogeochemical processes as well [2].

Methods

In 2008, the Oceanography Center at the University of Cyprus acquired two underwater gliders from the University of Washington. Both gliders are rated to 1000 m and carry non-pumped conductivity-temperature-depth sensors (CTD) from SeaBird Electronics (SBE-4 and SBE-5), a dissolved oxygen sensor from SeaBird (SBE-43), an optical triplet from WetLabs (BB2F-VMG) is also installed to measure optical backscatter at 400 nm, 700 nm, and chlorophyll-a fluorescence. Since March 2009, the gliders have been used in a long-term observing program of the Cypriot EEZ, and by August 2015, have covered more than 16000 km and 3500 dive cycles in 942 of glider days, most to 1000 m (Fig. 1). The glider endurance lines criss-cross the region in order to more accurately locate and investigate the mesoscale structures south of Cyprus, and in particular the Cyprus eddy.

Results

The first goal is to chart the presence, location, size and intensity of the Cyprus eddy from the bow-tie pattern. The plots of maximum LIW depth in Fig. 1 show that the eddy is most commonly located near the Eratosthenes Seamount, but shifts by 0.5-1 degrees in both longitude and latitude. We also observe variations in intensity, core thickness and temperature/salinity values based on glider data (Table 1). The Cyprus eddy at its maximum is 90 km across and 400 m high, making it a distinct homogeneous biome of the Levantine Sea. However, the eddy structure varies by year, in some cases showing reversals in the salinity or downwelling at the outer edge [2, 3].

Discussion and Conclusions

This study demonstrates the usefulness of ocean gliders in acquiring mesoscale information. Similar characteristics can be obtained from ships and floats only in special cases, since it is not normally possible to obtain adequate spatial detail from low resolution or freely-drifting platforms. However, T/S values can be used to track the eddy between glider missions. Further study is required on processes involved in shaping, evolving eddy in order to understand why the changes are happening. More study is also needed to discover the mechanism that creates and maintains this eddy.

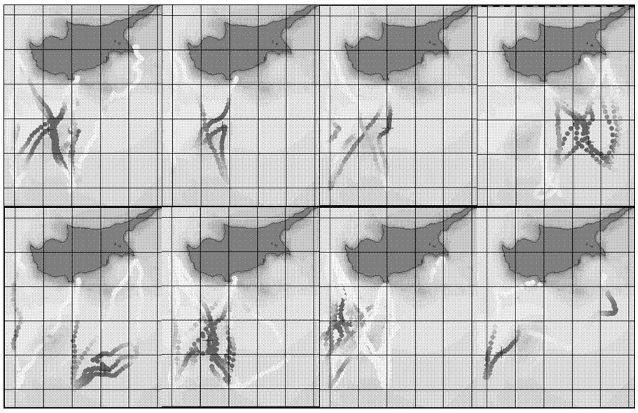

Fig. 1. Cyprus and a subset of the glider surfacing locations from 2009 to 2015. Darker colors mean deeper depth of the σ_θ_0 29.0 layer of the LIW . White is 100 m and darker shades begin at 400 m.

Tab. 1. Cyprus eddy characteristics from glider observations.

Dates	Center	Thickness/Max Dep	Temp, Sal
Mo/yr	Lat, Lon	m (S-based)	deg C, psu, m
05/09-08/09	32.59E, 33.85N	250, 404	17.13, 39.38
11/09-01/10	32.88E, 33.87N	260, 412	17.14, 39.38
01/10-02/10	33.02E, 33.87N	204, 400	17.13, 39.38
10/10-02/11	33.78E, 33.68N	230, 506	17.15, 39.39
12/11-02/12	33.58E, 33.28N	148, 458	17.16, 39.36
02/13-08/13	32.67E, 33.76N	420, 430	16.0-17.12, 39.11
04/14-05/14	32.12E, 33.94N	150, 352	16.88-17.18, 39.12
07/15-08/15	32.31E, 33.56N	125, 230	17.32-17.57, 39.08

References

1 - Hayes, D., Hannides, A., Georgiou, G., Testor, P., Gildor, H. and G. Zodiatis, 2014. Description of the long-lived subsurface mesoscale eddy south of Cyprus. 6th EGO Meeting and Final Symposium of the COST Action ES0904, Kiel, Germany, 16-17.06.2014.

2 - Hannides, A.K., D'Ortenzio, F., Hayes, D.R., Mortier, L., Testor, P. and V. Taillandier, 2015. Levantine biogeochemical cycling elucidated by glider data for the period 2009-2014. Aquatic Sciences Meeting 2015, Granada, Spain, 22-27.02.2015.

3 - Hayes, D. R., G. Zodiatis, G. Konnaris, A. Hannides, D. Solovyov, and P. Testor, 2011. Glider Transects in the Levantine Sea: Characteristics of the Warm Core Cyprus Eddy. Paper PID1762407. Santander, Spain: IEEE, 2011. doi:10.1109/Oceans-Spain.2011.6003393.

DISTRIBUTION OF HYDROLOGICAL PARAMETERS, CARBONATE PROPERTIES AND NUTRIENTS IN THE ALGERIAN BASIN DURING SUMMER 2014: SOMBA-GE-2014 CRUISE

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Abstract

This work presents the main observations that have been collected during a 2014 summer cruise in the Algerian Basin SOMBA-GE-2014. We discuss the distributions of carbonate properties, oxygen, nutrients and chlorophyll along with those of hydrological parameters. Air-sea oxygen and CO2 fluxes, elemental ratios and anthropogenic carbon are calculated and compared to earlier observations for the same area.

Keywords: Open sea, Algerian Basin

The global warming and the increasing pressures of anthropogenic activities affect the marine ecosystems. In this context, it is requested to monitor the behavior of such ecosystems to better predict their fate. SOMBA-GE-2014 was conducted between 14 August and 10 September 2014 in the Algerian Basin on "Tethys II" oceanographic vessel (CNRS-INSU). The cruise was divided into 4 legs and included 70 hydrological stations, which cover the whole Algerian basin. A hydrological study, using ?-S diagram showed the typical water masses for this area: the AW (Atlantic Water) in surface layers, LIW (Levantine Intermediate Water) and WIW (Winter Intermediate water) in intermediate layers and WMDW (Western Mediterranean Deep Water) in deep layers with warmer and saltier waters between 2000m and the bottom (new WMDW). This new water mass is observed and described by many authors [1]. In surface waters, super-saturations for both CO2 and O2 are found. In summer, it has been shown earlier that Mediterranean surface waters were acting as a source of CO2 for the atmosphere, following the seasonal temperature increase. O2 super-saturations must be linked to the spring/summer production as the nutrients are found depleted in late summer. The deep chlorophyll maximum DCM shows a deepening from 40 m to 75 m along a west-east transect. It follows nutrient availability and eddy structures. Maximum chlorophyll concentrations reach 2 µg/l in the western part of the basin. In intermediate waters, the maxima of DIC, AOU, nutrients are found in the core of LIW. These are supposed to be the oldest water masses of the Algerian basin. The oxygen minimum (AOU~80µmol/kg) found generally between 200 and 800m, deepens eastward to reach 1500m near the Sicily strait. Below 2000m, relatively low AOU indicates newly formed deep waters. Below the photic zone, for depths higher than 150 m, we have found a N/P ratio of 15.5 (Figure 1). This result is in good agreement with earlier observations for the same area, [2]. In the photic zone, the signal is scattered and N/P ratio exhibits value around 21 confirming the phosphorus limitation of the primary production in that area, [3]. We have computed anthropogenic carbon estimates by using several methods. Not surprisingly, our results show that the Algerian basin is totally invaded by anthropogenic carbon. These estimates are compared to those obtained by using earlier data sets in the same region and the rate of surface acidification is discussed.

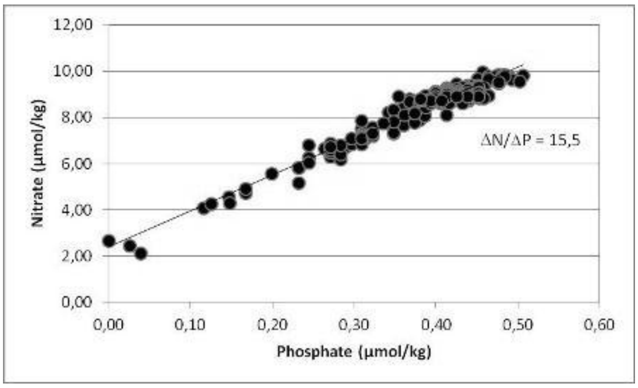

Fig. 1. Nitrate to phosphate ratio in the Algerian Basin for depths above 150 m during SOMBA-GE-2014 cruise

References

1 - Schroeder, K., A. Ribotti, M. Borghini, R. Sorgente, A. Perilli, and G. P. Gasparini. 2008. "An Extensive Western Mediterranean Deep Water Renewal between 2004 and 2006." Geophysical Research Letters 35, no. 18: L18605. doi:10.1029/2008GL035146

2 - Moutin T., Prieur L., 2012. Influence of anticyclonic eddies on the biogeochemistry from the oligotrophic to the ultraoligotrophic Mediterranean (BOUM cruise). Biogeoscience, 9, 3827 – 3855

HYDROLOGIE ET CIRCULATION OCÉANIQUE DANS LE GYRE EST ET OUEST DU BASSIN ALGÉRIEN

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Abstract
Une première exploration des données de la campagne SOMBA-GE2014 complétées par d'autre données , nous a permis de confirmer la présence des deux gyres Algériens. Nous avons noté pour la première fois une séparation hydrologique entre les eaux des deux gyres, mis en évidence la présence du phénomène de double diffusion notamment dans le gyre Est, et une tendance au réchauffement et à l'augmentation de la salinité différente d'un gyre à l'autre.

Keywords: Hydrology, Algerian Basin, Salinity, Temperature

La Méditerranée Occidentale se compose de plusieurs sous bassins, dont l'étude des traits de circulations est primordiale pour la compréhension de la dynamique dans le Bassin Méditerranéen. Dans cette optique, nous avons utilisé les premières données récoltées dans le cadre du Système d'Observation à la Mer du Bassin Algérien (SOMBA), lors de la campagne océanographique qui s'est déroulée l'été 2014 [1], comprenant 70 stations hydrologiques, avec mesure de plusieurs paramètres en continu sur toute la colonne d'eau (température, salinité et vitesse et direction du courant mesurée par LADCP (Lowered Accoustic Doppler Current Profiler)) qui sont utilisées ici. Nous avons également utilisé d'autres données disponibles provenant de sources différentes afin de décrire au mieux la dynamique et l'évolution des eaux du bassin. Grâce aux mesures de LADCP, nous avons pu observer les gyres Algériens déjà mis en évidence dans [2] par des données lagrangiennes de sub-surface. Ces mesures montrent clairement la présence des deux gyres cycloniques, centrés respectivement vers 6.5 °E, 38 °N (gyre Est), et 2.5 °E 37.5 °N (gyre Ouest), avec des vitesses orbitales d'environ 5 cm/s à la périphérie de ces derniers, les vitesses diminuant vers le centre des gyres. La séparation des deux gyres est située vers 3.5 °E. Les sections de température potentielle et de salinité de la radiale Est-Ouest des années 2008, 2010 [3] et 2014 montrent une séparation hydrologique nette entre les eaux du gyre Est et Ouest située elle aussi vers 3.5 °E. Les eaux intermédiaires ou LIW (Levantine Intermediate Water) sont plus chaudes et salées dans le gyre Algérien Est, ce qui pourrait être dû au fait que ces LIW sont injectées dans le gyre par des tourbillons Algériens qui arrachent des LIW « jeunes » à la veine de courant provenant de la mer Tyrrhénienne qui longe les côtes de la Sardaigne [4], puis les relâchent à l'intérieur du gyre où elles restent confinées. La figure 1 représente une section de Salinité Est-Ouest dans le bassin Algérien en 2014 lors de la campagne SOMBA. Les sections des années 2008 et 2010 obtenues grâce aux données fournies par Katrin Schroeder [3] confirment cette séparation hydrologique.

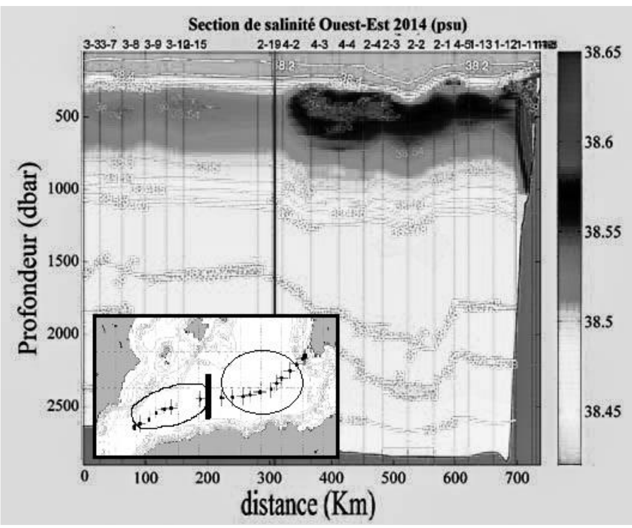

Fig. 1. Section de salinité Ouest-Est dans le bassin Algérien faite à partir des données SOMBA-GE2014 représentées sur la carte (en bas à droite) par des petits points noirs, les cercles sur la carte représentent l'emplacement des gyres Algériens suggéré par les vecteurs de courant.

La forme en escalier caractéristique apparait sur les profils de température potentielle et salinité représentés pour les stations faites à l'intérieur du gyre Est témoignant du phénomène de double diffusion est due au fait que les LIW se trouvant à l'intérieur de ce gyre sont relativement jeunes et donc salées et chaudes reposant sur une masse d'eau plus froide et moins salée, condition permettant l'établissement de ce phénomène. Enfin, nous avons utilisé toutes les données disponibles depuis 1980 jusqu'à 2015, pour cette partie de la Méditerranée pour étudier l'évolution des caractéristiques des eaux, et nous avons noté sans surprise un réchauffement des eaux profondes du bassin (moyennées entre 1000-2000 m) de 0.0047 ± 0.0011 °C/an et une augmentation de la salinité moyenne de 0.00148 ±0.0005 psu/an. Cette évolution est néanmoins différentes dans chaque gyres (augmentation de 0.0053 ± 0.0011 °C/an et 0.0013 ± 0.0006 psu/an dans le gyre Est, et augmentation de 0.0038± 0.0003°C/an et 0.0017 ± 0.00007 psu/an dans le gyre Ouest), ce qui témoigne sans doute de l'apport de masses d'eau différentes dans les deux gyres, hypothèse cohérente avec les schémas de circulations des eaux intermédiaires (LIW) et profondes (WMDW) de Millot [4].

References

1 - Mortier L., Aït Ameur N., Taillandier V., 2014. SOMBA GE cruise, RV Téthys II, http://dx.doi.org/10.17600/14007500
2 - Testor P., Send U., Gascard J., Millot C., Taupier-Letage I., and Béranger K., 2005. The mean circulation of the southwestern Mediterranean Sea: Algerian Gyres. Journal of Geophysical Research, 110(C11):017.
3 - Schroeder K., communication personnelle ; MEDCO08 cruise, 2008, RV Urania ; VENUS1 cruise, 2010, RV Urania.
4 - Millot C., 1999. Circulation in the Western Mediterranean Sea. Journal of Marine Systems, 20:423–442.

DOC AND FDOM DISTRIBUTION IN THE MEDITERRANEAN SEA: RESULTS FROM THE MEDBLACK GEOTRACES CRUISE

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Abstract
Vertical distributions of Dissolved Organic Carbon (DOC) and Fluorescent Dissolved Organic Matter (FDOM) were studied in the framework of the international cruise "MedBlack Geotraces". DOC vertical distributions were similar to those reported for the open ocean. Fluorescence analysis together with Parallel Factorial Analysis (PARAFAC) highlighted the occurrence of humic-like, protein-like and PAH-like compounds in the open Mediterranean Sea.

Keywords: Organic matter, Deep waters, Global change, Geochemical cycles, Mediterranean Sea

Dissolved Organic Matter (DOM) represents the largest reservoir of organic carbon on the Earth and the main source of energy for heterotrophic prokaryotes [1]. A fraction of DOM is Fluorescent (FDOM) and is therefore able to absorb light in the visible and UV wavelengths and to emit fluorescence. This fraction affects the penetration of light through the water column, limiting the quantity of light available for photosynthesis but also reducing the amount of harmful UV rays. Despite its importance, there is still little information about FDOM for the Mediterranean Sea (Med Sea); existing data are mostly limited to coastal areas. The main goals of this work are: (1) to present the first FDOM data for a large area of the Med Sea, (2) to study Dissolved Organic Carbon (DOC) distribution on a basin scale and (3) to evaluate DOC variability on the short temporal scale. In the framework of the international cruise "MedBlack Geotraces", held between April and August 2013, 880 samples were collected in the Med Sea (Fig. 1).

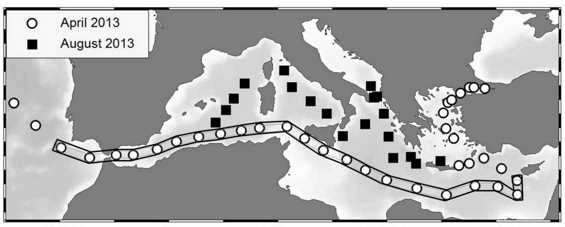

Fig. 1. Study area and sampling station.

Dissolved Organic Carbon concentrations and fluorescence Excitation Emission Matrices (EEMs) were measured in order to gain quantitative and qualitative information on DOM. DOC showed the highest values (60-80 µM) in the surface layer (0-150 m), with local maxima in the areas affected by mesoscale activity and a gradual decrease to values of 38-40 µM below 1000 m. A slight increase was observed close to the bottom (41-43 µM) (Fig. 2). Even if these values and distributions are in agreement with previous studies [2-3] and with oceanic observations [1, 4], DOC concentrations in the deep waters (>2000 m) of the western Med Sea were lower than observed in 2008, when values up to 50 µM were measured [3]. This difference could be attributed to warmer winters and consequently to a reduced deep water formation rate in recent years.

The application of PARAFAC to the EEMs allowed for the validation of a 6-component model. The components were identified by comparison with the literature [5-8] and similarity with spectra of commercial substances. Three components (C1, C3, C4) were identified as humic-like substances, of both marine and terrestrial origin; 2 components (C2, C5) were identified as protein-like; while the last (C6) was identified as PAH-like, due to its spectroscopic characteristics similar to fluorene [7]. Humic-like components showed a minimum in the surface layer, probably due to the photobleaching, and higher values below 150 m. Protein-like components showed an opposite distribution with a maximum in the surface layer and a decrease up to 200 m, without any particular trend down the column water. FDOM distributions are similar to those reported for open ocean areas [5], even if fluorescence intensity is higher than that reported for both humic-like and protein-like components for the Atlantic and Pacific Oceans [6].

The similarities between DOC and FDOM dynamics in the Med Sea and in the open ocean confirm that the Med Sea can be a natural laboratory to study how climate change can affect the global DOM cycle.

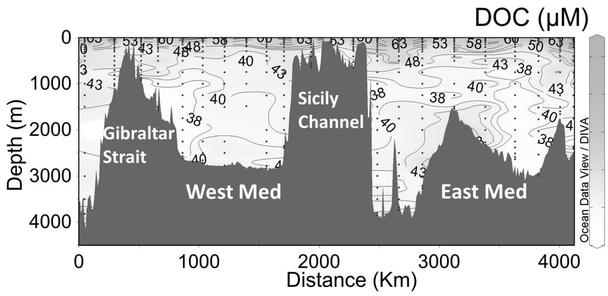

Fig. 2. DOC vertical distribution along the West-East section reported in Fig. 1

References
1 - Carlson C. A. and Hansell D. A. 2015. DOM sources, sinks, reactivity and budgets. *In:* Hansell, DA and Carlson, CA, (eds.), Biogeochemistry of marine dissolved organic matter 2nd ed., Elsevier, pp 66-109.
2 - Santinelli C., Nannicini L.and Seritti A. 2010. DOC dynamics in the meso and bathypelagic layers of the Mediterranean Sea. *Deep Sea Research Part II: Topical Studies in Oceanography*, 57 (16): 1446-1459.
3 - Santinelli C. 2015. DOC in the Mediterranean Sea. *In:* Hansell, DA and Carlson, CA, (eds.), Biogeochemistry of marine dissolved organic matter 2nd ed., Elsevier, pp 579-608.
4 - Hansell D. A. 2013. Recalcitrant dissolved organic carbon fractions. *Marine Science*, 5: 421-445
5 - Stedmon C. and Nelson N. B. 2015. The optical properties of DOM in the ocean. *In:* Hansell, DA and Carlson, CA, (eds.), Biogeochemistry of marine dissolved organic matter 2nd ed., Elsevier, pp 481-502.
6 - Jorgensen L., Stedmon C. A., Kragh T., Markager S., Middelboe M., and Sondergaard, M. 2011. Global trends in the fluorescence characteristics and distribution of marine dissolved organic matter. *Marine Chemistry*, 126(1): 39-148.
7 - Ferretto N., Tedetti M., Guigue C., Mounier S., Redon R. and Goutx M. 2014. Identification and quantification of known polycyclic aromatic hydrocarbons and pesticides in complex mixtures using fluorescence excitation–emission matrices and parallel factor analysis. *Chemosphere*, 107: 344-353.

HIGH-RESOLUTION SIMULATION OF THE BLACK SEA DYNAMICS USING NEMO MODELING FRAMEWORK

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Abstract
High-resolution numerical modeling of the Black Sea circulation is carried out using parallel version of NEMO (Nucleus for European Modeling of the Ocean). Spatial variability of temperature reconstructed for 2005 – 2008 is analysed.

Keywords: Black Sea, Models, Mesoscale phenomena

During last two decades a large number of numerical ocean models were implemented for reconstruction of the Black Sea dynamics, e.g. [1 – 3]. Their simulations showed rather similar syn optical structures of general circulation, like RIM current and the main anticyclonic eddies. Recently studies of mesoscale phenomena in the ocean and seas became to be popular. They are carried out widely now due to availability of high performance computing. In the sense semi-enclosed shape of basin and relatively small sizes of the calculation domain make the Black Sea a good test bed for tuning the model physics to reproduce meso- and even submesoscale variability. High-resolution modeling is important for continuous development of the Black Sea Marine Forecasting System (BS MFC), which is still operating and remains the only one providing forecasting products for the region. The present study is an extension of previous works [4] aimed on implementation of NEMO modeling framework [5] in BS MFC. Two model setups with spatial resolutions 5 km (high) and 2.5 km (ultra-high) are used to study the effect of the calculation domain grid refinement. Simulations for both resolutions are produced using Moscow State University mainframe. Applying of the finer model grid allowed to obtain qualitatively new structure of the Black Sea circulation (figure 1, b, c), comparing to results reconstructed on a coarser grid (figure 1, a) which are rather smooth.

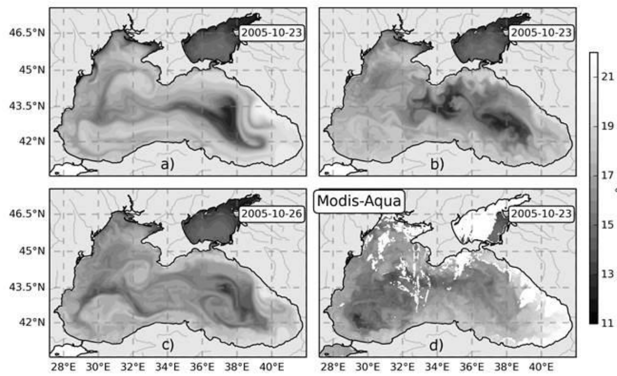

Fig. 1. Sea surface temperature (ºC): in simulations a) – with high-resolution model grid, b, c) – ultrahigh-resolution model grid; d) – from satellite (MODIS/Aqua).

Several model runs were carried out for ultra-high resolution making an attempt to reproduce spatial variability similar to high-resolution sea surface temperature derived from satellite images (figure 1, d). Analysis of the dynamics reproduced in ultra-high resolution simulations allowed to choose acceptable values of model lateral mixing. To compare simulated and observed spatial variability lagged correlation functions and spatial spectra are usually analysed. Analysis of spatial spectra from imagery is rather complicated due to inhomogeneity of observations (e.g., figure 1, d). In this work a product from Copernicus based on optimal interpolation of satellite images (OI SST) is also used for inter-comparison. Spatial horizontal scales obtained from modeling results and observations are rather close (comparing zero-crossing position).

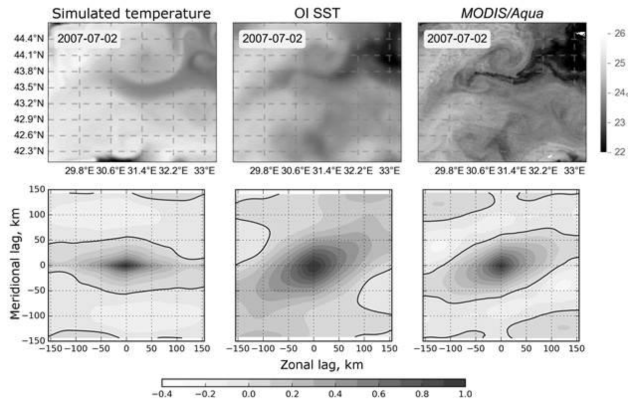

Fig. 2. Sea surface temperature (ºC) of the Black Sea western part (top) and corresponding lagged correlation functions (bottom) from simulation, MODIS/Aqua and OI SST.

Estimation of the spatial spectra slope for the reconstructed surface temperature showed values around 5, which is quite close to the theory of turbulent spectra of the upper ocean temperature [6]. The research leading to this results has received funding from Russian Science Foundation (project No. 15-17-20020).

References
1 - Demyshev S.G. and Korotaev G.K., 1992: C-grid numerical energy-balanced model of the baroclynic currents with rough bottom. In: Numerical models and results of calibration calculations of currents in the Atlantic Ocean circulation. (IVM RAN, Moscow, 1992), p. 163 – 231 (in Russian).
2 - Staneva J.V., Dietrich E.D., Stanev E.V., Bowman M.J., 2001: Rim current and coastal eddy mechanisms in an eddy-resolving Black Sea general circulation model. Journal of Marine Systems, 31, p. 137 – 157.
3 - Kubryakov A.I., 2004: Implementation of the nested grids for the monitoring system of the hydrophysical fields in the Black Sea coastal regions. Ecological safety of coastal and shelf zone and complex use of their resources (Marine Hydrophysical Institute, Sevastopol, Vol. 11, 2004), p. 31 – 50 (in Russian).
4 - Demyshev S., Knysh V., Korotaev G., Kubryakov A., Mizyuk A., 2010: The MyOcean Black Sea from a scientific point of view. Mercator Ocean Quarterly Newsletter, No. 39. p.16 – 24.
5 - Madec G. 2008: NEMO reference manual, ocean dynamics component // Note du pôle de modélisation, IPSL, France N°27 ISSN N. p.1288 – 1619.
6 - Saunders P. M., 1972: Space and time variability of temperature in the upper ocean. Deep-Sea Research, 19, p. 467 – 480.

SMALL-SCALE PROCESSES IN THE MEDITERRANEAN SEA DEEP CONVECTION AREAS : A NUMERICAL STUDY THROUGH NESTING APPROACH

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Abstract
Two-ways nesting approach using a regional Mediterranean configuration of the NEMO model is developed to study key areas of deep winter convection, including mechanisms such as pre-conditioning, mixing and spreading at mesoscale in other parts of the basin. Inter-annual variability of the convection is evaluated as well as the impact of explicitly resolved mesoscale structures on the general thermohaline circulation. Results show an increase of the convective volume and a large impact on the spreading dynamics of newly formed deep waters.

Keywords: Water convection, Circulation models, Mediterranean Sea

Oceanic circulation of the Mediterranean Sea is mainly driven by two important processes : the surface circulation of Atlantic buoyant water along the southern coasts [1] and the winter deep convection in several locations of the northern part of the basin : North-Western sub-basin, Adriatic Sea and Aegean Sea [2]. The latter is a key process impacting the long term general thermohaline circulation of the Mediterranean Sea by redistributing the water masses throughout the whole water column and playing a major role in the ventilation of surface waters. Convection also plays a major role in the ventilation of surface water and therefore is crucial for ocean heat and CO2 uptake in a context of climate warming.

Recent progress in observation networks have highlighted the formation of submesoscale coherent vortices at the end of the convection episode [3] implying the need to provide new insights regarding the mechanisms at small-scales involved in the turbulent mixing of surface waters and the subsequent export of newly formed water mass outside of the convection area. Those structures could last several months and therefore potentially impact the spreading of intermediate and deep water masses. More generally, (sub) mesoscale features are expected to account for a significant part of the deep convection inter-annual variability. Therefore, this study aims to explore the impact of such structure on the deep-convection and in fine on the general thermohaline circulation.

To tackle this problem, eddy resolving models are needed. However even for regional configuration such as the Mediterranean Sea, the cost of high resolution simulation over several decades to study long-term variability is still high. We therefore follow a two-ways nesting approach, ie inside a low resolution (eddy-permitting) simulation, key areas are modelled using a higher (eddy-resolving) resolution and both part of the domain are interacting with each other. This approach allows us to explicitly resolve mesoscale dynamics inside defined area (downscaling) and to diagnose the feedback of this dynamics outside of the high-resolution area (upscaling). We use a mediterranean regional configuration of NEMO general circulation model at 1/12^{o} resolution (NEMO-MED12 [4]). We take advantage of the Adaptative Mesh Refinement module AGRIF [5] included in NEMO to implement two-ways nested domain at 1/36^{o} resolution. Nested domain are defined in the largest convection area of the Mediterranean Sea *i.e.* Gulf of Lion, Adriatic Sea and Aegean Sea. Several simulations covering the 1979-2013 time frame are carried-out : a control case without nesting, a set of 3 simulations with a single nested domain in one of the convection area and a simulation with the 3 nested domain altogether. Challenging those simulations allows us to determine the contribution of each area in the formation of deep and intermediate water.

Numerical studies [6] using a nested domain in the Gulf of Lion to reproduce one particular convection event, have shown a large impact of mesoscale structures on the resolution of the pre-conditioning and mixing stages of the convection leading to a 36% average increase of the convective volume. It is expected that the explicit resolution of mesoscale dynamics in area of intense winter convection will strongly impact the export/spreading of deep and intermediate water. An example of such transport by mesoscale eddies is shown in Fig. 1 for the Gulf of Lion area for simulations at 1/12^{o} and 1/36^{o}.

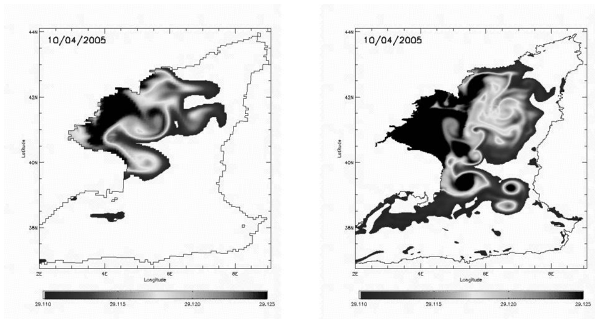

Fig. 1. Density at 2000 m depth at the end of a convection event in 2005 showing the spreading of deep water in the western mediterranean basin for (left) the control case at 1/12 resolution and (right) a simulation at 1/36 resolution (NEMO-MED36) of the Mediterranean Sea.

Future works will be devoted to achieve the resolution of ~1km and explicitly resolve the submesoscale coherent vortices (SCVs) and filaments by implementing several levels of nested domains.

References

1 - Millot C. and Taupier-Letage I., 2005. The handbook of environmental chemistry, Vol.1, chap. Circulation in the Mediterranean Sea
2 - Gascard J-C., 1991. Open Ocean Convection and Deep Water Formation Revisited in the Mediterranean, Labrador, Greenland and Weddell Seas, In: P.C. Chu and J.C. Gascard, Editor(s), Elsevier Oceanography Series, Elsevier, Volume 57, Pages 157-181
3 - Bosse, A., Testor, P., Mortier, L., Prieur, L., Taillandier, V., d'Ortenzio, F., and Coppola, L. , 2015. Spreading of Levantine Intermediate Waters by submesoscale coherent vortices in the northwestern Mediterranean Sea as observed with gliders. *Journal of Geophysical Research: Oceans*, 120(3): 1599-1622
4 - Beuvier J., Béranger K., Lebeaupin Brossier C., Somot S., Sevault F., Drillet Y., Bourdallé-Badie R., Ferry N. and Lyard F., 2012. Spreading of the Western Mediterranean Deep Water after winter 2005: Time scales and deep cyclone transport. *Journal of Geophysical Research: Oceans*, 117 : C07022
5 - Debreu, L., Vouland, C. and Blayo, E., 2008. AGRIF: Adaptive grid refinement in Fortran. *Computers & Geosciences.*, 34(1): 8-13
6 - Waldman, R., Somot, S., Hermann, M, Sevault, F., Caniaux, G., Testor, P., Estournel, C., Giordani, H., Benshila, R. and Arsouze, T., 2015. Impact of Sub/Mesoscale dynamics on ocean deep convection in the Northwestern Mediterranean. *9th HyMeX workshop*, Mykonos, Greece

CIESM Congress Session : Basin-wide variability
Moderator : Katrin Schroeder, CNR-ISMAR, Italy

Moderator's Synthesis

During the session on *Basin-wide variability* the conveners discussed a variety of topics, ranging from impacts of different land-surface exchanges schemes and of strait dynamics at Gibraltar on the Mediterranean thermohaline circulation, to basin-wide geostrophic descriptions, up to the suggestion of existence of teleconnections between Mediterranean dynamics and the Bay of Biscay dynamics.

Thus, variability on the basin wide scale has been interpreted and discussed from the point of view of a number of interrelated disciplines: physics (oceanographic and atmospheric), biology and biogeochemistry. These studies have been carried out both by using models as well as observations.

The discussion further evolved on the identification of the role of “trends” vs the role of “oscillations”, the role of the different forcings, atmospheric and boundary conditions (e.g. strait dynamics, river inflow), the effects of a warmer and saltier Mediterranean on the Mediterranean Outflowing Water (MOW), the implication for stratification, thermohaline circulation and ventilation and the implications for biogeochemical and biological dynamics.

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SENSITIVITY OF THE MEDITERRANEAN THERMOHALINE CIRCULATION TO THE ATMOSPHERIC HEAT AND FRESHWATER BUDGETS

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Abstract

Two simulations of the Mediterranean sea circulation are performed with the NEMO model forced by two atmospheric datasets, obtained performing a dynamical downscaling of the ERA-Interim reanalysis with the WRF model in a regional MED-CORDEX configuration. The first atmospheric simulation uses the RUC model for the land surface exchanges while the second one is coupled with the ORCHIDEE model. Both simulations use the same river routing scheme. The atmospheric run and routing scheme skills are investigated through heat and freshawter budgets over the Mediterranean Sea. Also, the thermohaline circulation is analyzed by looking at the temperature and salinity variations and at the winter convection characteristics during extreme transient events

Keywords: Circulation models, Heat budget, River input, Mediterranean Sea

The Mediterranean thermohaline circulation is characterized by a large interannual variability and events like the Eastern Mediterranean Transient (EMT) or the Western Mediterranean Transition (WMT). The winter convection, which occurs at several depths and in specific places, is largely triggered by the atmospheric forcing and air-sea interactions. The modelling of these processes is a hard challenge because of the complex circulation of the Mediterranean Sea. Also, a major contribution of the land surface models to the difference in the water budget of the Mediterranean sea comes through the riverine flux. In order to make projections, the use of coupled ocean-atmosphere-land models is needed. This work is a step towards the fully coupled model. Our analyses focus on the heat and freshwater budgets over the sea and on the the 3D long-term means of thermohaline characteristics.

1- Tools

ORCHIDEE model [1] includes a complex routing scheme (cf. Fig. 1), using HydroSHEDS data as input, which routes the water to the ocean and has been validated with in-situ observations. This scheme is also used to route the RUC [2] runoff and explore various scenario of the human impact on the river discharge. This spread in possible riverine inputs into the Mediterranean sea will serve to compare the sensitivity of the thermohaline circulation in the Mediterranean version of NEMO (damped toward ORAS4 hydrology in the Atlantic) [3, 4] to one obtained by with the atmospheric fluxes of the two WRF [5] dynamical downscaling of the ERA-I reanalysis [6] performed from January 1979 to December 2012**.**

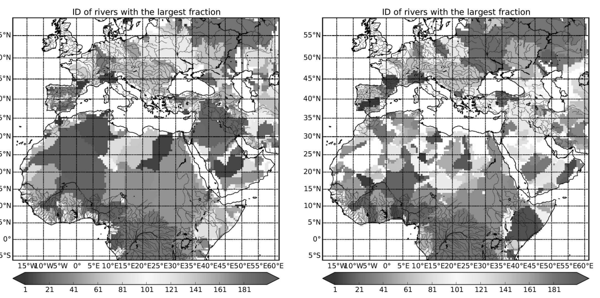

Fig. 1. Basin maps of the 200 controlled rivers by the ORCHIDEE using the old (left, 50km resolution) and the new (right, 1km resolution) river routing scheme.

2- Results

In average over the sea surface, the atmospheric fields show a good agreement with observations (satellite, in situ observations) for the sensible and net longwave heat fluxes. The net shortwave flux is warmer compared to observations with a shift is of the order of 15 W.m^{-2}. This shift is partly compensated by the latent heat flux which is larger than observations. Thus the 34-years budgets are around -2.5 W.m^{-2} for the net heat flux and 0.9 m.yr^{-1} for the evaporation minus precipitation. The two applied Mediterranean water (evaporation minus precipitation minus river runoff) and heat budgets slightly differ between the two companion atmospheric and routing simulations.

The ocean response is analyzed in terms of oceanic winter convection signatures, 3D temperature and salinity variations in four specific layers (surface, intermediate 150-600m, deep 600-1000m, and bottom). The winter convection is underestimated in the westerm Mediterranean while it is in agreement with observations in the eastern Mediterranean, but decadal variations of the temperature and salinity in each layer are well captured by the ocean model. The resulting timeseries show some drifts in the upper layer which is warmer than the EN4 observations [7], with a better agreement for the coupled WRF-ORCHIDEE model compared to the RUC scheme.

3- Conclusion

A 34-year ocean NEMO simulation of the Mediterranean Sea has been done for the 1979-2012 period forced by WRF simulation and two different land surface models using the same high resolution routing scheme. The integration of this model in the fully NEMO/WRF/ORCHIDEE coupled model will be achieved.

References

1 - Polcher, J., 2003. Les processus de surface à l'échelle globale et leurs interactions avec l'atmosphère, Habilitation à Diriger des Recherches, Université Paris VI.
2 - Smirnova, T. G. , Brown, J. M., Benjamin, S. G., Kim, D., 2000. Parameterization of cold season processes in the MAPS land-surface scheme, J. Geophys. Res., 105(D3), 4077-4086.
3 - Madec, G. 2014. NEMO ocean engine, IPSL technical report 27, 1288-1619.
4 - Beuvier J., Béranger K., Lebeaupin Brossier C. et al., 2012. Spreading of the Western Mediterranean Deep Water : Time scales and deep cyclone transport, J. Geophys. Res. 117(C07022), 10.1029/2011JC007679.
5 - Skamarock W.C., Klemp J. B., Dudhia J. et al., 2008. A description of the Advanced Research WRF Version 3, 125pp, NCAR Tech. Note NCAR/TN-475+STR.
6 - Simons A., Uppala S., Dee D., Kobayashi S, 2007. ERA-interim: New ECMWF re- analysis products from 1989 onwards, ECMWF Newsletter, Vol. 110, pp. 25-35.
7 - Good, S. A., M. J. Martin and N. A. Rayner, 2013. EN4: quality controlled ocean temperature and salinity profiles and monthly objective analyses with uncertainty estimates, Journal of Geophysical Research: Oceans, 118, 6704-6716, doi:10.1002/2013JC009067

MEDITERRANEAN OUTFLOW AND ITS LINK WITH UPSTREAM CONDITIONS IN ALBORAN SEA

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Abstract
The Western Alboran Gyre (WAG) can influence the Mediterranean outflow (MOW) through the Strait of Gibraltar by regulating the proportion of Levantine and Western Mediterranean (LIW and WMDW) in the MOW. Observations at Camarinal sill in the Strait and AVISO data suggest that a well-developed WAG hampers (favors) the LIW (WMDW) drainage and vice-versa.

Keywords: Water transport, Gibraltar Strait, Deep waters

The MOW through the Strait of Gibraltar is mainly formed by LIW, characterized by an absolute salinity maximum, and WMDW, the densest and usually coldest water. In the Alboran Sea these waters approach the Strait along different paths, the LIW flowing closer to the Spanish coast and the WMDW attached to the Moroccan coast. This spatial pattern is still observed in the Strait east of Camarinal ([1]), whose topography depicts two troughs (Fig. 1). Thus waters with LIW and WMDW characteristics are expected to flow across the northern and southern (CN and CS) channels, respectively. To analyze this cross-strait structure, two twin mooring lines equipped with autonomous CTs at around 10m above the seafloor and uplooking ADCPs were deployed in both channels from early June to late September of 2013.

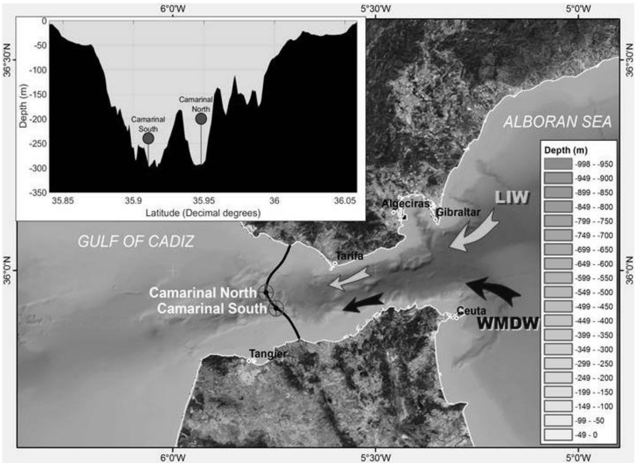

Fig. 1. Strait of Gibraltar and cross-section of Camarinal sill bathymetries. The location of the mooring lines is indicated. The arrows sketch the preferred path of the incoming LIW and WMDW in the Alboran Sea and eastern Strait.

Considering the path of each of these water masses in the Alboran Sea, the flow of WMDW would benefit from a well-developed WAG, whereas the LIW would be favored by a weak or absent WAG. While the first process has been studied by different authors ([2], [3]), the influence of the WAG on the LIW flow seems to not have been addressed yet. Should this entraining mechanism be acting, the observations collected at the Sill would show up some indication of it. We present next a first attempt to prove such a relationship using these obserations and altimetry data from AVISO. The hydrological observations confirm that, on average, saltier and warmer water flows across CN (Fig. 2c, d), although this fact only arises clearly when the tidal variability is removed by retaining the saltiest and/or coldest sample of every semidiurnal tidal cycle, as it is done in [4].

An estimate of the outflow per width unit has been obtained integrating the along-strait ADCP velocity from the deepest bin to the depth of maximum shear, which is a good indicative of the interface according to [5]. Flows are strongly dominated by tides so that the flow time series were filtered with a low-pass filter of 3-day cut-off period that removes semidiurnal and diurnal variability, but not the fortnightly cycle (Fig. 2b). It is seen that, during spring tides, both flows and salinities and potential temperatures decrease as a result of the enhanced tidal mixing during this part of the cycle. Another expected feature in Fig. 2b is the very coherent co-oscillation of the flows (r=0.95), with the flow at CS being greater than at CN by 12 m^2s^{-1} on average. The difference is not constant, however, and fluctuates between 28 m^2s^{-1} at the beginning of the series and -4 m^2s^{-1} by the end of August beginning of September. These transversal oscillations are better seen in the series of flow differences (Fig. 2d) and are just the ones of interest.

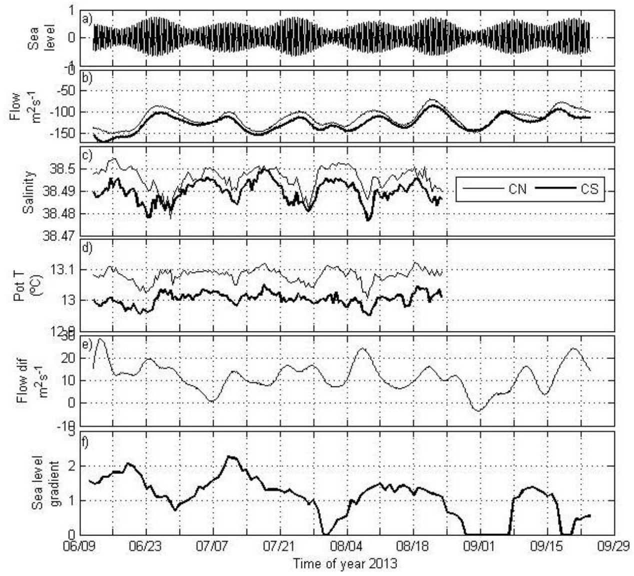

Fig. 2. (a) Sea level at Tarifa. (b) Low-passed flows per width unit at CN and CS (see legend). (c) Series of maximum salinity samples during each semidiurnal cycle at CN and CS. (d) Same as (c) for minimum potential temperature. (d) Flow difference per width unit (CN-CS; therefore positive values indicate greater absolute flow at CS). (e) Mean sea level gradient (x 10^6) across the WAG, inferred from altimetry (AVISO) data.

According to our hypothesis, a well-developed WAG would hamper (favor) the LIW (WMDW) flow and, hence, increase the difference, while a weakened WAG would produce the opposite result. In other words, negative or close-to-zero values in Fig. 2d would be associated with situations of weak or, even, non-existing WAG. Fig. 2e shows the mean surface gradient as a proxy of the strength of the WAG. Interestingly, the events of low or null (no WAG) gradient correspond with minimum differences rather satisfactorily. Of particular concern is the WAG disappearance by the end of August beginning of September coincidentally with the only period in which the difference is negative (stronger flow across CN than across CS). The coincidence is encouraging and stimulates further research on this topic.

References
1 - Naranjo *et al.*, 2015, DSR1, DOI: 10.1016/j.dsr.2015.08.003
2 - Bryden, Stommel, 1982, Origin of Med. outflow, J.Mar.Res. 40, 55–71
3 - Naranjo *et al*., 2012, DSR1, DOI: 10.1016/j.dsr.2011.10.003
4 - García Lafuente et *al*., 2007, JGR, DOI: 10.1029/2006JC003992
5 - Sammartino et *al.*, 2015, JGR, DOI: 10.1002/2014JC010674.

BASIN-WIDE CONSEQUENCES FOR THE HYDRODYNAMICS AND BIOGEOCHEMICAL CONDITIONS IN THE MEDITERRANEAN SEA OF A CLOSURE IN THE STRAIT OF GIBRALTAR. A MODELLING STUDY.

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Abstract
The Strait of Gibraltar is the only connection between the Mediterranean Sea and the open ocean and controls the majority of its water and substances budgets. Water circulation in the Strait is set by the hydric deficit in the Mediterranean and by the quasi-continuous transformation of surface waters into deep ones but the specific role of this circulation on the basin wide characteristics is not fully understood. We use a set of numerical simulations of the hydrological and biogeochemical conditions of the Mediterranean to explore the consequences of a total and partial closure of the Strait of Gibraltar. Our results show that surface properties are affected in large fractions of the basin. Also the strength of the vertical stratification, winter mixing and associated production is affected in many places of the Mediterranean

Keywords: Circulation models, Primary production, Straits and channels, Gibraltar Strait, Mediterranean Sea

The Strait of Gibraltar is the unique connection between the Mediterranean Sea and the open ocean. The water and heat budget in the Mediterranean is, hence, controlled by the water interchange through this narrow connection [1] where relatively fresher Atlantic waters flow in at the surface while saltier Mediterranean waters flow out at depth [2]. This antiestuarine exchange has been proposed to have far-reaching consequences for the whole Mediterranean basin as, for example, tidal propagation [3], salinity anomalies [4] and thermohaline circulation [5]. However, up to date, no specific ad-hoc quantitative assessment of the basin-wide consequences of the water interchange through the strait has been done. In this work we have used a hydrodynamic-biogeochemical coupled model of the entire Mediterranean basin to perform a set of different model runs covering the period 1990 – 2000 only changing the conditions in the Strait of Gibraltar. In the first simulation ('realistic') the strait is treated as an open boundary imposing climatologic temperature and salinity conditions. In the second simulation a closed boundary is imposed at the Strait (e.g., like with a concrete dam) while in the third simulation, a certain flux of Atlantic water is allowed through the boundary in order to maintain the sea level stable within the Mediterranean (i.e., compensating the evaporative losses). We evaluate the difference between the different runs in terms of sea surface temperature, surface salinity, surface kinetic energy, deep water convection and integrated primary production rate in the whole Mediterranean basin. We found that, as expected, conditions in the western basin are much more affected than in the eastern although some variables did also significantly change in the central Mediterranean Sea. In short, restricting the circulation at the Strait creates a surface salinity anomaly that alters the vertical stability of the water column in large fractions of the basin. That enhances winter mixing and foster primary production (Figure 1).

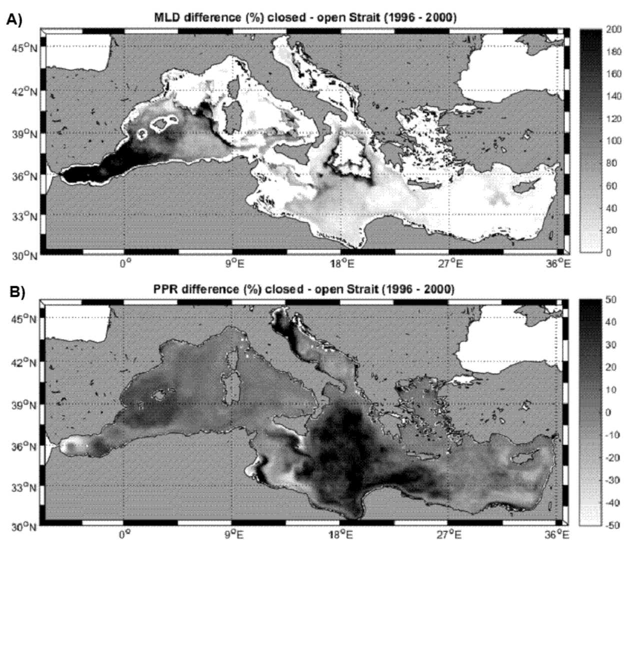

Fig. 1. A) Winter mixed layer depth differences (%) between closed and open Strait simulations. B) Integrated primary production differences (%) between closed and open Strait simulations

On the other hand, surface kinetic energy within the basin tends to reduce specially along the north-western coast, changing the position and strength of the main surface currents. With this work we have, for the first time, explored the basin-wide consequences of the water interchange through the Strait of Gibraltar for the entire Mediterranean Sea. Our results clearly indicate that this local interchange is important not only to determine the hydrological and biogeochemical conditions of the nearby Alboran Sea (the most affected region) but also for the entire western basin and even for some properties within the Ionian Sea. These results, thus, demonstrate the necessity to accurately represent the interchange processes in Gibraltar in order obtain a good representation of the basin-wide Mediterranean properties with numerical models.

References

1 - Lacombe, H., Richez, C., 1982. The regime of the Strait of Gibraltar, Elsevier Oceanography Series, vol. 34, J.C.J. Nilhoul (ed)
2 - Armi, L., Farmer, D., 1988. The flow of Mediterranean Water through the Strait of Gibraltar. Progress in Oceanography, 21, pp. 41–82
3 - Sannino, G., Carillo, A., Pisacane, G., Naranjo, C., 2015. On the relevance of tidal forcing in modelling the Mediterranean thermohaline circulation. Progress in Oceanography, 134, 304-339
4 - Naranjo, C., Garcia-Lafuente, J., Sannino, G., Sanchez-Garrido, J.C., 2015. How much do tides affect the circulation of the Mediterranean Sea? From local processes in the Strait of Gibraltar to basin-scale effects. Progress in Oceanography, 127, 108-116
5 - Macias, D., Garcia-Gorriz, E., Stips, A., 2016. The seasonal cycle of the Atlantic Jet dynamics in the Alboran Sea: direct atmospheric forcing versus Mediterranean thermohaline circulation. Ocean Dynamics, 66(2), 137-151

GEOSTROPHIC CURRENTS IN THE MEDITERRANEAN AND BLACK SEAS DERIVED FROM ARGO FLOAT PROFILES

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Abstract
Data from profiling floats and CTD sections are used to reconstruct the mean geostrophic currents in the Mediterranean and Black Seas at different pressure levels. The main features of the basin and sub-basin scale circulation and their vertical extension are analysed and described.

Keywords: Circulation, Mediterranean Sea, Black Sea

Temperature and salinity profiles derived from Argo floats are used in conjunction with MEDAR/MEDATLAS and altimetry data in order to describe the main characteristics of the geostrophic circulation during the period 2001-2014 in the Mediterranean Sea and 2005-2014 in the Black Sea. Hydrographical data were linearly interpolated on standard pressure levels (i.e., [10 20 50 100 200 400 600 800 1000 1200 1400 1600 1800] dbar), then the CTD profiles were organised in pairs according to spatial and temporal criterions. Surface altimetry currents were interpolated at the mean location and time of each pair of profiles and the geostrophic velocities relative to the surface currents were estimated using the thermal wind equation. These velocities were then divided in bins of 0.5°x 0.5° and the best evaluation of the mean geostrophic velocity in each bin is estimated using the least-square method.

In the Black Sea, the basin-scale cyclonic boundary current (Rim Current-RC) is coherently reconstructed at 10 dbar depth (Fig. 1), showing typical velocities of ~50 cm/s, in agreement with [1] and [2]; in the interior of the basin the geostrophic currents define two cyclonic sub-basin gyres. On the 400 dbar depth (Fig. 2), the eastern sub-basin gyre flows anti-cyclonically, showing a reversal of the intermediate currents with respect to the surface. The anticyclonic gyre persists between 400 and 1000 dbar depths.

In the Western Mediterranean the Northern Current (NC) as well as the cyclonic circulation of the Liguro-Provencal basin extend vertically between the surface and the bottom layer (see Figs. 1 & 2). The Algerian Current (AC) show intense velocities of 20-25 cm/s between 10 and 100 dbar depths (Fig. 1), whereas it disappears below 100 dbar. In the Tyrrhenian Sea currents flow cyclonically above the 400 dbar depth (Figs. 1 and 2) and the Northern Tyrrhenian Eddy (NTE) is recognizable east of the Corsica and Sardinia Island.

In the Eastern Mediterranean the cyclonic signature of the South Adriatic Gyre (SAG) dominates the circulation of the southern Adriatic in the whole water column (Figs. 1 & 2). The Northern Ionian Gyre (NIG) shows an anticyclonic pattern in the surface layer and a cyclonic one in the intermediate layer. The Atlantic-Ionian Stream (AIS) shows intensities of 15 cm/s between the surface and the 800 dbar depth. In the Levantine basin the Mid Mediterranean Jet (MMJ), the Mersa-Matruh Eddy (MME) and the Rhodes Gyre (RG) are clearly recognizable above the 400 dbar depth (Figs. 1 & 2); the Ierapetra Eddy (IE) shows a deeper signature between the surface and 800 dbar depth.

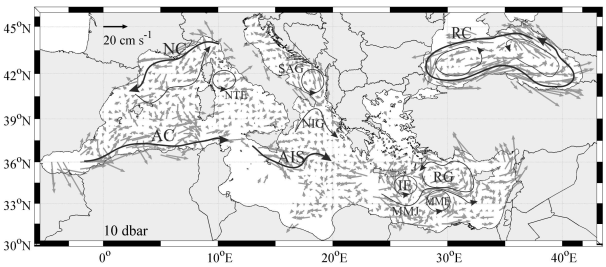

Fig. 1. Mean geostrophic currents in the Mediterranean and Black Seas at 10 dbar depth (grey arrows); the main currents and circulation features are emphasized with black arrows; the acronyms are defined in the text.

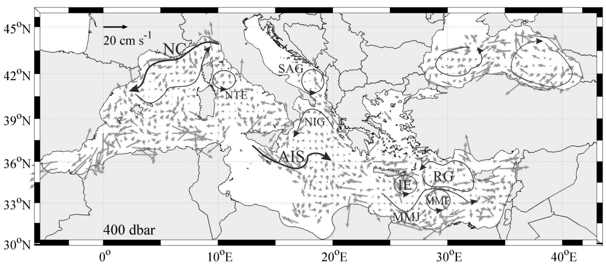

Fig. 2. Same as Fig. 1 but for 400 dbar.

References
1 - Oguz, T. and S. Besiktepe, 1999. Observations on the Rim Current structure, CIW formation and transport in the western Black Sea. Deep sea Res Pt I, 46 (10), 1733-1753.
2 - M. Menna, P.-M. Poulain, 2014. Geostrophic currents and kinetic energies in the Black Sea estimated from merged drifter and satellite altimetry data. Ocean Sci., 10, 155-165.

ATMOSPHERIC TELECONNECTIONS AND CONCOMITANT OCEANOGRAPHIC PROCESSES IN THE NORTH WESTERN MEDITERRANEAN SEA AND THE BAY OF BISCAY

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Abstract
The ocean response to atmospheric forcing is critical to many oceanographic processes. Data on air temperature, heat and buoyancy losses, and water temperature from winter 2005 allowed detecting the formation of dense water in the NW Mediterranean Sea, both on the continental shelf and offshore, which led to cascading and open sea convection, respectively. This was synchronous with the deepening of the mixed layer depth in the Bay of Biscay. Our study shows that the geographical proximity of both basins favors atmospheric forcings to simultaneously trigger significant oceanographic processes. This is indicative of the relevance of teleconnections in between these two regions when a high-pressure center west of the British Islands modulates the penetration of cold and dry continental air masses during winter months

Keywords: Air-sea interactions, North-Western Mediterranean, Gulf of Lyon

The study of the interannual variability of the deep winter mixing and of dense water formation has grabbed the attention of multiple studies over the past decades (e.g. Kolodziejczyk et al., 2015 and references there in). In the Gulf of Lion (GoL, NW Mediterranean Sea), the density increase of shelf waters during winter months and their spreading and cascading down the slope is a major oceanographic process affecting the hydrology of the whole basin, as it contributes to the formation of the Western Mediterranean Deep Water. Likewise, in the nearby Bay of Biscay (BoB), intense winter convective mixing events significantly modifies the hydrography of the upper ocean and the properties of the water masses below the mixed layer. Studies conducted both in the BoB and in the GoL (e.g. Somavilla et al., 2009; López-Jurado et al., 2005) showed that the abnormally dry, windy and cold winter of 2005 strongly altered the hydrography of both regions, which pointed to atmospheric teleconnections. To verify the existence and check the spatial structure of such atmospheric connection, a correlation map of surface winter averaged air temperature anomalies between the GoL and the entire grid points existing elsewhere around the world has been carried out. Figure 1 shows that a major part of the air temperature anomalies vary in parallel ($r \geq 0.8$) within a radius of about 1000 km.

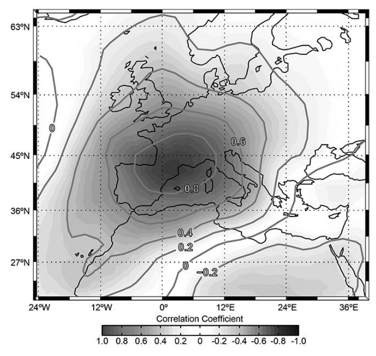

Fig. 1. Correlation map of surface air temperature anomalies between the GoL and the global grid of data points from the NOAA Global Surface Temperature Dataset. To be consistent with the extensive NOAA (http://www.noaa.gov/) published data, anomalies have been calculated using the period 1981-2010 as a reference.

The correlation length between both regions is not the typical of long-range teleconnection patterns but just the expected for points that are within a relative short distance. Several striking consequences result from such atmospheric connection.The quasi-permanent synchronic atmospheric (and therefore air-sea heat exchange) forcing over the BoB and the GoL ultimately favors a concomitant hydrographic response, which achieves its maximum expression especially during severe winters and leads to (1) intense events of open sea convection and dense shelf water cascading in the GoL and (2) extreme events of convective mixing in the BoB, as in winter 2005 and 2006.

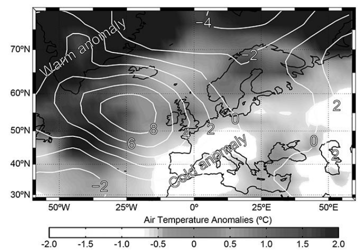

Fig. 2. Large-scale fields of winter averaged sea level pressure (white lines, in millibars) and air temperature (gray scale, in ºC) anomalies over the NE Atlantic and Mediterranean regions leading to severe heat losses and dense water formation over the continental shelf and offshore in the NW Mediterranean Sea, and to the deepening of the mixed layer in the Bay of Biscay. The image corresponds to winter 2005. Anomalies calculated using the period 1981-2010 as a reference.

The synchronicity between both regions is directly dependent on atmospheric pressure distribution, which itself depends on the location of an anomalous high-pressure center west of the British Islands during winter. This center governs the penetration of continental cold air masses to the BoB and GoL latitude and ultimately controls ocean to atmosphere surface heat exchanges and the subsequent oceanographic responses (Fig. 2).

References
1 - Kolodziejczyk, N., Reverdin, G., Lazar, A., 2014. Interannual variability of the mixed layer winter convection and spice injection in the eastern subtropical North Atlantic. J. Phys. Oceanogr. 45, 504-25.
2 - López-Jurado, J. L., González-Pola, C., Vélez-Belchí, P., 2005. Observation of an abrupt disruption of the long-term warming trend at the Balearic Sea, western Mediterranean Sea, in summer 2005. Geophys. Res. Lett. 32, 2003-2006.
3 - Somavilla, R., González-Pola, C., Rodríguez, C., Josey, S. A., Sánchez, R. F., Lavín, A., 2009. Large changes in the hydrographic structure of the Bay of Biscay after the extreme mixing of winter 2005. J. Geophys. Res. 114, 1-14.

CIESM Congress Session : Sub-basin & mesoscale variability

Moderator's Synthesis

Not available

UNDERSTANDING OF THE BLACK SEA CIRCULATION AND THERMODYNAMICS USING OPERATIONAL OCEANOGRAPHY TOOLS

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Abstract
New datasets became available last years due to realization EC FP5, 6 and 7 projects in the Black Sea. Analysis of those datasets shows that the circulation variability on scales from week to years is induced by wind. Seasonal cycle of the Rim current is driven by regional air-sea coupling. Overlapping of the Rim current intensification and surface cooling is the reason of the warm stream formation in winter along the eastern boundary of the Black Sea, which smoothes climate of the Caucasian and Southern Crimea coasts. Specific phases of onshore or offshore Ekman layer transport and river runoff contributes to formation of the sea surface salinity. Simulations of the Black Sea ecosystem using current reanalysis permit to assume that the deep-sea upwelling provides also significant contribution to the basin eutrophication in 1980s.

Keywords: Circulation, Black Sea, Upwelling

DDevelopment of the Black Sea nowcasting and forecasting system in the framework of FP5 ARENA, FP6 ECOOP, SESAME and ASCABOS, FP7 MyOcean and MyOcean2 projects made possible to integrate all observations by means of their assimilation in circulation and ecosystem models [1]. Two set of standard MyOcean and MyOcean2 products which are provided by the Black Sea Monitoring and Forecasting Center [2] present three-dimensional arrays of temperature, salinity and current velocity resulted from operational nowcast and reanalysis cover 1971 – 2015 years. Those datasets analysis allow improve significantly understanding of the Black Sea circulation and thermodynamics against previous knowledge summarized by Stanev [3].

Common consideration of space altimetry and profiling float data shows that variability of temperature and salinity fields is adiabatic in a broad scale range starting from weeks and up to few years [4] and is controlled by the wind stress vorticity. Particularly seasonal cycle of the Black Sea circulation is controlled by the annual variability of the wind stress curl. Available potential energy support by the annual mean wind stress curl is realized in instability of the Black Sea Rim current and generation of mesoscale eddies. Numerical simulations show that mesoscale eddies cause formation of well known western and eastern gyres of the Black Sea circulation [5].

Analysis of temperature and current velocity arrays shows that heating of local atmosphere by the sea in winter produces cyclonic winds above the basin which generate onshore Ekman transport and following intensification of the Black Sea Rim current. Proper shift of phases between onshore or offshore Ekman transport and river fresh water runoff together with cross-frontal transport by eddies and deep-sea upwelling form surface salinity of the Black Sea. Consideration of temperature field show that the Rim current in winter transports warm water along the eastern boundary of the basin which smoothes climate of the Caucasian and Southern Crimea coasts.

Prominent feature of the Black Sea circulation is deep upwelling in the central part of the basin. This upwelling supports permanent pycnocline and restricts deepening of the Black Sea mixed layer. Simulations of the long-term Black Sea ecosystem evolution based on three-dimensional current reanalysis permit to assume that the deep-sea upwelling provides also significant contribution to the basin eutrophication in 1980s.

References
1 - Korotaev, G.K., Oguz, T., Dorofeyev, V.L., Demyshev, S.G., Kubryakov, A.I., Ratner, Yu.B. Development of Black Sea nowcasting and forecasting system (2011) Ocean Science, 7 (5), pp. 629-649.
2 - Marchuk, G.I., Paton, B.E., Korotaev, G.K., Zalesny, V.B. Data-computing technologies: A new stage in the development of operational oceanography (2013) Izvestiya - Atmospheric and Ocean Physics, 49 (6), pp. 579-591.
3 - Stanev E.V. Understanding Black Sea dynamics: Overview of recent numerical modeling (2005) Oceanography Vol.18 No2 pp.52-71.
4 - Korotaev G. K., Lishaev P. N., Knysh V. V. Reconstruction of Three-Dimensional Fields of Temperature and Salinity Based on Satellite Altimetry (2016) Earth Research from Space No1-2 pp. 1-14.
5 - Neumann G. Die absolute Topography des physicalischen Meersniveaus und die Oberflachen – Stromungen des Schwarzen Meers (1942) Ann. Hydrogr. Berlin 70 pp. 265 - 282.
6 - Dorofeev, V.L., Korotaev, G.K., Sukhikh, L.I. Study of long-term variations in the Black Sea fields using an interdisciplinary physical and biogeochemical model (2013) Izvestiya - Atmospheric and Ocean Physics, 49 (6), pp. 622-631.
7 - Kubryakova E. A., Korotaev G. K. Influence of Vertical Motions on Maintaining the Nitrate Balance in the Black Sea Based on Numerical Simulation (2016) Oceanology, Vol. 56, No. 1, pp. 25–35.

ANALYSIS OF DEEP VARIATIONS RECORDED IN THE LIGURO-PROVENÇAL SUBBASIN DURING WINTER 2005-2006

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Abstract

Although historical data [1,2] identifie in the Gulf of Lions the main important site for dense water formation for the whole Western Mediterranean. Hydrological data performed during the last decade report interesting episodes of deep water convection also in the Ligurian Sea, indicating significant changes in temperature and salinity of the Western Mediterranean Deep Water [3,4].Between 2004 and 2009, six moorings were deployed along the Var submarine canyon, on a distance of about 100 km, at variable depths starting from 500 m down to 2300 m. An accurate analysis of this huge current dataset revealed a long period of strong near bottom currents not attributable to the turbidity flows, but rather imputable to processes of water sinking.

Keywords: Deep sea processes, Ligurian Sea, Deep waters

The analysis of about four years of current measurements collected off Nice (up to a distance of about 100 km from the coast) have shown an interesting mesoscale deep variability occurred on winter 2006. Hydrographic and moored data, as well as meteorological conditions have been taken into account in order to investigate thisdeep variability and correlate it to possible processes of dense water formation. In fact, it is well known that the combination of cold and dry winds, can be able to modify significantly the surface layer with a consequent buoyancy loss, leading to mixing and homogenization of the underlying water column.

Accurate spectral and Wavelet analyses of bottom long term series allowed us to distinguish between events strictly related to the canyon activity, as hyperpycnal currents, and mesoscale events representative of a wider circulation dynamic. Also, the use of a Wavelet analysis on the whole dataset offers the rare opportunity to easily compare sites affected by very different dynamics (mooring cover a vertical thickness of about 1000 m and an horizontal distance of about 100 km from the coastal area to the deep ocean). In general, all moored time series show the presence of energetic signals starting from periods ~ 10 days. These behaviors may be related to mesoscale processes which intensify during the wintry season. This is in good agreement with literature data [5] that show a slow weakening of Liguro-Provençal current during spring and summer, and an intensification afterwards in autumn and winter.
This mesoscale phenomenon presents two main fluctuation bands: one with period 10-30 days related to the Liguro-Provençal main direction (westwards), and another one with period 3-6 days related to a branch which separates from the main current and flows perpendicularly (southwards) polarizing anticlowckwise at a certain distance from the coast.

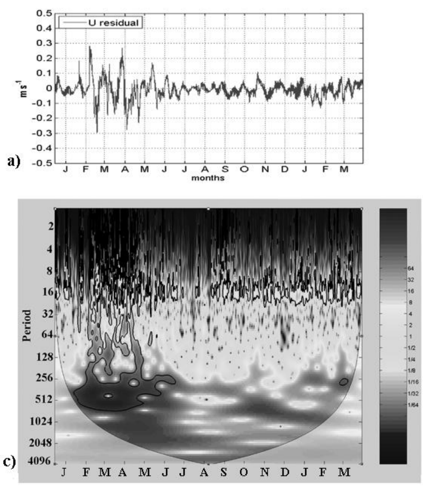

Fig. 1. Time series residual of U velocity component acquired by bottom current meter RCM8 and related wavelet analysis showing the main period of variation recorded during winter 2006.

References

1 - Bunker, A. F. (1972), Wintertime Interactions of the Atmosphere with the Mediterranean Sea, Journal of Physical Oceanography, 2(3), 225-238, doi:10.1175/1520-0485(1972)002
2 - Medoc, G. (1970), Observation of Formation of Deep Water in the Mediterranean Sea, 1969, Nature, 227(5262), 1037-1040.
3 - Marty, J. C., and J. Chiavérini (2010), Hydrological changes in the Ligurian Sea (NW Mediterranean, DYFAMED site) during 1995–2007 and biogeochemical consequences, Biogeosciences, 7(7), 2117-2128, doi:10.5194/bg-7-2117-2010.
4 - Smith, R. O., H. L. Bryden, and K. Stansfield (2008), Observations of new western Mediterranean deep water formation using Argo floats 2004-2006, Ocean Sci., 4(2),doi:10.5194/os-4-133-2008.
5 - Sammari, C., C. Millot, and L. Prieur (1995), Aspects of the seasonal and mesoscale variabilities of the Northern Current in the western Mediterranean Sea inferred from the PROLIG-2 and PROS-6 experiments, Deep Sea

AIR-SEA INTERACTION AND DEEP WATER FORMATION IN THELIGURO-PROVENÇAL SUBBASIN

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Abstract

The variability recorded at the bottom layers represents an important proxy in the study of climatic changes, so that the deep sea monitoring takes more and more important connotations in the study of formation and spreading of new water masses and their contribute in the thermohaline circulation. The long term monitoring performed between 2004 and 2009 in the framework of the ENVAR program carried out in the Liguro-Provencal subbasin, showed a strong and abrupt variation of bottom current lasting over three months. Previous analyses made on these data attributed this variation to processes of superficial water sinking. In order to better characterize this kind of process a new analysis takes more into account the surface heat flux and the relative buoyancy flux able to generate turbulence and convective instability

Keywords: Air-sea interactions, Ligurian Sea

During the ENVAR program several moorings were deployed along the Var canyon on a distance of about 100 km from the Nice coast (Fig.1).On winter 2006, a strong current variability was simultaneously recorded by all stations at the bottom layers, highlighting the occurrence of a mesoscale process whose effects interested avast thickness of the water column (about 500 m).The analysis up to now performed ascribed this abrupt variability to vertical movement of the water column pushed down by surface forcing. Due to the water sinking a renew of the bottom seawater was observed,in accord with ARGO results [*1*] that reveal the surprising presence of saltier and warmer deep water beyond 2000 m of depth. At the beginning of May 2006, the deep layers of Liguro-Provençal subbasin were enhanced with warmer and saltier waters, superimposing to the already existing warming trend concerning the Western Mediterranean Deep Water (WMDW), known since 1950s [*2*; *3*]. At today, all speculations made about the variations recorded at the bottom layers on winter 2006 are referred to vertical mixing processes as main responsibleof changes in the deep dynamic, although there is no evidence todiscriminate a contributions induced by lateral advection.The state of the art presented in this work consists in a new analysis taking into account the air-sea heat and the moisture fluxes responsible for change of the surface density and consequently of its buoyancy. The buoyancy loss rapidly impacts in the stratification of the water column. In fact, the destabilization of the buoyancy forcing produces a certain surface turbulence that, in turn, induce vertical movement and thus results in mixing. Current data are combined with some meteorological data (i.e.heat flux,wind, precipitation) in order to calculate the influence of the air-sea coupling in the triggering of dense water sinking process. It allows to definitely exclude horizontal advection that can also produce mixing of the water column and variation at the bottom layers.

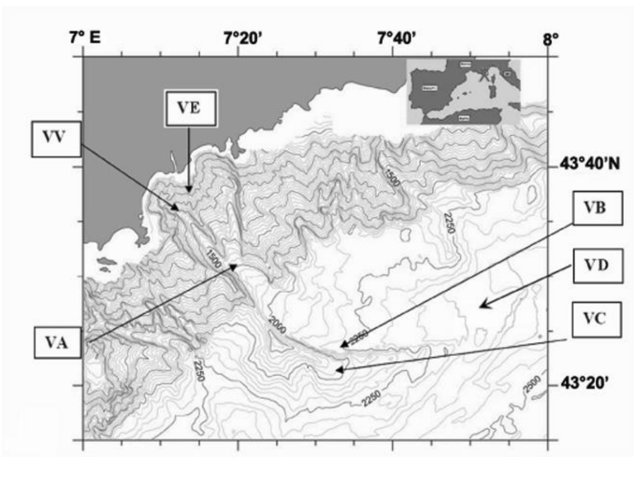

Fig. 1. Map of all mooring stations deployed along the Var canyon axis. VE, VV, VA and VB stations were moored inside the canyon system. VC stations was deployed on the levee outside the canyon, while VD station was located in proximity of the DYFAMED reference point.

References

1 - Bethoux, J. P., B. Gentili, J. Raunet, and D. Tailliez (1990), Warming trend in the western Mediterranean deep water, Nature, 347(6294), 660-662.

2 - Rixen, M., Beckers, J. M., Levitus, S.,Antonov, J.,Boyer, T.,Maillard, C.,Fichaut, M.,Balopoulos, E., Iona, S., Dooley, H., Garcia, M. J., Manca, B., Giorgetti, A.,Manzella, G., Mikhailov, N., Pinardi, N., Zavatarelli, M. (2005), The Western Mediterranean Deep Water: A proxy for climate change, Geophys. Res. Lett., 32(12), L12608, doi:10.1029/2005gl022702.

3 - Smith, R. O., H. L. Bryden, and K. Stansfield (2008), Observations of new western Mediterranean deep water formation using Argo floats 2004-2006, Ocean Sci., 4(2), doi:10.5194/os-4-133-2008.

MODELLING STUDIES OF DENSE WATER FORMATION IN THE ADRIATIC SEA DURING THE WINTER OF 2012

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Abstract
The paper overviews modelling efforts used for reproduction of extreme cold outbreak in 2012 in the Adriatic Sea. Focus was directed toward quantification of atmosphere-ocean interaction, dense water formation, effects of preconditioning, introduction of proper river forcing, wave-ocean coupling effects and dense water spreading towards the deep Adriatic. Major achievements of these studies are documented, particularly emphasizing the importance of introducing proper river runoffs along the eastern Adriatic to reproduce dense water formation.

Keywords: Air-sea interactions, Continental shelf, North Adriatic Sea

Dense water formation (DWF) has been known to occur in the northern Adriatic for a long time [1]. However, it occurs only in years with substantial cooling of the whole water column, during wintertime bora outbreaks and preconditioned by a lower-than-usual river discharges. These studies have been reinforced after the winter of 2012, which was characterized by a prolonged and extreme bora wind episode, preconditioned by a dry multi-month conditions, altogether resulting in an extensive DWF event encompassing both open and coastal parts of the northern Adriatic and ending in record-breaking densities (up to 1030.6 kg/m^3). Figure 1 shows bottom potential density anomaly distribution modelled at the end of the DWF episode.

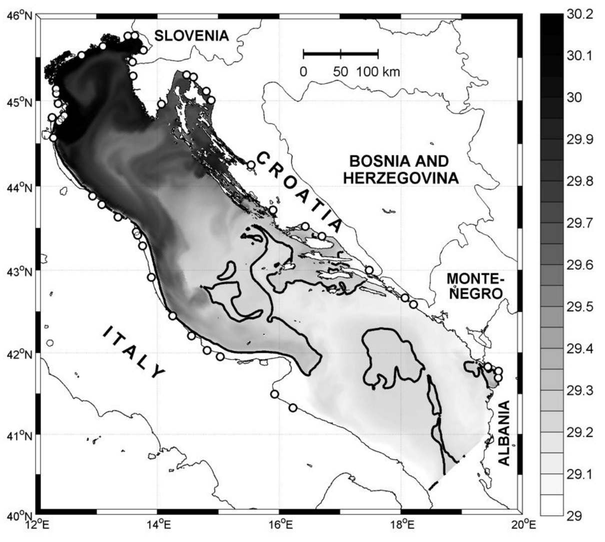

Fig. 1. Potential density anomaly (PDA, in kg/m^3) at the lowest sigma layer modelled by ROMS/ALADIN one-way high-resolution modelling system on 14 February 2012 (after [4]). Thick line stands for PDA>29.2 kg/m^3. Circles denote river sources used in the model.

Several research studies carried out immediately after the event were mostly focused on observations, including its unusual capture by an ARGO profiler [2]. The first modelling study [3] quantified the DWF volumes; however, the computations were based on old river climatology, known to substantially exaggerate the Adriatic freshwater budget. An improper introduction of rivers along the eastern Adriatic coastline was found to prevent the DWF in the eastern coastal area [4]. The DWF was modelled there for the first time when the Raicich river climatology was substituted with recently measured river discharge data. It seems that the eastern coastal area contributed by 40% to the overall dense water budget in the northern Adriatic [5]; however, this result may be a consequence of the exceptional year, both by heat losses and by preconditioning. Therefore, an “ordinary” DWF winters should be investigated to show if this area is a common DWF area or it is excited only during anomalous years.

The densest waters were formed in the shallow Gulf of Trieste [6]; however, the largest cooling and heat losses (up to 2000 W/m^2) were documented in a deep channel area off Velebit Mountain [5]. From a modelling perspective, it seems that the initialization of the atmospheric models by sea surface temperature fields strongly affects the computations of atmosphere-ocean heat exchange and in turn DWF rates [7]. Also, the wave-induced forcing was found to have a substantial role in DWF and dense water spreading phases [8]. The DWF event was strong enough to substantially impact the bottom of the deep South Adriatic Pit [9], replenishing old waters and triggering a modulation of the saw-tooth pattern, which normally has a period of 5 to 10 years.

Summarily, the extreme DWF event of 2012 is the most comprehensively researched dense water event in the Adriatic Sea so far, due to both availability of in situ data and to maturity of atmospheric and ocean models.

References

1 - Zore-Armanda M. 1963. Les masses d’eau de la mer Adriatique. *Acta Adriat.*, 10: 5-88.
2 - Vilibic I. and Mihanovic H., 2013. Observing the bottom density current over a shelf using an Argo profiling float. *Geophys. Res. Lett.*, 40: 910–915
3 - Mihanovic H., Vilibic I., Carniel S., Tudor M., Russo A., Bergamasco A., Bubic N., Ljubesic Z., Vilicic D., Boldrin A., Malacic V., Celio M., Comici C. and Raicich F., 2013. Exceptional dense water formation on the Adriatic shelf in the winter of 2012. *Ocean Sci.*, 9: 561-572.
4 - Vilibic I., Mihanovic H., Janekovic I. and Sepic J., 2016. Modelling the formation of dense water in the northern Adriatic: sensitivity studies. *Ocean Model.*, accepted
5 - Janekovic I., Mihanovic H., Vilibic I. and Tudor M., 2014. Extreme cooling and dense water formation estimates in open and coastal regions of the Adriatic Sea during the winter of 2012. *J. Geophys. Res.*, 119: 3200-3218.
6 - Raicich F., Malacic V., Celio M., Giaiotti D., Cantoni C., Colucci R.R., Cermelj B. and Pucillo A., 2013. Extreme air-sea interactions in the Gulf of Trieste (North Adriatic) during the strong Bora event in winter 2012. *J. Geophys. Res.*, 118: 5238-5250.
7 - Davolio S., Stocchi P., Benetazzo A., Bohm E., Riminucci F., Ravaioli M., Li X.M. and Carniel S., 2015. Exceptional Bora outbreak in winter 2012: Validation and analysis of high-resolution atmospheric model simulations in the northern Adriatic area. *Dyn. Atm. Oceans*, 71: 1-20.
8 - Benetazzo A., Bergamasco A., Bonaldo D., Falcier, F. M., Sclavo M., Langone L. and Carniel S., 2014. Response of the Adriatic Sea to an intense cold air outbreak: Dense water dynamics and wave-induced transport. *Prog. Oceanogr.*, 128: 115-138.
9 - Bensi M., Cardin V., Rubino A., Notarstefano G. and Poulain P.-M., 2013. Effects of winter convection on the deep layer of the Southern Adriatic Sea in 2012. *J. Geophys. Res.*, 118: 6064-6075.

HIGH-FREQUENCY VARIABILITY OF CURRENT FIELD IN THE NORTHERN ADRIATIC

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Abstract
A large set of ADCP-measured currents in the Northern Adriatic is analysed. At diurnal and shorter periods, the data document a number of physical phenomena which are spatially and seasonally variable. In winter the Adriatic-wide seiches are induced, while in summer baroclinic tides and energetic inertial oscillations are present.

Keywords: Currents, North Adriatic Sea, Stratification, Waves, Tides

An extensive set of data was gathered at the eastern side of Northern Adriatic within the Northern Adriatic Experiment. The currents were measured with Acoustic Doppler Current Profiler (ADCP) at eight stations during a 8-month interval from Dec 2014 to Aug 2015, with sampling at 10-minute/15-minute time step and 10-meter/15-meter vertical resolution.

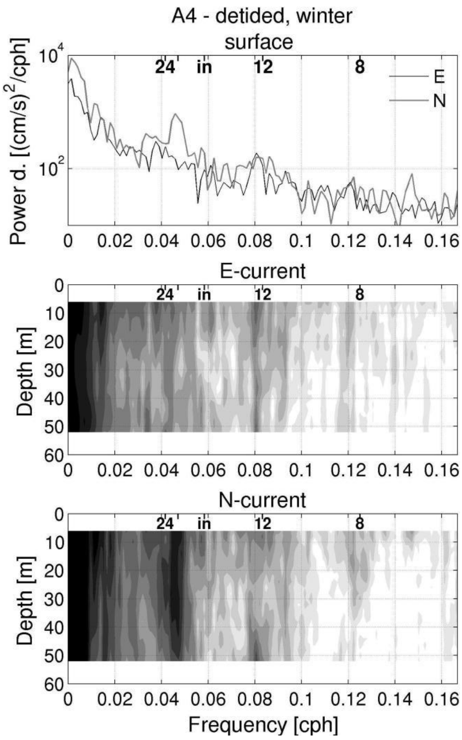

Fig. 1. Winter power density spectra of detided current (E – eastward, N – northward), near surface (*top*) and along the water column (*bottom*), at a station in the southern part of Northern Adriatic.

The high-frequency part of the current spectra is dominated by tides, with prevailing semidiurnal tides. Tidal currents are largerly polarized along the basin, except south of the tip of Istria where tidal flow is in the east-west direction.

The oscillations in the current field at diurnal and shorter periods are spatially and seasonaly variable. The Adriatic-wide seiches, with the principal-mode period at 21.2 h and the second-mode period at 10.9 hours [1], are recorded further from the head of the basin, the latter being significant only at the southernmost station. The seiche activity is strong during winter season when meteorological forcing is more energetic (Fig. 1).

In summer (Fig. 2), during stratified season, inertial oscillations are very energetic at offshore stations positioned in the entrance to the Kvarner Bay. They have a pronounced baroclinic structure, with anticyclonically rotating currents in the top and bottom layer, and a 180 deg phase shift between the two layers [2]. Further, baroclinic tides are observed at several locations; at the southernmost station, which is positioned in a long channel between two chains of islands and where tidal currents are strong, baroclinic nonlinear tidal harmonics at the periods of 8 hours and 6 hours are induced as well.

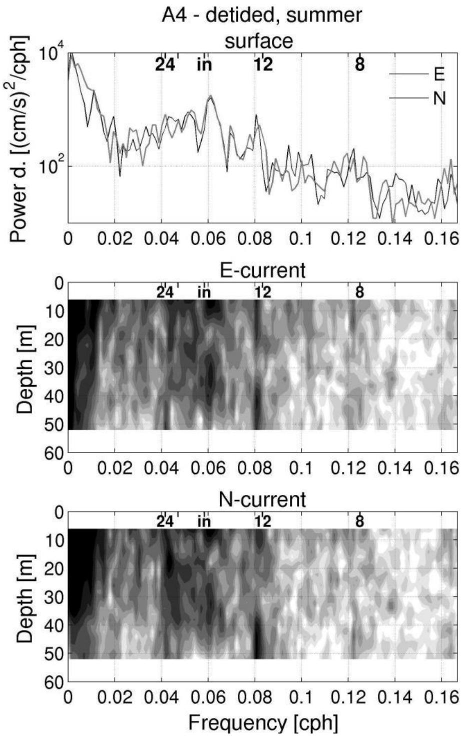

Fig. 2. The same as in Fig. 1, but for summer.

Acknowledgements
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References

1 - Cerovecki I., Orlic M. and Hendershott M. C., 1997. Adriatic seiche decay and energy loss to the Mediterranean. *Deep-Sea Res. I*, 44: 2007-2029.
2 - Orlic M., 1987. Oscillations of the inertia period on the Adriatic Sea shelf. Cont. Shelf Res., 7: 577-598.

DYNAMICS OF THE NORTH BALEARIC FRONT WITH SATELLITE DATA, IN-SITU DATA AND A HIGH-RESOLUTION AIR-SEA COUPLED MODEL : A CASE-STUDY FROM HYMEX IOP16

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Abstract
The objective of this study is to describe the dynamics of the North Balearic Front during a strong wind event (SWE) of Mistral and Tramontane. This study focus on an Intensive Observation Period (IOP16), of the HyMeX program, dedicated to SWE. During this SWE the SST shows a rapid displacement of the surface front to the south (50-60 km in 7 days). As satellite data shows only a partial view of the frontal dynamics, in order to better understand this process, a new high resolution air-sea coupled model (Meso-NH - SURFEX - Symphonie) was used at kilometric scale and in-situ data collected during HyMeX program were analysed.

Keywords: Air-sea interactions, Fronts, Models, North-Western Mediterranean

The North Balearic Front forms the south branch of the cyclonic gyre [1] of the North Western Mediterranean Sea (NWMS). This front separates the Atlantic Water (AW) present in the south of the basin from the Modified Atlantic Water (MAW) to the North. The cyclonic gyre plays a major role on the oceanic deep convection observed in NWMS [2].
This study focuses on an Intense Observation Period (IOP16) of the first Special Observation Period (SOP1) [3] of the HyMeX program (http://www.hymex.org). IOP16 starts on 25 October 2012 and ends three days later. Its first phase was dedicated to the study of an Heavy Precipitation Event (HPE). The consequence of this event was clear on the surface salinity measured at the Lion buoy (4.64E - 42.06N) the 26 October (Fig. 1.). The second phase of the IOP was dedicated to the study of an SWE (Tramontane and Mistral) with wind velocities up to 26m.s-1 at the Lion buoy (Fig. 1.). The SWE produced a sea surface temperature drop of 4°C in few hours (Fig. 1.).

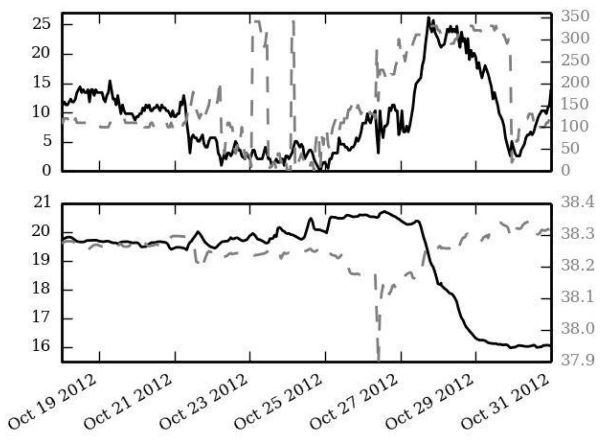

Fig. 1. Time series of surface parameters measured at the Lion buoy. Top : Wind speed in black line and wind direction in gray dashed line. Bottom : Sea surface temperature in black line and sea surface salinity in gray dashed line.

The HyMeX in-situ data have been completed by gliders observations of the MOOSE (http://www.moose-network.fr) and SOCIB (http://www.socib.eu) French and Spanish monitoring programs. Fig. 2 shows the position of all in-situ data available from 16/10/2012 to 06/10/2012 as well as the positions of the North Balearic Front derived from satellite SST [4] for three differents days (18/10/2012, 24/10/2012 and 31/10/2012). Before the SWE (between 18 and 24 October) the front moved to the North. This is confirmed by in-situ surface temperature and salinity measurements at the Lion buoy (Fig. 1.). During the SWE (from 24 to 31 October the satellite data showed a rapid displacement of the surface front to the south (50-60 km in 7 days).

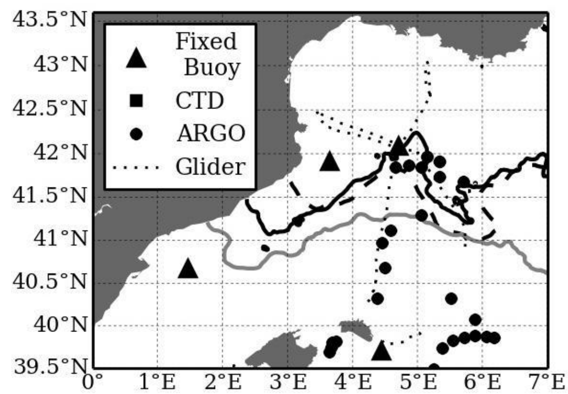

Fig. 2. Positions of the in-situ measurements (Fixed buoy, CTD, ARGO, Glider) represented with symbols and positions of the North Balearic Front obtained with satellite SST for different days (18 October : black dashed line, 24 October: black solid line and 31 October : gray line).

To better describe the frontal dynamics during SWE, we used an approach combining satellite data, in-situ data and an air-sea coupled model at kilometric scale based on the Meso-NH atmospheric model [5], the SURFEX surface model [6] and the Symphonie oceanic model [7] coupled with OASIS3-MCT coupleur [8]. Sensitivity studies of this coupled model to initial conditions, coupling frequency, air-sea fluxes parameterizations ...) were performed and discussed.

References
1 - Millot C., 1999. Circulation in the western mediterranean sea J. Mar. Syst., 20 (1–4), pp. 423–442.
2 - Marshall J., and Schott F., 1999. Open-ocean convection: Observations, theory, and models, Rev. Geophys., 37(1), 1–64.
3 - Ducrocq V., et al., 2014. Hymex-sop1: the field campaign dedicated to heavy precipitation and flash flooding in the northwestern mediterranean. Bull. Amer. Meteor. Soc., 95, 1083–1100.
4 - Buongiorno Nardelli B., et al., 2013. High and Ultra-High resolution processing of satellite Sea Surface Temperature data over Southern European Seas in the framework of MyOcean project, Rem. Sens. Env., 129, 1-16.
5 - Lafore J. P., et al., 1998. The Meso-NH Atmospheric Simulation System. Part I: Adiabatic formulation and control simulations. Annales Geophysicae, 16, 90-109.
6 - Masson V., et al., 2013. the SURFEXv7.2 land and ocean surface platform for coupled or offline simulation of earth surface variables and fluxes, Geosci. Model Dev., 6, 929-960.
7 - Marsaleix P., et al., 2008. Energy conservation issues in sigma-coordinate free-surface ocean models. Ocean Modelling. 20, 61-89.
8 - Valcke S.,et al., 2015.OASIS3-MCT 3.0, Technical Report, TR/CMGC/15/38, CERFACS/CNRS SUC URA No 1875, Toulouse, France.

CIESM Congress Session : Sea level variations

Moderator : Mikis Tsimplis, Inst. of Maritime Law, Southampton Univ., UK

Moderator's Synthesis

Mediterranean Sea level changes pose significant risks for the coastal areas. For impact studies, local changes are important and these include contributions from local, Mediterranean basin and sub-basin contributions as well as contributions from global processes like the water mass addition to the oceans by melting glaciers and ice sheets, the land response to the redistribution of mass as well as the steric sea level change. Coastal hazards are caused by extreme events which can be combination of storm surges , tides, resonances including meteo-tsunamis. Increases in mean sea level will make these events more dangerous as their effects will reach higher grounds. Because the Mediterranean Sea is in most places a low tide and low storm surge environment infrastructure is built close to the water line and thus its vulnerability to local mean sea level change is high.

Within this framework Scarascia and Lionello presented an empirical model which includes several forcing parameters and which shows good skill in describing mean sea level variability of the Adriatic and the Baltic Sea. This model was then forced using variables extracted from climate model projections for exploring the contribution of the local forcing factors and of changes of large scale ocean circulation to the future sea level rise in these two basins. The suggested maximum contribution was around 23 cm in the Adriatic, but with high uncertainty and around 3 cm in the Baltic Sea. It was thus concluded that these mechanisms are of smaller scale than the predicted changes from mass addition and global steric expansion and thus the global perspective cannot be ignored or downplayed.

Orlic and Pasaric presented a study on semi-empirical sea level modelling where they experimented with modelling the sea level change as well as the sea level rate of change. Such models are in general based on assumptions of the response of sea level to global temperature changes. However in this study different response rates for slow and fast processes were attempted, the former was found to have large uncertainty while the latter was defined well. The forcing of the models was done on temperatures taken from the RCP4.5 scenarios and using only the fast component response time. The authors suggest that the observed slowdown in global atmospheric temperature will result in a steady sea level rise over the next few years. Pasaric and Pasaric presented a study on the statistical significance of observed sea level trends in the Mediterranean by analysing the statistical properties of the residual sea levels. Regional sea levels were estimated by averaging the available tide-gauges. The residual time series were positively autocorrelated thus increasing the uncertainty in all regions. While by using the standard least square estimate for the linear trend all regions would have positive sea level trends, the study of the residual conducted with Bayes methodology suggests that at least in one of the five regions, the Aegean Sea, there is no significant trend available.

Said and El-Geziry provided a comparative study of two tidal analyses packages. The data from a tide gauge located in Abu-Qir Bay which is around 35km east of Alexandria were analysed by the use of the t-tide and the World Tides packages. The comparison was based on hourly sea level values for the year 2008, the one which had fewer missing values. The tidal analysis estimates from the two packages were found to be in good agreement in relation to the amplitudes although for five tidal constituents significant phase differences were found. The authors conclude that both tidal packages are suitable for tidal analysis in that part of the world.

Vilibic and Sepic provided an overview paper on meteo-tsunamis. These are sea level disturbances created by resonance occurring when the speed of travelling atmospheric pressure systems matches that the speed of long ocean waves. They normally occur over regions shallower than a hundred of meters and have been detected and impacted several parts of the Mediterranean and the Black Seas. Their size can range from a tenth of a meter to a couple of meters and they can be particularly destructive in vulnerable areas like the Mediterranean and the Black Seas coasts. The authors urge for two necessary actions. First, education of coastal populations so that they understand and are prepared for such events and second inclusion of such high frequency events into flood risk estimations for coastal regions. Such advances of understanding has been based on the availability of sea level values at 1 min rather than 1 hr, a practice that needs to expand and become the standard.

The session on the Mediterranean sea level was overall very interesting and demonstrated that while there is consensus on the importance of sea level change for coastal regions there is no concession yet on what is the relative importance between global and local processes. In addition there is no understanding on how local phenomena like meteo-tsunamis will change (or not) under climate change scenarios and the knowledge of land movements across the Mediterranean Sea has been considered as being far from complete.

AN IMPROVEMENT OF THE SEMI-EMPIRICAL METHOD OF ANALYSIS AND PROJECTION OF SEA LEVEL

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Abstract

A new variant of the semi-empirical method used to analyze and project sea level is developed. The variant allows for two response times, one of them being arbitrary and the other extending to infinity. Three parameters underlying the variant are determined from global temperature and sea level data extending over the 1880-2009 interval. The results show that the data provide useful information on fast processes but do not adequately document slow processes. Projections based on the semi-empirical method that allows for fast processes reveal the future behavior not only of sea levels but also of related trends.

Keywords: Sea level, Temperature, Mediterranean Sea

Global warming brings about expansion of the sea and melting of the land-based ice and therefore results in a rise of sea level [1]. With about 10% of the global population living in the coastal area at an altitude not surpassing 10 m, the rise is already very worrisome and is expected to be even more so in the future. In the analysis and projection of sea level, two dynamic methods are commonly used: the process-based one and the semi-empirical one. It is increasingly recognized that a combination of the two methods represents the best approach to the study of sea level [2], because it strengthens confidence in the results obtained with both methods.

In a previous study [3] we have compared three variants of the semi-empirical method, all of them characterized by a single response time but assuming that the response of sea level to temperature forcing is purely equilibrium, purely inertial, or some combination of the two. It turned out that a realistic response time is obtained only if both the equilibrium and inertial dynamics are taken into account. In the same paper another variant of the semi-empirical method, allowing for two response times and assuming that one of them equals zero whereas the other extends to infinity, has also been commented upon. It was found that application of this variant results in at least one parameter having numerical value that is not physically acceptable.

Here we introduce a new variant of the semi-empirical method, allowing for two response times with the fast-process one being arbitrary and the slow-process one extending to infinity. The variant is calibrated using global temperature data [4, with updates] and global sea level data [5] that extend over the 1880-2009 interval. The three parameters underlying the variant are obtained by a two-step procedure. First, the equilibrium and inertia coefficients controlling the fast response are determined by performing a two-to-one orthogonal regression analysis of the data. Second, the inertia coefficient constraining the slow response is calculated by assuming that the two coefficients characterizing the fast response are known and therefore applying a one-to-one orthogonal regression analysis on the data.

It turns out that the two coefficients related to fast processes are realistic: the equilibrium coefficient equals 3.3 °C/m whereas the inertia coefficient amounts to 143 °Cyr/m, which implies the response time of 43 yr. On the other hand, the inertia coefficient related to slow processes is found to equal –605 °Cyr/m, thus suggesting that these processes are not well documented by the available data sets. It is not clear whether the problem stems from the method used to extend coastal measurements to the open ocean, from the way the glacial isostatic adjustment is taken into account, or from the influence of terrestrial water storage on sea level. Whatever the reason, it is concluded that the semi-empirical method and the available data allow fast processes to be projected into the future, but leave us silent on slow processes.

Finally, we present in Fig. 1 observations and projections of temperatures and related trends as well as of sea levels and related trends. Temperature projections under the RCP4.5 scenario are taken from literature [1], whereas sea level projections are obtained by the semi-empirical method allowing for fast processes only. The results are interesting. In particular, they show that the global warming hiatus has manifested itself in the recent slowdown of temperature increase, and that it will result in a steady, non-accelerating sea level rise over the next decade or two if the RCP4.5 scenario is realized.

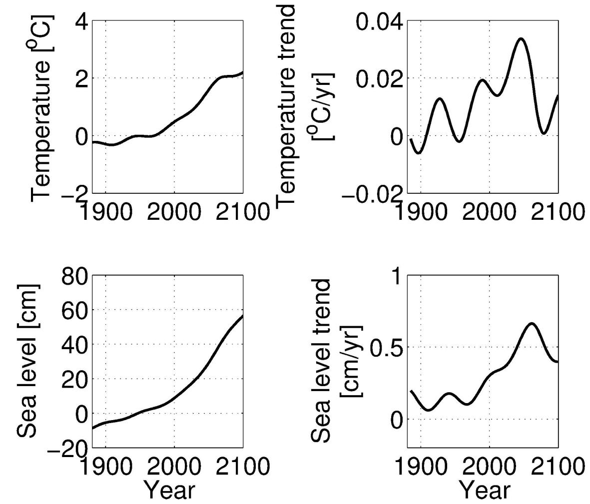

Fig. 1. Temperatures (up, left) and related trends (up, right), sea levels (down, left) and related trends (down, right). Time series represent observations prior to the year 2009 and projections under the RCP4.5 scenario after that year. Methodology used to construct the time series is explained in the text.

References

1 - Stocker T. F. and coauthors (Eds.), 2014. *Climate Change 2013 – The Physical Science Basis.* Cambridge University Press, Cambridge, 1535 pp.
2 - Orlic M. and Pasaric Z., 2013. Semi-empirical versus process-based sea-level projections for the twenty-first century. *Nature Clim. Change* 3: 735-738.
3 - Orlic M. and Pasaric Z., 2015. Some pitfalls of the semiempirical method used to project sea level. *J. Climate* 28: 3779-3785.
4 - Hansen J. and coauthors, 2001. A closer look at United States and global surface temperature change. *J. Geophys. Res.* 106: 23947-23963.
5 - Church J. A. and White N. J., 2011. Sea-level rise from the late 19th to the early 21st century. *Surv. Geophys.* 32: 585-602.

EXAMINING LINEAR TRENDS: EXAMPLES OF SEA LEVELS IN THE MEDITERANEAN

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Abstract
Long term linear trends for mean regional annual sea levels in Mediterranean are assessed with four models assuming the existence of linear trend vs. no trend and correlated vs. non-correlated residuals. Bayes methodology is applied. Positive autocorrelation is found in all regions which considerably increases the uncertainties of estimated trends. Model comparison strongly indicates the existence of (linear) trends in all regions except in the Aegean sea, where the data slightly prefer the no-trend model.

Keywords: Sea level, Mediterranean Sea

The assessment of trends is an important task in the analysis of long term variability of geophysical time series. Due to their simplicity, linear trends are often employed, at least as a starting model. One is interested in the estimate of the slope of the trend line as well as the uncertainty of this estimate. The former is usually obtained by least squares technique (although robust alternative exists [1]) while the latter is obtained from the assumed statistical model of residuals. Most often it is assumed, at least implicitly, that the residuals are equally (normally) distributed and mutually independent. Both assumptions could be questioned, but it is the assumption of independence that is usually violated in geophysical time series. This does not affect the trends themselves, as calculated by least squares, but usually has a strong impact on the estimated uncertainties. For this reason it is necessary to model the autocorrelation of residuals. The problem is sometimes approached within the so called generalized least squares, but the procedure is heuristic and involved. Another possibility is to apply the Bayes methodology, where various assumptions about the residuals can be implemented with relative easy [e.g. 2]. In Bayes approach one does not estimate the 'significance' of trend or any other particular model and/or hypothesis. Instead, it is possible to compare how much the two or more models are favored by the data at hand.

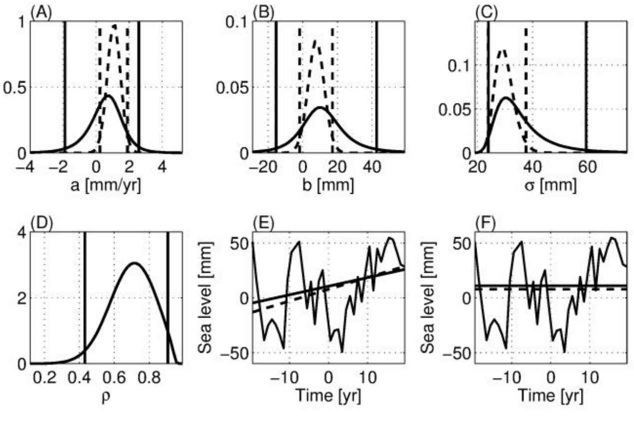

Fig. 1. Posteriors of parameters for models M1(full) and M2 (dashed) (A-D) and corresponding linear trends (E). Constant fits within models M3 (full) and M4 (dashed) (F), all for region R4.

The data analyzed in the present study comprise five time series of mean annual values of sea level for five regions related to the Mediterranean area: Atlantic ocean in the vicinity of Gibraltar strait (R1), West Mediterranean (R2), Adriatic Sea (R3), Aegean Sea (R4) and Black Sea (R5). These series are obtained by averaging the tide gauge data from stations belonging to the particular region. Among all stations available at [3], we retained those with correlation coefficient between neighboring stations being sufficiently high, depending on the region. Prior to the averaging, zero level at each station was adjusted by subtracting the long term mean value calculated over the longest interval that contains the data from all stations. The obtained time series for regions R1- R3 and R5 span the 1927-2008 interval. For R4 the interval is 1969-2008.

We consider a model of linear trend with correlated residuals:

$$y_t = a\ t + b + \epsilon_t$$

where y_t (mm) is sea level, t is time (years, zero corresponds to the middle of the time series), a is slope and b is intercept. The residual ϵ_t is modeled as Gaussian AR(1) process with zero mean, unknown standard deviation σ and unknown lag-one auto-correlation ρ. From this model, denoted here as M1, three additional models are obtained by assuming $\rho = 0$ (M2), $a = 0$ (M3) and $a = \rho = 0$ (M4). Thus, M2 is classical linear model with uncorrelated residuals, while M3 and M4 are constant models with correlated and non correlated residuals, respectively. Uniform priors are used in all calculations.

Figure 1 (A-D) depicts the posterior distributions of parameters for models M1 (full) and M2 (dashed line), together with corresponding 95%-credible intervals. As expected, these intervals are considerably wider if one allows the residuals to be autocorrelated. The posterior for ρ (Figure 1 (D)) suggests that likely the lag-one correlation coefficient falls between 0.6 and 0.8 and almost certainly is greater than 0.4. For M2, the modes of posteriors for a, b and σ are almost equal to corresponding values obtained by classical least squares. The same is valid for credible intervals and classical confidence intervals (assuming the non correlated residuals). Results for other regions and also for (no-trend) models M3 and M4 are similar. Next, the evidences for all models and all regions were calculated and scaled so to set the value at M1 to 100 (Table 1). The M1 model is always preferred (by the data) over the M2 in accordance with the estimated auto-correlation. The M1 is preferred over the M3, except in R4, where the data mildly prefer M3 (3.6:1). Also, in R4, the M2 is slightly preferred over the M4 (2.4:1), so if autocorrelation is not taken into account, the linear trend will be indicated. In classical approach, assuming no auto-correlation, the Kendal's tau p-values [1] (last row in Table 1) would imply significant trends in all regions.

Tab. 1. Evidences (scaled) and p-values for all models and regions (see text).

Model\Region	R1	R2	R3	R4	R5
M1	100	100	100	100	100
M2	5.4	0.64	8.4	0.012	9.6
M3	0.0049	0.16	1.34	361	0.12
M4	3e-18	1e-13	3e-06	0.0050	3e-09
p-value	2e-16	2e-12	1e-08	0.013	1e-10

This work has been supported in part by Croatian Science Foundation under the project 2831 (CARE).

References

1 - Sen, P.K. 1968. Estimates of the regression coefficient based on Kendall's tau. J. Am. Stat. Assoc. 63: 1379-1389.
2 - Sivia, D. and Skilling, J., 2006. Data Analysis: A Bayesian Tutorial, Oxford University Press, Oxford, 189 pp.
3 - PSMSL, 2011. Permanent Service for Mean Sea Level; http://www.psmsl.org/data/obtaining(accessed on 9 March 2016).

COMPARISON OF TWO PACKAGES FOR TIDAL ANALYSIS AND PREDICTION: AN EXEMPLAR CASE STUDY OF ABU-QIR BAY, ALEXANDRIA, EGYPT

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Abstract

The sea level at Abu-Qir bay was analysed and predicted with two tidal packages: t_tide and World Tides, each of which works under the Matlab environment. The five main tidal constituents, namely: O1, K1, N2, M2 and S2 were constructed for 2008 calendar year. The tidal elevations above the Mean Sea Level (MSL) were predicted for April 2010, and compared to the actual records. The Root Mean Square Error (RMSE) was used to evaluate the accuracy of the estimated data and to justify the preference of using any of the two packages in the area of investigation.

Keywords: Sea level, Surface waters, Tides, Nile Delta, South-Eastern Mediterranean

Abu-Qir Bay is a semi-circular basin lying 35 km east of Alexandria City between latitudes 31° 16' and 31° 28' N and longitudes 30° 03' and 30° 22' E. The present work aims at analysing the sea level in Abu-Qir bay, over the period 2005-2010, by the two different tidal packages namely: t_tide [1] and World Tides [2].

The year 2008, having the fully continuous hourly records, is then selected for a full independent analysis using the two packages. The t_tide is a package of routines that can be used to perform classical harmonic analysis with nodal corrections, inference, and a variety of user specified options. Moreover, it can be used for predictions using the analyzed constituents. The t_tide package is principally based on the concept of the ability of expressing the tidal amplitudes at any location as the sum of all the harmonic components. The World Tides is a package for sea level analysis and prediction, which permits quick separation of a time series of water level measurements into its tidal and non-tidal components using a selective least squares harmonic reduction employing up to 35 tidal constituents. The two software were also used for the sea level prediction above the MSL for April 2010. The Root Mean Square Error (RMSE) was determined in order to conclude any preference of one package over the other in the area of investigation. The hourly sea level data taken directly from the tide gauge in Abu-Qir Bay for the six-year period 2005-2010 consists of 43755 hourly records.

Over the period of investigation, the hourly sea level varied between 0.05 m and 1.0 m, i.e. 0.95 m tidal range, with a MSL of 0.507 m. During 2008, the records varied between 0.20 m and 0.84 m, with a Mean Seal Level (MSL) of 0.527 m. The astronomical elevations varied between 0.34 m and 0.67 m (t_tide), and between 0.51 m and 0.54 m (World Tide). The residual elevations varied between -0.34 m and + 0.34 m (t_tide), and between -0.32 m and +0.31 m (World Tide). There were large differences between the calculated phases of the five main astronomical constituents, but the amplitudes were almost the same (Table 1).

Tab. 1. Tidal harmonic constituents during 2008.

	T_tide Package		World Tides Package	
Tidal Constituents	Amplitude (m)	Phase (°)	Amplitude (m)	Phase (°)
O1	0.034	237.84	0.034	23.18
K1	0.033	158.87	0.033	358.98
N2	0.008	19.86	0.010	280.97
M2	0.042	47.79	0.040	33.89
S2	0.031	14.31	0.030	35.63

For the predicted elevations (Fig. 1), the RMSE of the predicted elevations in April 2010 using the two packages have shown the same value of 0.09.

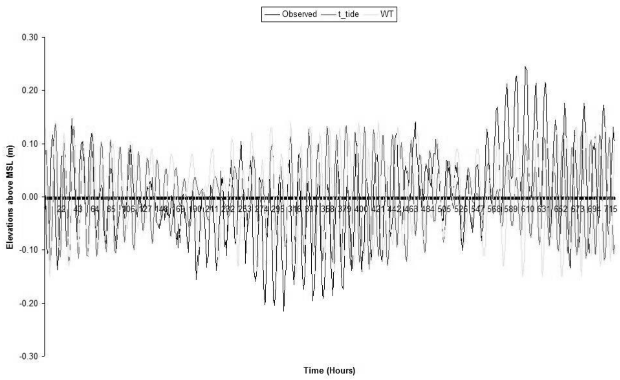

Fig. 1. The predicted water elevations above the MSL for April 2010.

In conclusion, there is no preference in using one of the two applied packages over the other. They both could be applied successfully in Abu-Qir Bay for the purpose of analysis and prediction and can be therefore recommended for any area along the Egyptian Mediterranean coast.

References

1 - Pawlowicz R., Beardsley B. and Lentz S., 2002. Classical tidal harmonic analysis including error estimates in MATLAB using T_TIDE”, Comp. Geosci. 28: 929–937.

2 - Boon J., 2004. Secrets of the Tide: Tide and Tidal Current analysis and Predictions, Storm surges and Sea Level Trends, Horwood Publishing, Chichester, UK, 210p.

DEVIATION OF SEA LEVEL OF SEMI-ENCLOSED BASINS FROM THE GLOBAL MEAN: ANALYSIS OF THE MAIN FACTORS ACTING ON THE ADRIATIC, BLACK AND BALTIC SEA

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Abstract
This work analyzes the main factors that are responsible for interannual variability and past centennial trends of the sea level in three semi-enclosed seas: the Adriatic, Black and Baltic Sea. The analysis produces a linear model that is capable to explain most of the sea level variability in the Adriatic and Baltic Sea, but is much less successful in the Black Sea. If such model is forced with a set of CMIP5 simulations it suggests that meteorological forcing is unable to produce a deviation of the regional sea level from the global mean larger than 15cm for the Adriatic and Baltic Sea.

Keywords: Sea level, Mediterranean Sea

The first objective of this study has been to reconstruct the time series of mean sea level in the Black, Adriatic and Baltic seas from tide gauges data extracted from the Permanent Service of Mean Sea Level (PSMSL). Three seamless time series covering the whole period from 1901 to 2009 are computed using tide records from 13 stations in Baltic Sea, 7 stations in the Adriatic Sea and 5 in Black Sea adopting a statistical method based on PCA and Least Square Method (Scarascia and Lionello, 2013). For all the three basins the very high spatial coherency of the involved stations implies that the resulting time series can be considered a reliable representation of mean sea level of the whole basin. The Glacial Isostatic Adjustment (GIA) has been subtracted to the Baltic sea level records (Church and White 2011, Peltier 2004). The comparison between the reconstructed time series and mean sea level from satellite data (covering the period 1993 to 2009) shows very high correlation both at monthly and annual scale where correlation is 0.97 and 0.87 for the Baltic and Adriatic Sea, respectively, while a slightly lower value (0.70) results for the Black Sea.

Past variability has been analyzed taking into account separately different factors that at regional scale determine the sea level anomaly. The factors involved are: the Inverse Barometer effect due to the local Sea Level Pressure (SLP), the steric effects due to sea temperature and salinity variation and finally the contribute due to the effect of the wind. Results show that among all these factors the wind is the largest one (particularly for the Baltic Sea) with the Inverse barometer playing a minor role and the steric effects being almost negligible. In the Black Sea, the effect of the wind has been found to be negligible, and the it has been replaced by an estimate of the effect of the rivers, which has been made assuming that the variability of the Sulina discharge (for which data are available) is representative of the variability of the Danube river and of the other rivers discharging in the Black Sea. The respective annual cycles are showed in Figure 1.

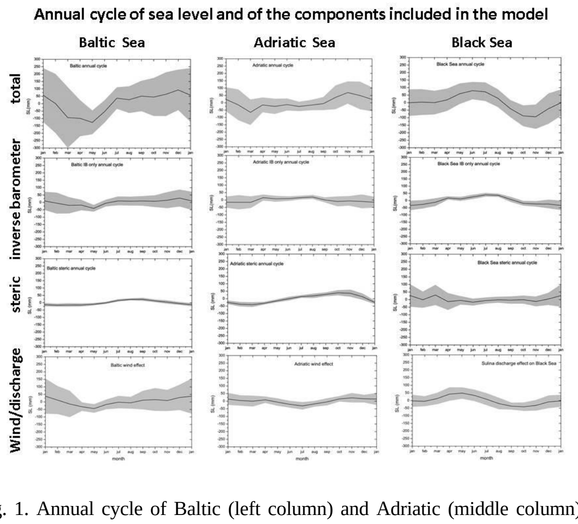

Fig. 1. Annual cycle of Baltic (left column) and Adriatic (middle column) and Black Sea (right column) sea level computed for the period 1945 – 2002. Grey areas show the interannual variability computed as the monthly standard deviation. The upper line refers to the total sea level, while the following lines display the contribution of the various factors.

A linear regression model has been built, which is capable of reconstructing these fluctuations with acceptable accuracy on the basis of analyzed sea level pressure and wind fields. This model has been forced with a set of CMIP5 model sea level pressure and surface wind projections to provide future projections of sea level anomalies at basin scale caused by these factors. However, deviations from the global mean sea level predicted by the linear regression model are small (in the order of 1cm). Though there are good reasons for considering that this result underestimates future deviations, it remains however clear that mechanical forcing due to wind and atmospheric pressure would be unable to provide large deviations. In fact, assuming high end changes of mean sea level pressure (a decrease of 5hPa) and of the wind (an increase of 2m/s of mean wind speed) would imply increases of basin sea level less than 10cm for the Baltic and Adriatic Sea. A similar analysis for the Black Sea, replacing the increase of the wing with a 20% increase of the river discharge would bring a similar conclusion for this basis. If the mass exchange with the world ocean is included in the computation, the overall deviation of the sea level from the global mean remains small, not exceeding the 15 cm for Adriatic and Baltic Sea by the end of 21st century. Presently, results for the Black Sea appears not reliable, and reason for this have to be clarified.

Acknowledgements: the authors thanks Adrian Stanica (GeoEcoMar) for the river discharge data at Sulina. This study is part of the RISES-AM project (FP7-EU-603396).

References
1 - Church, J. A. and N.J. White ,2011, Sea-level rise from the late 19th to the early 21st Century. Surveys in Geophysics, doi:10.1007/s10712-011-9119-1.
2 - Peltier W.R ,,2004 Global Glacial Isostasy and the Surface of the Ice-Age Earth: The ICE-5G(VM2) model and GRACE. Ann. Rev. Earth. Planet. Sci. 2004. 32,111-149
3 - Permanent Service for Mean Sea Level (PSMSL), 2015, "Tide Gauge Data", Retrieved 09 Feb 2015 from http://www.psmsl.org/data/obtaining/
4 - Scarascia L. and Lionello P. ,2013, Global and regional factors contributing to the past and future sea level rise in the Northern Adriatic Sea. Global and Planetary Change. 07/2013; 106:51-63. DOI: 10.1016/j.gloplacha.2013.03.004

DESTRUCTIVE HIGH-FREQUENCY SEA LEVEL OSCILLATIONS IN THE MEDITERRANEAN AND BLACK SEAS: PHENOMENOLOGY AND RELEVANCE

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Abstract
The paper presents recent research activities on meteotsunamis, high-frequency sea level oscillations, which are known to occur occasionally at destructive levels in the Mediterranean and Black Seas. These waves are multi-resonantly driven by intense and rapid air pressure travelling disturbances. Wide shelves and harbours with high amplification factors are found particularly vulnerable. Proper observing and reproduction of the phenomenon is particularly challenging, as non-standard meteorological and oceanographic measurements are required.

Keywords: Air-sea interactions, Sea level, Mediterranean Sea

Meteotsunamis, or meteorological tsunamis, belong to a class of a high-frequency tsunami-like sea level oscillations, triggered not by submarine earthquakes or landslides but by a small-scale atmospheric disturbances travelling over shallow regions (depths < 120 m), where their speed matches speed of long ocean waves [1]. They have been documented to appear in coastal waters of all continents and world seas [2], but with most substantial impact to coastal areas in low-tidal basins such as the Mediterranean. Intensity of meteotsunami waves is dependent on the Froude number (ratio between speeds of atmospheric disturbance and long ocean waves), bathymetry of a region and intensity/spectral content of the atmospheric disturbance.

In the Mediterranean and Black Seas, destructive meteotsunamis are documented in the Balearic Islands, eastern Spanish coast, the Adriatic Sea, western Sicily coast, the Maltese Islands, Greece, western Black Sea coast and Odessa region (Fig. 1), with several meters high waves occurring occasionally, flooding coastal areas and damaging coastal infrastructure [1]. Meteorological tsunamis normally occur during warm seasons, when inflow of warm and dry air from Africa is persistent in lower troposphere, and a strong and unstable mid-tropospheric south-westerly jet stream can become a dominant atmospheric feature serving as a reflecting layer for surface atmospheric disturbances propagating over long distances.

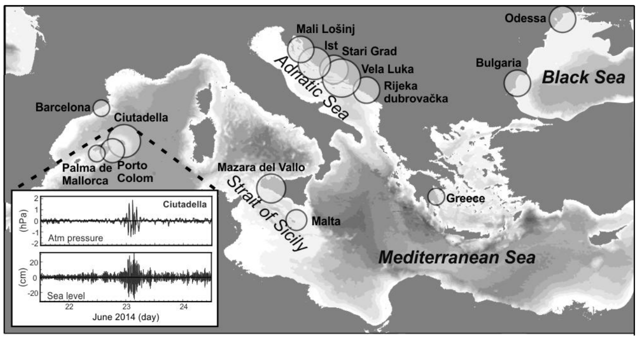

Fig. 1. Mediterranean and Black Sea locations where meteotsunamis had been documented (size of circle is proportional to intensity of the strongest events). Inset shows high-frequency (3-h cut-off period) air pressure and sea level time series recorded during a meteotsunami.

Described synoptic situation has been recognized as a necessary prerequisite for generation of a series of meteotsunami events taking place between 23 and 27 June 2014 over the Mediterranean (the Balearic Islands, the Adriatic Sea, Sicily) and the northern Black Sea shelf [3]. Strongest event occurred in Odessa, Ukraine, on 27 June when couple of beaches were hit by a sudden 2-m wave, injuring a dozen of people [4]. As similar events have been unheard of in Ukraine, a panic overtook population, with media ascribing the phenomenon to a passage of a giant submarine, underwater explosions and even to “the great cross of planets”.

This event may serve as an example how a science-based education of local population, also through media, may mitigate negative impacts of such rare but vigorous ocean phenomena. Aside for affecting local population, damages to coastal infrastructure during destructive meteotsunami events have been documented to be very high, more than several millions of Euros, like during the Great Vela Luka Flood of 1978 and the 2006 Balearic meteotsunami [1, 2]. For that reason, all future coastal hazard assessment studies should include an assessment of high-frequency oscillations, which, due to recent availability of sea level data at 1-min resolutions, are finally being recognized to significantly contribute to the sea level budget in low-tidal basins, such as the Mediterranean [5].

References
1 - Monserrat S., Vilibic I. and Rabinovich A.B., 2006. Meteotsunamis: atmospherically induced destructive ocean waves in the tsunami frequency band. *Natural Hazards and Earth System Sciences*, 6: 1035-1051.
2 - Vilibic I., Monserrat S. and Rabinovich A.B., 2014. Meteorological tsunamis on the US East Coast and in other regions of the World Ocean. *Natural Hazards*, 74: 1-9.
3 - Sepic J., Vilibic I., Rabinovich A.B. and Monserrat S., 2015. Widespread tsunami-like waves of 23-27 June in the Mediterranean and Black Seas generated by high-altitude atmospheric forcing. Scientific Reports, 5: 11682, doi: 10.1038/srep11682.
4 - Rabinovich A.B. and Sepic J., 2016. Meteorological tsunami: what is it? (in Russian). Priroda, 1: 12-26.
5 - Sepic J., Vilibic I., Lafon A., Macheboeuf L. and Ivanovic Z., 2015. High-frequency sea level oscillations in the Mediterranean and their connection to synoptic patterns. *Progress in Oceanography*, 137: 284-298.

CIESM Congress Session : Observing systems
Moderator : Vanessa Cardin, OGS, Trieste, Italy

Moderator's Synthesis

The session argument for debate was focused on the need for an integrated and comprehensive Ocean Observing System to provide information for oceanic and atmospheric forecasting and for global environmental change research. Concepts such as future developments in ocean science, based on science drivers, ocean instrumentation and technological developments and strategic frameworks for cooperation as “One Planet One Ocean” were also tackled.

The need for observing systems as fixed-point measurements, floats and gliders was discussed and analysed with respect to their level of readiness, specially focusing on Europe. Particular interest was expressed for the EMSO-Eric program orienting the discussion to the benefits of such programs for the scientific community.

Finally, the difference between observing systems and networks was debated, with a conclusion that a network consists of observing systems of the same type (and not the contrary), for example floats that are components of EuroARGO. Networks should preferably be developed within the framework of programs that will guarantee their long-term viability.

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EMSO RESEARCH INFRASTRUCTURE IN THE FRAMEWORK OF THE EUROPEAN MARINE RESEARCH

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Abstract
EMSO (European Multidisciplinary Seafloor and water-column Observatory) is an European-scale Research Infrastructure of fixed-point, deep-sea observatories. It is geographically distributed in key sites of European waters, and spans from polar to sub-tropical climatic zones and from the open ocean to closed basins thus offering a broad spectrum of study across diverse environments. EMSO provides scientists with near-real time and real-time, long-term time-series of relevant variables related to environmental processes and is a special tool to investigate interactions between the geosphere, hydrosphere and biosphere. EMSO, coordinated by a consortium of European Countries, is implementing services for the exploitation of its facilities (devices, sensor packages and data) by the scientists from various disciplinary marine communities.

Keywords: Deep sea processes, Mediterranean Sea

EMSO (European Multidisciplinary Seafloor and water-column Observatory) is a European-scale Research Infrastructure (RI) based on fixed-point, seafloor and water-column observatories with the basic scientific objective of near-real time and real-time, long-term monitoring of environmental processes related to the interaction between the geosphere, hydrosphere and biosphere. The RI is geographically distributed in key sites of European waters, and spans from polar to subtropical climatic zones and from the open ocean to closed basins thus offering a broad spectrum of study across diverse environments. EMSO open ocean observatory locations were identified according to the scientific priorities of the European marine Science community, through multiple EU coordination projects and infrastructure development projects. These key sites were selected because their ongoing key natural processes require continuous long-term monitoring to understand their dynamics at a continental scale. Tests sites are also integral parts of the observatory network and they are fundamental facilities for testing devices (software and hardware) to be incorporated in EMSO nodes. Figure 1 shows the location of the EMSO nodes presently targeted to establish permanent, fixed-point observatories. From the technological point of view, the most striking characteristic of observatory design is the ability to address interdisciplinary objectives simultaneously across scales. Data are collected from the ocean surface, through the water column, the benthos, and the sub-seafloor. Depending on the application, in situ infrastructures can either be attached to a cable, which provides power and enables data transfer, or they operate as independent benthic and moored instruments. Data, also in the latter case, can be transmitted through acoustic networks that are connected to a satellite-linked buoy. Cabled infrastructures provide important benefits such as real-time data transfer, when a processing of huge amount of data (as for bioacoustics) or a real-time integration with land-based networks (as for the seismology), as well as a rapid geo-hazard early warning system, is needed. EMSO ERIC (European Research Infrastructure Consortium) is the legal entity managing the infrastructure. The ERIC implements the organization to facilitate scientists from various disciplinary marine communities to access the infrastructure remotely, physically, virtually, and spreads the data produced encouraging the use and integration. The ERIC also promotes the enrichment of the infrastructure with new components and new monitoring nodes. Marine Science communities at national levels are progressively joining together to network, share and exploit their research infrastructures, efforts and skills in support of EMSO. It is particularly important to have this national-level coordination as the ERIC structure is according to national membership. Italian and French communities have already established joint research groups, namely EMSO Italia and EMSO France, gathering research institutions and universities under the leadership of INGV in Italy and Ifremer and CNRS in France. These research groups help to increase awareness of the EMSO opportunities and in broadening the scientific user base. EMSO is going to be one of the sub-sea segments of the COPERNICUS initiative and can significantly enhance the observational capabilities of European Member States. EMSO ERIC will also be an important component of the future EOOS (European Ocean Observing System), a system of systems federating single initiatives (such as Euro-ARGO). EOOS will integrate Eulerian coastal and open ocean monitoring systems looking at sub-seafloor, seafloor, water-column, sea-air interface with Lagrangian systems and Earth Observation. EMSO is the European "voice" that can speak to worldwide counterpart programs, such as ONCNEPTUNE in Canada, NSF-OOI In US, JAMSTEC-DONET in Japan and IMOS in Australia. EMSO Team: P. Favali* (1,2), L. Beranzoli (1,2), M. Best(1), M. Cannat (3), N. Cagatay (4), J.-J. Dañobeitia(5), E. Delory (6), H. de Stigter(7), B. Ferré (8), M. Gillooly (9), F. Grant(9), P. O. J. Hall (10), V. Lykousis(11), J. Mienert(8), J. M.A. de Miranda(12), G. Oaie (13), V. Radulescu (14), J.-F. Rolin (15), H. Ruhl (16) and C. Waldmann (17) (1) EMSO Interim Office, (2) INGV, (3) IPGP, (4) ITU, (5)CSIC, (6) PLOCAN, (7) NIOZ ,(9) MI, (10) UGOT, (11) HCMR, (12) IPMA, (13) GeoEcomar, (15) Ifremer, (16) NERC, (17) MARUM.

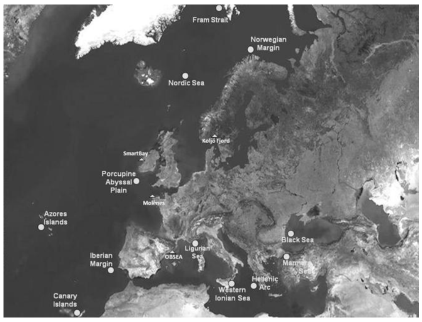

Fig. 1. Geographical distribution of the EMSO nodes around the European Seas.

References
1 - Auffret, Y., J Blandin, D. Choqueuse, C. Compère, L. Delauney, J.-F. Drogou, P. Jegou, C. Leveque, J.-F. Rolin, and P. Valdy. 2014. Long-term sub-sea observatories: Comparison of architectures and solutions for infrastructure design, interfaces, materials, sensor protection and deployment operations. Chapter 8 in Seafloor Observatories: A New Vision of the Earth from the Abyss. P. Favali, L. Beranzoli, and A. De Santis, eds, Series: Springer Praxis Books, Subseries: Geophysical Sciences.
2 - Favali, P., L. Beranzoli, M. Best, and EMSO Partners. 2014. EMSO—The European Multidisciplinary Seafloor and Water-Column Observatory: Transition from planning to implementation. Paper presented at the IEEE Oceans'14 Conference, April 2014, Taipei.
3 - Person, R., P. Favali, H.A. Ruhl, L. Beranzoli, J.-F. Rolin, C. Waldmann, R. Huber, Y. Auffret, M.N. Çagatay, M. Cannat an,

A MULTIDISCIPLINARY OBSERVING SYSTEM TO UNDERSTAND OCEANOGRAPHIC PROCESSES IN THE OPEN ADRIATIC SEA

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Abstract

Eulerian high frequency measurements coming from the E2M^{3}A observatory, located in the Southern Adriatic Pit, give invaluable multidisciplinary information to understand processes on different time scales, as they provide several unique features that cannot be found in other observing systems. Intrusion of northern waters into the deepest layer of the pit, lateral advection and dense water formation in the area are among the processes involved. A better understanding of the processes influencing the carbonate system, especially during winter cooling, is obtained by means of an automatic monitoring of the carbonate system set up, which measures two of its main variables i.e. the partial pressure of CO2 (pCO2) and the pH. The amount of the dense water formed also influences the water exchange between the Adriatic and Eastern Mediterranean.

Keywords: Open sea, Time series, South Adriatic Sea, Carbon, Monitoring

Continuous measurements are essential to assess the interannual variability of the thermohaline circulation, water masses properties and transports, and biochemical contents. The need for high-frequency sampling to resolve events and rapid processes and the long sustained measurements of multiple interrelated variables from the sea surface to the seafloor is provided by the observatory E2M^{3}A located in the area of the Southern Adriatic Pit at 41° 31.971'N, 18°03.787'E. The dynamics of the southern basin is dominated by the presence of a quasi-permanent cyclonic gyre that intensifies in the winter season creating the conditions for the production of dense and oxygenated waters. Thermohaline measurements collected at the E2M^{3}A since 2006, almost continuously, give valuable information of the variability of the ocean's interior. The sudden temperature and salinity decreases, depicted in the time-series (Fig.1) and noticed after each winter convection phase confirms the effectiveness of dense water formation processes (especially during winters 2008/09 and 2011/12), which transfer colder and fresher surface waters toward deeper levels. Furthermore, the high frequency sampling permitted to detect positive bottom trends in temperature and salinity, associated with a saw-tooth pattern caused by the concomitant effect of intrusion of very dense waters (cold but relatively fresh) of northern Adriatic origin, and local mixing dynamics.

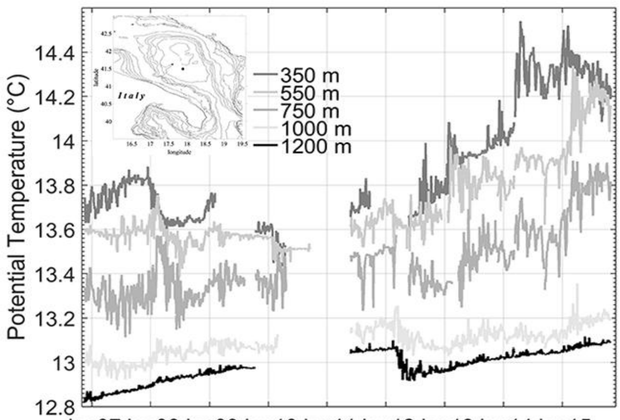

Fig. 1. Saw-tooth and deep-water formation signal from temperature data at different depths in the souther Adriatic Sea

The joint analysis of thermohaline and current records highlighted an intense mesoscale activity (e.g. passage of cyclonic and anticyclonic eddies), and revealed a diurnal zooplankton vertical migration in the upper layer. The multivariable approach is enhanced by the sediment traps positioned at two levels (below the photic layer at-125m and near the bottom at -1050m) allowing the understanding of the processes that are responsible for the high-frequency and interannual variability of new production and of phytoplankton biomass in the oligotrophic southern Adriatic. During the first 15 months of the experiment fluxes of particulate matter showed high seasonal variability, with maximum values in late winter-spring season. Total mass fluxes (TMF) measured at the shallower trap were generally lower that those measured at the bottom trap, ranging from 38 to 412 mg m^{-2} d^{-1}, with a time- weighted average of 159 mg m^{-2} d^{-1}, whereas at the bottom trap TMF varied from 33 to 885 mg m^{-2} d^{-1}, with a time-weighted average of 198 mg m^{-2} d^{-1}. The organic carbon flux, followed the same seasonal trend, with higher values below the photic zone, varying from 2.5 to 19.5 mg m^{-2} d^{-1}, with a mean of 5.0 mg m^{-2} d^{-1} at the shallow trap.

The estimation of the air-sea interaction at the site, one of the factors that plays an important role in triggering the convection, confirms the importance of the southern Adriatic as a site of dense water formation. The heat flux time series also depict the non-homogeneity in winter heat loss intensity [1] between the northern and southern Adriatic basins [2].

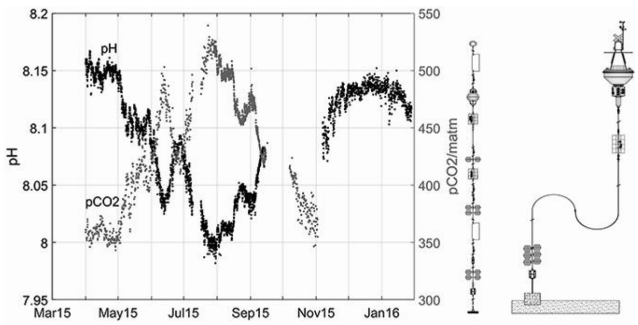

Fig. 2. Data from the carbonate automatic monitoring system at the E2M^{3}A

The automatic monitoring of the carbonate system set up on the E2-M3A buoy (Fig. 2) is measuring two of its main variables i.e. the partial pressure of CO_2 ($p$$CO_2$) and the pH. This allows a better understanding of the processes influencing the carbonate system in the southern Adriatic, especially during winter season. A strong seasonal variability was evidenced during the surface measurements of pH and pCO_2, which is roughly connected to the thermal effects (temperature variation from 14.16 °C in April to 30. 26 °C in July) on the CO_2 solubility and on the dissociation of carbonic acids forms, besides to the microbiological activity of heterotrophs and primary producers. The variations of pH measured during more than 8 months ranged from 7.98 (July) to 8.17 (April), while pCO_2 values ranged from 348 (October) to 539 µatm (July).

References

1 - Cardin V. and Gacic M., 2003. Long-term heat flux variability and winter convection in the Adriatic Sea. J. Geophys. Res., Vol. 108 (C9)

2 - Bensi M., Cardin V., Rubino A., Notarstefano G., and Poulain P. M., 2013. Effects of winter convection on the deep layer of the Southern Adriatic Sea in 2012, J. Geophys. Res. Oceans, 118, doi:10.1002/2013JC00943

SEASONAL AND INTERANNUAL CHLOROPHYLL A VARIABILITY IN THE BLACK SEA FROM SATELLITE AND BIOARGO MEASUREMENTS

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Abstract
Vertical distribution of the concentration of the chlorophyll A in the Black Sea and its interannual variability is investigated using combined satellite measurements of SeaWIFS and MODIS and recently deployed two Argo floats with biogeochemical sensors.

Keywords: Black Sea, Chlorophyll-A, Phytoplankton, Blooms

The variability of chlorophyll A concentration (Ca) in the Black Sea is investigated on the base of 15 years satellite optical measurements and recently deployed two Argo floats with biogeochemical sensors. Analysis of surface chlorophyll A is carried using blended array of SeaWiFS and MODIS-Aqua measurements for 1999-2015 years. According to satellite data surface Ca in the central part of the basin have prominent seasonal variability with the maximum in early winter and minimum in summer months (fig. 1a). Peak of the surface Ca in the deep part (depths more than 500 meters) is triggered by the beginning of winter convection [1,2] and is in counterphase with sea surface temperature on seasonal time scales. The surface maximum is detected first in the central eastern and western gyres of the Black Sea, where the convection is most intensive, and in the northwestern part of the continental slope (due to effect of slope convection). After ~1 week the maximum is observed in the periphery of the basin.

At the same time in the several areas of the Black Sea shelf the peak of surface Ca is detected in late spring-early summer, which is related to the intensification of river discharge. This effect is seen in the large part of the north-western shelf near the mouth of Danube, and in the coastal south-western and south parts, where smaller Caucasian and Turkish rivers outflow.

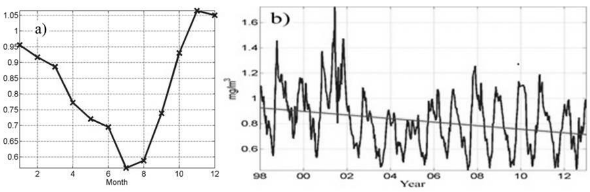

Fig. 1. Seasonal(a) and interannual (b) variability of the Ca in the deep part of the basin (depths >500 meters).

The most noticeable feature of interannual variability is an abrupt decrease observed in 2002, which coincide in time with the sharp intensification of the Black Sea basinscale circulation [3]. The averaged over the deep basin Ca changes from mean values of about 1 mg/l in 1998-2001 (period of "weak" currents) to 0.73 mg/l in 2002-2013 (period of "intense" currents). This decrease can be caused by the reduction of the number of eddies that is related to the Rim current intensification [4, 5]. As a result eddy-induced horizontal transport of the nutrient-rich coastal waters to the deep part of the basin declines [3].
The measurements of two Bio-Argo floats in 2013-2015 were used to investigate the vertical distribution of the Ca and its seasonal evolution. Computed seasonal time-depth diagram and column-averaged over 0-100 meters Ca is shown in fig.2 . Maximum of the layer-averaged Ca is observed in March when the Ca in the whole 0-55 meters is ~ 1-1.5 mg/m3. In April-May Ca peaks at 40-50 meters depth and is lower in upper layer. Subsurface summer maximum develops from June to October at 20-40 meters depth in agreement with [6]. Chlorophyll A concentrations in this layer in summer are even higher than in winter period. From October to February with the start of winter mixing large values of Ca are observed in surface layer and can be detected by satellite.
The comparison of Argo buoys with MODIS-Aqua surface Ca shows reasonable coincidence with correlation 0.7. Satellite data overestimate Argo measurements in 1.3-1.5 times.

Analysis of satellite data was made with support from RFBR , according to the research project No. **16-35-60036 mol_a_dk**. Bio-Argo measurements were analyzed with support from RFBR , according to the research project No. **16-05-00264 a**.

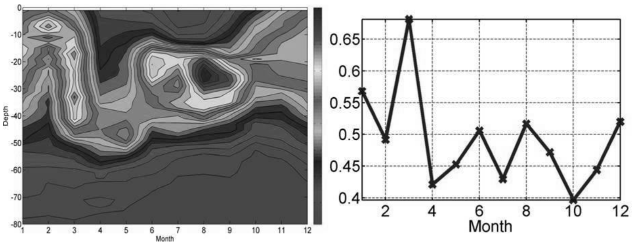

Fig. 2. Seasonal(a) and interannual (b) variability of the Ca in the deep part of the basin (depths >500 meters).

References
1 - Yunev, O. A., Vedernikov, V. I., Basturk, O., Yilmaz, A., Kideys, A. E., Moncheva, S., & Konovalov, S. K. (2002). Long-term variations of surface chlorophyll a and primary production in the open Black Sea. Marine Ecology Progress Series, 230, 11-28.
2 - Finenko, Z. Z., Suslin, V. V., & Kovaleva, I. V. (2014). Seasonal and long-term dynamics of the chlorophyll concentration in the Black Sea according to satellite observations. Oceanology, 54(5), 596-605.
3 - Kubryakov A.A, Stanichny S.V., Zatsepin A.G, Kremenetskiy V.V. Long-term variations of the Black sea dynamics and its impact on the marine ecosystem. Journal of Marine Systems, 2016 (in press).
4 - Kubryakov, A. A., & Stanichny, S. V. (2015a). Seasonal and interannual variability of the Black Sea eddies and its dependence on characteristics of the large-scale circulation. Deep Sea Research Part I: Oceanographic Research Papers, 97, 80-91.
5 - Kubryakov, A. A., & Stanichny, S. V. (2015b). Mesoscale eddies in the Black Sea from satellite altimetry data. Oceanology, 55(1), 56-67.
6 - Finenko, Z. Z., Churilova, T. Y., & Sosik, H. M. (2004). Vertical distribution of phytoplankton photosynthetic characteristics in the Black Sea. Oceanology, 44(2), 205-218.

MODELLING THE FATE OF WATER AND SUSPENDED MATTER FROM THE PRECIPITATION TO THE WATERSHED AND TO THE SEA: THE CASE OF FLASH FLOODS IN THE GULF OF LION

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Abstract
The objective is to study in an integrated way Mediterranean flash floods and the associated suspended particulate matter transport during heavy precipitation events, from the watershed to the sea. The atmosphere, continental hydrology, and the ocean are modelled using a coupled numerical approach to take into account feedbacks and to achieve a real continuity of forcing throughout the brief but intense events. Comparisons between models results will be shown concerning the precipitation rate and the river discharge during the flash floods as well as the oceanic current and the variations of the sea level during the storm.

Keywords: Coastal processes, Air-sea interactions, Gulf of Lyon, Precipitation regime, Sediment transport

A watershed-scale hydrologic model, SWAT [1], receives precipitation from the atmospheric model MESO-NH [2] which feeds the second runoff model, MARINE [3], focusing on the flash flood events. The ocean circulation model SYMPHONIE [4] redistributes freshwater and suspended matter in the marine environment. Simultaneously, the coupling of SYMPHONIE with the sea state model WAVEWATCH III [5] produces a feedback from the storm-increased sea level on the river discharge and hence on the flooding of the coastal plain. The simulation of several intense events will be presented and illustrated by comparisons with observations taken along the water continuum of the Têt river (~1400 km²), a French Mediterranean coastal basin and in the coastal ocean of the Gulf of Lion (Fig 1). Attention will be paid to the simulation of chronology of the river discharge and to the different factors (wind, waves, tide, atmospheric pressure) affecting the sea level at the river mouth potentially responsible of the coastal plain flooding.

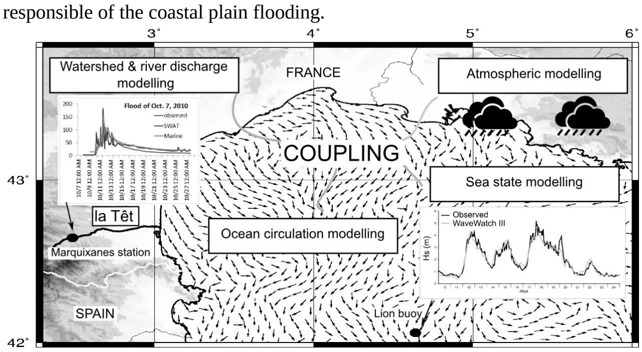

Fig. 1. Map of the Gulf of Lion with the models layout and illustrations of model results

References

1 - Jeong, J., Kannan, N., Arnold, J.G., Glick, R., Gosselink, L., Srinivasan, R., Harmel, R.D., 2011. Development of sub-daily erosion and sediment transport algorithms for SWAT. Trans. ASABE 54, 1685–1691.
2 - Lafore, J. P., J. Stein, N. Asencio, P. Bougeault, V. Ducrocq, J. Duron, C. Fischer, P. Hereil, P. Mascart, J. P. Pinty, J. L. Redelsperger, E. Richard, and J. Vila-Guerau de Arellano, 1998. The Meso-NH Atmospheric Simulation System. Part I: Adiabatic formulation and control simulations. Annales Geophysicae, 16, 90-109.
3 - Roux, H., Labat, D., Garambois, P.-A., Maubourguet, M.-M., Chorda, J., Dartus, D., 2011. A physically-based parsimonious hydrological model for flash floods in Mediterranean catchments. Nat. Hazards Earth Syst. Sci. 11, 2567–2582.
4 - P. Marsaleix, F. Auclair, and C. Estournel, 2006. Considerations on open boundary conditions for regional and coastal ocean models. Journal of Atmospheric and Oceanic Technology, 23:1604–1613
5 - Tolman, H., 2015. User manual and system documentation of WAVEWATCH-III version 5.08,Tech. rep. NOAA/NWS/NCEP/MMAB.

CIESM Congress Session : Variability of thermohaline properties I
Moderator : Toste Tanhua, GEOMAR, Kiel, Germany

Moderator's Synthesis

The session was visited by roughly 40 participants. All presenters were present and most presentations were shorter than 5 minutes, leading to about 20 minute discussion by the end of the session. The presentations were a mix of observational records (4 presentations), model analysis (2 presentations) and reanalysis. This mixture created a good atmosphere for a lively discussion after the presentations. The discussions focused on the observed trends in deep waters in the Sicily Channel and north of Menorca, and the discussion if these observations of an order of magnitude faster change than the global ocean are effects of the Mediterranean circulation and ventilation, or if it is dominated by variability on a smaller trend. The moderator pointed out a 18 year old paper by two Kiel scientists that already then documented a half century trend of increasing salinity and temperature in the surface of the western Mediterranean Sea, and posed the question if such a long record should not be enough, together with more modern records, for making statements about trends in the Mediterranean Sea.

MULTIPLE EQUILIBRIA AND OVERTURNING VARIABILITY OF THE AEGEAN-ADRIATIC CIRCULATION

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Abstract
The Eastern Mediterranean Transient—a transition of the Eastern Mediterranean Sea deep water source from the Adriatic Sea to the Aegean Sea—was observed in the mid-90'. Here we show that the overturning circulation of the Eastern Mediterranean (Adriatic-Aegean-Ionian basins) has multiple equilibria states under present-day-like conditions, and that the water exchange between the Aegean and the Adriatic Seas can drastically affect these states. More specifically, we found two stable states and hysteresis behavior of deep water formation in the Adriatic basin when changing the atmospheric (restoring) temperature over the Aegean.

Keywords: Deep waters, Mediterranean Sea, Levantine Basin, Models

The Eastern Mediterranean Transient (EMT) is an intriguing change in Mediterranean circulation that has been observed in the mid-90' . Understanding the causes and nature of abrupt changes such as the EMT is important for various reasons. For example, Deep Water Formation (DWF) processes affect the exchange of physical and biochemical properties (e.g., oxygen and nutrients) between the surface and the deep layers. There is an ongoing discussion whether the EMT was a single phenomenon that was caused by the unique conditions during 1987-1992, or whether it is a recurrent phenomenon associated with the natural variability of the EM circulation. Stommel [1] raised the possibility of multiple equilibria states of the overturning circulation in the Mediterranean Sea, similar to the ones he predicted (using a simple two-box model) to exist in the Atlantic Ocean. Recently, [2] showed, using a three-box model representing the Adriatic, Aegean, and Ionian basins, that the overturning circulation of the EM may indeed have a few steady states and a transition between them may be associated with the EMT. Here we performed a set of numerical experiments using the Massachusetts Institute of Technology general circulation model to show the multiple equilibria states under present-day-like conditions. Specifically, we modified the Aegean temperature boundary condition, i.e., the restoring temperature over the Aegean, but kept fixed the rest of the forcing and boundary conditions.

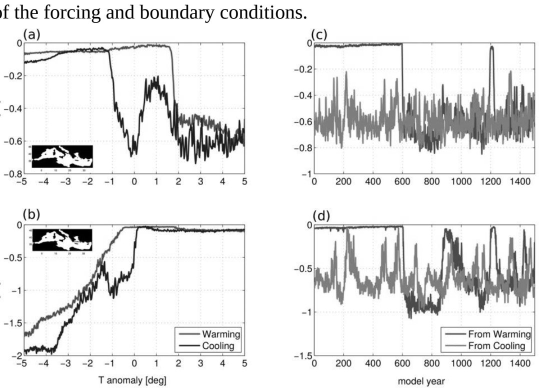

Fig. 1. Adriatic (a,c) and Aegean (b,d) annual mean outflow of water denser than 1029.1 kg m^{-3} as a function of the temperature anomaly of the Aegean (a,b) and as a function of the model year (c,d) in the entire set of experiments.

The Adriatic and Aegean DWF during the adiabatic warming\cooling of the Aegean is presented in Fig. 1a,b. The most prominent result is that the Adriatic outflow exhibits hysteresis despite the fact that the boundary conditions were modified only over the Aegean. Such hysteresis curve suggests that there are two Adriatic steady states, with either active or passive DWF, under the same Aegean forcing. The largest difference in the outflow is found around zero forcing anomaly, i.e., under present-day-like conditions. To examine the stability of the two Adriatic DWF states shown in Fig. 1a,b, we initiate the model transient states from the warming and cooling steps under zero forcing anomaly, and ran them for additional 1500 years (Fig. 1c,d). Both simulations kept their initial Adriatic outflow for 600 years until passive DWF state abruptly changed and merged with the active. In year 1200 of the 'From Warming' (previously passive) simulation there is another abrupt, but transient, change of a drastic weakening of the Adriatic outflow for almost a decade. To understand the interaction between the Aegean and Adriatic Seas, we retrieved density profiles in the south Adriatic and south Aegean over years 1170-1270 of the 'From Warming' simulation, during which the abrupt transient occurred in the Adriatic.

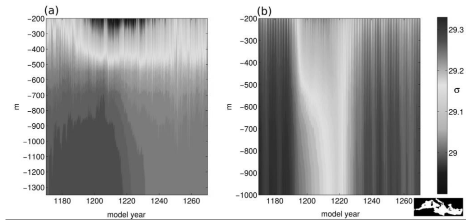

Fig. 2. Density profile time series in the Aegean (a) and in the Adriatic (b) over the years 1170-1270 of the 'From Warming' (shown in Fig. 1) simulation. Profiles locations are marked by the squares in the reference map embedded.

It is evident from Fig. 2 that a freshening of intermediate south Aegean water occurred prior to and during the Adriatic transition. It appears that dense (saline) water associated with the Levantine Intermediate Water (200-700 meter) is found only deeper than 400 meter starting from year 1190, indicating that when the Aegean stops providing saline intermediate water to the Adriatic, the Adriatic DWF becomes passive. The Ionian upper circulation was reported to play an important role in this saline water advection into the Adriatic [3], and indeed we detect a mainly unidirectional influence of the Aegean outflow on the Adriatic outflow. The Aegean-Adriatic interaction can be summarized as follows: warm and saline water of the Aegean can either flow in the sub-surface to the Adriatic, switching "on" its DWF by increasing its salinity, or the Aegean water can feed the deeper layer of the Ionian and Levantine basins, turning "off" the Adriatic DFW. Furthermore, the fast transition between the two steady states resembles some aspect of the EMT abrupt nature.

References

1 - Stommel, H., 1961. Thermohaline convection with two stable regimes of flow. *Tellus 11.*

2 - Ashkenazy, Y., Stone, P. H., Malanotte-Rizzoli, P., 2012. Box modeling of the Eastern Mediterranean sea. *Physica A: Statistical Mechanics and its Applications* 391 (4): 1519–1531.

3 - Gacic, M., G. Civitarese, G. L. Eusebi Borzelli, V. Kovacevic, P.-M. Poulain, A. Theocharis,M. Menna, A. Catucci, and Zarokanellos, N., 2011. On the relationship between the decadal oscillations of the northern Ionian Sea and the salinity distributions in the eastern Mediterranean, J. Geophys. Res., 116, C12002.

TEN-YEAR EVOLUTION OF THE (NEW) WESTERN MEDITERRANEAN DEEP WATER

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Abstract
The evolution of the Western Mediterranean Deep Water (WMDW) thermohaline anomaly originated after winter 2005, has been recorded by two deep hydrographic stations seasonally sampled during the RADMED monitoring program at the NE of the Menorca Island and at Cape Palos (Spanish Mediterranean). The data reveal an increasing trend in salinity and temperature in the WMDW one order of magnitude higher that previous reported values. A deep mooring recently installed at the NE of Menorca and RADMED data will be used to characterize the relative contribution of new WMDW and diffusion on the evolution of the salinity and temperature profiles.

Keywords: Deep waters, Temperature, Salinity, North-Western Mediterranean, South-Western Mediterranean

In the Western Mediterranean after the winter 2005 an abrupt change in the Western Mediterranean Deep Water (WMDW) was observed, involving a complex termohaline structure (López-Jurado et al. 2005). This new situation, named Western Mediterranean Transition (WMT) (CIESM, 2009), which implied the contribution of different water masses and the appearance of a new WMDW, has been tracked up to now.

Along the Spanish Mediterranean coast, areas where differences in the large-scale hydrographic conditions are expected have been seasonally monitored through the RADMED programme (López-Jurado et al. 2015). RADMED deep stations provide a description of the water column, including intermediate and deep water masses and their anomalies along the time. They also allow for the study of some seasonal phenomena such as intermediate and deep waters formation and transport.

Two RADMED deep stations, one near Cape Palos lower continental slope (00º 45.45 W, 37º 22.37 N, 2400 m depth, sampled since 2007) and one NE of the Menorca Island (04º 34.96 E, 40º 10.00 N, 2540 m depth, sampled since 2003) are used to characterize the new WMDW temporal evolution. The interface between new and old WMDW has been defined as the salinity minimum below 700 m, well beneath the Levantine Intermediate Water (LIW) core. Mean salinity, $\langle S \rangle$, potential temperature, $\langle \theta \rangle$, and potential density anomaly, $\langle \sigma_0 \rangle$, below the interface to the bottom have been calculated to compare their temporal evolution with the mean values below 700 m to the bottom.

Figure 1 shows the interface depth at Menorca station and the mean values of the three analysed variables. Similar trends have been observed at the Cape Palos site (not shown) with a seasonal oscillation of the interface depth from 2007 to 2011, probably a dynamic feature due to a combined effect of seasonal forcing with the proximity of the continental slope. Both stations thus show an increasing trend in S and θ of the order of 10^{-3} year^{-1} and 5 10^{-3} ºC year^{-1} respectively along the analysed period, an order of magnitude higher than values previously reported for the 1900-2008 period (Vargas-Yáñez et al. 2010). Same temperature trend is found in the Strait of Gibraltar for the Deep Mediterranean Waters flowing out the Mediterranean through the Espartel sill (C. Naranjo, personal communication)

To clarify the relative contribution of new WMDW formation and the diffusive evolution of the S and θ profiles a deep mooring equipped with five current meters, eight CTDs, eight thermistors and two sediment traps has been installed at the Menorca station, in the frame of the RADMED programme and the ATHAPOC project. ATHAPOC main objective is the study of the new WMDW. The information provided by this mooring together with the historical RADMED data is going to be used to quantify the contribution of the different terms.

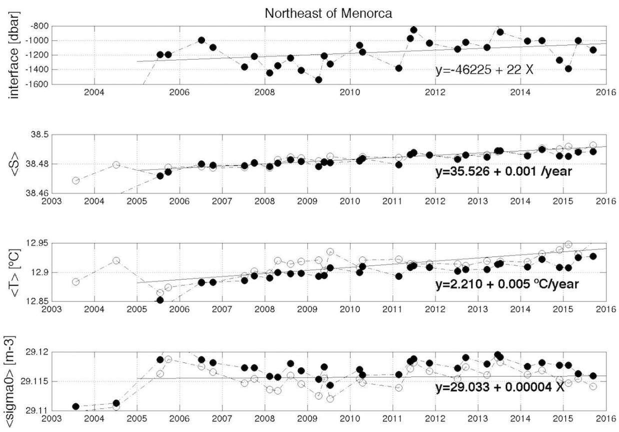

Fig. 1. Temporal evolution of interface depth, mean S, potential temperature and potential density anomaly from new WMDW to bottom (closed dots) and from 700 dbar to bottom (open dots). Lines indicate linear trends of mean values from 700 dbar to bottom, calculated from 2005 to 2015.

References
1 - CIESM Workshop Monographs, 38. Malta, 2009.
2 - López-Jurado, J.L., González-Pola, C., and Vélez-Belchí, P. Observation of an abrupt disruption of the long-term warming trend at the Balearic Sea, Western Mediterranean Sea, in summer 2005. Geophysical Research Letters, 32 (24), 2005.
3 - López-Jurado, J.L., Balbín, R., Amengual, B., Aparicio, A., Fernández de Puelles, M.L., García, M.C., Gazá, M., Jansá, J., Morillas-Kiefer, A., Moyá, F., Santiago, R., Serra, M., Vargas-Yáñez, M., Vicente, L. The RADMED monitoring programm: towards an ecosistema approach. Ocean Science Discussions, 12-3 (2015) 645-671.
4 - Vargas-Yáñez, M., Moya, F., García-Martínez, M.C., Tel, E., Zunino, P., Plaza, F., Salat. J., Pascual, J., López-Jurado, J.L. and Serra, M.. (2010) Climate change in the Western Mediterranean Sea 1900-2008. Journal of Marine Systems 82:171-176

EFFECTS OF THE EASTERN MEDITERRANEAN SEA CIRCULATION ON THE THERMOHALINE PROPERTIES AS RECORDED BY FIXED DEEP-OCEAN OBSERVATORIES

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Abstract

The anti-correlated behaviour in terms of thermohaline variability between the Adriatic and Cretan Seas is verified analysing long-term high-frequency time-series from fixed observatories. From our analyses, the travel time of the Levantine/Cretan Intermediate waters from the Cretan to the Adriatic resulted of about 1.5 yrs. Further analyses performed on time-series and float data gathered in the easternmost Ionian region reveal an interesting thermohaline variability associated with the periodical reversals of the North Ionian Gyre (NIG). In particular, salinity in this region increases when the NIG is anticyclonic and vice-versa.

Keywords: Circulation, Time series, Water transport, South Adriatic Sea, Aegean Sea

Temperature and salinity time-series from three fixed observatories in the Eastern Mediterranean Sea are investigated using multi-annual (2006-2014), high-frequency (up to 3 hours sampling rate) data. Two of the observatories are deployed in areas of dense water formation (DWF, the Southern Adriatic Sea, E2-M3A; the Cretan Sea, E1-M3A). The third one (Southeast Ionian Sea, PYLOS) lays directly on the intermediate water masses pathway that connects the DWF sources (Fig. 1).

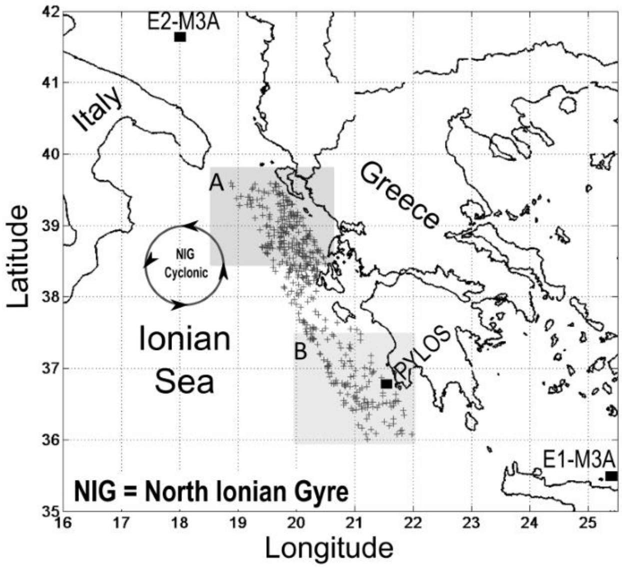

Fig. 1. Geographical distribution of the data. The black squares indicate the moorings position, the crosses indicate the float profiles gathered in the period 2004-2014 (http://marine.copernicus.eu).

The long-term variations of the hydrological properties at the observatories reflect the oscillating large-scale circulation modes of the basin (i.e. BiOS-Bimodal Oscillating System and internal thermohaline pump theories). In particular, an anti-correlated behaviour of the intermediate layer (200-600m) salinity between the Adriatic and Cretan/Ionian Sea observatories in the period 2006-2014 is verified and discussed (Fig. 2). This behaviour is directly linked to reversals of the NIG, which appeared anticyclonic during 2006-2011 and turned cyclonic after 2011. Statistical analysis suggests that the travel time of the intermediate salinity maximum signal associated with the Levantine/Cretan Intermediate waters (LIW/CIW), between the Cretan and Adriatic Sea, is roughly 1.5 years. This result is supported by the analysis of additionally presented ARGO data (Fig. 2) collected along the main route of LIW/CIW in the easternmost Ionian region. They revealed that the travel time of the LIW/CIW between the southeastern Ionian and the approaches to the Strait of Otranto is less than 1 year.

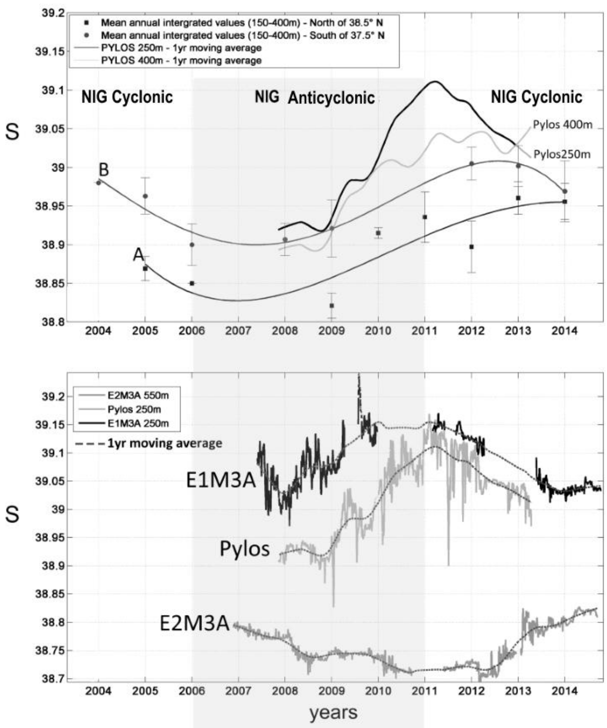

Fig. 2. Upper panel: the 4th order polynomial fit curve over the annual mean integrated float data in the layer 150-400m for area north of 38.5°N (zone A in Fig.1) and south of 37.5°N (zone B in Fig.1). Data from PYLOS have been superimposed. Lower panel: data from the three moorings.

We argue that the understanding of such oscillations provides important foresight on future DWF events, as increased salinity may act as a crucial preconditioning factor for DWF processes. Additionally, energy spectrum analysis of the time-series revealed interesting short-term variability (~15 days) connected to mesoscale activity at the observatories, both in the Adriatic and in the Cretan Sea. Hence, the network of permanent observatories able to monitor oceanographic parameters at high sampling rates may play a key role in understanding both climatic and oceanic processes and trends.

References

1 - Bensi M., D. Velaoras, V.L. Meccia, V. Cardin, 2016. Effects of the Eastern Mediterranean Sea circulation on the thermohaline properties as recorded by fixed deep-ocean observatories. Deep-Sea Res. I, 112: 1-13, http://dx.doi.org/10.1016/j.dsr.2016.02.015

NEW VERSION OF MEDRYS, A MEDITERRANEAN SEA REANALYSIS DURING 1992-2013

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Abstract

The French research community on the Mediterranean Sea and the French operational ocean forecasting center Mercator Océan are gathering their skills and expertises in physical oceanography, ocean modelling, atmospheric forcings and data assimilation, to carry out a MEDiterranean Sea ReanalYsiS (MEDRYS) at high resolution for the period 1992-2013. The reanalysis is used to have a realistic description of the ocean state over the recent decades and helps to understand the long-term water cycle over the Mediterranean basin in terms of variability and trends. This work describes the latest version of MEDRYS and its main results.

Keywords: Mediterranean Sea, Circulation models, Hydrography, Water convection

In this study, we use the regional ocean model NEMOMED12 [1], a Mediterranean configuration of NEMO [2], with a 1/12° (~ 7 km) horizontal resolution and 75 vertical z-levels with partial steps. At the sea surface, it is forced by a new atmospheric forcing dataset (ALDERA, [3]), coming from a dynamical downscaling of the ERA-Interim atmospheric reanalysis by the regional climate model ALADIN-Climate with 12-km horizontal and 3-hour temporal resolutions. The exchanges with the Atlantic Ocean are performed through a buffer zone, with a damping on 3D T-S and on sea level towards the ORA-S4 oceanic reanalysis [4]. This model configuration is used to carry a 34-year free simulation over the period 1979-2013. The reanalysis starts in October 1992 from the state of the free run at this date, and ends in June 2013.

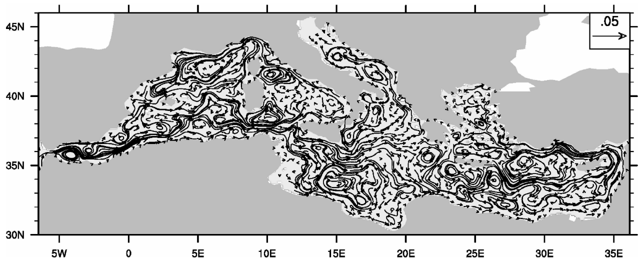

Fig. 1. Circulation at 40m-depth for MEDRYS, in average over 1993-2012; the reference arrow corresponds to 0.05 m.s^{-1}.

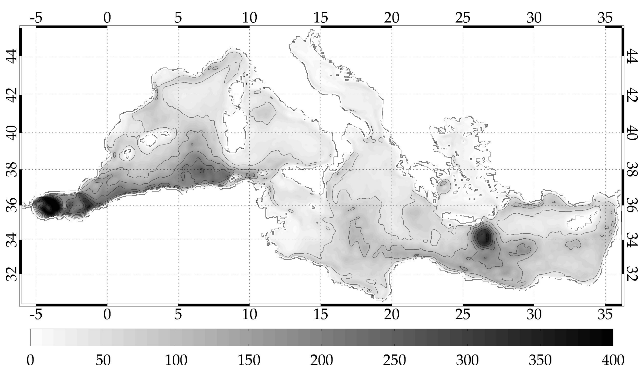

Fig. 2. Eddy Kinetic Energy (EKE, in cm^2.s^{-2}; contour every 50 cm^2.s^{-2}) at 40m-depth, for MEDRYS, in average over 1993-2012.

MEDRYS [3] uses the current Mercator Océan operational data assimilation system [5]. It uses a reduced order Kalman filter with a 3D multivariate modal decomposition of the forecast error. A 3D-Var scheme corrects biases in temperature and salinity for the slowly evolving large-scale. In this new version of MEDRYS, some modifications dedicated to the Mediterranean area (shorter analysis cycle, specific Mean Sea Surface Height field, new model-equivalent for the Sea Level Anomaly for example) have been introduced. Temperature and salinity vertical profiles from the newly released CORA4.1 database [6], altimeter data from AVISO and satellite SST [7] are jointly assimilated.

Regarding the heat and salt contents, and with respect to reference observational gridded products, the latest version of the reanalysis displays on average no bias in the surface (<0.01 psu and <0.3°C) and intermediate layers (<0.02 psu and <0.04°C), with well reproduced interannual variations. Only the deep layer shows small drifts both for temperature and variability, but lower than in the previous version. For the transports through the main Mediterranean straits, the data assimilation restores correct values, especially for the Strait of Gibraltar: +0.81 Sv, -0.76 Sv and +0.05 Sv respectively for in, out and net water transports. The mean surface circulation and its variability are also well reproduced, and non-permanent small-scale features, such as Ierapetra, Pelops or Bonifacio eddies, are well captured (Figure 1). This mesoscale activity is also highlighted by the EKE field (Figure 2), where high values can be seen in Alboran and Ierapertra areas, but also along the paths of the main coastal currents (Algerian, Lybio-Egyptian, Asia Minor and Liguro-Provencal currents).

References

1 - Beuvier, J., K. Béranger, C. Lebeaupin-Brossier, S. Somot, F. Sevault, Y. Drillet, R. Bourdallé-Badie, N. Ferry, and F. Lyard, 2012. Spreading of the Western Mediterranean Deep Water after winter 2005: time-scales and deep cyclone transport, *J. Geophys. Res., 117*, C07022, doi:10.1029/2011JC007679

2 - Madec, G., and the NEMO Team, 2008. NEMO ocean engine. *Note du Pôle de modélisation*, Institut Pierre-Simon Laplace (IPSL), France, n° 27, ISSN n° 1288-1619

3 - Hamon, M., Beuvier, J., Somot, S., Lellouche, J.-M., Greiner, E., Jordà, G., Bouin, M.-N., Arsouze, T., Béranger, F., Dubois, C., Sevault, F., Drévillon, M., Drillet, Y., 2015. Design and validation of MEDRYS, a Mediterranean Sea reanalysis over 1992-2013. *Oc. Sci. Disc.*, 12, 1815-1867, doi:10.5194/osd-12-1815-2015, *in revision to Oc. Sci.*

4 - Balmaseda, M.A., Mogensen, K., and Weaver, A., 2012. Evaluation of the ECMWF Ocean Reanalysis ORAS4, *Q. J. R. Meteorol. Soc.*, 139(674), 1132-1161, doi:10.1002/qj.2063

5 - Lellouche, J.-M., Le Galloudec, O., Drévillon, M., Régnier, C., Greiner, E., Garric, G., Ferry, N., Desportes, C., Testut, C.-E., Bricaud, C., Bourdallé-Badie, R., Tranchant, B., Benkiran, M., Drillet, Y., Daudin, A., and De Nicola, C., 2013. Evaluation of global monitoring and forecasting systems at Mercator Océan, *Oc. Sci., 9*(1), 57-81, doi:10.5194/os-9-57-2013

6 - Cabanes, C., Grouazel, A., von Schuckmann, K., Hamon, M., Turpin, V., Coatanoan, C., Paris, F., Guinehut, S., Boone, C., Ferry, N., de Boyer Montégut, C., Carval, T., Reverdin, G., Pouliquen, S., and Le Traon, P.-Y., 2013. The CORA dataset: validation and diagnostics of in-situ ocean temperature and salinity measurements, *Oc. Sci., 9*, 1-18, doi:10.5194/os-9-1-13 2013

7 - Reynolds, R. W., Smith, T. M., Liu, C., Chelton, D. B., Casey, K. S., and Schlax, M. G., 2007. Daily high-resolution blended analyses for sea surface temperature, *J. Climate, 20*, 5473–5496

RENEWAL OF DEEP WATER IN VICINITY OF THE EASTERN LEVANTINE SLOPE

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Abstract

During the winter of 2012-2013 the deep water mass in the vicinity of the Eastern Levantine Slope had a three layer structure: the old water, originating from Adriatic Sea (400-1100m); the water that originated from the Aegean Sea during the Eastern Mediterranean Transient (EMT) (1100-2000m); and a new water (deeper than 2000m) that originated from the Adriatic Sea after the EMT relaxation.

Keywords: Deep waters, Salinity, Temperature, Levantine Basin

Before the EMT [1], only about 800 casts in the abyssal regions (deeper than 1500 m) of the Levantine Basin reached the bottom (PERSEUS Cast DB: http://isramar.ocean.org.il/perseus_data/CastMap.aspx). Based on that data, the Eastern Mediterranean Deep Water (EMDW) was seen as a homogeneous water mass with quite stable thermohaline properties (38.67±0.02; 13.35±0.02°C) and the large residence time (of about one hundred years [1]). The discovery of the EMT in 1995 contradicted that notion and motivated scientists to investigate the variability of the EMDW. After a series of cruises, it was discovered that the new formed deep water was of Aegean origin (EMDW_AG) and propagated through the Cretan Passage westward and eastward, following bottom depressions [1]. In the deep region (>2000m) south of Cyprus, the EMDW_AG were first observed using the R/V Meteor in 1995 [1]. In 1996 they were found near the continental slope, west of the Israeli shelf [2]. During the period of 1996-2002, the salinity and potential temperature of the bottom water near this slope increased due to advection from the west, by approximately 0.1±0.02 and 0.25±0.02°C. A stabilization of the deep water salinity and potential temperature (38.77±0.01; 13.60±0.01°C) was observed after 2002. During the winter of 2012-2013 a large CTD survey was carried out using the R/V Shikmona within the exclusive economic zones of Cyprus and Israel. The core of the old deep water (EMDWold) was found as an intermediate minimum of salinity and potential temperature (38.75±0.01; 13.58±0.01°C) at a depth of about 900m (Fig.1).

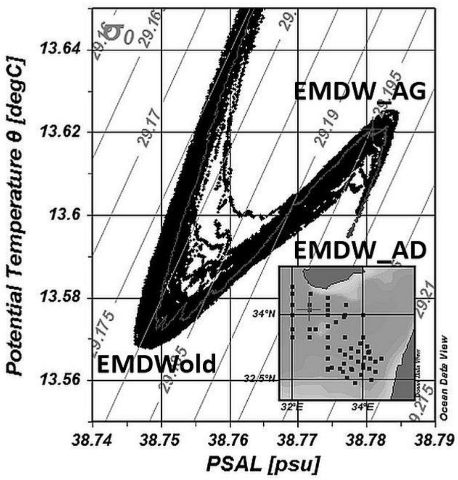

Fig. 1. Three layers of different origins within the Eastern Mediterranean Deep Water (winter of 2012-2013).

Below this water mass, inversions of salinity and potential temperature were observed at each station. These inversions are signatures of the deep water formed in the Aegean Sea (EMDW_AG) during the EMT. In the regions where the bottom depth is lower than 2000m, salinity and potential temperature reach maximal values at the bottom layer (38.78±0.005; 13.62±0.005°C). In regions where the bottom depth is greater than 2000m, the EMDW_AG appears to be an intermediate water mass located above a colder and less saline water mass that occupies the bottom layer. This bottom layer, which wasn't observed during the EMT before, had a stronger signal at the western and deeper stations (Fig. 2). Apparently, this water is of Adriatic origin (EMDW_AD). A front between the EMDW_AD and the EMDW_AG was observed in zonal sections at approximately 24°E (Meteor-2001) and 27°E (Shikmona-2008) [1,2]. The three observed positions of the front can be used to construct a timeline of the propagation. The eastward propagation of the EMDW_AD suggests a regular generation of deep water of Adriatic origin since 1999 [1], after a relaxation to typical hydrologic conditions occurred.

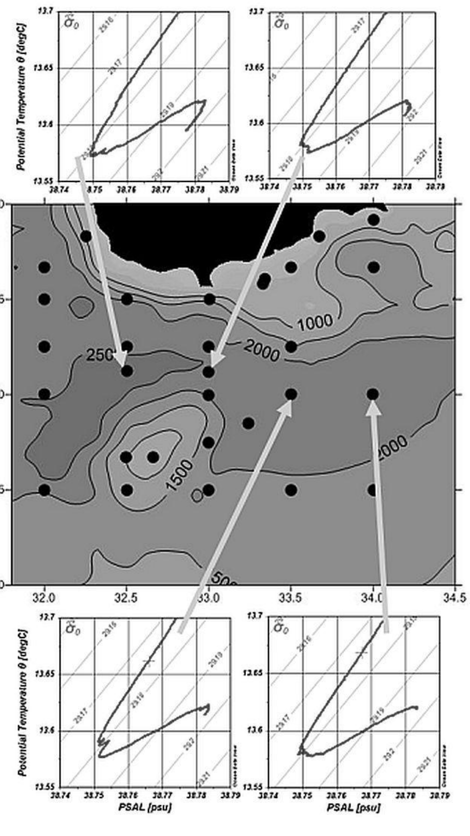

Fig. 2. Disappearance of the Adriatic Sea deep water signal eastward along the depression in the south of Cyprus.

References

1 - Roether, W., Klein, B., Manca, B. B., Theocharis, A., Kioroglou, S., 2007. Transient Eastern Mediterranean deep waters in response to the massive dense-water output of the Aegean Sea in the 1990s. Progress in Oceanography, Vol. 74, 540-571.

2 - Gertman I., Barak H., Kress N. (2010). Assessment of post-transient changes in Levantine basin deep water. Rapp. Comm. int. Mer Medit. (CIESM Congress Proceedings). Vol 39: 113.

HYDRODYNAMIC MODELLING OF THE CASSIDAIGNE CANYON: LIVING CONDITIONS OF COLD-WATER CORALS IN AN UPWELLING AREA

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Abstract
Canyons are known to be areas of strong cross-shelf exchanges of properties like carbon and nutrients. In the framework of the MSFD, a focus was made on the conditions that favor cold-water corals habitats in the Cassidaigne canyon at the eastern entrance of the Gulf of Lions (NW Mediterranean), and on their vulnerability, after 50 years of red mud release. A high resolution modelling of the canyon hydrodynamics was thus developed. Results confirm the strong influence of the bottom currents (hence bathymetry) on the habitats location. This work contributed to the DISCOREF project and is part of the AMICO-next project.

Keywords: Coastal models, Canyons, Upwelling, Gulf of Lyon

Canyons are areas of complex hydrodynamics, including interactions with the general circulation [1]. The Cassidaigne canyon is located in the area of the strongest upwelling of the Gulf of Lions, with associated cooling of surface water of more than 10 °C. The local hydrodynamics in the canyon interacts with the upwelling and with the general circulation, especially when the Northern Current intrudes over the shelf. Satellite images showed that this area was depleted in Chlorophyll during upwellings [2]. This pattern is unusual as upwellings are mostly associated with high nutrients and hence high productivity in various regions of the world. Associated with the low temperatures at the seabed, cold-water corals were observed at the canyon edges [3]. An accurate modelling of the canyon is thus needed to understand the impact of the physical forcing on biogeochemistry and biology, and to feed the habitat models of cold-water corals.

A high resolution configuration of the MARS3D ocean model was set up in the Cassidaigne canyon area, using a strategy of model nesting (see fig. 1) to increase the horizontal model resolution. The CASCANL configuration horizontal resolution is of 400 m, with 60 vertical generalized sigma levels. The general circulation forcing at open boundaries is provided by the operational MARS3D MENOR model configuration of the NW Mediterranean. Thanks to the use of a refined bathymetry at 10m resolution, a two-way nesting is operated in the CASCANL configuration, with an embedded zoom at 80 m horizontal resolution centered on the canyon (CASCANS configuration). This two-way nesting is necessary to take into account the effect of fine scale bathymetry over bottom currents and retroactions over larger scales. Comparisons of model results with observations were performed following the approach by [4] previously used in the Marseilles area. Comparisons with satellite images (ocean color and sea surface temperature) and *in situ* data (hydrology and current) were first performed in terms of processes through their physical signature patterns. Then statistical comparisons with *in situ* data were performed at fixed stations or along vessels transects to explore the differences in terms of quantitative bias and processes variability. The main features of the area, including the upwelling characteristics, were explored.

The model provides hourly information on the hydrology and dynamics of the area. The first sigma levels near sea bottom (roughly 10 meters) were considered over a period of four months (autumn 2013) for the predictive habitat mapping of cold-water corals. These hydrodynamics variables, together with seafloor characteristics combined with the geographic coordinates of the known occurrences of dense cold-water coral colonies in the canyon (presence-only data), allowed establishing a model using the MAXENT software package to predict the habitat distribution in terms of probability of occurrence [5]. Statistical results confirmed that water temperature followed by current velocity were the most important predictors after seafloor ruggedness.

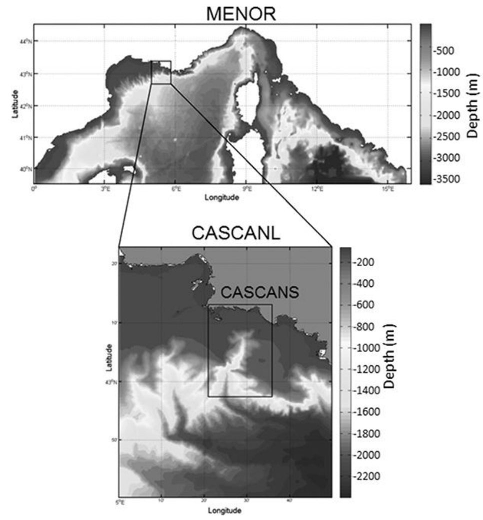

Fig. 1. Bathymetry of the model configurations and nesting strategy: MENOR fields force CASCANL, 2-way nesting between CASCANL and CASCANS using AGRIF.

References
1 - Allen S.E. and Hickey B.M., 2010. Dynamics of advection-driven upwelling over a shelf break submarine canyon, J. Geophys. Res., 115, C08018. doi:10.1029/2009JC005731.
2 - Pinazo C., Fraysse M., Doglioli A., Faure V., Pairaud I., et al., 2013. MASSILIA: Modélisation de la baie de MArSeILLe : Influence des apports Anthropiques de la métropole sur l'écosystème marin. http://archimer.ifremer.fr/doc/00145/25592.
3 - Fabri M.C., Bargain A., Arnaubec A., Pairaud I., Pedel L. and Raugel E., 2015. A case study on Vulnerable Marine Ecosystems in Cassidaigne Canyon - New technologies to track anthropogenic impact. pp. 79-86 In: CIESM Monograph 47 [F. Briand ed.] Submarine canyon dynamics in the Mediterranean and tributary seas - An integrated geological, oceanographic and biological perspective, 232p. CIESM Publisher, Monaco.
4 - Pairaud I.L., Gatti J., Bensoussan N., Verney R. and P. Garreau, 2011. Hydrology and circulation in a coastal area off Marseille: Validation of a nested 3D model with observations, J. Marine Syst., 88:20-33.
5 - Phillips S.J., Anderson R.P. and Schapire R.E., 2006. Maximum entropy modeling of species geographic distributions, Ecol. Model. 190 (3-4): 231-259.

THE SICILY CHANNEL RECORD: HOW A MARGINAL SEA RAPIDLY RESPONSES TO CLIMATE CHANGE

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Abstract

Due to its relatively small size and its geographical location, enclosed between continents, the Mediterranean Sea is very sensitive and responds relatively rapidly to atmospheric forcings and/or anthropogenic influences, compared to oceanic timescales. Indeed, the whole Mediterranean region has been defined as a "hot-spot" for climate change [1], as numerical model projections indicate pronounced mean warming and large decrease in precipitation. The long term record of thermohaline properties in the Sicily Channel provides us a unique occasion to observe how fast this climate change response can be in a marginal sea like the Mediterranean Sea: temperature and salinity trends at 400 m are now up to 10 times larger than the trends reported in literature.

Keywords: Temperature, Salinity, Sicily Channel, Mediterranean Sea, Time series

The Sicily Channel (Figure 1) is the most important Mediterranean passage after Gibraltar. It is the relatively shallow boundary between the two main deep Mediterranean basins, the Eastern Mediterranean Sea (EMED) and the Western Mediterranean Sea (WMED). The monitoring of the Sicily Channel [2] is fundamental for the quantification of the heat and salt exchanges between the EMED and the WMED. The amount and characteristics of the intermediate water flowing westward through the Sicily Channel is crucial in modulating the decadal variability of the Mediterranean thermohaline circulation and the intensity and timing of the dense water formation processes occurring in the northern part of the WMED [3]. The Sicily Channel record, one of the longest Mediterranean time series, starts in 1993 with the aim to detect the hydrological variability in the intermediate water layer.

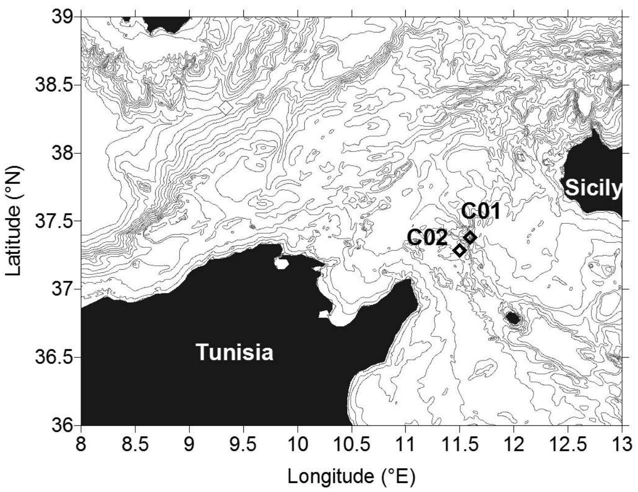

Fig. 1. Location of the moorings in the Sicily Channel (C01 and C02). The sites are part of the CIESM HYDROCHANGES Programme [2].

The long term series at 400 m depth of temperature and salinity (Figure 2) show very important trends: since the beginning of the time series (almost 22 years ago), temperature has increased by about 0.15 °C while salinity has increased by about 0.6 psu. These trends have undergone a dramatic acceleration since 2010, each year reaching higher and higher peak values, and are now up to 10 times larger than the trends reported for intermediate waters in literature (e.g. [4], who reports mean temperature and salinity trends of 0.006 °C/yr and 0.002 /yr, respectively). The intermediate water crossing the Sicily Channel forms both in the Levantine basin and in the Cretan Sea. Analysis of data coming from ARGO profilers and from ship-based CTD suggest that there are important intermediate temperature and salinity peaks in both areas, and that what we observe in the mooring data is a mixture with time-varying mixing percentages of both water masses, Levantine and Cretan Intermediate Waters (LIW and CIW).

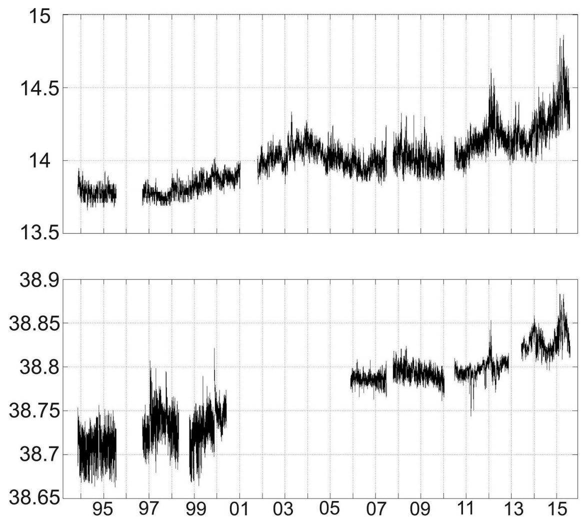

Fig. 2. Time series (3-hourly) of temperature (above) and salinity (below) in the LIW/CIW layer crossing the Sicily Channel (@400m).

It is very likely that the enhancement of the warming trend in LIW/CIW has to be ascribed to an effect of global warming and that the corresponding acceleration in the salinity trend is due to a general reduction of precipitation and riverine inputs and an increase of the evaporation over the Eastern Mediterranean. A recent climatological study [5] reports that the recent drought in the Levant (since 1998) is the driest in the record of the past 500 years. Thus it appears that the Mediterranean is more and more rapidly responding to climate change, and that the concomitant effect of higher regional air temperatures and a stronger evaporation is leading to important water mass changes, that will make more evident the existence of an "oceanographic" teleconnection between the intermediate water formation process in the Levantine basin and the dense water formation in the Gulf of Lion.

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References

1 - Giorgi F., 2006. Geophys. Res. Lett., 33, L08707.
2 - Schroeder K. et al., 2013. Ocean Sci., 9, 301-324.
3 - Schroeder K. et al., 2016. Sci. Rep. 6:23009.
4 - Vargas-Yanez M. et al., 2009. Sci. Mar. 73(1): 7-28.
5 - Cook, B. I. et al., 2016. J. Geophys. Res. Atmos., 121, 2060–2074.

CIESM Congress Session : Variability of thermohaline properties II

Moderator's Synthesis

Not available

CARBON, ANCILLARY AND TRACER DATA IN THE MEDSEA: COMPILATION AND QUALITY CONTROL

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Abstract

A consistent, complete and formatted data product containing inorganic carbon relevant data is presented. Ancillary (hydrographic, inorganic nutrients and dissolved oxygen), CO2 (pH, total alkalinity - TA, dissolved inorganic carbon - DIC) and transient tracer data of several basin-wide cruises in the Mediterranean Sea from 1976 until 2014 were assembled. The final aim is obtaining an internally consistent data collection of interior physical and biogeochemical variables, with emphasis on CO2 data, in order to investigate their temporal variability, natural and anthropogenic. Referred procedures for the first and secondary quality control will be applied as in CO2 synthesis data products CARINA and GLODAPV2.

Keywords: Hydrography, Oxygen, Mediterranean Sea, Ph, Time series

Introduction

The overall goal of this work is to create a merged, calibrated, homogenous, consistent and public data set collecting historic and recent subsurface measurements in the Mediterranean Sea involving carbon (pH, total alkalinity - TA, total inorganic carbon - TIC), tracer (chlorofluorocarbons, helium / tritium, sulphur hexafluoride) and ancillary (temperature, salinity, inorganic nutrients and dissolved oxygen) data. From the oceanographic point of view the processes occurring in the Mediterranean Sea (MedSea) have a global repercussion. Despite representing only 0.8% of the total surface area of the world oceans and the paucity of quality water column CO_2 measurements (Álvarez, CIESM, 2011), the MedSea has been identified as an important anthropogenic carbon storage (Schneider et al., JGR, 2010; Lee et al., Energy Envir. Sc., 2011). The reasons for this are the intrinsic physico-chemical characteristics of the MedSea waters, warm, salty and high in pH and alkalinity (Álvarez et al., Oc. Sc., 2014), thus with a low Revelle factor and prone to dissolve more inorganic carbon for a given CO_2 increase in the atmosphere. In addition this anthropogenic carbon can be rapidly transported to the interior ocean with the active overturning circulation (e.g., the review by Schroeder et al., Elsevier, 2013). Regardless of these facts, subsurface CO_2 measurements in the MedSea are scarce (see the review in Álvarez, CIESM, 2011) and the first high quality basin wide internally consistent subsurface CO_2 data were collected in April 2011 and made publicly available at CDIAC one year after approximately (see Tanhua et al. (ESSD, 2013) and Álvarez et al. (Oc. Sc., 2014). This recent data set has been directly and widely used in modelling and observation studies related with the CO_2 chemistry in the MedSea. Referenced, public and quality controlled data bases are valuable and extremely useful products scientists and society claim.

Cruise data compilation and quality control

In order to directly quantify the inorganic carbon changes in the MedSea and study the mechanisms, either natural or anthropogenic, leading to those changes, two groups (IEO - A Coruña and CMCC – Bologna) independently started a data rescue assembly and synthesis of subsurface CO_2 and ancillary measurements in the Mediterranean Sea basins. In the same manner as CARINA but in a much much smallar scale, just for the Mediterranean Sea, we defined CARTAMED. The first steps to accomplish the CARTAMED data rescue effort consisted in: - Locate and physically find (in public data bases, by direct contact with the Principal Investigator or even typing or digitalizing old cruise reports in paper) historical and recent CO2, tracer and ancillary subsurface data in the MedSea, preferably those with a basin scale. - Collect all the metadata and other information regarding those cruises and measurements: cruise reports, referenced or other publications. - Gather all the data together (station location, date, time, depth, temperature, salinity..) for each individual cruise and create a unique formatted file with all the physical and biogeochemical data converted to common units. - Special care was taken with pH data regarding the scale and temperature it was measured and reported (Velo et al., ESSD, 2009). All pH measurements were converted to pH at 25ºC on the Total scale. - All the individual cruise files are in "WHP-exchange" format, a comma separated file including header names and units. Each file (each cruise) is named with an expocode (unique code identifying each cruise as it depends on the research vessel and the date when the cruise left port. - 1st QC (Quality Control) consisting in assigning a quality flag to each measurement, thus inspecting and scrutinizing each cruise following the recommendations in Key et al. (ESSD, 2010). We will proceed with a 2nd QC to detect and quantify any measurement bias, following the expertise gained with CARINA (see Key et al., ESSD, 2010 and Tanhua et al., ESSD, 2010, and references therein). The overall goal of this step is improving the accuracy of the data set as we want to detect and quantify changes in TIC and ascribe them to natural (modelled with oxygen and inorganic nutrient data) or anthropogenic (correlated with transient tracers) drivers. The 2nd QC procedure consists in the following steps: 1) Interpolation of missing values of ancillary data (salinity, oxygen and nutrients) preferably were CO_2 data is available. 2) Identify areas / layers where the assumption of being in steady-state can be applied with reasonable confidence. Remember that the oceanography in the MedSea both in the eastern and western basins has suffered dramatic changes (see the review Schroeder et al., Elsevier, 2013). 3) Quantify the relative measurement offset between cruises bsed on the crossover analysis as in CARINA (Tanhua et al., ESSD, 2010) and the nearly finished GLODAPV2. 4) Assign an adjustment factor to data deemed to have a measurement bias that exceeds some limit.

References

1 - Álvarez, M., Sanleón-Bartolomé H., Tanhua T., Mintrop L., Luchetta A., Cantoni C., Schroeder K., and Civitarese G., 2014. The CO2 system in the Mediterranean Sea: a basin wide perspective. Ocean Sci., 10, 69-92, doi:10.5194/os-10-69-2014.

DEEP CIRCULATION AND MIXING IN THE TYRRHENIAN SEA: MORE THAN 10 YEARS OF DATA

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Abstract
This investigation aims to explore the variability of the hydrological characteristics of the Tyrrhenian basin water masses in the last 12 years, with particular attention to the Sicily channel inflow. Data collected consist of a long time series of two deep repeated CTD stations in the Tyrrhenian sub basin, whose specific feature is the well defined and permanent step-like profile of the water column. Despite the sability of the basin a rising trend of the staircases can be highlighted in the time series, and the whole water column movement can be linked to recent changes in the deep layers. This investigation will estabilish if this link is plausible or the staircase movements are of different nature.

Keywords: Deep waters, Tyrrhenian Sea, Turbulence, Circulation, Hydrology

This study aims to underline if and how recent changes in the Western Mediterranean circulation affect the water column structure and the deep stratification of the Tyrrhenian basin. Previous studies [1] show that significant changes, such as salinification and preconditioning to dense water masses formation, observed up to 2004 in the western Mediterranean basin were mostly related to the Eastern Mediterranean Transient (EMT). In the subsequent years the presence of a new layer of deep water was observed, showing higher salinity, temperature and density with respect to the resident deep water previously observed. This new, denser layer was produced to an exceptional deep water formation event in winter 2004/05 [2], and it is now spreading at the bottom of the western basin, setting the beginning of the Western Mediterranean Transition (WMT), which changed the basic structure of the intermediate and deep layers in the Western Mediterranean. An important consequence of the WMT is, in particular, a perturbation of the deep Tyrrhenian Sea, due to the propagation of these anomalies through the Sardinian Channel, observed for the first time after 2010.
One of the main features in a typical vertical profile of the water column of the Tyrrhenian basin is a step-like structure, due to double diffusion processes, which has a strong impact on the vertical mixing rates. Indeed when the bottom slope does not influence the water motion anymore, as in the Tyrrhenian basin, the mixing is entirely ascribable to molecular diffusion via finger instability [3].

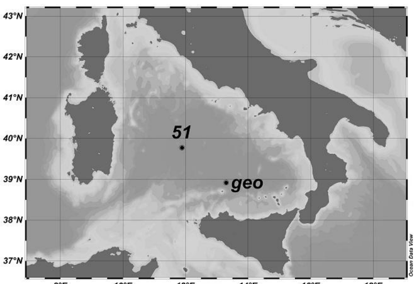

Fig. 1. Map of the two stations

In both of the two control stations analyzed in the middle of the Tyrrhenian sea (Fig. 1), among over 10 years of measurements the step-like profiles of the water columns are considerably superimposable, and seems to be very stable. Despite, a vertical raising of the whole profile in time is highlighted, as it can be seen in Figure 2 in particular for stn 51.
One of the possible explanations for the raising of the steps is the new deep water entering the Tyrrhenian basin, moving them upwards.
To prove this hypothesis a method developed by Bindoff and McDougall [4] is now under test for the specific Tyrrhenian case, in order to identify the contribution of pure warming, pure freshening, pure heaving mechanis, and to discern if the displacements seen in the whole water column profile in time are due to internal or external forcings such as the new deep water layer pushing from the bottom of the basin.

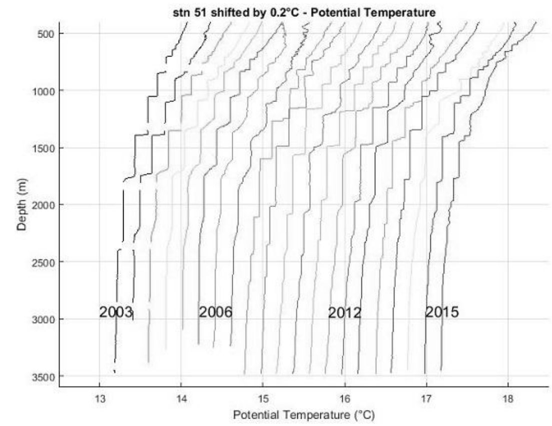

Fig. 2. Historical series of Potential Temperature for one of the two control deep Tyrrhenian station (stn 51), shifted by 0,2°C form 2003 to 2015, to better underline the similarity among the profiles and the rising trend.

Acknowledgement: This work has been partially supported by the FP7 projects OCEAN CERTAIN and COMMON SENSE and by the Italian National Flagship Project RITMARE.

References
1 - Schroeder, K., G. P.Gasparini, M. Tangherlini, and M. Astraldi (2006), Deep and intermediate water in the western Mediterranean under the influence of the Eastern Mediterranean Transient, Geophys. Res. Lett., 33, L21607, doi:10.1029/2006GL027121.
2 - Schroeder, K., A. Ribotti, M. Borghini, R. Sorgente, A. Perilli, and G. P. Gasparini (2008), An extensive western Mediterranean deep water renewal between 2004 and 2006, Geophys. Res. Lett., 35, L18605, doi:10.1029/2008GL035146.
3 - Sparnocchia, S., Gasparini, G.P., Astraldi, M., Borghini, M., Pistek, P., (1999), Dynamics and mixing of the Eastern Mediterranean outflow in the Tyrrhenian basin, Journal of Marine System 20 (301-317)
4 - Bindoff, N.L., Mc Dougall, T.J. (1993), Diagnosing Climate Change and Ocean Ventilation Using Hydrographic Data, American Meteorological Society, vol 24, 1137-1152.

CREATION OF INDEXES FOR THE VARIABILITY OF WATER MASSES IN THE MEDITERRANEAN SEA INTERCOMPARING AN IN-SITU DATASET AND THE NEMO-MED12 MODEL.

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Abstract

Since 2007 intense observational efforts in the northewestern Mediterranean Sea have been carried out in the the framework of numerous projects leading to a quasi continuous monitoring of this area. By considering these data in regional boxes and at certain depths, we obtain time series typical of the evolution of the water masses. We compare these results with same estimates from model outputs (NEMO-Med12). We show that these timeseries can be considered as indexes of water masses distribution by assessing the relevance of the data sampling in following the water masses and evaluate the skill of the model using that approach.

Keywords: Circulation, Mediterranean Sea, Models

Water masses distribution in the Mediterranean Sea is affected by the circulations in and between the basins as well as by the external forcings. Thanks to the substantial dataset collected -especially in the Northwestern Mediterranean- with autonomous platforms (gliders, argo) as well as during cruises, an effective follow up of the water masses and of their properties is ensured. This follow up enables a near synoptic view of those properties and gives hydrographic time series for the basin, allowing to aprehend interannual variations and tendancies. Changes in salinity and temperature in Levantine Intermediate Waters (LIW) are important factors for the deep convection process and influence the properties of the newly formed deep waters [1]. In a climate change context, the heating of the deep waters (heat storage at depth) is influenced by the salt and temperature contents at intermediate levels [2,3]. It is consequently crucial to monitor the variability of these water masses in order to assess and predict those evolutions. Here, we use both the in-situ dataset and an interannual simulation performed with the NEMO-Med12 model to assess the evolution of the northwestern Mediterranean Sea on interannual time scales. Considering data in chosen regional boxes, we follow the evolution of different water masses in the basin and generate indexes to follow their evolution. We then put those indexes in relation with external (atmospheric) forcings and present an intercomparison with the NEMO-Med12 model to estimate both the skill of the model and the pertinence of the data-sampling in reproducing the evolution of water masses properties.

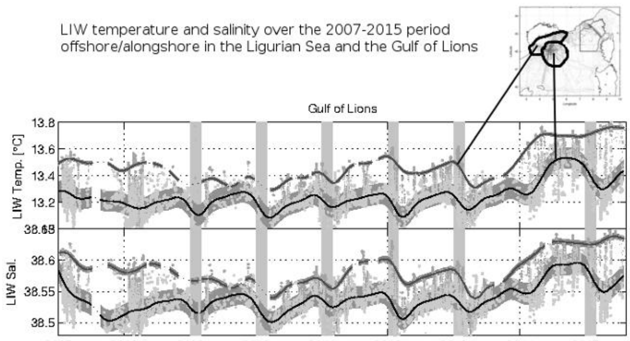

Fig. 1. LIW salinity and temperature in the Gulf of Lions along the coast and offshore during the 2007-2015 period. The vertical patches indicate deep convection episodes.

Figure 1 shows the evolution of LIW alongshore and offshore in the Gulf of Lions over the 2007-2015 period. We note the contrast between the coastal LIW which is warmer and saltier than the offshore one, as could be expected from the boundary current controlled along the continental slope. After each deep convection episode occuring in the Gulf of Lions, a decrease in temperature (0.1-0.3°C) and salinity (0.02-0.05psu) is noted for the LIW, denoting the transfer of salt and heat to the deep waters. Transfer confirmed in the time series of the deep waters which on the contrary see an increase in temperature and salinity after those episodes. These time series are obtained from region to region and the water masses are thus followed, enabling an assessment of their mixing and and spatial evolution as well as their temporal one. After a 2014 winter with little convection, we note that the LIW salinity and temperature have not decreased in winter as usual. The absence of convection results in a shift in LIW properties towards warmer and saltier waters, pressing the global trend from its formation point to the Gulf of Lions. The NEMO-Med12 model is used to assess this trend and see if the recent weak deep convection events, as well as the heating and salting of the intermediate layers are reproduced in the model. The intercomparison assesses the skill of the model in representing the variability of the deep conevection.

References

1 - Grignon, L., Smeed, D. A., Bryden, H. L., and Schroeder, K. (2010). Importance of the variability of hydrographic preconditioning for deep convection in the Gulf of Lion, NW Mediterranean. Ocean Science, 6(2) :573–586. e), f), 1, c), A3, 6

2 - Schroeder, K., Gasparini, G. P., Tangherlini, M., and Astraldi, M. (2006). Deep and intermediate water in the western Mediterranean under the influence of the Eastern Mediterranean Transient. Geophysical Research Letters, 33(21). e), 1, c), 6

3 - Herrmann, M. J., Somot, S., Sevault, F., Estournel, C., and Déqué, M. (2008). Modeling the deep convection in the northwestern Mediterranean sea using an eddy-permitting and an eddy-resolving model : Case study of winter 1986-1987. Jour- nal of Geophysical Research : Oceans, 113(C4) :1–25. 1

INTER-ANNUAL THERMOHALINE AND NUTRIENT DYNAMICS (2002-2014) IN THE LEVANTINE INTERMEDIATE WATER MASS, SE MEDITERRANEAN SEA

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Abstract

A 13 years (2002-2014) dataset (Haifa section cruises, IOLR) was used to explore the relations between the physical and nutrient properties ofthe Levantine Intermediate water (LIW) in the eastern Levantine Basin. Decadal variations in LIW core were observed in nutrient levels and integrated chlorophyll a in nearly opposite phase with temperature and salinity. These variations occurred with a similar decadal periodicity, but in shifted phase of those observed in LIW mass in the Southern Adriatic and North Ionian Seas, attributed to decadal reversals in the North Ionian Gyre, i.e. Bimodal Oscillation System (BiOS).

Keywords: South-Eastern Mediterranean, Salinity, Temperature, Nutrients, Time series

The Mediterranean Sea (MS) is characterized by limited water exchange with the Atlantic Ocean through the Gibraltar Strait. Surface water from the Atlantic flows eastward and undergo continuous transformation due to air–sea heat and moisture fluxes resulting in the highest salinities in the Levantine Basin (LB). Levantine Surface Water (LSW) are the product of these Modified Atlantic Water (MAW) at the extreme eastern end of the Eastern MS. The LB is significantly influenced by the water exchange with the Ionian Basin (IB) via the Cretan passage, which isolates it from the rest of the MS. The BiOS mechanism controls the trajectory of the MAW flow to both the Southern Adriatic (SA) and the LB through decadal reversals in the North Ionian Gyre ([2]).

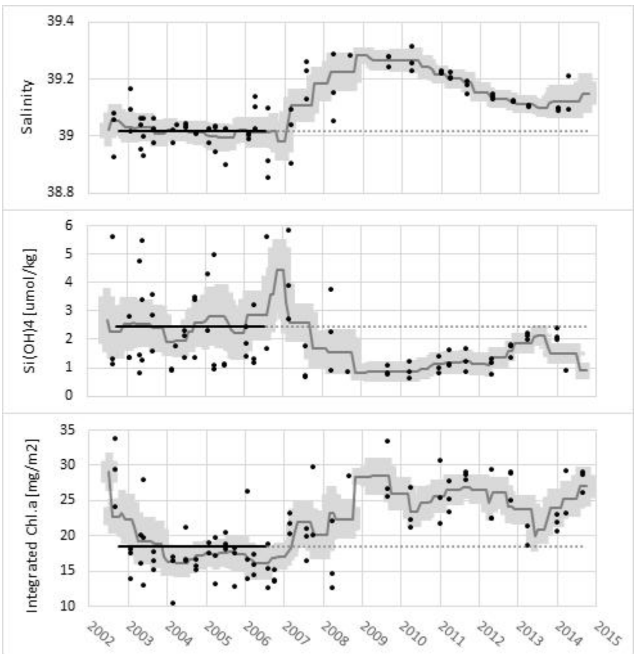

Fig. 1. Salinity, nitrate+nitrite and Integrated Chlorophyll a (0-200m) time series of measurements made in the LIW water mass from Haifa Section cruises (2002-2014). Station specific values are presented in dots, moving average in solid gray line and standard error ranges in light gray area.

The presented LIW investigation is derived from a 13 years dataset (2002-2014) including 3 deep stations (>1000m) of Haifa section cruises. The vertical position of LIW core was identified by the maximal salinity value within the depth limits of 130m to 350m attained from LIW analysis in >30 years dataset ([3]). Subsequently, physical and chemical LIW core values were averaged for each cruise and smoothed using a one-year window moving average. Additionally, Chl-a concentrations obtained from calibrated CTD Fluorescence readings were integrated over the photic zone (0-200db) and underwent the same procedure of averaging and smoothing. The smoothed salinity time-series of LIW was compared to the results of the >30 year analysis ([3]) and showed significant agreement. Temporal trends of nutrient levels starting in winter 2006-2007 corresponded with the evident shift in LIW physical properties. As salinity and temperature values rose nitrate+nitrite, phosphate and silicic acid levels decreased during 2006-2009 (Partially presented, Fig.1).

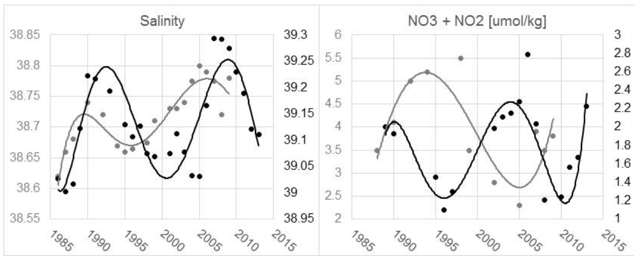

Fig. 2. Polynomial trend lines of salinity and nitrogen concentration (NO2+NO3) for LIW from the South Adriatic (Gary) and the South Eastern Levantine (Black).

The salinity peak in LIW can be attributed anticyclonic circulation in the north Ionian between 2006 and 2009 in linkage to the BiOS theory. Limited MAW advection to the LB prolonged residence time and caused a positive buoyancy flux which favored deeper winter convection increasing nutrient supply to the photic zone. The similar behavior of salinity and integrated Chl-a, and opposing phase of nutrient patters supports this proposition (Fig. 1). Such anti-phase relations, between salinity and nitrate levels were found in the SA and northeastern IB ([1]). Temporal variations of nitrate levels in the SA and the LB appear to be in shift-phase of about 9 years, offering evidence for the connection between the two observed phenomena (Fig. 2). Published estimates of the average travel time of LIW from the Rhodes Gyre to the Sicily Channel are in the range of 8 to13 years. It can be inferred that the travel time of LIW to the SA has a similar temporal range. The observed inter-annual variations in LIW thermohaline and nutrient properties may have profound consequences for biogeochemical processes. While the East MS is fed by several external sources of nutrients (atmosphere, rivers, terrestrial runoff and submarine groundwater) we believe that the thermohaline flux variations attributed to the BiOS mechanism have the most immediate and significant impact in magnitude on the available nutrients and the dynamics of the eastern basin primary productivity.

References

1 - Civitarese G., Gacic M., Lipizer M. and Borzelli G.L.E., 2010. On the impact of the Bimodal Oscillating System (BiOS) on the biogeochemistry and biology of the Adriatic and Ionian Seas (Eastern Mediterranean). Biogeosciences 7, 3987–3997.

2 - Gacic M., Borzelli G.L.E., Civitarese G., Cardin V. and Yari, S., 2010. Can internal processes sustain reversals of the ocean upper circulation? The Ionian Sea example. Geophys. Res. Lett. 37, L09608.

3 - Gertman I., Goldman R., Tal O. and Zodiatis G. (2013). Interannual changes in the thermohaline structure of the south eastern Mediterranean. Rapp. Comm. int. Mer Medit. (CIESM Congress Proceedings). Vol. 40: 211.

THE LAST STAND OF EMT INFLUENCE ALONG THE EASTERN COAST OF THE AEGEAN SEA

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Abstract
The time evolution of water properties along the Eastern Aegean Coast is studied by analyzing CTD data to depict the temporal variability of the water characteristics of the Eastern Aegean Sea. The data show the relaxation period of the EMT, which continued well into the early 2000s. The Central Aegean seems to play the key role in the Aegean deep water formation processes. Our analysis reveals that the dense water formation in the Central Aegean Sea is considerably connected mainly to the anomalous decrease in winter atmospheric temperature during the EMT period and to preconditioning settled before. The isopycnal levels started to increase not only in the Central Aegean Sea also in the regions near the Eastern Aegean Coast and reached their maximum after the EMT relaxation period in 2007.

Keywords: Hydrography, Aegean Sea, Water transport

The water exchange between the Aegean Sea and the Mediterranean Sea is related to the deep water formation in the Aegean Sea. The causes concerning the increasing the density of the Aegean Sea water is mainly due to strong winter convection and the resulting dense water formation occurring in the cold winters 1992 and 1993 especially in the Central Aegean Sea [1-4]. Time series of density obtaining from the CTD data of the Saroz, Edremit, Candarli, Izmir, Kusadasi, Güllük Bays and Chios Cyclonic Region show the relaxation period of the EMT continued well into the early 2000s. The isopycnal levels started to increase not only in the Central Aegean Sea also in the regions near the Eastern Aegean Coast and reached their maximum after the EMT relaxation period in 2007 together with a salinity increase in the water column (Figure 1) [5].

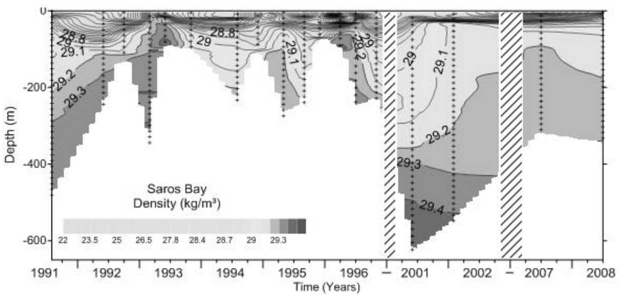

Fig. 1. Temporal evaluations of density fields of the Saros region from summer 1991 up to summer 2008. The areas in white represent where data were not collected. The slash lines show the shortening of the long gap in time (from Eronat and Sayin, 2014 [5]).

A numerical simulation by Androulidakis et al. [6] showed that the period 2006–2008 was marked by dense water formation in the Central Aegean mainly caused by the intrusion of saline masses of Levantine origin. Salinity driven dense Cretan Sea outflow occurring during 2007, 2008, and 2009 is investigated by Velaoras et al. 2014 [7]. He called this occurrence as "EMT-like" event. Georgiou et al. [8] showed that the period of 2006–2012 is characterized by two strong cooling events (2008–2009 and 2012) in the south Aegean Sea and by a significant increase (2010–2011).

References
1 - Lascaratos A., Roether W., Nittis K, Klein B., 1999. Recent changes in deep water formation and spreading in the eastern Mediterranean Sea. *Progress in Oceanography* 44(1–3): 5–36.
2 - Velaoras, D., and Lascaratos A., (2005). Deep water mass characteristics and interannual variability in the North and Central Aegean Sea, J. Mar. Syst., 53, 59–85.
3 - Sayin, E. and Besiktepe, S. T., (2010). "Temporal evolution of the water mass properties during the Eastern Mediterranean Transient (EMT) in the Aegean Sea", J. Geophys. Res., 115, C10025, doi:10.1029/2009JC005694.
4 - Sayin, E., Eronat, C, Uçkaç, S and Besiktepe, S. T., (2011). Hydrography of the eastern part of the Aegean Sea during the Eastern Mediterranean Transient (EMT), Journal of Marine Systems 88 (2011) 502–515, doi:10.1016/j.jmarsys.2011.06.005.
5 - Eronat, C., Sayin, E., (2014). "Temporal evolution of the water characteristics in the bays along the eastern coast of the Aegean Sea: Saros, Izmir, and Gökova bays" Turkish J. Earth Sci., 23, 53-66, 2014.
6 - Androulidakis, Y. S., V. H. Kourafalou, Y. N. Krestenitis, and V. Zervakis (2012). Variability of deep water mass characteristics in the North Aegean Sea: The role of lateral inputs and atmospheric conditions, Deep Sea Res., Part I, 67, 55–72, doi: 10.1016/j.dsr.2012.05.004.
7 - Velaoras, D., G. Krokos, K. Nittis, and A. Theocharis (2014). Dense intermediate water outflow from the Cretan Sea: A salinity driven, recurrent phenomenon, connected to thermohaline circulation changes, J. Geophys. Res. Oceans, 119, doi:10.1002/2014JC009937.
8 - Georgiou, S., Mantziafou, A., Sofianos, S., Gertman, I., Özsoy, E., Somot, S., & Vervatis, V. (2015). Climate variability and deep water mass characteristics in the Aegean Sea. Atmospheric Research, 152, 146-158.

APPEARANCE OF TRANSITIONAL MEDITERRANEAN WATER (TMW) IN THE CRETAN SEA (1987 – 2015) IN RELATION TO DENSE WATER FORMATION EVENTS

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Abstract
The appearance of low salinity, temperature, oxygen and nutrient-rich waters inside the Cretan Sea at depths below the saline intermediate water layer is a recurrent phenomenon related to the intrusion of Transitional Mediterranean Water (TMW) from the Eastern Mediterranean Sea. The inflow of TMW through the Cretan Straits acts as compensation for the outflow of equally dense or denser masses. This export is a result of dense water formation (DWF) events taking place inside the Aegean Sea. Hence, TMW intrusions in the Cretan Sea can be used as a tracer of DWF in the Aegean. During the last 30 years data show that TMW intrusion followed both the massive DWF event known as the Eastern Mediterranean Transient (EMT) as well as a less severe DWF event of the late 2000's decade.

Keywords: Cretan Sea, Aegean Sea, Deep waters, Circulation

The low salinity, temperature, oxygen and nutrient-rich waters separating the deep from the intermediate layers in the Cretan Sea, represents waters that originate from the transient layers of the EMed, i.e. between Levantine Intermediate Water and EMed Deep Water. However, data suggest that the appearance of such TMW masses in the Cretan Sea is not continuous but displays a rather recurrent character.

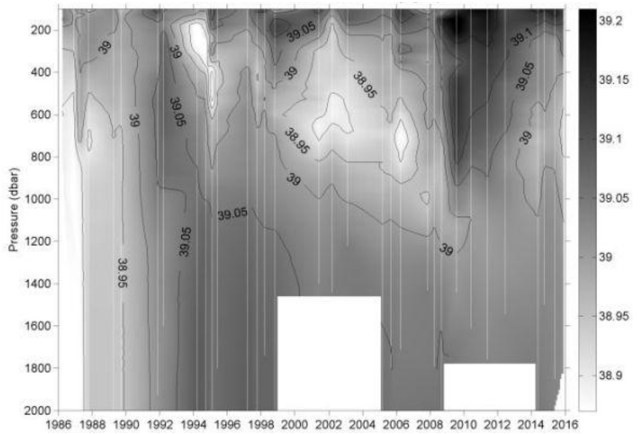

Fig. 1. 1986-2015 Hovmoller salinity diagram in the Central-Eastern Cretan Sea limited between 100 and 2000 dbar. Contour interval is 0.05

Figure 1 shows the Hovmoller salinity diagram in the Central-Eastern Cretan Sea between 1986 and 2015. Data originate from CTD casts conducted by the Hellenic Centre for Marine Research. During the EMT onset period (1987 – 1991) the Cretan Sea gradually increased its salinity (preconditioning phase) followed by a more abrupt salinity increase during the peak-EMT period (1992-1994) which led to the development of maximum salinity (>39.05) and density values ($\sigma\theta$>29.3 kg/m^3) below intermediate layers as a result of the event. By the end of the peak-EMT period (1994-5 onwards) the low salinity TMW mass appears in the Cretan Sea at depths of 200-600 dbar as compensation to the massive outflow of Cretan Deep Water (CDW) from the Cretan basin. Between 1998 and up to ~2008 the TMW core deepened mostly following the deepening of the isopycnals inside the basin which took place during the relaxation phase after the EMT. From 2006 onwards there is a continuous intermediate layer salinity increase in the Cretan basin that gradually reached depths of more than 1000 dbar as reported in [1] and [2]. Consequently, the TMW layer was eroded by diffusive processes with the more saline overlying masses and its core progressively moved to greater depths showing higher salinity values. According to [1] and [2], the salinity increase observed in the Cretan Sea after 2006 acted as a preconditioning factor that finally led to the outflow of dense Cretan Intermediate Water (dCIW) towards the EMed by the end of the decade. As a result of this outflow, TMW progressively re-entered the Cretan Sea from the EMed as early as 2012. In late 2015, the TMW occupied a layer roughly between 500 and 900 dbar with its core being at 700 dbar with S<38.93.

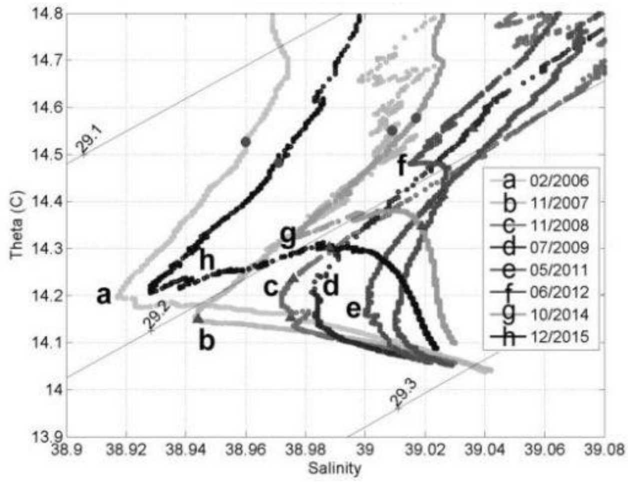

Fig. 2. Theta – S diagram of 2006-2015 CTD casts in the Central Cretan Sea limited to $\sigma\theta$>29.1 kg/m^3

Figure 2 is a Theta-S diagram showing the deep part of CTD casts in the Central Cretan Sea between 2006 and 2015. The deep salinity minimum characterizing the TMW core is clearly seen. From 2006 to 2011 (a to e) the TMW core gradually erodes towards greater depths, increasing both its salinity and density, while the Theta-S curve "smoothens" gradually as a result of mixing. The re-emergence of TMW into the water column starts in 2012 (f) forming a "wedge" in the Theta-S curve which gradually widens moving towards lower core salinity values (g,h) at $\sigma\theta$ density of ~29.17 kg/m^3. According to [3], the appearance of TMW in the Cretan Sea is the result of a compensatory inflow that follows DWF events taking place in the Aegean Sea. As such, TMW presence can be used as a valuable trace of such past or future events.

References

1 - Krokos, G., Velaoras, D., Korres, G., Perivoliotis, L., Theocharis, A., 2014. On the continuous functioning of an internal mechanism that drives the Eastern Mediterranean thermohaline circulation: The recent activation of the Aegean Sea as a dense water source area, J. Mar. Syst., 129, 484-489
2 - Velaoras, D., Krokos, G., Nittis, K., Theocharis, A., 2014. Dense intermediate water outflow from the Cretan Sea: A salinity driven, recurrent phenomenon, connected to thermohaline circulation changes. J. Geophys. Res. Oceans, 119 (8), 4797–4820
3 - Velaoras, D., Krokos, G., Theocharis, A., 2015. Recurrent intrusions of transitional waters of Eastern Mediterranean origin in the Cretan Sea as a tracer of Aegean dense water formation events. Prog. Oceanogr., 135, 113-124

CIESM Congress Session : Oceanographic networks
Moderator : Joaquin Tintoré, SOCIB, Palma, Spain

Moderator's Synthesis

Objective: the main objective of these sessions was to present the recent findings and to discuss the changes in the approach to understanding the oceans in the last ten years, today focusing on the links between projects and initiatives that allow focusing on the complexity and on the scales and multi-disciplinary approaches in the ocean, interactions, physical and biological examples of features and processes.

The session**:** we reviewed the evolution from studying single pieces of the puzzle, the ocean-atmosphere system, single process and single scientist approach to now being able to address the problem in its whole complexity, from the nearshore to the open ocean, from episodic water masses formation events to decadal variability. Examples were presented from key international initiatives such as Med-SHIP, Argo, Euro-Argo and Med-Argo, BIOS, HydroChanges 2002-2016, FixO3 (the RT ones…), the ongoing JERICO-NEXT projects, etc…. and therefore concluding that the combination of networks is the key.

The importance of the present time in Mediterranean oceanography was discussed: we are now starting to be able to connect the pieces of the n-dimensional Ocean Planet puzzle, linking water mass changes to dynamical effects at seasonal, annual and inter-annual to decadal time scale, ecosystem variability at the different scales… etc… And the reason for this…. is the paradigm change in ocean observation and data availability.

Data: the importance of data harmonization among the different observatories. The interesting EU Trans National Agreements for platforms use (TNA), and new tools such as Service Activity (you can ask the data from different places, but you can also request specific services related for example with deep water formation…). The EMODnet leadership in Europe on free and open data, examples. MedSea Checkpoint project is also a key example.

EOOS: the relevant EOOS initiative providing a common framework in line with UN agenda for SDG's, COP21 which did not ignore the role of the oceans in climate change, the G7 communiqué on the role of ocean observations, and the need of free and open data. EOOS is a concept. Concept plus action become a Reality. The key: leadership and coordination. The Mediterranean leadership is recognised at EU and international level.

THE OCEAN SAMPLING DAY AND ANALYSIS CONSORTIUM

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Abstract
Ocean Sampling Day is a simultaneous, global mega-sequencing campaign that takes place during the boreal summer solstice each year. The European-funded 7th Framework project Micro B3 (Marine Microbial Biodiversity, Bioinformatics, Biotechnology) initiated the first sampling campaign in 2014 with the aim of generating the largest standardized global microbial data set on a single day. Currently, the OSD Analysis Consortium is performing a collective comparative analysis of the OSD 2014 data. The Consortium was established in October 2015 and consists of more than 130 experts in marine science and informatics. Initial results show that the genetic repertoires of the OSD sites are yielding unprecedented insights into microbial adaptations to coastal marine environments.

Keywords: Biodiversity, Metagenomics, Coastal waters, Mediterranean Sea, North Atlantic

Ocean Sampling Day 2014 Data

The Ocean Sampling Day initiative [1] has catalyzed an international network of scientists and citizens to gather the largest standardized microbial phylogenetic and functional dataset on a global scale to date. On June 21st, 2014, the solstice, 150 sampling stations worldwide sampled seawater to characterize DNA for community metagenomic analysis and biodiversity profiling via 16S and 18S rRNA gene amplicon sequencing. OSD participants collect environmental and geospatial data conforming to the M2B3 Standard [2] and Consortium members further extrapolate ancillary data from relevant public repositories [3] to produce highly contextualized molecular datasets.
To comply with the legal requirements for sampling in coastal Exclusive Economic Zones characterizing many of OSD's sampling locations, Micro B3 pioneered the use of an Access and Benefit Sharing (ABS) model agreement and data policy. Our ABS agreement directly implements the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization in compliance with the Convention on Biological Diversity.

Results

Our initial results show that the genetic repertoire of the mostly coastal OSD sampling sites complements that of the Ocean Microbial-Gene Reference Catalogue (OM-RGC) with the addition of a collection of distinct genes. With over 40 million genes, the OM-RGC represents the largest collection of genes derived from marine reference genomes and mega-sequencing expeditions to date. In addition, the low level of similarity in the genetic distances between the different OSD metagenomes reflects the dynamic and heterogeneous nature of coastal environments.

Coastal zones are at the interface between the terrestrial and marine realms: they are dynamic environments impacted by both natural and anthropogenic drivers. This renders them particularly interesting ecosystems for marine microbial investigations. For example, a global survey of the genes involved in antibiotic resistance, the so-called resistome, is revealing hotspots among OSD coastal sampling locations.

All OSD 2014 data along with detailed documentation are publicly available via the OSD GitHub account (https://github.com/MicroB3-IS/osd-analysis). The OSD dataset is a comprehensive and openly accessible resource for future insights into anthropogenic influences and factors shaping the diversity and function of coastal microbial communities.

Fig. 1.

References

1 - Kopf A et al. (2015) The ocean sampling day consortium. GigaScience 4:27.
2 - Ten Hoopen P, Pesant S, Kottmann R, Kopf A, Bicak M, Claus S, Deneudt K, Borremans C, Thijsse P, Dekeyzer S, Schaap D, Bowler C, Glöckner F, Cochrane G (2015) Marine microbial biodiversity, bioinformatics and biotechnology (M2B3) data reporting and service standards. SIGS 10:1-10.
3 - Halpern BS, Longo C, Lowndes JSS, Best BD, Frazier M, Katona SK, Kleisner KM, Rosenberg AA, Scarborough C, Selig ER (2015) Patterns and Emerging Trends in Global Ocean Health. PLoS ONE 10:e0117863.

THE LONG TERM INITIATIVE TO FACILITATE ACCESS AND RE-USE OF MARINE CHEMICAL DATA, METADATA AND DATA PRODUCTS: EMODNET CHEMISTRY

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Abstract
EMODnet Chemistry (http://www.emodnet-chemistry.eu/) is the long-term initiative from DG MARE aiming to extend chemical data collection, management, quality control, access and visualization, contributing to the MSFD. Particular effort is dedicated to data quality assurance, facing the issue of enriching the data with all information related to data collection method and analyses, data quality control and parameter homogenization. Aggregated and validated data are produced and dynamically visualized as standards WMS and WPS OGC services. The Mediterranean sea dataset includes 33287 stations of nitrate, nitrite, phosphate and silicate (all data aggregated to umole/l and quality controlled). Based on these data, seasonal basin scale concentration maps are computed using a 10-year moving window spanning from 1960 to 2014.

Keywords: Nutrients, Pollution, Mediterranean Sea

EMODnet Chemistry (http://www.emodnet-chemistry.eu/) aims to assemble fragmented marine chemical data into interoperable and publicly available data streams for complete maritime basins, to assess data quality according to common and standardized protocols and to generate suitable data products in agreement with the requests from the MSFD addressing three of the descriptors of GES: eutrophication, contaminants and contaminants in seafood. The project started in 2009 as a pilot component of the European Marine Observation and Data Network (EMODnet), as proposed in the EU Green Paper on Future Maritime Policy [1] and implemented in the vision document Marine Knowledge 2020 [2]. It was focused on selected chemical groups on limited sea basins (namely North sea, Black sea and five spots in the Mediterranean sea) [3]. In 2012, a new call was opened to extend the parameter coverage as well as the spatial resolution, covering in the current phase all European sea basins. The partnership is built upon 46 institutes from EU and not EU countries. They are acting either as Data Centers, to provide data collections for the requested geographic areas, as Technical partners, to further develop and run the distributed infrastructure, or as Specific experts, to coordinate data analyses and validation and the creation of data products. The technical set-up is based on the principle of adopting and adapting the SeaDataNet pan-European distributed infrastructure for ocean and marine data, duly extended to manage the chemical component. Data quality control is considered as a key element when merging heterogeneous data coming from different sources and a data validation loop has been agreed within EMODnet Chemistry community and is routinely performed.

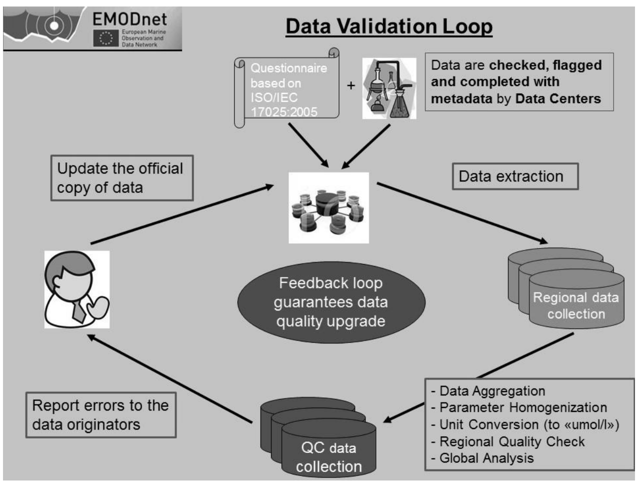

Fig. 1. Data validation loop from the distributed infrastructure to the regional quality controlled data collections with feedback to the data centers giving distributed access to the data

Aggregated and validated regional datasets for nutrients, dissolved oxygen, chlorophyll-a and pollutants (as concentrations of hydrocarbons, metals, pesticides and antifoulants) in the five EU marine basins (Mediterranean Sea, Black Sea, Atlantic Sea, North Sea and Baltic Sea) are released and used to develop data products useful for the requirements of the MSFD. Seasonal concentration maps of nutrients (mostly nitrate, nitrite, phosphate, silicate and ammonium, presenting a good spatial coverage at basin scale) are computed using the variational analysis method [4] to interpolate irregularly-spaced data. A dedicated dynamic service has been developed for the visualization of the datasets as station maps, vertical profiles and time series. All visualization services are developed following OGC standards as WMS and WPS.

Fig. 2. Concentration map of surface nitrate in spring for the decade centered in 2000 (1996-2005) with the distribution of all available data station points.

To guarantee high level performances and long-term availability, the Cloud environment offered by Cineca (the Consortium of Italian Universities and Research Institutes) has been chosen to host the regional aggregated datasets and the visualization services for the dynamic plots and the seasonal analysis.

References

1 - Towards a future Maritime Policy for the Union: A European vision for the oceans and seas, 2006, COM(2006) 275 final, Volume II - ANNEX, 49 pp.
2 - "Marine Knowledge 2020: from seabed mapping to ocean forecasting", 29 August 2012, COM(2012) 473, 28 pp.
3 - Vinci M., Giorgetti A., Brosich A., 2013, New EU efforts to assess the state of the marine environment: the Emodnet Chemistry pilot project. Boll. Geof. Teor. Appl., Vol.54 Supp. (2013), IMDIS, pp. 121-122, ISSN: 0006-6729.
4 - Brankart J.-M. and Brasseur P., 1996, Optimal analysis of in situ data in the Western Mediterranean using statistics and cross-validation, J. Atmos. Ocean. Tech., 13, 477–491.

ASSESSMENT OF THE BLACK SEA WAVE CLIMATE EVOLUTION OVER LAST 37 YEARS

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Abstract
In this paper the analysis of storm activity in the Black sea over the past 37 years with the help of mathematical modeling is presented. It is shown that the wave activity was experiencing long-period oscillations, and throughout the whole basin this variability is most evident in the Western part of the sea. Also, the current trends in the wave energy potential changing for the entire Black sea are shown.

Keywords: Waves, Black Sea, Models

The purpose of this study is the analysis of storm activity in the Black sea, and the identification of climate trends on interannual fluctuations of wave energy. The main method of investigation is mathematical modeling. The spectral wave model, DHI MIKE SW is used [2]. The atmospheric pressure and the horizontal components of wind speed, obtained from the dataset of global atmospheric reanalysis ERA-Interim over the period 1979 to 2015 are used as atmospheric forcing fields. Spatial resolution in latitude and longitude is 0.25 degrees, the time step is 3 hours. The model is verified according to all available direct instrumental and satellite observations of wind wave parameters [1]. Output estimated parameters of the model, the spatial distribution of wave heights (significant and maximum), mean periods, periods of maximum range, direction, excitement, power, wind waves and two-dimensional (frequency-directional) spectra of wind waves. The vast array of data, consisting of spatial fields of the calculated parameters of wind waves in the Black sea with a time step of 1 hour and covering a period of 37 years (from 1979 to 2015) is obtained.

In comparison with other waters of the World ocean wave activity of the Black sea is rather moderate. Despite the fact that in certain storms, the wind wave power can reach 1000 kW/m, the average indicators of the wave power can be about 8-9 kW/m in the Western part of the sea and 2-3 in the Eastern division.

Fig. 1 shows that long-period variability of the wave power field is most pronounced in the Western part of the sea becomes apparent as quasidecades cycles of a sharp increasing in wave activity. The Eastern part of the sea is more homogeneous and is characterized by minor fluctuations.

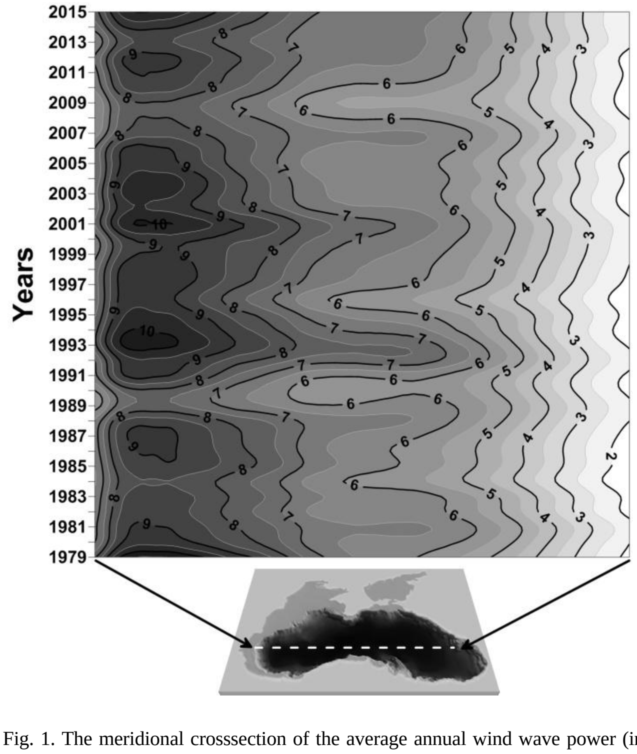

Fig. 1. The meridional crosssection of the average annual wind wave power (in kW per meter of wave front) for the period from 1979 to 2015

Fig. 2 illustrates the spatial heterogeneity of the climate wave field variability, which shows the normalized difference (in percent) wave capacity, averaged over the last decade, to an average wave power for the period 1979-2015.

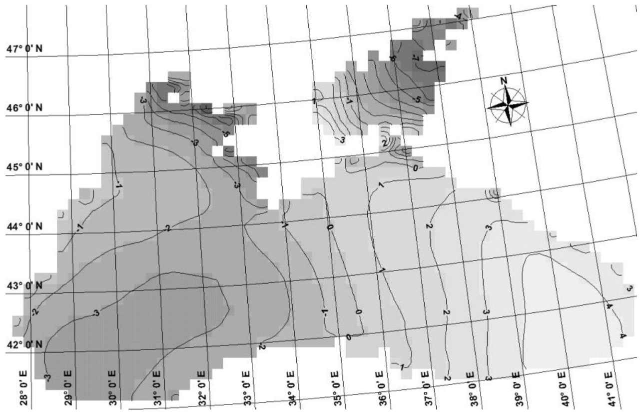

Fig. 2. The normalized difference (in percent) wave power, averaged over the last decade (2006-2015), the average wave power for the period 1979-2015

It is possible to note the increase in the contribution to the total wave energy from storms of moderate from the East. The contribution of the winter seasons most significant in the Western regions, in the Eastern part of the Black sea in the framework of the annual cycle increases the influence of the summer months.

The Western part of the sea, being the most stormy, the least studied by means of direct instrumental observations. Our calculations show that in this area it is not so rare situation that lead to the development of storms with significant wave heights of about 8-10 meters.

Collection of data for this research was carried out with the support of the Russian Scientific Foundation (grant no. 14-17-00547). The office data processing and analysis of the literature and archive data were supported by the Russian Scientific Foundation (grant no. 14-50-00095).

References

1 - Divinsky B., Kosyan R. Observed Wave Climate Trends in the Offshore Black Sea from 1990 to 2014, 2015. Oceanology, Vol. 55, No. 6, pp. 837–843, ISSN 0001-4370.
2 - DHI Water & Environment, 2007. MIKE 21, Spectral Wave Module.

FIXO3 NETWORK PROJECT: INTEGRATION, HARMONIZATION AND INNOVATION

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Abstract
The Fixed point Open Ocean Observatory Network (FixO3, http://www.fixo3.eu/) project is an European project coordinated by the National Oceanography Centre (NOC), which objective is to integrate 23 in situ platforms operated by European organizations and to improve access to data and services they provide for the broad ocean community. Started in September 2013, FixO3 has produced several outputs useful for scientists, industry and policy-makers beyond the project partners.

Keywords: Open sea, Time series, Mediterranean Sea, Deep waters

FixO3 is an international project that involves 29 partners from academia, industry and research institutions from 12 European countries. The programme is structured in 12 work packages (WPs) that carry out three different types of activities:

1. Coordination activities (COORD) to integrate and harmonise the current procedures and processes
2. Support actions (SUPP) to offer free access to observatory infrastructures and open data services and products
3. Joint research activities (RTD) to innovate and enhance the current capability for multidisciplinary in situ ocean observation.

Fig. 1. FixO3 observatories distribution

One of the main aims of FixO3 is to harmonize technologies and procedures. A major achievement in this direction has been a detailed review and complete synthesis of the current operational status of all observatories included in the network. Each observatory has a dedicated page with details on the study area, the platform status and maintenance, information on data provided, hardware and software, and a list of all sensors mounted on the platform.

An inventory of new sensor developments and their applicability has also been carried out within the technological harmonization and is available to project partners. The inventory includes sensors for pH, pCO2 & pH/pCO2, ADCP, CTD, tide recorders, hydrophones, current meters and underwater technologies (mass spectrometer, HD camera, acoustic modem). This inventory constitutes an update of the ESONET Yellow Pages, a public database of all available sensors along with their specifications.

The available documentation related to the observatory is collected in a library of instrument-specific preparation, deployment & calibration techniques, a catalogue for all the data managers and instrument developers and technicians who need to access quickly the reports and manuals related to an observatory in the network.

A handbook of best practices for observatory operations has been compiled to gather all common methodologies and protocols on pre-deployment, deployment and recovery and post-deployment within the network and to provide recommendations on sampling, calibration, the latest anti-fouling measures, Q/C methods for high quality products.

Open access to data & visualization of available parameters from all the observatories is made available through EarthVO (Earth Virtual Observatory), a powerful and versatile tool that enables users to easily view and compare parameters and observatories on a variety of fixed and mobile devices.

Two more essential tools have been made publicly available to facilitate data and metadata availability: a standards & services registry complying with GEO to enable effective interoperability among FixO3 data archives and a searchable metadata catalogue that collects and indexes the metadata of data hosted within the several data archives used by the FixO3 community.

A cost-benefit analysis has been carried out to justify Eulerian observations. The report summarises the rationale behind sustained open ocean observatories, provides an estimate of the costs to operate a typical fixed-point observatory and assesses the type of data and services provided and their value for society.

Service Activities (SA) give access to fully-process multidisciplinary data services and products from 18 fixed-point multidisciplinary open ocean observatories included in the FixO3 network. They demonstrate direct applications, such as maps of ecosystem indicators over European seas, or model validations with respect to in-situ data. In addition, FixO3 provides highly derived information products such as regional trends in ecosystem function and diversity.

Through a targeted action for transnational access to infrastructures (TNA), FixO3 supported external users by providing fully coordinated logistical and financial support to 13 of the 23 observatories included in the network.

An inter-comparison experiment has been carried out at a test site in a coastal environment to evaluate the performance of pCO2 sensors and compare 10 instruments.

The FixO3 project is due to end in August 2017 and more data and tools will be available for the scientific community to use and apply in other contexts and projects.

References

1 - Cristini L. et al. (submitted): Costs and benefits of multidisciplinary fixed-point ocean observatories. JMPO_2016_48

TOWARDS A EUROPEAN OCEAN OBSERVING SYSTEM (EOOS)

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Abstract

A European Ocean Observing System1 is proposed to provide accurate ocean forecasts that support operational decision making in European open and coastal seas. The proposed system can satisfy the considerable demand for ecosystem products and services, in particular the need for biogeochemical observations that are still relatively sparse in coastal and shelf seas. A broader technique for assessing the fitness for purpose and gaps in the ocean observing system is presented. Progress towards developing new partnerships in particular with the biological community to build EOOS will be elaborated.

Keywords: Hydrography, Coastal management, Time series, Mediterranean Sea, Black Sea

An inclusive, integrated, and sustained pan-European framework is needed to link the currently disparate ocean observing components by an overarching strategy, maximizing the benefits of optimization, infrastructure use, standardization, open data exchange and capacity building. EOOS will provide a flexible coordinating framework to help manage and improve the existing ocean observing effort, making it more efficient and effective at different geographical scales, and for different end-users. EOOS will align and integrate existing initiatives to ensure efficiency and value for money and to eliminate duplication of effort, identify gaps in observing capacity and foster initiatives to fill those gaps. It will promote standardization of the end-to-end system from observation collection to data management and products, drive capacity building and provide leadership for ocean observation, promote ocean observing services for multiple sectors including research, policy, management and industry and promote a common European voice and integration at the international level (Fig. 1).

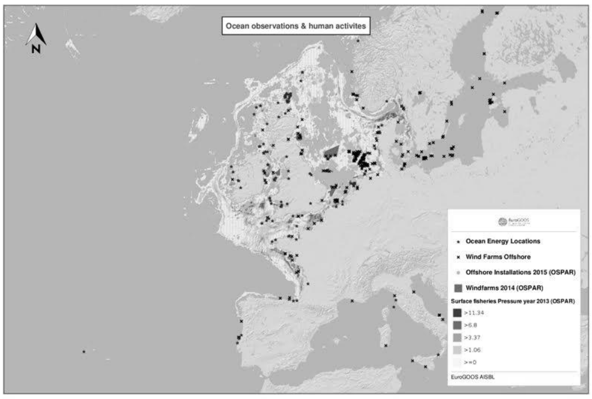

Fig. 1. Human activities in European shelf seas that provide basis for future European Ocean Observing System.

EOOS will bring an added value to existing observing efforts, catalyse new initiatives in a strategic way by targeting identified gaps and engaging a wide range of stakeholders.

EOOS will contribute to several areas of benefit. Knowledge for society will be generated through a systems approach to characterising the state of European seas and oceans, creating knowledge for stakeholders driving economic and societal benefits, providing a knowledge base for sustainable ocean governance and management of marine resources and offering a framework for connecting all the ocean observation underway to wider society, improving societal awareness of ocean observation and its value.

EOOS will optimise and standardise existing systems by improving efficiency and cost effectiveness, integrating and connecting existing capacities, providing strategic guidance and coordination of multidisciplinary observations, standardising of the end-to-end system from observation collection to data management and products. It will make data free at point of access (data policy) and provide data and knowledge products, providing real-time and delayed mode data via an appropriate cyber infrastructure. Quality assurance, network monitoring and harmonized collection of EOVs at appropriate spatial and temporal scales will form part of the EOOS focus.

European leadership and capability in ocean observing will be demonstrated by EOOS. Specifically, EOOS will promote a strong European voice for international cooperation, support knowledge generation and drive European innovation and leadership, help transfer innovation into operations, state of the art science and technology, demonstrate value and impact and in turn drive sustainable funding and drive capacity building and provide leadership for ocean observation.

References

1 - European Marine Board. 2013. Navigating the Future IV. Position Paper 20. Ostend, Belgium. ISBN: 9789082093100

MEDARGO: MEASUREMENTS OF WATER MASS PROPERTIES AND SUBSURFACE CURRENTS IN THE MEDITERRANEAN AND BLACK SEAS WITH ARGO FLOATS

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Abstract
Argo floats have been deployed in the Mediterranean and Black Seas (MBS) since 2000 to measure profiles of temperature, salinity and biogeochemical/optical properties, and estimate sub-surface currents. In 2015, the Argo network reached a maximum of about 100 active floats, covering most sub-basins. The operation of floats in the MBS is coordinated by the Argo regional Center (MedArgo), which is a component of the Euro-Argo European research infrastructure. The MedArgo data, for instance, have been used to study dense water formation processes in the Adriatic, the temporal evolution and spatial distribution of the Atlantic Water (AW) and the Levantine Intermediate Water (LIW), and the Mediterranean subsurface circulation.

Keywords: Monitoring, Mediterranean Sea, Black Sea

As part of the international Argo program, profiling floats have been deployed in the World Oceans and some marginal seas since 1999 to collect temperature-conductivity-depth (CTD) profiles. In recent years, some floats have also been equipped with additional sensors to measure biogeochemical and optical seawater properties. Argo is a major component of the Global Ocean Observing System (GOOS) and its main goals are to: 1) provide near-real time (NRT) in-situ data for operational oceanography applications, and 2) collect worldwide observations on a long term basis to support climate change studies. The Argo data are readily and freely available in both NRT and, after quality control and validation, in delayed mode (DM), through dedicated Global Data Assembly Centers.

Argo floats are autonomous freely-drifting profilers which reduce their buoyancy to dive to a prescribed parking depth (typically 1000 m in the World Ocean but for the Mediterranean typically 350 m and the Black Sea 200 m), drift for a little less than 10 (World Ocean) or 5 (MBS) days, dive down to a maximum of 2000 m and rise to surface (by increasing their volume) while measuring seawater properties. At the surface floats are localized by Argos or GPS, and transmit their data to satellites (Argos or Iridium) before they repeat their diving cycle.

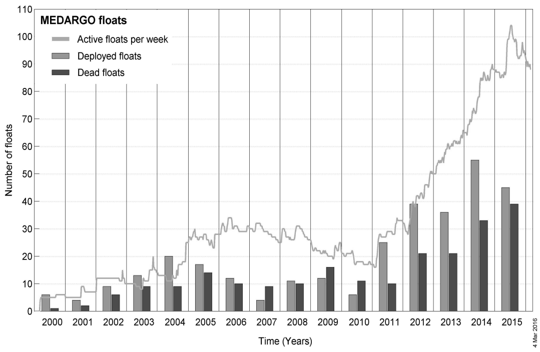

Fig. 1. Temporal evolution of the number of active Argo floats in the MBS with weekly resolution. Number of float deployments and losses per year.

In the MBS, Argo floats have been operated starting in late 2000. The number of float deployments per year in the Mediterranean reached a maximum of 20 in 2014 with the EC FP5 MFSTEP project [1], then it reduced to less than 5 in 2007 before increasing substantially and reaching about 50 in 2004. For the Black Sea, the number of deployments varied between 0 and 6 per year with a maximum in 2013-2014. The temporal evolution of the number of active floats in the MBS is shown in Fig. 1, along with the number of deployments/losses per year. The recent increase in the number of active Argo floats is mostly due to contributions of several countries participating in the Euro-Argo European Research Infrastructure Consortium. This number tends to stabilize around 80 and 10 floats for the Mediterranean and Black Sea, respectively, in late 2015. At the end of 2015, a total of 314 floats had been deployed and more than 31400 CTD profiles had been acquired. In May 2015, the Argo fleet reached a maximum of 104 active floats, providing about 750 CTD profiles per month.

Floats equipped with additional biogeochemical sensors have been deployed since 2008. In total, 18 floats were equipped with dissolved oxygen (DO) sensors, while 40 included more biogeochemical sensors to measure chlorophyll and colored dissolved organic matter and other optical properties. A limited number of floats had also a sensor to measure nitrate concentration and, in the Black Sea, hydrogen sulphide. Fig. 2 shows the geographical distribution of the Argo floats in the MBS at the end of 2015.

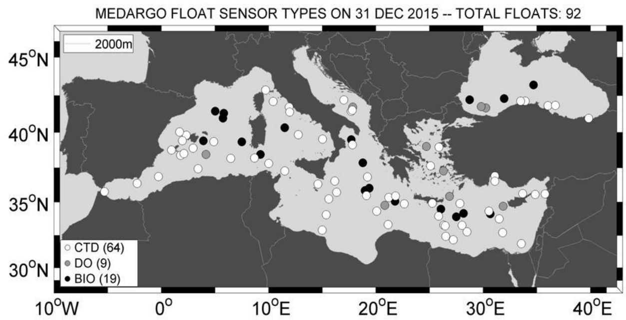

Fig. 2. Geographical distribution of the Argo floats in the MBS at the end of 2015 (CTD, DO and biogeochemical - BIO)

MedArgo NRT CTD data are routinely being assimilated into numerical forecasting models as part of the Copernicus Marine Environment Monitoring Service. In addition, the DM quality controlled MedArgo data have used to investigate several aspects of the MBS oceanography. We hereby mention only a few studies: 1) The subsurface displacements of the floats have been analyzed to estimate the currents near 350 m in the entire Mediterranean Sea [2]; 2) MedArgo data have been used to describe the formation, pathways and temporal evolution of exceptionally dense water formed in the Adriatic in winter 2012 [3]; 3) The temporal variations and spatial structure of the two most important water masses in the Mediterranean, the AW (minimum salinity) and LIW (maximum salinity), have been described using the entire MedArgo dataset.

References
1 - Poulain, P.-M., R. Barbanti, J. Font, A. Cruzado, C. Millot, I. Gertman, A. Griffa, A. Molcard, V. Rupolo, S. Le Bras, and L. Petit de la Villeon, 2007. MedArgo: a drifting profiler program in the Mediterranean Sea. Ocean Sci., 3, 379-395.
2 - Menna, M. and P. M. Poulain, 2010. Mediterranean intermediate circulation estimated from Argo data. Ocean Science, 6, 331–343.
3 - Bensi M., Cardin V., Rubino A., Notarstefano G., and Poulain P.-M., 2013. Effects of winter convection on the deep layer of the Southern Adriatic Sea in 2012. Journal of Geophysical Research: Oceans, 118, 1-12, doi:10.1002/2013JC009432

THE CIESM HYDROCHANGES NETWORK (2002-2016)

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[2] Others

Abstract
The long-term monitoring of temperature and salinity, collected as time series with adequate temporal resolution in key places of the Mediterranean Sea (straits and channels, zones of dense water formation, deep parts of the basins), constitute a priority in the context of global changes. This led CIESM to support, since 2002, the HYDROCHANGES programme, a network of autonomous conductivity, temperature, and depth (CTD) sensors, deployed on mainly short and easily manageable subsurface moorings, within the core of a certain water mass. The network already supported the study of water exchanges at Gibraltar, exchanges across Mediterranean channels, dense water formation processes, climate-change related warming trends. Here we present a review of the achievements of the Programme and will discuss our future commitments.

Keywords: Mediterranean Sea, Salinity, Temperature

HYDROCHANGES has become over the years one of the emblematic CIESM programmes, as it well reflects key characteristics of the Commission engagement: limited but guaranteed funding over a long-term horizon, donation and maintenance of material (CTDs in this case) provided to developing Mediterranean countries, north-south cooperation with continuous capacity building (training of local engineers and physicists), cross-basin scale with a gradual but sure extension of the network towards eastern and southern waters, in-depth discussion of HC at each CIESM Congress, etc.

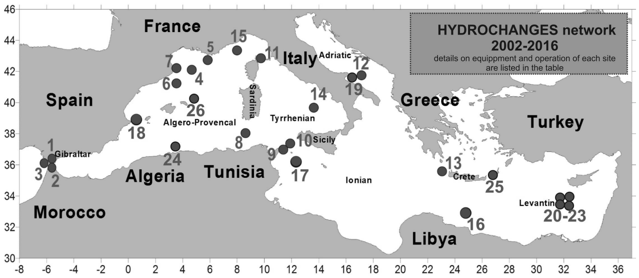

Fig. 1. The *HYDROCHANGES network*

With the focus on trend detection, the HYDROCHANGES coordinated action is thus aimed at (i) addressing problems on the long term, (ii) focusing on temporal variability, using eulerian data at few selected key locations and from the surface layer down to the greatest depths, (iii) achieving the necessary time and space resolutions (i.e. to resolve all important variations, at least in time), which requires autonomous instrumentation collecting data at high temporal resolution over decades in as many places as possible (a sort of sea-wide experiment), (iv) using instrumentations as cheap and simple as possible [1].

Many of the collected time series are providing important first-quality "material" for scientific papers that have been published throughout the years by the network partners. These studies range from the in-depth description of Mediterranean Outflowing and Inflowing waters at Gibraltar, to the assessment of interbasin exchanges through the main Mediterranean channels, to the monitoring of the dense water formation processes occurring in the north-western Mediterranean Sea as well as in the southern Adriatic Sea, and to the assessment of long-term temperature and salinity trends potentially related to climate change.

Future commitments and open issue that are being discussed within the community range from optimal location of monitored and planned sites, data policy, databases, sampling and calibration protocols, data format and harmonization, financial and customary issues, to the role and extension of the CIESM support. All discussions will be further tackled during the upcoming Congress in 2016.

Tab. 1. List of station details

ID	Managing Institute/Group (country)/Point of contact	Site (lon, lat) Acronym used in figures	Period	Bottom depth/ mooring length
1	SHOMAR&CNRS/COM (Morocco, France)/Bouchta El Moumni, Lahoucine Bengara, Gilles Rougier, Isabelle Taupier-Letage	Camarinal Sill – Gibraltar, (35° 55.2 N, 5° 44.9' W)	Jan 2003-Jun 2010	270 m/10 m
2	SHOMAR&CNRS/COM (Morocco, France)/ Bouchta El Moumni, Lahoucine Bengara, Gilles Rougier, Isabelle Taupier-Letage	Moroccan shelf – Gibraltar (35° 52.9 N, 5° 43.6' W)	January 2003- October 2008 & discont. to July 2012	80 m/10 m
3	University of Malaga, UMA (Spain)/Jesus García-Lafuente	Espartel Sill – Gibraltar (35° 51.709' N, 5° 58.217' W)	October 2004 – Aug 2011 & Aug 12 - present	355 m/18 m
4	CNRS/COM (France)/Gilles Rougier, Isabelle Taupier-Letage	Gulf of Lion (41° 59.0' N, 04° 55' E)	October 2006 - 2012	2400 m/10 m
5	ANTARES Group (France)/Dominque Levefre, Christian Tamburini	Offshore Toulon (42°45'N, 6°10'E) ANTARES	Dec 2007 – 2011 may2013-Sept2014 Sept 2013-present	2500 m/350 m 2500-1000 m
6	ICM-CSIC (Spain)/ Pere Puig, Jordi Salat	Catalan Slope (41° 28.0' N, 03° 40.4' E)	October 2003 - present	1890 m/30 m
7	ICM-CSIC (Spain) /Pere Puig	Cap de Creus Canyon (42°23.4' N, 3°19.3' E)	November 2003 - 2012	315 m/15 m
8	INSTM & CNR ISMAR (Tunisia, Italy)/Cherif Sammari, Sana Ben Ismail, Katrin Schroeder	Sardinian Channel (38° 20.047' N, 09° 19.959' E)	July 2003 - present	1900 m/10 m
9	CNR-ISMAR (Italy)/Katrin Schroeder, Mireno Borghini	Sicily Channel (37°17.120' N, 11°30.019' E)	Since 1993	530 m/273 m
10	CNR-ISMAR (Italy)/Katrin Schroeder, Mireno Borghini	Sicily Channel (37°22.836' N, 11°35.636' E)	Since 1993	450 m/365 m
11	CNR-ISMAR (Italy)/Katrin Schroeder, Mireno Borghini	Corsica Channel (43°02.021' N, 9°41.154' E)	Since 1985	440 m/370 m
12	OGS (Italy)/Vanessa Cardin	Southern Adriatic (41° 30.4' N, 18° 5' E)	November 2006 - present	1186 m/840 m
13	HCMR (Greece)/Harilaos Kontoyiannis	Antikythira Strait (35° 36.8' N, 23° 32.2' E)	Nov07-May09 & Jun10-Feb 13 & Dec 15 - present	890 m/15 m
14	Univer. Parthenope DiST, & CINFAI-CoNISMa (Italy)/Giorgio Budillon, PierPaolo Falco	Central Tyrrhenian (39° 30.008' N, 013°34.012' E)	August 2010 - present	3350m/40 m
15	Observatoire Oceanologique de Villefranche-sur-mer (France)/Laurent Coppola	Ligurian subbasin (43.4185° N, 7.903° E)	June 2009 - present	2350 m/2200 m
16	COM/LOB (France)/Gilles Rougier, Isabelle Taupier-Letage	South-western Levantine (32.2967° N, 25.6018° E)	April 2006 - March 2007	3226 m
17	INSTM&CNRS/COM (Tunisia, France)	Central Sicily Channel		
18	IEO (Spain)/Rosa Balbin	Ibiza Channel (39° 03.733 N, 00° 27.745 E)	June 2014 - present	860m/30m
19	CNR-ISMAR (Italy)/Leonardo Langone, Stefano Miserocchi	Southern Adriatic (41° 20'N, 17° 12'E)	March 2010 - present	600/114 m
20	Oceanography Center University of Cyprus /(Nicosia, Cyprus)/ George Zodiatis, Dan Hayes	Levantine Sea (33 22' 10.31"N, 32 12' 34.95" E)	October 2008 - April 2009	1612m/ 1010m
21	Oceanography Center University of Cyprus /(Nicosia, Cyprus)/ George Zodiatis, Dan Hayes	Levantine Sea (33 10' 51.624401" N, 31 49' 00.00"E)	October 2008 - February 2010	1790m/1507m
22	Oceanography Center University of Cyprus /(Nicosia, Cyprus)/ George Zodiatis, Dan Hayes	Levantine Sea (33 32' 18.045629N, 31 47' 35.9915"E)	October 2009 - December 2012	2304m/2007m
23	Oceanography Center University of Cyprus /(Nicosia, Cyprus)/ George Zodiatis, Dan Hayes	Levantine Sea (33° 39.993'N, 32° 9.478'E)	October 2007 - October 2008	2700m/2500m
24	Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral, ENSSMAL(Algeria)/ Ferial Louanchi	South Algero-Provencal basin (37° 6.027'N, 3°14.556'E)	August 2014 - present	2430m/15m
25	HCMR (Greece)/Harilaos Kontoyiannis	Kassos Strait (35° 15.3' N, 26° 40.3' E)	May 2015 - present	1050 m/15 m
26	IEO (Spain)/Rosa Balbin	NE Menorca (40° 09.919 N, 04° 36.914 E)	September 2015 - present	2500 m/2300 m

References
1 - Schroeder K., Millot C., Bengara L., Ben Ismail S., Bensi M., Borghini M., Budillon G., Cardin V., Coppola L., Curtil C., Drago A., El Moumni B., Font J., Fuda J.L., García-Lafuente J., Gasparini G.P., Kontoyiannis H., Lefevre D., Puig P., Raimbault P., Rougier G., Salat J., Sammari C., Sánchez Garrido J.C., Sanchez-Roman A., Sparnocchia S., Tamburini C., Taupier-Letage I., Theocharis A., Vargas-Yáñez M. and Vetrano A., 2013. Long-term monitoring programme of the hydrological variability in the Mediterranean Sea: a first overview of the HYDROCHANGES network. Ocean Sci. , 9: 301-324, doi:10.5194/os-9-301-2013. See http://www.ocean-sci.net/9/301/2013/os-9-301-2013.html

MED-SHIP: FIRST PRELIMINARY RESULTS OF THE RECENTLY COMPLETED FIRST REPEAT CYCLE

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Abstract

Med-SHIP is an initiative for sustained ship-based observations covering the whole Mediterranean Sea and a range of biogeochemical variables. In 2016 the first circle of repeat surveys along the Med-SHIP network will have been completed. Here we outline the project and present first results from the first repeat cycle of Med-SHIP.

Keywords: Hydrography, Algerian Sea

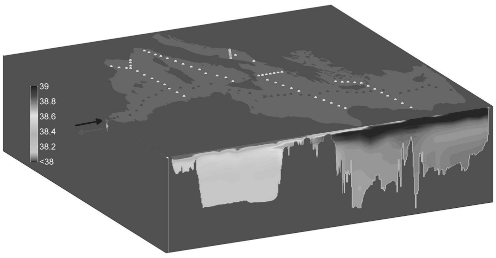

Fig. 1. Repeat Med-SHIP sections (low frequency zonal section in red, high frequency meridional sections in yellow), interior salinity along the zonal section is shown in color.

The Mediterranean Sea has so far been observed by ship-based research cruises at mainly irregular intervals, mostly by national initiatives in regional areas. Moreover, the Mediterranean has largely been neglected by global-scale international programs such as the one time survey conducted during the World Ocean Circulation Experiment (WOCE) and the subsequent repeat of key WOCE hydrographic lines that are promoted and coordinated by GO-SHIP (www.go-ship.org). The ship-based component of the observing system in the Mediterranean is not yet as well defined as other components, such as profiling floats, fixed point observatories or gliders. Coordinated, high-accuracy and high-precision, sustained observations of changes in water mass properties in the Mediterranean are urgently called for. Here we the first result of an initiative towards achieving this goal as spelled out in the Med-SHIP (Mediterranean Sea Ship-based Hydrographic Investigations Programme) initiative.

A workshop in May 2011 sponsored by the Mediterranean Science Commission (CIESM) defined Med-SHIP as a means to observe the Mediterranean in a manner similar to the international GO-SHIP programme [1, 2]. By Med-SHIP the Mediterranean marine science community is committing to conduct sustained, regularly repeated and internationally coordinated oceanographic surveys through the Mediterranean.

In response to documented changes, and to the expected acceleration of changes of the Mediterranean, marine scientists have designed a plan involving 5 hydrographic sections on which comprehensive physical and biogeochemical properties will be regularly measured to highest international standards: 2 north-south sections in each of the eastern and western Mediterranean and a zonal section from the Strait of Gibraltar to the easternmost Mediterranean. Primary objectives for the Med-SHIP repeat hydrography are twofold:
(1) to observe long-term changes in physical and biogeochemical properties
(2) to observe changes in the thermohaline circulation

The overall plan is for the north-south sections to be done every 3 years and the zonal section to be done every 6 years. During these cruises a suite of relevant physical, chemical and biological variables should be measured to the highest possible standard. The repetition frequency proposed for the Mediterranean is somewhat higher than in GO-SHIP, considering its typical shorter spatial and temporal scales. The zonal transect, repeated on a low-frequency basis and including the full suite of the GO-SHIP parameters, would allow to assess long-term variations of heat and freshwater budgets and to compute basin-wide inventories of natural and anthropogenic carbon in the Mediterranean, with a focus on its deeper layers, being less subject to small scale variability. But the Mediterranean is a "coastal ocean" with open ocean characteristics, where the circulation is not driven by basin scale forcings, but by intense, variable and diverse local forcings. With this regard the high-frequency repetition of subbasin meridional transects, including a subset of the GO-SHIP parameters, is essential to capture those degrees of variability.

If adequately funded and coordinated at an international level, Med-SHIP is now ready to become part of the Mediterranean and the global sustained observing systems, as a reference component for long term studies of processes, events and changes in the Mediterranean Sea.

Here we present preliminary results from the first repeat cycle of the Med-SHIP program: The zonal section carried out in 2011, and three short sections to be carried out in 2015 and 2016. In the framework of EUROFLEETS2, we were awarded 3 cruises (4 legs) during the 2015/16 time-frame: One section in the Eastern Mediterranean Sea on the Greek R/V Aegaeo in June, one section in the Tyrrhenian Sea and the Western Mediterranean Sea in August on the Spanish R/V Ángeles Alvariño, and two sections repeated twice across the Adriatic Sea on the Croatian R/V Bios-Dva in December 2015 and April 2016. Although only one of four legs have been completed at the time of writing this abstract, at the time of the CIESM congress, all legs should have been completed. We will also discuss possible future cruises within the Med-SHIP framework.

References

1 - CIESM, 2012. Designing Med-SHIP: a Program for repeated oceanographic surveys. N.43 in CIESM Workshop Monographs [F. Briand Ed.], 164 pages, Monaco (can be downloaded from: http:/www.ciesm.org/online/monographs/Supetar.html)

2 - Schroeder, K., Tanhua, T., Bryden, H., Alvarez, M., Chiggiato, J., Aracri, S., 2015. Mediterranean Sea Ship-based Hydrographic Investigations Programme (Med-SHIP), 28(3), 12-15, Oceanography, http://dx.doi.org/10.5670/oceanog.2015.71.

THE 2015 NORTHERN ADRIATIC EXPERIMENT: PRELIMINARY RESULTS

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Abstract
The paper overviews research activities carried out as within the 2015 Northern Adriatic Experiment, aiming to explore wintertime processes occurring in the coastal northeastern Adriatic Sea. Field campaigns employing moored ADCPs, a towed undulator, a glider, drifters, a profiling float and ship-borne CTD were conducted in the winter/spring of 2014/2015, accompanied with coupled atmosphere-ocean high-resolution model. The dense water formation have been documented to occur in the area during several consecutive Bora wind outbreaks. Advection of open ocean waters towards the coast, mesoscale variability of a thermohaline front and high-frequency phenomena have been investigated as well.

Keywords: Coastal waters, Mesoscale phenomena, Air-sea interactions, North Adriatic Sea

Shelf-type dense water formation (DWF) has been known for a long time to occur in the Northern Adriatic, resulting in a dense water outflow and driving of the Adriatic thermohaline circulation [1,2]. However, the contribution of a complex multi-channel eastern Adriatic coastal area to the DWF has only been quantified recently during an extreme winter following anomalous preconditioning [3]. The wintertime dynamics in the area have also been known for strong frontal zones stretching in the direction of the bora jet [4,5] and for a complex small strait dynamics with gradients occurring between the open Adriatic and coastal waters.

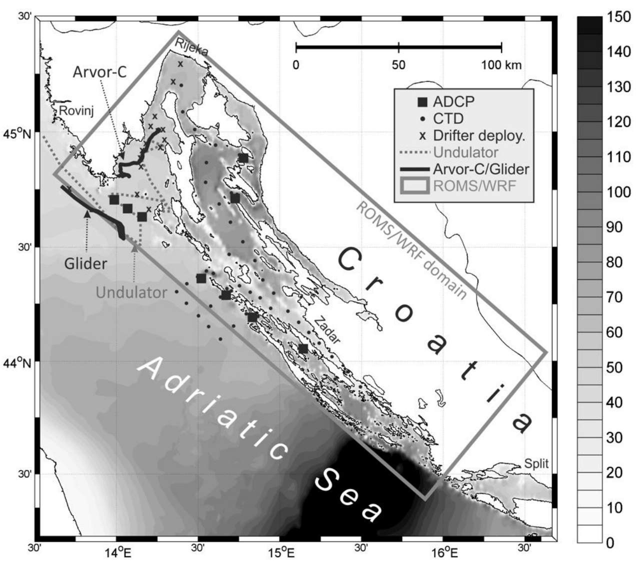

Fig. 1. The setting of the 2015 Northern Adriatic Experiment, with marked CTD lines and stations, ADCP moorings, glider and towed undulator lines, Arvor-C trajectory, surface drifter deployment positions and inner domain of the northern Adriatic modelling system.

Despite its complexity and presumed importance, the eastern Adriatic coastal area has been somehow neglected in oceanographic campaigns, and particularly its inner zone, where numerical modelling and sparse CTD campaigns have been the only tool used for quantifying the ocean dynamics. For that reason, a multi-platform oceanographic experiment was organized in the winter/spring of 2014/2015, through collaboration of several Croatian and Italian ocean research institutes and universities. The campaigns included: (1) eight-month-long monitoring of currents in connecting channels at nine ADCP stations, (2) two CTD surveys, (3) a four-day survey with a glider, (4) a survey with a towed undulator crossing the thermohaline front, (5) deployments of 13 surface drifters, and (6) CTD profiles by a Arvor-C float. High-resolution ocean model (ROMS) forced by numerical weather prediction mesoscale models (Aladin/HR, WRF) accompanied the field campaigns. The illustration of the experimental setting is presented in Fig. 1.

Initial analysis of both observational and modelling data indicates a variety of processes, of which the most interesting include: (1) the inflow of saline waters from the open Adriatic to coastal area in early winter, continued during the spring and intensified by the outflow of newly-generated coastal dense waters; (2) the DWF in the coastal area in winter that occurred during several consecutive severe bora wind outbreaks; the dense waters have been found to subsequently overflow towards the open Adriatic, and to influence the Adriatic water mass budget; (3) the formation, degradation and mesoscale variability of the Istrian thermohaline front over a daily timescale as measured by the glider; along-front change in temperature and salinity was as high as 1.5^{o}C and 1.0 for temperature and salinity, respectively; also, a cosine-like horizontal oscillations have been found in drifter trajectories perpendicular to the mainstream, indicating mesoscale pulsations and waves along the front; (4) high-frequency phenomena of inertial, tidal (barotropic and baroclinic), topographic (the Adriatic seiche of 21.5 h) and advective origin.

An in-depth investigation of these processes will complement ongoing efforts to quantify a number of hot Adriatic topics, like the DWF and the role of the coastal eastern Adriatic in a changing Adriatic environment.

References
1 - Orlic M., Gacic M. and La Violette, P. E., 1992. The currents and circulation of the Adriatic Sea. *Oceanol. Acta*, 15: 109-124.
2 - Vilibic I., Sepic J. and Proust N., 2013. Weakening of thermohaline circulation in the Adriatic Sea. *Clim. Res.*, 55: 217–225.
3 - Janekovic I., Mihanovic H., Vilibic I. and Tudor M., 2014. Extreme cooling and dense water formation estimates in open and coastal regions of the Adriatic Sea during the winter of 2012. *J. Geophys. Res*. 119: 3200-3218.
4 - Dorman C. E., Carniel S., Cavaleri L., Chiggiato J., Doyle J., Haack T., Grbec B., Janekovic I., Lee C., Malacic V., Orlic M., Paschini E., Pullen J., Russo A., Sclavo M., and Vilibic I., 2007. Winter 2003 marine atmospheric conditions and the Bora over the northern Adriatic. *J. Geophys. Res*., 112, C03S03, doi: 10.1029/2005JC003134.
5 - Poulain P.-M., Lee C., Mauri E., Notarstefano G. and Ursella, L., 2011. Observations of currents and temperature-salinity-pigment fields in the northern Adriatic Sea in winter 2003. *Boll. Geof. Teor. Appl*., 52: 149-174.

COMITÉ 3

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Biogéochimie marine

Président : François Galgani
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CIESM Congress Session : Transitional waters

Moderator : Jürgen Möbius, Inst. of Geology, Hamburg Univ., Germany

Moderator's Synthesis

The main points raised in the general discussion were as follows:

1. We need a clear definition of transitional waters. Does it include all waterbodies near the shore line or is it restricted to influx of waters of lower salinity?

2. We need a clear classification of the different types of transitional waters occurring in the Mediterranean realm.

3. What are the characteristic features of Mediterranean transitional waters? A discussant remarked that nutrient turnover and removal in Mediterranean estuaries is less efficient than in other seas.

4. There are no common protocols and strategies for monitoring and investigating transitional waters. Transitional waters need a much higher monitoring and sampling resolution than the open ocean as they are more dynamic with regard to tides, terrestrial seasonal events, and anthropogenic activities. Protocols and strategies should be individually adapted to each type of transitional waters.

We agreed that transitional waters are suffering the highest anthropogenic pressure of marine waters. The upcoming threat by climate change (mainly sea level rise, warming, and decrease of precipitation) seems enormous but poorly investigated/ considered in the Mediterranean.

TOTAL PHOSPHORUS VARIATION IN A RESTORED SOUTH MEDITERRANEAN LAGOON (NORTH LAGOON OF TUNIS)

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[2] Société de Promotion du Lac de Tunis

Abstract

The characterization of the trophic state and the water quality of the North lagoon of Tunis through phosphorus concentration was monitored in two times during early and late spring session. Different areas were identified on the basis of the water circulation in the lagoon in order to supervise its proper functioning, especialy after the restoration and to characterize the ecological state of the lagoon.

Keywords: Anoxia, Bacteria, Algerian-Tyrrhenian Trough

The North lagoon of Tunis is one of the well-known Mediterranean lagoon in the north Africa regarding to its strategic position, biological impact on conserving sea-birds and its economic role for fishers society. This lagoon has known a critical situation due to the accumulation of urban residues and other polluted materials from the town that were thrown up directly in it. this eutrophic state has pushed the authorities in that time to set up a clearance process. Water's phosphorus concentration is one of the important indicators of the trophic state that we have controlled in the North lagoon of Tunis. Even though its basic role in the acquatic life, a high phosphorus concentration can induce to an excessive multiplication of the flora compared to the ecosystem potential and that, can indicate a serious state of eutrophication. This can induce to the decrease of the oxygen levels and even asphyxia that can affect the fishes, due to the respiration of plant biomass and their degradation by the aerobic bacteria when the plants die. We can mention here that the water levels of this nutrient has fallen in the north lagoon of Tunis thanks to the clearance process and the annual average of the phosphor has decreased from 600µg/l to 20µg/l after the sanitation [1]. We have been able to cover 35 positions throughout the lagoon to study the variation of the phosphor's concentration. For convenience, we have started our prospections at the opening of the "kheireddine" channel gates which are situated in the north of the lagoon, to follow the water entering quality encircling the lagoon. In early spring prospection, This nutrient is present in a heterogeneously way in the water. The values oscillated between a maximum of 65µg/l in the Southeast stations and a minimum of 4 µg/l in the Northwest stations. The average value is about 30µg/l. At a spatial scale two areas can be individualized: (1) The Northwest and Southwest part, relatively undisturbed area with good circulation of marine flows. (2) The Northeast part and Southeast where the slower currents promotes nutrient release and where there has been a fragile ecological balance.

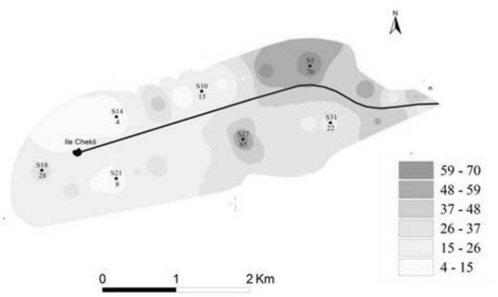

Fig. 1. Cartography of the phosphor's spatial distribution during early spring (concentration in µg/l)

In late spring prospection, there was an average total phosphorus content of about 22 µg /l. The total phosphorus content showed a decrease in May. This can be explained by the reduction of the storm water inflows in this period, also by the augmentation of the photosynthetic activity of the algae. The total phosphorus content shows fairly strong fluctuation depending on the stations. There was a maximum of about 33 µg /l at the Northwest stations and a minimum of about 9 µg /l at the Northeast stations. The Northwest, center and the southeast are the fullest in total phosphorus which may be explained by the presence of a relatively large amount of algal biomass in these areas of the Lagoon.

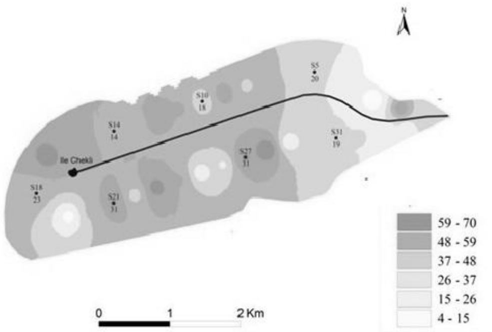

Fig. 2. Cartography of the phosphor's spatial distribution during late spring (concentration in µg/l)

The average of total phosphorus content recorded at 1993 in the north lagoon of Tunis was in the order of
19 µg /l [2]. The presence of the ell fishing nets dams at the entrance and the exit of the lagoon, which is an area of accumulation of the floating macroalgae and the decomposition may be the cause of the increase of the total phosphorus during our prospections. The control of the evolution of physico-chemical parameters in space and time has shown an improvement of the ecosystem's balance thanks to the clearness process held in 1987, and the values of total phosphorus agree well with the marked improvement of the condition in the north lagoon of Tunis, but, this ecosystem has shown a big fragility and must remain under supervision.

References

1 - Ben Maiz N., 1997. North lagoon of Tunis: a changing environment. In: management and conservation of Tunisian wetlands, p 77-84
2 - Shili A., 1995. Contribution to the study of *Ruppia* in the north lagoon of Tunis .Diploma of advanced studies in marine biology and oceanography, p 182

CHLOROPHYLL *A* VARIATION IN THE NORTH LAGOON OF TUNIS (SOUTH MEDITERRANEAN LAGOON)

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[2] Société de Promotion du Lac de Tunis

Abstract
In order to characterize the water quality and the trophic state of the north lagoon of Tunis during early and late spring 2014, a specialized study of water chlorophyll *a* variation was monitored. Different zones were identified throughout the area of lagoon, in the basis of their content of this essential pigment. That made us able to identify the areas which are the most affected by the eutrophication in the lagoon. Chlorophyll a levels oscillated between 2.06 µg/l to 9.25 µg/l in early spring session and between 0.64 µg/l to 7.47 µg/l in late spring session.

Keywords: Algae, Algerian-Tyrrhenian Trough

The photosynthetic component (chlorophyll *a*) is one of the most important representative of the trophic chain first link. The chlorophyll *a* is used as an indicator of water phytoplankton biomass and that can help us to identify the degree of eutrophication which can show us the disturbance in the lagoon. All algae contain chlorophyll *a*, therefore , the measure of its water concentration can provide a good estimation of the living vegetable materials [1]. The study and the quantification of the chlorophyll *a* are necessary to identify the ecological state of the aquatic ecosystems. The north lagoon of Tunis is really known for the fragile situation that has been through before its restoration. Nevertheless, this lagoon is known for its important position, and its necessery role on conserving sea-birds, for thatreason, the study of the chlorophyll *a* variation can help us to keep this important wetland in Tunisia under supervision. We have been able to cover 35 positions throughout the lagoon to study the variation of the chlorophyll *a* concentration. We have started our prospections at the opening of the "kheireddine" channel gates which are situated in the north of the lagoon, to follow the water entering quality encircling the lagoon. In early spring , the chlorophyll *a* average value recorded is of about 1.19 µg/l. the gap between the average and extreme values vary between 8.06 µg/l and 0.87µg/l. The Northeast sector, which is the area in direct contact with marine flows, is where chlorophyll *a* production is the highest with a value of about 9.25 µg/l. We can mention here that the presence of the dam fishing nets in the Northeast sector can contribute in increasing the chlorophyll *a* rate in this zone.

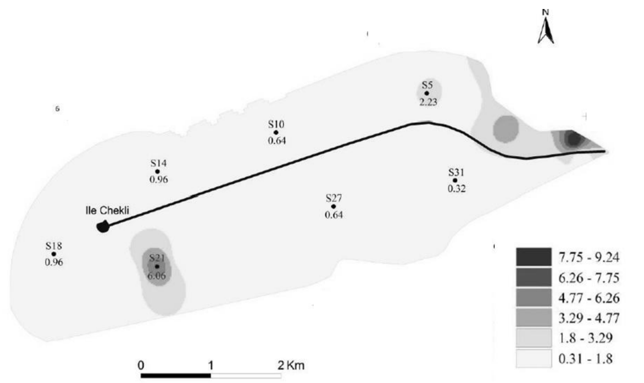

Fig. 1. Cartography of the chlorophyll *a*'s distribution during early spring 2014 in the North lagoon of Tunis (concentration in µg/l)

The average of water chlorophyll *a* content in late spring , is of about 1.79 µg/l. It's lightly higher than in early spring, this can be explained by the change in weather conditions (temperature increase) that causes seaweeds proliferation and so, increasing the rate of chlorophyll *a*. The chlorophyll *a* variation has shown some fluctuations depending on the areas. We have recorded a maximum of about 7.47 µg/l in the Northwest sector of the lagoon which is the area where a high seaweeds biomass could be present. Some dam fishing nets set near to "Chikly" island can contribute to macrophytes proliferation and the increase of chlorophyll *a* levels. A minimum of about 0.64 µg/l was recorded at the North center and Southeast sectors of the lagoon.

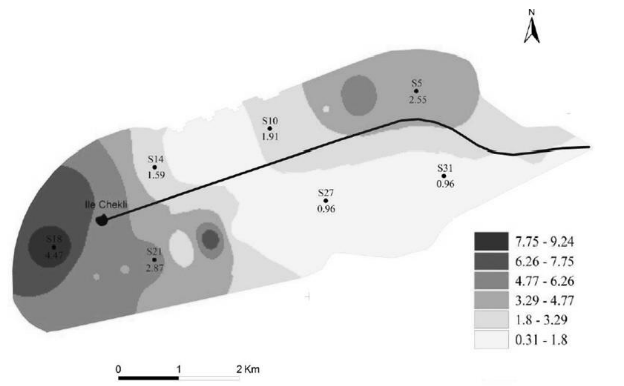

Fig. 2. Cartography of the chlorophyll *a*'s distribution during late spring 2014 in the North lagoon of Tunis (concentration in µg/l)

We can mention, that before the clearness process held in 1987, The ecosystem was marked by a high chlorophyll *a* concentration (an annual average of about 60 µg/l) [2]. Currently, The production of chlorophyll *a* in the entire lagoon has fallen significantly since the restoration work, showing clearly a big improvement in water quality. Also, we can add that the variability in chlorophyll *a* concentration between the lagoon sectors had decreased. Before 1987, the variability in the north lagoon of Tunis used to be very remarkable with a big difference in the water quality between east sector and west sector.

References

1 - Daly yahiya Kefi O., 1998. Le phytoplancton de la baie de Tunis: Analyse systématique, biogéographique, quantitative, et synécologique des diatomées et dinoflagellées. Thèse de Doctorat en Sciences Biologiques. Faculté des sciences de Tunis, 332p.
2 - Ben Maiz N., 2008. Le milieu naturel du Lac Nord de Tunis. In: Le Lac Nord de Tunis et le fort « Chikly » - De l'eau jaillit la vie et se développent les civilisations. p: 96-117

PRESENT AND PAST NITROGEN TURNOVER IN THE DANUBE ESTUARINE TRANSITION ZONE

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[2] Helmholtz Center Geesthacht
[3] GeoEcoMar

Abstract

After decades of heavy eutrophication the NW Black Sea Shelf slowly recovers towards a natural state. During two cruises we investigated the turnover of nitrogen in the Danube estuarine transition zone. Isotopic patterns of dissolved and particulate N-species highlight the River Danube as dominant source in spring but they give also evidence for diazotrophic N_2 fixation during summer. Sedimentary $d^{15}N$ records track the temporal changes of dominant N sources and the current recovery from eutrophication.

Keywords: Nutrients, River input, Black Sea, Danube Delta

The Danube Delta–Black Sea shelf region has overall received dynamic nutrient loads from the River Danube that rose to critical levels in the 1970s and 1980s but decreased sharply in the 1990s due to the collapse of eastern European economies. However, nutrient release from organic rich sediments retarded the recovery of the ecosystem for another decade. During two cruises (spring 2012 and summer 2013) in the Danube River Delta–Black Sea transition zone, we analyzed dissolved nutrients, dual isotope signatures of nitrate, and $d^{15}N$ of suspended particulate matter across the salinity gradient. Water column data were complemented by a series of short sediment cores that were analyzed for organic carbon and nitrogen contents as well as for $d^{15}N$. During high run-off (May 2012) data highlight the Danube as a point source of nutrients to a nutrient starving sea. Data further indicate intense drawdown of river-borne nutrients in the river plume - and spatial isotopic patterns of nitrate and suspended N clearly attribute this drawdown to assimilation over entire salinity gradient [1]. However, an unusual 1.9 : 1 but very strict enrichment of $d^{18}O_{NO3}$ to $d^{15}N_{NO3}$ questions the usually uniform 1 : 1 enrichment that is attributed to assimilation by phytoplankton [2]. Similar ratios are known only for heterotrophic bacteria in laboratory experiments [3] but have never been observed in field studies. Moreover, the relatively low isotopic enrichment factor e^{15} of -2.7 ‰ in residual nitrate is in good agreement with the fractionation expected for heterotrophs [3]. Consequently, this aberrant fractionation pattern could evidence the occurrence (and dominance) of heterotrophic bacteria in the Danube estuarine transition zone. These bacteria generally may play a more important role in coastal N-turnover than previously thought. However, the dominance of heterotrophic nitrate consumers is probably a seasonal feature that only plays a major role if large quantities of nitrate as well as suspended and dissolved organic matter are available. During low run-off August 2013 nitrate concentrations were too low for isotope measurements but $d^{15}N$ values of suspended matter strongly suggest a seasonal shift from a single (riverine) source to a two endmember mixing of isotopically even more enriched particulate nitrogen (derived from residual riverine nitrate) and isotopically depleted particulate marine nitrogen. Possible sources for isotopically light marine nitrogen are diazotrophic N_2 fixation (postulated by several researchers but not observed yet in the Black Sea), incomplete NO_3^- uptake due to phosphorous limitation or the atmospheric deposition of anthropogenic NO_x as observed in the Eastern Mediterranean Sea [3, 4]. However, spatial and temporal patterns in sedimentary $d^{15}N$ witness the shift from past severe eutrophic conditions to the currently recovered ecosystem. A significant role of nitrogen fixation as a consequence of phosphorous release from organic rich sediments is evidenced by a depth decrease of sedimentary $d^{15}N$ values in the outer plume. Isochronous time-slices at depth imply a two endmember mixing of isotopically enriched riverine nitrate with isotopically depleted nitrate from the shelf that turns to the presently dominant one endmember. Overall, all N species analyzed exceptionally clearly illustrate the isotopic coherences that characterize the present and the past nitrogen turnover.

References

1 - Möbius, J. and Dähnke, K. 2015. Nitrate drawdown and its unexpected isotope effect in the Danube estuarine transition zone. *Limnology and Oceanography* 60 (3),1008-1019.

2 - Granger, J., D. M. Sigman, J. A. Needoba, and P. J. Harrison. 2004. Coupled nitrogen and oxygen isotope fractionation of nitrate during assimilation by cultures of marine phytoplankton. *Limnology and Oceanography* 49: 1763-1773.

3 - Granger, J., D. M. Sigman, M. M. Rohde, M. T. Maldonado, and P. D. Tortell. 2010. N and O isotope effects during nitrate assimilation by unicellular prokaryotic and eukaryotic plankton cultures. *Geochimica et Cosmochimica Acta* 74: 1030-1040.

4 - Mara, P., Mihalopoulos, N., Gogou, A., Daehnke, K., Schlarbaum, T., Emeis, K.C., Krom, M., 2009. Isotopic composition of nitrate in wet and dry atmospheric deposition on Crete in the eastern Mediterranean Sea. *Global Biogeochem. Cycles* 23.

5 - Emeis, K.C., Mara, P., Schlarbaum, T., Möbius, J., Dähnke, K., Struck, U., Mihalopoulos, N., Krom, M., 2010. External N inputs and internal N cycling traced by isotope ratios of nitrate, dissolved reduced nitrogen, and particulate nitrogen in the eastern Mediterranean Sea. *J. Geophys. Res. Biogeosci.* 115.

POPS LEVELS IN BLUE CRAB AND EDIBLE FISH FROM EASTERN MEDITERRANEAN COASTS

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[2] Ege University, Centre For Drug Research and Development and Pharmacokinetic Applications

Abstract
The levels of organochlorinated pesticides (OCPs) and polychlorinated biphenyls (PCBs) were determined in fish and crab samples collected from the Eastern Mediterranean coasts. The concentrations of OCPs and PCBs ranged from 1.1-8.6 and 9-47.5 ng g^{-1} wet weight, respectively. Concentrations of ΣDDT and ΣPCB in sea food samples were lower than the tolerance level established by the FDA (U.S. Food and Drug Administration).

Keywords: Pesticides, Mediterranean Sea, Fishes

Introduction

OCPs and PCBs have been recognized as Priority Organic Pollutants (POPs) and they have adverse effects on humans and on ecosystems, according to the Stockholm Convention of 2009 [1]. The aquatic ecosystems have been contaminated by POPs. Biota, that provides relevant information on impacts of pollutants, defines ecological status of aquatic systems [2]. In this study levels of OCPs, PCBs were measured in different biota samples; blue crab, sea bream and gray mullet in Eastern coasts of Mediterranean in Turkey. POPs levels were compared with the recommended limits of POPs concentrations in sea food, suggested by different authorities.

Material and Methods

A total of 29 blue crabs, 30 thirty sea bream and 30 gray mullets were collected from Dalyan Lagoon, Fethiye, Beymelek Lagoon, Tasucu, Akyatan Lagoon and Goksu Delta in 2013 (Fig. 1). Biota samples were analysed according to (DFG Method S 19, 1999). Quantitative analysis of OCPs and PCBs were performed with GC–MS. Biota (IAEA-435) sample was used as a control for the analytical methods.

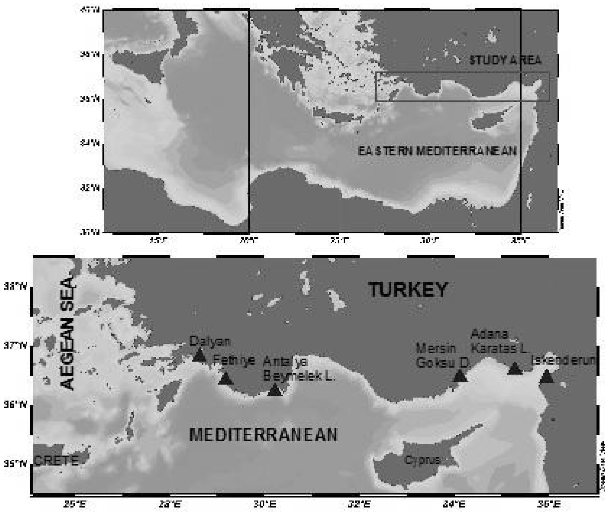

Fig. 1. Study area

Result and Discussion

ΣOCPs and PCBs were found between 1.1 and 2.7 and 17-30 in blue crab; 2-8.6 and 48-487 ng g^{-1} wet weight in fish samples respectively, indicated that the concentrations of OCPs were generally low in blue crab compared to fish samples (Fig. 2). Concentrations of ΣDDT and ΣPCB in sea food samples from the Mediterranean coast of Turkey were lower than the action level established by the FDA [3].

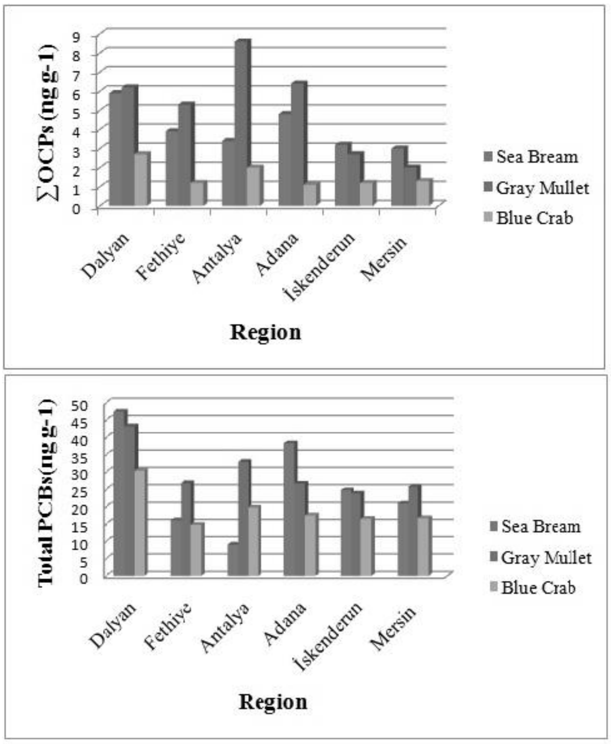

Fig. 2. Total concentrations of OCPs (ng g^{-1})

Conclusion

The contamination levels of OCPs and PCBs in fish and crabs at six sites from the Mediterranean coast of Turkey showed that POPs were at the lower range compared to the other areas in the world and the study area is less affected by anthropogenic pollution.Distribution of DDTs indicated that historical residues remained and significant degradation has occurred. Blue crab samples compared to fish samples it was concluded that blue crab has lower contamination level than sea bream and gray mullet in terms of pesticides and PCBs.

References
1 - UNEP (United Nations Environment Programme) 2009. Stockholm Convention on POPs (http://www.pops.int).
2 - Fisk, A.T., Hobson, K.A., Norstrom, R.J., 2001. Influence of chemical and biological factors on trophic transfer of persistent organic pollutants in the Northwater Polynya marine food web. Environ Sci Technol 35:732–738.
3 - FAO/WHO, 2003. Food Standarts. Pesticide Residues in Food and Feed.

PHTHALATE ESTERS IN THE GOLDEN HORN ESTUARY SEDIMENTS, TURKEY

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Abstract

Surface sediments from the Golden Horn Estuary, Turkey, were analyzed for 4 phthalate esters (PEs); namely diethyl phthalate (DEP), di-n-butyl phthalate (DnBP), di-(2-ethylhexyl) phthalate (DEHP) and di-n-octylphthalate (DnOP). The DEHP was found to be dominant (97% of total) with concentrations ranged from 2.23 to 166.9 µg/g dry weight (dw), increasing towards the inner estuary and mostly related with domestic and industrial sewage waters transported by the rivers. Non-point sources such as surface runoff and marine traffic are also responsible sources. DEHP is correlated with TOC% in sediment (r^2=0.274, n=15), while bottom water salinity has a significant impact on the solubility and sorption behavior of DEHP (r^2=-0.354, n=15).

Keywords: Pollution, Marmara Sea, Plastics

Introduction

The global production of phthalate esters (PEs) is more than 6.0 million tones [1] and used mostly as non-reactive additives in plastics, rubber, cellulose and styrene production. As PEs can enter the environment directly or indirectly with production or after disposal, they are ubiquitous in air, water, soil and sediment. Some PEs have low- water solubility and high octanol partition coefficient, and concentrated in suspended matter and sediment. The main objectives of the present study are to investigate the levels of 4 PEs in the sediments from the Golden Horn Estuary, Turkey, and to discuss the possible sources and the ecological effects of PEs.

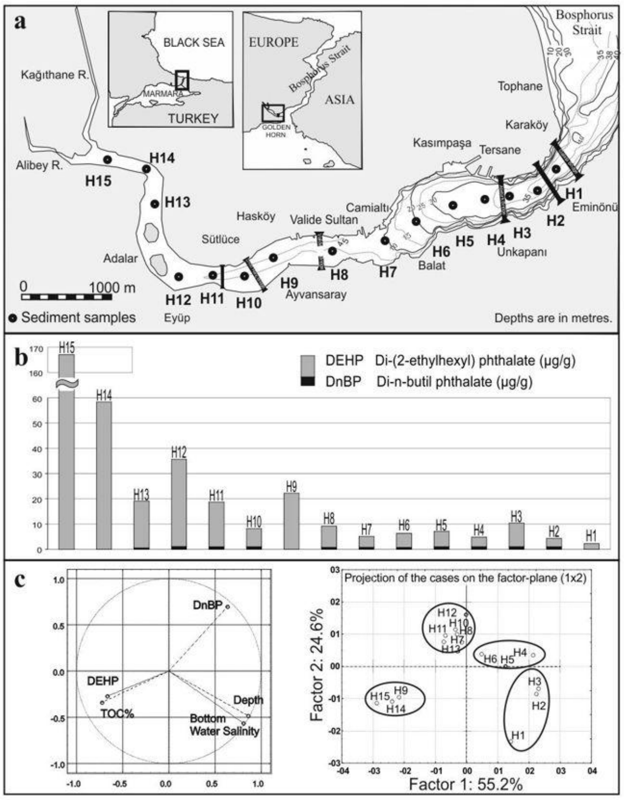

Fig. 1. a) Study area and sampling stations b) the distribution of DEHP and DnBP in sediment along the Golden Horn estuary, c) PCA analysis among the PEs, TOC% in sediment, bottom water salinity and water depth.

Material and Method

The Golden Horn is a highly dynamic estuary at the southern end of the Strait of Istanbul, entangled with coastal and fresh water discharges (Figure 1a). The inner part of the estuary is shallower than 10 m where the Alibey and Kagithane rivers carry their load, whilst the maximum is 40 m at the mouth. In December 2012, bottom surface sediment samples were recovered with a snapper along the thalweg line of the Golden Horn estuary (Figure 1a). The samples, all mud, were stored in a freezer at -20°C until analysis.Extraction of samples with Soxhlet apparatus and PEs analyses by GC/MS (Finnigan, Thermo, Trace DSQ) were given in [2]. The standard mixture was obtained from Dr. Ehrenstorfer GmbH Inc. The recoveries of spiked blanks (n=3) varied from 78.2 to 108.2%. The organic carbon content of sediment samples were measured by Shimadzu TOC-V cph + SSM-5000 A (solid sample module) using the method TS 12089 EN 13137.

Results and Discussion

The $\sum_4$PEs concentrations ranged from 2.28 to 166.9 µg/g dw; median 25.31 µg/g-dw. DEHP is the dominant PE congener with a maximum concentration of 166.9 µg/g-dw and accounted for 97% of the $\sum_4$PEs concentrations (Figure 1b). It is followed by DnBP with a maximum of 10.40 µg/g-dw and accounted for 3% of the total. DEHP and DnBP are the most commonly used plasticizers worldwide. Their main sources in the study area are the domestic and industrial sewage waters mostly transported by the Alibey and Kagithane rivers. In addition non-point sources such as surface runoff and marine traffic are also responsible for the major pollutants discharging into the estuary. The correlation coefficients were 0.27 ($p<0.01$) for total PEs concentrations and for DEHP. On the other hand, a negative correlation exists between the levels of $\sum_4$PEs (or DEHP) with bottom water salinity (r^2=-0.355, n=15). Principal component analysis (PCA) identified the relationship among contaminants in sediments and their probable sources (Figure 1c). Two factors explain 79.8% of the total variance in the 15 sediment samples analyzed. The first principal component explains 55.2% of the total variance and separates high level of DEHP and TOC. The second principal component explains 24.6% of the total variance and exhibits positive loadings for bottom water salinity and therefore the water depth decreasing along the estuary. Based on ecotoxicology and environmental chemistry the environmental risk limits (ERLs) in sediment was reported 1.0 and 0.7 µg/g for DEHP and DnBP [3]. So the median value of the DEHP concentrations measured in the sediments of the Golden Horn estuary (24.67 µg/g) exceeds the ERL risk limit about 25 times, while that of DnBP concentrations (0.69 µg/g) is very comparable to the environmental risk limits. These first results also emphasize the need for adequate monitoring along the feeding rivers.

Acknowledgment: This study was financially supported by the Research Funds of Istanbul University (YOP26219 and UDP2016).

References

1 - Ritsema R.,Cofino W. P.,Frintrop P. C. M. and Brinkman U. A. T., 1989. Trace level analysis of phthalate esters. *Chemosphere*.18: 2161–2175.

2 - Zeng F., Cui K., Xie Z., Liu M, Li Y, Lin Y, Zeng Z and Li F., 2008. Occurrence of phthalate esters in water and sediment of urban lakes in a subtropical city, Guangzhou, South China. *Environ. Int.,* 34:372-380.

3 - Wezel A.P., Vlaardingen P., Posthumus R., Grommentijn G.H. and Sijm D.T.H., 2000. Environmental risk limits for two phthalates with special emphasis on endocrine disruptive properties. *Ecotoxicol. Environ.Saf.*46:305-321.

THE SEASONAL ANALYSIS OF HEAVY METAL CONTENT IN SOFT TISSUES AND SHELL OF THE SPECIES MYTILASTER MARIONI (LOCARD, 1889), GATHERED FROM THE LAKE BAFA

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Abstract

The purpose of this study is to reveal the existence of elements Cu, Ni, Cr, Cd, and Pb in the shells and soft tissues of the species *Mytilaster marioni* (Locard, 1889) gathered seasonally from Lake Bafa. In this regard, after digestion of soft tissues and shells, heavy metal concentrations were determined with ICP-MS. The elements of Cu and Pb were found more in shells and Ni, Cr and Cd were found more in soft tissues. Pb and Cd amounts in soft tissues did not exceed the maximum residue limits specified for bivalve mollusks in EC 1881/2006.

Keywords: Metals, Aegean Sea, Bivalves, Brackish water, Bio-accumulation

Introduction

Lake Bafa is located on Dilek Peninsula National Park at 37 ° 29' N and 27 ° 28' E at 2 m above sea level. The lake has an area of 68.6 km^2, a catchment area of 315 km^2 and a maximum depth of 21m. It is one of the largest coastal lakes in Turkey. Bafa Lake is situated 30 km southeast from the delta of Büyük Menderes River. In the past six or so millennia, the river sediments have gradually in filled nearly the whole marine embayment of the so-called Latmian Gulf, thereby separating its southeastern part from the Aegean Sea (Mullenhoff et al. 2004). *Mytilaster* Monterosato (1884: 89) is a genus of the family *Mytilidae* composed of small species inhabiting mainly the Mediterranean and Black Sea basins. Species of *Mytilaster* are typical epibenthic forms, living attached with their byssus threads to a wide array of hard substrata. During field studies carried out in 1997 to determine the ecological characteristics of Bafa Lake, located in the south-western part of Turkey, *M.marioni* are observed in some regions of the lake and it was recorded for the first time from the coastal lakes of the Aegean Sea (Öztürk et al., 2002). As there is not any study on heavy metal accumulation within relevant species that has been encountered during literature review, the current study is significant for filling the gap within the literature. In the hatcheries around the Lake Bafa, larvae of saltwater fish (Gilthead seabream, *Sparus aurata* and European sea bass, *Dichentrachus labrax*) are produced. These larvae entered in Lake Bafa in various ways have formed a population in the lake, though they are not a local species. *M. marioni* is an important food source for these species. Therefore, it is worth researching transmission of heavy metals in this mussel species through food pyramid to upper levels.

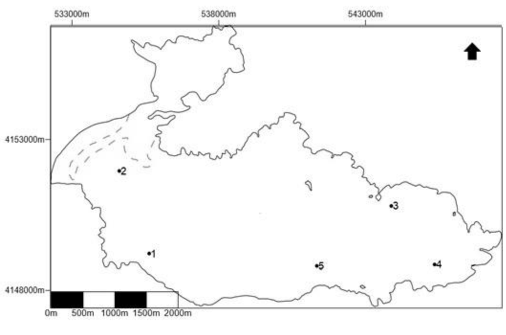

Fig. 1. Sampling site.

Material and Method

A total of 394 samples of the wild mussel *M. marioni* (Locard, 1889**)** with shell length of between 8-20 mm were collected from five different locations in the Bafa Lake in between December 2013-October 2014 (Fig. 1). The shells and soft tissues of the mussel samples were separated by dissection. After shells were pounded in a ceramic press and transformed into powder and after soft tissues were homogenized, they were digested according to the method of Licata et al., (2004). Inductively coupled plasma-mass spectroscopy (ICP-MS) was used to determine the concentrations of the elements. The results were given as mg kg^{-1}. Statistics were performed using SPSS software version 21.0. The data obtained by the values of studied elements were subjected to analysis of covariance (ANCOVA) followed by nonparametric correlation analyses based on the Spearman test.

Results and Discussions

The concentrations of five different heavy metals in mussel shells and soft tissues of 394 samples gathered in four seasons from Lake Bafa were determined (Table 1).

Tab. 1. Descriptive statistics of all results.

	Tissue	Mean	Minimum	Maximum	S.D.
Shell Length (mm)		1,340	0,700	2,400	0,223
Cr	S*	0,389	0,031	1,040	0,360
	ST**	1,985	0,259	6,746	1,657
Ni	S	1,115	UDL	6,626	1,682
	ST	4,038	0,334	17,506	4,365
Cu	S	5,524	1,646	15,376	4,363
	ST	5,168	1,922	12,903	2,693
Cd	S	0,072	0,008	0,231	0,070
	ST	0,278	0,119	0,925	0,177
Pb	S	2,433	0,558	7,105	2,145
	ST	1,418	0,286	3,415	0,830

***S:** Shell
****ST:** SoftTissue

According to the results, the concentrations of Cu (p= 0.0011), Pb (p= 0.0275) and Cd (p= 0.0001) in the shells showed significant difference seasonally (p<0.01). The length of shells with Cu concentration in shells and the length of shells with Pb concentrations in soft tissues showed strong negative correlation (r^2=-0.571 and r^2=-0.598 respectively) . The mean concentrations obtained from Pb and Cd did not exceed maximum residue limits [Pb (1.50 mg kg^{-1}) and Cd (1.0 mg kg^{-1})] which could be found in bivalve mollusks according to EC 1881/2006. Nonetheless, as heavy metals are transmitted to next level in food pyramid incrementally and heavy metal input into ecosystem shows constant change, it is important that these kinds of studies should be done in a continuous way.

Acknowledgement

This study was supported by The Department of Scientific Research Projects in Mugla Sitki Kocman University (Project No: 14/045).

References

1 - European Union. Commission Regulation (EU) No 835/2011 of 19 August 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for heavymetals in shellfish. Off J Eur Union. L214:5.
2 - Licata, P., Trombetta, D., Cristani, M., Martino, D. and Naccari, F. (2004) Organochlorine compounds and heavy metals in the soft tissues of mussel Mytilus galloprovincialis collected from Lake Faro (Sicily, Italy). Environment International 30:805–810.
3 - Müllenhoff M, Handl M, Knipping M, Brückner H (2004) The evolution of Lake Bafa (Western Turkey)–Sedimentological, microfaunal and palynological results. Coastline Rep 1:55–66.
4 - Öztürk B, Poutiers JM, Sari HM, Özbek M (2002). On the occurrence of Mytilaster marioni (Locard, 1889) (Mollusca; Bivalvia; Mytilidae) in Bafa Lake (Turkey), with a redescription of the species. Hydrobiologia 485: 121–131.

CIESM Congress Session : Sources of pollution / fluxes
Moderator : Muhammet Turkoglu, Hydrobiology Dept., Çanakkale Univ., Turkey

Moderator's Synthesis

This session was followed by about 45 participants. The presentations concerned mostly heavy metal contamination in different Mediterranean environments, relevant river and estuaries.

The session was very active, with a dense and open discussion on the different aspects of the issue, emphasizing the importance of the subject, especially in CIESM related seas, rivers and estuaries. The presentations and discussion enabled to identify the scientific questions to be addressed in the future and the specific issues in the Mediterranean ecosystems such as Adriatic Sea, Turkish Straits System and Black Sea.

Typically, we discussed how to reduce/ mitigate the mechanisms of pollution sources and fluxes discharged to Mediterranean ecosystems how to monitor marine pollution processes and better understand why certain areas of the Mediterranean ecosystem such as the Adriatic Sea, the Sea of Marmara and the Black sea are among the most affected basins in the world. Overall, the session provided a basis for the networking of scientists from both the Mediterranean Sea and the Black Sea, the support of further research, the harmonisation of common projects and the implementation of monitoring.

EVALUATION DE LA CONTAMINATION MÉTALLIQUE ET DES RISQUES ÉCOLOGIQUES LIÉS AUX SÉDIMENTS CÔTIERS À GABÈS

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Abstract

La présente étude a permis de déterminer 'l'état de santé' des sédiments littoraux de surface situés à proximité du complexe chimique de Gabès. Les fortes concentrations des différents polluants métalliques étudiés ainsi que les indices environnementaux et écologiques calculés montrent que la zone interportuaire de Chatt Essalam, représente la zone la plus touchée par cette pollution marine d'origine industrielle. En effet, les rejets du phosphogypse du Groupe Chimique Tunisien représentent la principale source de ces contaminants. Plus généralement, la distribution spatiale des polluants métalliques est due à l'effet combiné des installations portuaires associées aux courants côtiers. L'état de la pollution des sédiments de surface de la partie centrale du Golfe de Gabès est très préoccupant et nécessite une intervention rapide.

Keywords: Metals, Sediments, Trace elements, Pollution, Gulf of Gabes

Toute étude de la pollution marine nécessite l'évaluation de 'l'état de santé' des sédiments côtiers de surface. Dans la présente étude, les concentrations de 6 métaux en trace (Hg, Cd, Cu, Pb, Zn et Cr) ont été analysées dans les sédiments côtiers de surface de 15 stations d'échantillonnage situées à proximité du complexe chimique de Gabès (Fig.1). Le but est de déterminer les niveaux, les sources ainsi que les risques écologiques liés à cette contamination métallique.

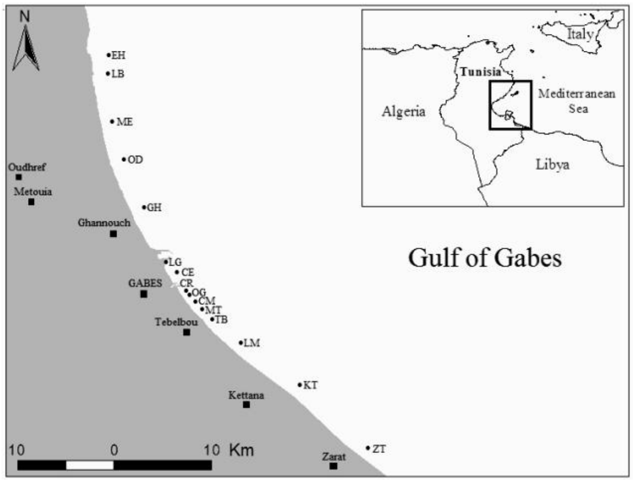

Fig. 1. Localisation des sites d'échantillonnage des sédiments de surface au niveau du Golfe de Gabès.

L'ordre des concentrations moyennes de contaminants obtenu est comme suit : Zn > Cd > Cr > Pb > Cu > Hg (Tab.1). L'analyse de corrélation des concentrations de ces polluants a révélé l'existence de corrélations positives hautement significatives entre le Cd et le Zn, indiquant que ces deux métaux ont une source commune: le phosphogypse du Groupe Chimique Tunisien [1].

Tab. 1. Concentrations du Hg, Cd, Cu, Pb, Zn et Cr dans les sédiments de surface (mg kg^{-1} PS), collectés des diverses stations d'étude au niveau du Golfe de Gabès.

Elements	Stations																
	ZT	KT	LM	TB	MT	CM	OG	CR	CE	LG	GH	OD	ME	LB	EH	Min	Max	Mean
Hg	0.008 ± 2	0.007 ± 2	0.006 ± 2	0.007 ± 2	0.007 ± 2	0.006 ± 2	0.007 ± 2	0.008 ± 2	0.045 ± 2	0.066 ± 2	0.093 ± 2	0.028 ± 2	0.035 ± 2	0.01 ± 2	0.043 ± 2	0.006	0.093	0.03
Cd	0.49 ± 0.15	0.54 ± 0.16	0.63 ± 0.18	0.89 ± 0.22	1.7 ± 0.3	1.8 ± 0.4	1.6 ± 0.3	5.4 ± 0.7	950 ± 24	131 ± 6	0.5 ± 0.15	0.18 ± 0.08	0.11 ± 0.05	0.15 ± 0.07	0.15 ± 0.07	0.11	950	73.01
Cu	3 ± 0.9	2.6 ± 0.8	2.2 ± 0.7	2.4 ± 0.8	2.6 ± 0.8	2.3 ± 0.8	2.5 ± 0.8	2.4 ± 0.8	4.1 ± 1.2	5.8 ± 1.5	2.9 ± 0.9	1.6 ± 0.6	0.59 ± 0.27	1.6 ± 0.6	1.8 ± 0.6	0.59	5.8	2.56
Pb	13.9 ± 3.9	5.3 ± 2.3	5.3 ± 2.3	5.5 ± 2.3	5.2 ± 2.3	5.1 ± 2.2	5.0 ± 2.2	5.4 ± 2.3	5.8 ± 2.4	4.9 ± 2.2	10.8 ± 3.4	7.1 ± 2.7	5 ± 2.2	3.9 ± 1.9	3.8 ± 1.9	3.8	13.9	6.13
Cr	14.4 ± 3.4	12.2 ± 3	13.9 ± 3.3	13.3 ± 3.2	13.9 ± 3.3	12.3 ± 3	10.4 ± 2.7	11.7 ± 2.9	24.8 ± 5.2	69.3 ± 11.5	11.7 ± 2.9	10.8 ± 2.7	9 ± 2.4	12.1 ± 3	11.6 ± 2.9	9	69.3	16.76
Zn	13.8 ± 4	10.4 ± 3.3	11.8 ± 3.6	14.7 ± 4.1	18.5 ± 4.7	19.1 ± 4.8	15.6 ± 4.3	42.6 ± 8	7165 ± 192	830 ± 50	10.8 ± 3.4	5.9 ± 2.3	5.4 ± 2.2	6.7 ± 2.5	5.2 ± 2.2	5.2	7165	545.03

Stations abbreviations: ZT Zarat; KT Kettana; LM Limaoua; TB Tebelbou; MT M'torrech; CM Casmate; OG Oued Gabes; CR Corniche; CE Chatt Essalam; LG Leguair; GH Ghannouche; OD Ouedhref; LB Lebsisi; EH El Hicha; ME Metouia. Elements abbreviations: Hg Mercury; Cd Cadmium; Cu Copper; Pb Lead; Cr Chromium; Zn Zinc. Other abbreviations: Min: minimum; Max: maximum.

Les valeurs les plus élevées de tous les indices environnementaux (Facteur de Contamination (C_f), Indice de la Charge de Pollution (PLI) et l'Indice de Geoaccumulation (I_{geo})) et écologiques (les Lignes Directrices Basses (ERL) et Médianes (ERM) de l'Intervalle d'Effet, l'Indice du Risque Ecologique (PERI), le Quotient Moyen de l'ERM (M-ERM-Q) et l'Unité Toxique (TU)) calculés pour tous les éléments de traces métalliques étudiés, ont été enregistrés dans la zone inter-portuaire de Chatt Essalam, qui représente le siège de rejet en mer de tous les déchets industriels du complexe chimique de Gabès-Ghannouche, en particulier le phosphogypse. Cependant, la frange littorale située au nord de ce complexe industriel apparaît être protégée contre cette contamination grâce aux jetées du port commercial. Il apparaît également que la contamination industrielle se propage plus facilement vers le sud. Ceci est dû au fait que les jetées du port de pêche de Gabès ne semblent pas être capables d'arrêter le transfert de ces polluants ainsi qu'aux courants côtiers Nord-Sud [1].

Compte tenu de tous les derniers critères d'évaluation, les déchets de l'industrie des engrais phosphatés sont responsables d'une contamination métallique très significative des sédiments de surface de la partie centrale du Golfe de Gabès. En conclusion, l'état de la pollution métallique de ces sédiments est évidente, très préoccupante et nécessite une intervention rapide afin de sauver ce qui reste de vie aquatique dans le Golfe de Gabès.

References

1 - El Zrelli R., Courjault-Radé P., Rabaoui L., Castet S., Michel S. and Bejaoui N., 2015. Heavy metal contamination and ecological risk assessment in the surface sediments of the coastal area surrounding the industrial complex of Gabes city, Gulf of Gabes, SE Tunisia. *Mar. Poll. Bull.*, 101: 922-929.

THE RIMMEL OBSERVATION NETWORK: HARMONIZING THE APPROACH FOR MONITORING OF FLOATING MACRO LITTER ENTERING THE SEAS

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Abstract
The RIMMEL project aims to quantify loads of riverine floating macro litter entering the European seas. The project establishes an observation network that will collect new data using a harmonized approach for monitoring. The monitoring protocol is based on visual observations using a tablet computer application to register data. Eventually, the monitoring data will be used to build a model of litter loading based on the upstream catchments characteristics.

Keywords: Riverine litter, Marine litter, Monitoring, Mediterranean Sea, European Seas

Introduction
Marine litter, an increasing issue at global level, is taken into account under the Marine Strategy Framework Directive (MSFD) [1] by Descriptor 10: 'Properties and quantities of marine litter do not cause harm to the coastal and marine environment'. A great percentage of the litter found in the marine environment is assumed to come from land-based sources. However, little scientific work has been done about quantities of litter transported by rivers. The lack of knowledge and data in the field call for initiatives that can lead to harmonization of approaches for monitoring and assessment of litter inputs from rivers to the seas. The RIMMEL project (RIverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading) is the first initiative at European-scale that aims to quantify riverine fluxes of floating macro litter to the European seas [2].

The RIMMEL Observation Network
The project launches a monitoring activity called the RIMMEL Observation Network, where researchers, MS authorities, River Commissions, NGOs and other interested institutions are invited to participate in the gathering of new data. The key elements of the monitoring network include the following:

• Visual observations of floating macro litter (>2.5 cm) on river water surface

• Monitoring at river/sea boundary (estuaries) from elevated position (e.g. a bridge)

• Harmonized approach using the JRC Floating Litter Monitoring Application

• Starting summer 2016 and finishing autumn 2017 (no mandatory frequency monitoring)

Eventually, the monitoring data will be collected into the RIMMEL database in order to build a statistical inverse model of litter loading based on the upstream catchments characteristics. The project will bring a better understanding on litter quantities and dynamics from rivers to the seas, providing relevant information for the implementation of both freshwater and marine environmental policies.

Protocol for riverine floating macro litter monitoring
In order to harmonize the approach, the project develops a protocol for visual observation of floating macro litter that uses a tablet computer application to register the monitoring data. The application allows the observer to select litter items and size, based on MSFD Category Master List and agreed size ranges, as described by the MSFD Task Group on Marine Litter [3]. The harmonization of the approach for monitoring and collection of data on riverine inputs will facilitate a consistent and comparable database, supporting the RIMMEL modelling activities and further developments at international scale.

References
1 - EC, 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056
2 - EC JRC (2016). European Commission, Joint Research Centre. Exploratory Research Project: RIMMEL (RIverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading). http://mcc.jrc.ec.europa.eu/dev.py?N=simple&O=380&titre_page=RIMMEL&titre_chap=JRC%20Projects
3 - EC JRC (2013). European Commission, Joint Research Centre, 2013. MSFD Technical Subgroup on Marine Litter (TSG-ML). Guidance on Monitoring of Marine Litter in European Seas. https://ec.europa.eu/jrc/sites/default/files/lb-na-26113-en-n.pdf

CONTENTS OF HEAVY METALS IN COASTAL SURFACE SEDIMENTS FROM MONTENEGRIAN COAST

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Abstract

The aim of the study was to determine the levels and distribution of heavy metals in the sediments in coastal surface sediments, also to assess the extent of anthropogenic impact using geo-accumulation index (Igeo) and enrichment factor (EF). Surface samples were taken from 3 locations: two stations located in the „inner shore" waters Boka Kotor Bay, and at one station located „off shore" Montenegrin coast, considered as a reference station. Based on the obtained data we can conclude that significant amounts of heavy metals are deposed in Boka Kotorska Bay sediments.

Keywords: Sediments, Trace elements, Mediterranean 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]. Due to rapid industrialization and uncontrolled urbanization around many cites and coastal areas, an alarming level of pollutants have contaminated these aquatic environments [2]. Heavy metals can be introduced into the aquatic environment and accumulate in sediment through disposal of liquid effluents, chemical leachate and runoff originating from domestic, industrial and agricultural activities, as well as atmospheric deposition [3].Trace metals can be released from sediments to the overlying water via natural or anthropogenic processes, consequently causing potential danger to the ecosystem.

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 during November 2014 / May 2015 at three stations in the Montenegrin coast: 1. IBM, 2. CogiMar and 3. Zanjice, Fig.1.

Fig. 1. Map of investigation area

Dry samples (about 0.5 g) were digested in 10 ml solution of mixture HNO3 and H2O2 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. Determinations of heavy metals in sediment were measured according to methods Laboratory Procedure Book, IAEA (International Atomic Energy Agency), Marine Environment Laboratory, Monaco 2009. All measurements are performed on ICP-OES, Spectro Arcos.

Result and Discussion

Improved interpretations are obtained by normalizing metal concentration in sediments to percentage of a given grain sizes or Al, Fe or organic carbon concentrations [4]. Enrichment factor (EF) is good tool to differentiate the metal source between lithogenic and naturally occurring. In this study we used Fe to compute EF because it is the fourth major element in the earth's crust and most often has no contamination concern. The Geoaccumulation Index (Igeo) was calculated to determine metals in sediment of Montenegrin coast. This expression was proposed by M?ller (1997) in order to calculate metals concentrations with undisturbed or crustal sediment (control) levels [5]. The results from the present investigation showed that EF of Mn ranged from 1.59-5.36, EF from 1.03-5.75 for Zn, from 1.02-5.26 for Cu, from 3.24-10.59 for Ni and from 0.54-3.79 for Pb. The average EF values of Zn, Cu and Pb indicated that these metals were caused by minor enrichment, whereas, the average EF value of Mn suggested moderate enrichment. In station CogiMar metals Zn, Cu and Ni caused by moderately severe enrichment and severe enrichment, respectively. Overall, EF of these metals was high in urban-affected area (mostly from domestic source) and mariculture area. The lgeo of Zn and Cu at several locations were of classified to class 1 (unpolluted to moderately polluted), for Mn and Hg to class 2 (moderately polluted) and Igeo for Ni to class 3 (moderately to strongly polluted). The main reasons of higher contamination are anthropogenic factor, harbor activates and anti-corrosion treatment for vessels.

Acknowledgement

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References

1 - Loring D.H. 1991. Normalization of heavy-metal data from estuarine and coastal sediments. ICES Journal of Marine Science 48.104.
2 - Naji A. Ismail A. and Ismail, A.R. 2010. Chemical speciation and contamination assessment of Zn and Cd by sequential extraction in surface sediment of Klang River, Malaysia. Microchemical Journal 95: 285-292.
3 - Mucha A.P. Vasconcelos M.T.S.D. and Bordalo A.A. 2003. Macrobentic community in the Douroestuary: relations with trace metals and natural sediment characteristic. Environmental Pollution 121: 169-180.
4 - Luoma S.N. and Rainbow P.S. 2008. Metal concentration in aquatic environmentals. New York: Cambrige University press, USA: 101-116.
5 - Muller, G. 1997. Schwermetalle in den sedimenten des Rheins-Veranderungen seitt 1971. Umschau 79:778-783.

DISTRIBUTION OF TRACE METALS IN THE ARNO RIVER AND ITS ESTUARY

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Abstract
Trace metal (TM) concentrations in water samples collected in the Arno River, its main tributaries and estuarine transect were measured in order to evaluate anthropogenic influence, TM dynamics and a potential impact on the coastal sea. A downstream increase of concentration for most of TM was observed in the river, whereas a (near)conservative behavior was registered for the majority of dissolved TM in estuarine salinity gradient.

Keywords: Trace elements, Estuaries, Mediterranean Sea

Introduction and study site: In order to understand the impact, behavior and fate of trace metals (TM) in natural waters, studies of interactions between TM and other constituents of the water body (particles, organic matter, organisms, etc.) are highly demanded [1,2]. The Arno river is located in the central Italy (Tuscany), with its source in the Northern Apennines and a total length of ~242 km. Through entire flow, the Arno River is altered by various tributaries, natural factors, and sources of anthropogenic contamination [3]. The objectives of this work were to examine the distribution of TM along the Arno river, to evaluate the influence of its major tributaries (Canale della Chiana, Sieve, Bisenzio, Ombrone and Era), to identify the main sources and finally, to assess the behavior of TM in estuarine salinity gradient.

Sampling and analysis methods: During the field campaign organized in September 2015, water samples were taken either by hand grab sampling (in river; 18 sites) or by using Van-Dorn type horizontal water sampler (in estuary; surface and bottom layers; 10+6 sites). Samples were immediately on-site filtered using syringe filters (0.22 µm) and afterwards acidified to pH<2 and UV digested. Hydrolab DS5 multiprobe was used for in-situ profiling of salinity, temperature, pH, dissolved oxygen. Analyses of TM were performed either by HR ICPMS or by stripping. voltammetry.

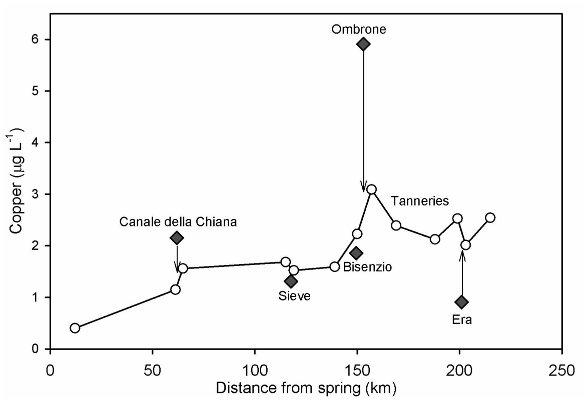

Fig. 1. Distribution of dissolved Cu along the Arno River and its tributaries

Results and discussion: As expected, for most of the metals very low concentrations were measured in samples collected at the first site (12 km from the spring), before any evident anthropogenic inputs, representing the location comparable to other clean freshwater systems [4]. A generally increasing trend of TM concentrations along the entire freshwater part was registered for most of the examined TM (Fig. 1). TM showed a highly variable concentration among the examined tributaries. After merging with the Canale della Chiana, Bisenzio and Ombrone Rivers an obvious increase of TM concentrations was observed in the Arno River. The particular characteristic of the examined 12 km long estuarine segment was a strong salinity stratification (Fig. 2). In the surface layer, seawater-conservative metals (Cs, Li, Mo, Rb, U, Sr) showed a clear linear increase in concentration as a function of salinity (Fig. 2; left inset). TM followed a near-conservative behavior (Cr, Co, Ni, Pb, Sb) or were under the influence of anthropogenic or natural process (As, Cd, Cu, Fe, Mn, Zn), as exemplified by dissolved Cu (Fig. 2), for which an additional input from antifouling paints of the numerous boats was evidenced [4]. Out of the plume, the concentrations of metals reached the range characteristic for clean costal Mediterranean Sea. In the bottom seawater layer, a strong hypoxia was registered in the upper estuary region. In combination with the progressive accumulation and partial TM scavenging, either increase (Co, Cr, Fe, Mn, Ni, Sb) or removal (Cd, Cu, Pb, U, V) of TM was observed in the upstream direction of seawater flow.

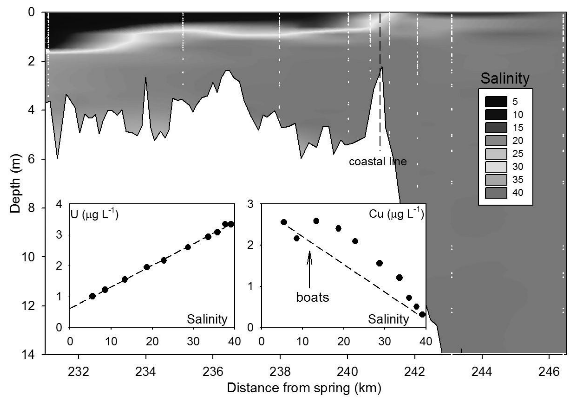

Fig. 2. Salinity distribution along the Arno estuary: Insets: dissolved U and Cu distributions in surface layer

Acknowledgements: This work was financially supported by the multilateral "Envimed-Comecom Project" and the MERMEX-WP3-C3A project. This study was a part of the project IP-2014-09-7530-MEBTRACE (Croatian Science Foundation).

References
1 - Duran, I., Beiras, R., 2013. Ecotoxicologically based marine acute water quality criteria for metals intended for protection of coastal areas. Sci. Total Environ. 463, 446–453.
2 - Oursel, B., Garnier, C., Durrieu, G., Mounier, S., Omanovic, D., Lucas, Y., 2013. Dynamics and fates of trace metals chronically input in a mediterranean coastal zone impacted by a large urban area. Mar. Pollut. Bull. 69, 137–149.
3 - Cortecci G., Boschetti T., Dinelli E., Cidu R., Podda F., Doveri M., 2009. Geochemistry of trace elements in surface waters of the Arno River Basin, northern Tuscany, Italy. Applied Geochemistry 24, 1005-102.
4 - Cindric, A.M., Garnier, C., Oursel, B,. Pižeta, I., Omanovic, D., 2015. Evidencing the natural and anthropogenic processes controlling trace metals dynamic in a highly stratified estuary: The Krka River estuary (Adriatic, Croatia), Mar. Pollut. Bull. 94, 199–216.

HEAVY METAL CONTENTS IN *MYTILUS GALLOPROVINCIALIS* FROM BOKA KOTORSKA BAY, ADRIATIC SEA

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Abstract
Contents of two essential, Cu and Zn, and three toxic metals, Hg, Pb and Cd, were determined in mussel samples collected in the Boka Kotorska Bay, Montenegro, in order to evaluate their levels in different locations and seasons in this important area of Montenegro. The obtained results were compared with their maximum allowable concentrations (MAC), as well as with results that were obtained in *Mytilus galloprovincialias* in other areas of Adriatic Sea.

Keywords: Metals, Bio-indicators, South Adriatic Sea

Introduction
During the last decades human activities have led to increased concentrations of heavy metals in the marine environment. Although these elements occur naturally and some of them are essential in small quantities, at higher concentrations they can be toxic to organisms [1]. On the other hand, non-essential metals, such as Hg, Pb and Cd, are very toxic even at low concentrations. Mussels *Mytilus galloprovincialias* are known as bioindicators of marine pollution since, as sedentary, filter-feeding animals, they accumulate heavy metals present in water [2]. Having in mind that Montenegrin coastal area receives a heavy influx of sewage and industrial effluents, as well as domestic and agricultural wastes, and considering the fact that mussels are consumed as a food, the determination of the levels of potentially toxic metals in mussels is very important [3].

Material and methods
Fresh mussels were taken from three locations, which present different levels and sources of human impact in the Boka Kotorska Bay. Sampling was performed in the fall of 2014 and spring of 2015 at two locations in Kotor Bay, IMB and COGIMAR (Ljuta), and at one open sea location, near the Žanjice beach. Mussels were dissected by removing the bysiss and shells. After that soft tissue was dried, homogenized and digested with HNO_3 and H_2O_2 in closed vessel microwave digestion system under high temperature and pressure (Ethos 1). Concentrations of Cu, Zn, Pb and Cd were determined by inductively coupled plasma-optical emission spectrometer (ICP-OES, Spectro Arcos) and Hg was determined by Direct Mercury Analyzer (Milestone, DMA-80). In order to validate the method for accuracy, also certified reference material (NIST 2976) was analyzed.

Results and discussion
The highest heavy metal contents were mostly at Žanjice, especially in the fall, except for the Pb, which was higher at IMB in the fall and also at COGIMAR in both, fall and spring, and in the spring Cd was the highest at COGIMAR. Žanjice is a beach near the open sea, but with a lot of cottages and restaurants, with a discharge of wastewater directly into the sea. This is especially increased during summer tourist season, when there is also a problem of recreational activities. We didn't find significant differences in heavy metals concentrations between the investigated seasons, although there were some variations. The most considerable difference was found for Cu contents, which were lower at all locations in the spring. Comparing the obtained results with maximum allowable concentrations (MAC) for certain trace elements, it was found that the metal contents in mussels from Boka Kotorska Bay were mostly lower than permitted limits for *M. galloprovincialis* [4]. Only mussel samples from COGIMAR in the spring (224.4 mg/kg) and from Žanjice in the fall (239.6 mg/kg) and spring (225.6 mg/kg), were found to contain Zn above limits. Also Hg in mussels from Žanjice in the fall (0.31 mg/kg) and from COGIMAR in the spring (0.27 mg/kg) was above the limit. However, the results are within the range of values commonly found in other areas of Adriatic Sea (Table 1).

Tab. 1. The concentration of heavy metals (mg/kg) in mussels from the Adriatic coast

Location	Cu	Zn	Pb	Cd	Hg
SE Adriatic, Albania [5]	4.61–28.9	59.8–244.6	1.39–5.69	0.27–0.77	0.08–0.42
E Adriatic, Croatia [6]	1.98–11.0	49.4–418.3	0.24–3.69	0.39–2.40	0.08–0.28
SW Adriatic, Italy [1]	4.66–19.2	/	0.37–3.25	0.38–1.84	0.10–0.81
MAC [4]	10	200	3.2	3.7	0.23
SE Adriatic, Montenegro (This study)	2.52–8.04	105.0–239.6	1.26–2.02	1.20–2.62	0.13–0.31

Acknowledgement
This work has been supported by the Ministry of Science of Montenegro and HERIC project trough the BIO-ICT Centre of Excellence (Contract No. 01-1001).

References
1 - Spada, L., Annicchiarico, C., Cardellicchio, N., Giandomenico, S., Di Leo, A., 2013. Heavy metals monitoring in the mussel *Mytilus galloprovincialis* from the Apulian coast (Southern Italy). *Mediterr. Mar. Sci.* 14, 99–108.
2 - Jovic, M., Onjia, A., Stankovic, S., 2011. Toxic metal health risk by mussel consumption. *Environ. Chem. Lett.* 10, 69–77.
3 - Joksimovic, D., Tomic, I., Stankovic, A.R., Jovic, M., Stankovic, S., 2011.Trace metal concentrations in Mediterranean blue mussel and surface sediments and evaluation of the mussels quality and possible risks of high human consumption. *Food Chem.* 127, 632-637.
4 - Cantilo, A. Y., 1997. World Mussel Watch Data. Silver Spring, 1-209.
5 - Çullaj, A., Lazo, P., Duka, S., 2006. Heavy metals and metallothionein levels in mussel samples of Albanian seacoast. MAP/Med Pol. In *Biological effects monitoring programme, MAP Technical Reports Series No. 166*, Italy: Alessandria. pp. 141–151.
6 - Kljakovic-Gašpic, Z., Ujevic, I., Zvonaric, T., Baric, A., 2007. Biomonitoring of trace metals (Cu, Cd, Cr, Hg, Pb, Zn) in Mali Ston Bay (eastern Adriatic) using the Mediterranean blue mussel (1998–2005). *Acta Adriat.* 48, 73–88.

QUANTIFICATION OF DIRECT DISCHARGES OF WASTEWATER PHOSPHORUS AND NITROGEN TO THE MEDITERRANEAN SEA

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Abstract

Current nutrient budgets for the Mediterranean Sea do not account for inputs associated with direct wastewater discharges. Here, we demonstrate that the inputs of phosphorus and nitrogen from domestic sources in Mediterranean coastal cities are on the same order of magnitude as inputs from rivers. Population growth, dietary changes and expanded connectivity to sewers are expected to further increase direct wastewater nutrient inputs to the Mediterranean Sea, especially in the southern and eastern regions. Regionally targeted upgrades to tertiary wastewater treatment, combined with enhanced wastewater recycling and banning phosphates from laundry and dishwasher detergents, may be the most cost-effective way to prevent the expansion of coastal eutrophication related to wastewater inputs.

Keywords: Phosphorus, Nutrients, Sewage pollution, Mediterranean Sea

Direct discharges of treated and untreated wastewater can be an important source of nutrients to coastal marine ecosystems. Both treated and untreated wastewater from coastal cities are discharged directly into the Mediterranean Sea (MS), either at the surface or via submarine pipes (referred to as direct discharges in the following). Wastewater inputs pose a threat to the vulnerable ecosystems of the MS and are likely to increase in the near future. Of particular concern are algal blooms within the coastal zone of the MS linked to discharges of wastewater. Nonetheless, current nutrient budgets for the MS do not include direct wastewater discharges of phosphorus (P) and nitrogen (N).

Here, we use an empirical formula [1] to estimate the spatially distributed annual inputs to the MS of P and N associated with direct domestic wastewater discharges from coastal cities exceeding 2000 inhabitants:

$$D_{P,N} = P,N_{capita} * pop * f_c * (1-f_R)$$

where $D_{P,N}$ is expressed in units of mol yr^{-1}, P,N_{capita} is the annual P or N domestic wastewater load per inhabitant (mol capita^{-1} yr^{-1}), *pop* is the population of the city, f_c is the fraction of the city's population connected to the sewer system, and f_R is the fraction of P or N removed from the wastewater stream in the city's wastewater treatment plants, which is dependent on the type of treatment – primary, secondary or tertiary.

$D_{P,N}$ is calculated for each individual city using data from surveys collected by UNEP [2,3] and supplemented with estimates for discharges from Gaza and Cairo into Lake Manzalla. These estimates are representative of the first few years of the 21st century.

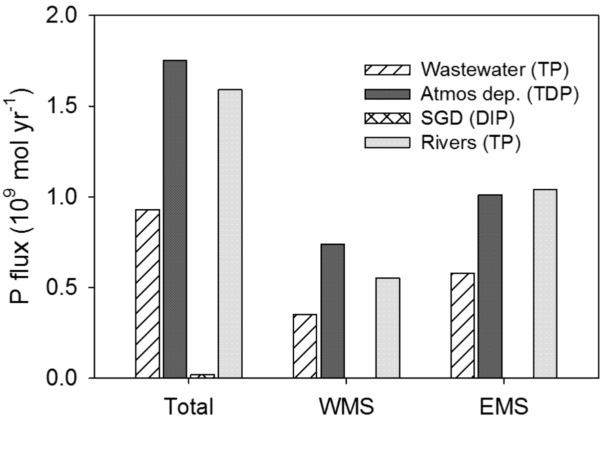

Fig. 1. Inputs of total phosphorus to the Mediterranean Sea: 2003 direct domestic wastewater (this study) versus atmospheric deposition (atm. dep.) [5], submarine groundwater discharge (SGD) [6] and 1998 riverine discharges [4]. WMS = Western Mediterranean Sea, EMS = Eastern Mediterranean Sea, TP= total phosphorus, TDP = total dissolved phosphorus, DIP = dissolved inorganic phosphorus.

According to our best estimates, in 2003, direct wastewater inputs amounted to 0.9x10^9 mol P yr^{-1} and 15x10^9 mol N yr^{-1} for the entire MS. They are on the same order of magnitude as 1998 riverine input fluxes to the entire MS of 1.6x10^9 mol P yr^{-1} and 77 x10^9 mol N yr^{-1} [4] (Fig. 1). In addition wastewater P discharges are comparable to atmospheric deposition of total dissolved P [5], and an order of magnitude greater than estimates of the freshwater dissolved inorganic P delivered by submarine groundwater discharge [6]. Although relatively less significant, wastewater N inputs are still on the same order of magnitude as other external inputs. Thus wastewater discharges are an important, but so far largely ignored, source of P and N and should be included in biogeochemical budgets for the MS.

Wastewater inputs are projected to increase significantly in the future across the Mediterranean region. Primary productivity in the MS is P limited and hence we calculate changes in P inputs from wastewater discharges in 2050 relative to 2003. Population growth, higher per capita protein intake and increased connectivity to the sewage system increase 2050 direct discharges of P from wastewater by 272, 181 and 41% for South, East and North Mediterranean countries respectively if no mitigation occurs. To reduce 2050 inputs to below 2003 values all wastewater discharged to the sea is required to have tertiary treatment, but this would come at an additional estimated cost of over €2 billion yr^{-1}. Other and more realistic mitigation measures include enhanced recycling of treated wastewater and legislation to curb the use of P in laundry and dishwasher detergents, although these measures alone will not entirely offset rising domestic wastewater P loads in East and South Mediterranean countries. Management of coastal eutrophication may therefore best be achieved through targeted tertiary treatment in coastal areas susceptible to eutrophication at a predicted additional cost of over €500 million yr^{-1} together with enhanced recycling of domestic wastewater and implementation of detergent legislation throughout Mediterranean countries.

References

1 - Kristensen P, Fribourg-Blanc B, & Nixon S (2004) Outlooks on nutrient discharges in Europe from urban waste water treatment plants. Final draft. p33.
2 - UNEP/MAP/MED-POL/WHO (2004) Municipal wastewater treatment plants in Mediterranean coastal cities (II). *MAP Technical Report Series No. 157* (Athens).
3 - UNEP/WHO (1999) Identification of priority pollution hot spots and sensitive areas in the Mediterranean. *MAP Technical Reports Series No. 124*.
4 - Ludwig W, Dumont E, Meybeck M, & Heussner S (2009) River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades? *Prog Oceanogr* 80(3-4):199-217.
5 - Markaki Z, Loÿe-Pilot MD, Violaki K, Benyahya L, & Mihalopoulos N (2010) Variability of atmospheric deposition of dissolved nitrogen and phosphorus in the Mediterranean and possible link to the anomalous seawater N/P ratio. *Mar Chem* 120(1-4):187-194.
6 - Rodellas V, Garcia-Orellana J, Masque P, Feldman M, & Weinstein Y (2015) Submarine groundwater discharge as a major source of nutrients to the Mediterranean Sea. *PNAS* 112(13):3926-3930.

LONG TIME VARIATIONS OF MERCURY IN SURFACE WATERS OF THE TURKISH STRAITS SYSTEM

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Abstract

Long time variations of total mercury (Hg) in the Sea of Marmara (St.1) and the Dardanelles (St.2) were investigated in relation to the physical water quality parameters such as temperature, salinity and pH between March 2002 and December 2005. Hg concentrations at St.1 ranged from 2.08 to 7.85 µg L^{-1} (average: 4.49±1.39 µg L^{-1}), whereas the concentrations at St.2 ranged from 2.68 to 24.5 µg L^{-1} (average: 5.25±3.27 µg L^{-1}). Although average Hg concentrations at both stations were nearly similar to each other, the variations at both stations were different from each other.

Keywords: Marmara Sea, Dardanelles, Surface waters, Mercury, Pollution

The Turkish Straits System (TSS) including the Bosphorus (IS), Marmara Sea (MS) and Dardanelles (CS) is located between the Black Sea (BS) and Mediterranean Sea (AS). The TSS has two flow systems reverse to each other [1]. MS takes in both the BS surface waters and the Mediterranean deep waters via two Straits. Therefore, biogeochemical cycles of the MS are influenced by neighboring seas [1]. Therefore, TSS receives a number of pollutants originating from different sources such as direct and indirect discharge of land based pollutants, sewage etc. TSS is highly contaminated by the Black Sea which accepts wastes in many urban and industrialized areas of the many countries, ended with severe eco-toxicological impacts. To determine Hg levels of two stations of the TSS, long temporal variations of Hg were carried out connected with some CTD parameters in the period of March 2002 and December 2005. This study was derived from 92 Hg surface water sampling materials carried out during four years between March 2002 and December 2005 in the framework of "DIE-DPT project of 2000K100210, Turkey. While CTD parameters were measured by using YSI 6600 MPS, Hg concentrations were measured according to UNEP [2].

CTD results showed that while surface temperature values ranged from 5.83 to 29.8 °C (average: 17.33±6.94 ºC) at St.1, the values ranged from 5.83 to 26.6 °C (average: 16.1±6.37 ºC) at St.2. Due to two flow systems reverse to each other, surface salinity values varied between 21.1 and 28.8 ppt (average: 23.8±1.79 ppt) at St.1, whereas the salinity ranged from 21.9 to 37.1 ppt (average: 25.3±2.71 ppt) at St.2. Concentrations of dissolved oxygen were generally close to saturation limit (average: 8.79±1.69 mg L^{-1}). pH levels were in limit values and ranged from 7.68 to 8.67 (average: 8.26±0.18). While Hg levels were correlated with temperature and pH (R=430) in positive manner, the levels of Hg were correlated with temperature (R=-292) and salinity (R=-253) in negative manner. However, it is known that Hg resolution increase in high temperature and pH levels in water [3].

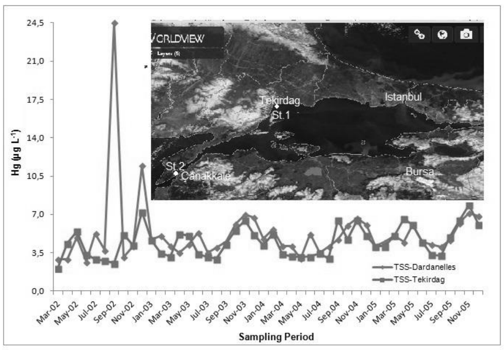

Fig. 1. Temporal variations of total Hg in the coastal waters of the Sea of Marmara

Hg concentrations in the Sea of Marmara (St.1) varied between 2.08 and 7.85 µg L^{-1} (average: 4.49±1.39 µgHgL^{-1}), whereas the concentrations in the Dardanelles (St.2) ranged from 2.68 to 24.5 µg L^{-1} (average: 5.25±3.27 µg L^{-1}). During the long sampling period, while average Hg concentrations at both stations were nearly similar to each other, the Hg variations at St.2 were higher than St.1. Hg concentrations in the study area were dramatically higher (average: 4.92±1.97 µg L^{-1}) than background levels in the oceans (0.005 µg L^{-1}) [3]. On the other hand, the concentrations in the Dardanelles (St.2) were higher (average: 5.25±3.27 µg L^{-1}) than the concentrations in the Sea of Marmara (St.1) (4.49±1.39 µg L^{-1}) (Fig. 1). Hg levels exceeded the levels of Marine General Quality Criteria given in Turkish Water Pollution Control Regulation (2004).

Bray-Curtis cluster similarity index results between years revealed that while the lowest similarity at St.1 was higher (similarity index: 80,3%) than the lowest similarity at St.2 (similarity index: 67.8%) (Fig.2), the highest similarity was above 90.0% for both stations. On the other hand, both stations were only in rate of correlation of 0.123. Both the similarity index and correlation results also showed that temporal variations of Hg in the Dardanelles (St.2) suggest the existence of additional pollution sources according to Tekirdag station (St.1). The addition source/s is/are probably mercury pollutants in the domestic and industrial waste waters of Canakkale.

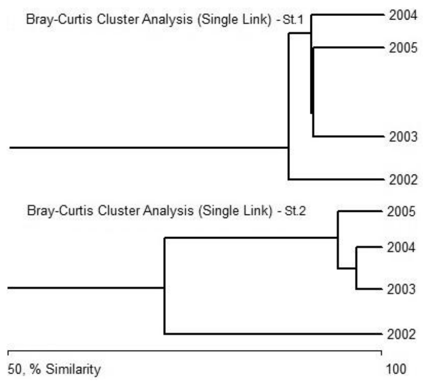

Fig. 2. Bray-Curtis cluster similarity analysis results according to annual Hg distribution

In light of the very high levels of Hg, TSS are underneath risk of the heavy metal pollution due to the urban waste waters of Istanbul and North West Black Sea surface waters more polluted by Danube. When considered that various heavy metal pollutant sources are roughly similar, the system is under risk not only in view of Hg, but also other heavy metal pollutants.

References

1 - Polat S.C. and Tugrul S., 1996. Chemical exchange between the Mediterranean and Black Sea via the Turkish strait. *Bull. Inst. Oceanography*, 17: 167-186.

2 - UNEP, 1985. Determination of mercury in estuarine waters and suspended sediment by cold vapour atomic absorption spectrophotometry. *Reference methods for marine pollution studies*, No: 19, pp. 14.

3 - Nishimura M., Konishi S., Matsunaga K., Hata K. and Kosuga T., 1988. Mercury concentrations in the ocean. *Journal of the Oceanographical Society of Japan*, 39: 295-300.

CIESM Congress Session : Sources of pollution / processes

Moderator : Jörg Klasmeier, Inst. of Environmental Systems Research, Osnabrück Univ., Germany

Moderator's Synthesis

The session included six flash presentations dealing with different aspects of the general topic. Two presentations highlighted specific sources of trace metals (nautical tourism, fertilizer industry). Three studies dealt with nutrient input/loads (aquaculture, land-based input, influence of varying river flow) and one study elucidated the fate of riverine organic matter. In the session introduction, the moderator linked the presentations to the goals of the EU Marine Strategy Framework Directive (MSFD) showing the importance of the results for the descriptors D5 (Eutrophication) and D8 (Environmental Contaminants). This should stimulate a more general discussion on the importance of further research to close potential knowledge gaps.

The discussion following the presentations was very lively, focusing on the many aspects of how science can trigger political action and support implementation of management strategies. Some participants criticized insufficient political will to act against pollution even if a negative impact on the environment is obvious, e.g. the phosphogypse production sites in the gulf of Gabés (Tunisia). It was commonly accepted that research should on the one hand be directed towards finding solutions for well-known problems and on the other hand focus on gathering objective information on processes to better understand the complex interactions in the marine system. A research goal with respect to the MSFD could be support for defining indicators and target values that represent the good environmental status (GES) of the marine environment.

EFFECTS OF TERRESTRIAL INPUTS ON PARTICULATE ORGANIC MATTER (POM) COMPOSITION (C/N/P RATIO) IN SURFACE WATERS AND SEDIMENTS OF THE MERSIN BAY

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Abstract
For the assessment of impacts of terrestrial nutrients and organic matter inputs on the elemental composition (C/N/P ratio) of bulk POM in seawater and surface sediments of highly and low productive zones (8-50 m depth ranges) of Mersin Bay, located at northeastern Mediterranean (NE), two filed surveys were performed in April 2014 and February 2015. Eutrophication-related parameters (nutrients, Chlorophyll-*a*, (Chl-*a*) and dissolved oxygen (DO)) and POM in the surface and bottom waters were measured. Geochemical properties were also determined to understand effects of land-based sources on POM composition and concentrations in surface sediments.

Keywords: Organic matter, Nutrients, Sediments, Mersin Bay

Although the eastern Mediterranean is one of the world's oligotrophic seas due to limited nutrient inputs to its surface waters [1-2], its coastal ecosystem is highly fueled by nutrient inputs from land-based sources mainly by river discharges [3]. High nutrient concentrations (DIN: 10-16 µM, PO_4: 0.1-0.2 µM) of polluted coastal surface waters enhanced Chl-*a* and bulk POM concentrations in the near-shore zone of the bay in spring and winter period (Figure 1).

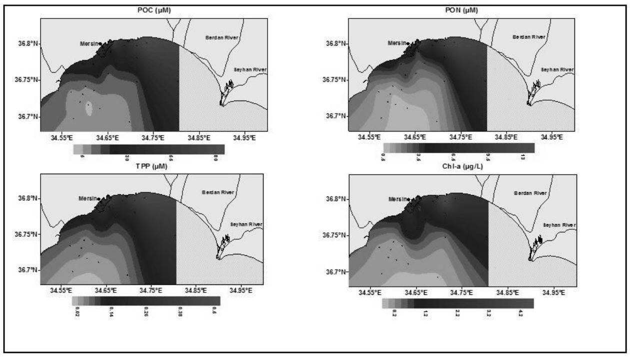

Fig. 1. Surface water distributions of POC, PON, TPP and Chl-*a* measured in the Mersin bay in April 2014.

Surface POM concentrations reached the peak values of 77-107 µM for POC and 6-13 µM for PON, with C/N ratios of 6.0-10.7 in the eutrophic coastal zone, decreasing by at least 5-10 fold in less contaminated central bay waters. Similar regional distribution was also observed in total particulate phosphorus (TPP) concentrations, decreasing from 0.2-0.5 µM in polluted coastal waters to 0.03-0.10 in the central bay. However, no similar changes were seen in the C/N ratio varying regionally and seasonally between 6 and 11 whilst POC/Chl-*a* ratios varied regionally between 76-1531 indicating contributions of detrital and heterotrophic biomass to the POM pool within the bay. Regional variations were also appeared in the surface PON/TPP ratio of bulk POM, ranging between 11 and 56, with greater ratio values in more productive coastal waters. Molar ratios of POC/PON and PON/TPP ratios, derived from regression analyses of the particulate data, were about 6.84 and 20.5 in the productive bay waters, implying P-limited primary production in the Mersin Bay as also experienced in recent studies [4].

POM enhancement in the highly productive coastal waters had limited impact on the POM content of the coastal surface sediments. Higher concentrations of organic matter were observed in the less contaminated sites of the central bay. The TOC concentrations in sediment increased from 0.4-0.5 mmol/g dw (dry weight) in the near-shore zone to levels of 0.6-0.63 mmol/g dw in muddy sediments of the central bay. The TOC/TN molar ratio of sediment was more variable and greater than the ratio in the bulk POM of surface waters, indicating selective bio-chemical degradation of more labile N-rich organic compounds in surface sediments. The large spatial and temporal variations appeared in TN/POP ratios of bulk POM and organic matter of surface sediments: The ratio was markedly high (> 50) in the polluted and highly productive coastal zone sediments in the spring, whereas the winter ratios merely ranged between 13 and 28, consistent with changing grain-size distributions of the samples. Lower N/P molar ratios were consistently determined in the muddy sediments of the central bay fed by fine particles of terrestrial origin.

Acknowledgements
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References
1 - UNEP, 1989: State of the Mediterranean Marine Environment. MAP Technical Series No. 28, UNEP, Athens.
2 - Yilmaz, A., Tugrul, S. 1998. The effect of cold- and warm- core eddies on the distribution and stoichiometry of dissolved nutrients in the northeastern Mediterranean. Journal of Marine Systems, 16, 253-268.
3 - Krom, M. D., Herut, B., and Mantoura, R. F. C.: Nutrient budget for the Eastern Mediterranean: implications for P limitation, Limnol. Oceanorg., 49, 1582–1592, 2004.
4 - Tüfekçi, V., Kuzyaka, E., Tüfekçi, H., Avaz, G., Günay, A.S., Tugrul, S. 2013. Determination of limited nutrients in the Turkish coastal waters of the Mediterranean and Aegean Seas. J. Black Sea/Mediterranean Environment Vol. 19, No. 3: 299?311.

RECENT VARIATIONS OF FRESHWATER AND NUTRIENT LOADS FROM N ADRIATIC RIVERS AND DANUBE

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Abstract

The analysis of the recent (2004-2012) river water and nutrient loads in N Adriatic and NW Black Sea was made in order to assess dynamics and potential effect of the continental inputs in these coastal marine ecosystems. River data made available by national/international research projects and by institutional monitoring activities were collected and analyzed. They indicated that runoff and nutrient transport have been highly variable in these coastal systems during the recent years. These variations should be better considered, both at seasonal and interannual scales, as they can induce important changes in trophic conditions and ecosystem structures in these marine areas.

Keywords: Nutrients, Deltas, North Adriatic Sea, Black Sea

N Adriatic and NW Black Sea are coastal ecosystems strongly affected by river loads. The continental loads have significant consequences on the productivity and on the structure of this marine ecosystem [1, 2]. Danube water discharge strongly affects, together to Dniepr and Dniestr rivers, the shallow and semi-enclosed shelf of NW Black Sea. In this marine area, human-induced eutrophication has been reported as cause of extensive damages biological communities [e.g. 3].

In 2004-2012, the total flow of N Adriatic rivers (401-9162 m^3 s^{-1}) corresponded to an average of 59 km^3 yr^{-1} (Fig. 1). The drought in 2003-2007 was followed by a period of high regime in 2008-2010 and by a decrease in 2011-2012, suggesting the presence of strong oscillations of runoff mainly originated by the behavior of Po. The most important difference between the years with high (low) runoff was the presence (absence) of the peaks of flow in spring and autumn. Danube flow (2340-5190 m^3 s^{-1}) corresponded to an average of 211 km^3 yr^{-1}, a value that was similar to that in the last 50 years. For Danube, spring was usually a season characterized by high flows, whereas autumn was often dry. Contrary to N Adriatic rivers, Danube regime was high in 2005-2006 and low in 2007-2009. However, the highest flows in 2010 and the scarce flows in 2011-2012 were common to both areas.

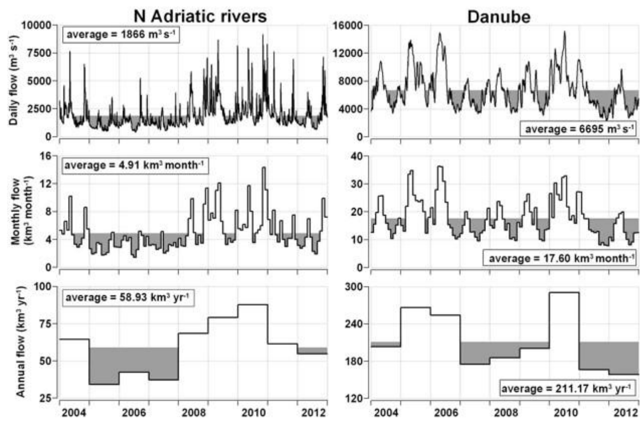

Fig. 1. Daily averaged flow, monthly and annual integrated loads of N Adriatic rivers and Danube in 2004-2012.

In N Adriatic, TN transport increased since the 1960s, whereas TP transport was stabilized in the 1980s and reduced during the following decades. In 2004-2012, TN and TP transports were in the range of 113-265 kt N yr^{-1} and 4.7-13.5 kt P yr^{-1}, respectively. Nutrient supply by N Adriatic rivers showed a high interannual variability: during the drought in 2005-2007, it was about half than that estimated during the years with a high runoff. TN emission from Danube increased in 1950-1990 and then reduced after the early 2000s. TP emission followed a similar trend, but it was an order of magnitude smaller. In 2004-2012, the total loads of TN and TP were respectively 284-616 kt N yr^{-1} and 11.8-40.6 kt P yr^{-1}, confirming that the Danube is the largest source of nutrients in Mediterranean and Black Sea. Both marine areas were subjected to overloads of nitrogen compared to phosphorus (molar ratios TN/TP = 48-221, DIN/PO4 = 31-476) and silicon (Si/DIN = 0.5-1.1).

Distinct seasonal river cycles were observed in N Adriatic and NW Black Sea, probably because of the different climatic characteristics of the drainage basins. In both areas, the overload of nitrogen compared to phosphorus and silicon mainly originates by the high concentration of NO_3 in the river waters. As a consequence, the largest pool of nitrogen is inorganic, whereas inorganic and organic pools are more equilibrated in the case of phosphorus. This unbalance of N/P ratio is the main factor that partially limits the extreme eutrophication potential of the continental loads in these marine ecosystems.

References

1 - Cozzi S. and Giani M., 2011. River water and nutrient discharges in the Northern Adriatic Sea: current importance and long term changes. *Cont. Shelf Res.*, 31: 1881-1893.
2 - Giani M., Djakovac T., Degobbis D., Cozzi S., Solidoro C. and Fonda Umani S., 2012. Recent changes in the marine ecosystems of the northern Adriatic Sea. *Est. Coast. Shelf Sci.*, 115: 1-13.
3 - Gomoiu M. T. 1992. Marine eutrophication syndrome in the North-Western part of the Black Sea. *Sci. Tot. Environ.*, Supp: 683-692.

AN IMPACT OF NAUTICAL TOURISM ON COPPER CONCENTRATIONS IN THE KRKA RIVER ESTUARY (CROATIA)

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Abstract

To evaluate impact of nautical tourism on copper concentrations in surface layer of Krka River estuary (Croatia), one-year monitoring was established. Monitoring consisted of two main activities: 1) counting vessels by video observing and 2) measuring copper content in water. The conducted research confirmed strong relation between nautical tourism and copper concentration in water.

Keywords: Trace elements, Surface waters, Estuaries, Coastal waters, Central Adriatic Sea

Introduction

Copper (Cu) is a micronutrient required in a number of cellular processes that are key for phytoplankton growth. As phytoplankton is the first level of the food chain, deficiency in copper can lead to numerous unfavourable biological conditions in the sea ecosystem. At physiologically high concentrations, copper is toxic and may affect both planktonic abundance and diversity in coastal waters. Range of copper concentrations between these two extremes is relatively narrow [1, 2, 3]. Copper contaminates coastal waters mainly by anthropogenic inputs. It is used as an anti-biofouling agent with Cu-based paint covering the hull of boats, releasing considerable quantity in coastal waters. The areas which are potentially endangered are those with high copper input and weak water exchange. One of these potentially endangered areas is the Krka River estuary protected as NATURA 2000 site. Preliminary studies carried out in last several years, have showed that during summer season concentrations of copper could be 20 times higher compared to winter season [4]. Unfortunately, there are no data available for number of vessels (per day/month/year) in the Estuary. To evaluate relation between copper contents in water, the number of vessels during one-year period and other parameters such are salinity, rainfall, Krka River flow, wind strength and direction, a monitoring survey has been established.

Methodology

Monitoring system was based on the two main activities: (1) video surveillance/observing system for vessels counting, (2) monitoring of copper content in water. Video surveillance system consisted of video camera that was monitoring the entrance to the estuary and software which provided continuous information about entrance/exit and statistics of the vessels (hour, day, month, year). As a part of second monitoring activity, surface water samples have been collected every 2-3 days within the estuary. Voltammetry was used for copper measurements. Furthermore, salinity was measured in each sample and meteorological and hydrological data were collected.

Results

Results of counting vessels system have shown significant differences between number of boat passes during winter and summer season (~50/day to ~1100/day). Moreover, obtained copper concentrations demonstrate clear distinction between winter and summer values (min/max: 3.8/19.2 nM of Cu). The established monitoring has confirmed strong relation between the nautical tourism and concentrations of copper in surface layer (Fig. 1).

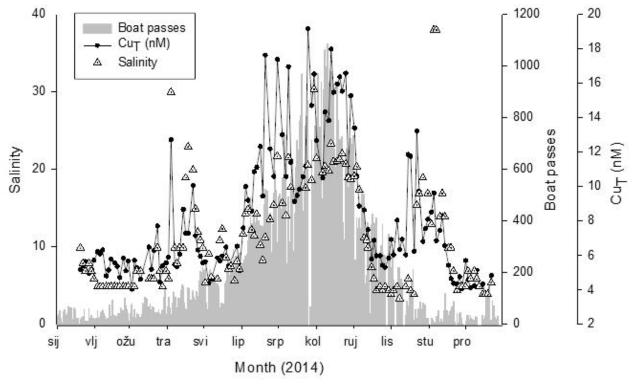

Fig. 1. Boat passes, salinity and copper concentrations in surface layer of the Krka River estuary

Additionally, it was estimated that other factors, such as salinity, the Krka River flow and wind strength and direction have additional influence on temporal copper distribution. The results from this study can be used as support in planning sustainable tourism in this, as well as in other protected areas.

References

1 - Donat J. and Dryden C., 2001. Transition metals and heavy metal speciation. In: Steele J.H., Thorpe S.A. and Turekian, K.K. (eds.), Marine Chemistry and Geochemistry. Academic press, London, pp 72-81.

2 - Sunda W.G., Tester P.A. and Huntsman S.A.,1987. Effects of Cupric and Zinc Ion Activities on the Survival and Reproduction of Marine Copepods. Mar. Biol., 94: 203-210.

3 - Tessier A. and Turner D.R., 1996. Metal Speciation and Bioavailability in Aquatic Systems. John Wiley & Sons, Chichester, pp 696.

4 - Cindric A.M., Garnier C., Oursel B., Pižeta I. and Omanovic D., 2015. Evidencing the natural and anthropogenic processes controlling trace metals dynamic in a highly stratified estuary: The Krka River estuary (Adriatic, Croatia). Mar. Pollut. Bull., 94: 199-216.

DYNAMIQUE DES CONTAMINANTS MÉTALLIQUES DANS LE PHOSPHOGYPSE ISSU DES USINES D'ENGRAIS PHOSPHATÉS DE GABÈS

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Abstract
Des échantillons de phosphates, de phosphogypse pur et noir ont fait l'objet d'analyses de 4 métaux en trace (Cd, Cr, Cu et Pb). Le phosphogypse rejeté dans le Golfe de Gabès comporte 3 phases: le phosphogypse noir qui concentre 3 des métaux analysés (Cd, Cr et Cu), une phase aqueuse enrichie en Pb et une couche blanche appauvrie en contaminants métalliques. Le phosphogypse noir a la capacité de concentrer la quasi-totalité des polluants métalliques hérités du phosphate lors de son attaque sulfurique et de les relarguer ultérieurement en mer, sous l'effet conjugué de l'action mécanique des vagues, la variation de la température et du pH des eaux marines. En terme de rémédiation, la floculation de la mousse au niveau des usines du Groupe Chimique Tunisien, pourrait réduire la pollution marine et protéger ainsi les ressources halieutiques.

Keywords: Pollution, Metals, Gulf of Gabes

Le phosphogypse, sous-produit de la fabrication de l'acide phosphorique par attaque sulfurique du minerai de phosphate, constitue l'enjeu environnemental majeur des usines de valorisation de phosphate dans le monde, en particulier à Gabès, par sa composition chimique, radiologique et ses énormes quantités rejetées quotidiennement et sans traitement préalable dans le milieu marin, depuis les années 1970 [1]. Malgré qu'il soit économique, le procédé dihydraté (DH) utilisé dans les usines de Gabès représente le procédé industriel le plus polluant dans ce type de transformation du minerai. En effet, ce procédé reconcentre les impuretés métalliques dans le phosphogypse (Fig.1).

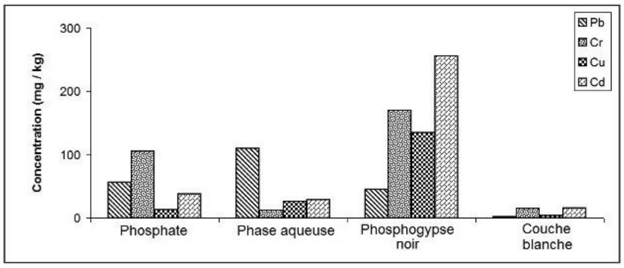

Fig. 1. Variations des concentrations du Cd, Cu, Cr et Pb (mg/kg) dans le phosphate et les 3 phases du phosphogypse rejeté dans le Golfe Gabès.

Nous avons identifié 3 phases au sein du phosphogypse rejeté en mer: une phase flottante (phosphogypse noir), une phase aqueuse et une phase solide (phosphogypse blanc). La dernière phase se localise exclusivement aux alentours du delta de l'émissaire des rejets du complexe industriel à Chatt Essalam alors que les deux autres se diffusent plus loin dans le milieu marin, en particulier le phosphogypse noir. Ce dernier concentre la grande partie de la charge polluante métallique du phosphate à l'exception du plomb qui reste en solution dans la phase aqueuse du phosphogypse (Fig.1). La comparaison des concentrations en métaux des 3 échantillons de phosphogypse noir (Emissaire, Chatt Essalam et Ghannouche), spatialement éloignés les uns des autres, montre un décroissement des teneurs (Fig.2). Ce phénomène de relarguage en mer des polluants métalliques semble être étroitement lié à la variation de 3 paramètres: l'agitation, le pH et la température du milieu marin.

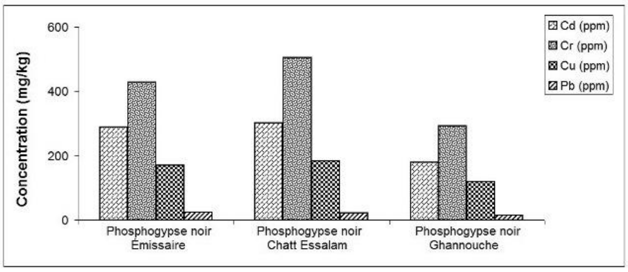

Fig. 2. Variations des concentrations du Cd, Cu, Cr et Pb (mg/kg) dans 3 types de phosphogypse noir rejeté dans le Golfe Gabès.

En conclusion, le phosphogypse noir se caractérise par sa grande capacité de rétention de polluants métalliques mis en solution lors de l'attaque acide du minerai de phosphate et du relarguage progressif de cette charge polluante au fur et à mesure de sa migration dans le milieu marin. Par conséquent, l'élimination de cette phase par floculation pourrait réduire considérablement la pollution marine dans le Golfe de Gabès et protéger ce qui reste de vie aquatique.

References
1 - El Zrelli R., Courjault-Radé P., Rabaoui L., Castet S., Michel S. and Bejaoui N., 2015. Heavy metal contamination and ecological risk assessment in the surface sediments of the coastal area surrounding the industrial complex of Gabes city, Gulf of Gabes, SE Tunisia. *Mar. Poll. Bull.*, 101: 922-929.

ENRICHISSEMENT EN SELS NUTRITIFS DE FERMES AQUACOLES TUNISIENNES

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Abstract

Dans cette étude nous avons évalué les degrés des sels nutritifs (Nitrate (NO3), Nitrite (NO2), Ammonium (NH4), Phosphate (PO4),Phosphore total (PT), Silicium (Si), Azote (N) dans la colonne d'eau ainsi que les taux de Carbone Organique Total (COT) et de l'Azote Total (NT) dans les sédiments en provenance de quatre fermes aquacoles (1, 2, 3 et 4) dans le golfe de Hammamet (Est de la Méditerranée). Les résultats obtenus montrent que les degrés les plus élevées de NO2, NO3, PO4 et PT ont été enregistrées au niveau de la ferme 1 et celles de NH4, Si et N au niveau de la ferme 4. Les fermes relativement anciennes sont les plus enrichies en sels nutritifs.

Keywords: Tunisian Plateau, Nutrients, Aquaculture

Introduction

Durant ces dernières années l'aquaculture offshore a connu une croissance considérable à travers le monde, ce qui a généré des revenus liés à cette activité et crée des milliers d'emplois directs et indirects. Cependant, les fermes aquacoles peuvent engendrer des rejets de composés chimiques ainsi que des nutriments persistants comme les sels nutritifs. Toutefois, L'évaluation de la teneur de l'azote et du phosphate joue un grand rôle dans la détermination du statut écologique du système aquatique [1]. Aucune étude jusqu'à nos jours n'a été entreprise sur les fermes aquacoles implantées en Tunisie. Ce travail est réalisé afin de déterminer la variabilité des principaux paramètres d'eutrophisation des eaux collectées de quatre fermes aquacoles tunisiennes.

Matériel et Méthodes

Les échantillons été collectée au printemps de l'année 2013, à partir des quatre fermes et d'une zone standard (zone témoin : entre les fermes aquacoles). Nous avons choisi quatre fermes aquacoles qui produisent du loup (*Dicentrachus labrax*) et de la Daurade (*Sparus aurata*).Ces fermes sont localisées au niveau du golfe de Hammamet (Est de la Mer Méditerranée).

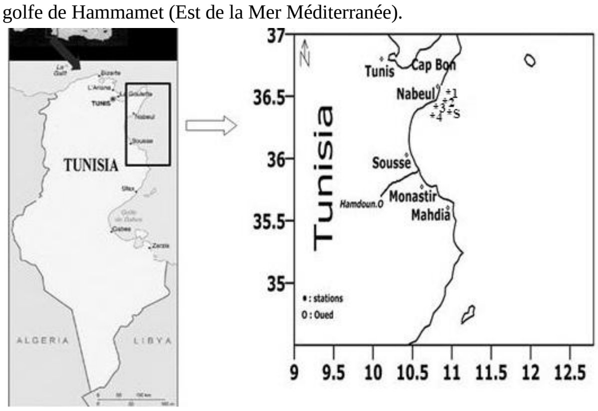

Fig. 1. Localisation des fermes aquacoles

Trois réplicas d'eau et de sédiments superficiels ont été collectés à partir de trois cages de chaque ferme ainsi que de la zone standard. L'analyse des sels nutritifs a été réalisée à l'aide d'un Autoanalyseur selon la méthode colorimétrique. Le COT et NT ont été déterminés par l'analyseur CHNS.

Résultats et Discussion

Pour NO2, les concentrations en µmol/l varient de 0,1 à 0,45; alors qu'elles oscillent entre 0,96 et 2,79 pour NO3 ; entre 1,75 et 4,07 pour NH4; de 0,06 à 0,12 pour PO4; entre 1,74 et 4,79 pour Si; de 11,99 à 13,93 pour N et entre 1,44 et 2,03 pour PT. Les pourcentages du COT et du NT dans les sédiments étudiés varient respectivement entre 2 % et 7 % et 0,15 % et 1,26 %. L'Analyse en Composante Principale a montré qu'au niveau de la ferme 1, qui est la ferme la plus ancienne, nous avons enregistré les teneurs les plus élevées en sels nutritifs (nitrate, nitrite, phosphate et phosphore).

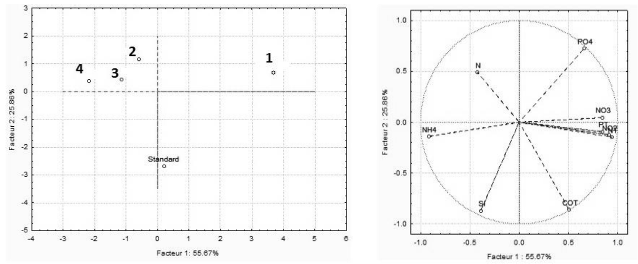

Fig. 2. Analyse en composante principale des éléments nutritifs

Malgré que ces éléments nutritifs dosés soient relativement les plus élevées par rapport aux trois autres fermes étudiées, les teneurs restent inférieures à celles trouvées dans d'autres fermes aquacoles en Méditerranée. En effet, au niveau de mer Egée [2], les teneurs en nitrate ont atteint 7 µmol/l ; celles en nitrite 1,5 µmol/l et pour le phosphate 6,8 µmol/l. Au niveau de la ferme 1 les teneurs en nitrate, nitrite et phosphate sont respectivement de l'ordre de 2,9 ; 0,5 et 0,1 µmol/l. La ferme 4 présente les teneurs les plus élevées en ammonium, silicium et azote. Certains auteurs ont démontré [3] que la répartition de l'ammonium et de l'azote peut être en relation avec la variation des paramètres physiques comme la température, la salinité et la densité de l'eau. Les taux du COT et du NT dans les sédiments, qui sont plus élevés au niveau de la ferme de 1 et de la zone Standard, sont en relation très étroite avec la granulométrie des sédiments [4].

Conclusion

Dans ce travail, nous avons pu démontrer que les taux en éléments minéraux au voisinage des cages d'élevage augmentent parallèlement avec l'ancienneté des fermes. Cet enrichissement peut être lié à l'activité aquacole intense dans la zone de Benikhiar (golfe de Hammamet). Il serait judicieux de surveiller à court et à long terme la colonne d'eau et les sédiments aux alentour des fermes aquacoles afin d'assurer un développement durable de l'activité aquacole dans les eaux tunisiennes.

References

1 - Jarvie H.P., Whitton B.A. and Neal C. 1998. Nitrogen and phosphorus in east coast British rivers: speciation, sources and biological significance. *Sci. Total Environ*., 79–109.

2 - Aydin-onen S., Kocak F. and Kucuksezgin F., 2012. Evaluation of spatial and temporal variations of inorganic nutrient species in the eastern Aegean Sea waters. *Mar Pollut Bull.*, 64: 2849-2856.

3 - Mantzavrakos E., Kornaros M., Lyberatos G. and Kaspiris P., 2007. Impact of marine fish farm in Agrolikos Gulf (Greece) on the water column and the sediment. *Desalination*., 210: 110-124.

4 - Mcghie T.K., Crawford C.M., Mitchell M. and O'brien D. 2000. The degradation of fish-cage waste in sediments during fallowing. *Aquaculture*, 187: 351–366.

ORGANIC MATTER DYNAMICS ALONG THE ARNO RIVER (ITALY) AND ITS ESTUARY

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Abstract
Organic matter concentration and the optical properties of its chromophoric fraction (CDOM) were measured along the Arno River and in its estuary, in September 2015. Organic matter concentration strongly increased along the river, while in the estuary it was mainly affected by conservative mixing.

Keywords: River input, Tyrrhenian Sea, Organic matter, Estuaries

Over the last years, the interest in organic matter (OM) dynamics in rivers and estuaries has grown, due to the potential role of these areas as a source of CO_2 to the atmosphere and to the impact of climate change on river floods. The Arno River is the largest river in Tuscany, it is characterized by a highly variable water discharge and it is impacted by many different anthropic activities [1]. It is also an important source of C to the Med Sea, due to its high dissolved organic carbon (DOC) concentration [2-4]. The main goals of this work were: to elucidate the main sources/origin (natural, industrial, agriculture, anthropic) of OM along the Arno River, and to investigate the main processes removing DOC in the estuary. In September 2015, in the framework of the Envimed-Comecom Project, samples were collected along the Arno River and in its major tributaries. In the estuary, samples were collected in the surface layer, across the salinity gradient, and in the bottom layer, across the deoxygenation gradient. The application of PARAFAC to the Excitation-Emission matrixes resulted in the validation of a 5-component model, identified as: humic-like (C1, C4), fulvic-like (C2), protein-like (C3) and PAH-like (C5) compounds. Flow cytometry was used to enumerate free-living heterotrophic prokaryotes and to evaluate ultraphytoplankton abundance and structure. DOC and POC concentration, as well as absorption, humic-like fluorescence and heterotrophic prokaryotes abundance (HPA), increased from the spring to the estuary (ΔDOC= 405 µM; ΔPOC= 286 µM; ΔHPA = 3.3×10^6 cells/ml) (Fig. 1).

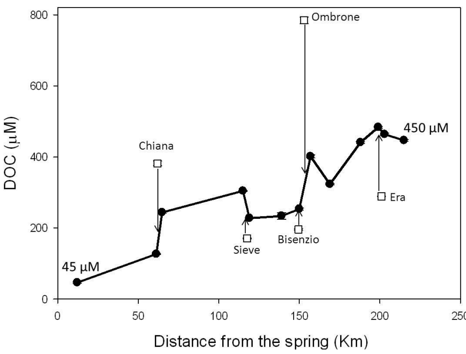

Fig. 1. DOC concentration along the Arno River (black circles) and in its major tributaries (empty squares).

Protein-like and PAH-like fluorescence started to increase after Florence. CDOM fluorescence, normalized on DOC concentration, indicated that the increase in humic-like compounds was mainly related to the increase in DOC, while protein-like and PAH-like fluorescence increased not linearly with DOC. Along the river, the percentages of DOC and POC were highly variable (~25-75%). The major tributaries had highly variable DOC and POC concentrations (DOC = 171 - 786 µM, POC = 96 - 455 µM). Chiana and Ombrone showed the highest DOC values (368 and 786 µM, respectively; Fig. 1) and CDOM absorption and fluorescence, but the lowest HPA. In the estuary, POC, DOC and CDOM were mainly affected by conservative mixing, as confirmed by their good linear relationship with salinity. At intermediate salinity, DOC values were slightly lower than those predicted by the relationship (ΔDOC=17-18 µM), suggesting the occurrence of removal processes. In order to assess if the removal can be due to biological activity, two mineralization experiments were carried out in March and September 2015 by adding the microbial community of the estuary (S=12), to the water collected at a S=12 and filtered at 0.2 µm. The bottles were incubated in the dark and at in situ temperature for 2 months. In both experiments, DOC showed an exponential decrease with time. The largest decrease was observed in the first 48 h, together with a marked increase in HPA (Fig. 2).

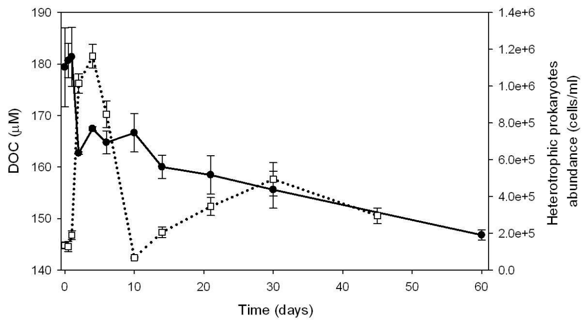

Fig. 2. DOC concentration (black circles) and heterotrophic prokaryotes abundance (empty squares) during the March 2015 experiment. Error bars refer to standard deviation between three replicates.

DOC removal rates ranged between 15 and 24 µM/month. In the bottom layer, a very thick salt intrusion was observed up to 12 Km inside the river, where a hypoxic zone was observed below 0.5 m. Following the deoxygenation gradient DOC concentration and HPA increased linearly. These data suggest that DOM accumulates under hypoxic conditions despite HPA is ≈ 3-fold higher than in marine surface waters.

References
1 - Cortecci G. et al., 2009. Geochemistry of trace elements in surface waters of the Arno River Basin, northern Tuscany, Italy. *Applied Geochemistry* 24, 1005-1022
2 - Vignudelli S. et al., 2004. Distributions of dissolved organic carbon (DOC) and chromophoric dissolved organic matter (CDOM) in coastal waters of the northern Tyrrhenian Sea (Italy). *Estuarine, Coastal and Shelf Science*, 60 (1), 133-149.
3 - Gonnelli M. et al., 2013. Chromophoric dissolved organic matter and microbial enzymatic activity. A biophysical approach to understand the marine carbon cycle. *Biophysical chemistry*, 182, 79-85.
4 - Retelletti Brogi S. et al., 2015. Biophysical processes affecting DOM dynamics at the Arno river mouth (Tyrrhenian Sea). *Biophysical chemistry*, 197, 1-9.

CIESM Congress Session : Atmospheric chemical pollutants
Moderator : Michael Angelidis, Monaco Environment Laboratories, IAEA

Moderator's Synthesis

Monitoring data and modelling results presented in this session provided evidence that nutrient inputs from atmospheric deposition may lead to increased primary production in specific areas of the Mediterranean Sea. However, participants noted that there is still uncertainty on the magnitude of the impact of atmospherically transported nutrients on the Mediterranean marine environment and that related research should be maintained. It was underlined that in order to understand the magnitude of the potential impact, it is important to know more accurately the load of nutrients (and soluble Fe) transported to the Mediterranean. Actual atmospheric deposition models are using precipitation estimations based on satellite data and available meteorological models. However, in order to improve the accuracy of estimations on nutrients loads transported to the marine environment, it is important to gather more data on the volume of precipitation at the open sea.

One presentation provided evidence that atmospheric transportation of microorganisms may impact the ambient microbial population in the marine environment, through viral infection and/or predation and may also influence C and N fixation. The influence of airborne microorganisms on the receiving marine environment is an issue that needs further study. The discussion pointed out recent evidence that atmospheric deposition may also be an important pathway for the transport of microplastics (mainly microfibers) to the surface microlayer of the sea. Important information on the distribution pattern of microplastics in the ocean could be gathered by including microplastics determination in the protocols of wet deposition studies.

Participants noted that certain important issues were not presented in the Session. Specific mention was made to the atmospheric transfer of POPs to the Mediterranean Sea, as well as to the deposition and methylation of Hg in the marine water column. Studies in the open ocean suggest that although anthropogenic Hg emissions are relatively constant for the last decade, Hg burden in intermediate ocean waters will continue to increase maybe due to cycling of “legacy” Hg between compartments. Given the natural and anthropogenic Hg enrichment in the Mediterranean basin, further studies would be needed to better understand the transfer, cycling and transformation of Hg in the Mediterranean atmospheric/marine environment.

ATMOSPHERIC DEPOSITION OF DISSOLVED ORGANIC CARBON (DOC) AT THE ISLAND OF LAMPEDUSA: A PRELIMINARY STUDY

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Abstract
Atmospheric deposition of dissolved organic carbon (DOC) at the Lampedusa Island allowed for a first estimate of the DOC fluxes at this site. The excitation-emission matrixes (EEMs) allowed to gain information about the composition of atmospheric DOM.

Keywords: Atmospheric input, Organic matter, Mediterranean Sea

Marine dissolved organic carbon (DOC) represents the largest reservoir of organic carbon on Earth. Its pool is equivalent to the atmospheric CO_2, the net oxidation of only 1% of marine DOC would therefore generate a CO_2 flux similar as that produced annually by fossil fuel combustion [1]. The Mediterranean Sea (Med Sea) receives different types of compounds (inorganic and organic) from the atmosphere via wet or dry deposition. The organic fraction of atmospheric deposition can undergo biotic and abiotic transformations in the atmosphere and upon its arrival to the surface ocean, with an important impact on the marine carbon cycle. Although the organic fraction of aerosol plays a crucial role in the C, N, and P biogeochemical cycles, very limited information is available in the Med Sea. The main goals of this study are: (1) to obtain the first information on the atmospheric deposition of DOC at the island of Lampedusa and (2) to gain some qualitative information about the composition of atmospheric dissolved organic matter (DOM) through the analysis of the optical properties (absorption and fluorescence) of its chromophoric fraction (CDOM). A specifically designed total atmospheric deposition sampler for DOM was installed at the ENEA Station for Climate Observations at Lampedusa in March 2015. The sampling site is strategic because Lampedusa is far from continental regions and from relevant pollutant sources. It is suitable for the study of specific phenomena relevant for climate, such as the transport and effects of Saharan dust, as well as for oceanographic studies, since it is close to the Sicily Channel, a strategic point for the Med Sea circulation. Atmospheric deposition was collected between March 19th and December 2nd 2015. Measured DOC fluxes range between 0.07 and 1.81 mmol C m^{-2} day^{-1}, with a marked variability (Fig. 1).

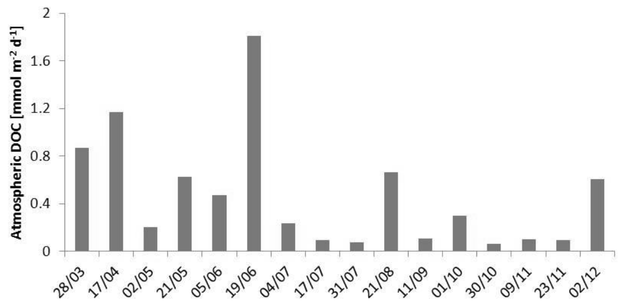

Fig. 1. DOC fluxes between March and December 2015

These data are in the range of DOC atmospheric fluxes measured at Cap Ferrat in 2006 (0.04-1.2 mmol C m^{-2} day^{-1}) [2] and of total OC (TOC) in rainwater at the island of Crete (0.14 mmol C m^{-2} day^{-1}) [3]. Assuming this range valid for the whole basin, a total input of $0.4\text{-}4.3\cdot10^{12}$ g C $year^{-1}$ can be estimated. This rough estimate suggests that DOC input from the atmosphere could be up to 18 times larger than the river input [4].

The excitation-emission matrixes (EEMs) of CDOM in total deposition generally show 3 peaks (2 examples are reported in Fig. 2). (1) Peak A (excitation wavelength, λ_{ex} = 250 nm and emission wavelength, λ_{em} = 400-500 nm), this peak has been observed in many studies on marine DOM, in particular in coastal regions and is attributed to terrestrial humic-like substances [5,6,7]. (2) Peak M (λ_{ex} = 310-320 nm and λ_{em} = 400-450 nm) shows lower levels of fluorescence intensity than peak A and it is observed in all the samples. In previous studies it was attributed to marine as well as terrestrial humic-like substances [5,6,7]. (3) Peak T (λ_{ex} = 280 nm and λ_{em} = 340 nm) is attributed to protein-like substances [5,6,7] and it is present in a sub-group of samples.

These preliminary results suggest that atmospheric input can be an important, and up to now overlooked, source of DOC and CDOM to the Med Sea.

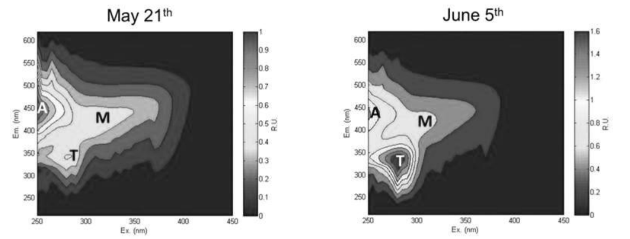

Fig. 2. The EEMs of CDOM. The letters refer to the 3 main peaks reported in the text.

References
1 - Hansell, 2013. Recalcitrant Dissolved Organic Carbon Fractions. *Ann. Rev. Mar. Sci.*, 5: 421-445.
2 - Pulido-Villena, E., T. Wagener, and C. Guieu (2008), Bacterial response to dust pulses in the western Mediterranean: Implications for carbon cycling in the oligotrophic ocean, *Global Biogeochem. Cycles*, 22, GB1020, doi:10.1029/2007GB003091.
3 - Economou C. and Mihalopoulos N., 2002. Formaldehyde in the rainwater in the eastern Mediterranean: occurrence, deposition and contribution to organic carbon budget. *Atmos. Environ.* 36, 1337-1347.
4 - Santinelli C., 2015. "DOC in the Mediterranean Sea." *Biogeochemistry of Marine Dissolved Organic Matter*. Academic Press Elsevier, Burlington. 579-608
5 - Coble P.G., 1996. Characterization of marine and terrestrial DOM in seawater using excitation-emission matrix spectroscopy. *Mar. Chem.* 51, 325-346.
6 - Murphy K.R., Stedmon C.A., Waite T.D., Ruiz G.M., 2008. Distinguishing between terrestrial and autochthonous organic matter in marine environments using fluorescence spectroscopy. *Mar. Chem.* 108, 40-58.
7 - Kowalczuk, P., W. J. Cooper, R. F. Whitehead, M. J. Durako, W. Sheldon. 2009. Characterization of CDOM in an organic-rich river and surrounding coastal ocean in the South Atlantic Bight. *Aquat. Sci.* 65: 384–401.

WET ATMOSPHERIC DEPOSITION OF DISSOLVED NUTRIENTS (N, P, SI) IN NORTH AFRICA COASTAL SITE (ANNABA, ALGERIA) FROM LONG-TERM SURVEY

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Abstract

Wet atmospheric deposition of dissolved inorganic nitrogen (DIN), phosphate (PO_4) and silicates ($Si(OH_4)$) was studied in 271 samples collected at a fixed coastal site (Annaba, Algeria), during October 2011-February 2016. The DIN WAD was three-fold low when compared to Mediterranean values. In contrast, PO_4 wet atmospheric deposition may be considered as the highest value in the Mediterranean area. Annual $Si(OH)_4$ fluxes were also elevated and followed the same seasonal pattern of PO_4.

Keywords: Nutrients, Atmospheric input, South-Western Mediterranean

Wet atmospheric deposition (WAD) has been reported as the main source of dissolved nutrients to the western Mediterranean [1]. The WAD of dissolved inorganic nitrogen (DIN) has been recognized as significant in the Mediterranean region, contributing in the same magnitude of the riverine input [1]. Because of its proximity to Algerian desert, Annaba region is directly submitted to African high dust loads [2], which transport during rain events bioavailable phosphorus (phosphate: PO_4) and silicon (silicates: $Si(OH)_4$). However, data on wet atmospheric deposition of nutrients are missing in almost North African countries, and practically lacking in Algeria. The objective was to estimate the WAD of dissolved inorganic nutrients (N, P, Si) and to assess how much this input influenced the enrichment of Annaba Bay coast waters.

Wet atmospheric deposition of dissolved inorganic nitrogen DIN (NH_4^+ + NO_3^- + NO_2^-), PO_4 and $Si(OH)_4$ was studied from 271 samples collected at a fixed coastal location around Annaba city, Algeria, during October 2011-February 2016. The rain gauge used for rainfall sampling was placed in a cleared and fenced area of Badji Mokhtar University (4 km from Annaba coast, 30 m above the sea level). All samples were collected on an event basis. Data of daily precipitation in the Annaba region were obtained from Annaba meteorological station and completed from http://fr.tutiempo.net/climat/ws-603600.html. In the laboratory, all nutrient concentrations (µmol l^{-1}) were determined following the methods described in Parsons et al. (1989). The instantaneous flux of nutrients were assessed by multiplying the nutrient level (µmol l^{-1}) by the amount of the precipitation (liter/m²) for each rain event, and expressed in µmol/m².

Seasonal average levels of PO_4 and SiO_4 ranged from 1-1.60 µmol l^{-1} and 8-17 µmol l^{-1}, respectively, with maximum values encountered during spring and autumn when Saharan and tropical (El Niño Southern Oscillation: ENSO) influences dominated the area. At the opposite, levels of these nutrients dropped to their minimum under winter North Atlantic Oscillation (NOA) effects. PO_4 wet atmospheric loads varied with seasons (17-320 µmol m^{-2} yr^{-1}) and years (650-940 µmol m^{-2} yr^{-1}). These amounts may be considered as the highest values in the Mediterranean area. PO_4 inputs increased during winter rainy period (340 µmol m^{-2} yr^{-1}), and during autumn coinciding with large scale meteorological event impacts, in particular ENSO warm events which may increase autumn rainfall. Annual SiO_4 fluxes ranged from 6,740 to 8,960 µmol m^{-2} yr^{-1}, and followed the same seasonal pattern of PO_4. The rainfall over Annaba coastal area is heavily loaded with PO_4 and SiO_4 in particular during autumn and spring when ENSO event prevails in the region. Due to direct Saharan dust transport (and local human activities), levels of PO_4 and SiO_4 over Annaba coastal zone are the highest in the Mediterranean region. In winter, when the North Atlantic Oscillation (NOA) dominated, the levels of these nutrients decreased but their loads increased with the increasing of the precipitation events and amounts.

The DIN average levels (25 µmol l^{-1}) were three-fold low when compared to Mediterranean values. Ammonium ($NH_4^{+)}$ and nitrate (NO_3^-) had comparable levels (11-13 µmol l^{-1}) with a maximum during autumn and summer for NO_3, and can be considered among the lowest known values in the Mediterranean Sea. The DIN wet atmospheric deposition fluxes were in the order 1,800 µmol m^{-2} yr^{-1}. Inputs were elevated during winter, autumn and in a lesser degree during spring. The local atmosphere in Annaba area seems to be weakly impacted by the low anthropogenic activities (transport, agriculture, industry emissions), as the WAD of dissolved nitrogen, was the lowest in the Mediterranean region. Also, large scale (NOA) transport (of nitrogen gaseous forms) may be limited. Similar fluxes were reported [1] in a contiguous coastal city (Mahdia, Tunisia), where human activities and climate are very comparables.

References

1 - M. Koçak, N. Kubilay, S. Tugrul, N. Mihalopoulos, 2010. Atmospheric nutrient inputs to the northern Levantine basin from a long-term observation: sources and comparison with riverine inputs. Biogeosciences 7, 4037-4050.

2 - R. Morales-Baquero, E. Pulido-Villena, I. Reche, 2013. Chemical signature of Saharan dust on dry and wet atmospheric deposition in the south-western Mediterranean region. Tellus B 2013, 65, 18720.

THE POTENTIAL IMPACTS OF AIRBORNE MICROBES IN DESERT DUST ON THE SE MEDITERRANEAN SURFACE SEAWATER

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Abstract
Atmospheric dust events can create a transoceanic bridge, injecting a wide variety of airborne microorganisms. This study documents their potential impacts on the SE Mediterranean surface water (SEMS) production and ambient microbial population. Our results show a significant microbial variability in aerosol samples collected at the shoreline of the SEMS, and demonstrate that some heterotrophic airborne bacteria are active in sterile Mediterranean seawater and fix both C and N under some circumstances. Furthermore, we show that airborne microbes caused a specific decrease in ambient Prochlorococcus abundance, possibly triggered by some airborne viral infection or airborne bacterial predation on the Prochlorococcus' cells.

Keywords: Aerosols, Levantine Basin, Atmospheric input, Bacteria, Primary production

Aerosols and dust are periodically transported across the oceans and seas, supplying nutrients and trace metals to the surface water [1]. Additionally, aerosols may also contain a wide array of different airborne microorganisms (heterotrophic bacteria, viruses, cyanobacteria and fungi), which can easily be transported thousands of kilometers away from their origin within a few days [2]. The SEMS is an ideal marine system for studying the potential impact of aerosols and airborne microbes on surface microbial production, because it is an oligotrophic environment with low inorganic nutrients and low autotrophic and heterotrophic activity [3] that is subject to relatively high aerosol deposition throughout the year [4]. Thus, any external input of micro/macronutrients, along with airborne microbes, can have a relatively significant effect upon interaction with the ambient microbial populations, thereby having a potential impact on the system’s production and ecological function [5]. The heterotrophic airborne microbial community exhibits high diversity (Fig. 1). A principle component analysis of the 16S rRNA gene, extracted from aerosol filters that represent different geographical origins (determined by air mass back trajectory), indicated similar biological signatures in filters of a similar source but different signatures in aerosols from dissimilar geographical origins (Fig. 1). Microcosm bioassay experiments in which aerosols were added to sterile (0.2-µm filtered and autoclaved) SEMS were performed in order to assess the potential impact of airborne bacteria on bacterial abundance, production and N2 fixation. A significant increase was observed in all parameters within a few hours (ANOVA, p<0.05), suggesting that airborne microbes can account for one-third of bacterial abundance and 50-100% of bacterial production and N2-fixation rates, following dust/aerosol amendments to surface SEMS (Fig. 1). Experiments in which dust collected during an intense dust storm (September 2015) was added to surface SEMS indicate that airborne microbes cause a rapid decrease in Prochlorococcus abundance and that the effect is dose-dependent (Fig. 2). While the addition of UV-killed (48h) aerosol resulted in a modest decrease in Prochlorococcus, possibly due to certain chemical toxicity effects, the addition of ‘live’ dust caused a much larger decline within 48 hours of the addition. We hypothesize that this effect can be attributed to some airborne viral infection or to bacterial predation on the Prochlorococcus cells. Our results suggest that dust/aerosol deposition can be a potential source of a wide array of microorganisms, all of which may affect microbial composition and food-web dynamics in oligotrophic marine systems such as the SEMS.

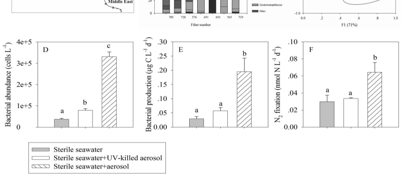

Fig. 1. Upper panel: (A) Representative air mass back trajectories analyses (3 days) derived from NOAA/ARL HYSPLIT-4 backward trajectories model showing the route and origin of the aerosols used in this study. Different colors represent different air mass trajectories; Middle East (gray, filters # 450,565,739), Sahara desert (red, filters # 576, 691 and dust collected in February 2015) and Eastern Europe (yellow, filters # 785, 738), (B) Taxonomic distributions of 16S rRNA genes analyses (family level) retrieved from the different aerosol samples, and (C) The genetic discrimination of bacterial phylotypes based on a/the principle component analysis (PCA) of the different dust sources. Lower panel: (E) Bacterial abundance, (F) bacterial production and (G) N_2 fixation rates following the addition of aerosol (collected during February 2015) to sterile SEMS surface water. The letters above the columns represent statistically significant differences (one-way ANOVA and a Fisher-LSD

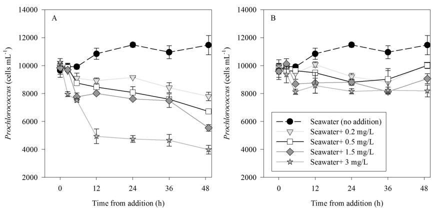

Fig. 2. Changes in the *Prochlorococcus* abundance in water collected from the SEMS following the addition of various amounts of (A) non-killed and (B) UV-killed aerosols collected during a dust storm in September 2015, Haifa, Israel.

References
1 - Guieu C, Aumont O, Paytan A, et al. 2014. Global Biogeochemical Cycles deposition to Low Nutrient Low Chlorophyll regions. Global Biogeochemical Cycles: 11:79–98.
2 - Griffin DW. 2007. Atmospheric movement of microorganisms in clouds of desert dust and implications for human health. Clinical Microbiology Reviews 20: 459–77.
3 - Raveh O, David N, Rilov G, and Rahav E. 2015. The temporal dynamics of coastal phytoplankton and bacterioplankton in the Eastern Mediterranean Sea. Plos One 10: e0140690.
4 - Guerzoni S, Chester R, Dulac F, et al. 1999. The role of atmospheric deposition in the biogeochemistry of the Mediterranean Sea. Prog Oceanogr 44: 147–90.
5 - Rahav E, Ovadia G, Paytan A, and Herut B. 2016. Contribution of airborne microbes to bacterial production and N2 fixation in seawater upon aerosol deposition. Geophys Res Lett 43: 1–9.

ATMOSPHERIC DEPOSITION IMPACTS ON NUTRIENTS AND BIOLOGICAL BUDGETS OF THE MEDITERRANEAN SEA, RESULTS FROM THE HIGH RESOLUTION COUPLED MODEL NEMOMED12/PISCES

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Abstract
We use a high resolution (1/12°) version of the 3D coupled model NEMOMED12/PISCES to investigate the effects of high resolution atmospheric dust deposition forcings on the biogeochemistry of the Mediterranean basin. Our results show that natural dust deposition accounts for 5% of global PO4 budget and that it influences primarily the southern part of the basin. Anthropogenic nitrogen accounts for 10% of bioavailable N supply for the northern part. Deposition events significantly affect biological production; primary productivity enhancement can be as high as 20% in the areas of high deposition, especially during the stratified period.

Keywords: Primary production, Mediterranean Sea, Aerosols, Nutrients, Models

Atmospheric deposition is at present not included in regional oceanic biogeochemical models of the Mediterranean Sea, whereas, along with river inputs, it represents a significant source of nutrients at the basin scale, especially through intense desert dust events. Moreover, observations [1,2] show that these events significantly modify the biogeochemistry of the oligotrophic Mediterranean Sea.

We use dust deposition simulations from an atmospheric regional models (ALADIN-Clim) [3,4] and nitrogen deposition from a global atmospheric chemistry model (INCA) [6]. We first evaluate atmospheric deposition fluxes by confrontation with observations of dust and nitrogen deposition over the Mediterranean basin. Then, we use the 3D coupled model NEMOMED12/PISCES in a high resolution (1/12°) regional configuration of the Mediterranean basin to investigate the effects atmospheric deposition forcings on the biogeochemistry. The model represents the evolution of 24 prognostic tracers in the Mediterranean Sea [5]. We evaluate the influence of deposition on the budget of nutrients in the basin on a decadal simulation (1997-2012) and its impact on the biogeochemistry (primary production, plankton distributions...). Our results suggest that nitrogen and dust deposition display different patterns. Nitrogen impacts primarily the northern part of the basin, and dust impacts primarily the south. The impacts of nitrogen deposition on nutrient budgets and biological production are greater than the impacts of natural dust deposition. Moreover, dust deposition effects are significant during the stratified period in the areas of high deposition (figure). Biological production is locally enhanced by dust up to 15% during deposition events.

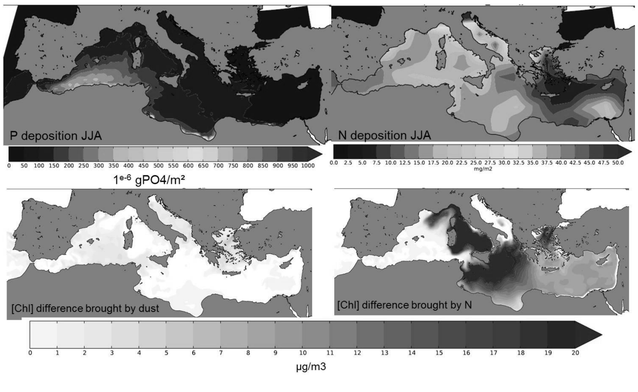

Fig. 1. Figure 1 Impacts of atmospheric deposition on surface Chla production in the summer period.

References
1 - Guieu, C., Dulac, F., Ridame C. and Pondaven, P. (2014a) Introduction to project DUNE, a DUst experiment in a low Nutrient, low chlorophyll Ecosystem, Biogeosci., 11, 425–442.
2 - Guieu, C., Ridame C., Pulido-Villena, E., Bressac, M., Desboeufs, K. and Dulac, F. (2014c) Impact of dust deposition on carbon budget: a tentative assessment from a mesocosm approach, Biogeosci., 11, 5621-5635.
3 - Nabat, P., Solmon, F., Mallet, M., Kok, J.F. and Somot, S. (2012) Dust emission size distribution impact on aerosol budget and radiative forcing over the Mediterranean region: a regional climate model approach, Atmospheric Chemistry and Physics Discussion, 12, pp. 17835–17886
4 - Nabat, P., Somot, S., Mallet, M., Michou, M., Sevault, F., Driouech, F., Meloni, D., di Sarra, A., Di Biagio, C., Formenti, P., Sicard, M., Léon, J.-F., and Bouin, M.-N. (2015) Dust aerosol radiative effects during summer 2012 simulated with a coupled regional aerosol–atmosphere–ocean model over the Mediterranean, Atmospheric Chemistry and physics, 15, pp. 3303-3326
5 - Palmiéri, J., Modélisation Biogéochimique de la mer Méditerranée avec le modèle régional couplé NEMO-MED12/PISCES (2014), thèse de doctorat d'université de Versailles Saint Quentin, 221p
6 - Hauglustaine, D. A., Balkanski, Y. and Schulz, M.: A global model simulation of present and future nitrate aerosols and their direct radiative forcing of climate, Atmos. Chem. Phys., 14(20), 11031–11063, doi:10.5194/acp-14-11031-2014, 2014.

WET DEPOSITION EFFECTS ON IRON AND NUTRIENT DISTRIBUTIONS IN IZMIR BAY, EASTERN AEGEAN SEA

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Abstract

The aim of this study was to determine the impacts of wet atmospheric deposition on nutrients and iron levels in Izmir Bay (Turkey). Rain water and marine water were collected monthly between 2012-2013 from the selected three stations. At the and of the research we found that nutrients and iron contents of rain water effected the quality of coastal marine water.

Keywords: Atmospheric input, Coastal waters, Nutrients, Eutrophication, Aegean Sea

Iron is an element essential for the biochemical and physiological activity of marine phytoplankton due to its role in many metabolic processes, i.e. photosynthesis, nitrate reduction, nitrogen assimilation, nitrogen fixation and oxidation reactions. In the aquatic environment iron and nutrients deficiency are responsible for the growth restriction of phytoplankton. Wet and dry deposition of iron molecules from the atmosphere is an important source for both HNLC (high nutrient low chlorophyll) and coastal marine waters. Particle iron (Fe^{+3}) transport over long distance by adsorbing onto particles in the air. In the meanwhile, reduced to Fe^{+2}, the bioavailable form to the marine phytoplankton (1).

The main purpose of this study primarily determination of particulate and dissolved (Fe^{+2} and Fe^{+3}) iron and nutrients (such as, nitrite, nitrate, ammonium, phosphorus and silicate) concentrations in rain water at the selected three stations (Homa Lagoon: Station1; Ege University: Station 2; Urla: Station 3). The sampling stations designated by the degree of rurality. St 1 is an rural area with no settlement, St 2 is an built up area with an high pressure of urbanization and St 3 is a semi urban area. Simultaneously, samples from the coastal marine waters were taken from the selected stations and analyzed on a regular basis for 12 months.

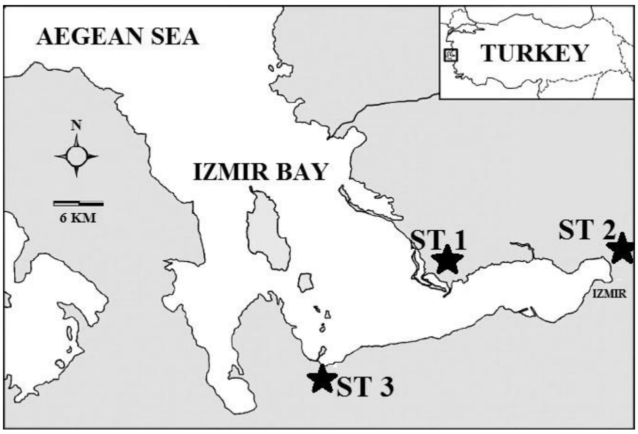

Fig. 1. Sampling stations for rain and marine water along the Izmir Bay

Izmir Bay is a part of the eastern coast of the Aegean Sea (Figure 1). Rain and marine water were collected with dark PE bottles from three stations (figure 1) (St.1, St. 2, St.3) on a monthly basis during a year. Since the summer is dry season in the area, rain water can't be collected in that period. Spectrophotometric analysis applied for nitrite, nitrate, ammonium, phosphate, silicate, particulate (Fe^{+3}) and dissolved iron (Fe^{+2}) concentrations (2, 3). Hatch Lange Dr 4000 model spectrophotometer is utilised for the determination of concentrations. Levels of nutrients and iron are shown in Table 1.

Tab. 1. Minimum–maksimum (average) nutrient and iron concentrations of coastal marine and rain waters (µg M/L)

	ST1 Rain Water	ST 1 Sea Water	ST 2 Rain Water	ST 2 Sea Water	ST 3Rain Water	ST 3 Sea Water
NO_2	0.46-2.52 (1.44)	0.01-6.28 (0.93)	0.03-1.04 (0.27)	0.08-4.67 (0.77)	0.59-2.19 (1.41)	0.01-0.88 (0.21)
NO_3	2.08-12.82 (8.50)	1.51-9.56 (3.29)	0.84-21.95 (13.99)	1.13-25.62 (9.67)	1.65-19.48 (10.75)	1.08-8.17 (2.97)
NH_4	2.63-15.03 (9.48)	1.49-19.93 (5.39)	3.24-29.01 (12.79)	0.93-29.87 (13.28)	3.49-17.10 (10.35)	0.29-7.83 (3.47)
PO_4	0.10-0.99 (0.41)	0.14-1.36 (0.35)	0.22-2.61 (0.71)	0.80-5.08 (1.99)	0.09-0.37 (0.24)	0.02-1.15 (0.30)
SiO_2	9.89-13.27 (11.66)	6.01-17.69 (8.52)	9.38-17.18 (13.82)	3.93-25.41 (14.68)	5.68-32.38 (18.54)	3.65-23.60 (9.77)
Fe^{+2}	0.10-0.32 (0.24)	0.02-0.04 (0.02)	0.07-0.14 (0.10)	0.01-0.05 (0.03)	0.05-0.19 (0.15)	0.03-0.07 (0.05)
Fe^{+3}	0.90-1.54 (1.25)	0.38-0.69 (0.56)	0.13-0.32 (0.24)	0.16-0.55 (0.37)	0.56-0.72 (0.65)	0.01-0.05 (0.02)

The most abundant nutrients were silicate, nitrate and ammonium both in sea and rain water from the all stations. Iron levels were more in the rain water than the marine water. While the order of total N was St 1<St 3< St 2 in rain water, it was St 3< St 1< St 2 in marine waters. Both Fe(II) and Fe(III) has the highest levels in St 3 during the year. The order of particulate iron levels in rain water were ST 2 < ST 3 < ST 1, which can be explained by the direction of the predominant wind. The dominant wind direction of Izmir Bay is N and NE (4). These winds are coming from the northerly agricultural land, Menemen lowland, where the fertilizers are intensively used. We assume that the iron–steel plants of the area is also contribute to the iron load of the air.

The high amount of nutrients and iron in rain water has contribution to marine waters and in certain months there is a eutrophication in Izmir Bay, even tough there is a treatment facilities.

At the end of the research, we found that nutrient and total iron concentrations in rain water affectted the coastal sea water quality directly. In addition, nutrient and total iron contents of rain water showed significant variations depending on the seasons and the sampling locations.

Acknowledgement; This research is supported by the Ege University Scientific Research Branch Office (Project number: 11/CSUAM/001)

References

1 - Siefert, R.L., 2009. Atmospheric Iron Deposition:Global Distribution, Variability, and Human Perturbations, Annu. Rev. Mar. Sci., 1:245–278.
2 - Strickland, J. D., Parsons, T. R., 1972. A Practical Handbook of Seawater Analysis, Fisheries Research Board of Canada, 2nd edition, 310p.
3 - Strickland, J.D, Austin, K.H., 1959. Analysis of Water. Conseil Perm. Intern. Exploration Mer, 24:446p.
4 - Sayin, E., 2003. Physical features of the Izmir Bay. Continental Shelf Research, 23(10), 957-970.

CIESM Congress Session : Environmental and pollution monitoring

Moderator : François Galgani, LER/PAC, Ifremer, France

Moderator's Synthesis

The session included 7 presentations mainly focusing on the development of methods and new approaches in support to future monitoring, rather than on assessment.

The context of monitoring the Mediterranean Sea, in the framework of various institutions (CIESM, MEDPOL, MSFD, IAEA, etc.) and the expected outputs were introduced prior to the session. Presentations were dealing with the chemical assessment of organic matter through HPLC, electroanalysis of nanoparticles, assessing /modelling methyl mercury in the Black Sea and satellite imagery with potential applications in both the Adriatic and Black Seas. The discussion was active and focusing on the general interest of monitoring, its future and expected outputs. The selection of indicators and the monitoring strategy were also discussed with a specific interest on the diversity of monitoring schemes, approaches, parameters and methods. The conclusion stated the importance of setting up priorities for a more efficient and harmonized monitoring and the necessity to consider both the scientific and political aspects in defining and implementing strategies.

A FAST HPLC METHOD FOR DETERMINATION OF D-/L-AMINO ACIDS IN SEAWATER

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Abstract

The organic matter pool in the seawater is consisted of different classes of organic molecules with varying sizes and structures. The origin of these organic molecules could be the terrestrial processes or *in situ* marine production or degradation. Determination of D/L-amino acids in the seawater has been used in the last decades as one of the confirmatory tools to understand the origin of the organic matter. In this study, a fast and modified HPLC method was proposed for the analysis of amino acids in the seawater.

Keywords: Organic matter, Izmir Bay, Analytical methods

Introduction

Dissolved organic matter (DOM) can be classified as autochthonous (marine origin) and allochthonous (terrestrial origin) according to its source. However, there are vast amount of biomolecules at different structures and sizes that hardens their characterization and separation from each other. Among these biomolecules, most abundant ones found in DOM are amino acids, carbohydrates, lipids, fatty acids, sterols, humic acids, fulvic acids, and lignins. From these classes, amino acids are studied as a descriptive tool for prediction of the origin and transformation rate of DOM [1]. For example, D-amino acids are found in the cell walls of marine bacteria and the enantiomeric amino acid ratio in seawater gives important information about the origin of DOM [1,2]. However, total analysis time of the existing enantiomeric amino acid determination methods in HPLC are long and new rapid resolution columns could be used to decrease the analysis time [3,4]. In this study, a fast and modified HPLC method was proposed for the analysis of amino acids in the seawater.

Materials and Methods

The HPLC method used in this study is based on the fluorometric detection of chiral reaction products of amino acids according to Dittmar et al. 2009's method with modified mobile phase, HPLC column, column temperature and analysis time [3]. The derivatization was first achieved with o-phtaldialdehyde (OPA) and sequentially by N-isobutyryl-D/L-cysteine (IBLC/IBDC). Briefly, OPA was dissolved within 0.5 M borate buffer whose pH was adjusted to 9.5. IBLC and IBDC were first dissolved in methanol and after ultrapure water with the ratio of 4:6. For the derivatization reaction, 100 µL of sample was sequentially mixed with 2 µL of OPA and 2 µL of IBLC or IBDC in the autosampler whose temperature was adjusted to 4 °C. The injection volume was 10 µL. The separation was performed with Eclipse Plus C_{18} (4.6x150 mm, 3.5 µm) analytical HPLC column. The mobile phases A and B were 25 mM sodium acetate buffer (pH 6.0) and acetonitrile:methanol:water (45:45:10), respectively. The mobile phase conditions for the linear gradient elution were as follows: 0-2 min. 2-8% B, 2-20 min. 8-16% B, 20-23 min. 16-16.5% B, 23-35 min. 16.5-22.1% B, 35-67 min. 22.1-39.5% B, 67-68 min. 39.5-100% B, 68-75 min. hold at 100% B, 75-76 min. 100-2% B, 76-78 min. hold at 2% B. The flow rate was 1.1 mL/min and the column oven was kept at 40 °C. The fluorescence of the derivatized samples were recorded at excitation/emission wavelengths of 330/445 nm and 230/445 nm, respectively. The certified L-amino acid mix standards (including QNMR result) for the calibration were purchased from Sigma-Aldrich (Prod. No: 79248).

Discussion and Conclusion

In this study, total analysis time was reduced to 68 min. except the wash period which was applied for an extra 10 min (from 68 to 78 min.) (Figure 1). The method proposed in this study has high peak resolutions (minimum $R \geq 1.5$) and acceptable separation factors with minimum $\alpha \geq 1.03$. The amino acids that could be identified with this method are D/L-Asp, D/L-Glu, D/L-Ser, D/L-Thr, Gly, D/L-Arg, D/L-Ala, D/L-Tyr, D/L-Val, L-Ile, and D/L-Phe, respectively. With the method proposed in this study, it is possible to determine 20 D/L-amino acids in the seawater. However, in further studies, this method could be improved by using columns with smaller particle size or shorter columns and also by using different gradient elution programmes. The authors thank to TUBITAK for financial support of the project (113Y447). The authors also thank to project personnel and R/V K. Piri Reis crew for their support. Hakan Alyuruk thanks to TUBITAK-BIDEB 2211 for scholarship. This study was also a part of the Ph.D. thesis of Hakan Alyuruk.

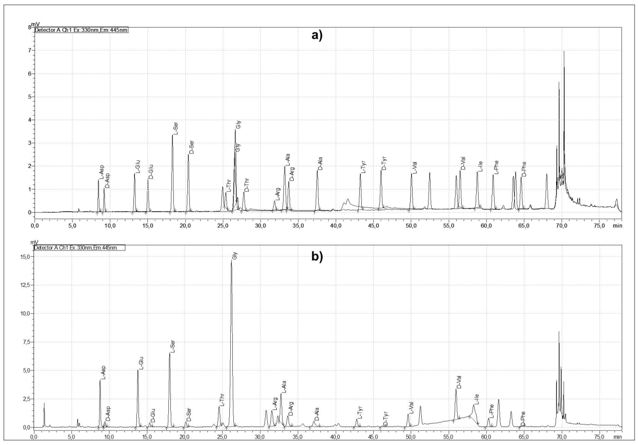

Fig. 1. The superimposed chromatograms for IBDC and IBLC methods using L-amino acid standards at 50 nM (a), and the chromatogram of a surface seawater sample (filtrated from GF/F filter) taken from the inner Izmir Bay, Aegean Sea, Autumn 2015 (38°27.216' N, 27°08.484' E) (b).

References

1 - Fitznar H.P., Lobbes J.M. and Kattner G., 1999. Determination of enantiomeric amino acids with high-performance liquid chromatography and pre-column derivatisation with o-phtaldialdehyde and N-isobutylrylcysteine in seawater and fossil samples (mollusks). J. Chromatogr. A, 832: 123-132.

2 - McCarthy M.D., Hedges J.I. and Benner R., 1998. Major bacterial contribution to marine dissolved organic nitrogen. Science 281: 231-234.

3 - Dittmar T., Cherrier J. and Ludwichowski K.U., 2009. The analysis of amino acids in seawater. In: Wurl O. (ed.), Practical Guidelines for the analysis of seawater. Taylor & Francis Group, pp 67-77.

4 - Escoubeyrou K. and Tremblay L., 2014. Quantification of free, dissolved combined, particulate, and total amino acid enantiomers using simple sample preparation and more robust chromatographic procedures. Limnol. Oceanogr. Methods, 12: 421-431.

AN EMPIRICAL OCEAN COLOR ALGORITHM FOR ESTIMATING THE CONTRIBUTION OF COLORED DISSOLVED ORGANIC MATTER IN WESTERN ADRIATIC SEA

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Abstract
Empirical band ratio algorithms for the estimation of Colored Dissolved Organic Matter (CDOM) using MODIS ocean color sensor were developed for Western Adriatic Sea (Mediterranean Sea). Correlations between in situ measurements of CDOM absorption coefficients at 355 nm ($a_{CDOM}355$) with Modis remote sensing band ratios were examined. The best performance was obtained by linear regression using $R_{rs}(667)/R_{rs}(488)$ band ratio both for the entire pool of data (R^2=0.85) and for data with salinity <35 (R^2=0.89).

Keywords: Organic matter, North Adriatic Sea, Ocean colours, Remote sensing

Introduction
The Colored fraction of Dissolved Organic Matter (CDOM) plays various roles in physical and biogeochemical processes. CDOM absorption coefficient, a_{CDOM}(*lambda*), has been shown to vary mainly with type and source of CDOM. It can dominate the inherent light absorption at the blue wavelengths in surface waters of the coastal and pelagic ocean/sea [1]. In many coastal areas, CDOM absorption is several times that of chlorophyll proving to be a useful tracer not only for carbon but also as a proxy for mixing in a wide variety of environments. The accurate retrieval of CDOM absorption is, however, a prerequisite for applying ocean color remote sensing data to separate it from other optically active ocean constituents such as chlorophyll *a* or rate processes such as phytoplankton productivity. Numerous bio-optical algorithms have been developed to retrieve CDOM absorption from ocean color satellite observations around the world.
As a part of several national and international projects (RITMARE, BALMAS, ECOSEE/A), oceanographic cruises in the Central and Northern Adriatic Sea were conducted between 2013 and 2015. This work aims to develop an empirical algorithm to retrieve CDOM from satellite remote sensing reflectance (R_{rs}) in Western Adriatic Sea, which is a complex system influenced by one of the largest Mediterranean rivers (Po).

Methods
The in situ measurements were performed in Western Adriatic Sea from December 2013 to May 2015 (Fig. 1).

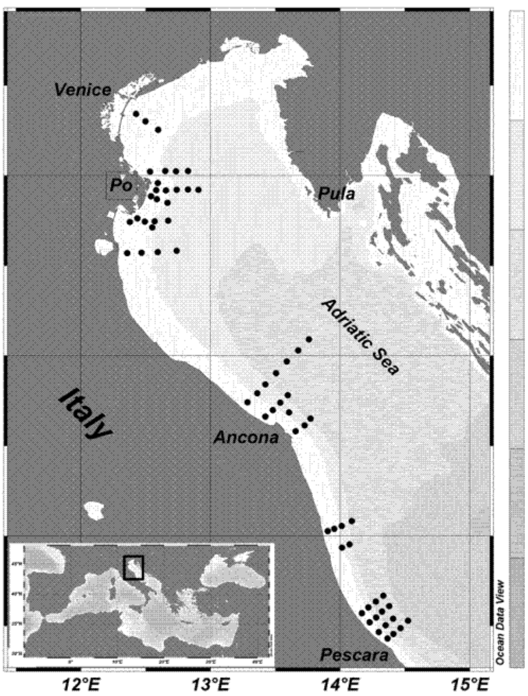

Fig. 1. Fig. 1 Map of all sampling stations in the Italian waters of the Adriatic Sea. Some stations were sampled more than once.

Sea surface water samples from different areas of the Adriatic Sea were collected in different seasons. A total of 91 samples corresponded to clear-sky days during which satellite Modis-Aqua acquired Rrs. For each of these samples, temperature, salinity (S) and $a_{CDOM}355$ were measured. The CDOM absorption coefficient $a_{CDOM}355$ was then correlated, using linear or exponential regressions, with the following MODIS R_{rs} band ratios: ($R_{rs}(412)/R_{rs}(547)$, $R_{rs}(488)/R_{rs}(547)$, $R_{rs}(667)/R_{rs}(412)$ and $R_{rs}(667)/R_{rs}(488)$).

Results and Discussions
The linear regression was proved to be most performing (i.e. higher R^2) with respect to the exponential regression. A linear relationship between $a_{CDOM}355$ and the different ratios of R_{rs} was observed but with different goodness of fit. The best linear regression between CDOM absorption and the in situ values were obtained by using the $R_{rs}(667)/R_{rs}(412)$ and $R_{rs}(667)/R_{rs}(488)$ band ratios with R^2 values of 0.79 and 0.85, respectively, whereas the use of the $R_{rs}(412)/R_{rs}(547)$ and $R_{rs}(488)/R_{rs}(547)$ band ratio generated lower R^2 values. A linear regression analysis was applied also to the split dataset for less salty waters (S<35) and salty ones (S>35). The optimal regression was obtained using the $R_{rs}(667)/R_{rs}(488)$ band ratio for S<35 (R^2=0.89). The use of $R_{rs}(667)/R_{rs}(488)$ band ratio resulted to be the best variate for the retrieval of $a_{CDOM}355$ in our test areas in Western Adriatic Sea that are characterized by high river discharges [2], [3]. Though CDOM does not adsorb strongly at 667 nm, riverine CDOM shows a significant absorption at 488 nm, a wavelength at which the chlorophyll absorption is rather low. Therefore, this ratio should be more sensitive to changes in CDOM rather than in chlorophyll. The algorithms (1) and (2) based on this relationship should be a good compromise for the retrieval of $a_{CDOM}355$ in North-Central Western Adriatic Sea:
(1) $a_{CDOM}355_{\text{(ENTIRE DATASET)}} = 0.1165 + 1.9089 * (R_{rs}(667)/R_{rs}(488))$
(2) $a_{CDOM}355_{(S<35)} = 0.0262 + 2.202 * (R_{rs}(667)/R_{rs}(488))$
Further work is ongoing in order to validate the proposed algorithms.

References
1 - Coble P, 2007. Marine Optical Biogeochemistry: The Chemistry of Ocean Color. Chem. Rev., 107: 402-418.
2 - Campanelli A., Fornasiero P. & Marini M. 2004. Physical and Chemical characterization of water column in the Piceno coastal area (Adriatic Sea). Fresen. Environ. Bull., 13(5): 430-435.
3 - Campanelli A., Grilli F., Paschini E., Marini M., 2011. The influence of an exceptional Po River flood on the physical and chemical oceanographic properties of the Adriatic Sea. Dyn. Atmos. Oceans 52: 284–297.

THE POTENTIAL OF COLORED DISSOLVED ORGANIC MATTER AS WATER MASS TRACER. COMPARISON BETWEEN CENTRAL AND SOUTHERN ADRIATIC SEA

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Abstract

This work investigates the role of CDOM as a potential tracer of water masses, by comparing two different areas of the Adriatic Sea, Senigallia and Gulf of Manfredonia, based on two sampling campaigns conducted in October 2014 (Autumn) and May 2015 (Spring). The results showed that the CDOM is a good tracer for the Senigallia area while the Gulf of Manfredonia presents as a more complex biogeochemical system.

Keywords: Organic matter, Central Adriatic Sea, Chlorophyll-A

Introduction

The paper reports the hydrological (Temperature, Salinity) and the biogeochemical (Colored Dissolved Organic Matter-CDOM; Chlorophyll *a*-Chl*a*) data gathered along two cross-shore transects located in front of Senigallia (Midwestern Adriatic Sea) and in the Gulf of Manfredonia (Southwestern Adriatic Sea) during two oceanographic surveys dating back to October 2014 (autumn) and May 2015 (spring), respectively (Fig. 1). Both surveys are included in the framework of two Italian projects, (i.e. Ritmare and DSS-Pesca).

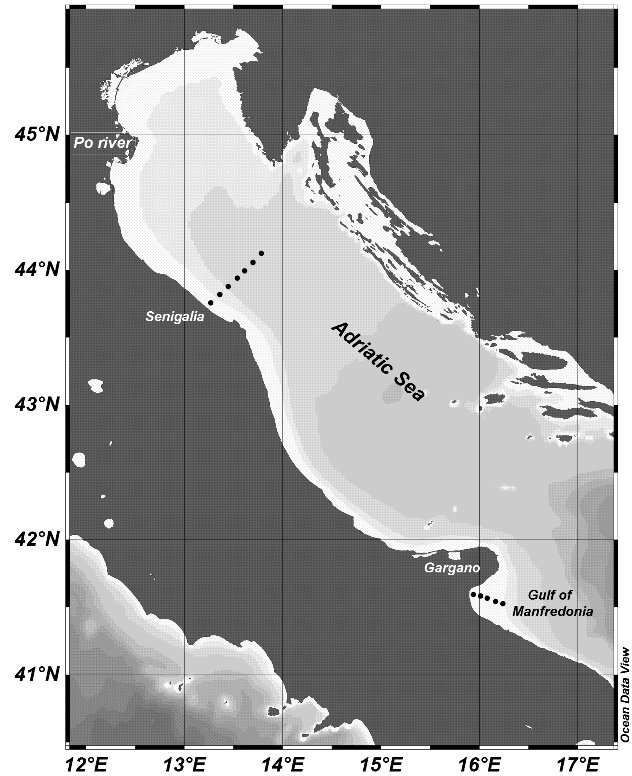

Fig. 1. Map of all sampling stations in the italian waters of the Ariatic Sea

The Western Adriatic Current (WAC) flows south-eastwards along the Italian coast, transporting the freshwaters of the main Italian river, the Po, affecting mainly the Senigallia area and the offshore zone of the Gulf of Manfredonia (in winter). Here in the nearshore area, the physical forcings able to affect the biogeochemical variability are represented by minor local rivers (i.e the Calendaro and the Ofanto), that play a similar role to the Po in the North Adriatic Sea. In addition the timing of the survey allowed evaluation of the effects of the exceptional river floods occurred in the Gargano Promontory area in September 2014. CDOM plays an important role in many marine biogeochemical processes, regulating the penetration of UV light throughout the water column and mediating photochemical reactions [1]. Moreover it can be a useful tracer for carbon and also a proxy for mixing in a wide variety of environments. The aim of the study is to investigate the potential of CDOM as tracer of water masses comparing two coastal zones of the Adriatic Sea with a different hydrological asset.

Methods

Profiles of Temperature and Salinity were performed at 7 stations along the Senigallia Transect (ST) and at 5 stations along the Gulf of Manfredonia Transect (MT). Sea surface and bottom water samples were also collected for the analyses of CDOM ($a_{CDOM}355$ and Spectral Slope $S_{275\text{-}295}$) and Chl*a*.

Results and Discussions

Temperature, salinity and CDOM showed gradients offshorewards and from surface to the bottom along the ST. In both periods the ST was characterised by a wider salinity range (autumn 2014: 32-38.5; spring 2015: 35-38), especially at the surface, than the MT (autumn 2014: 35-37; spring 2015: 36.5-38). Similar patterns were detected for temperature and organic matter. The $a_{CDOM}355$ showed more variability along the ST (autumn 2014: 0.16-0.81 m^{-1};$a_{CDOM}355$ spring 2015:0.18-0.45 m^{-1}) than along the MT (autumn 2014: 0.25-0.49 m^{-1}; spring: 0.26-0.55 m^{-1}), especially in autumn, despite the alluvium. In autumn, along the MT, a weak gradient is observed, with fresher coastal waters rich in organic matter, while in spring this feature is almost absent. ST shows a significant negative correlation ($p<0.01$) between salinity and $a_{CDOM}355$ both at the surface and at the bottom in both periods. The analyses of $S_{275\text{-}295}$ [2] and Chl*a* revealed that CDOM was mainly of terrestrial origin (humic substance with high molecular weight) in spring (surface and bottom) and of marine origin (i.e. substance with low molecular weight) in autumn (surface).

In autumn, the MT shows a significant negative correlation ($p<0.05$) between $a_{CDOM}355$ and S both at the surface and on the bottom while in spring the correlation ($p<0.01$) is limited to the surface. Furthermore, the analyses of $S_{275\text{-}295}$ and Chl*a* show that, in autumn the chemical nature of surface CDOM is mainly of marine origin and in spring it is of terrestrial origin.

These patterns reveal that the CDOM (and thus salinity) is a good tracer of water masses along the ST during the investigated periods. In fact ,this transect intercept different water masses that are carried by the WAC and that seem to be detectable using CDOM ($a_{CDOM}355$ and $S_{275\text{-}295}$). The MT shows a more complex pattern with abundance and distribution of organic matter of different origin (rivers runoff, decomposition of terrestrial organic matter, phytoplankton etc.). This is due to the strong influence of instantaneous local river organic inputs or possibly of different origin. The CDOM measured in the MT seems a rather ambiguous tracer during the studied periods.

Further investigations are needed to better understand the role of CDOM as tracer in these areas and assess its seasonal and annual variability.

References

1 - Coble P, 2007. Marine Optical Biogeochemistry: The Chemistry of Ocean Color. Chem. Rev., 107: 402-418.

2 - Helms JR, A Stubbins, JD Ritchie and EC Minor 2008. Absorption spectral slopes and slope ratios as indicators of molecular weight, source, and photobleaching of chromophoric dissolved organic matter. Limnol. Oceanogr., 53(3): 955-969.

LIGHT ABSORPTION BY ALL OPTICALLY ACTIVE COMPONENTS IN THE BLACK SEA: APPLICATION FOR DEVELOPMENT OF REGIONAL ALGORITHMS OF PRODUCTIVITY INDICATORS ASSESSMENT

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Abstract
Application of satellite information for assessment of productivity indicators of the Black Sea requires development of the regional algorithms, which take into account bio-optical properties of the Black Sea waters. The parameterization of light absorption by all optically active components in upper mixed layer has been done and seasonal differences have been revealed.

Keywords: Absorption, Phytoplankton, Models, Organic matter, Black Sea

Application of satellite information for assessment of productivity indicators (chlorophyll a concentration, photosynthesis rate, primary production depth-resolved and depth-integrated) of the Black Sea requires development of the regional algorithms, which take into account bio-optical properties of the Black Sea waters. It has been shown for the Black Sea that spectral features of water leaving radiance are determined by optical properties of the upper mixed water layer (UML) because first optical depth located within UML depth almost for all year with the exception of the spring season when seasonal stratification of waters started forming. Analysis of the bio-optical data has revealed seasonal dynamics of chlorophyll a-specific light absorption coefficients of phytoplankton within UML caused by adaptive changes of composition and intracellular pigment concentration because of the different environment condition: light intensity averaged for UML increased from 2.2(±1) E m^{-2} d^{-1} in winter to 32 (± 6.5) E m^{-2} d^{-1} in summer. Parameterization of phytoplankton light absorption has been done for different season (Fig.1).

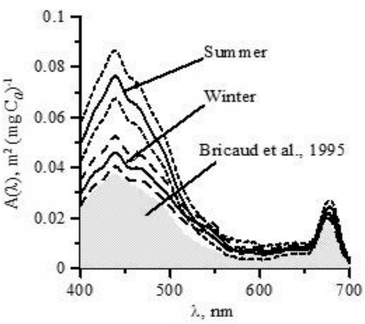

Fig. 1. Coefficient A(lambda) of the phytoplankton light absorption (aph (lambda)) parameterization: aph(lambda) = A(lambda) Chl^B(lambda), done for upper mixed layer of the Black Sea (grey – data [4]).

Parametrization of non-algal particles absorption (a_{NAP}(lambda)) showed that spectral slope S_{NAP} was equal 0.011 (± 0.002) nm^{-1} in averaged without seasonal differences. Relative contribution of $a_{NAP}(440)$ to total particulate absorption at 440 nm ($a_{NAP}(440)/a_p(440)$) was 20 (± 9) % in winter and 37 (± 16) % in summer and reached ~ 50 % after diatom blooms in yearly spring. The vertical distribution of $a_{NAP}(440)/a_p(440)$ within UML was uniform. Parametrization of colored dissolved organic matter absorption (a_{CDOM} (lambda)) showed pronounced seasonal differences in values and vertical distribution of S_{CDOM} and $a_{CDOM}(440)$ within UML. In winter S_{CDOM}(350-500) was 0.020 (± 0.008) nm^{-1}.The values $a_{CDOM}(440)$ were uniformly distributed within UML and equal 0.077 (± 0.040) m^{-1}. The contribution of $a_{CDOM}(440)$ and $a_{CDM}(440)$ (CDM=CDOM+NAP) to total light absorption at 440 nm was ~ 52 and 63 %, correspondently. In summer in UML S_{CDOM}(350-500) values were higher (0.025±0.0046 nm^{-1} in averaged) than in winter. The S_{CDOM}(350-500) values decreased, but $a_{CDOM}(440)$ increased from surface to thermocline (~ 10 m) due to photodestruction of dissolved organic matter (PAR (0m) ~ 45 E m^{-2} d^{-1}) (Fig.2).

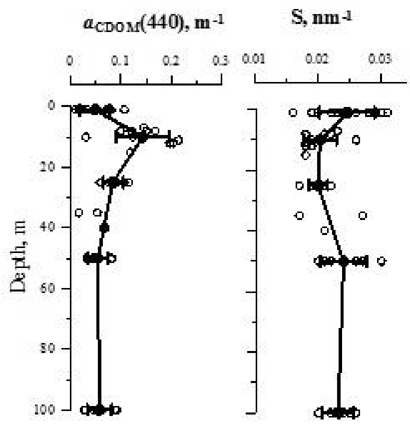

Fig. 2. Vertical distribution of colored dissolved organic matter light absorption coefficient at 440 nm (aCDOM(440)) and slope coefficient for 350 - 500 nm range (S) in deep-waters of the Black Sea in summer season.

The contribution of $a_{CDOM}(440)$ and $a_{CDM}(440)$ to total light absorption was ~ 56±11% and 71± 14 %, correspondently. Analysis of biooptical properties of the Black Sea coastal waters is to be done soon. Assimilation of these new seasonal bio-optical properties of the Black sea waters in the regional models of chlorophyll [1], downwelling radiance [2], primary production [3] will provide correct assessment of several indicators of water quality and productivity of the Black Sea because interannual variability in environmental conditions and relevant changes in bio-optics will be taken into account.

References
1 - Suslin V. and Churilova T., 2015. Three-band algorithm for splitting of light absorption by phytoplankton and colored detrital matter: application to ocean color remote sensing. In: Proceedings of VIII International Conference Current problems in optics of natural waters (ONW'2015), Saint-Petersburg, pp. 199-203.
2 - Churilova T., Suslin V. and Sosik H., 2009. A spectral model of underwater irradiance in the Black Sea. Physical Oceanogr., 19 (6): pp. 366-378.
3 - Churilova T., Suslin V., Sosik H. M., 2008. Bio-optical spectral modelling of underwater irradiance and primary production in the Black Sea. In: Proceeding of XIX Ocean Optics conference, 6-10 October 2008, Tuscany, Italy (published on CD).
4 - Bricaud A., Babin M., Morel A. and Claustre H., 1995. Variability in the chlorophyll-specific absorption coefficients of natural phytoplankton: Analysis and parameterization. Jour. Geophys. Res., 100 (C7): pp. 13321-13332.

THE BLACK SEA ECOSYSTEM STATE MONITORING: DEVELOPMENT OF THE APPROACH BASED ON REMOTE SENSED DATA

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Abstract
Approach to application of remote sensing and regional models for development of productivity and habitat conditions indicators and their application for operative monitoring of the Black Sea ecosystem state were given.

Keywords: Bio-indicators, Remote sensing, Models, Black Sea

Ocean color sensors information gives unique opportunities for development Operational Monitoring of the Black Sea ecosystem state using regional algorithms. The regional algorithms developed based on the Black Sea peculiarities of bio-optical properties [1-4] allow to transform correctly optical data of satellite sensors to set of parameters: chlorophyll a concentration (Chl), organic carbon to chlorophyll a ratio, biomass of phytoplankton (B), water transparency (k_d), suspended and dissolved organic matter light absorption coefficient(a_{CDM}(490)), total and new primary production (PP). These parameters could be considered as indicators of waters productivity (total and new PP), of habitat conditions (k_d, a_{CDM}(490)), of phytoplankton bloom intensity and frequency (B, Chl). Development of the indicators requires: (a) designation of the regions with similar features of the parameters; (b) assessment of "reference point" of the indicator for each regions; (c) testing of sensitivity of indicators to pressures. The long-time series (1998 – 2013) of the parameters have been calculated with high spatial (4x4 km) and temporal (2 weeks) resolution (http://blackseacolor.com). For these parameters long-term annual average, monthly means, anomalies and standard deviations (SD) have been calculated for the regions designated before based on spatial and temporal variability of these parameters (Fig. 1).

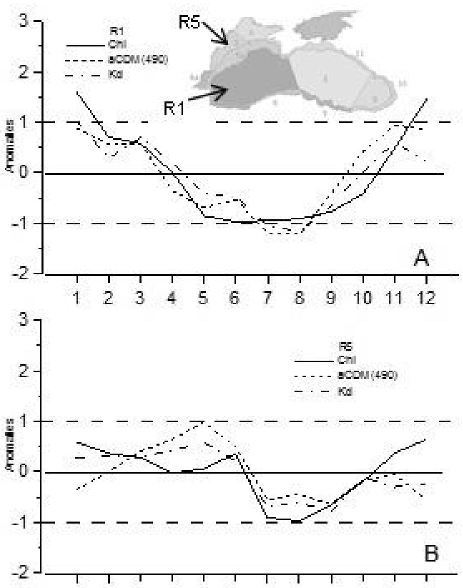

Fig. 1. Annual cycles of anomalies (normalized on standard deviation) of Chl, a_{CDM}(490), k_d for waters with contrast trophic status: near Danube estuary region 5 (A), western deep-waters region 1 (B).

It was proposed to consider annual cycle of particular parameter's anomalies (normalized on SD) as "reference cycle" relevant to sustainable ecosystem functioning. Disturbance ecosystem functioning due to any pressures could be identified based on comparison to the "reference cycle". The Black sea is semi-enclosed basin, strongly affected by riverine run off (mainly of Danube). It results in significant eutrophication pressure impact on the western part of the Black Sea ecosystem due to appearance of redundant phytoplankton biomass, which is described correctly by obtained reference levels of the indicators in comparison to deep-water region (Fig 1). The sensitivity of phytoplankton biomass indicator (expressed as Chl) to eutrophication pressure was tested based on inter-annual variability in intensity of phytoplankton bloom in June and relative degree of Danube discharge, for assessment of which a_{CDM}(490) was used. It was shown, that in June of different years (1998 – 2013) anomalies of Chl and a_{CDM}(490) exceeded their long-term means synchronously (Fig. 2).

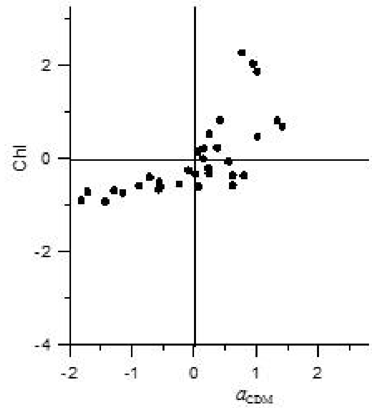

Fig. 2. Relationships between anomalies of Chl and a_{CDM} relevant for June of different years (1998 – 2013) for waters near Danube estuary.

The obtained results showed that Chl is sensible indicator, which immediately responds to anthropogenic eutrophication associated with river runoff. The proposed approach for development of indicators, assessment of their reference levels and application for operative monitoring of the Black Sea ecosystem state could be really important for management perspective.

References
1 - Suslin V., Churilova T., 2015. Three-band algorithm for splitting of light absorption by phytoplankton and colored detrital matter: application to ocean color remote sensing. In: Proceedings of VIII International Conference "Current problems in optics of natural waters" (ONW'2015), Saint-Petersburg, pp. 199-203.
2 - Churilova T., Suslin V., Sosik H., 2009. A spectral model of underwater irradiance in the Black Sea. Physical Oceanogr., 19 (6): pp. 366-378.
3 - Churilova T., Suslin V., Sosik H. M., 2008. Bio-optical spectral modelling of underwater irradiance and primary production in the Black Sea. In: Proceeding of XIX Ocean Optics conference, 6-10 October 2008, Tuscany, Italy (published on CD).
4 - Kryvenko O., Suslin V., Churilova T., 2014. Assessment of inorganic nitrogen component fluxes through phytoplankton community in the Black Sea based on remote sensed chlorophyll a concentration. In: Proceeding of papers "Ecological safety of coastal and shelf zones and comprehensive use of shelf resources", 28: pp. 287-302.

ELECTROANALYTICAL METHODS IN DETECTION AND CHARACTERIZATION OF ELEMENTAL SULPHUR NANOPARTICLES IN THE SEAWATER ENVIRONMENT

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Abstract

Electroanalytical methods, voltammetry and chronoamperometry were applied for detection and characterization of reduced sulphur species in euxinic seawater. Colloidal finest fraction, i.e. elemental sulphur nanoparticles (S(0) NPs), were detected. Chronoamperometric signals recorded in acidified euxinic seawater samples were used for evaluation of S(0) concentration and size of formed NPs. The observed results indicate a great potential of chronoamperometic measurements in characterization of similarly sulphur containing NPs (metal sulphides) in aquatic environment.

Keywords: Analytical methods, Central Adriatic Sea, Anoxia, Chemical speciation

Introduction

The dramatic change in physical and chemical characteristics that substances experience at reduced length scales and potential toxicity of such nano-sized material triggered scientific interest for characterization of natural and engineered NPs in aquatic environment. Rogoznica Lake (RL), permanently stratified marine lake with euxinic conditions in the deeper water layer where hydrogen sulphide can be found in milimolar concentrations (Fig. 1), was used as study site for reduced sulphur species (RSS) characterization. Differentiation between volatile and non-volatile RSS (RSSv, RSSnv) was done by voltammetric measurements in original and acidified samples (Fig. 1) [1,2]. In acidification step the S(0) is released by hydrolyses mainly from polysulfide in form of NPs [1,2 3] and measured by chronoamperometry (Fig. 2) [3].

Materials and methods

Natural water samples were collected at marine lake, Rogoznica Lake (Eastern Adriatic Coast). All electrochemical measurements were performed with Autolab PGSTAT 128N (Eco Chemie, Netherlands) in combination with an automatic Hg electrode (VA Stand 663, Metrohm, Switzerland). Voltammetric measurements of RSS_{total} are based on interaction between sulphur and Hg electrode. To differentiate between RSS_{v} and RSS_{nv} acidification step is used [1,2]. Chronamperometric measurement, where interaction of S(0) NPs and Hg electrode results in spike like signals superimposed on background diffusion limited curve were monitored in acidified RL samples at -0,8V (vs. Ag/AgCl). Spikes are consequence of S(0) NPs reduction during the contact with the Hg electrode when potentials are more negative than -0,6 V (vs. Ag/AgCl) [3]. Frequency and charge of the signals can be related with concentration and size of the colloidal S(0) [3].

Results and Discussion

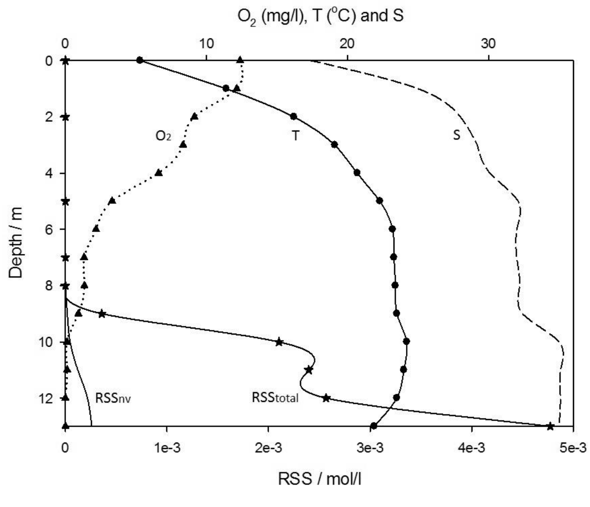

Fig. 1. Vertical profile of temperature, salinity, dissolved oxygen and RSS concentration in Rogoznica Lake

During the sampled period the RL was stratified with halocline at 9 m. The upper part was saturated with the dissolved oxygen, while under the halocline dissolved oxygen was absent and consequently free sulphide was accumulated (Fig. 1). High concentration of sulphide in the anoxic part of RL increases solubility of the elemental sulphur and formation of the polysulphides as the most stabile non-volatile RSS fraction [1,2]. Concentration of RSS_{total} and RSS_{nv} reflects the physico-chemical characteristics of the water column (Fig. 1). Chronoampetometric measurements in the acidified RL samples provided information on S(0) content (Fig. 2). Frequency of the recorded spikes, related to reduction of S(0) NPs, can be coupled with the concentration of the S(0) in samples. From charge of the spike signals size of the S(0) NPs was calculated. Similar methodology was tested for characterization of metal sulphide NPs.

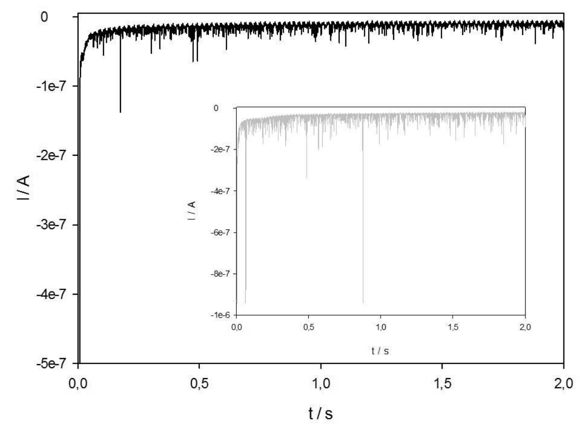

Fig. 2. Chronoamperogram of 10m RL sample and (insert) partly oxidize 10m RL sample

Conclusion

For the first time, the chronoamperometry was used for detection and size determination of colloidal S(0) in natural aquatic samples. Observed results are a base for further development of electroanalytical methodology for polysulfide, as well as natural and engineered NPs determination in natural waters.
This study was funded by IP-11-2013-1205-SHERE project.

References

1 - Ciglenecki I., Kodba Z. and Cosovic B.,1996. Sulfur species in Rogoznica Lake, Mar. Chem. 53:101-110.
2 - Bura-Nakic E., Helz, G.R., Ciglenecki I. and Cosovic B., 2009. Sesonal variations in reduced sulphur species in a stratified seawater lake (Rogoznica Lake, Croatia), Geochim. Cosmochim. Ac. 73:3798-3751.
3 - Bura-Nakic E., Marguš M., Jurašin D., et al., 2015. Chronoamperometric study of elemental suphur (S) nanoparticles (NPs) in NaCl water solution: new methodology for S NPs sizing and detection, Geochem. Trans. 16:1-9.

METHYLMERCURY IN THE BLACK SEA: NEW OBSERVATIONS COMPARED WITH A 1D NUMERICAL MODEL

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Abstract

Here we present the results of a 1D mercury (Hg) model implemented to the Black Sea based on the results of the 2013 GEOTRACES MEDBlack cruise. We discuss the observed vertical profiles of Hg and methylmercury (MeHg) in the water column as well as preliminary model results, providing interesting insights into the Hg dynamics and Hg methylation process along the redox gradient.

Keywords: Models, Black Sea, Mercury, Vertical profile, Anoxic basin

Concern has been raised about possible implications for ecosystems and human health from anthropogenic Hg emissions, that may enhance the production of the toxic and bioaccumulating MeHg species. MeHg production is thought to be a microbially mediated process, related to the remineralization of organic matter (OM) in marine sediments and the water column [1]. In addition to initial HgII concentrations [2], microbial and redox conditions as well as OM quantity and quality, may determine MeHg production. Sedimentary MeHg data and equilibrium modeling suggest that at high sulfide levels (<10 µM) methylation is hindered due to reduced Hg availability to microbes [3] but this theory has been debated [4]. The Black Sea water column is permanently stratified, with anoxic sulfidic deep waters and a large suboxic layer. Thus, it is an ideal site to investigate on the relations among OM oxidation and Hg dynamics under changing redox conditions. We collected vertical profiles of Hg and MeHg, nutrients and other dissolved metals along an E to W transect in the southern Black Sea. Analysis of MeHg and Hg samples were performed according to [5]. Our new data were integrated with literature data to implement a fate and transport 1D-model for Hg and MeHg [6]. We compiled the Hg budget and simulated present day conditions. To investigate the vertical profile of MeHg, we performed scenario analysis, imposing the occurrence of methylation at different depths in each scenario and comparing modeled MeHg profiles with observations. Methylation rates in oxic, suboxic and anoxic environment were taken from the literature. For both Hg and MeHg, we observe peak concentrations in the upper part of the anoxic zone, tightly coupled to Mn and Fe peaks (Fig. 1).

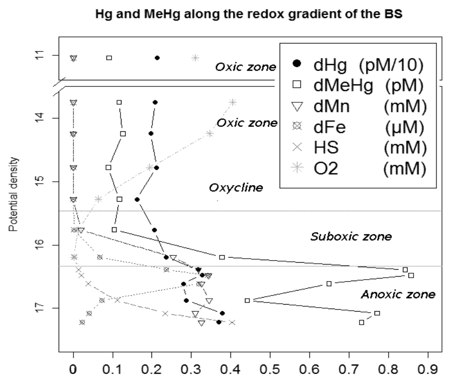

Fig. 1. Horizontally averaged (n=10) vertical profiles of dissolved Hg, MeHg, Mn and Fe in relation to redox conditions in the Black Sea, as detected during the GEOTRACES MEDBlack cruise (July 2013). Data show concentrations in the whole water column up to 2200 m depth. Potential density is used as y-axis (note the break in the axis).

Observed vertical profiles hint that most of the Hg is scavenged by OM and Mn oxides and transported to deeper waters, where it is released during the concomitant reduction of Mn and OM oxidation. MeHg may be either regulated by mechanisms similar to Hg or be produced *in situ* in the anoxic layer. A previous study in the Black Sea [7] found a maximum of MeHg in the suboxic layer, likely due to the different analytical method. On the other hand, high MeHg levels in sulfidic water were observed by others [8],[9]. Preliminary model results show that input of MeHg from watershed and system boundaries cannot explain the observed MeHg levels. The best fit between modeled and measured MeHg is achieved when methylation is set either in the whole water column with variable rates or only in the anoxic zone.

References

1 - Sonke, J.E., Heimbürger, L.E., Dommergue, A., 2013. Mercury biogeochemistry: Paradigm shifts, outstanding issues and research needs. Comptes Rendus - Geosci. 345: 213–224.

2 - Cossa, D., Garnier, C., Buscail, R., Elbaz-Poulichet, Francoise Mikac, N., Patel-Sorrentino, Nathalie Tessier, E., Rigaud, S., Lenoble, V., Gobeil, C., 2014. A Michaelis–Menten type equation for describing methylmercury dependence on inorganic mercury in aquatic sediments. Biogeochemistry 119: 35–43.

3 - Benoit, J.M., Gilmour, C.C., Mason, R.P., Heyes, A., 1999. Sufide Controls on Bioavailability to Methylating Bacteria in Sediment Pore Waters. Environ. Sci. Technol. 33: 951–957.

4 - Merritt, K.A., Amirbahman, A., 2009. Mercury methylation dynamics in estuarine and coastal marine environments - A critical review. Earth-Science Rev. 96: 54–66.

5 - Heimbürger, L.-E., Sonke, J.E., Cossa, D., Point, D., Lagane, C., Laffont, L., Galfond, B.T., Nicolaus, M., Rabe, B., van der Loeff, M.R., 2015. Shallow methylmercury production in the marginal sea ice zone of the central Arctic Ocean. Sci. Rep. 5: 10318.

6 - Wool, T.A., Ambrose, R.B., Martin, J.L., Comer, E.A., 2001. Water Quality Analysis Simula- tion Program (WASP) Version 6.0: User'sManual

7 - Lamborg, C.H., Yigiterhan, O., Fitzgerald, W.F., Balcom, P.H., Hammerschmidt, C.R., Murray, J., 2008. Vertical distribution of mercury species at two sites in the Western Black Sea. Mar. Chem. 111: 77–89.

8 - Mason, R.P., Fitzgerald, W.F., Hurley, J., Hanson, a. K., Donaghay, P.L., Sieburth, J.M., 1993. Mercury biogeochemical cycling in a stratified estuary. Limnol. Oceanogr. 38: 1227–1241.

9 - Han, S., Lehman, R.D., Choe, K.-Y., Gill, G. a., 2007. Chemical and physical speciation of mercury in Offatts Bayou: A seasonally anoxic bayou in Galveston Bay. Limnol. Oceanogr. 52: 1380–1392.

CIESM Congress Session : Ecotoxicology / experimental
Moderator : François Galgani, LER/PAC, Ifremer, France

Moderator's Synthesis

The session first discussed the importance of experimental ecotoxicology, its importance to complete chemical approaches, providing some original information on effects of contaminants or response of marine organisms.

Eight presentations were given, focusing on biomarkers, toxicity tests, DNA damage considering the effects of chemicals, including antifoulings, on various metabolic activities and species. Original presentations were given on the reversibility of metal inducibility of teratogenesis , the effects of gold nanoparticles and the interaction prey/predators.

A very open discussion developed on the selection of indicators/parameters, the ecological relevance of measurements, the importance of thresholds, baselines and the selection or range of concentrations tested. The relevance of the experimental ecotoxicological approach was finally noted as a tool to assess the extention of contamination and its effects, also for long term monitoring, on regular basis, of the contamination of effluents or chemicals, through *in vitro* testing.

CHANGES IN LIPID CLASSES, FATTY ACID COMPOSITION AND LIPID PEROXIDATION IN THE GILLS OF THE CLAM *DONAX TRUNCULUS* AFTER PERMETHRIN EXPOSURE

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Abstract
A short term exposure experiment (72 h) to permethrin (PER) of the clam *Donax trunculus* from the Tunisian coast was carried out. Changes in the lipid classes, fatty acid (FA) composition and lipid peroxidation were determined in the gills of adults and juveniles. A significant decrease of total lipid content was followed by a decrease in polar lipids (PL) and polyunsaturated fatty acids (PUFAs) especially n-3 and n-6. As, for the oxidative stress response, a significant elevation in lipid peroxidation (LPO) was found after the exposure of both adults and juveniles.

Keywords: Bivalves, Gulf of Tunis

Introduction
Pesticides cause changes in physiological and metabolic functions of non-target organisms. The permethrin (PER), a synthetic pyrethroid insecticide, can be very toxic to aquatic invertebrate communities. Contaminants like pesticides may induce the formation of reactive oxygen species (ROS) which are responsible of damage to lipids, proteins, carbohydrates and nucleic acids. The aim of the present investigation was to provide new data concerning the changes in the lipid classes and fatty acid composition as well as in the lipid peroxidation in the gills of *Donax trunculus* exposed to PER for 72 h.

Materials and methods
Specimens of *D. trunculus* (adults and juveniles) were collected from the gulf of Tunis (Tunisia) and exposed to 150µg/L PER for 72h. Gills were dissected, immediately frozen in liquid nitrogen and stored at -80°C until analysis. Lipids were extracted according to [1] method. Lipid classes were separated in precoated HPTLC silica gel 60 plates using a double development method. Methylation of fatty acids was performed according to Cecchi et al. [3], and lipid peroxidation was determined using the method of Draper et al. [4] and expressed as nanomoles of malondialdehyde (MDA) per g wet weight of tissues. Significant differences between control and exposed groups was assessed by using one way ANOVA (Statistica 8.0.).

Results and discussion
Exposure of *D. trunculus* adults and juveniles to 150µg/L PER for 72h produced a significant decrease in the total lipid content and polar lipid percentages of the gills Indeed, neutral lipids increased significantly following the elevation of triacylglycerols (TAG) and free fatty acids (FFA) fractions (Table 1). Several studies have demonstrated that TAG and NL increase significantly in aquatic organisms in contaminated sampling sites. Regarding fatty acid composition, a significant decrease ($p<0.05$) in SFA and PUFA of adults and in PUFA of juveniles was found after PER exposure, compared to controls (Table 1). These results may be due to oxidative damage caused by exposure to PER, evidenced by a significant elevation of LPO in the gill of exposed clams (juveniles and adults) (Table 1), potentially due to the antioxidant enzyme system not being able to totally eliminate O^-_2 and induce the production of LPO.

Conclusion The present investigation showed that PER, was able to generate lipid accumulation in the form of TAG and FFA, a decrease in total FA content, especially PUFAs and induce the production of LPO as an oxidative stress response in both adults and juveniles.

Tab. 1. Total lipid content, lipid classes, fatty acid composition and lipid peroxidation in gills of adults and juveniles *D. trunculus* exposed to 150 µg/L PER for 72 hours. Values with the different letters as superscript present significant difference (p<0.05), for adults (A, B); for juveniles (a, b).

		Adults		Juveniles	
		Control	Exposure	Control	Exposure
Total lipid contents (g/100g dry weight)		33.6±1.6^{A}	17.2±2.9^{B}	27.1±3.7^{a}	10.1±1.3^{b}
Lipid classes (% total lipids)	Cholesterol esterified	4.9±1^{A}	6.5±1.3^{A}	3.3±0.6^{a}	5.3±1.5^{a}
	Triacylglycerol	2.4±1.6^{A}	9.5±1^{B}	2.2±1.1^{a}	11.5±0.9^{b}
	Free fatty acids	16.1±0.9^{A}	19.8±1.1^{B}	13.5±1.4^{a}	19.7±0.6^{b}
	Cholesterol	22.3±1.7^{A}	15.8±2.8^{B}	28±1.5^{a}	21.2±1.9^{b}
	Neutral lipids	45.6±1.3^{A}	51.5±2.5^{B}	47±2.2^{a}	57.7±3.6^{b}
	Sphingolipids	5.8±1.1^{A}	3.7±0.3^{B}	4±0.6^{a}	2.1±1^{b}
	Phosphatidylethanolamne	16.2±1.2^{A}	13.1±0.2^{B}	16.5±1.1^{a}	10.1±1^{b}
	Phosphatidylisonitol	10±0.3^{A}	8.1±0.7^{B}	9.8±1^{a}	5.7±1.4^{b}
	Phosphatidylserine	9.3±1^{A}	8.4±0.9^{A}	8.1±0.8^{a}	6.5±0.6^{b}
	Phosphatidylcholine	13.2±2.6^{A}	15.3±3.3^{A}	14.6±1.3^{a}	18.9±0.9^{b}
	Polar lipid	54.4±1.3^{A}	48.5±2.5^{B}	53.1±1.8^{a}	43.3±3.3^{b}
Fatty acids (g/ 100g dry weight)	SFA	11.5±1.1^{A}	6.4±1.3^{B}	4.7±0.5^{a}	4.1±0.9^{a}
	MUFA	3.7±0.4^{A}	2.6±0.3^{A}	1.5±0.3^{a}	1.4±0.1^{a}
	PUFA	8.16±0.7^{A}	5.9±1.2^{B}	9.9±3.3^{a}	2.8±0.4^{b}
	∑n-3	4.23±0.6^{A}	2.92±0.6^{B}	3.4±0.9^{a}	1.5±0.1^{b}
	∑n-6	1.74±0.1^{A}	0.7±0.2^{B}	3.1±1.1^{a}	0.7±0.1^{b}
Lipid peroxidation (Nmol MDA/g ww)		306.7±16.4^{A}	762.6±50.7^{B}	438.1±8.9^{a}	675.4±5.8^{b}

References
1 - Bligh, E.G., & Dyer, W.J., 1959. A rapid method of total lipid extraction and purification. Canadian Journal of Biochemistry and Physiology, 37 : 911–917.
2 - Olsen RE, Henderson RJ (1989) The rapid analysis of neutral and polar marine lipids using double-development HPTLC and scanning densitometry. J Exp Mar Biol Ecol 129:189-197.
3 - Cecchi, G., Basini, S., Castano, C., 1985. Méthanolyse rapide des huiles en solvant. Revue française des corps gras n4.
4 - Draper, H.H., Hadley, M., 1990. Malondialdehyde determination as index of lipid peroxidation. Methods in Enzymology. 86:421-431.

BIOMARKER RESPONSES IN THE CLAM *RUDITAPES PHILIPPINARUM* TO LEAD EXPOSURE

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Abstract

A lead exposure experiment (7 days) was carried out to determine the biomarker responses in the gills and digestive gland of the clam *Ruditapes philippinarum*. Non significant response was found in acetylcholinesterase (AChE), catalase (CAT), superoxidase dismutase (SOD) in both gills and digestive gland. On the contrary, phase II antioxidant enzyme (glutathione S-transferase, GST) and antioxidant enzyme, glutathione peroxidase (GPx) have shown significant variation after 7 days of exposure to 100µg/L Pb. GST was induced significantly (p<0.05), contrariwise, GPx was significantly (p<0.05) inhibited in the digestive gland. The present investigation showed that 10 µg/L Pb did not show any toxic effect on the clam *R. philippinarum*, while, 100 µg/L could engender some oxidative stress variations.

Keywords: Ecotoxicology, Gulf of Cadiz

Introduction

Metals discharged to the marine ecosystems constitute significant pollutants of these areas. A non-essential metal, the lead (Pb), is a highly toxic contaminant and one of the greatest metallic inputs. Several studies demonstrated that exposure to metals is accompanied by the induction of oxidative stress [1]. The clam, *Ruditapes philippinarum*, is an important commercial species in Mediterranean area and used as sentinel and "model organism" for biomonitoring and aquatic pollution investigations. The aim of this study is to provide new knowledge about the mechanisms involved in the response to lead pollution in *R. philippinarum*.

Materials and Methods

Specimens of *R. philippinarum* were collected from the bay of Cadiz (Spain) and exposed to 10 and 100 µg/L Pb for 7 days. At t0; t48h and t7 days, digestive gland and gills were dissected, immediately frozen in liquid nitrogen and stored at -80ºC until their processing. For biochemical analysis, tissues were homogenized in 10 mM Tris-HCl buffer (pH 7.6) and centrifuged at 4ºC to obtain a clarified supernatant S12 fraction. S12 was used for biochemical analysis: total protein, AchE, CAT, GST and GPx and SOD activities. Significant differences between control and exposed groups was assessed by using one way ANOVA (Statistica 8.0.).

Results and discussion

All results are present in Table 1. In the present investigation, AChE as a biomarker of neurotoxicity, CAT and SOD activities as oxidative stress biomarkers have shown no significant difference (p<0.05) after 48 hours and 7 days of exposure to 10 and 100µg/L Pb in the gills and digestive gland of *R. Philippinarum*. For phase II antioxidant enzymes (GST) and the antioxidant enzyme (GPx), the digestive gland was more sensitive compared to gills. GST activity was significantly (p<0.05) reduced after 7 days of exposure in the digestive gland, while, GPx activity was significantly (p<0.05) induced in the digestive gland at 7 days of exposure to 100µg/L. Lead was reported to be a highly toxic metal and its interference resulted in the generation of highly ROS, including O2•−, H2O2, and •OH [2]. Changes in GST and GPx have been shown to play an important role in protection against oxidation. The decrease of GST antioxidant activity after Pb exposure may be due to over production of reactive oxygen metabolites (ROMs) or it could be attributed to their nature of synergistic functioning as indicated in [3].

Conclusion It is well obvious that exposure of *R. philippinarum* to 10µg/L Pb has no significant toxic effect, while, 100µg/L induces significant transitory antioxidant defences responses after 7 days of exposure.

Tab. 1. Table.1 Gills and digestive gland activity of AChE, CAT, GST, GPx and SOD over the 7-day Pb exposure. Data given as mean±standard deviation. Values with different letters as superscript present no significant difference (p<0.05).

		Gill					Digestive gland				
Time of exposure	Pb (µg/L)	AchE (nmol/min/ mg Prot)	CAT (µmol/min/ mg Prot)	GST (nmol CDNB conj/min/mg Prot)	GPx (µUnits GPx/mg Prot)	SOD (Units SOD/ mg Prot)	AchE (nmol/min/ mg Prot)	CAT (µmol/min/ mg Prot)	GST (nmol CDNB conj/min/mg Prot)	GPx (µUnits GPx/mg Prot)	SOD (Units SOD/ mg Prot)
T0	Control	8.4±1.2	8.3±1.5	0.18±0.03^a	0.1±0.02	9.06±3.49	1.61±0.67	3.84±0.64	0.25±0.03	0.1±0.06	9.48±0.08
T48h	Control	7±2.3	7.4±1.1^a	0.15±0.03	0.03±0.02	9.92±1.86	3.02±1.69	5.50±0.70	0.25±0.02^a	0.07±0.03	9.91±0.13
	10	4.5±1.5	7.9±0.2	0.17±0.07	0.03±0.02	6.61±4.19	2.89±1.16	4.06±0.62	0.19±0.06	0.04±0.01	9.09±0.27
	100	6.4±1.3	8.3±1.1	0.11±4	0.05±0.03	13.99±5.98	2.18±1.86	4.85±1.25	0.16±0.02^b	0.05±0.02	9.87±0.04
T7days	Control	6.2±3.3	10.7±.40^b	0.13±0.2^b	0.19±0.14	7.85±1.71	4.16±2.25	4.05±0.66	0.22±0.04^a	0.08±0.03^a	9.63±0.31
	10	6.4±3.6	9.80±1.75	0.19±0.14	0.08±0.05^a	11.28±1.04	2.53±0.35	2.89±0.42	0.15±0.03^a	0.08±0.05^a	9.14±0.04
	100	9.2±2.1	8.58±1.70	0.11±0.04	0.22±0.08^b	8.27±3.65	4.13±2.65	5.29±1.17	0.16±0.02^b	0.22±0.08^b	9.71±0.53

References

1 - Valko, M., Morris, H., Cronin, M.T.D., 2005. Metals, toxicity and oxidative stress. Curr. Med. Chem., 12: 1161–1208.

2 - Bokara, K.K., Brown, E., McCormick, R., Yallapragada, P.R., Rajanna, S., Bettaiya, R., 2008. Lead-induced increase in antioxidant enzymes and lipid peroxidation products in developing rat brain, Dallas, TX, pp. 9–16.

3 - Zhang, Y., Song, J., Yuan, H., Xu, Y., He, Z. and Duan, L., 2010. Biomarker responses in the bivalve (Chlamys farreri) to exposure of the environmentally relevant concentrations of lead, mercury, copper. Environmental Toxicology and Pharmacology. 30: 19-25.

GLUTATHION- S TRANSFERASE ACTIVITY OF THE MUSSEL MYTILUS GALLOPROVINCIALIS DURING EXPOSURE OF BISPHENOL-A

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Abstract
Bisphenol A (BPA), is one of the most important industrial chemicals synthesized for diverse applications. The environmental concentrations of BPA are at high risk level due to use widely in many fields of industry according to the latest studies. In our study mussels *Mytilus galloprovinciali* were exposed to 50, 75 and 100 µg-BPA/L and the changes of hepatic biomarker glutathione-s transferase (GST) activity were investigated. The results showed that the activity of GST was increased in all concentarions of BPA group. Based on this experiment, we recommended that GST might be used as a biomarker of environmental pollution.

Keywords: Ecotoxicology, Aegean Sea

It is well-known that a wide variety of man-made chemicals in the environment is capable of adversely affecting aquatic organisms. BPA has generated concern due to their high production and widespread use BPA produce is used to make polycarbonate, epoxy resin production and other products such as specialty resins and in the manufacture of flame retardants.The environmental concentrations of these chemicals, which are used extensively in households and in industry, have been determined by researchers. It is released into the environment through permitted discharges of treated industrial waste water or directly marine environments. Several studies have been completed to determine the fate of BPA in the environment and the possible impacts on aquatic organisms [1]. Exposure to environmental stressors can result in biochemical, physiological and histological alterations in living organisms. Biological changes in organisms that under environmental stress, observed at various organization levels; molecular, cellular, population, community and ecosystem. The presence of these alterations can serve as biomarkers signaling exposure to stressors or adverse effect [2]. Biomarkers can be measured in different organisms, but mussel biological indicators in determining pollution are preferred in most ecotoxicological studies as they filter-feeding, live as sessile, and are of economic interest. The enzymes GST frequently used as biomarker of oxidative stress. Detoxification exists in all organisms this generally affected by various environmental factor. So that detoxification enzymes are useful assessment of an organism under environmental pollution. Induction of the antioxidant defense system can be considered an adaptation of species to their environment; however inhibition may lead to antioxidant-mediated toxicity [3]. In this study we asses suitability of using GST of M.galloprovincialis </i>as potential biomarkers of BPA in the environment. For this purpose, the concentration of 50, 75 and 100 µgBPA/L was added mussels environment (15 day).During the experiment the water quality parameters were stable and the mortality of the mussels was not observed. the hepatopancreas of groups of samples were found to be a significant increase in enzyme activity.The mussels exposed to the BPA showed a different pattern of GST activity when the compared control groups (Figure 1)

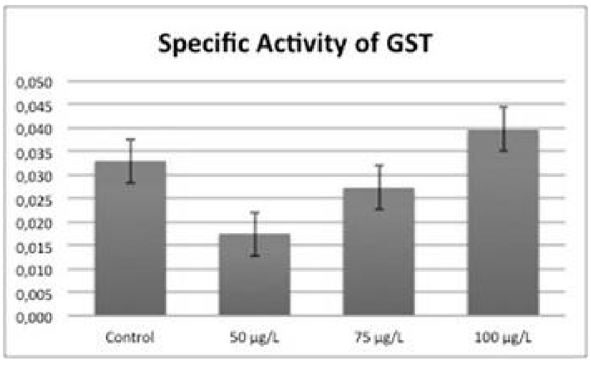

Fig. 1. The activity of GST in digestive gland

This specific enzyme activity was observed 0.033 µ;mol/min/mg protein in control group in digestive gland of mussel. The lowest GST activities recorded in mussels at 12.5 µgBPA/L were significantly different than those at control group. Previous studies indicates that the level of expression of GST is an important factor in determining the sensitivity of cells to toxic chemicals and that GST induction is part of an adaptive response mechanism to chemical stress that is widely distributed in nature. Walsh and OHalloran [4] were investigated the possibility of oxidative stress (GST) in Mytilus edulis which exposed to tannery effluents and these researcher presents the effluents not induce the GST specific activity in M. edulis.This result compared with our study, levels of GST enzyme activity of control similar to our measurement however BPA significantly increased GST enzyme activity in mussel digestive gland (0.005).The study by Xiangli et al [5] was to evaluate the use of endogenous glutathione and glutathione-related enzymes as biomarkers o f exposure to landfill leachate effluent and BPA in the freshwater snail,Bellamya purificata following exposure to 1, 5 and 10% landfill leachate effluent and 1, 10, 50 and 100µgBPA/L for 0, 2, 7 and 15 d, activities of GST, In this study significant dose-dependent changes were observed for GST activities and total glutathione levels in the gills and digestive glands, and also GST activities increased by about 80%, while total glutathione decreased to 70-80% in the gills and digestive glands, respectively. Based on this literature information, the various GST-like proteins may have different binding properties for many different types of chemical. Besides that previous Works contributed that the GST is suitable markers for monitoring environmental contamination because it is a major enzyme involved in phase II detoxification.

References

1 - Arslan O.C., Parlak H. 2008., Effects Of Bisphenol-A On The Embryological Development Of The Sea Urchin Arbacia Lixula (Linnaeus, 1758), Fresen.Environ. Bull. 17(2), 127-130
2 - Huggett R.J., Kimerle R.A., Mehrle J.R., Bergman H.L. 1992. Biomarkers: Biochemical, Physiological and Histological Markers of Anthropogenic Stress. Boca Raton, Fla.Lewis. 346.
3 - Regoli F And Principato G. 1995. Glutathione, glutathione-dependent and antioxidant enzymes in mussel, *Mytilus galloprovincialis*, exposed to metals under field and laboratory conditions: implications for the use of biochemical biomarkers. Aqu.Tox. 31, 143-164.
4 - Walsh A.R. And O'halloran J. 1997.The toxicity of leather tannery effluent to a population of mussels *Mytilus edulis* (L.) in an estuary. Ecotox.6; 137-152.
5 - Xiangli L, Lin L, Luan T, Yang L, Lan C. 2008. Effects of landfill leachate effluent and bisphenol A on glutathione and glutathione-related enzymes in the gills and digestive glands of the freshwater snail *Bellamya purificata*, Chemosphere, 70 (10), 1903–1909.

CHANGES IN THE ACTIVITY OF GST ENZYME ON MUSSEL (*MYTILUS GALLOPROVINCIALIS*) EXPOSED TO ANTIFOULING AGENT ZINC PYRITHIONE

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Abstract

Zinc pyrithione (Zpt) is widely used in various areas ranging from medicine to the treatment of skin diseases, from cosmetic industry, anti-dandruff shampoo to paint industry as an antifouling material. According to our results we can assumed that although there is significant differences in GST enzyme activity between experiment groups (0.02 ppm and 0.04 ppm) no correlation in the manner of dose response as increasing concentrations did not stimulated GST enzyme activity probably a higher concentration of ZnPT caused toxic effects on the hepatocytes and gills of mussels *M. galloprovincialis*.

Keywords: Bivalves, Mediterranean Sea

Introduction

Zinc pyrithione is widely used in various areas ranging from medicine to the treatment of skin diseases, from cosmetic industry, anti-dandruff shampoo to paint industry as an antifouling material (1). At the same time, it is necessary to evaluate zinc pirition as an ecotoxicologic material since it is an alternative biosit to tribütilin (TBT). Zinc pyrithione rapidly accumulated in the tissues of the exposed mussels, proportionately to both exposure concentration and time, identifying the gills and digestive gland as important targets in the biological pathway of the contaminants. Monitoring of biomarkers in sentinel organisms is very essential for assessing the ecosystems health and further more mussels which are highly important among the aquatic organisms can be one of the most suitable organisms for bioexperiences and toxicologic researches. *M. galloprovincialis* is a very sensitive 'early warning' tool for various kind of pollutants such as POP's, heavy metals and micropollutants of a marine environment. Changes in enzyme activity is a good biomarker for assessing the pollutant effects on organisms (2). Glutathione –S- transferase enyzme one of the member of antioxidant defence system takes important part in detoxification of pollutants. Numerous studies with the observing changes in GST enzyme activities has been used by many researchers (3, 4).

Methods and Results

To assess changes in GST enzyme activity mussels were exposed to the two concentrations (0.02 and 0.04 ppm) of Zpt. GST enzyme activity was 0.098 µ mol/min/mg protein so it increased compared with control group (0.075) at low concentration (0.02 ppm) but in higher concentration GST activity did not increase (0.083 – 0.038 in hepatopancreas and gill respectively) compared with 0.02 ppm. According to our results we can assumed that although there is significant differences in GST enzyme activity between experiment groups (Table1)

Tab. 1. The results of GST enzyme activity of hepatopancreas and gill tissue of mussel (*Mytilus galloprovincialis*)

Conc. (mg/L)	Protein (mg/mL)	GST Activity (µmol/mL/min)	GST Specific Activity (µmol/min/mg) protein
Control Hepato	11,926 ± 0,92	0,894± 0,04	0,075
0.02 ppm	7,476± 0,39	0,733± 0,02	0,098
0.04 ppm	9,151± 0,50	0,762± 0,04	0,083
Control Gill	9,030 ± 1,51	0,526 ± 0,02	0,058
0.02 ppm	2,888 ± 0,75	0,437 ± 0,01	0,151
0.04 ppm	7,876 ± 0,10	0,300 ± 0,03	0,038

in hepatopancreas and gill no correlation in the manner of dose response as increasing concentrations did not stimulated GST enzyme activity probably a higher concentration of ZnPT caused toxic effects on the hepatocytes and gills of mussels *M. galloprovincialis* (Fig1).

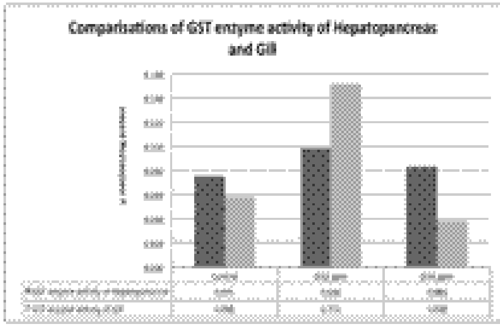

Fig. 1. Comparison of GST enzyme activity of hepatopancreas and gill in mussel (*Mytilus galloprovincialis*)

References

1 - Voulvoulis, N., Scrimshaw, M. D., & Lester, J. N. (1999). Alternative antifouling biocides. *Applied organometallic chemistry*, *13*(3), 135-143.

2 - Kaaya, A., Najimi, S., Ribera, D., Narbonne, J. F., & Moukrim, A. (1999). Characterization of glutathione S-transferases (GST) activities in Perna perna and Mytilus galloprovincialis used as a biomarker of pollution in the Agadir Marine Bay (South of Morocco). *Bulletin of environmental contamination and toxicology*, *62*(5), 623-629.

3 - Arslan, O. C., Parlak, H., Boyacioglu, M., Karaslan, M. A., & Katalay, S. (2014). Changes in the glutathione-s transferase activity of the mussel *Mytilus galloprovincialis* during exposure to bisphenol-A. *Fresenius Environmental Bulletin*, *23*(10 A), 2525-2530.

4 - Regoli, F., Frenzilli, G., Bocchetti, R., Annarumma, F., Scarcelli, V., Fattorini, D., & Nigro, M. (2004). Time-course variations of oxyradical metabolism, DNA integrity and lysosomal stability in mussels, Mytilus galloprovincialis, during a field translocation experiment. *Aquatic toxicology*, *68*(2), 167-178.

EXPERIMENTAL EVIDENCE FOR THE DISRUPTION OF PREDATOR-PREY INTERACTIONS BY CHEMICAL POLLUTION

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Abstract
Predator-prey relationships are complex and chemical communication plays an important role. The role of chemical communication between *Scorpaena porcus* and *Pomatoschistus* spp. was assessed including the added effects of a herbicide. Tank trials featured living free-roaming and confined *S. porcus* as well as a maquets. This allowed for manipulations of cues perceived by the prey. Trials were performed in chemically polluted and unpolluted seawater. *Pomatoschistus* spp. assessed predation threats using multiple sources of information. Kairomones of *S. porcus* were detected by the prey, yet simultaneous visual and olfactory cues resulted in stronger anti-predator responses. Glyphosate disrupted predator-prey interactions.This work was supported by the Croatian Science Foundation under the project COREBIO (3107).

Keywords: Fish behaviour, Predation, Pollution, Ecotoxicology, Mediterranean Sea

Predator-prey relationships have long been in the focus of biological and ecological research. In predator-prey relationships the most effective prey investment is to prevent detection and attack [1]. A prerequisite is to know where the predator is located and read its condition and behaviour by using multiple cues, at least visual and chemical. Chemical cues provide information that visual cues cannot and studies have shown that fish respond to chemical cues without an additional visual cue [2]. Glyphosate is one of the most frequent contaminants in surface, ground and drinking water. It is widely used in the world and very mobile in water and air. Its application is likely to accelerate in the future. The negative effects of pesticides in marine organisms are varied. Glyphosate has been shown to cause changes in acetylcholinesterase (AChE) activity. Changes in AChE activity are known to induce an alteration in prey location, predator avoidance, and orientation towards food [3].

The following hypotheses motivated our reasearch: 1. The predator *Scorpaena porcus* is perceived as threat by the prey *Pomatoschistus* spp. and provokes anti-predator behaviour. 2. Chemical cues of the predator provoke anti-predator behaviour in the prey. 3. The combination of chemical and visual cues of the predator result in a stronger anti-predator reaction in the prey than each cue by itself. 4. Concentrations of the herbicide glyphosate in sea water which are below the EU limit alter the behaviour of prey towards their predator. To test these hypotheses, we conducted a multifactorial indoor tank experiment. We observed prey responses to the predator under normal and polluted seawater conditions, under presence of only chemical, only visual, and both predator cues, and within environments offering zwo types of habitat, seagrass and open sand.

Concerning the behavior of prey to predator in normal ambient seawater the following results can be summarized: 1. The degree of prey activity decreased and its motionlessness increased in the presence of predator cues compared to their absence. This is consistent with the prediction that increased motion increases the risk of being detected. 2. Prey habitat choice showed no clear pattern. In daytime, when the predator was in the seagrass, prey preferred the bare sand. Pooling data from day and night suggests that prey more often finds itself in the same habitat as the predator. At night localization of the predator may be best achieved by staying closeby. 3. The prey responded differently to confined predators, seen and smelled, than to the maquet-predators which are visible but odorless. Prey did detect and react to kairomones of the predator and responded with significantly higher immobility and distance to the predator when odors were present. 4. When visual cues were presented by a living but constrained predator giving off no chemicals, the prey kept a greater diatance from the predators than to the a maquet and prey was also more likely to aggregate. Thus prey does respond to visual cues alone. 5. Presentation of both predator cues resulted in further increases in the distances between predator and prey and in more prey aggregation. However, there were no differences in the amount of activity level comparing single cue and double cue treatments.
Concerning the prey behaviour in polluted (glyphosate) water, the following results can be summarized: 1. When a very low concentration of glyphosate was added to the seawater, the prey kept a larger distance to a predator with chemical cues only than to predators offering visual and chemical cues. With only visual cues present, prey kept a larger distance to the predator in the treatment featuring the higher glyphosate concentration (EU exposure limit) than in the treatments featuring either unpolluted seawater or lower glyphosate concentration. Thus, with a higher glyphosate concentration, prey may have increased overall vigilance. 2. While there always was a regular pattern of aggregation and dispersion of prey in all glyphosate-free treatments, no pattern of aggregation/dispersion was found for any of the glyphosate treatments. This total lack of regular bahavioral patterns in the glyphosate treatments suggests that prey is not behaving normally. 3. While overall activity levels of prey in the glyphosate treatments are similar to those in the unpolluted treatments, half of the glyphosate trials resulted in a significantly higher proportion of motionless prey when under predator presence compared to the no-predator treatment. Prey in all trials featuring unpolluted seawater showed a consistent reduction in activity during the presence of predators.

We conclude that *Scorpeana porcus* and *Pomatoschistus* ssp. show classic predator prey interactions, with the prey altering aggregation patterns, distance to the prey, activity levels and habitat choice in response to the various predator presentations. Both, visual and chemical cues are important and solicit different responses in the prey. Furthermore, prey which is confronted with predators in water polluted with the herbicide glyphosate, show markedly altered predator responses compared to being in unpolluted water. Prey keeps a larger distance from the predator which is potentially an outcome of significantly higher overall activity levels. This „hyperactivity“ may also be responsible for the lack of the regular patterns of aggergation and dispersal in all polluted treatments.

This work has been partly supported by the Croatian Science Foundation under the project COREBIO (3107), “Conditions, Resources, Enemies, and Biodiversity: Forces structuring marine communities of the shallow Adriatic Sea.”

References

1 - Broom, M., Higginson, A.D., Ruxton, G.D. 2010. Optimal investment across different aspects of anti-predator defences. Journal of Theoretical Biology, 263: 579-586.
2 - Kruschel, C. and Schultz, S.T. 2011. Juvenile Gobius niger avoids seagrass in the presence and uncertain absence of seagrass-inhabiting predators. Journal of Experimental Marine Biology and Ecology, 409: 240-246.
3 - Moraes, B.S., Loro, V.L., Glusczak, L., Pretto, A., Menezes, C., Marchezan, E., Machado,S.d.O. 2007. Effects of four rice herbicides on some metabolic and toxicology parameters of teleost fish (*Leporinus obtusidens*). Chemosphere, 68:1597-1601

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REVERSIBILITY OF METAL INDUCED MALFORMATIONS IN SEA URCHIN EMBRYOS

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Abstract

Trace metals are widespread pollutants in marine sediments. Exposure to these elements can induce well documented malformations during the early embryogenesis of sea urchin, but the reversibility of such effects is largely unknown. Our results showed the highest effects at pluteus stage, but the damage observed at 48 h after fertilization was mostly reversible. This study suggests the need to perform the sea urchin embryo test at different times of incubation, in order to discriminate between delay and block of embryogenesis, thus obtaining a more realistic interpretation on embryotoxicity potential of marine sediments.

Keywords: Ecotoxicology, Mediterranean Sea, Metals, Sediments, Echinodermata

Introduction

Trace metals are accumulated in marine sediment, constituting an important risk for living organisms. The sea urchin embryo test is one of the most sensitive and widespread bioassays to assess the ecotoxicological effects of marine sediments [1]. Although the sensitivity of sea urchin embryos to trace metals has been largely reported, no studies have assessed the possible reversibility of these effects during the early life stage. The aim of this study was to characterize and quantify the main anomalies induced by metals during embryo development of *Paracentrotus lividus*, investigating whether the damage is reversible.

Materials and methods

P. lividus embryo test was conducted with standardized methodology [2]. Moreover, different aliquots of the same pool of embryos were incubated with metals for 24 h and then allowed to continue developing in filtered control seawater for up to 72 h. Analysis of developmental defects was performed at 24 h, 48 h (standard time of incubation) and 72 h after fertilization both for washed and non-washed embryos, in order to understanding whether embryos exhibit block or delay in embryogenesis. The percentage of well-developed embryos (n=100) was recorded along with: 1) stage of development 2) occurrence of malformation.

Results and discussion

All trace metals to which the embryos were exposed showed a minimum of toxicity at 24 h, with an increase of the toxic effects at 48 h and a partial recover at 72 h (Fig. 1A). Pluteus stage appeared to be more sensitive than embryos at the end of gastrulation. The majority of embryos analysed at 48 h presented reversible anomalies, reaching the correct developmental stage at 72 h. This trend was particularly evident in embryos transferred to clean seawater at 24 h; despite no significant differences were observed at 48 with non-washed embryos, at 72 h washed embryos exhibited higher values of normally developed plutei (Fig 1B). In addition, specific malformations, time of occurrence and magnitude of effects was influenced by the considered metal.

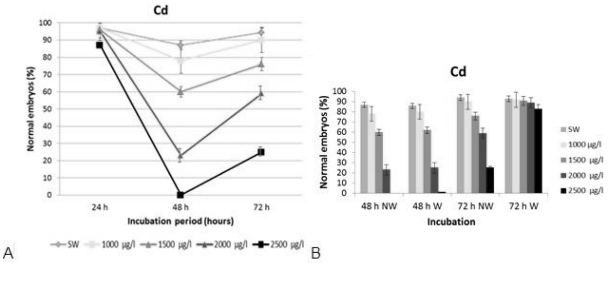

Fig. 1. A: Non-washed embryos: percentage of normal embryos (ordinate) at different times of incubation (abscissa) for each Cd concentration (coloured lines). SW: control. B: Histograms refer to non-washed embryos (NW) and to washed embryos (W) 48 h after fertilization and 72 h after fertilization.

Conclusions

In conclusion, results suggest the need to perform the sea urchin embryo test not only at the standard time of 48 hours, considering also the effects on pre-pluteus stage and the temporal evolution of these effects, allowing a more realistic estimation of the ecotoxicity of environmental matrices.

References

1 - His, E., Heyvang, I., Geffard, O., & De Montaudouin, X. (1999). A comparison between oyster (*Crassostrea gigas*) and sea urchin (*Paracentrotus lividus*) larval bioassays for toxicological studies. Water Research. 33(7):1706–1718.

2 - Arizzi Novelli A., Argese E., Tagliapietra D., Bettiol C., Ghirardini A.V. (2002). Toxicity of tributyltin and triphenyltin to early life-stages of Paracentrotus lividus (Echinodermata: Echinoidea). Environmental Toxicology and Chemistry. 21(4):859–864.

A MODEL STUDY TO USE DUCKWEED, *LEMNA MINOR* AS INHIBITOR OF HEAVY METALS (CU & ZN) STRESS GENES IN NILE TILAPIA *ORIOCHROMIS NILOTECUS*

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Abstract

Aquatic plants have been known for metals bioaccumulation and sequestration. The ability of Duckweed (*Lemna minor*) to regulate heavy metals uptake and to reduce their impacts on the activity and gene expression of main enzymatic antioxidants was evaluated. *L. minor* was exposed to high levels of the most dominant heavy metals in the Egyptian environment; copper and zinc. Nile tilapia within different treatment groups were exposed to water contaminated with copper and zinc for 4 weeks to assess the damage in DNA and alteration in expression of the stress related genes as GST, CAT, SOD and GPx as well as its protective mechanism on DNA structure against damage in response to the exposure to low and high doses of Cu and Zn.

Keywords: Biotechnologies, Mediterranean Sea

Introduction

Cu naturally occurs in the aquatic environment in low concentrations. Cu is one of the most toxic elements to aquatic species, at levels just above that needed for growth and reproduction it can accumulate and cause irreversible harm to some species. Copper is an essential trace metal necessary for growth and metabolism of all living organisms Cu is acutely toxic (lethal) to freshwater fish via their gills in soft water at concentrations ranging from 10 – 20 ppb.

Zn is an essential trace element for organisms, but in excessive amount is toxic for organisms. The present wide industrial use of zinc makes it one of the most common pollutants in natural waters. Excessive zinc could inhibit physiological activities of aquatic organisms and even be lethal. Zinc can be accumulated in organisms and transmitted by the aquatic food chain and finally harm human health.

Duckweed (*Lemna minor* L.) is used in water quality studies to monitor heavy metals and other aquatic pollutants, because duckweed, like other water plants, may selectively accumulate certain chemicals and may serve as biological monitors.

Material & methods

Ten fish from each treatment were sampled after 4 weeks of treatment. At the end of the experimental period, all fish were sampled and dissected. Gills and liver samples from tilapia within different treatment groups were collected in liquid nitrogen and stored at -80ºC until used for RNA extraction. Several techniques including enzyme activity determination, comet assay, alteration in gene expression, and Quantitative Real Time-Polymerase Chain Reaction were applied.

Results and discussion

Treatment of Cu or Zn contaminated water with Duckweed decreased the DNA damage by 36 and 37% respectively. On the other hand duckweed increased the activity levels of GST, SOD, CAT and GPx (Figure 1). Expression levels of GST, and GPx genes were significantly increased in contaminated water fishes treated with duckweed.

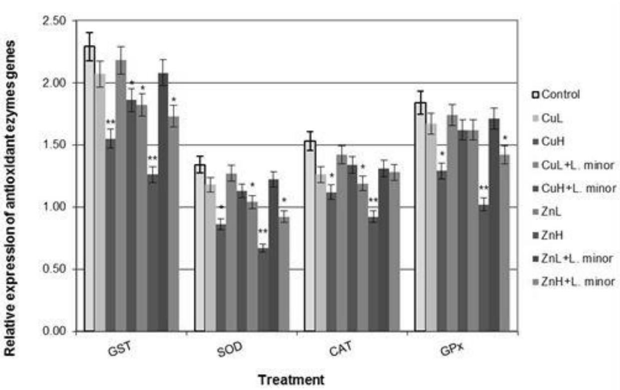

Fig. 1. The relative expression of antioxidant enzyme genes (GST, SOD, CAT, GPs) in liver of Nile tilapia exposed to heavy metals (Cu and Zn) in water with or without duckweed (*L. minor*) (L: low dose, H: high dose). *$P < 0.05$ and ** $P < 0.01$ for the treated groups compared with control group.

References

1 - Nassar, H. F., Shaban, M., A., Bassem, M. S., and Abdel-Gawad Kh., F., 2015. Utilization of duckweed (DW) in nutrient removal from agricultural waste water and producing alternative economic animal fodder. Der Pharma Chemica. 7: issue 12, 2015.

2 - Blasiak, J.; Arabski,M.; Krupa, R.; Wozniak, K.; Zadrozny, M.; Kasznicki, J.; Zurawska, M. and Drzewoski, J.(2004): DNA damage and repair in type 2 diabetes mellitus. Mutation Research, 554: 297-304.

3 - Kumar V, Khalil WK, Weiler U, Becker K. (2013). Influences of incorporating detoxified Jatropha curcas kernel meal in common carp (Cyprinus carpio L.) diet on the expression of growth hormone- and insulin-like growth factor-1-encoding genes. J Anim Physiol Anim Nutr; 97(1):97-108

4 - F.Kh. Abdel-Gawad, N.M. Lotfy, M.A. Hassanein, S.M. Bassem, Evaluation of DNA Damage in Fish and Aquatic Insects Induced By Environmental Pollutants in River Nile. World Applied Sciences Journal, 14(7), (2011) 1085-1090.

5 - F. Kh. Abdel-Gawad, H. F. Nassar, S. M. Bassem, G. Guerriero, W. K. B. Khalil, Effect of Polycyclic Aromatic Hydrocarbons (PAHs) on Modulate Genes Encoding Stress Related Proteins and Antioxidant Enzymes in Different Marine Fish Species of Red Sea Water. World Applied Sciences Journal 32 (12), (2014) 2337-2346

EFFECTS OF GOLD NANOPARICLES ON THE MEDITERRANEAN CLAMS *RUDITAPES DECUSSATUS* (LINNAEUS, 1758)

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Abstract

Mediterranean clam (*R. decussatus*), were exposed for seven days to different amount of Au nanoparticles (AuNP1 = 0.05 mg/L and AuNP2 = 0.1 mg/L). Iron level and enzyme activities (SOD, CAT) were analyzed in the gills. Results proved that AuNP increased significantly Iron level showing toxicity of AuNPs. Additionally, SOD and CAT activities increased in concentration dependent manner indicating defense against oxidative stress. This study provides original data on the interactions between AuNPs and marine organisms and confirms that Mediterranean *R. decussatus* is model species for monitoring aquatic pollution by nanoparticles.

Keywords: Ecotoxicology, Mediterranean Sea, Bivalves

Introduction

Aquatic bivalves have been used as environmental indicators since they may reflect the ecosystem contamination. An example is the Mediterranean clam *Ruditapes decussatus*, which have been used as pollution indicators due to its tolerance against contaminants [1,2]. *Ruditapes decussatus* is an economically important bivalve species, very abundant and well commercialized around the Mediterranean Sea [1]. It is also relatively resistant to a wide variety of pollutants and environmental stressors, making it suitable for marine biomonitoring. its was considered as prime candidates for uptake of pollutants from environmental releases. Aquatic environment especially coastal systems are likely to be the ultimate sink for nanomaterials, deliberately or purposely discharged into the environment. Bivalves can filter large volumes of pollutants and may represent a significant target for NPs [3].To this fact, rigorous identification of environmental hazard and full risk assessments of nanoparticles are needed more precisely, the ecotoxicity of these nanomaterials in coastal systems, in which ecologically significant organisms are affected, is starting to drive research by many groups. The present paper aims at describing the effects of gold nanoparticle (AuNPs) on clams *Ruditapes decussatus*.

Materials and Methods

Adult clams (*Ruditapes decussatus*) of between 2.5 and 3 cm shell length (maximum axis) were purchased from a site in Bizerte lagoon (37°13'18.54''N, 9°55'59.61''E). For the course of the experiment, 5 individuals were placed in each tank with 3 L of sea water obtained from the sampling site containing 0.5 and 1 mg/L of AuNPs respectively. A control series without AuNPs was run in parallel. After 7 days Gill were homogenised by a polytron homogenizer and supernatants were collected by centrifugation at 20,000 × g (4°C for 30 min). Antioxidant enzymatic activities (SOD and CAT) and Iron level were measured in the cytosolic fraction of 15 clams from control groups and exposed to AuNPs.

Results and discussion

Ecotoxicological effects of gold nanoparticles still lacking. This review focuses on the impact of AuNPs on health and particularly on antioxidant biomarkers and addresses potential risks of exposure to this nanoparticle on non target species *R. decussatus*. SOD and CAT GST are involved in the defense against oxidative stress. In the present study, mean values of Iron level and antioxidant enzymes in control and treated clams with AuNP1 and Au2NPs for 7 days are displayed in Fig.1. Thus, AuNPs induced an overall increase in the antioxidant enzymes and Iron level in gills on concentration dependent manner. This result showed the sensibility of gills to AuNPs and we can hypothesize that reactive oxygen species are produced as a result of AuNPs uptake by this organ even at low concentrations (0.05 mg/L) since it is known that NPs are capable of crossing cell membranes, leading to oxidative damage [4]. Oxidative stress results confirmed with SOD and CAT activities are supported by the free iron measurement. These biochemical damages may bring consequences that can damage macromolecules such as proteins, DNA and lipids, finally leading to the damage of different cellular organelles.Considering the increase of nanotechnology, the present study provides valuable information regarding the interaction between AuNPs and molecular status giving potential risk for mollusks bivalves. Thus several questions remain incompletely answered and further investigations focusing on the mechanism of nanomaterial bio-transformation on marine organisms are needed.

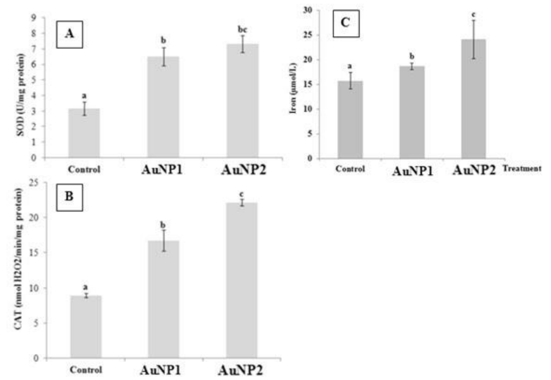

Fig. 1. Figure 1. Superoxide dismutase (A), Catalase (B) activities and Iron level (C) in gill of untreated (Control) and treated *R. decussatus* after 7 days of exposure to AuNPs.

References

1 - Dellali M., Gnassia-Barelli M., Romeo M. and Aissa P., 2001. The use of acetylcholinesterase activity in *Ruditapes decussatus* and *Mytilus galloprovincialis* in the biomonitoring of Bizerta lagoon. Comp. Biochem. Physiol C., 130: 227–235.

2 - Sellami B., Khazri A., Mezni A., Louati H., Dellali M., Aissa P., Mahmoudi E., Beyrem H. and Sheehan D., 2015. Effect of permethrin, anthracene and mixture exposure on shell components, enzymatic activities and proteins status in the Mediterranean clam *Venerupis decussata*. Aquat. Toxicol. 158 : 22–32.

3 - Canesi L., Ciacci C., Fabbri R., Marcomini A., Pojana G. and Gallo G., 2012. Bivalve molluscs as a unique target group for nanoparticle toxicity. Mar. Environ. Res. 76: 16–21.

4 - Li J., Zhu Y., Li W., Zhang X., Peng Y. and Huang Q., 2010. Nanodiamonds as intracellular transporters of chemotherapeutic drug. Biomaterials, 31: 8410–8418.

CIESM Congress Session : Ecotoxicology / field studies

Moderator : Katrin Vorkamp, Dept. of Environmental Science, Aarhus Univ., Denmark

Moderator's Synthesis

The moderator opened the session with a brief introduction, consisting of her personal view on interesting topics in this area of research. The following research topics were presented:

• Contaminants of emerging concern (e.g. replacement products of banned chemicals, “pseudo-persistent” chemicals such as personal care products and pharmaceuticals) [1,2]
• Mixture toxicity (e.g. concentration addition and the case of additive solubilities of solid chemicals) [3,4]
• Litter/microplastics (exceeding OSPAR’s Ecological Quality Objective, even in remote areas) [5]
• Passive sampling/passive dosing (promising techniques in exposure and toxicity tests) [6,7]
• Food chain accumulation and biomagnification (lack of process understanding) [8]
• Seven snapshot presentations were given in this session, the majority studying biomarker responses in bivalves and fish. The general discussion covered the following items:
• Specificity of biomarkers: A positive signal has to be a true sign of an effect. It is not always possible to relate the signal to a specific cause. This is particularly challenging in the complex situation of field studies where biomarker responses can be influenced by biological and environmental factors. [9]
• Threshold levels in marine monitoring: The assessment of the environmental status usually involves a threshold value. These threshold levels are derived from (eco)toxicological data, but data gaps and/or conflicting data exist, with potential consequences for soundness and applicability of these values. [10]
• Early warning systems: Ecotoxicological studies can indicate environmental problems, which need to be followed up by chemists for compound identification and quantification. This calls for enhanced collaboration between these disciplines.
• Effect-directed analyses: Promising tool on the interface ecotoxicology/chemistry where a sequence of fractionations reduces complexity of a sample. Biological tests and chemicals analyses of each fraction aim to establish and confirm cause-effect relationships. [11]

References:

[1] Vorkamp et al., 2015, Environ. Poll. 196, 284.[2] Fabbri and Franzellitti, 2016, Environ. Toxicol. Chem. 35, 799. [3] Cedergren, 2014, PLoS One 9(5), e96580. [4] Smith et al., 2013, Environ. Sci. Technol. 47, 2026. [5] Avery-Gomm et al., 2012, Mar. Poll. Bull. 64, 1776. [6] Booij et al., 2016, Environ. Sci. Technol. 50, 3. [7] Smith et al., 2012, Environ. Sci. Technol. 46, 4852. [8] Norstrom and Muir, 1994, Sci. Total Environ. 154, 107. [9] Amiard-Triquet and Berthet, 2015, in: Amiard-Triquet et al. (eds.) Aquatic Ecotoxicology, Chapter 7, 153. [10] OSPAR, 2009, Background document on CEMP assessment criteria for QSR 2010, 461/2009. [11] Brack, 2003, Anal. Bioanal. Chem. 377, 397.

SPECTROSCOPIC ANALYSES AND GENOTOXICITY OF DIOXINS IN THE AQUATIC ENVIRONMENT OF ALEXANDRIA

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Abstract
Dioxins have a global concerns of the bioaccumulation tendency and persistency. Twenty four samples of water, seabream Pagrus auratus and Seabass Dicentrarchus labrax samples were collected from Alexandria to evaluate the concentration of the 2,8-dichloro dibenzo-p-dioxin.Fourier Transform Infrared Spectrometer (FTIR) and HPLC with UV was applied. RT-PCR assay was conducted to verify the expression of some immune genes. The average detected concentrations ranged between 0.2 to 1.3 µg/l. Immune genes expression revealed that MHC class 1 and C3 were highly upregulated in liver and muscles of seabass and seabream while T2BP was highly regulated in seabass liver and seabream muscle and also seabass muscle for transferrin. Application of HF/3-21G* molecular model indicates that hydrated dioxin could interact with amino acid.

Keywords: Biotechnologies, Mediterranean Sea

Introduction
Aquatic pollution is a serious problem due to its ubiquitous occurrence, recalcitrance properties, suspected carcinogenicity and mutagenicity to humans and biota. Moreover, water pollution with organic compounds is a hot topic of concern. Although some of such pollutants are naturally occurring, the majorities are anthropogenic and enter the environment through release of petroleum products or by combustion of organic matter. For millenniums, the Mediterranean Sea has been the scenery of human development, which has extensively influenced the coastal areas. Alexandria is an Egypt largest city on the Mediterranean coast, and is one of the most important industrial centers, comprised 100 large factories and about 260 smaller ones. Aquatic organism, such as fish, accumulates pollutants directly from contaminated water and indirectly via the food chain. Persistent organic pollutants can be detected in environment after being banned for generations (DDT banned in 1960s and still being detected).

Methodology
Several techniques including FTIR were used to study marine fish from the Mediterranean, then molecular modeling at HF/3-21G* (Figure 1) was used to model the effect of dioxin upon protein. HPLC with UV was used to determine the concentration of dioxins while RT-PCR assay was conducted to verify the expression of some immune genes in the studied fish species (Figure 2).

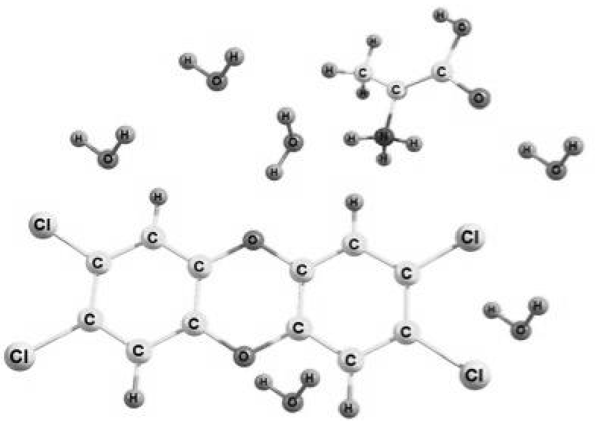

Fig. 1. HF/3-21G* optimized structure for the model molecule of dioxin- alanine which subjected to six water molecules.

Results and discussion
Elevated concentration of 2,8-dichloro dibenzo-p-dioxin were detected in summer and this may be attributed to the intensifying of maritime activities in coastal area at this season. Pollution evoked an immune response in fish collected from Alexandria coastal water. The results verified by RT-PCR, revealed that MHC class 1 and C3 genes were highly upregulated in seabass and se bream muscle and liver, alsoT2BP was highly upregulated in liver of seabass and muscle of seabream. The molecular modelling suggests that a change in the protein structure may take place under the influence of the hydrated dioxin. Further studies are encouraged to identify gene expression biomarkers as indicator to specific pollutants.

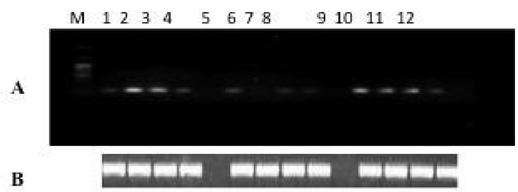

Fig. 2. A) RT- PCR: M: Marker; 1,2: Seabass (muscle and liver) T2BP gene; 3, 4: Seabream (muscle and liver) T2BP gene; 5,6: Seabass (muscle and liver) Transferrin gene; 7,8 Seabream (muscle and liver) Transferrin gene; 9, 10 Seabass (muscle and liver) MHC class 1& 11, 12: Seabream (muscle and liver) MHC class 1.
Fig. 2 B) RT-PCR: B actin gene.

References
1 - F. Kh. Ali, S.A. El-Shafai, F.A. Samhan, W.K.B. Khalil, Effect of water pollution on expression of immune response genes of Soleaa egyptiaca in Lake Qarun. African Journal of Biotechnology, 7(10), (2008) 1418-1425.
2 - F.Kh. Abdel-Gawad, N.M. Lotfy, M.A. Hassanein, S.M. Bassem, Evaluation of DNA Damage in Fish and Aquatic Insects Induced By Environmental Pollutants in River Nile. World Applied Sciences Journal, 14(7), (2011) 1085-1090.
3 - F. Kh. Abdel-Gawad, H. F. Nassar, S. M. Bassem, G. Guerriero, W. K. B. Khalil, Effect of Polycyclic Aromatic Hydrocarbons (PAHs) on Modulate Genes Encoding Stress Related Proteins and Antioxidant Enzymes in Different Marine Fish Species of Red Sea Water. World Applied Sciences Journal 32 (12), (2014) 2337-2346
4 - M. Ibrahim, A. J. Hameed, A. Jalbout, ”Molecular Spectroscopic Study of River Nile Sediment in the Greater Cairo Region”, Applied Spectroscopy, 62 (2008), 306-311.
5 - M. Ibrahim, O. Osman, A-A. Mahmoud, H. Elhaes, " Spectroscopic Analyses of Water Hyacinth: FTIR and Modeling Approaches", Der Pharma Chemica. 7 (2015) 182-188.

OXIDATIVE STRESS INDICES IN NATURAL CLAM POPULATIONS, *VENERUPIS DECUSSATA* AS BIOMARKER TO EVALUATE POLLUTION IN TWO COASTAL MEDITERRANEAN LAGOONS (TUNISIA)

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Abstract

New results concerning five biomarkers of oxidative stress, malondialdehyde (MDA), advanced production produce (AOPP), glutathione peroxidase (GPx), glutathione (GSH) and ascoebic acid (Vit C), in *Venerupis decussata* digestive gland collected in summer 2014 from two Tunisian lagoons, located in the southern part of the Mediterranean Sea coast, are reported. All oxidative stress biomarkers measured were higher in *V.decussata* sampled from Boughrara lagoon than those from Tunisia Northern lagoon. These results indicate that *V.decussata* constitutes a useful tool on biomonitoring of aquatic pollution and the Boughrara lagoon was more polluted than Tunisia Northern lagoon.

Keywords: Bio-indicators, North-Eastern Mediterranean

Introduction

Biomarkers are required to assess the biological effects of pollutants on marine organisms in order to monitor ecosystem status. Highly productive areas, such as coastal lagoons, are among the most extensively modified and threatened ecosystems, especially for Mediterranean lagoons [1], affected by anthropogenic pressures, with very long water residence time. To assess the environmental quality of Mediterranean southern lagoons (Tunisia), biomarkers were measured in native clams *V.decussata* from two selected sites: The Boughrara lagoon site (S1) (N33°32'34.20" - E10°40'56.37"), located in southern coastal of Tunisia characterized by urban effluents [2], while the Northern lagoon site (S2) (N36°49'4.31"- E10°13'5.94"), located in the northern of Tunisia is subjected to various impacts from the channel area [3].

Materials and methods

Clams of similar sizes (29–35 cm shell length) were sampled monthly from both sites in summer 2014. In the laboratory, 30 individuals (per month and per site) were used for stress analyses. In fact, clams were scarified for excision of the digestive gland (DG), for the purpose of biomarker analyses and stored in liquid nitrogen at −80 °C prior to the assays. The biochemical parameters were tested with Kruskal-Walis test (ANOVA) after normality analysis (Shapiro test).

Results and discussions

This paper provides evidence of the anthropogenic contamination in two Tunisian lagoons on the marine clams *V.decussata*. Pollutants induced a situation of oxidative stress on clam collected from Boughrara lagoon, resulting in a transient significant increase in MDA, AOPP levels and antioxidant enzymes, as evidenced by an increase of GPx level ($p>0.05$). Conversely, remarkably low levels of non-enzymatic antioxidants such as GSH and Vit C (Table 1), observed at *V.decussata* from North lagoon indicate that animals may use these compounds to counteract stress in the digestive gland, which is a major metabolic function tissue involved in xenobiotic uptake and oxyradical-generation [4]. Our data confirm the pollution status of Boughrara lagoon, due to the presence of continuous discharge of wadis, fishing port and industrials activities [5] and the abundance of toxics phycotoxins [6]. According to others studies, North lagoon was also considerate as polluted site [7] but with lesser degree compared to Boughrara lagoon.

Tab. 1. Oxidative stress variation in clam's digestive gland sampled from Tunisia coastal lagoons (Boughrara [S1]; North lagoon [S2])

	MDA	AOPP	GPx	GSH	Vit C
June					
S1	157,02±13,48 ^{a}	0,03±0,00	1,28±0,06	5,42±0,22^a	24,10±2,58
S2	48,42±2,13 ^{b}	0,03±0,00	1,38±0,09	1,87±0,11 ^{b}	18,28±1,31
July					
S1	79,10±6,86	0,10±0,00 ^{a}	3,39±1,00	4,65±0,16 ^{a}	16,42±1,53
S2	47,82±2,84	0,01±0,00 ^{b}	1,90±0,63	1,04±0,10 ^{b}	11,93±1,58
August					
S1	148,34±13,25	0,10±0,01 ^{a}	1,86±0,57	5,46±0,27 ^{a}	21,56±2,47 ^{a}
S2	86,89±2,13	0,01±0,00 ^{b}	0,64±0,04	1,91±0,10 ^{b}	12,20±0,85 ^{b}

References

1 - Mahmoud N., Dellali M., El Bour M., Aissa P. and Mahmoudi E., 2010. The use of *Fulvia fragilis* (Mollusca :Cardiidae) in the biomonitoring of Bizerta lagoon : A mutimarkers approach. *Ecological Indicators*., 10: 696-702.

2 - Ben Aoun Z., Farhat F., Chouba L. and M.S. Hadj Ali., 2007. Investigation on possible chemical pollution of the Boughrara lagoon, South of Tunisia, by chemical wastes. *Bull.Inst.Natn.Scien.Tech.Mer de Salambo*, Vol 34,119.

3 - Ben Maïz.N., 1997. Le Lac Nord de Tunis : un milieu en mutation. In Gestion et conservation des zones humides tunisiennes. *Actes de séminaire* ;77-84.

4 - Ramos-Gomez M., Kwak MK., Dolan PM, Ltoh K., Yamamoto M., Talalay P. and Kensler. TW., 2001. Sensitivity to carcinogenesis is increased and chemoprotective efficacy of enzyme inducers is lost in nrf2 transcription factor-deficient mice. *Proc. Natal. Acad. Sci. U. S. A.*, 13:98 (6), 3410-5.

5 - Kharroubi A., Garqouri D., Baati H. and Azri C., 2012. Assessment of sediment quality in the Mediterranean Sea-Boughrara lagoon exchange areas (southeastern Tunisia): GIS approach-based chemometric methods. *Environ. Monit. Assess*., 184(6): 4001-14.

6 - Marrouci R., Dziri F., Belayouni N., Hamza A., Benoit E., Molgo J. and Kharrat., R., 2010. Quantitative Determination of Gymnodimine-A by High Performance Liquid Chromatography in Contaminated Clams from Tunisia Coastline. *Mar Biotechnol*., 12:579–585. DOI 10.1007/s10126-009-9245-7.

7 - Banni M., Bouraoui Z., Ghedira J., Clearandeau C., Jebali J. and Boussetta H., 2009. Seasonal variation of oxidative stress biomarkers in clams *Ruditapes decussatus* sampled from Tunisian coastal areas. *Environ. Monit. Assess.*, 155:119–128.

EVALUATION OF METALLOTHIONEINS LEVELS IN THE MARINE GASTROPOD *PHORCUS TURBINATUS* (BORN 1778) ALONG THE NORTHEASTERN AND EASTERN COASTS OF TUNISIA

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Abstract
This work is an estimation of metallothioneins rates in the digestive gland of *Phorcus turbinatus*, collected from the northeastern and eastern coasts of Tunisia during different seasons. The results suggested a seasonal variation of the protein's levels (high concentration in winter), which could be explained by the strong correlations of these rates with the physicochemical environmental variables (temperature, salinity, pH and dissolved oxygen). Furthermore, the analyses of metallothioneins content suggest variations depending on intrinsic factors of organisms (size, weight, digestive gland weight).

Keywords: Gastropods, Rocky shores, Ecotoxicology, Tunisian Plateau

Introduction

Phorcus turbinatus (Born 1778) species is found in abundance at the rocky midlittoral of the Tunisian coasts. Researches on this bio indicator are still rather few. For this reason, we were interested in estimating the metallothioneins rates (low molecular weight protein) in the studied snail along the northeastern and eastern rocky coasts of Tunisia.

Material and methods

In order to estimate the variation of metallothioneins levels in *P. turbinatus*, a seasonal monitoring was conducted between April 2014 and January 2015 at six stations (Zarzouna, La Goulette, Korbous, Sidi Daoued, Kelibia and Monastir). Salinity values, water temperature, dissolved oxygen level and pH were recorded *in situ*. At each sampling, 30 adult individuals ([15-25mm]) were collected. The size, the total weight and the gland weight of each specimen were recorded. Digestive glands were extracted and homogenized. Proteins were isolated through a series of precipitations and resolubilizations and were allowed to react with DTNB ([1]). The colored solutions were analyzed using a spectrophotometer and the absorbences were correlated to MTs rates (µg MTs / g wet tissue) based on the values of standard solutions. The significance of the differences was evaluated using Kruskal-Wallis test.

Results

All studied stations, except La Goulette, presented a high rate of MTs in winter and less important levels in spring and autumn (Fig. 1). The maximum values of MTs were recorded at La Goulette in summer and at Zarzouna, Kelibia and Sidi Daoued stations in winter. The minimum value was observed at Korbous station in spring. The comparisons of MTs rates showed significant differences between seasons (p-value = 0.006) and not significant differences between stations (p-value = 0.721).

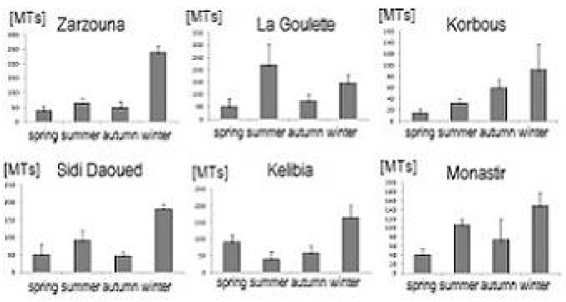

Fig. 1. Seasonal changes of metallothioneins (MTs) rates

At Zarzouna station, MTs content depends on dissolved oxygen level, pH, temperature, individuals' total weight and size. The levels of this protein in La Goulette, vary according to the size and the weight of the individuals and to the weight of the digestive glands. At Korbous, the rate of MTs was closely related to temperature, dissolved oxygen and the total weight of individuals. It is also influenced by the size of the shell and the weight of the gland. As for Sidi Daoud station, it showed a MTs rate depending on the oxygen levels, salinity, temperature, pH and the size of the shells. At Kelibia station, the rate of MTs was strongly correlated to all the physic-chemical variables. Except salinity and total weight of the individuals, the protein level in Monastir was influenced by the other studied variables.

Tab. 1. Estimated correlation between MTs rates and the various factors
S = salinity; T ° = water temperature; TL = total length; TW = total weight; GW = digestive gland weight; + Positive correlation; - Negative correlation

	S	T°	pH	O_2	TL	TW	GW
Zarzouna	0.496	**0.934 -**	**0.825 -**	**0.750 +**	**0.832 -**	**0.999 -**	**0.571 -**
La Goulette	0.250	0.280	0.070	0.343	**0.756 +**	**0.633 +**	**0.964 -**
Korbous	0.428	**0.971 -**	0.330	**0.761 +**	**0.519 -**	**0.794 -**	**0.540 -**
Sidi Daoued	**0.799 -**	**0.681 -**	**0.685 -**	**0.807 +**	**0.724 +**	0.339	0.298
Kelibia	**0.826 -**	**0.865 -**	**0.957 -**	**0.916 +**	0.030	0.024	0.321
Monastir	0.353	**0.566 -**	**0.756 -**	**0.572 +**	**0.679 +**	0.458	**0.679 -**

Discussion and Conclusion

The absence of spatial variation in the rate of MTs could be related to the geographical proximity of the studied stations. The high levels of MTs, registered in winter, could be explained by the strong correlations of these concentrations with the physicochemical environmental variables (temperature, salinity, and pH decrease and dissolved oxygen level rise) ([2]). Furthermore, the analysis of MTs concentrations suggests variations depending on intrinsic factors of organisms (size, weight, digestive gland weight).

References
1 - 1- Ellman G.L. 1959, Tissue sulphydryl groups. *Archives of Biochemistry and Biophysics*, 82: 70-77.
2 - 2- Smaoui-Damak W., Berthet B. and Hamza-Chaffai A. 2009, *In situ* potential use of metallothionein as a biomarker of cadmium contamination in *Ruditapes decussates*. *Ecotoxicology and Environmental Safety*, 72: 1489-1498.

GLUTATHIONE REDUCTASE. A POTENTIAL BIOMARKER FOR THE IMPACT OF HEAVY METAL POLLUTION IN *VENUS VERRUCOSA*

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Abstract
The effects of the metal pollution on *Venus verrucosa*, a common Mediterranean marine bivalve, were studied in a laboratory experiment. The test organisms were exposed to Pb, Cd and Ni at different exposure levels for 20 days. Four different parts of the organisms were examined for the bioaccumulation and distribution of the added heavy metals and the levels of glutathione reductase; a biomarker with multiple cellular functions, which plays an important role in the detoxification of reactive oxygen species and the regulation of redox balance. The organisms exhibited quite different behavior regarding each metal bioconcentration pattern as well as the tissue distribution and glutathione reductase activity.

Keywords: Saronikos Bay, Bio-accumulation, Bivalves, Bio-indicators, Ecotoxicology

Introduction
Heavy metals may generate oxidative stress in aquatic organisms. Glutathione reductase (GR) catalyzes the reduction of glutathione disulfide (GSSG) to glutathione (GSH), a critical molecule against oxidative stress. Any significant change of the ratio GSSG/GSH in the cells; is a sign of oxidative damage. This balance is maintained by glutathione reductase [1].

Materials and Methods
In this work, specimens of the marine bivalve *Venus verrucosa* remained for 20 days in aquaria contaminated with 0.5 mg/L or 2.5 mg/L of either Pb, Cd or Ni. Every 5 days of the exposure period, gills, mantle, digestive system and the remaining body were dissected and analyzed for heavy metal content and GR activity. After the 20 days period, the remaining bivalves were transferred to heavy metal-free seawater for a 10 day depuration experiment. Tissue samples were lyophilized, homogenized and digested with c. HNO_3 [2]. Heavy metals concentrations were determined by FAAS. Glutathione Reductase assay measures GR activity by measuring the rate of NADPH oxidation. GR was determined according to the method described by Carlsberg and Mannervik (1985) [3].

Results and Discussion
Ni was mainly accumulated in *V. verrucosa* gills, while the accumulation trend between the tissues for Cd and Pb was: gills>digestive system≈mantle>body. Heavy metal accumulation (for all three heavy metals examined) in the tissues of *V. verrucosa* presented an almost linear trend with the days of exposure. Organisms exposed to higher heavy metal concentrations in seawater, accumulated higher amounts of heavy metals. During the depuration period, Cd and Pb concentrations in all tissues of the organisms reduced, but the levels still remain high and statistically different from the pre-exposure levels in every tissue of all the test metals ($p>0.05$), whereas Ni concentrations seemed to be unaffected.

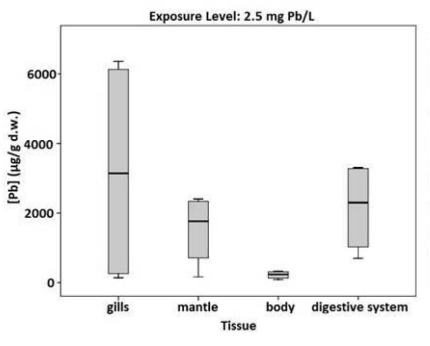

Fig. 1. Box-plots of Pb concentration per tissue of *Venus verrucosa* exposed to 2.5 mg Pb/L seawater

The highest GR activity for the organisms exposed to Pb, was measured in their digestive systems. For the Cd-exposed organisms, the highest GR activitiy was measured in their gills, while for the Ni-exposed, the highest enzyme activity was measured in their bodies for both the exposure levels. The trend for the GR activity in the mantle and digestive system of the organisms exposed to both heavy metal levels was: exposure to Pb>Cd>Ni whereas for gills: exposure to Cd>Pb>Ni and for the remaining body: Pb>Ni>Cd. During the exposure to Pb and Cd in all the organisms' tissues; GR activity increased with time and the level of exposure, while for Ni the trend was the opposite for all the tissues. During depuration, GR decreased in all the tissues of the organisms exposed to Pb and Cd and in the gills of the organisms exposed to Ni.

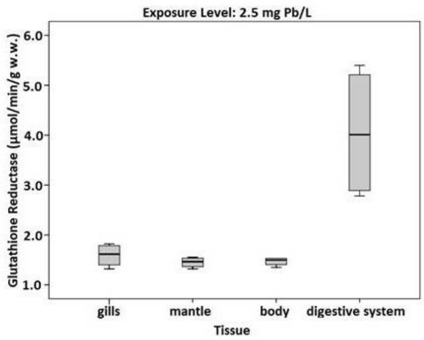

Fig. 2. Box-plots of Glutathione Reductase per tissue of *Venus verrucosa* exposed to 2.5 mg Pb/L seawater

Conclusion
Depending on the main pollutants of the area studied, glutathione reductase could be used as a biomarker in selected tissues of Venus verrucosa.

Acknowledgments This research has been co-financed by the European Union (European Social Fund) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

References
1 - Couto N., Wood J. and Barber J., 2016. The role of glutathione reductase and related enzymes on cellular redox homeostasis network, Free Radic. Biol. Med., In Press, accepted manuscript.
2 - Chalkiadaki O., Dassenakis M., Lydakis-Simantiris N., 2014. Bioconcentration of Cd and Ni in various tissues of two marine bivalves living in different habitats and exposed to heavily polluted seawater, Chem. Ecol., 30: 726–742.
3 - Carlberg I., Mannervik B., 1985. Glutathione reductase assay, Method. Enzymol., 113: 484–495.

OXIDATIVE STRESS AND DAMAGE BIOMARKERS IN CLAM *RUDITAPES DECUSSATUS* TO ASSESS POLLUTION IN THE SOUTH LAGOON OF TUNIS (TUNISIA)

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Abstract

The aim of this study was to assess the biological effect of the pollution in the south lagoon of Tunis in the clam *Ruditapes decussatus*, using a multi-biomarker approach. The results showed a high catalase, superoxide dismutase, caspase 3 activities and MDA level in clams collected from the navigation canal. These high values of the biomarkers confirm the presence of anthropogenic contaminants in the area of study, which essentially due to the industrial rejections.

Keywords: Bio-indicators, Bivalves, Pollution, Tunisian Plateau

Introduction. The south Lagoon of Tunis is a Mediterranean Lagoon located in the Southwest of the Gulf of Tunis. It is adversely affected by industrial contaminants from the industrial zone, urban untreated sewage from the city of Tunis and its southern suburbs and the important harbor activities. Bivalves are commonly used as sentinel species for monitoring coastal environments. *Ruditapes decussatus* (Linnaeus, 1758), the European clam is a characteristic bivalve of Tunis lagoon. This specie is considered as a good biological indicator of health status and contamination of the marine environment. Being a sedentary filter-feeding organism clams can accumulate environmental contaminants. The aim of this study was to assess the biological effect in a characteristic bivalve of this polluted lagoon. For that, a multi-biomarker approach was applied in Ruditapes decussatus clams collected from three different sites of on the lagoon. Biomarkers evaluated for this study were catalase, superoxide dismutase, LPO and caspase 3.

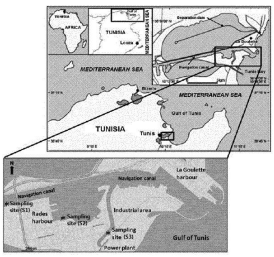

Fig. 1. Sampling sites for *Tapes decussatus* in the south lagoon of Tunis.

Material and methods. Bivalves were collected from an intertidal mudflat in September 2015 in three different sites in the south Lagoon of Tunis: the navigation canal (S1), the Rades harbour (S2) and the chemical industrial area (S3) (Fig.1). Control clams were collected from Louza (St) site which has been considered as a reference site [1]. The entire soft body of 10 animals was separated and homogenized in TRIS buffer. SOD activity was determined according to the method of [3] slightly modified by [4]. Lipid peroxidation was determined using the method of [5]. Results were expressed as nmol of MDA per mg protein. CSP 3-like activity was determined as described by [6].

Results and Discussion. In the present study, higher CAT activities were found in clams from S1, S2 and S3 (Fig.2), suggesting that animals had a high efficiency to cope with oxidative stress. In this context, it is suggested that increases in the activity of antioxidant enzymes may reflect an adaptation of animals to the chronic exposure to high/moderate levels of contamination, since this would confer increased protection from oxidative stress [7]. Higher SOD activity was found in clams from S1compared to clams from St, S2 and S3. The reduction in antioxidant enzyme activities recorded in clams is explained by the exposure of clams to both natural and anthropogenic factors [8]. Therefore, results obtained in the present study suggested a reduced antioxidant status of clams from S2 and S3. S1 showed the highest MDA level. The low level found at S2 and S3 might be explained by the compensatory or adaptative antioxidative responses. Only S1 showed a significant increase in CSP 3-like activity. This result might be explained by the damage cell in clams from S1. This hypothesis is supported by the high MDA level described previously in clams from S1. Conclusion This study suggests that catalase, superoxide dismutase, Lipid peroxidation and caspase 3 activities are indicators of stress in *Ruditapes decussatus*. Then, the results confirm the presence of anthropogenic contaminants in the area of study, which essentially due to the industrial rejections.

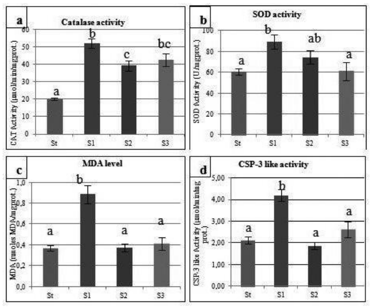

Fig. 2. CAT activities for *Tapes decussatus*.

References

1 - Banni M, Bouraoui Z, Ghedira J, Clearandeau C, Jebali J, Boussetta H.2009. Seasonal variation of oxidative stress biomarkers in clams *Ruditapes decussatus* sampled from Tunisian coastal areas. Environ Monit Assess. 155,119-128.

2 - McCord J, Fridovich I. 1969. An enzymatic function for erythrocuprein. J. Biol. Chem. 244, 6049-6055.

3 - Aebi H. 1984. Catalase in vitro. Methods in Enzymology.105, 21-126.

4 - Claiborne A. 1985. Catalase activity. In: Greenwald, R.A. (Ed.), Handbook of Methods for Oxygen Radical Research. CRC Press, Boca Raton London New York, pp. 283-284.

5 - Buege J A, Aust S D. 1978. Microsomal lipidperoxidation. Meth. Enzymol. 52, 302-310. View Record in Scopus Cited By in Scopus (2079).

6 - Buffet P M, Pan J F, Poirier L, Amiard-Triquet C, Amiard J C, Gaudin P, Risso-de Faverney C, Guibbolini M, Gilliland D, Valsami-Jones E, Mouneyrac C. 2013. Biochemical and behavioural responses of the endobenthic bivalve *Scrobicularia plana* to silver nanoparticles in sea water and microalgal food. Ecotoxicology and Environmental Safety 89, 117-124.

7 - Romero-Ruiz A *et al.*, 2003. Oxidative stress biomarkers in bivalves transplanted to the Guadalquivir estuary after Aznalcóllar spill. Environ Toxicol Chem., 22(1): 92-100.

8 - Matozzoa V, Binelli A, Parolini M, Previatoa M, Masieroa L, Finosc L, Bressana M, Marina M G. 2012. Biomarker responses in the clam *Ruditapes philippinarum* and contamination levels in sediments from seaward and landward sites in the Lagoon of Venice. Ecological Indicators. 19, 191-205.

ENVIRONMENTAL RISK ASSESSMENT OF WASTED CATALYSER FORM EUROCARGO VENEZIA SHIP INCIDENT: A MULTIDISCIPLINARY APPROACH

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Abstract

After the lost at sea of 198 barrels of spent catalyst from RO-RO ferry "Eurocargo Venezia", an assessment of possible environmental impact was performed. A multidisciplinary approach including bioassays, laboratory bioaccumulation tests, investigations on benthic communities and bioaccumulation analyses on organisms from the accident area were performed. Results revealed high toxicity and bioaccumulation of the catalyst, but the absence of toxic substances in organisms from the impacted area.

Keywords: Bio-accumulation, Deep sea sediments, Ecotoxicology, Metals, Ligurian Sea

Introduction

On the 17th December 2011, crossing the route Catania-Genoa, the RO-RO ferry "Eurocargo Venezia" lost at sea, near the Isle of Gorgona (Tyrrhenian Sea), 198 barrels of spent catalyst rich in trace metals, especially nickel, vanadium and molybdenum oxides. The catalyst is a residue of desulfurization process in the crude oil refining and when in contact with sea water, it can release chemicals harmful to the ecosystem. After the accident, a technical advisory group developed a multidisciplinary monitoring plan to assess possible environmental impacts.

Materials and methods

We evaluated the toxicity of the spent catalyst and investigated the bioaccumulation of metals in the area of the barrel release. In particular elutriate obtained from barrel contents were tested with the unicellular alga *Phaeodactylum tricornutum* and the sea urchin *Paracentrotus lividus* [1]. Furthermore laboratory bioaccumulation test with polychaete *Hediste diversicolor* was performed [2]. Investigations on benthic communities were also performed, identifying the crustacean *C. macandreae* as a target species for bioaccumulation analysis of critical metals for its feeding habits (i.e., deposit-feeder) and its abundance in the survey sites. After that bioaccumulation analysis were performed on the burrowing crustacean *Calocaris macandreae*, collected during 9 surveys in the area of the accident and in two control areas.

Results and discussion

Bioassays showed that elutriates obtained from spent catalyst is extremely toxic until a dilution of more than 1000:1. In particular *P. tricornutum* showed an EC50 (5.95%) and an EC20 (1.82%), while *P. lividus* EC50 values obtained in the fertilization test ranged from 5.01% to 16.09%, whereas for the embryo development ranged from 9,07% to 0,71%.

Laboratory bioaccumulation test with *H. diversicolor* showed that metals contained in the spent catalyst and released in the sediment, may concentrate in the tissues of marine organisms and therefore can be potentially transferred within the local food web. In particular Ni and Mo shows higher values than V, more than 40 times greater with respect to controls.

The analyses of benthic communities revealed the presence of 67 taxa, with significant differences between areas but not related with the incident. Also bioaccumulation levels on *C. macandreae* were not significantly different between impacted and control areas. Only results from one survey showed that NI and V values were significantly greater in one of the two control areas, while Mo generally present lower concentrations than other metals, with no differences between areas.

Conlusions

In conclusion, barrels contained a very toxic material, potentially affecting marine organisms, especially in the area where catalyst was dispersed. Considering results obtained for *C. macandreae*, we hypothesize that sea water column may remarkably dilute toxic substances, avoiding their bioaccumulation in benthic organisms and in turn along the food web.

References

1 - EPA (2000). Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. EPA/600/R-99/064.

2 - Arizzi Novelli A., Argese E., Tagliapietra D., Bettiol C., Ghirardini A.V. (2002) Toxicity of tributyltin and triphenyltin to early life-stages of *Paracentrotus lividus* (Echinodermata: Echinoidea). Environ. Toxicol. Chem. 21(4):859–864.

CHANGES IN THE ACTIVITY OF GST ENZYME ON MUSSEL (*MYTILUS GALLOPROVINCIALIS*) FROM IZMIR BAY

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Abstract
Izmir Bay as a study area has been polluted by various kind of domestic and industrial wastes without any wastewater treatment process until 2000's when central WWTP is introduced. Glutathione–s-transferase (GST, EC:2.5.1.18) is one of important enzyme in detoxification process and used by many researchers for assessing the effects of pollutants on the organisms. In this study it was aimed to find out the changes in GST enzyme activity of mussels (*Mytilus galloprovincialis*) which were collected from different stations of Izmir Bay. According to obtained results GST activity were decreased in all stations compared with control group (taken from mussel farm) and as a conclusion GST activity is essential but not enough for assessing pollution effects.

Keywords: Bivalves, Ecotoxicology, Izmir Bay

Aquatic environments are under great pressure due to anthropogenic factors such as chemical pollution and population growth. Izmir bay as a study area has been polluted by various kind of domestic and industrial wastes without any wastewater treatment process until 2000's when central WWTP is introduced (1). Although discharging pollutant agents are stopped Izmir bay is not still ameliorated fully so monitoring of biomarkers in sentinel organisms is very essential for assessing the healing process of ecosystem. Analytical studies are very important for the determination of pollutants quantitatively but insufficient for assessing effects on organisms. Antioxidant defence system is essential for organisms to cope with many stressors like biological, physical or chemical pollutants and changes in enzyme activity is a good biomarker for assessing the pollutant effects on organisms (2). Glutathione –s-transferase (GST, EC:2.5.1.18) is one of important enzyme in detoxification process and used by many researchers for assessing the effects of pollutants on the organisms (3,4). Changes in activity of GST can be early warning system for detecting the ecosystem problems if the toxicant levels are below lethal concentrations. In this study it was aimed to find out the changes in GST enzyme activity of mussels (Mytilus galloprovincialis) which were collected from different stations of Izmir Bay (Fig.1). Mussels were collected from different ports (Uckuyular, Goztepe, Konak, Pasoport, Alsancak, Karsiyaka and Bostanli) and near of Bayrakli and Alaybey than brought to laboratory in icebox.

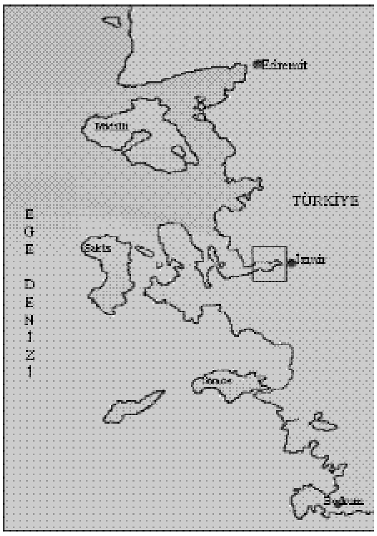

Fig. 1. Inner part of Izmir Bay

According to obtained results GST activity were decreased in all stations compared with control group (taken from mussel farm). Among the stations the lowest GST activity was measured in Uckuyular and Pasaport stations (0.11) and although the highest was at the Konak harbour (Fig. 2) still it was under control values (0.15).

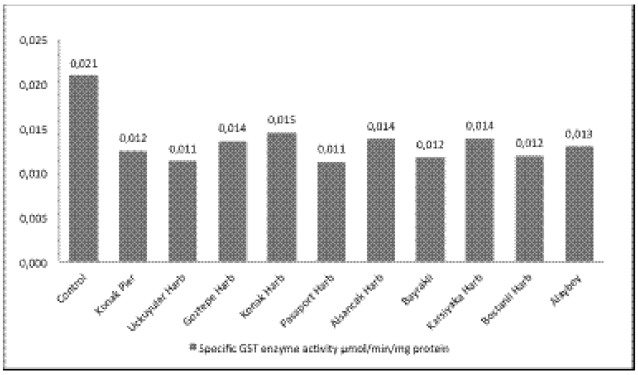

Fig. 2. The specific GST enzyme activity (µmol/min/mg protein)

In study with mussels exposed to Bisphenol-A GST enzyme activity was low in higher concentration as it cause high toxicity parallel to current study (5). GST enzyme activity is probably the first defence for pollutant and as increasing levels of toxicants the activity decreases in a critical level where the organism can not cope with pollutant by antioxidant defence system. This study will be expanded for other biomarkers not only biochemical ones but also genotoxicity to find out health of organisms in Izmir bay.

References

1 - Arslan, O. C., Parlak, H., Boyacioglu, M., Karaslan, M. A., & Katalay, S. (2014). Changes in the Glutathione-s- Transferase Activity of the mussel *Mytilus galloprovincialis* during exposure to Bisphenol-A. *Fresenius Environmental Bulletin*, *23*(10 A), 2525-2530.

2 - De Almeida, E. A., Bainy, A. C. D., de Melo Loureiro, A. P., Martinez, G. R., Miyamoto, S., Onuki, J., ... & Sigolo, C. A. (2007). Oxidative stress in Perna perna and other bivalves as indicators of environmental stress in the Brazilian marine environment: antioxidants, lipid peroxidation and DNA damage. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, *146*(4), 588-600.

3 - Regoli, F., Frenzilli, G., Bocchetti, R., Annarumma, F., Scarcelli, V., Fattorini, D., & Nigro, M. (2004). Time-course variations of oxyradical metabolism, DNA integrity and lysosomal stability in mussels, Mytilus galloprovincialis, during a field translocation experiment. *Aquatic toxicology*, *68* (2), 167-178.

4 - Akcha, F., Izuel, C., Venier, P., Budzinski, H., Burgeot, T., & Narbonne, J. F. (2000). Enzymatic biomarker measurement and study of DNA adduct formation in benzo [a] pyrene-contaminated mussels, Mytilus galloprovincialis. *Aquatic Toxicology*, *49*(4), 269-287.

5 - Gulsever G. (2015), Perflorooktansülfonat (PFOS)'in midyelerde (*Mytilus galloprovincialis*) Biyokimyasal Etkilerinin incelenmesi. E.Ü Fen Bilimleri Enst. Yüksek lisans tezi. Bornova - Izmir

CIESM Congress Session : Seabed contamination

Moderator : Lucy Woodall, Natural History Museum, London, UK

Moderator's Synthesis

The presentations were focused on geochemistry and covered nutrient, organic pollutants and heavy metals. The moderator invited the audience to think more broadly about seabed contamination, by including biology and physical parameters in the discussion, and highlighted these aspects in her introduction.
Discussion points were

- Hotspots and monitoring MSFD
- Multidisciplinary collaborations- transport and food web bioaccumulation
- New technologies = new sources e.g. Vent mining
- New techniques to analyse the seabed

Although discussions were pretty much limited to the first two points, there was a consensus that current sources of contamination are generally known, but their paths of transportation and the impact of aspects such as seabed topography were less understood. It was also suggested, that in the future, background reference concentrations should be determined. This would require local effort which, for certain chemicals, would be very challenging. It was also acknowledged that due to differences in sampling it is often difficult to compare between sites for monitoring purposes.

While there was not enough time to discuss the potential of multidisciplinary collaborations, a few speakers noted in their presentations that there was a need to understand the impact of the pollutants that they found on the marine environment.

COMPARISON OF GEOCHEMICAL PROPERTIES OF SURFACE SEDIMENTS IN MERSIN AND ISKENDERUN BAY (NE MEDITERRANEAN)

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Abstract
In the present study, surface sediment samples were collected at 17 stations selected within the inner sites of Mersin and Iskenderun bays (including city harbors) to examine regional variations of heavy metals (Cr, Mn, Fe, Co, Ni, Cu, Zn), total/organic carbon (TC/TOC) and total nitrogen (TN) concentrations and grain-size distributions in less and highly contaminated sites. Though similar grain-size properties were observed, the surface sediments from the Mersin Harbor and nearby zone fed by wastewater river discharges were highly enriched in organic carbon (8.7-20.1%) with the mean C/N ratio of 11.1. However, Iskenderun inner bay surface sediments with 6.2-16.2% of TOC (C/N:~10.2) were relatively enriched in Cr, Mn, Co and Ni due to inputs from metal industries established along the inner bay.

Keywords: Metals, Organic matter, Sediments, Mersin Bay, Iskenderun Bay

Shelf waters of northeastern (NE) Mediterranean (Figure 1), especially the bays of Mersin and Iskenderun, are highly contaminated by direct wastewater discharges from domestic and industrial sources and polluted river inflows [1]. The results in the Table 1 show that metal concentrations (Cr, Mn, Fe, Co, Ni, Cu, Zn) in surface sediments from the Iskenderun inner bay were higher than in the Mersin bay, due to greater inputs from metal industries established in the region. On the other hand, the suspended particles and nutrients carried by regional major rivers to the Mersin bay (Berdan, Seyhan) and wastewater discharges have led to enhancement of TC, TOC and TN in surface sediments of the inner bay and Mersin Harbor region as compared those obtained in surface sediments from the Iskenderun inner bay and Harbor.

Significant and negative correlations were observed between the concentrations of organic carbon and Cr, Co, Ni in the surface sediments whereas TOC and lead concentrations displayed positive correlation, indicating role of organic compounds on the enrichment of lead in the surface sediments of the Mersin Bay.

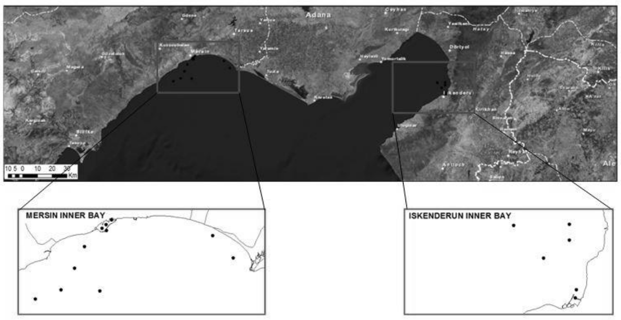

Fig. 1. Sampling stations visited in Mersin and Iskenderun inner bays.

Tab. 1. Concentrations of geochemical parameters in surface sediments from the Mersin and Iskenderun inner bays

Parameters (unit)		Mersin Inner Bay			Iskenderun Inner Bay		
		Mean	Std. Dev.	Interval	Mean	Std. Dev.	Interval
Cr	(mg/kg)	255.2	73.2	162.5 - 414.7	666.4	244.7	378.8 - 944.4
Mn	(mg/kg)	620.0	110.0	373.7 - 760.0	1082.9	310.7	651.9 - 1593.9
Fe	(g/kg)	44.0	7.9	27.3 - 55.3	55.6	4.2	47.5 - 58.6
Co	(mg/kg)	27.7	6.7	19.1 - 39.6	46.2	8.9	34.3-57.3
Ni	(mg/kg)	318.0	127.5	200.7 - 562.7	636.8	151.8	450.4 - 814.2
Cu	(mg/kg)	31.1	8.3	20.5-49.6	36.4	2.9	31.8 - 39.1
Zn	(mg/kg)	90.7	28.5	55.2-158.2	119.8	41.5	91.6 - 200.2
Cd	(mg/kg)	0.4	0.1	0.2 - 0.6	0.4	0.1	0.2-0.5
Pb	(mg/kg)	28.2	7.3	17.4 - 44.0	25.5	11.0	16.8 - 46
Al	(g/kg)	57.4	12.9	30.9 - 77.1	56.2	5.3	50.9 - 65.1
TC	(mg/g)	45.62	8.02	37.01 - 67.62	38.29	5.74	32.06 - 46.21
TOC	(mg/g)	6.49	0.73	5.42 - 7.95	4.38	2.04	2.00 - 6.54
TN	(mg/g)	0.69	0.11	0.59 - 0.97	0.51	0.25	0.21 - 0.76
Gravel	(%)	1.7	2.5	0.0 - 8.7	0.0	0.0	0.0 - 0.0
Sand	(%)	32.2	22.2	3.4 - 69.6	38.8	15.4	21.3 - 57.7
Mud	(%)	66.1	23.8	28.2 - 96.6	61.2	15.4	42.3 - 78.7

Acknowledgements
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References
1 - Koçak, M., Kubilay, N., Tugrul, S., Mihalopoulos, N. 2010. Atmospheric nutrient inputs to the northern levantine basin from a long-term observation: sources and comparison with riverine inputs. Biogeosciences, 7, 12, 4037-4050.

STRUCTURE AND CARBON CONTENT OF DEEP SEDIMENTS OF THE MARMARA SEA

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Abstract

The aim of the study was to determine structure and total organic carbon contents of deep sediments of the Marmara Sea which were not investigated in those depths before. In the study, silt and clay contents were found to be considerably high (Up to 90%) except at stations S1, S7, S21, S26. Total organic carbon (%) values of sediments varied from 0.55 to 4.45 % with a mean of 1.48 % in depths of 500 m, from 0.30 to 1.87 with a mean of 1.24 % in depths of 1000 m. As a result, the deep sediments of Marmara Trough showed the high silt+clay amounts and high concentrations of total organic carbon.

Keywords: Deep sea sediments, Marmara Sea, Marmara Trough, Organic matter

Introduction

The Marmara Sea is an intercontinental sea which connects the Aegean Sea and the Black Sea and covers an area of 11350 km^2. Its deepest depth is 1390 m [3]. Deepest 3 trenches of the Marmara lay in the northern part of the Sea. Çinarcik Trough is located in the eastern part of Marmara and its deepest depth reach to 1238 m. In the middle there is another trench called Centre Trough with highest depth reaching 1390 m. The third trench is located in the western part with the depth of 1112 m [4]. Although all around the Sea of Marmara were investigated by many scientists, there are no studies conducted in the deep sediments of Marmara Trough which reach 500 – 1000 meters. The aim of the study was to determine structure and total organic carbon contents of deep sediments of the Marmara Sea which were not investigated in those depths before

Materials and methods

The study was performed with R/V Yunus S of Istanbul University around the Marmara Sea between 6.6.2013 and 26.6.2013. 32 deep sea sediments (≥500 m) were taken by box corer which samples an area of 0.1 m^2. Sediment structure was determined according to [1]. Sieve of set of 2 mm, 250μ, 63μ and 20μ were used. Silt and clay are determined together. Organic carbon concentrations were determined according to modified Walkley-Black titration method [2].

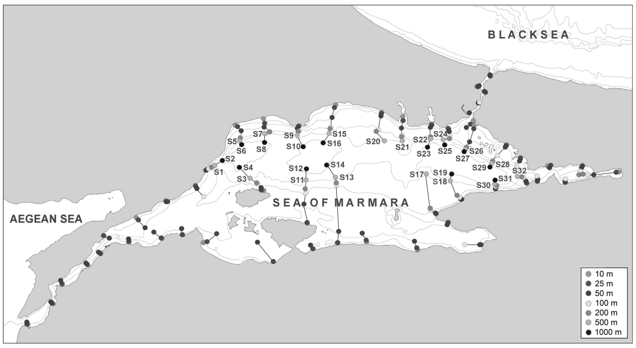

Fig. 1. Map of sampling stations

Results and discussion

The deep sediments of the Marmara Sea are usually rich in mud. In the study, silt and clay contents were found to be considerably high (Up to 90%) except at stations S1, S7, S21, S26. Similar to the present study, high silt and clay amounts were also found in the deep sediments of the Marmara [5]. Total organic carbon (%) values of sediments varied from 0.55 to 4.45 % with a mean of 1.48 % in depths of 500 m, from 0.30 to 1.87 with a mean of 1.24 % in depths of 1000 m (Fig 1-2). Mean of TOC (%) values was higher than the shale average (0.8 %) [6]. It was determined four critical TOC ranges in the Marmara Sea as low (0.1-0.59%), moderate (0.6-1.19 %), high (1.2-2.19%), and very high (2.2≤) [7]. When compared with our results, TOC values measured was low at S15, S27; was moderate at S1, S2,S8, S9, S10, S11, S17, S18, S19, S20, S22, S26, S29, S30; was high at S4, S5, S6, S7, S12, S13, S14, S16, S23, S25, S28, S31; was very high at S3, S24, S32. Coarser sediments accumulate near the shore while finer sediments are transported offshore due to waves and currents [5]. As a result, the deep sediments of Marmara Trough showed the high silt+clay amounts and high concentrations of total organic carbon.

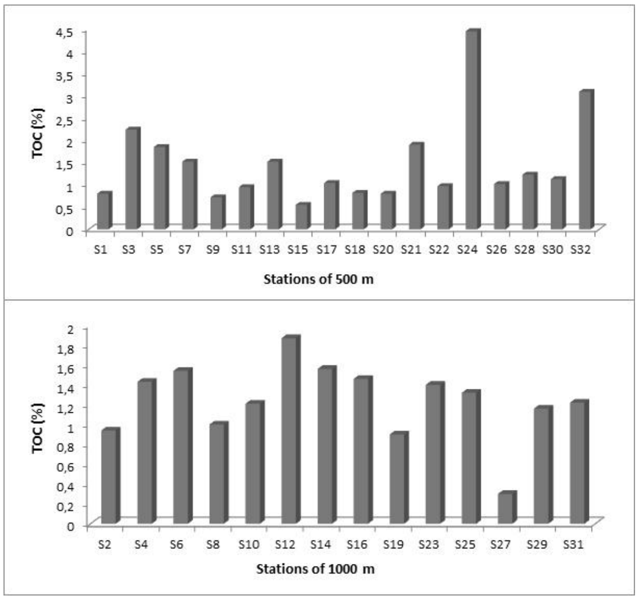

Fig. 2. TOC values of 500m and 1000m stations

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References

1 - Folk, R.L. 1974. Petrology of Sedimentary Rocks. Austin: Hemphill, 182 p.
2 - Gaudette, H. E., Flight, W. R., Toner, L., & Folger, W. (1974). An inexpensive titration method for the determination of organic carbon in recent sediments. Journal of Sedimentary Petrology, 44, 249–253
3 - Besiktepe, S.T., Sur, H.I., Özsoy, E., Latif, M.A., Orguz, T., Ünlüata, A.1994. The circulation and hydrography of the Marmara Sea. Prog. Oceanogr. 34, 285-334.
4 - Artüz, M.L., Okay, I.A., Mater, B., Artüz, O.B., Gürseller, G., Okay, N. 2007. Bilimsel Açidan Marmara Denizi. Türkiye Barolar Birligi Yayinlari. 209p
5 - Ergin, M., Bodur M.N.1999. Silt/clay fractions in surficial Marmara sediments: implication for water movement and sediment transport paths in a semi-enclosed and two-layered flow system (northeastern Mediterranean Sea). Geo-Marine Letters18: 225-233.
6 - Mason B., Moore C.B. 1982. Principles of Geochemistry. John Wiley & Sons. Newyork, 344 p.
7 - Albayrak, S., H. Balkis, A. Zenetos, A. Kurun, and C. Kubanç. 2006. Ecological quality status of coastal benthic ecosystems in the Marmara Sea. Marine Pollution Bulletin 52:790-799

PERSISTENT ORGANOCHLORINE RESIDUES IN SEDIMENTS FROM THE NORTHERN COAST OF CYPRUS, EASTERN MEDITERRANEAN

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Abstract
The OCPs and PCBs ranged between 2.78 to 306 and 15 to 325 ngg^{-1}, respectively. The highest level was found at Yedi Dalga site. DDE was the most abundant compound. POPs in sediments were found to be lower than those in samples for Mediterranean and Black Sea coasts. The SQG showed that, PCBs generally exceeded the ERL and TEL values at most of the studied sites. DDTs were dominant and more ecotoxicological concern in the northern Cyprus.

Keywords: Pesticides, Pcb, Sediments, North-Eastern Mediterranean

Introduction
OCPs and PCBs were produced and widely used for several purposes in the world since 1950s. The use of OCPs have been restricted in most of the developed countries since 1970. However, many developing countries are still using OCPs for agricultural purposes [1]. The Mediterranean Sea is one of the semi-closed sea in the world and has been extensively influenced from the land-based impacts. Cilician Basin, located in the NE part of the Levantine Basin of the Eastern Mediterranean covers the area between Turkey and the Cyprus. Several rivers are reaching to the Cilician Basin along the southern coast of Turkey. In Turkey, production and usage of OCPs were completely offcially banned in the 1990s. Cyprus is situated in the extreme northeast corner of the Mediterranean. The southern part of Clician basin is threatened by industrial pollutants, pesticides used in agricultural areas, and the lack of adequate sewage treatment from the northern Cyprus. No information available from literatures to asses the POPs in the Cilician Basin. The aim of this study is to determine persistent organochlorine residues in the sediments, to explain the sources of POPs and to evaluate the ecological risk in the northern coast of Cyprus.

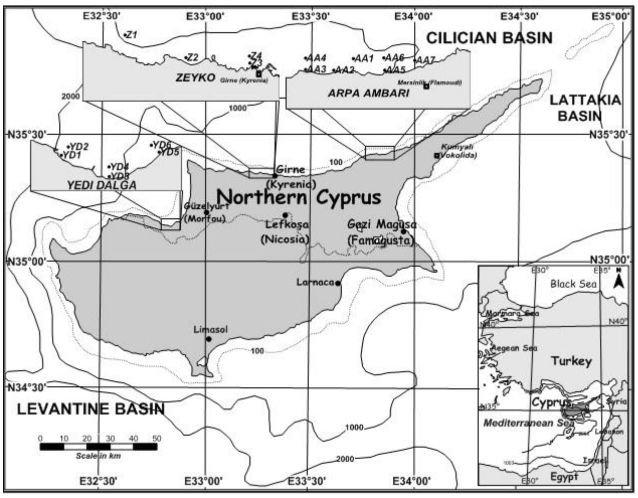

Fig. 1. Location of surface sediment sampling stations from Yedi Dalga, Zeyko and Arpa Ambari regions. Sample locations (black dots) from each area and labelled water depths, while the map to the right corner show Cyprus and main basins in the eastern Mediterranean

Material and Methods
17 sediment samples were collected using a Van Veen grab and the <250 µm fraction was chosen for grain size correction (Fig. 1). Extractions were performed in microwave extraction system with n-hexane/dichlorometane followed by sulphur removel procedure. The extracts were cleaned up and fractioned using florosil column. Quantitative analysis was performed with Agilent 5975C GC–MS. The reference sediment (IAEA-417) was used as a control for the analysis method.

Results and Discussion
DDE was the most found pesticide, with concentrations ranging from 0.64 to 108 ngg^{-1} dw while the contents of HCB were the lowest. Maximum concentrations of OCPs were found in Yedi Dalga Region. Minimum levels of ∑DDTs and ∑Cyclodienes were observed in Zeyko region. PCBs showed maximum levels in Yedi Dalga and Zeyko regions. The high PCB levels at these location, suggests anthropogenic sources from western shelf of Cyprus. The ratios of DDE+DDD/∑DDT were above 0.5 and DDD/DDE were lower than 1 indicated past usage of DDT. The usage of DDT was completely banned in Turkey before 1990s. The southern part of Clician basin was threatened by pesticides used in agricultural areas from the northern Cyprus.
According to the established sediment quality guidelines [2], DDTs are the compounds of highest ecotoxicological concern in the northern Cyprus coasts, while other OCPs in surface sediments would be less possible to cause adverse biological effect. The total PCB concentrations in sediment samples exceeded the ERL and TEL values, indicating that adverse biological effects are expected occasionally at the most of the stations. However, PCB levels were above the ERM and PEL values at Yedi Dalga region demonstrated that adverse biological effects on benthic organisms are expected frequently.

Conclusions
In summary, DDT contamination was not highlighted as a contemporary and ubiquitous problem in the sampling area. The highest PCB values were measured in samples from Yedi Dalga and Zeyko sites due to industrial activities. Based on the sediment quality guidelines, the PCBs of the samples generally exceeded the ERL and TEL values, indicating that adverse biological effects are expected occasionally at most of the stations. PCBs were also above the ERM and PEL values at stations from Yedi Dalga site. It may be summarized that DDTs will impose ecologically hazardous impacts in the sedimentary environment at the present.

References
1 - Hong S.H., Yim U.H., Shim W.J., Oh J.R., Lee I.S., 2003. Horizontal and vertical distribution of PCBs and chlorinated pesticides in sediments from Masan Bay. Korea. Mar. Pollut. Bull., 46: 244-253.
2 - Long E.R., Field L.J., MacDonald D.D., 1998. Predicting toxicity in marine sediments with numeral sediment quality guidelines. Environ. Toxicol. Chem., 17: 714-727.

TRACE METAL CONTENTS IN SURFICIAL SEDIMENTS FROM THE WESTERN ADRIATIC SEA

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Abstract
Zn and Pb are well known for having a large anthropogenic component in the Adriatic Sea. These trace elements were measured along with OC and mud content in sediments to distinguish their trends among three sectors within the western Adriatic Sea (North, Central and South). The highest concentrations were found in the North within to the Po river prodelta. Discriminant analysis results showed the separation of the North from the Central and the South due to Zn, OC and mud content. Pb did not display a specific trend probably being more associated to the clay fraction of sediments.

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

This work was developed in the Adriatic Sea under the PERSEUS EU Project (Policy-oriented marine Environmental research in the Southern European Seas), guided by the Marine Strategy Framework Directive (MSFD), which in turn, aims to achieve a Good Environmental Status in European seas by 2020. Mapping the spatial distribution of target trace elements at basin scale would provide a basis for a comprehensive examination of the contamination status according to descriptor 8 “Contaminants in the Marine Environment” of the MSFD. Therefore, the aim of this biogeochemical study was to evaluate spatial patterns of Zn and Pb in sediments from the western Adriatic Sea as they provide the most anthropogenic signals in this system.
Zinc displayed higher levels in sediments from the North section with respect to the Central and South sections (106±23 mg kg^{-1}, 90±11 mg kg^{-1}, 75±22 mg kg^{-1}, respectively) when compared to background values (70 mg kg^{-1}; Faganeli et al., 1991). The highest Zn value were detected near the Po River prodelta (137 mg kg^{-1}); southwards, relatively high concentrations were found near Cesenatico (87-119 mg kg^{-1}). Lead spatial distribution displayed fairly a similar behavior, with higher concentrations near the Po River prodelta (30 mg kg^{-1}) exceeding the background value of 23 mg kg^{-1}; slightly high concentrations were locally found offshore Ancona and the Gargano promontory (26 mg kg^{-1} and 28 mg kg^{-1}, respectively). Pearson positive correlation were found only between Zn and OC, and mud (r=0.77 and r=0.62, $p<0.001$, respectively). The absence of relation between OC and Pb implied that the interaction with organic matter was not an important process for the removal and metal fixation of this element. The OC and mud contents were well correlated (r=0.59; $p<0.001$). The highest contents were found mostly in the northern section, which was probably related to the high and rapid sediment accumulation due to the Po river discharge. Discriminant analysis was used to investigate whether the spatial variations of the target trace elements had statistically significant concentrations within the defined sectors of the western Adriatic Sea. The accuracy of classification matrix was 75%. There was a separation between the North, and the other two sectors (Figure 1). Variables found to be the most significant were OC, mud and Zn, and this fact suggests they presented a high variation along the western Adriatic Sea; conversely, Pb low significance pointed to a more homogeneous distribution of this element among sectors.

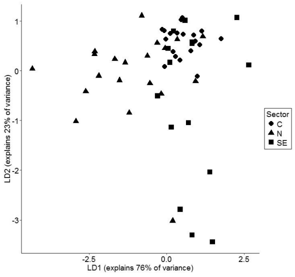

Fig. 1. Scatter plot of samples from the three sectors (North, Central and South) based on the two discriminant functions.

In general, Zn concentrations were above the background levels in the North section in the proximity of the Po river prodelta, originating from the coastal and hinterland area influenced by anthropogenic activities (Dolenec et al., 1998). The LDA results suggested that OC plays the key role in transporting this element, hence combining the chemical and granulometric features of sediments with water circulation in the Adriatic basin. Pb distribution in this basin was previously found to be related to Fe (De Lazzari et al., 2004), pointing to an affinity of this element with the clay fraction of the sediment.

References

1 - De Lazzari, A., Rampazzo, G., Pavoni, B., 2004. Geochemistry of sediments in the Northern and Central Adriatic Sea. Estuar. Coast. Shelf Sci. 59, 429–440. doi:10.1016/j.ecss.2003.10.003.
2 - Dolenec, T., Faganeli, J., Pirc, S., 1998. Major, Minor and Trace Elements in Surficial Sediments from the Open Adriatic Sea: A Regional Geochemical Study. Geol. Croat. 51/1, 59–73.
3 - Faganeli, J., Planinc, R., Pezdi, J. et al, 1991. Marine geology of the Gulf of Trieste (northern Adriatic): Geochemical aspects. Mar. Geol. 99, 93–108.

POLYCYCLIC AROMATIC HYDROCARBONS IN THE OPEN/DEEP EASTERN MEDITERRANEAN SEA: TOWARDS THE IMPLEMENTATION OF MSFD D8

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Abstract

In this study, we report reference information on polycyclic aromatic hydrocarbons (PAHs) inventories in surface sediments, top-bottom profiles of suspended particles and sediment trap material collected in the open Eastern Mediterranean Sea (Ionian and NW Levantine basins; up to 4300 m depth), essential for the implementation of the MSFD Descriptor 8 in the area. The concentrations of total determined PAHs in all matrices were comparable to those reported for unpolluted open/deep-sea settings, while their molecular profiles reveal contributions from both fossil and pyrolytic sources and chronic petrogenic pollution in the study area. Biogeochemical processes and sub-basin variability of water masses overall control the regional patterns of PAH occurrence, vertical distribution and final accumulation in deep sea sediments.

Keywords: Pah, Pollution, Open sea, Deep sea basins, Mediterranean Sea

PAHs are a widespread class of persistent organic pollutants abundant in the marine domain. Mostly originating from various anthropogenic activities, PAHs are included in lists of priority pollutants since certain compounds present carcinogenic/mutagenic properties. The Eastern Mediterranean Sea (EMS) is a marine setting under anthropogenic pressure that has been receiving major concern regarding the monitoring of chemical pollutants. The Marine Strategy Framework Directive (2008/56/EC; MSFD) aims to achieve GES in European marine waters by 2020. However, there is a lack of data regarding the occurrence of chemical contaminants in deep/open settings of the European Seas [1]. In order to fill this gap, PAHs were investigated in surface sediments, top-bottom profiles of suspended particles and sediment trap material collected in the open EMS (Fig. 1). Our main goal was to assess their major sources, provide reference concentration values of their inventories and shed light on the factors which control their occurrence and fate in open/deep EMS waters/basins in order to provide essential data for the implementation of the MSFD Descriptor 8 in the area.

Undisturbed surface sediments (top 1-cm) were collected at 21 stations in deep basins (1018-4087 m depth) of the open EMS during four oceanographic cruises between 2007-2012. Suspended particulate matter was collected close to the sea surface, within the maximum of chlorophyll fluorescence, the base of the euphotic zone, mesopelagic and bathypelagic layers at 9 stations across the open EMS (1008-4087 m water depth) in January 2007. Sediment trap material was collected at 700 m and 4300 m water depth in the SE Ionian Sea on a two-week basis from May 2007 to October 2008. All collected samples were analyzed by GC-MS for 14 parent (unsubstituted) priority PAHs (EEA-EU, EPA-US), including 7 priority substances identified by the European Water Framework Directive (WFD; 2013/39/EC), along with methyl- and dimethyl-homologues of phenanthrene which are widely considered in marine pollution studies. $TPAH_{16}$ and $TPAH_{WFD}$ refer to hereafter to the total sum of monitored compounds and the sum of the seven WFD priority compounds, respectively.

Sedimentary PAH concentrations ranged between 8.95-154 ng g^{-1} for $TPAH_{16}$ and 3.47-78.1 ng g^{-1} for $TPAH_{WFD}$, while regarding suspended particle-associated PAHs, $TPAH_{16}$ concentrations ranged between 90.6-918 pg L^{-1} and $TPAH_{WFD}$ from 14.8-381 pg L^{-1}. These values are low, comparable to those reported for unpolluted open/deep-sea settings in the Mediterranean Sea and worldwide [2, 3, 4]. Settling fluxes of the studied PAHs ranged between 18.7 and 13.7 μg m^{-2} y^{-1} for $TPAH_{16}$ and 4.75 to 3.39 μg m^{-2} y^{-1} for $TPAH_{WFD}$, at 700 m and 4300 m depth respectively, for the study period.

The occurrence of PAHs in all martices is attributed to a mixed contribution from both fossil (atmospheric inputs and maritime activities) and pyrolytic (atmospheric inputs) sources, as inferred from their molecular profile and source-specific indices, while results are indicative of chronic petrogenic pollution in the study area, with a prominent fossil PAHs signal in deep waters. On the contrary, in deep sediments pyrolytic PAHs predominated, probably due to the degradation of the labile fossil compounds into the sediment-water interface, as a result of their long residence time in this marine site.

The vertical and spatial distribution patterns of PAH mixtures displayed significant variability amongst the study sites, with their overall occurrence and fate being controlled by both biogeochemical processes and water mass circulation patterns. The concentrations of suspended particle-associated PAHs were fairly comparable for particles in mesopelagic/bathypelagic waters and those measured in surface particulate matter, while sedimentary PAH concentrations were positively correlated to water column depth. The above imply that deep EMS waters/basins constitute a pollutant depository.

A substantial standing-stock of PAHs in deep EMS waters (in the order of 970 t for $TPAH_{16}$ and 272 t for $TPAH_{WFD}$) with a residence time in the water column of ~30 y for $TPAH_{16}$ and ~24 y for $TPAH_{WFD}$ (considering only particle settling), can be attributed to 1) the continuous delivery of these compounds from their anthropogenic sources and 2) the water mass circulation patterns resulting into lateral/advective inputs at mesopelagic and bathypelagic waters [3,5]. Our results imply a transport of petrogenic PAHs from the central Aegean Sea towards the EMS through the western Cretan-Antikythera straits canyons, the latter acting as a sink of PAHs [4].

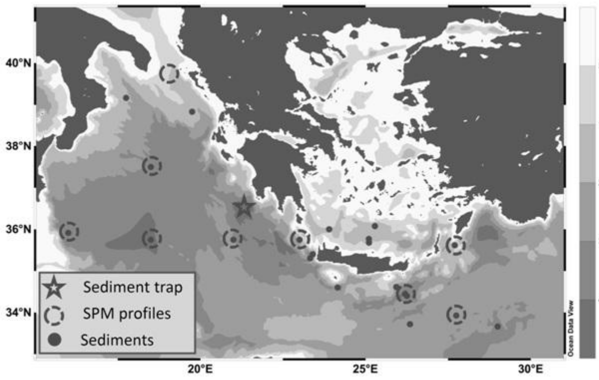

Fig. 1. Location of sampling sites across the open Eastern Mediterranean Sea

References

1 - Crise, A., et al., 2015. A MSFD complementary approach for the assessment of pressures, knowledge and data gaps in Southern European Seas: The PERSEUS experience. Marine Pollution Bulletin, 95 (1): 28-39.

2 - Gogou, A., et al., 2000. Marine organic geochemistry of the Eastern Mediterranean: 1. Aliphatic and polyaromatic hydrocarbons in Cretan Sea surficial sediments. Marine Chemistry, 68: 265-282.

3 - Parinos, C., and Gogou, A., 2016. Suspended particle-associated PAHs in the open eastern Mediterranean Sea: occurrence, sources and processes affecting their distribution patterns. Marine Chemistry, 180: 42-50.

4 - Parinos, C., et al., 2013. Occurrence, sources and transport pathways of natural and anthropogenic hydrocarbons in deep-sea sediments of the Eastern Mediterranean Sea. Biogeosciences, 10 (9): 6069-6089.

5 - Theodosi, C., et al., 2013. Downward fluxes of elemental carbon, metals and polycyclic aromatic hydrocarbons in settling particles from the deep Ionian Sea (NESTOR site), Eastern Mediterranean. Biogeosciences, 10: 4449-4464.

CIESM Congress Session : Large scale biogeochemical cycles

Moderator : Gert J. De Lange, Utrecht Univ., Netherlands

Moderator's Synthesis

For some (e.g. microbiologists), **Large-Scale** means ~mms, whereas for others (geologists) it may mean 1000's of kms. Similarly large differences occur for defining **Biogeochemical Cycles**, partly predestined by disciplinary visions. A very general definition is: *a biogeochemical cycle is a pathway by which a chemical substance moves through both biotic (biosphere) and abiotic (lithosphere, atmosphere, and hydrosphere) components of Earth*. The C-cycle is often cited these days, and in relation to climate (past-present-future).

Biogeochemical processes are general, global and are directly related to environmental conditions. The latter are variable not only regionally, but also on short/long timescales; thus to understand such processes we need to study these under the largest possible range of environmental conditions. To understand biogeochemical process and cycles in the Mediterranean, we should not limit our exploration to this area alone, but need to explore also other areas. It was great to have at this CIESM congress in Kiel also contributions from Baltic (and Atlantic)! The Baltic, Black and Mediterranean seas have in common their semi-enclosed setting. In an ESF White paper it is stated that
"..some of the ocean sub-basins, ranking among the most vulnerable on Earth, are within the European realm: the Baltic, Mediterranean and Black Sea..." All of them have suffered or still suffer from anoxic deep-water conditions, to various degrees. These three basins also represent a large range in environmental factors such as salinity, temperature, oxygenation, deep-water residence time, excess evaporation,...
Although in this committee, we are in the biogeochemical community, clearly for such large-scale processes we need to know about large-scale physical/hydrological processes and of partly related climate conditions in particular run-off => these are of direct and dominating influence on nutrients and oxygen distribution and availability. This is directly evident when looking into the past. Thus the (eastern) Mediterranean is presently oxic but its deepwater has been repetitively anoxic for extended periods of time, the most recent period was 6-10 kyr BP. At that time, it was the largest anoxic basin on Earth; therefore for some aspects, the present Black Sea can be considered as a recent analogue.

It is not only the evidence of past anoxic conditions that is relevant, but even more so, the rate at which these seem to have been established (probably within a few decades). The latter may be due to self-enforcing processes => deep-water stagnation -> enhanced deep-water/sediment regeneration and subsequent phosphate-supply to surface mixed layer -> enhanced primary productivity -> enhanced Corg fluxes to deep basin -> enhanced O2-depletion -> more enhanced phosphate-flux to surface mixed layer....->

Any environmental change will have impact on the delicate balances for the Baltic, Black Sea and Mediterranean seas, that are highly sensitive to even subtle changes.Such impact will thus have a major effect on biogeochemical processes, biological diversity and human use of these seas, including fisheries and recreation.

Several aspects of biogeochemical cycles related processes were briefly outlined by the speakers, whereas other relevant topics were not fully touched. Following these talks there was a vivid discussion where young and senior scientists participated; fortunately there was no subsequent session, allowing discussions to continue well beyond the sessions deadline.

- Why is there more/less pp; more/less preservation; ....
- Is Dust contributing to pp or is it removing nutrients from surface waters (ads.).. (?!)

Different dust sources/composition/... ?? =>

- Are rivers contributing to basin-wide pp (or only near-source ?!) (some interesting pictures by S. Salon, contribution.. but also on basin-wide nutrient availability and gradients)
- Is seasonal contrast important for biogeochemical cycles ? (and their preservation)
- (interesting contributions from G. Cossarini -> impact for global C-uptake; M. Giani for N. Adriatic Carbonate-system)
- Is the Mediterranean pp limited by NO3 or PO4, or Dissolved organic matter (DOM) (e.g. C. Santinelli-session-17) ..?? (or..?)

Is circulation/ventilation constant/variable// how to detect..? (interesting approach by M. Ayache: first talk, given by T. Arsouze)

HIGH RESOLUTION NEODYMIUM CHARACTERIZATION ALONG THE MEDITERRANEAN MARGINS AND MODELING OF ND DISTRIBUTION IN THE MEDITERRANEAN BASINS.

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Abstract
An extensive compilation of published neodymium (Nd) concentrations and isotopic compositions (Nd IC) was realized in order to establish a new database and a map (using a high resolution geological map of the area) of the distribution of these parameters for all the Mediterranean margins. The use of a high resolution regional oceanic model (1/12° of horizontal resolution) allows to realistically simulate for the first time the epsilonNd distribution in the Mediterranean Sea. This modelling set-up provides the opportunity to study in more the role of the BE on the distribution of Nd IC parameters in the marine environment.

Keywords: Circulation models, Paleoceanography, Continental margin, Geochemical cycles, Mediterranean Sea

Neodymium is a Rare Earth Element (REE) with seven naturally occurring isotopes, all stable. At the continent surface, the eNd of a given material is a function of the Sm/Nd ratio characterizing this material, which is primarily a function of its age and lithology. As a consequence, the εNd of the continents presents a heterogeneous distribution (Goldstein and Hemming, 2003 ; Jeandel et al. 2007).
In this study, we developed a new modelling platform for simulating Nd isotopic composition at high resolution in the Mediterranean basin.
First, the results of a dense compilation of the concentrations and isotopic compositions of the different materials that constitute the Mediterranean margins and are expected to interact with the water masses are presented. This high resolution mapping was also established using a detailed geological map, providing the most realistic representation of the Mediterranean geology existing so far (Fig.1).

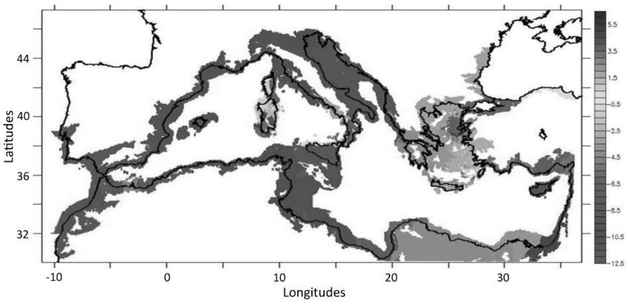

Fig. 1. Map of the Nd margin used in the model, done by interpolation of existing data on a geological map of the Mediterranean basin.

The quality of this interpolated map allows using it as a continuous source of eNd to make a link between an ocean circulation model and the tracer inputs from the margins .The eNd distribution was simulated using a high-resolution regional model (Beuvier et al., 2012) at 1/12° of horizontal resolution (6–8 km).
As a first test, Boundary Exchange (BE, Jeandel et al. 2007) is the only source term of eNd (Arsouze et al., 2007) taken into account. Results reinforce the preceding conclusions at global scale on "BE" as an important process in the Nd oceanic cycle. Nevertheless the present approach simulates a slightly too radiogenic value in the Med Sea (Fig.2). This bias will likely be corrected once the dust and river inputs will be included in the model.

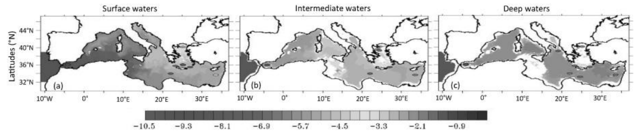

Fig. 2. Modeled eNd distribution in the surface intermediate and deep waters with data superimposed (colored dots).

This work highlights that a significant interannual variability of Nd IC distribution in seawater could occur. In particular, important hydrological events such as the Eastern Mediterranean Transient (EMT), associated with deep water formed in the Aegean sub-basin, could induce a shift in Nd IC at deep/intermediate depths that could be noticeable in the Eastern part of the basin. This confirms that Nd IC could represent an appropriate proxy to improve our knowledge on the long term trend in the Med Sea circulation, especially to explore if EMT-type events occurred in the past. New Nd-paleo-data or recent Nd observations collected on corals or foraminifera in the context of the the PaleoMeX (Paleo Mediterranean Experiment) program should give the opportunity to address this question.
Our next step was therefore to use a fully prognostic coupled dynamical/biogeochemical model with an explicit representation of all Nd sources and sinks to simulate the Nd oceanic cycle in another dedicated study.

References
1 - Arsouze, T., Dutay, J.-C., Lacan, F., and Jeandel, C.: Modeling the neodymium isotopic composition with a global ocean circulation model, Chem. Geol., 239, 165–177, 2007.
2 - Jeandel, C., Arsouze, T., Lacan, F., Techine, P., and Dutay, J. C.: Isotopic Nd compositions and concentrations of the lithogenic inputs into the ocean: A compilation, with an emphasis on the margins, Chem. Geol., 239, 156–164, 2007.

DEEP CARBON SEQUESTRATION IN THE MEDITERRANEAN SEA AND THE ROLE OF MARGINAL SEAS

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Abstract
A suite of 3D coupled hydrodynamic-biogeochemical models (CMEMS-Reanalysis and high-resolution MITgcm-BFM) has been used to estimate the carbon sequestration in the Mediterranean Sea and the processes that contribute to the transport of carbon into the deepest part of the marine ecosystem. Results of simulation show that the Mediterranean Sea is a net sink of atmospheric carbon of about 8 TgC/y. Carbon transport into the interior of the Mediterranean Sea is driven by both soft and hard tissue pumps, however, with different spatial and temporal impacts. Further, deep water formation and cascading flows in marginal seas, such as the Adriatic Sea, are other important mechanisms for the sequestration of carbon.

Keywords: Carbon, Models, Air-sea interactions, Mediterranean Sea, Otranto Strait

Materials. The carbon cycle in the Mediterranean Sea is investigated with two nested models. First, the CMEMS biogeochemical reanalysis for the Mediterranean Sea at 1/16 degree (available at marine.copernicus.eu) was carried out along the period 1999-2014, using the 3DVAR-OGSTM-BFM biogeochemical model [1, 2, 3]. The reanalysis is designed with a transport model (OGSTM) driven by physical forcing fields produced as output by the Med-Currents model. The Biogeochemical Flux Model (BFM) describes the energy and material fluxes through both "classical food chain" and "microbial food web". The carbonate system of BFM considers alkalinity and DIC, whose dynamics are driven by biological (e.g. photosynthesis and respiration, nitrification and de-nitrification, ion uptake and release and precipitation and dissolution of CaCO3) and physical processes (exchanges at air-sea interface and dilution-concentration due to evaporation minus precipitation). The reanalysis is coupled with a 3DVAR data assimilation scheme that uses the ESA-CCI surface chlorophyll dataset of CMEMS-OCTAC. Second, the high-resolution (1/32°) coupled MITgcm-BFM model for the Adriatic - Ionian Seas (nested in the Mediterranean reanalysis) is used to estimate the specific impact of the continental shelf pump process of the Adriatic Sea (a combination of biological productivity and carbon transport associated to the dense water formation and spreading [4]). The simulations have been validated through quantitative skill assessment analyses for nutrients (nitrate and phosphate), chlorophyll, oxygen and the carbonate system variables (alkalinity and DIC) [5].

Results. Results of the 1999-2014 reanalysis show that Mediterranean Sea is a net weak sink of atmospheric carbon. The simulated mean annual value, about 8 TgC/y, is consistent with other recent estimates [6], however the interannual variability is significant (Figure 1) and correlated to the year-to-year variability of atmospheric and marine conditions.

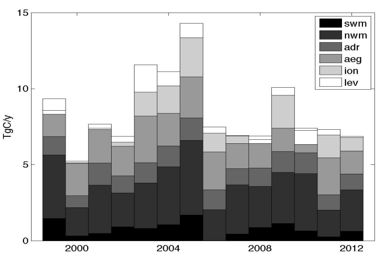

Fig. 1. Time series of the mean annual atmospheric carbon sequestration in southwestern (sam) and northwestern (nwm) Mediterranean Sea, Adriatic Sea (adr), Aegean Sea (aeg), Ionian Sea (ion) and Levantine basin (lev).

The air-sea CO2 exchanges (overall average of 0.8 mmolC/m2/d) show very high spatial and seasonal variability. During summer the Mediterranean Sea is a source of CO2 to the atmosphere (6.5 mmolC/m^2/d) while during winter is a sink (up to 9 mmolC/m^2/d). Marginal seas are the areas characterized by the highest mean rate of carbon sequestration (up to 4-5 mmol/m^2/d), while Levantine sub-basin and southern Ionian Sea are, on average, sources of CO2 (from -2 to -1 mmolC/m^2/d). Sequestered atmospheric carbon is exported to the interior of the Mediterranean Sea by several processes, which involve both vertical and horizontal components. Soft tissue carbon pump (sink and export of organic carbon, up to 1 mmol/m2/d) is correlated to the spatial distribution of net primary production in the Mediterranean Sea [5] whereas the hard tissue pump (up to 0.2-0.3 mmolC/m2/d) is correlated to calcifier dynamics (i.e. precipitation and dissolution of CaCO3). The Adriatic Sea works as a carbon pump because of the combination of the high biological productivity and of the dense water formation and transport [4]. Results of the MITgcm-BFM simulation shows that the Adriatic Sea exports to the interior of the Mediterranean Sea almost 4.7 TgC/y, which balances the import of carbon from rivers plus the atmosphere; and the inflow at the surface layer. At the Otranto strait, the surface outflow flux associated to WAC and the entering flux associated to the incoming Ionian water are almost in equilibrium, whereas the flux associated to the cascading dense water outflow at 600-900m is the mechanism for the carbon sequestration into the interior of the Mediterranean Sea (Figure 2).

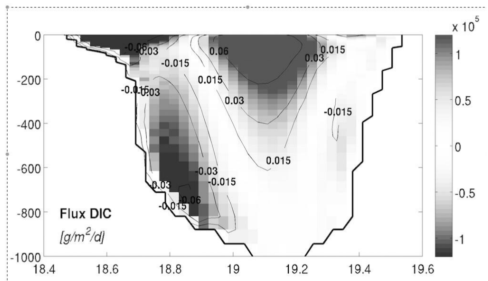

Fig. 2. Contour (solid black lines) of zonal velocities (positive velocities are oriented northwards, negative ones are oriented southward); and northward and southward (see sign of velocities) fluxes of DIC across the Otranto Strait.

References
1 - Lazzari P. et al., 2012. Seasonal and inter-annual variability of plankton chlorophyll and primary production in the Mediterranean Sea: a modelling approach. Biogeosciences, 9, 217-233.
2 - Teruzzi A. et al., A 3D variational assimilation scheme in coupled transport biogeochemical models: Forecast of Mediterranean biogeochemical properties, Journal of Geophysical Research, doi:10.1002/2013JC009277.
3 - Cossarini G. et al., 2015. Spatiotemporal variability of alkalinity in the Mediterranean Sea. Biogeosciences, 12(6), 1647-1658.
4 - Cossarini G. et al., 2015. The continental shelf carbon pump in the northern Adriatic Sea (Mediterranean Sea): Influence of wintertime variability." Ecological Modelling 314, 118-134.
5 - CMEMS-Med-QUID-006-008-V2, 2016. QUality Information Document for Med biogeochemistry reanalysis: April 2016, available at www.marine.copernicus.eu
6 - Melaku Canu D. et al., 2015. Ecological Economics valuation of carbon sequestration ecosystem service in the Mediterranean Sea. Global Environmental Change, GEC-D-14-00359R1.

SEASONAL VARIABILITY OF NORTHERN ADRIATIC'S CARBONATE SYSTEM

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Abstract
The considerable amount of anthropogenic carbon dioxide absorbed by oceans since the Industrial Revolution, brought to acidification of the sea on a global scale and it represents one of the worst danger of this century for marine ecosystems. The negative impact of this phenomenon could be greater especially in coastal ecosystems, characterized by a higher variability, as the northern Adriatic Sea. The temporal and spatial variability of the carbonate system has been studied, on a seasonal scale, focusing on a representative area of the northern Adriatic Sea.

Keywords: Carbon, North Adriatic Sea, Deltas

Shallow semi-enclosed ecosystems as the northern Adriatic Sea (NAd) are characterized by a high variability. In this area an acidification process of 0.0025 pHT units year^{-1} was observed [1]. Riverine waters inflow in the NAd contribute to increase the total alkalinity due to the carbonate weathering in the drainage basin.
Samplings have been performed at 4 depths (0, 10, 20 and bottom) on an almost monthly basis from December 2014 to January 2016 on 6 sampling stations along a transect crossing the NAd (figure 1). Total alkalinity (TA) and pH were measured by open cell potentiometric titration and by m-cresol purple spectrophotometric method, respectively Other parameters as salinity, temperature, dissolved oxygen, nutrients, chlorophyll a were measured. TCO_2 was derived from the measured variables of the carbonate system with CO2SYS software [2].

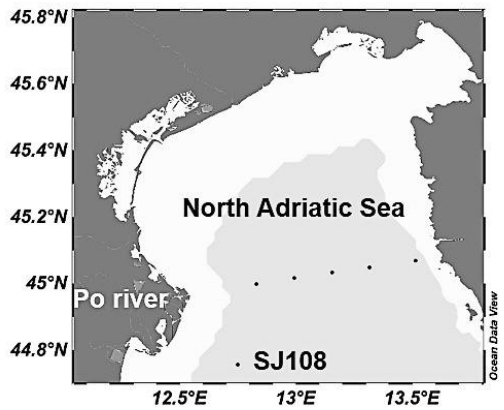

Fig. 1. Map of the sampling stations along a transect from Istria to Po river delta and of the SJ108 station positioned south of the delta.

The data showed a strong influence of riverine waters on the majority of the parameters, indeed, smaller variations of temperature, pH_T(25°C), total alkalinity, dissolved inorganic carbonate (TCO_2) and oxygen concentration have been observed in the oriental sector of the basin (oligotrophic) rather than in the occidental sector (mesotrophic). During spring, with the beginning of stratification, superficial waters were characterized by negative values of apparent oxygen utilization (AOU) and by high values of in situ pH_T, index of the prevailing of primary production processes, in the same period a positive correlation between TCO_2 and AOU was found ($p<0.0001$) indicating a strong influence of respiration on TCO_2. In months with higher riverine discharges, both alkalinity and TCO_2 were increasing in correspondence with higher nutrients concentrations. TA and TCO_2 showed a significant negative correlation with salinity ($p<0.0001$) in surface waters, stronger for samplings performed closer to flood events. Moreover an inverse linear regression between AOU and pH_T(25°C) was indicating a crucial influence of primary production and respiration processes in determining pH. The overall variations of pH_T were similar to the annual variations observed in the Trieste gulf [3, 4].
The freshwater discharges increase alkalinity and TCO_2 and the overall effect is an increase of the buffering capacity of the system. During the seasonal stratification under the pycnocline the respiration processes highly contribute to increase the TCO_2 in summer, as shown in figure 2 for a station (SJ108) under the direct influence of the Po river discharge.

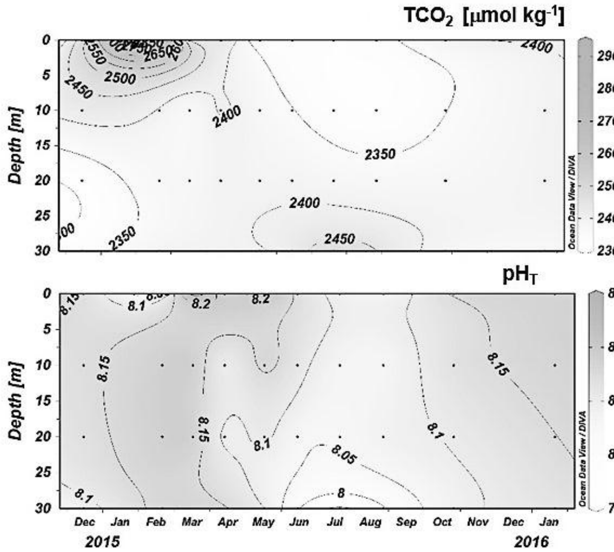

Fig. 2. Temporal variations of TCO_2 and *in situ* pH_T in the water column at the station SJ108.

References
1 - Luchetta A., Cantoni C. and Catalano G., 2010. New observations of CO2 – induced acidification in the northern Adriatic Sea over the last quarter century. *Chem. Ecology*, 26: 1-17.
2 - Pierrot D., Lewis E., and Wallace D. W. R., 2006. MS Excel Program Developed for CO2 System Calculations., ORNL/CDIAC-105., Oak Ridge National Laboratory, U.S. Department of Energy.
3 - Cantoni C., Luchetta A., Celio M., Cozzi S., Raicich F. and Catalano G., 2012. Carbonate system variability in the Gulf of Trieste (North Adriatic Sea). *Est. Coast. Shelf Sci.*, 115: 51-62.
4 - Ingrosso G., Giani M., Comici C., Kralj M., Piacentino S., De Vittor C. and Del Negro P. 2016. Drivers of the carbonate system seasonal variations in a Mediterranean gulf. *Est. Coast. Shelf Sci.*, 168: 58-70.

CURRENT STATE AND RECENT TREND OF MEDITERRANEAN SEA BIOGEOCHEMISTRY DERIVED BY A HIGH-RESOLUTION REANALYSIS

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Abstract

A high-resolution reanalysis of Mediterranean Sea biogeochemistry was developed within the Copernicus Marine Environment Monitoring Services (CMEMS). The quality of the reanalysis was assessed against several available data sets, in terms of the main surface and sub-surface biogeochemical essential climate variables (chlorophyll, carbon dioxide partial pressure, ocean acidity, nutrients, oxygen). The model system was capable to reproduce spatial patterns, seasonal cycle and interannual variability of the assessed variables, allowing for a proper description of recent trends and present status of important MFSD descriptors (such as nutrient content and primary production).

Keywords: Chlorophyll-A, Mediterranean Sea, Nutrients, Primary production, Models

The quality of multi-year model estimates of regional marine ecosystems can be improved with reanalyses, which assimilate observations (as satellite-based surface chlorophyll concentration) into the most advanced version of operational models. Reanalyses of a regional sea biogeochemistry are also important when used as boundary conditions to evaluate the ecosystem state of its sub-basins and coastal domains, thus allowing to meet EU and member states environmental requirements (e.g. MSFD).

In the frame of the Copernicus Services (CMEMS), we recently completed a high-resolution reanalysis (1/16 horizontal resolution; 1999-2014) of the Mediterranean Sea biogeochemistry using the 3DVAR-OGSTM-BFM model system ([1], [2], [3] and reference therein) embedded in the CMEMS Mediterranean Monitoring and Forecasting Centre (Med-MFC). The physical forcings were provided within the Med-MFC consortium, while the satellite-based surface chlorophyll ESA-CCI data set, supplied by the CMEMS - Ocean Colour TAC, was used for the assimilation. Biogeochemical initial and boundary conditions (at Gibraltar Strait, rivers and atmosphere) were set up on literature estimates.

The quality of the reanalysis was assessed against available independent (moorings, research vessels and historical-based climatology) and semi-independent (satellite) data sets, in terms of surface and sub-surface biogeochemical essential climate variables (chlorophyll, carbon dioxide partial pressure, ocean acidity, nutrients, oxygen), using GODAE-like metrics [4]. Our results highlight the capability of the model system to reproduce the present-day status of spatial patterns and seasonal cycle, confirming the vision of the Mediterranean as a mainly oligotrophic ecosystem with the presence of a significant zonal E-W gradient. Interannual variability of the chlorophyll field (Fig.1) is significant in the most productive areas (e.g. NWM) and reflects the interannual variability of the atmospheric-oceanic conditions.

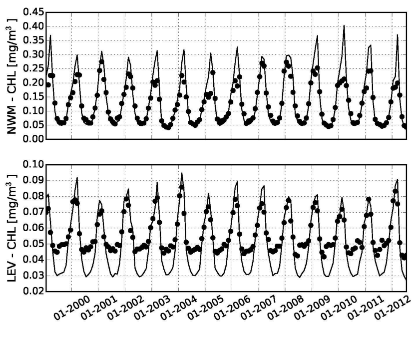

Fig. 1. Monthly mean surface chlorophyll concentration (solid line) compared with ESA-CCI satellite data set (dots) for North-western Med (NWM, top) and Levantine sub-basins (LEV, bottom).

Nutrients (phosphate and nitrate) and oxygen have been quantitatively evaluated against basin-wide estimates and in-situ observations (basically derived by research cruises in a specific time-spatial frame), which scarcely cover the basin-wide processes and are largely influenced by local and short-term processes. Indeed, the variability of reanalysis is lower than that of observations, due to the difference between the time discretization of the model outputs (monthly means) and the observations. However, the reanalysis well reproduces the basin-wide gradients and the mean vertical structures of the biogeochemical essential climate variables, and the error quantification represents a conservative measure of the model accuracy [4]. The current state of horizontal spatial nutrient distributions at surface (Fig.2, top) reflects the coastal-off shore interactions and the presence of areas with high mesoscale vertical dynamics (e.g. Northwestern Med, Alboran Sea) and of areas of permanent cyclonic structures (e.g. Cretan gyre).

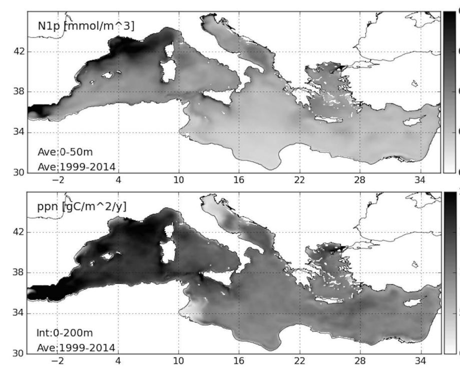

Fig. 2. Top: phosphate annual mean (0-50m; mmol P m^{-3}). Bottom: annual mean of 0-200m vertically integrated primary production (gC m^{-2} yr^{-1}).

Results of the reanalysis show a consolidated picture of the Mediterranean gradients (Fig. 2) and interannual variability. The system productivity (Fig. 2, bottom) is strongly related to the availability of nutrients during the winter period, which is a combination of nutricline height and vertical ventilation. Our reanalyses constitute a reliable dataset that can be used to estimate eutrophication MSFD descriptors, carbon cycle terms and the potential resources available for the higher trophic levels.

References

1 - Lazzari, P., Solidoro, C., Salon, S., Bolzon, G., 2016. Spatial variability of phosphate and nitrate in the Mediterranean Sea: a modelling approach. Deep Sea Research I, 108, 39-52.

2 - Teruzzi A., Dobricic S., Solidoro C., Cossarini G., 2013. A 3D variational assimilation scheme in coupled transport biogeochemical models: Forecast of Mediterranean biogeochemical properties. J. Geophys. Res. Oceans, 119, 200-217.

3 - Cossarini G., Lazzari P., Solidoro, C., 2015. Spatio-temporal variability of alkalinity in the Mediterranean Sea. Biogeosciences, 12(6), 1647-1658.

4 - Cossarini, G., Salon, S., Bolzon, G., Lazzari, P., Clementi, E., 2016. CMEMS-Med-QUID-006-008-V2. QUality Information Document for Med biogeochemistry reanalysis: MEDSEA_Reanalysis_BIO_006_008. Available on marine.copernicus.eu

CARBON ISOTOPES IN THE MEDITERRANEAN SEA

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Abstract
The first basin-wide survey of carbon isotopes in the Mediterranean Sea were from samples collected aboard Meteor cruise 84_3 in 2011. Here we present the delta^{13}C and Delta^{14}C in dissolved inorganic carbon (DIC) data and examine the implications for circulation, ventilation and of anthropogenic CO_2 uptake.

Keywords: Carbon, Vertical profile, Tyrrhenian Sea

The atmospheric stable carbon isotopic composition of CO_2 is changing due to the light carbon in fossil fuels, the Suess effect. The decreasing delta^{13}C signal in DIC can be traced in the ocean and provides an estimate of the anthropogenic CO_2 (Cant) uptake rate. This method is particularly useful since it mimics the slow equilibration time of CO_2 across the air-sea interface and provides an independent and integrated measure of interior ocean Cant storage. This is particularly useful for the Mediterranean Sea since large temporal variability in ventilation renders other Cant inference methods problematic. Those other methods assume steady-state circulation and ventilation. Here we compare the 2011 data [1] to delta^{13}C data from the 1988 and 1990 [2], VICCOMED data. A particularly large ?^{13}C (? ?^{13}C) decrease exists in the Western Mediterranean and Adriatic Seas over this time-period. The Deltadelta ^{13}C values in the Levantine Basin are particularly small, as recently reported by [3] using data near the Israeli coast. The VICCOMED data do not cover the water column below about 2500 meters. In the Mediterranean these waters are generally well ventilated so the full anthropogenic signal could not be estimated. The storage rate of Cant in the upper 2500 meters of Western Mediterranean Sea is in excess of 1 mol C m^2 y^{-1}. This is about twice the global average storage rate, and is likely an underestimate.
We also compare the Delta^{14}C data from 2011 with one profile taken in the Ionian Sea during the GEOSECS project in 1977. Fossil fuel is "dead" with respect to ^{14}C isotopes, so the atmosphere would get lighter with time. The transient signal is, however, dominated by atmospheric ^{14}C input from nuclear bomb tests in the 1960's. In the Ionian Sea we find a remarkable increase of Delta^{14}C throughout the entire water column. This very clear signal of deep ventilation and penetration implies similar Cant distributions through the water column of the Mediterranean Sea.

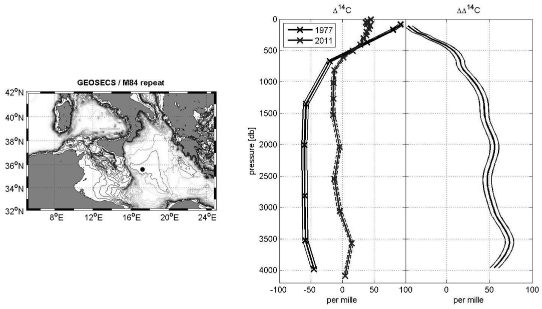

Fig. 1. Repeat measurements of Delta14C in the Ionian Sea; the left panel shows the location of the station, and the right panels show the measurements and the difference over time – narrow lines indicate level of analytical uncertainties.

The surface water Delta^{14}C decrease between 1977 and 2011 parallels the atmospheric decline and illuminates the ventilation signal as the bomb-produced ^{14}C transient moves into the water column.
These carbon isotope data help constrain the uptake and storage of anthropogenic carbon in the Mediterranean Sea. The values are very high due to: 1) high temperature and alkalinity of the deep waters (large buffer factor for Cant uptake), and 2) active deep water formation. While the Cant storage is high everywhere in the Mediterranean Sea, the data indicate significant regional differences.

References
1 - Tanhua, T., Hainbucher, D., Cardin, V., Álvarez, M., Civitarese, G., McNichol, A. P., and Key, R. M., 2013. Repeat hydrography in the Mediterranean Sea, data from the Meteor cruise 84/3 in 2011, Earth Syst. Sci. Data, 5, 289-294, 10.5194/essd-5-289-2013.
2 - Pierre, C., 1999. The oxygen and carbon isotope distribution in the Mediterranean water masses, Marine Geology, 153, 41-55, http://dx.doi.org/10.1016/S0025-3227(98)00090-5.
3 - Sisma-Ventura, G., Yam, R., Kress, N., and Shemesh, A., 2016. Water column distribution of stable isotopes and carbonate properties in the South-eastern Levantine basin (Eastern Mediterranean): Vertical and temporal change, J. Mar. Systems, 158, 13-25, http://dx.doi.org/10.1016/j.jmarsys.2016.01.012.

CIESM Congress Session : Bioaccumulation and trophic transfer / pelagic

Moderator : Ioannis Hatzianestis, HCMR, Greece

Moderator's Synthesis

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MICROPLASTIC INGESTION IN COMMERCIAL FISH SPECIES *BOOPS BOOPS*, *SARDINA PILCHARDUS* AND *ENGRAULIS ENCRASICOLUS* IN THE WESTERN MEDITERRANEAN SEA: MEDIAS SURVEY

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Abstract
Microplastic ingestion was assessed for three commercial fish species in the western Mediterranean Sea: *Boops boops*, *Sardina pilchardus* and *Engraulis encrasicolus* during the 2015 Spanish MEDIAS survey. Gastrointestinal tracts of 183 fish from 16 sites were examined. A total of 42 microplastics were found in the stomach contents of 31 individuals from all three species. *B. boops* was found to have ingested the most items (27%). No significant differences between abundance of ingested microplastics and spatial distribution of the sites were found, although it does appears microplastics are common in the food web of each species along the eastern coast of Spain.

Keywords: Plastics, Pollution, Food webs, Mediterranean Sea, Fisheries

Introduction
Marine plastic is found floating on the surface, suspended in the water column, and/or deposited on the seafloor, which overtime breaks down into microplastics (MPs) resulting in the accidental ingestion by marine fauna, especially fish [1,2]. This study aims to describe the presence of MPs in the gastrointestinal tract of three commercial fish species and evaluate the abundance of ingested MPs between species and spatial variation between sites along the eastern coast of Spain.

Methods and materials
Three commercial fish species were sampled for MPs: *Boops boops*, *Sardina pilchardus* and *Engraulis encrasicolus* at 16 sites during the oceanographic cruise MEDIAS (Mediterranean International Acoustic Survey) in 2015 which lies within the European Data Collection Regulation framework to estimate abundance and biomass of fish stocks. Measurements for length (mm), body weight (mg) and sex (male/female/undetermined) for each fish was recorded and the gastrointestinal tract was removed by dissection and immediately frozen onboard the research vessel. Once in the laboratory, samples were defrosted at room temperature and inspected using a dissection microscope. To prevent environmental contamination, protocols were adapted from previous studies to reduce risk [2]. Ingested MPs data was not normally distributed and variances were not equal, non-parametric Kruskal-Wallis rank sum tests (KW) were performed on species and sites. Analyses were performed using RStudio.

Results and discussion
The amount of individuals found with MPs at each site shows how abundant MPs are in the food web in the western Mediterranean Sea (Figure 1).

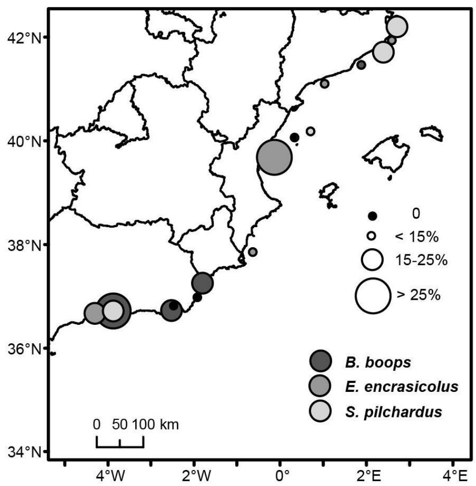

Fig. 1. Sites sampled for ingested microplastics in commercial fish species. Bubble size indicates percent of individuals of each species found with ingested microplastics surveyed at that particular site.

Out of the 183 gastrointestinal tracts examined, 17% were found to have MPs (all of which were fibers) and B. boops was found to have ingested the most (27%). Average number of items found per fish containing plastics in each species was the following: *B. boops* = 1.46 ± 0.66, *S. pilchardus* 1.43 ± 0.79 and *E. encrasicolus* 1.18 ± 0.40 (Figure 2). There were no significant differences in ingestion between all individuals (KW, n = 183, P = 0.136) or ingestion between all sampled sites (KW, n = 16, P = 0.052). Although no significant difference was found, small quantities of MPs were common in the food web of each of the commercial fish species sampled, similar to results found in demersal and pelagic fish species [2]. With the growing concern for marine health and public safety due to MPs, the results indicate the presence of MPs in these commercial fish species along the entire eastern coast of Spain.

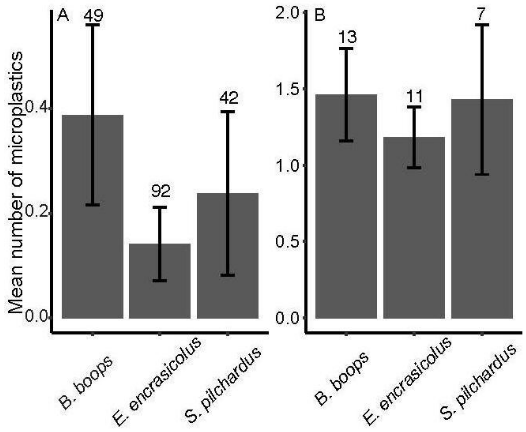

Fig. 2. Mean number of microplastic items in all individuals (A) and in individuals containing plastics (B). Errors bars indicate standard deviation and numbers above error bars indicate number of individuals examined.

References
1 - Choy, C.A. and Drazen, J.C., 2013. Plastic for dinner? Observations of frequent debris ingestion by pelagic predatory fishes from the central North Pacific. Marine Ecology Progress Series, 485, pp.155-163.
2 - Lusher, A.L., McHugh, M. and Thompson, R.C., 2013. Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel. Marine pollution bulletin, 67(1), pp.94-99.

ARE FEEDING TRAITS AND HABITAT RESPONSIBLE OF MICROPLASTICS INGESTION IN FISH, CRUSTACEANS AND ELASMOBRANCHS AT THE WESTERN MEDITERRANEAN?

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Abstract
Marine litter loads are increasing worldwide and impacts and effects on marine ecosystems and their inhabitants are still unknown [1,2]. Whereas interaction effects of macrolitter, especially on species as sea turtles and marine mammals has been more investigated, the microscopic fraction has been less addressed. Therefore, several key species of fish, crustaceans and elasmobranches have been studied to assess microplastics ingestion in the Western Mediterranean. Mean ingested microplastics (MPs) ranged up to 2.3 MPs/ind indicating a threat of this man made contaminant on species which are commercialised.

Keywords: South-Western Mediterranean, Plastics, Pollution

Introduction
The small size of MPs facilitates organisms' intake compared to macroplastics and widespread ecological impacts are expected from MPs. Quantities of MPs have already been reported in shallow marine coastal areas of the Balearic Islands [3].Therefore, MPs loads in the marine environment are available for organisms with different feeding strategies which can ingest them randomly or selectively having implications along the food web.

Material and Methods
Fishes, crustaceans and elasmobranchs exhibiting different trophic strategies and trophic levels have been taken as case study species to evaluate microplastics ingestion (<5mm plastic fragments). Stomach contents analyses of the selected species have been conducted to quantify mean number of MPs/ind [4,5]. Species have been classified into several feeding habits: browsing on substrate, hunting for macrofauna (predators), selective plankton feeding and variable, and analysed according to their environment: bathydemersal, bathypelagic, benthopelagic, demersal and pelagic-neritic.

Results and Discussion
Different results reveal MPs ingestion of commercial fish and crustacean species *Boops boops, Mullus surmuletus, Aristeus antennatus,* among others (Fig 1). Most species ingested less than 0.5 MPs/ind. However, *B. boops* is the most affected species exhibiting ingestion rates up to 2.3 MPs/ind. being mainly filament type MPs. Results indicate that combined functional traits: biology, autoecology, ethology could be responsible of microplastics ingestion at the studied species. Microplastics are menacing functional diversity through differential ingestion linked to organisms' trophic strategies.

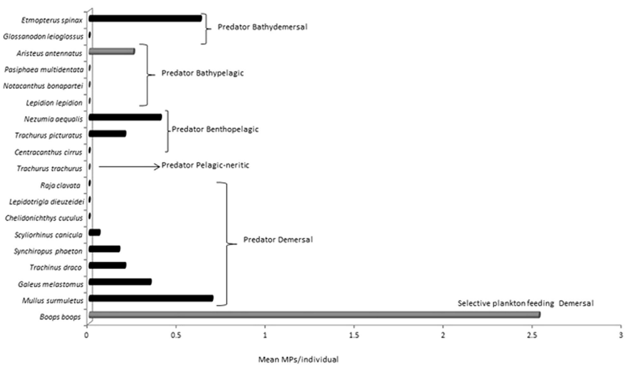

Fig. 1. Mean microplastics (MPs) per individual according to inhabiting environment.

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References
1 - Deudero, S and Alomar, C. 2015. Mediterranean marine biodiversity under threat: reviewing influence of marine litter on species. Marine Pollution Bulletin, 98: 58-68
2 - Deudero, S. and Alomar, C. 2014. Revising interactions of plastics with marine biota: evidence from the Mediterranean in CIESM 2014, Marine litter in the Mediterranean and Black Seas. CIESM Workshop Monograph n° 46 [F. Briand, ed.], 180 p., CIESM Publisher, Monaco.
3 - Alomar, C. Estarellas F., Deudero, S. 2016. Microplastics in the Mediterranean sea: Deposition in coastal shallow sediments, spatial variation and preferential grain size. Marine Environmental Research, 115: 1-10. doi:10.1016/j.marenvres.2016.01.005
4 - Deudero, S., Nadal, M.A., Estarellas, F., Alomar, C. 2014. Microplastic exposure in pelagic fishes and holothurians: a Mediterranean case study. 2nd International Ocean Research Conference. Barcelona 17-21 November 2014.
5 - Frank, Aida. 2015. Microplastic ingestion in elasmobranches from the Western Mediterranean. University of the Balearic Islands, Final Degree Thesis in Biology. September 2015.

MINERAL COMPOSITION OF *ENGRAULIS ENCRASICOLUS*

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Abstract
This study was designed to control the mineral content of Anchovy (*Engraulis encrasicolus*) which is one of most important species of Turkey seas. The mineral content was determined in muscle and viscera. According to findings, anchovy, caught for consume from Marmara and Black sea in Turkey, was found to be in ranged of International standards.

Keywords: Bio-accumulation, Black Sea, Macroelements, Monitoring, Trace elements

Introduction
Anchovy (*Engraulis encrasicolus*) is a pelagic and migrating species that constitutes the major biomass of Black sea. Anchovy feeds with phytoplankton and zooplankton in pelagic water. The feeding behavior of this species is resulted to accumulate of trace elements found in planktons or sea water where they go through. Metal accumulation is mainly occurred in muscle and some intestinal organs. Main living area of anchovy is well known to be as Black Sea in Turkey due to suitable water temperature, salinity and nutritional reservesfor their early and adult life stages. However, Black sea is bordered six riparian countries and affected many chemical pollutants carried by industrial rivers such as Danube and Dniester [1]. Thus, monitoring metal content in water columns and biomass in Black Sea can be considered as food safety and ecological evolution concerns. In this case, anchovy is one of the most important biomonitoring materials due to constituting majority of biomass in Black sea.

Materials and Methods
Samples were collected from fish boats, which fishes from Black Sea, in March 2014. Meat and viscera of anchovy samples divided into two groups and analyzed to determine mineral composition. Analyses were done according to the method of EPA [2],[3].

Results and Discussion
Calcium, magnesium, potassium, sodium, phosphorous, and iron were determined above than 1 mg/kg (Table 1). These elements were found to be statically different between meat and viscera. Among other minerals, cadmium, cobalt, lead tin and zinc were not determined in any samples.

Tab. 1. Mineral Content of Anchovy (mg/kg)

Mineral	Symbol	Meat	Viscera
Phosphorous	P	2282±151	6170±393
Sodium	Na	1057±24	1686±35
Magnesium	Mg	337±60	483±17
Potassium	K	3337±67	2373±58
Calcium	Ca	925±59	9809±1103
Iron	Fe	6,3±0,8	26,2±0,4
Aluminum	Al	0,92±0,08	3,93±0,28
Arsenic	As	0,84±0,03	0,95±0,02
Boron	B	0,72±0,02	0,75±0,03
Chromium	Cr	0,09±0,03	0,75±0,03
Copper	Cu	0,88±0,01	1,05±0,10
Manganese	Mn	0,34±0,08	1,95±0,03
Nickel	Ni	0,64±0,48	0,15±0,08
Selenium	Se	0,17±0,00	0,29±0,02
*Determination levels (mg/kg): Cadmium (Cd): 0,027; Cobalt (Co): 0,15; Lead (Pb): 0,076; Tin (Sn): 4,94; Zinc (Zn): 0,03.			

These metals are known to be discharges of industrial plants and can behazardous at high levels. Long term exposure of livings to these metals causes accumulation at higher concentrations. According to findings, anchovy samples, apparently, were not exposed to these metals via either feeding or living environments. Along with this, some of toxic metals such as arsenic and nickel were found at low amounts (<1mg/kg) and were not exceed the threshold levels indicated by international organizations [4],[5],[6]. However, such metals can be dangerous at low levels, so they should be closely monitored with water samples and other biomaterials.

Conclusion
This study has shown that the metal contamination levels of livings in Black Sea can be considered as safe. This study has shown that the metal contamination levels of livings in Black Sea can be considered as safe. However different biosamples and their parts along with waters should be monitored closely to ensure safety of seafood and ecological evolution in Black Sea.

References
1 - Colakoglu F.A., Ormanci H.B., Berik N., Kunili I.E. and Colakoglu S., 2011. Proximate and Elemental Composition of *Chamelea gallina* from the Southern Coast of the Marma Sea (Turkey). *Biol. Trace Elem. Res.,* 143: 983 - 981.
2 - EPA, 1998. Microwave assisted acid digestion of sediments, sludges, soils, and oils.Method3051A.http://www.epa.gov/sites/production/files/2015-12/documents/3051a.pdf (visit date Dec. 2015)
3 - EPA, 2000. Inductively coupled plasma - mass spectrometry.Method 6020A.http://www.epa.gov/sites/production/files/2015-07/documents/epa-6020a.pdf (visit date Dec. 2015).
4 - FDA, 2007. Action levels, tolerances and guidance levels for poisonous or deleterious substances in seafood, Section IV Chapter II.04. In: National Shellfish Sanitation Program guide for the control of molluscan shellfish.
5 - FAO/WHO, 1999.A Joint Expert Committee on Food Additives. In: Summary and conclusions, 53rd meeting, Rome (1–10 June).
6 - EC, 2001.Commission Regulation (EC) no. 221/2002 of 6 February 2002 amending regulation (EC) no.466/2002 setting maximum levels for certain contaminants in foodstuffs.Official Journal of theEuropean Communities, Brussels.

PRE-PRODUCTION PLASTIC PELLETS AS A TRANSPORT MEDIUM OF MERCURY ALONG THE EASTERN ADRIATIC COAST (CROATIA)

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Abstract

Plastic pellets are sampled (2014-2015) on six beaches along eastern Adriatic coast, from the island of Mljet in the south east to Kvarner Bay in the north east. In the same direction adsorbed mercury on the sampled pellets decreased. Quantities of plastic pellets on the beaches of southern and central Adriatic coast are higher than in northern part. Mercury was found to accumulate on plastic pellets from the surrounding coastal sea water by a factor up to 10000.

Keywords: Mercury, Beach, North Adriatic Sea, South Adriatic Sea, Plastics

Pre-production plastic pellets or plastic resin pellets or simply nurdles are small granules (most commonly polyethylene or polypropylene) cylindrical or a disc shaped with a diameter of a few millimetres. These plastic pellets are industrial raw material which is to be transported to different plastic production sites where are made by re-melting and molding into the final products (1).

Fig. 1. Map of the study area

Surprisingly large amounts of these virgin plastic pellets end up in marine environment during manufacturing and transportation. On some beaches where sampling is performed, Island of Mljet and Island of Rava, in one cubic meter of marine debris it was found more than 100.000 and more than 300.000 pieces of plastic pellets, respectively. The fact that the sampling sites are mainly away from industrial activities and serious anthropogenic impact, means that the plastic pellets as an important segment of overall flowing marine litter are stranded on the beaches carried by the sea currents and winds.

Pellets were collected on the beaches from the high tide line and berm zone of each beach using stainless steel tweezers. In laboratory all samples were cleaned to remove extraneous material. After cleaning and drying the thirty pieces of pellets per sample were digested in a mixture of nitric and perchloric acid following the six hours UV irradiation. Mercury was measured using CV AAS method. The detection limit of 0.005 ng L^{-1} for seawater and 0.001 µg g^{-1} for solid samples was estimated based on 3×SD of a blank measurement.

The concentrations of mercury on beached plastic pellets decreased from the south-east to north-west: Island of Mljet, inlet Grabova 0.015 µg g^{-1}, Šibenik Bay, Martinska 0.009 µg g^{-1}, Island of Rava, 0.005 µg g^{-1}, Kvarner Bay, inlet Brestova 0.003 µg g^{-1}. There was only one exception to the sample taken in the vicinity of former chlor alkali plant located at the shore of Kaštela Bay. The concentration of mercury on these pellets was up to 2 µg g^{-1}.

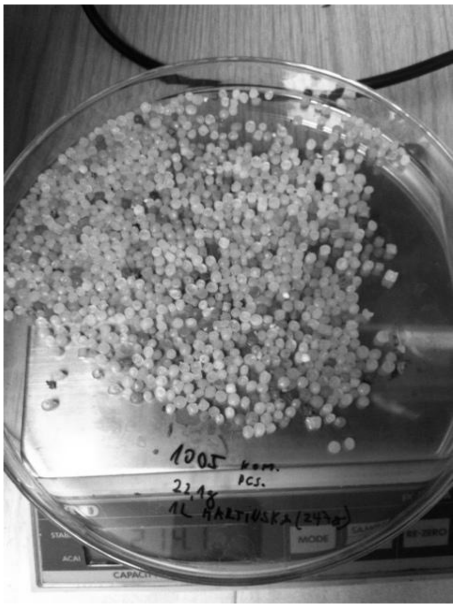

Fig. 2. Plastic pellets from Šibenik-Martinska coastal area

The question is why the concentration of adsorbed mercury on plastic pellets decreasing from south-east to north-west direction? After recently widely performed sampling and measurements of various species of mercury in sea water along eastern Adriatic coast these authors have found that average concentration of the total mercury are higher in the south than in Northern Adriatic Sea. On other hand countless islands and well developed mainland coast of southern and central Adriatic Sea are natural scavengers of floating litter which continuously in large quantities floated from Greece, Italy and especially Albania (2). Major and local sea currents with winds changes keep floating litter including plastic pellets enough time at sea for mercury adsorption processes.

References

1 - Karapanagioti H.K. and Klontza I., 2007. Investigation the properties of plastic resin pellets found in the coastal areas of Lesvos islands. Global NEST Journal, Vol 9, No1, pp 71-76.

2 - Kwokal Ž. and Štefanovic B., 2010. Floating marine litter without boundaries: A threat to the coves of Mljet Island (Croatia). Proceedings of the Symposium Branimir Gušic Days- Mljet. pp 349-362.

MICROPLASTIC FIBRE PRESENCE IN THE FOOD CHAIN OF *SPHYRAENA VIRIDENSIS* IN THE EASTERN AEGEAN SEA, GREECE

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Abstract

Microplastics are considered as a major threat not only for the wildlife but also for the human health as they accumulate within the food chain. This study evaluates the persistence of microplastic fibres in marine ecosystems around Samos Island in the eastern Aegean Sea, Greece and aims to correlate the density of microfibers to each trophic level which was represented by selected species, of the food chain. Irrespective that the results confirmed the correlation between trophic level and the mass of fibres, the smaller fish in lower trophic levels still pose a great threat due to higher concentration of microplastics.

Keywords: Plastics, Pollution, Food webs, Aegean Sea, Trophic relations

The research was carried out to assess the presence of microplastic fibres in the marine food chain and identify the potential threat to humans and the ecosystem itself. When ingested, microplastic fibres can cause cloggage in the digestive tract, become translocated to different tissues within the organism, and bioaccumulate [1]. Bioaccumulation at lower trophic levels endangers all subsequent trophic levels and high concentrations in the upper levels are partly a result of the transfer throughout the food chain [2]. To assess the presence and concentration of microplastics in the food chain of *Sphyraena viridensis*, the amount of microfibers of various species was compared, each one representing a different trophic level: *Boops boops*, *Trachurus mediterraneus* and zooplankton-surface water.

Surface water samples were collected by towing a net with 333 µm mesh and a 0.6 x 0.2 m^2 mouth. The samples were then sieved, treated with a saline solution and the supernatant processed using Whatman™ GF/F filters. Finally microplastic fibres were identified using a microscope X10. Individuals of each fish species were identified to the lowest taxonomic level and dissected. The stomach was placed in a saline solution, shaken and let to settle. After repetition of this process, supernatant was removed, filtered and the fibres were counted.

All samples were contaminated with microplastic fibres. The most contaminated species was *Sphyraena viridensis* with an average of 42 ± 20.5 (SD) fibres per individual. *Trachurus mediterraneus* and *Boops boops* had an average of 28 ± 19.5 (SD) and 15.4 ± 3.2 (SD) respectively. Surface water was contaminated with 9.6 ± 4.36 (SD) fibres per sample and an average of 568 ± 264 (SD) per m^3. These values of microplastics in the surface water attest their availability for all marine species. The results show that *Boops boops* at the lowest trophic level of the examined specimens had the lowest number of fibres and *Sphyraena viridensis*, at the highest level had the greatest values.

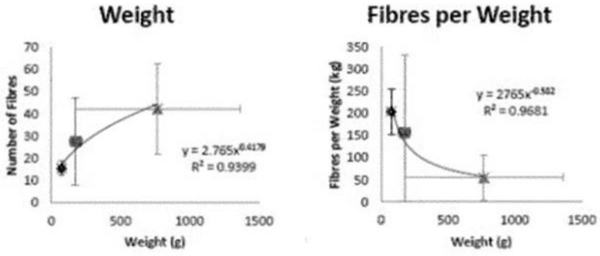

Fig. 1. Correlation Weight and Number of Fibres and correlation between Weight and Fibres per Weight

This observed accumulation in larger fish agrees with previous research dealing with heavy metal, mercury and pesticide accumulation. Previous studies have found that contaminants accumulate within the food chain and are more highly concentrated in high trophic levels than lower ones [3]. Even though the fibres bioaccumulate and are greater in number further up the food chain, it is important to underline that lower trophic levels showed a higher amount of fibres per weight. *Boops boops* showed an average of 204 ± 49,9 (SD) fibres per kg^{-1} representing the species with more fibres per weight (Fig 1). *Trachurus mediterraneus* had an average of 157 ± 173.1 (SD) fibres per kg^{-1} while *Sphyraena viridensis* obtained 55 ± 46.9 (SD) fibres per kg^{-1} implying that consumption of lower trophic level fish is more harmful than of higher levels. Further research should be conducted, in order to provide a better understandig of the real extent of the threat that microplastic pollution poses to marine biota.

References

1 - Mathalon, A., Hill, P., 2014. Microplastic fibres in the intertidal ecosystem surrounding Halifax Harbor, Nova Scotia. *In: Marine Pollution Bulletin*, 81: 69–79

2 - Xinhong W., Wang, W.-X., 2005. Uptake, absorption efficiency and elimination of DDT in marine phytoplankton, copepods and fish. *In: Environmental Pollution*, 136: 453-464

3 - Cresson, P., Bouchoucha, M., Miralles F., Elleboode R., Mahe K., Marusczak N., Cossa D., 2014. Are red mullet efficient as bio-indicators of mercury contamination? A case study from French Mediterranean. *In: Marine Pollution Bulletin*, 91: 191-199

CEPHALOPODS AS BIO-INDICATORS OF METALLIC ENRICHMENT OF MARINE ENVIRONMENT IN THE GULF OF GABES, SOUTH-EASTERN TUNISIA

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Abstract

In this study, we collected two cephalopod species, *Octopus vulgaris* and *Sepia officinalis*, from different sites in the Gulf of Gabes, south-eastern Tunisia, and analyzed the concentrations of mercury (Hg), zinc (Zn), cadmium (Cd) and copper (Cu) in their edible tissues (mantle and arms). The comparison of the results found showed significant differences only between the sampling sites, and not between the two species. The distribution of trace metals analyzed in the Gulf of Gabes was found to be similar for both tissues analyzed in the two species, with the highest concentrations found in the central area of Gabes Gulf, and the lowest in the northern and/or southern areas.

Keywords: Metals, Cephalopods, Pollution, Gulf of Gabes

In the Mediterranean Sea, many marine species accumulate various pollutants including trace metals. Most of these metals bio-accumulators are preys for many predators including the cephalopod molluscs which are known to host in their tissues higher contents of metals. It is for example the case of the two cephalopods *Octopus vulgaris* and *Sepia officinalis* which have been widely studied in this regard. Although these two latter species are widely consumed in Tunisia, only few studies have been carried out on their metals bioaccumulation. The aim of the present study is to assess the concentrations of trace metals in the edible tissues (mantle and arms) of *O. vulgaris* and *S. officinalis* collected from different sites in the Gulf of Gabes and discussing the metallic enrichment of the marine environment in this area. To do so, 39 octopuses and cuttlefishes were collected from four sites representing the entire surface area of Gabes Gulf (GG): Elbibane Lagoon (southern GG), Gabes (central GG), Kerkennah Island and Chebba (northern GG). Mantle and arms samples were taken from each collected cephalopod, preserved and analyzed for Hg (using a direct mercury analyzer), Zn, Cd and Cu (using an IC-PMS) and the concentrations found were reported as $\mu g\ g^{-1}$ WW. Similar patterns of spatial trace metals distribution were found with the two examined tissues of both cephalopod species (Table 1).

Tab. 1. Average (±Standard Deviation) concentrations of trace metals analyzed in mantle and arms tissues of *Octopus vulgaris* and *Sepia officinalis*, sampled from the Gulf of Gabes.

Cephalopod Species	Samples/Sites	Trace metals			
		Hg	Zn	Cd	Cu
Octopus vulgaris	Mantle				
	Elbibane lagoon	0.038±0.006	8.39±1.252	0.034±0.004	6.164±0.961
	Gabes	0.048±0.013	21.41±2.015	0.136±0.032	3.113±0.775
	Kerkennah Island	0.036±0.007	17.38±3.327	0.098±0.018	5.005±0.622
	Chebba	0.031±0.003	12.32±1.877	0.029±0.010	4.559±0.698
	Total	0.038±0.010	14.94±5.491	0.077±0.046	4.832±1.327
	Arms				
	Elbibane lagoon	0.035±0.005	9.237±1.780	0.024±0.009	5.041±1.104
	Gabes	0.045±0.010	21.943±2.402	0.127±0.037	2.451±0.722
	Kerkennah Island	0.034±0.007	17.131±2.808	0.088±0.016	3.768±0.907
	Chebba	0.029±0.003	12.299±1.406	0.024±0.009	3.643±0.568
	Total	0.036±0.008	15.203±5.283	0.068±0.047	3.808±1.263
Sepia officinalis	Mantle				
	Elbibane lagoon	0.036±0.005	8.427±1.396	0.032±0.004	5.328±1.514
	Gabes	0.048±0.010	20.864±2.135	0.127±0.023	3.278±0.848
	Kerkennah Island	0.033±0.007	16.170±2.247	0.108±0.014	4.678±1.031
	Chebba	0.030±0.005	11.941±2.087	0.026±0.008	4.222±1.108
	Total	0.037±0.009	13.901±5.238	0.071±0.046	4.474±1.405
	Arms				
	Elbibane lagoon	0.031±0.004	7.141±1.550	0.031±0.004	4.824±1.524
	Gabes	0.046±0.008	19.363±1.670	0.118±0.016	3.031±0.868
	Kerkennah Island	0.031±0.007	15.421±2.456	0.106±0.014	4.545±0.798
	Chebba	0.027±0.004	11.469±1.373	0.024±0.007	3.946±1.015
	Total	0.034±0.009	12.847±5.135	0.068±0.043	4.163±1.322

In fact, for both mantle and arms tissues of *O. vulgaris*, the highest concentrations of Hg, Zn and Cd were noted in Gabes; whereas the lowest were found in Chebba and/or Kerkennah Island (for Hg) and Elbibane Lagoon and/or Chebba (for both Zn and Cd). Regarding Cu, the analysis of both tissues of the common octopus showed that the highest contents were recorded in Elbibane Lagoon; whereas the lowest in Gabes. In the case of *S. officinalis*, trace metals analyses of both muscle tissues revealed also that the highest Hg, Zn and Cd concentrations were found in Gabes and that the lowest were noted in either a northern (Chebba or Kerkennah Island) or a southern (Elbibane Lagoon) sampling site. Similarly to the case of *O. vulgaris*, the Cu analysis of both mantle and arms of *S. officinalis* showed that the highest concentration was recorded in Elbibane Lagoon; whereas the lowest in Gabes. We conducted a dendrogram of hierarchic classification using the concentrations of all metals analyzed both muscle tissues of the common octopus and cuttlefish and the result is given in Figure 1.

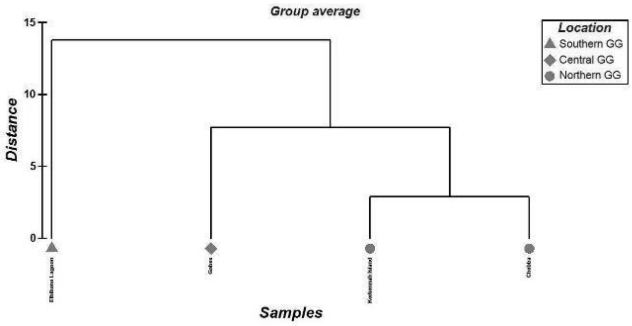

Fig. 1. Hierarchic classification dendrogram of GG sampling sites, performed using the concentrations of the four trace metals analyzed in the edible tissues of *Octopus vulgaris* and *Sepia officinalis*.

Two main clusters separated at a Euclidean distance of 7.5: while the first cluster was formed by only the southern sampling site (i.e. Elbibane Lagoon), the second was represented by those located in both central and northern GG areas (i.e. Gabes, Kerkennah Island and Chebba). At lower levels of Euclidean distance, these three latter sampling sites subdivided into two sub-clusters separating the central sampling site (i.e. Gabes) from the other two northern sites (i.e. Kerkennah Island and Chebba). It seems that the higher concentrations of metals observed in the two cephalopods collected from the central GG area are mainly due to the effects of the numerous coastal anthropogenic activities, represented particularly by the discharges of the industrial complex located between Gabes and Ghannouch [1].

References

1 - El Zrelli R., Courjault-Radé P., Rabaoui L., Castet S., Michel S. and Bejaoui N., 2015. Heavy metal contamination and ecological risk assessment in the surface sediments of the coastal area surrounding the industrial complex of Gabes city, Gulf of Gabes, SE Tunisia. *Mar. Poll. Bull.*, 101: 922-929.

TROPHIC TRANSFER OF METALLIC TRACE ELEMENTS WITHIN A PHYTOPLANKTON-ZOOPLANKTON-ANCHOVY/SARDINE FOOD WEB

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Abstract

The transfer of metallic trace elements through a phytoplankton-zooplankton-anchovy/sardine food web was studied in the Gulf of Lion (GoL), northwestern Mediterranean Sea. Samples of dissolved fraction, suspended particulate matter and of phytoplankton-zooplankton separated in different size classes were collected at different sites during two oceanographic cruises in the GoL. Anchovies and sardines were fished during two other campaigns and dissected to get fish tissue samples of muscles, liver, gonads and the body remains including skin, head and skeleton. MTE (Cu, Cd, Zn, Pb, Hg, CH_3Hg, Ni, Ag) and lead isotopes ratios were determined in water (dissolved), SPM, plankton fractions and in fishes tissues. The metals show different bioaccumulation trends within these entire trophic food webs.

Keywords: Bio-accumulation, Food webs, Metals, Plankton, Gulf of Lyon

The transfer of metallic trace elements (MTE) through a phytoplankton-zooplankton-anchovy/sardine food web was studied in the Gulf of Lion (GoL), northwestern Mediterranean Sea. Samples of dissolved fraction ,suspended particulate matter (SPM) and of phytoplankton-zooplankton separated in different size classes (6-60, 60-200, 200-500, 500-1000, 1000-2000 and >2000 µm) were collected at different sites during two oceanographic cruises (spring and winter) in the GoL (1). Anchovies and sardines were fished during two other campaigns, pooled by fish size and dissected to get fish tissue samples of muscles, liver, gonads and the body remains including skin, head and skeleton. MTE (Cu, Cd, Zn, Pb, Hg, CH_3Hg, Ni, Ag) and lead isotopes ratios were determined in water (dissolved), SPM, plankton fractions and in fishes tissues. C and N stable isotopes were also determined and used as markers of trophic levels for plankton and small pelagic fish and of SPM organic matter origin. Dissolved MTE concentrations were homogeneous in the water column, but spatial differences were found in water surface samples with a distinct enrichment in the eastern GoL, likely due to direct anthropogenic contribution from the Rhone River and the city of Marseille. This pollutant input was also characterized by marked lead isotope imprints. Similar spatial differences were also observed for some MTE in the planktonic fractions, with higher concentrations in the eastern GoL region. The most important variations in MTEs concentrations were observed in their distribution among the different size classes of plankton i.e. from the lowest size fraction (suspended matter plus phytoplankton) up to the >2000 µm of mesozooplankton fraction. Cu, Ni, CH_3Hg and Pb were enriched in the smallest size fraction (suspended matter plus phytoplankton) while Cd, Zn and Ag show highest concentrations in the intermediate fractions (60-200 and 200-500µm), the largest fractions (mesozooplankton >2000 µm) being generally depleted in MET. This latter distribution could be related to the accumulation (targets /mechanisms) of these metals in cell cytoplasm being therefore more mobile compared to the elements primarily adsorbed onto the surface membrane of the plankton cells. Interestingly, MTE displaying low concentrations in zooplankton were also depleted in fishes. MTE and lead isotope ratios generally showed significant shifts between fish tissues suggesting different biochemical distribution, entry pathways and/or sources for the measured metals. No significant spatial differences for both anchovy and sardine contamination were found and MTE levels did not differ between the two species or between the sex. Finally we found that methyl-Hg concentration was effectively higher enriched in the fish tissues, a typical result usually related to Me-Hg chemical speciation and bioaccumulation potential. The proportion of Methyl-Hg vs. total Hg was lower than 1% in the dissolved fraction, and it increased up to 10% in the plankton and exceeded 50% in the fish tissues.

References

1 - Strady E., Harmelin-Vivien M., Chiffoleau J.F., Veron A., Tronczynski J., Radakovitch O. 2015. 210Po and 210Pb trophic transfer within the phytoplankton-zooplankton-anchovy/sardine food web: a case study from the Gulf of Lion (North western Mediterranean Sea). Journal of Environmental radioactivity.143: 141-151.

TROPHIC TRANSFER OF POPS IN PLANKTON AND SMALL PELAGIC FISH IN THE WESTERN MEDITERRANEAN AND ADRIATIC SEA

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Abstract
Transfer of persistent organic pollutants within the plankton and the short food web of small pelagic fish (anchovies and sardines) was studied in the areas of the Western Mediterranean and Adriatic Sea. Spatial variations in the levels of POPs were observed. Relationships between POP concentrations and size class of plankton and plankton $\delta^{15}N$ signatures were examined. The highest concentrations of POPs were found in bacteria /nano and picoplankton and small pelagic fish. The results indicate that it is difficult to clearly distinguish prey-predator contaminant transfer in plankton. Anchovy plays a pertinent role in the transfer of contaminants to the open seas. Moreover, this study provides valuable insight for better understanding of interactions between the planktonic prey species and their predators.

Keywords: Food webs, Bio-accumulation, Plankton, Pcb, Mediterranean Sea

Introduction
Recent assessments of the present status and trends show that pollution by harmful substances continues to degrade coastal as well as remote areas of the Mediterranean and Black Seas [1]. In the open seas, a main concern with persistent organic pollutants (POPs) is related to their strong propensity to bioaccumulate in marine organisms, and to biomagnify up to the food chains [2]. Interaction between plankton and their predators have a key role in the trophic link between the planktonic ecosystems and the trophic levels of fish. The present study is aimed at better understanding of the bioaccumulation of POPs within the first levels of the marine trophic chain, including pico- and nanoplankton, and planktivorous small pelagic fish in the Gulf of Lion (GoL), Western Mediterranean and Eastern Adriatic Sea.

Material and Methods
Plankton and water samples were collected in the GoL and Adriatic Sea in spring and winter, during several research cruises in 2011 and 2014 (Costeau 5 and 7 and Persmed 1 and2). ** Plankton (phytoplankton and zooplankton) was collected with a net of 60 µm mesh size and fractionated on a sieve column to four size-classes (60-200, 200-500, 500-1000, 1000-2000 µm). The smallest plankton fraction, 0.7 - 63 µm, was obtained by *in situ* large volume pumping sampler (McLane WTS-LV). Small pelagic fish (mainly anchovies and sardines) were caught in the narrow size range, in the Gulf of Lions and in the Adriatic Sea, during reproduction and the resting seasons (cruises: PELMED-10 and -14; MEDITS -14).

Results and Discussion
The results show that levels of PCBs and PBDEs in phytoplankton and zooplankton in the GoL are spatially influenced by the distance from contamination source and that marine plankton seems to be able to assimilate rapidly POP compounds at the sites near the source of contaminants. Such spatial trend is not found in the smallest fraction of plankton, 0.7 - 63 µm. This fraction shows significantly different $\delta^{13}C$ and $\delta^{15}N$ signatures compared to other plankton fractions, indicating a high contribution of bacteria /nano and picoplankton to organic carbon pool in these samples. The relationships between POP concentrations and size class of plankton and plankton $\delta^{15}N$ signatures are found to be compound, season and location dependant. The highest concentrations of POPs were determined in the smallest fraction, 0.7 - 63 µm, of plankton (Figure 1). So far, the role of this fraction in the transfer of contaminants within plankton communities has been poorly documented. Furthermore, our results indicate that it is difficult to clearly distinguish the prey-predator contaminant transfer within planktonic food-webs. Larger zooplankton size classes are composed of organisms with different feeding habits, including herbivores, carnivores and detritivores, prone to adapt their diet to the quantity of the available resources. Additionally, size class and isotope signatures of field samples do not necessarily reflect a prey-predator relationships, complex ecology and ecosystem interactions within plankton communities. The highest concentrations of selected POPs (PCBs and PBDEs) were found in small pelagic fish tissues with higher total lipid content (liver, viscera and remaining carcass). The results also show that distribution of toxic substances in tissue of small pelagic fish is affected by metabolic processes. Differences in concentrations between male and female specimens are related to the loss of contaminants in females during spawning. Finally, the trophic transfer of selected POPs between plankton and small pelagic fish is assessed for an entire range of PCB congeners, along with the corresponding biomagnification factors, log(BMF fish/plankton), and their octanol water partition coefficients, log(Kow).

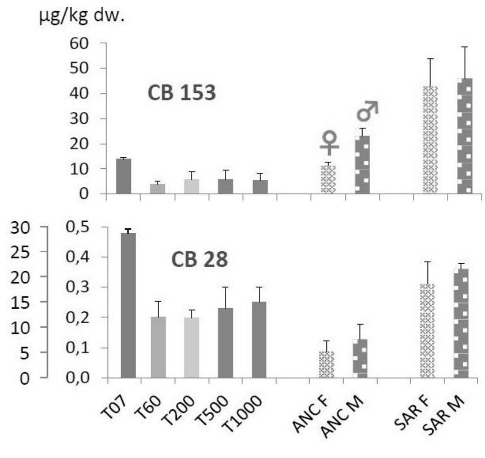

Fig. 1. CB153 and CB28 mean concentrations (µg/kg dw.) in the different size class of plankton (including 0.7- 63 µm of pico – nanoplankton and bacteria) compared to their concentrations in the muscle tissue of small fish and sardine (male and female); Second ordinate for CB28 in 0.7-63 µm fraction.

** Cruises performed within COSTAS-ANR and PERSEUS-EU projects.

References
1 - European Environment Agency (EEA) (2015). State of Europe's seas. ISBN 978-92-9213-652-9. 216p.
2 - Arnot, J.A. and Gobas F.A.P.C. 2006. A review of bioconcentration factor (BCF) and bioaccumulation factor (BAF) assessments for organic chemicals in aquatic organisms. Environ. Rev. 2006, 14, 257–297.

CIESM Congress Session : Marine litter, microplastics

Moderator : François Galgani, LER/PAC, Ifremer, France

Moderator's Synthesis

The session on marine litter was very active with more than 60 attendants. After a short introduction explaining why the Mediterranean Sea is one of the most affected region worldwide, 9 presentations were given covering the main aspects of marine litter pollution, including spatial and temporal distribution of floating and sea floor debris, typology, modelling, degradation, ingestion (fish, holothurians, etc.) and other impacts of marine debris and micro plastics, also considering new methods of separation. These studies were conducted all over the Mediterranean Basin , including the Iberian Peninsula, the Gulf of Lion, the north-eastern Adriatic, the Aegean Sea and the western Black Sea. The results demonstrated that marine litter has become a very important issue with knowledge gaps to be filled and needs for more scientific studies in order to better understand the fate and impacts in the Mediterranean Sea. Finally, a very active discussion highlighted the need for action and awareness to address its increasing pressures on marine and coastal ecosystems.

SPATIAL AND TEMPORAL DISTRIBUTION OF MARINE DEBRIS IN SEAFLOOR HABITATS OF THE BALEARIC ISLANDS

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Abstract
The weight and distribution of marine macrodebris in benthic habitats (continental shelves and upper slopes) from bottom trawl scientific surveys at the Balearic Islands was investigated. A time series of 15 years (2001 -2015) was studied at mesoscale level. Most abundant debris were glass, plastic and fishing material. The plastic fraction, which is highly persistent and resistant to biodegradation, showed a high variability in space and time with no clear trend.

Keywords: Plastics, Continental shelf, Time series, Demersal, Balearic Islands

Introduction
The Mediterranean basin is a hotspot of marine biodiversity and it is considered a sensitive ecosystem exposed to invasive species, fishing and tourism activities, numerous maritime routes and densely coastal urbanized zones which can increase marine debris. Former research has already demonstrated high values of microplastics in coastal shallow sediments in the Balearic Islands (1). Moreover, marine debris, especially the plastic fraction may drift and disperse long distances from the coast sinking into benthic and demersal habitats (2). Therefore, the main aim of this investigation is to assess marine debris in bottom trawl areas off the Balearic Islands.

Materials and Methods
Data on marine debris was collected during annual scientific bottom trawl surveys around the Balearic Islands (Western Mediterranean). Samples were taken between 50 and 800 m using the experimental bottom trawl gear GOC-73. Number of stations per survey varied between 41 and 69 per year. Once aboard, marine debris was sorted out and classified into 7 categories: coal, glass, rubber, fishing material, paper, plastic and cloth. Weight of marine debris was determined and standardized to surveyed area (km^2).

Results
Mean values of marine debris ranged from 0.0014 ± 0.01 kg/km^2 (2013 data for paper debris) to 7.61 ± 30.17 kg/km^2 (2003 data for glass debris). Glass observed in hauls showed high percentages (> 40%) in 2002-2004, 2006, 2011 and 2014. Fishing material was the most abundant type of marine debris (in weight) during three years (2008, 2010 and 2013). Regarding plastic, in 2009 and 2015 more than half of the marine debris sampled in the hauls was plastic and this type of contamination was the most common in 2001, 2005, 2007 and 2012 (Fig. 1). In addition, glass and plastic were observed in hauls throughout all years while the rest of marine debris categories were not. Plastic showed a high variability according to sampling locations with values ranging up to 82.95 kg/km^2 (Fig. 2) and significant differences were found according to location (PERMANOVA $p < 0.001$).

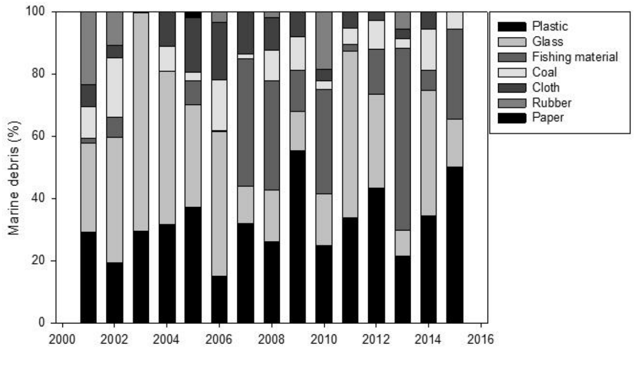

Fig. 1. Marine debris (%) according to 7 debris categories in bottom trawl surveys off the Balearic Island.

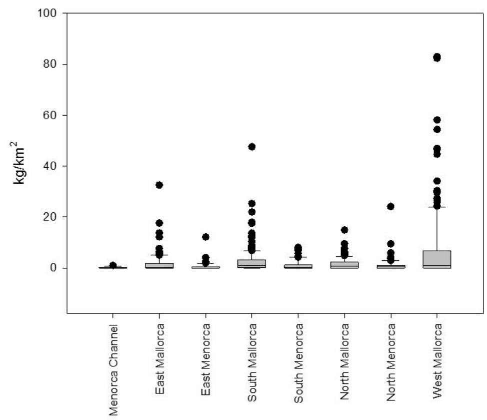

Fig. 2. Box plot with plastic weight at the different locations sampled around the Balearic Islands from 15 years time series including all depths (50 – 800 m).

Discussion
In the last years there has been an emerging number of investigations on marine debris and seafloor, however a large temporal and spatial coverage has not been analyzed. Results from 15 years have shown a large variability amongst debris types, sampling period and locations with quantities of plastic higher in Western followed by Southern Mallorca which is the most urbanized area (it includes the Bay of Palma). Different oceanographic and environmental conditions have been found between the north and the south of the Balearic Islands (3). The major currents characterizing the regional circulation (Northern and Balearic currents) are probably having an important role in marine debris distribution of the Balearic Promontory.

Acknowledgments
Scientific surveys belong to the MEDITS program which was funded by IEO and by the EU from 2007 onwards.

References
1 - Alomar, C., Estarellas, F. and Deudero, S., 2016. Microplastics in the Mediterranean sea: Deposition in coastal shallow sediments, spatial variation and preferential grain size. Marine Environmental Research, 115: 1-10.
2 - Ramirez-Llodra, E., De Mol, B., Company, J. B., Coll, M. and Sardà, F., 2013. Effects of natural and anthropogenic processes in the distribution of marine litter in the deep Mediterranean Sea. Progress in Oceanography, 118, 273-287.
3 - López-Jurado, J. L., Marcos, M. and Monserrat, S., 2008. Hydrographic conditions affecting two fishing grounds of Mallorca island (Western Mediterranean): during the IDEA Project (2003–2004). Journal of Marine Systems, 71(3), 303-315.

ASSESSING SPATIAL AND TEMPORAL DISTRIBUTIONS OF MARINE LITTER: 11-YEAR DATASET OF COASTAL FLOATING MARINE DEBRIS IN THE BALEARIC ISLANDS

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Abstract
The present work constitutes a preliminary assessment of the spatial and temporal distribution of floating marine debris along the Balearic Islands' coastline during the months of May - October from 2005 to 2015. This long-term dataset indicates marine debris was found in 42.46% of all monitoring surveys, with plastic marine debris being found in 93.41% of the marine debris surveyed. Elevated accumulation zones were present in the southern regions and plastic was consistently the most abundant for both nearshore and offshore coastal areas. This study provides insight into the magnitude of marine debris surrounding the Balearic Islands highlighting the need for action and awareness to address its increasing pressures on marine and coastal ecosystems.

Keywords: Coastal management, Pollution, Plastics, Mediterranean Sea

Introduction
Marine debris is ubiquitous throughout all marine and coastal ecosystems, vastly impacting both ecological and biological conditions creating a need for global action [1,2,3]. Initial results from an on-going marine debris removal and monitoring program over an 11-year period are presented in this study to describe the spatial and temporal distribution of floating marine debris (FMD) along the Balearic coastline.

Methods
From 2005-2015, coastal FMD was collected during the annual marine debris removal and monitoring program coordinated by ABAQUA (Agència Balear de l'Aigua I Qualitat Ambiental) on the islands of Mallorca, Menorca, Ibiza and Formentera. During this program, marine debris was collected daily on previously established monitoring survery areas from May - October (months vary yearly) along the coastline of each island. The fleet of 33 boats conducting the monitoring covered two coastal areas: nearshore from 0-500m from the shoreline (2005-2015) and offshore from 500-5000m from the coast (2005-2010). For the purpose of this study, marine debris was divided into four categories: plastic, wood, organic material (e.g., algae, jellyfish) and other (e.g., metal, fabric, oil).

Results and Discussion
Preliminary results from this study indicate marine debris was abundant along the entire Balearic coastline and plastic was present in 93.41% of all surveys containing marine debris. The estimated density of marine debris was divided into two categories for nearshore and offshore surveys, with offshore surveys showing a greater concentration of FMD, especially in the southern regions of the islands (Figure 1).

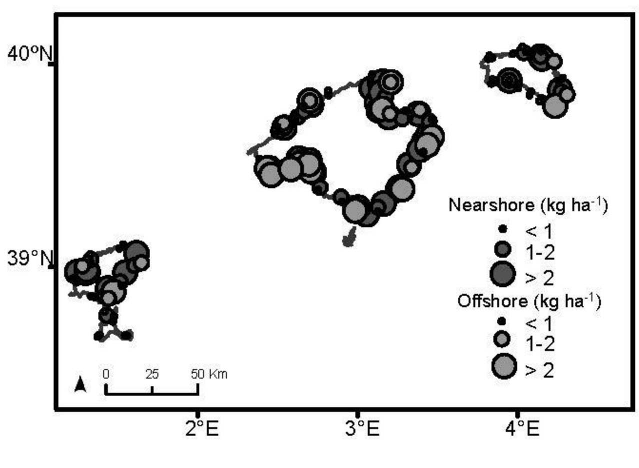

Fig. 1. Average marine debris densities (kg ha^{-1}) for nearshore (dark grey) 2005-2015 and offshore (light grey) 2005-2010 for the Balearic Islands of Mallorca, Menorca, Ibiza and Formentera.

Of the annual averages of marine debris estimated for each location at all sites, plastic marine debris was consistently the most abundant both nearshore and offshore (Figure 2). Although these results are preliminary, they give a brief description of marine debris surrounding the Balearic Islands and plastic marine debris being the most dominant regardless of location or time. Further research through modeling and integrating physical processes will allow for a more comprehensive approach into understanding the mechanisms that drive the distribution and accumulation of plastic marine debris.

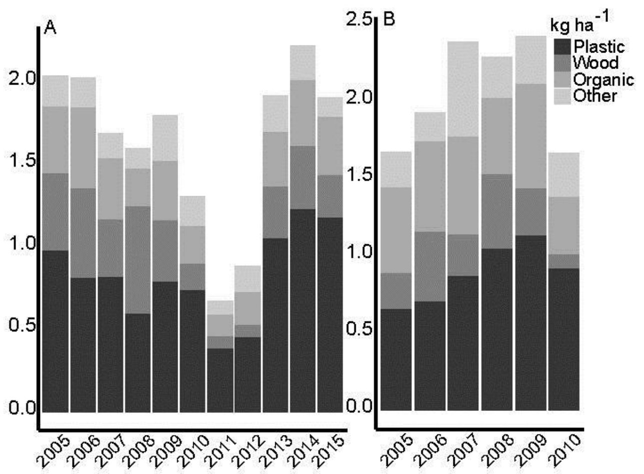

Fig. 2. Summary of average annual marine debris (kg ha^{-1}) collected along the Balearic Islands' coast. Nearshore (A) is 0-500m from 2005-2015 and offshore (B) is 500-5000m from 2005-2010.

References
1 - Eriksen, M., Lebreton, L.C., Carson, H.S., Thiel, M., Moore, C.J., Borerro, J.C., Galgani, F., Ryan, P.G. and Reisser, J., 2014. Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. *PloS one*, *9*(12), p.e111913.
2 - . Law, K.L., More´t-Ferguson, S.E., Goodwin, D.S., Zettler, E.R., DeForce, E., Kukulka, T. and Proskurowski, G., 2014. Distribution of surface plastic debris in the eastern Pacific Ocean from an 11-year data set. *Environmental science & technology*, *48*(9), pp.4732-4738.
3 - Pham, C.K., Ramirez-Llodra, E., Alt, C.H., Amaro, T., Bergmann, M., Canals, M., Davies, J., Duineveld, G., Galgani, F., Howell, K.L. and Huvenne, V.A., 2014. Marine litter distribution and density in European seas, from the shelves to deep basins. *PLoS One*, *9*(4), p.e95839.

MONITORING FLOATING MICROPLASTIC DEBRIS IN THE WESTERN MEDITERRANEAN SEA

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Abstract
In this study we provide a quantitative estimation of the distribution of floating microplastic debris in the Western Mediterranean Sea. We sampled 26 stations (three replicates for each tow) along the coastline of the Eastern Iberian Peninsula, from the Gulf of Lions to the Alboran Sea, during two time periods in 2014 and 2015. Microplastics were extracted using a two-step novel methodology to separate floating isolated microplastics from those aggregated to marine organic matter and thus potentially sinking. Debris were counted and classified according to their plastic nature (colour properties and polymer type), and density and temporal variations investigated to understand origins and pathways bringing and dispersing microplastics into the Mediterranean Sea.

Keywords: Mediterranean Sea, Plastics

It is well known that microscopic plastic fragments are ubiquitous marine pollutants around the world's oceans [1]. Recent studies show high relative abundances of floating microplastic debris in a global-scale context, with high densities found in shelf waters near highly populated areas. The high demography and visiting tourists concentrating in Mediterranean coastal countries, and the semi-enclosed character of the Mediterranean Sea with high residence time of surface waters, suggest the Mediterranean Sea could be acting as a microplastic concentrator and probably as source for Atlantic floating plastic pollution . Indeed current estimations set the weight of microplastics in the Mediterranean Sea between 1,000 and 3,000 tons (in average 1 plastic item in 4 m^2 as numerical concentration), which is comparable to the accumulation zones described for the five subtropical ocean gyres [2]. Here we provide an estimation of the floating microplastic debris distribution and abundance at a broad spatial and temporal scale in the Western Mediterranean Sea. Indeed the information collected in this study represents a step further in the implementation of the Marine Strategy Framework Directive (MSFD, 2008/56/EC) in the region as for one of the 11 descriptors used to assess the Good Environmental Status of Eurpean Marine waters, which is marine litter and microplastic pollution. More importantly, this study provides useful information about the spatiotemporal distribution of marine litter and the anthropic or natural factors that lead to possible dissimilarities between sampled sites. This research is framed in the Spanish NUREIEV project which main aim is to verify the hypothesis that sea storms are the main trigger for the transfer of matter and energy, including pollutants, litter and microplastics, from the coastal to the deep ocean. This will allow to fill critical gaps in the current knowledge of the environmental status of entire continental margin segments of the Western Mediterranean. Floating plastic debris were sampled in the Western Mediterranean basin off Almeria and Murcia in early spring and late summer 2015, and in the Catalan coast from the Cap de Creus to Barcelona in early and late summer 2015, onboard the Spanish vessels R/V Angeles Alvariño and I/V Lluerna, respectively [Fig.1]. Three consecutive 20 min interval net tows were taken at 26 locations (total: 72 net tows) while the ship was travelling at a speed of 2-3 knots. Plastic debris in surface waters were collected using a Manta Trawl net (0.61 x 0.25 m mouth, 335 µm mesh). After each tow, the net was rinsed to collect the remaining debris stuck to the mesh prior to their transfer into glass jars. Samples were then fixed in 30% formalin and stored in a cool dark place on board the vessel and in the lab prior to analysis. Afterwards, the samples were poured into a 2 L glass jar and filled with (0.7 µm) filtered Mediterranean seawater in order to separate the floating microplastics from the denser potentially-sinking microplastics aggregated to floating marine organic matter. Both fractions were analysed and stored separately. Analysis of plastic debris consisted in manual separation and maximum length determination with the aid of an optical microscope using the image processing NIS-Elements software. Colour data in CIE-l-a*-b* (using the Avaatech line scan software) and total weight of Microplastics of every sample was calculated. Finally, to confirm the plastic nature of the material, Raman spectroscopy was applied to a random subset of particles. This is the first study differentiating between those microplastics floating isolated in surface waters (floating debris) from those that are aggregated to alive marine organic matter floating in the sea surface and that thus may end sinking and become buried in the sediments as a part of the biological pump (potentially sunk debris). The importance of those sunk microplastic debris have been recently discovered, being deep sea sediments a major sink for microplastic debris [3]. In this presentation we are going to discuss how microplastics interact with organic matter according to their properties, which could help us to understand the key-playing role of organic matter and the biological pump in the removal of microplastic debris from surface waters. Furthermore, we will discuss how sea surface circulation dynamics (i.e. the southwards flowing Northern Current that connects all areas investigated) as well as other hydrodynamic patterns (e.g. eddies, storms, etc.) and anthropogenic pressure in the coastal sea could be affecting microplastic distribution and its characteristics. Finally, aspects of the seasonal variability in sampled sites will be discussed, as weather could be influencing plastic particle quantification.

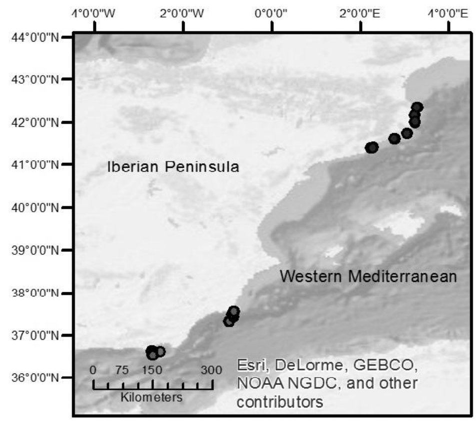

Fig. 1. Map with the sampled sites in the Western Mediterranean

References
1 - Thompson, R. *et al.* Lost at sea: where is all plastic? *Science*, **304**, 838 (2004)
2 - Cózar A, Sanz-Martín M, Martí E, González-Gordillo JI, Ubeda B, Gálvez JÁ, *et al.* (2015) Plastic Accumulation in the Mediterranean Sea. PLoS ONE **10(4)**: e0121762. doi:10.1371/journal.pone.0121762
3 - Woodall, L. C. *et al*. (2014). The deep sea is a major sink for microplastic debris. *Roy. Soc. Open. Sci.* **1(4)**, 140317 **(2014)**.

PREDICTION OF MICROPLASTIC HOT-SPOT AREAS IN THE EASTERN MEDITERRANEAN SEA: THE CASE STUDY OF THE AEGEAN SEA.

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Abstract

A particle-tracking model was coupled to a circulation model to simulate transport and accumulation of floating microplastics in the Aegean Sea (Eastern Mediterranean), Greece. The aim of the study was to identify floating microplastic hot-spots, predict corresponding accumulation zones and identify microplastic circulation paths and later target future survey cruises on the corresponding spots. The prediction of the accumulation zones for floating microplastics, in the Aegean Sea seems to follow an irregular pattern. The usefulness of the simulation results as a management tool is also discussed.

Keywords: Pollution, Models, Plastics, Aegean Sea, Water transport

Floating plastic pollution is a substantive, emerging threat for marine and human life, being present in massive quantities to world's oceans, reaching up to 5 trillion particles (Eriksen et al., 2015). There is a growing interest for both field and model studies aiming at finding the areas that foster the accumulation of floating debris (Mansui et al., 2015; Yoon et al., 2010; Lebtreton et al., 2012; Cozar et al., 2015), the so-called marine litter "hot-spots". In this model study, a hydrodynamic model (~3Km resolution), based on Princeton Ocean Model (POM, Blumberg and Mellor, 1983), currently operational within the POSEIDON forecast system (Korres et al. 2010,www.poseidon.hcmr.gr) provided the surface current fields as forcing to simulate the transport of floating plastics in the Aegean Sea (Greece). A particle-tracking model, based on Pollani et al. (2001), followed the fate of thousand particles in space and time for a total period of one year. As a risk exposure index, we defined the residence time (in days) of floating particles in different areas of the model domain. Based on existing studies (Lebreton et al., 2012), initial sources of plastic pollution were identified, corresponding to major rivers, cities, fishing grounds and shipping routes (Fig. 1a), while the residence time of floating litter particles, categorized in months (Fig. 1b) is also illustrated. The distribution and accumulation of floating microplastics in the Aegean Sea seems to follow an irregular pattern.

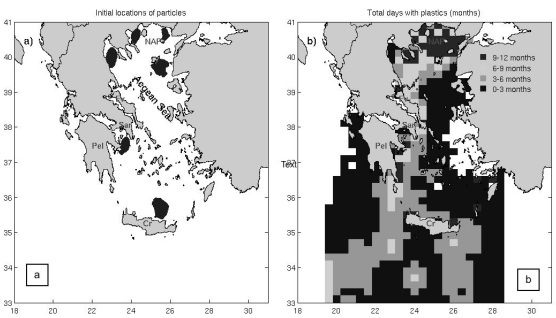

Fig. 1. Initial locations of particles (a) and residence time (b) of floating particles (categorized in months), over the whole Aegean Sea.

Higher residence time was identified in the northern part of the Aegean Sea, the Evoikos gulf (Ev) and the western part of Peloponnese (Pel). In the North Aegean Sea, one of major fishing grounds exists (North Aegean Plateau, NAP), which is of special concern for the accumulation of microplastics in the marine biota. For the western part of the Peloponnese, the high abundance of microplastic pollution might be related to the effect of the adjacent Saronikos Gulf (Sar). Future survey cruises should be conducted in the predicted areas in order to assess standing stocks of floating microplastic that can be used to evaluate the simulated microplastic spatial distribution. The application of particle tracking models on the identification of microplastic "hot-spots" has shown encouraging results that are still need to be confirmed. However, it is believed that it can surely be used as an effective management tool. The authors acknowledge the PERSEUS (FP7) Research Project for supporting the present work.
The present work has been conducted within the framework of the IRIS-SES (DG ENV GA no: 07.0335/2013/659540/SUB/C2) and ActionMed (DG ENV GA no: 11.0661/2015/712631/SUB/ENVC.2) projects

References

1 - Blumberg, A.F., Mellor, G.L. (1983). Diagnostic and prognostic numerical circulation studies of the South Atlantic Bight. Journal of Geophysical Research: Oceans 88, 4579-4592.
2 - Cózar A., Sanz-Martín M., Martí E., González-Gordillo J.I., Ubeda B., Gálvez J.Á., et al. (2015). Plastic accumulation in the Mediterranean Sea. PLoS ONE 10(4): e0121762. doi:10.1371/journal.pone.0121762.
3 - Eriksen M., Lebreton L.C.M., Carson H.S., Thiel M., Moore C.J., et al. (2014). Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. PLoS ONE 9(12): e111913. doi:10.1371/journal.pone.0111913.
4 - Korres, G., Nittis K, Perivoliotis L., Papadopoulos A., Triantafyllou G. (2010). Forecasting the Aegean Sea hydrodynamics within the POSEIDON-II operational system, Journal of Operational Oceanography, 3, 37-49.
5 - Lebreton, L.C.M., Greer, S.D., Borrero, J.C. (2012). Numerical modeling of floating debris in the worlds oceans. Mar. Pollut. Bull. 64, 653-661.
6 - Mansui J., Molcard A., Ourmières Y. (2015). Modeling the transport and accumulation of floating marine debris in the Mediterranean basin. Marine Pollution Bulletin 91, 249–257.
7 - Pollani A., G.Triantafyllou, G.Petihakis , K.Nittis, K.Dounas and C.Koutitas (2001). The POSEIDON Operational Tool for the Prediction of Floating Pollutant Transport, Marine Pollution Bulletin, Vol. 43/7-12, pp 270-278.

ASSESSMENT OF MICROPLASTIC FIBRE CONTAMINATION IN THE EASTERN AEGEAN SEA, WITH THE USE OF HOLOTHURIANS AS INDICATOR SPECIES

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Abstract
This study assesses the use of Holothurians as an indicator species for the presence of microplastics in the coastal zone of Samos island, NE Aegean, Greece. The aim of this investigation is to evaluate the contamination in deposit feeders in the lowest level of the trophic food chain. Individuals were sampled in the coastal zone at 5 sites on Samos Island and the total amount of egested fibres was measured. Microplastic fibres were found in all the samples with an average of 1.388 ± 0.041 (SD) fibres per individual and neither depth nor anthropogenic activities affected the concentration levels in this particular study.

Keywords: Plastics, Pollution, Bio-indicators, Aegean Sea

Microplastics are a major threat to the Mediterranean Sea, as their accumulation causes surface pollution in the water comparable to the level of pollution found in the five subtropical ocean gyres [1]. Due to their small size (<5mm), they are accessible to marine biota; in particular filter feeders and deposit feeders that feed unselectively. This research focused on identifying locations affected by microplastic fibre contamination and quantification using deposit feeding Holothuria as an indicator species. Holothuria species don't distinguish between organic and inorganic materials, are nonselective deposit scavengers [2] and have a natural defense mechanism in the form of self-evisceration of their digestive track, making them particularly suited to use as an indicator species.

27 Holothuria specimens, 18 *Holothuria poli* and 9 *Holothuria tubulosa* were sampled during March and April 2015 at 5 sites in the eastern part of Samos island, eastern Aegean Sea, Greece. The sites have different levels of anthropogenic influences and accessebility ranging from a wastewater treatment plant to urban zones. The Holothurians were stored in tanks of filtered sea water. Microplastic fibres were quantified after defecation or evisceration (if they triggered their defence mechanism). Containers were shaken for 2 minutes and left for sedimentation for 12 to 24 hours [3]. For each sampling, 500 ml of supernatant was extracted, filtered through a WhatmanTM filter and then microplastics were counted with a microscope at 100 x magnification [4].

All sites sampled were contaminated with MP fibres 1.388 ± 0.041 (SD) per 500 ml of supernatant. Depth and anthropogenic activities had no influence on the amount of egested MP fibres by Holothuria. 8 out of the 27 collected Holothuria specimens activated their defence mechanism.In addition, the amount of microplastic fibres in these samples (1.621 ± 0.035 (SD) fibres per 500 ml of supernatant) was significantly higher than the number of microplastic fibres detected in samples of the sea cucumber which did not generate their defence mechanism (1.260 ± 0.036 (SD) per 500 ml of supernatant).

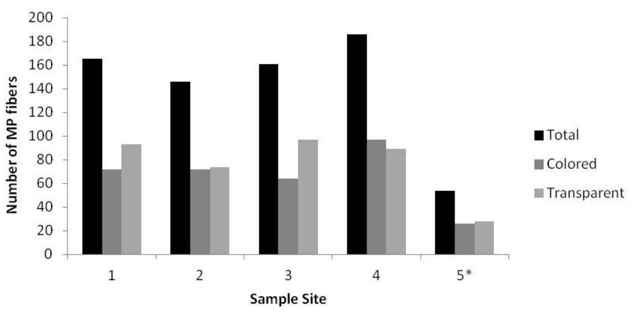

Fig. 1. Number of microplastic fibres (MP) per sampling site

This study showed that 100% of the examined Holothuria encountered microplastics in the benthic sediments while feeding and foraging the upper most layers of the sediments [2]. This observation conforms to findings made by other researches that suggest that high concentrations of microplastic fibres are available in benthic sediments in many parts of the world [5], particularly the Eastern Aegean and the Island of Samos [4].

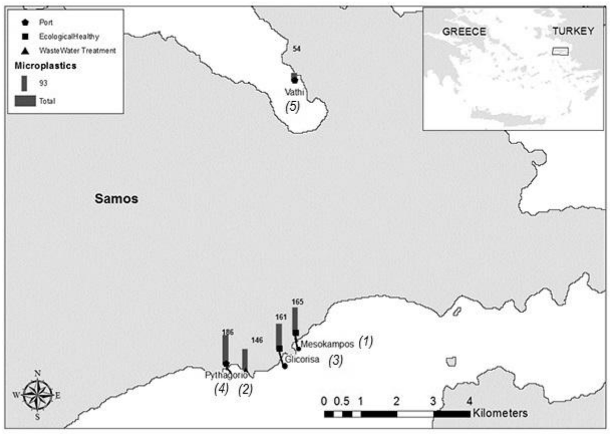

Fig. 2. Sampling sites in Samos and amount of microplastic fibres assessed in the individuals

References
1 - Cózar, A., Sanz-Martin, M., Marti, E., Gonzáles-Gordillo, J. I., Ubeda, B., Gálve, J. Á., Duarte, C. M., 2015. *Plastic Accumulation in the Mediterranean Sea*. Plos One. DOI: 10.1371/ 0121762
2 - Graham, E. R., Thompson, J. T., 2008. Deposit and suspension feeding sea cucumbers (Echinodermata) ingest plastic fragments. *Journal of Experimental Marine Biology and Ecology* 368: 22–29
3 - Seary, R., Acasuso-Rivero, C., Miliou, A., Standerwick, R., Demetriou, M., Chuda, D., and Siwka, I., 2013. Multiple Phase Microplastic Assessment of the Greek Marine Envrionment. *Rapp. Comm. Int. Mer. Medit.*
4 - Fransen, W., Parkes, A., Wright, H., Michalopoulou, E., Miliou, A., Kliukaite, J., & Van den Berg, J., 2015. Analysis of the microplastic fibre distribution around the coastal zones of the Islands Samos and Lipsi. Lesbos: *Archipelagos Institute of Marine Conservation - Pan-Hellenic Symposium of Oceanography and Fisheries*.
5 - Browne, M. A., Crump, P., Niven, S. J., Teuten, E., Tonkin, A., Galloway, T., & Thompson, R., 2011. Accumulation of Microplastics on Shorelines Worldwide: Sources and Sinks. Environmental Science & Technology. 45(21): 9175–9179

MICROPLASTICS OCCURENCE AND COMPOSITION IN THE CENTRAL-WESTERN MEDITERRANEAN SEA

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Abstract

We report the results of a large-scale survey of neustonic microplastics in Mediterranean waters. Plastics particles were found in all samples collected with an average concentration of 1.25 ± 1.62 particles/m^2 and 703.16 ± 1573.95 g/km^2. Thirteen different classes of synthetic polymers were identified, including polyethylene, polypropilene, polyamides, biodegradable polyesters and synthetic paints. A large heterogeneity in plastic concentrations and polymeric composition was found, likely reflecting the influence of diverse factors governing plastic distribution at sub-basin scales. According to our calculations, between 933.4 and 2675.4 tonnes of plastic were floating on the surface of the entire Mediterranean basin, confirming it as one of the most heavily impacted regions of the world with regards to microplastics pollution.

Keywords: Plastics, Mediterranean Sea, Pollution, Surface waters

Numerical models predict some of the highest concentrations of plastic particles in the world to occurr in the Mediterranean Sea [1]. As a result, together with the main five oceanic gyres, the Mediterranean basin has been proposed as the sixth great accumulation zone for marine litter [2]. In order to test model predictions, we present the results of a large-scale survey of neustonic microplastics in Mediterranean surface waters, carried out between May and June 2013 with the main goal of providing detailed information about the occurrence, abundance, distribution and polymeric composition of these floating particles.

A total of 74 samples were collected using a 200 µm neuston net. Plastic was found in all samples with a mean concentration of 1.25 ± 1.62 particles/m^2 and 703.16 ± 1573.95 g/km^2. Most of the particles (93.2%) were classified as hard-plastic fragments (i.e. secondary microplastics), while pellets, films and foam constituted only a small fraction of the total. Microplastics *sensu stricto (*i.e. particles smaller than 5 mm), accounted for the vast majority of all collected items (98.6%). However, particles > 1 mm accounted for 92.5% of the total weight of plastic collected, with meso-plastics alone (> 5 mm) accounting for 56.6% of the total. No indication about the loss of smaller size fractions from the sea surface was found and, contrarily to what has been previously reported in the literature, the number of particles steadily increased with decreasing size, with 26.4% of the particles being smaller than 0.3 mm and more than half of all items (50.8%) being smaller than 0.5 mm.

13 different polymer typologies were identified through FT-IR analysis (n = 4050 particles). More than half of all characterized items (52%) were classified as polyethylene (PE), which was followed in abundance by polypropylene (PP) (16%), synthetic paints (7.7%), polyamides (PA) (4.7%), epoxy resins (5%), polyvinyl chloride (PVC) (2.6%), polystyrene (PS) (2.8%), nylon (1.9%) and polyvinyl alcohol (PVA) (1.2%). Other polymer classes encountered less frequently included poly(ethylene terephthalate) (PET), polyisoprene (synthetic rubber), poly(vinyl stearate) (PVS), ethylene-vinyl acetate (EVA), cellulose acetate, paraffin wax and polycaprolactone, a biodegradable polymer, which was found in seven different samples throughout the study area. The molecular characterization revealed also that 4.4% of all analyzed particles did not consisted of plastic but were rather made of cotton, chitin, cellulose and other non-synthetic materials, suggesting a potential bias when visually sorting for microplastics.

A very high spatial heterogeneity was observed, with plastic concentrations spanning two or three orders of magnitude across the study area (Fig. 1). Maximum concentrations (9.23 particles/m^2 and 10.63 kg/km^2) were found in the Corsica Channel, while the lowest concentrations were observed in the Southern Adriatic Sea. On the whole, plastic was significantly ($p = 0.002$) less abundant in the Adriatic (0.83 ± 1.05 particles/m^2 ; 485.07 ± 1153.07 g/km^2; n = 30) than in the rest of the Mediterranean Sea (1.54 ± 1.87 particles/m^2 ; 851.85 ± 1803.66 g/km^2 ; n = 44).

Also, the polymeric composition of non-Adriatic samples was more homogeneous and markedly characterized by an higher occurrence of polyethylene and polypropylene fragments. In contrast, Adriatic samples appeared to be more heterogeneous and rather characterized by an higher presence of paint chips, PVC, PVA, PS and PA, probably indicating a closer link with pollution sources.

Lastly, by computing 95% BCa bootstrapped confidence intervals of our mean density values and averaging them over the entire basin we estimated that between 2.2 and 4.0 x 10^{12} particles and between 933.4 and 2675.4 tonnes of plastic were floating on the Mediterranean Sea during our survey, confirming the Mediterranean Sea as one of the most heavily poluted basins in the world with regards to microplastic pollution.

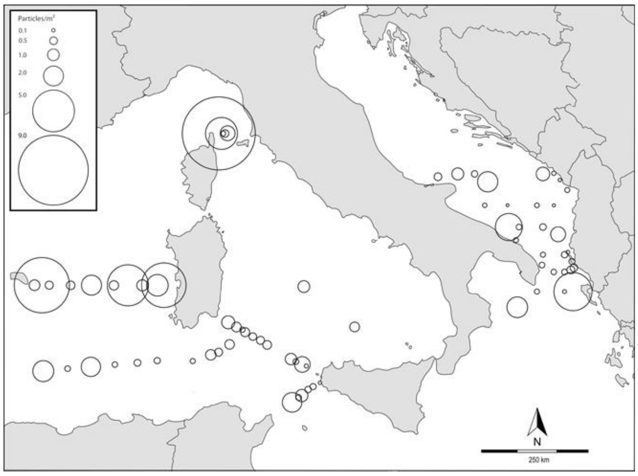

Fig. 1. Map of the study area showing the location of all sampling stations and measured microplastic concentrations expressed as number of items/m^2.

References

1 - Van Sebille E., Wilcox C., Lebreton L., Maximenko N., Hardesty B.D., van Franeker J.A., Eriksen M., Siegel D., Galgani F., Law K.L., 2015. A global inventory of small floating plastic debris. *Environmental Research Letters* 10 (12), 124006.

2 - Cózar A., Sanz-Martín M., Martí E., González-Gordillo J.I., Ubeda B., Gálvez J.Á., Irigoien X., Duarte C.M., 2015. Plastic accumulation in the Mediterranean Sea. *PLoS One,* 10:e0121762

PLASTIC IN THE NORTHERN ADRIATIC: ITS EVERYWHERE, BUT ITS NOT A "SOUP". NOW WHAT DOES IT DO?

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Abstract

Plastic litter is a very common and very persitent pollutant. And as most pollutants it ultimately ends up in marine ecosystems. Its dynamics and effects on the ecosystem are underinvestigated. We performed a first assessment of different size classes of plastic litter in the north-eastern Adriatic. Our results indicate a strong penetration of plastic litter throughout the marine ecosystem as well as throughout the food web.

Keywords: Plastics, Pollution, Plankton, North-Eastern Mediterranean

Plastics are the most commonly used materials nowadays. As heavily persistent materials, plastics tend to accumulate in the environment and ultimately end up in marine ecosystems. A particular concern is the increasing number of plastic microparticles in the environment. Microplastics comes from degradation of larger plastic pieces in the environment or stems directly from household wastewater and the use of microplastics in personal care products, paints, textile and plastic pellets from the plastic industry. Plastics can be found in every sea and ocean investigated so far, from the surface layer to the bottom. The impact of microplastics on ecosystem functions or e.g. biodiversity is so far not yet clear. However, microplastics was found throughout the trophic web raising the question of the plastics impact to marine organisms and ultimately to human health. Plastic litters was identified as transport vector and substrate for marine organisms as well as vector for a variety of toxic substance. It is furthermore supposed to change nutrient cycles in marine ecosystems by affecting feeding efficiency, buoyancy and by adsorption of nutrients. While it is generally accepted, that the concentration of a persistent pollutant can be expected to continuously rise in marine ecosystems. It is so far unclear how intense the interaction between microplastics and the marine environment is and what the respective effects are.

We performed an initial assessment of plastic litter in the north-eastern Adriatic. Our data on beachlitter (performed according to the European Commission "Guidance on Monitoring of Marine Litter in European Seas") demonstrates a high percentage of plastic litter as well a a relatively large fraction of presumed local origin. Ocean current models for the area support this notion. A quantiative analysis of microplastics in the watercolumn on a transect between Rovinj (Croatia) and the Po river mouth (Italy) showed alarmingly high concentrations of microsplastics throughout the watercolumn.

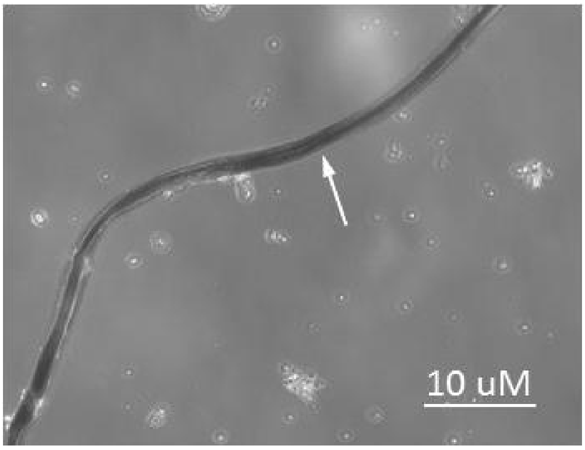

Fig. 1. A plastic fibre (arrow) as found in the watercolumn.

However, natural microfibres, including also e.g. cotton fibres, are even more abundant. This microlitter was not equally distributed, but showed higher abundances towards the Po river mouth and even more so towarsd coastal settlements. While we observed a frequent association of bacteria with organic fibres, we did not observe any significant association of bacteria and plastic microfibres. The same holds true for unicellular eucaryotes.

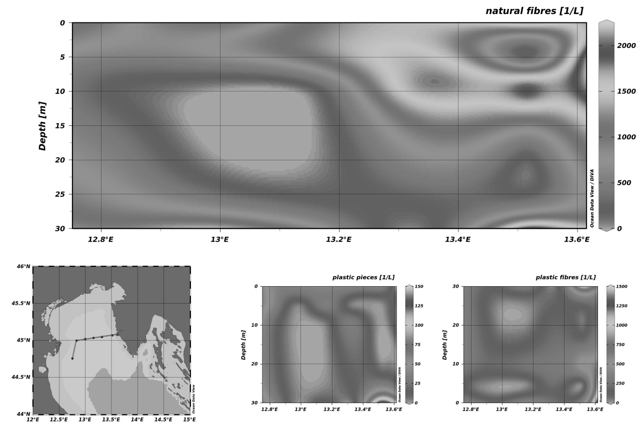

Fig. 2. Microlitter abundance and distribution across the northern Adriatic

To further search for possible effects of such microlitter on the ecosystem, we quantified plastics in the stomach content of fish (*Pagellus erythrinus* (Linnaeus 1758)) and found a relatively low percentage of individuals with ingested plastics. Finally we experimentally exposed blue mussels (*Mytilus galloprovincialis* (Lamarck, 1819)) to plastic microfibres. We found those fibres afterward on and in the filtering apparatus.
Overall our results seem to give reason for growing concern about plastic litter in the sea and especially about the dynamics of its effects on the ecosystem.

References

1 - Zettler Erik R.,Mincer Tracy J. and Amaral-ZettlerLinda A., 2013, Life in the “Plastisphere”: Microbial Communities on Plastic Marine Debris, Environmental Science & Technology 47 (13), 7137-7146
2 - Senga Green D., Boots B., Blockley D.J., Rocha C. and Thompson Richard, 2015, Impacts of Discarded Plastic Bags on Marine Assemblages and Ecosystem Functioning, Environmental Science & Technology 49 (9), 5380-5389
3 - Cole M., Lindeque P. K., Fileman E., Clark J., Halsband C. and Galloway T.S., 2016,Microplastics Alter the Properties and Sinking Rates of Zooplankton Faecal Pellets, Environ Sci Technol 50
4 - Pruter A.T., 2016, Sources, quantities and distribution of persistent plastics in the marine environment, Marine Pollution Bulletin 18,6

PLASTIC POLLUTION IN SINOP SARIKUM LAGOON COAST IN THE SOUTHERN BLACK SEA

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Abstract
Macro and micro plastic litter amount, density and composition were researched in the Western Black Sea in Sarikum Lagoon Coast in spring 2015. In this study was intended to determine the current situation the region under the Descriptor 10. Proposed methods by Guidance on Monitoring of Marine Litter in European Seas were adopted the region.

Keywords: Black Sea, Plastics, Pollution

Sarikum Lagoon which is one of the significant wetlands of the Black Sea has been announced as Nature Reserved Area in 1987 and then lagoon surroundings have been declared as Natural Protected Area in 1991. Lagoon and its surroundings is exposed to a significant accumulation of solid waste both with sea currents from neighboring countries and the influence of the prevailing winds in Sinop due to the geographical location. Marine litter causes a wide spectrum environmental, economic, safety, health and cultural impacts and mainly composed of plastics. Marine Strategy Framework Directive (2008/56/EC) published by European Union in 2008, includes necessary measures to provide or maintain "Good Environmental Status" (GES) of the Member States up to 2020. In Annex I to Directive is determined GES according to 11 qualitative 'descriptors' for marine regions and sub-regions and Descriptor 10 is related to marine litter.

Proposed methods by Guidance on Monitoring of Marine Litter in European Seas [1]'s published by European Marine Strategy Framework Directive Technical Subgroup on Marine Litter section of beach litter and section of microlitter adopted the region. Beach litter survey carried out in spring 2015, sampling stations were selected 4 sections of 50 m from the strandline to the back of the beach, because of heavily littered (figure 1). For macro plastics, within each sampling area, all debris items which were shown, collected, categorized, weighted and counted and the possible usage of items was recorded. For small fragment plastics (which are 0.5-2.5 cm size group) was selected sub-sampling area in sampling stations. Microplastic samples for 1-5 mm was collected 5 replicate samples from 5 cm of the sediment from strandline with used 50x50 cm quadrats for each sampling station and passed through a 1 mm metal sieve. Microplastic samples for <1 mm was collected 5 replicate samples by strand line and collecting approximately 250 ml of sediment. Collected sediment extracted in the laboratory by density separation and microplastic samples categorized according to size, type and color.

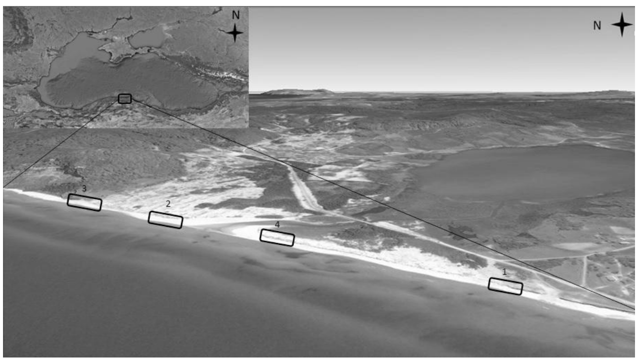

Fig. 1. Sinop Sarikum Lagoon and sampling stations

Macro plastic litter density varied from mean 1.0807-4.5054 pieces m^{-2} and most of the macro plastic items encountered on the sampling stations composed of mainly rapid consumption items (39.56%) and unidentifiable plastic pieces (35.43%) originate from breakdown of large plastic products and beverage related items (26.40%) and medical and personal hygiene, construction and domestic and household related items etc. followed them. Small plastic litter (0.5-2.5 cm) quantity varied from mean 0.5567- 1,5684 pieces m^{-2} and mainly composed of unidentifiable plastic pieces and . Microplastic results show that microplastic density for 1-5 mm varied from 0.005-0.024 pieces g^{-1}. Micro plastic results demonstrated that the most encountered microplastic items are polystyrene pieces (62.69%) and hard plastic pieces (26.80%) and followed by resin pellets (7.46%) and the others (3.05%). Microplastic density for <1 mm varied from 0.027-0.049 pieces g^{-1}. Our results are showed that most of the macro plastics consist of rapid consumption items and unidentifiable small plastics originate from breakdown of large plastic products by natural events like other studies in the Black Sea [2]. At the same time in the region was encountered with foreign-origin litter and nearly half of them originated from neighboring countries driven by currents and winds, the other part of this foreign-origin litter seem to come from international shipping activities in the Black Sea. Microplastic results are demonstrated that commonly consist of polystyrene pieces which are originated from polystyrene boxes especially used in fishing season (1 September-15 April) for transport the catch by fisherman. They are light and can be transported easily by currents and wind. And hard plastic pieces which are originate from breakdown of large plastic products by natural events as in macro plastic litter.

Acknowledgement: This study is financially supported by TUBITAK through the research project No: 115Y002

References
1 - Galgani F., Hanke G., Werner S., Oosterbaan L., Nilsson P., Fleet D., Kinsey S., Thompson R.C., Van Franeker J., Vlachogianni T., Scoullos M., Mira Veiga J., Palatinus A., Matiddi M., Maes T., Korpinen S., Budziak A., Leslie H., Gago J., Liebezeit G. 2013.Guidance on Monitoring of Marine Litter in European Seas. Luxembourg: Publications Office of the European Union, 128 pp.
2 - Topçu E. N., Tonay A. M., Dede A., Öztürk A. A., Öztürk B. 2013. Origin and Abundance of Marine Litter Along Sandy Beaches of the Turkish Western Black Sea Coast. Marine Environmental Research 85: 21-28.

CIESM Congress Session : Bioaccumulation and trophic transfer / benthic

Moderator : Alessia Rodriguez y Baena, IAEA

Moderator's Synthesis

The session was attended by about fifty multidisciplinary scientists from across the Mediterranean and Black Seas who engaged in lively discussions. While the potential of benthic organisms to provide insights into the environmental health status of our seas is evident, the discussion highlighted two main areas requiring further investigation and concerted efforts in order for the bio-indicator value of target species to be ascertained and optimised.

Combining field studies with experimental approaches, such as radio- and bio-assays, is a powerful tool to assess the effects of a given contaminant, or mixture of contaminants in the environment on bio-indicator species;. This remains, however, an uncommon practice in the region. Similarly, while the use of reliable bio-indicator data to monitor contamination trends and to assess the effectiveness of mitigation measures can much benefit sound, science-based decision making, established channels of communication between scientists and relevant governmental actors remain sparse.

By facilitating dialogue among field- and lab-specialists, and between the scientific community and policy makers, CIESM can play a key role for species such as the red mullet *Mullus barbutus* and the mussel *Mytilus galloprovincialis* to become stronger allies in our concerted efforts to preserve the Mediterranean and Black Seas.

USING MARINE MACROALGAE AS BIOMONITORS: HEAVY METAL POLLUTION ALONG THE TURKISH WEST COASTS OF THE BLACK SEA

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Abstract
Heavy metals (Fe, Zn, Ni, Cu, Mn, Co, Pb and Cd) were determined in *Ulva lactuca*, *Enteromorpha linza* and *Cystoseira barbata*. Samples were collected during summer 2013 from 4 different sites of the Turkish Black Sea coastal zone. All metals except Zn and Pb in macroalgae were high in Inebolu. Metal levels except Cd in *U. lactuca* from Inebolu region were lower than the maximum permissible values of French regulation (>0.5 mg/kg dry wt.).

Keywords: Algae, Black Sea, Metals, Bio-accumulation, Bio-indicators

Introduction
Aquatic ecosystems are contaminated by heavy metals and they cause serious ecological changes, due to their toxicity, persistence and accumulative behaviour in the organisms, resulting in accumulation in biota [1]. Marine macroalgae are used as biomonitors for environmental assessment in coastal areas due to their accumulation capacity. They are primary producers and have an important role for transferring of pollution to upper levels in food webs. Seaweeds have been used in many Asian countries as habitual diet, however in Europe they are considered as novel food [2]. France was the first European country to establish a specific regulation concerning the use of seaweeds for human consumption as non-traditional food substances. There is a tendency to monitoring macroalgae due to their ecological significance and also nutritional value. Therefore, it is important to determine heavy metal concentrations in seaweeds. The Black Sea has been exposed to pollution pressure that derives both from human activities and natural sources. Many studies are available on heavy metal concentrations in macroalgae species in the Black Sea [1]. Nevertheless, there is no a regulation about the usage of seaweeds for human consumption in the Black Sea countries. The aim of this study is to determine essential (Fe, Zn, Ni, Cu, Mn, and Co) and non-essential (Pb and Cd) metals in macroalgae of the southern Black Sea coasts for the monitoring of the metal pollution in 2013.

Materials and Methods
U. lactuca, *E. linza* and *C. barbata*) were collected in 2013 from Igneada, Inebolu, Sinop and Samsun (Fig. 1) and were washed, dried and homogenized. Then algae were digested with concentrated HNO_3 (Merck) and evaporated. Metals were determined using a UNICAM 929 Flame Atomic Absorption Spectrophotometer. The digested samples were analysed with 3 replicates and were expressed as mg/kg dry wt.

Fig. 1. Study area.

Results and Discussion
The relative abundance of metals in macroalgae followed the order of Fe>Zn>Mn>Cu>Ni>Pb>Co>Cd>Hg. Bat [1] pointed out the high uptake of Fe and Zn in green algae and Ni, Cu, Mn and Pb in brown algae, suggested that these algae may be used as potential biomonitors for heavy metal pollution. Results showed that metal concentrations were high in Inebolu whereas the highest Zn and Pb levels were determined in *C. barbata* and *U. lactuca* from Samsun coasts, respectively. All metal levels were the lowest in Sinop coasts (Table 1).

Tab. 1. Minimum and maximum concentrations (Mean± SD) of heavy metals in macroalgae collected during summer 2013 along the southern coastal zone of the Black Sea.

Metals		(mg/kg dry wt.)	Species	Stations
Fe	Min	327±18	*C. barbata*	Sinop
	Max	1754±65	*U. lactuca*	Inebolu
Zn	Min	7±0.6	*E. linza*	Sinop
	Max	65±16	*C. barbata*	Samsun
Ni	Min	0.8±0.01	*C. barbata*	Sinop
	Max	2.4±0.3	*U. lactuca*	Inebolu
Cu	Min	5±0.7	*C. barbata*	Sinop
	Max	37±7	*C. barbata*	Inebolu
Mn	Min	2±0.2	*E. linza*	Sinop
	Max	64±11	*U. lactuca*	Inebolu
Pb	Min	0.08±0.01	*U. lactuca*	Sinop
	Max	1.9±0.4	*U. lactuca*	Samsun
Cd	Min	0.09±0.01	*U. lactuca*	Sinop
	Max	0.66±0.07	*U. lactuca*	Inebolu
Co	Min	0.2±0.01	*C. barbata*	Sinop
	Max	1.5±0.4	*C. barbata*	Inebolu

;

Ulva spp. and *Enteromorpha* spp. are authorized as vegetables and condiments according to French regulation. Although mean Cd level (0.66±0.07 mg/kg dry wt.) in *U. lactuca* from Inebolu was slightly higher than those in French Regulation (0.5 mg/kg dry wt.) according to the regulation (EC) No 629/2008 setting maximum level for cadmium (3 mg/kg dry seaweed) is needed for food supplements consisting exclusively or mainly of seaweed [2]. *U. lactuca*, *E. linza* and *C. barbata* are widespread species in the Black Sea and thus can be used as a very good biomonitor for heavy metal pollution. Monitoring of coastal waters is also a requirement for Marine Strategy Framework Directive, so it is assumed that the regular monitoring of macroalgae of the Black Sea coastal areas is essentially required for assessment of environmental health of the future.

References
1 - Bat L. 2014. Heavy Metal Pollution in the Black Sea. In: Turkish Fisheries in the Black Sea published by TUDAV, Publication No: 40, Istanbul/Turkey.
2 - CEVA 2014. Edible seaweed and French regulation - Synthesis made by CEVA, 3 pp. Available from: www.ceva.fr/

RED ALGAE AS BIOINDICATORS OF HEAVY METAL POLLUTION FROM SAMSUN COASTS OF TURKEY

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Abstract
A total of four macroalgae species (*Porphyra umbilicalis, Corallina panizzoi, Antithamnion cruciatum, Ceramium rubrum*) belonging to Rhodophyta division were collected in 2013 along the Black Sea coast of Samsun in Turkey. Concentrations of Fe, Zn, Ni, Cu, Mn, Co, Pb and Cd were measured. As a result the highest concentrations of the trace elements found in algae were as follows: Fe (1714±53 mg/kg dry wt.), Cd (0.04±0.02 mg/kg dry wt.) and Co (0.6±0.07 mg/kg dry wt.) in *A. cruciatum*; Zn (41±6 mg/kg dry wt.), Cu (10±3 mg/kg dry wt.), and Mn (31±4 mg/kg dry wt.) in *C. panizzoi*; Ni (3±0.21 mg/kg dry wt.) in *C. rubrum*; and Pb (0.06±0.01 mg/kg dry wt.) in *P. umbilicalis.* All species can be used as bioindicators of heavy metal pollution in this area.

Keywords: Algae, Black Sea, Bio-indicators

Introduction
The metal levels have increased in the Black Sea due to some contaminants that are introduced into through rivers or discharges of effluents from industries, agricultural and municipal usage. Samsun extends along the coast between two major rivers: Kizilirmak and Yesilirmak in the Black Sea in Turkey (Fig. 1).

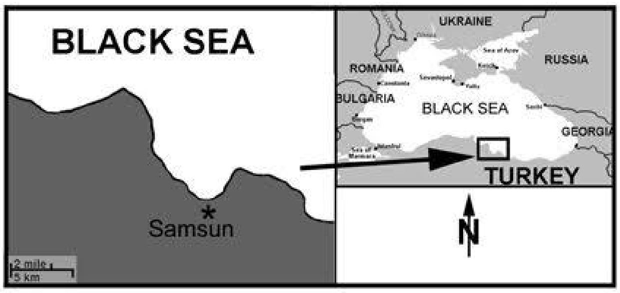

Fig. 1. Study area from Samsun coasts of the Black Sea, Turkey.

Therefore, Samsun coastline is mainly being affected by rivers. Moreover, fast-paced population, urbanization, intensive agricultural activities, small or full scale industrial activities and the commercial port activities present some of the major problems and all of these problems create heavy metal pollution along the Samsun coasts [1]. Macroalgae are useful and generally used in the monitoring of metal pollution because of their distribution, reasonable size, longevity, presence at pollution areas, ability to accumulate metals to an adequate degree and ease of identification [2]. They are primary producers in the coastal marine areas and transfer energy between trophic levels and also give information on concentrations of heavy metals in the surrounding environment [3]. The aim of the study was aim to measure essential and non-essential heavy metals (Fe, Zn, Ni, Cu, Mn, Co, Pb and Cd) in four macroalgae species named *Porphyra umbilicalis, Corallina panizzoi, Antithamnion cruciatum, Ceramium rubrum* belonging to Rhodophyta division in 2013 summer from Samsun coasts of the Black Sea, Turkey.

Materials and Methods
Porphyra umbilicalis, Corallina panizzoi, Antithamnion cruciatum, Ceramium rubrum macroalgae species were collected from Samsun, in the Black Sea city of Turkey. Samples firstly washed with clean sea water, then with tap and distilled water. Afterwards they were dried at 70°C and homogenized. Then selected algae were digested with concentrated HNO_3 (Merck) and evaporated. Metal concentrations were measured by using Flame Atomic Absorption Spectrophotometer (UNICAM 929) with 3 replicates for each measurement and were expressed mg kg^{-1} dry weight.

Results and Discussion
This study was performed for assessment of heavy metals (Fe, Zn, Ni, Cu, Mn, Co, Pb and Cd) in the red macroalgae collected from Samsun in the Black Sea, Turkey in 2013. Samsun coastline is mostly affected by urban processes, discharges of small industries and also harbor activities. As a result of study, the highest Fe (1714±53 mg/kg dry wt.), Cd (0.04±0.02 mg/kg dry wt.) and Co (0.6±0.07 mg/kg dry wt.) values were found in *A. cruciatum*; Zn (41±6 mg/kg dry wt.), Cu (10±3 mg/kg dry wt.), and Mn (31±4 mg/kg dry wt.) concentrations were detected in *C. panizzoi*; Ni (3±0.21 mg/kg dry wt.) was found in *C. rubrum*; and the last Pb (0.06±0.01 mg/kg dry wt.) level was determined in *P. umbilicalis* (Table 1). It was concluded that selected macroalgae were safe as regards the heavy metal studied. However, monitoring should be continually to assess environmental condition and Monitoring of coastal waters by indicator macroalgae is required for future studies according to Marine Strategy Framework Directive.

Tab. 1. The heavy metal concentrations (Mean±SD) in red macralgae species in Samsun coast.

Metals		(mg/kg dry wt.)	Species
Fe	min	280±11	*P. umbilicalis*
	max	1714±53	*A. cruciatum*
Zn	min	18±2	*A. cruciatum*
	max	41±6	*C. panizzoi*
Ni	min	0.4±0.01	*P. umbilicalis*
	max	3±0.21	*C. rubrum*
Cu	min	5±1	*P. umbilicalis*
	max	10±3	*C. panizzoi*
Mn	min	11±1.5	*A. cruciatum*
	max	31±4	*C. panizzoi*
Pb	min	<0.05	*A. cruciatum, C. rubrum*
	max	0.06±0.01	*P. umbilicalis*
Cd	min	<0.02	*P. umbilicalis, C. rubrum*
	max	0.04±0.02	*A. cruciatum*
Co	min	0.1±0.02	*C. rubrum*
	max	0.6±0.07	*A. cruciatum*

References
1 - Bat, L., Arici, E., Sezgin, M., Sahin, F. (2016). Heavy metals in edible tissues of benthic organisms from Samsun coasts, South Black Sea, Turkey and their potential risk to human health. *Journal of Food and Health Science*, 2:2: 57-66.
2 - Conti, M.E., Cecchetti, G. (2003). A biomonitoring study: trace metals in algae and molluscs from Tyrrhenian coastal areas. Environmental Research, 93 (1): 99-112.
3 - Topcuoglu, S., Kiliç, Ö., Belivermis, M., Ergül, H.A., Kalayci, G. (2010). Use of marine algae as biological indicator of heavy metal pollution in Turkish marine environment. J.Black Sea/Mediterranean Environment, 16(1):43-52

EFFETS DE LA CONTAMINATION METALLIQUE SUR *PERINEREIS CULTRIFERA* DANS LE LITTORAL EST D'ALGÉRIE

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Abstract

L'analyse des échantillons de sédiments et ceux de espèce bioindicatrice de pollution *Perinereis cultrifera* (Annélide, Polychète) a concerné deux sites du littoral Est Algérien (El-Kala et Skikda) durant l'année 2014. Le dosage des métaux lourds dans les sédiments et dans l'organisme de *P. cultrifera* a été effectué selon la méthode d'AFNOR, 1994. L'analyse des teneurs en ETM montrent que le site de Skikda est plus contaminé que celui d'El-Kala. Par ailleurs, il a été démontré une bioaccumulation des métaux lourds par *P. cultrifera*.

Keywords: Metals, Pollution, Annelida, Polychaeta, Algerian Sea

Introduction

Parmi les polluants des écosystèmes aquatiques, les métaux lourds constituent un problème écologique important [1]. Ces métaux qui se déposent dans l'environnement aquatique peuvent s'accumuler tout au long de la chaîne alimentaire et constituer une menace pour la santé humaine [2]. Divers xénobiotiques sont encore introduits dans le milieu aquatique ; ils s'accumulent au niveau des sédiments qui constituent alors de véritables réservoirs de contaminants [3].

Matériels et Méthodes

Ce travail a été réalisé sur deux sites du littoral Est Algérien : Skikda choisi comme site contaminé et El-Kala comme site de référence. Une étude comparative entres les deux sites a été réalisée par l'analyse des paramètres physico-chimiques des sédiments, et le dosage des métaux lourds (Zinc, Fer, Cuivre, Plomb, Cadmium) dans les sédiments et dans l'organisme d'une espèce benthique, bioindicatrice de pollution *Perinereis cultrifera* (Annélides, Polychètes) [4]. Concernant la Caractérisation des sédiments et le dosage des métaux lourds; trois prélèvements mensuels d'un mélange de sédiments ont été réalisés pour l'étude des apports d'origine anthropique. Pour la plupart des analyses physico-chimiques, les normes AFNOR sur la qualité des sols ont été appliquées. De plus, un dosage des métaux lourds dans les sédiments et dans l'organisme de *P. cultrifera* a été effectué selon la méthode d'AFNOR, 1994 [5] et le protocole utilisé est celui adapté par Descamps et al. 1996 [6]. Les concentrations ont été analysées par le spectromètre d'absorption atomique à flamme.

Résultats et Discussion

Les données de l'analyse granulométrique des sédiments de Skikda et d'El-Kala (Tableau1) montrent que la texture des sédiments est sableuse, ceci est en concordance avec les teneurs faibles enregistrées des traces métalliques et qui sont en rapport avec la texture fine des sédiments. Aussi, les valeurs enregistrées du pH justifient l'augmentation de la solubilité des ETM au niveau de ce type de sédiments. Cependant, les mécanismes d'accumulation des ETM seraient donc sensibles aux pH basiques au niveau de l'interface eau-sédiments.

Tab. 1. Paramètres physico-chimiques des sédiments prélevés à El-Kala (El-Morjane) et à Skikda (Bikini Djedid) de janvier à juin 2014; CE: Conductivité électrique, Sal: Salinité, MO: Matières organiques, CaCO3: Calcaire, A: Argile, LF/LG: limon fin/gros, SF/SG: sable fin/gros.

	pH	CE (ms/cm)	MO (%)	CaCo3 (%)	A	LF	LG	SF	SG
EL-KALA	7,12	2,71	4,4	0,45	0,69	1,37	6,42	30,69	60,83
SKIKDA	7,67	3,02	1,76	8,51	3,51	3,1	8,68	2,76	81,95

Par ailleurs, le dosage des métaux lourds dans les sédiments (Tableau 2), montrent que le Fer est le métal le plus abondant suivi du Zn, du Pb, du Cu et du Cd et ce au niveau des deux sites. Ceci est confirmé par certains travaux (7) présentant des résultats similaires à nos résultats, où les éléments trace métalliques sont classés selon l'abondance relative (Zn > Pb > Cu > Cd) dans les sédiments des Oued Rhumel et Sakiet Rouma au Les moyennes suivies d'une même lettre ne sont pas significativement différents (P>0,05) entre les deux sites pour le même métal. Les résultats obtenus montrent que les teneurs en métaux lourds dans les sédiments et dans l'organisme de *P. cultrifera* à Skikda sont plus élevées par rapport à celles d'El-Kala avec une différence significative. Le site de Skikda s'avère plus contaminé par les polluants métalliques que celui d'El-Kala. *P. cultrifera* semble accumuler le Cd et Zn plus que les autres Elements traces Mettalique .

Tab. 2. Teneurs (mg/g) des métaux lourds dans les sédiments et dans l'organisme de Perinereis cultrifera au niveau des deux sites de janvier à juin 2014 (m ± S).

Site		Cd	Cu	Pb	Zn	Fer
El-Kala	**sédiment (n=3)**	0,0033 ± 0,0001 A	0,008 ± 0,002 A	0,091 ± 0,006 A	0,107± 0,003 A	0,38± 0,087 A
	P. cultrifera **(n=4)**	0,0036 ± 0,000 A	0,0045 ± 0,002 A	0,084 ± 0,015 A	0,298 ± 0,001 A	0,619 ± 0,025 A
Skikda	**Sédiment (n=3)**	0,0043 ± 0,0001 D	0,023 ± 0,002 B	0,139 ± 0,003 D	0,228 ± 0,002 D	3,649 ± 0,080 D
	P.cultrifera **(n=4)**	0,0045 ± 0,000 C	0,008 ± 0,001 B	0,114 ± 0,012 B	0,455 ± 0,023 B	0,66 ± 0,010 D

References

1 - Rayms-Keller A., Olson K. E., Mcgaw M., Oray C., Carlson J. O. & Beaty B. J., 1998. Effect of Heavy Metals on Aedes aegypti (Diptera: Culicidea) Larvae. Ecotoxicology and Environmental Safety, 39: 41-47.

2 - Ermosele C. O., Ermosele, I. C., Muktar S. A. & Birdling S. A., 1995. Metals in fish from the upper Benue River and Lakes Geryo and Njuwa in Northern Nigeria. Bulletin of Environmental Contamination and Toxicology, 54: 8-14.

3 - Chapman P. M. & Wang F., 2001. Assessing sediment contamination in estuaries. *Environ. Toxicol. Chem.*, 20 (1): 3-22. Grübe E., 1840. Actinien Echinodermen und Würmer des Adriatischen und Mittelmeers. *J. H. Bon, königsberg*,92 p.

4 - Grübe E., 1840. Actinien Echinodermen und Würmer des Adriatischen und Mittelmeers. *J. H. Bon, königsberg*,92 p.

5 - AFNOR, *Recueil des normes françaises*, Qualité des sols, AFNOR Edition, (1994), 250 p.

6 - Descamps M., Fabre MC. ,Grelle S . ,Gerrard S.,1996 Cadmium and Lead Kineties During Experimental Contamination and Decontamination of the Centipede Lithobitus Forficatus L ., Arch.Envir.Contam.Toxicol.(31) : 350-353.

TRACE METALS IN SOFT TISSUE OF MARINE BIVALVE NOAH'S ARK (*ARCA NOAE*) FROM BIZERTE LAGOON (NORTHERN TUNISIA)

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Abstract

This study aimed to monitor the bioaccumulation of 5 trace elements (TEs: Zn, Fe, Cu, Cd, and Pb) in the soft tissue of the Ark shell (*Arca noae*), seasonally sampled in Bizerte lagoon, northern Tunisia, in order to assess the nutritional quality of this bivalve and to promote its consumption as marine resource in Tunisia. The levels of all trace metals analyzed in *Arca noae* are below maximum admissible level which makes this species a healthy and safe food for human consumption.

Keywords: Bio-accumulation, Trace elements, North-Eastern Mediterranean

Introduction

Bizerte lagoon is one of the most studied coastal areas in Tunisia, and is used for shellfish production since 1964. It is permanently connected to the Mediterranean Sea by a straight channel of 8.5 km long and communicates also with the Ichkeul Lake (110 km^2) through the Tinja channel (Fig.1). The Bizerte lagoon inhabit a wide diversity of marine invertebrates, among them the valuable shellfish Noah's ark. But like any benthic invertebrates, that mollusk may accumulate trace elements whether essential or not, which cause toxic effects above threshold levels. The number of papers studying the accumulation of trace metals in *Arca noae* worldwide is limited [1] [2].

Materials and Methods

Ten specimens of Ark shell of commercial size (46.23-65.08 mm) were collected monthly from Bizerte lagoon (Fig. 1) at 3 meter depth by scuba diving from October 2013 to September 2014. The sampling site was located far from urban and industrial sources of pollution, but remained influenced by agricultural inputs. TE concentrations were measured in the mollusk flesh by inductively coupled plasma mass spectrometry (ICP-MS). TE concentrations were averaged by seasons and significant seasonal differences between mean TE levels were highlighted through non-parametric analysis of variance (Kruskal–Wallis test) followed by Dunn pairwise comparison test of means ($p < 0.05$). Statistical analysis were performed using STATISTICA 8 (StatSoft Inc.).

Results & Discussions

Mean seasonal TE levels in *A. noae* flesh (mean ± SD, in mg kg_{ww}^{-1}) are given in Table 1. TE concentrations decreased in the following order: Zn > Fe > Cu > Pb > Cd. Essential (e.g. Zn) TEs were accumulated at higher levels than non-essential toxic ones (e.g. Pb, Cd). Significant differences ($p < 0.05$) were observed between mean seasonal TE concentrations in *A. noae* flesh, the highest values of all trace elements being recorded during summer 2014 and autumn 2014 (warmer compared to autumn 2013) and the lowest ones during winter 2014 (Table. 1). The winter period in Bizerte lagoon being characterized by the increase of provision in rainwaters washing out the agricultural bordering lands and enriching the lagoon on various pollutants (pesticides and heavy metals) [3] [4], higher TE levels were expected in ark flesh for that season. But since results showed the opposite trend, we assume that the strong surface water currents specific to Bizerte lagoon rapidly diluted and exported TEs brought through water runoff and river discharge that were consequently not bioaccumulated at higher levels in *A. noae* flesh. Food safety standards have been set for metals in bivalves by Food and Agricultural Organization (FAO) of United Nations. The food standards for bivalves set by the FAO [5] are 10.0-30.0, 40.0-100.0, 2.0 and 1.0-6.0 mg $kg_{ww}^{-1}$for Cu, Zn, Cd and Pb, respectively. The derived wet weight based-concentrations of all metals in *Arca noae* from the present study were well below their respective food standards. This result is very encouraging from an economic point of view to enable future commercial exploitation of *A. noae* in our country.

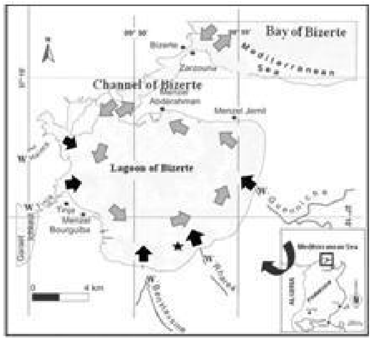

Fig. 1. Map of Bizerte lagoon (Northern Tunisia). The black full star in the Southern part of the lagoon shows the sampling site location.

Tab. 1. Seasonal mean Trace element (TEs) concentrations (mean ± SD, in mg kg_{ww}^{-1}) in *A. noae* flesh(n=40) (Letters indicate significant differences (p < 0.05) between seasons).

	Autumn 2013	Winter 2014	Spring 2014	Summer 2014	Autumn 2014
Zn	$37,44^{a}$±4.52	$42,02^{a}$±5.32	$42,23^{b}$±4.61	$42,41^{b}$±3.79	$75,02^{c}$±20.12
Fe	$36,81^{b}$±8.688	$33,20^{b}$±5.819	$30,06^{b}$±2.504	$45,73^{c}$±17.48	$46,94^{c}$±0.00
Cu	$1,06^{b}$±0.19	$0,97^{a}$±0.08	$1,26^{c}$±0.17	$1,56^{c}$±0.14	$1,12^{b}$±1.16
Cd	$0,14^{a}$±0.00	$0,20^{b}$±0.03	$0,21^{b}$±0.03	$0,23^{b}$±0.05	$0,31^{c}$±0.42
Pb	$0,29^{b}$±0.17	$0,13^{a}$±0.01	$0,28^{b}$±0.26	$0,48^{c}$±0.43	$0,40^{c}$±0.44

;

References

1 - Papadopoulu, 1973 in Eisler 2010. Compendium of trace metals and marine Biota, Elsevier, Amsterdam.

2 - Cuculic, V., Cukrov, N., Kwokal, Z., Mlakar, M. 2010. Trace metals in bivalves soft tissues from Mljet national park aquatorium, Croatia.*Rapp.Comm.int.Medit.,39,2010.*

3 - Kamel, N., Bourgeot, T., Banni, M., Chalghaf, M., Devin, S., Minier, M., Boussetta, H. 2014. Effects of increasing temperature on biomarker responses ans accumulation of hazardous substances in rope mussels (*Mytilus gallopranvinciallis*) from Bizerte lagoon. *Env Sci Poll., Vol. 21, Issue 9, pp. 6108-6123.*

4 - Mahmoud, N., Dellali, M., El bour M., Aissa, P., Mahmoudi, E. 2010. The use of *Fulvia fragilis* (Mollusca: cardiidae) in the biomonitoring of Bizerta lagoon : a multimarkers approach. *Ecol. Indi. 10. pp 696-702.*

5 - FAO. 1983. Compilation of legal limits for hazardous substances in fish and fishery products. *FAO fishery circular vol. no. 464, pp. 5-100.*

INVESTIGATION OF PESTICIDE RESIDUES AND SOME NATURAL RADIONUCLIDE ACTIVITY CONCENTRATIONS IN MUSSEL AND SOME FISH SAMPLES FROM IZMIR BAY, TURKEY

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Abstract
In this study, the activity concentrations of ^{210}Po and ^{210}Pb and pesticide residues were determined in mussel samples (*Mytilus galloprovincialis*) and fish samples (*Mullus barbatus, Solea solea, Engraulis encrasicolus, Sardina pilchardus,* and *Mugil cephalus*) collected from Izmir Bay. The highest ^{210}Po activity concentrations in anchovy and mussel were measured in winter. The study suggests that the historical organochlorine pesticides pollutants are persistent in this area.

Keywords: Fishes, Izmir Bay, Mollusca, Pesticides, Radionuclides

In this study we used the mussel (*Mytilus galloprovincialis)* and fish (*Mullus barbatus, S.solea, Engraulis encrasicolus, Sardina pilchardus, and Mugil cephalus)* samples collected seasonally from Izmir Bay (Figure 1) and analyzed for their ^{210}Po, ^{210}Pb and pesticide content.

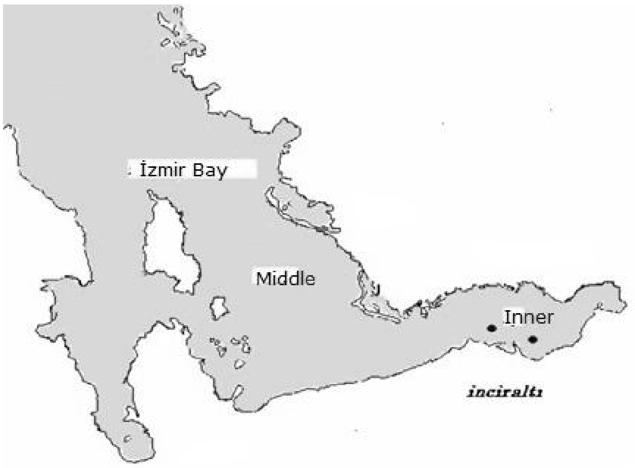

Fig. 1. The sampling stations.

^{210}Po and ^{210}Pb activity concentrations were measured by using an alpha spectrometry system (Ortec Octete Plus spectrometer). The analyses of environmentally persistent pollutants like polychlorinated biphenyls (PCBs), Organochlorine pesticides (OCP) and dichlorodiphenyltrichloroethane (DDT) and its metabolites in surficial fish and mussel *(Mytilus galloprovincialis)* samples collected from in Izmir were carried out using gas chromatograph and were confirmed with mass spectrometry [1].

The concentration of ^{210}Po in fish samples varied from 5.7±4.0 Bqkg^{-1} to 353.7±45.0 Bq kg^{-1} dw. The activity concentrations of ^{210}Po in mussels (*M. galloprovincialis*) determined to vary between 50±16 Bq kg^{-1} and 122±26 Bq kg^{-1} dw. The highest ^{210}Po activity concentrations in anchovy and mussel were measured in winter. The concentration of ^{210}Pb in fish samples varied from 0.7±0.3 Bq kg^{-1} to 3.6±3.0 Bq kg^{-1} dw. The activity concentrations of ^{210}Pb in mussels (*M. galloprovincialis*) determined to vary between 1.8±0.4 Bq kg^{-1} and 4.2±0.4 Bq kg^{-1} dw.

The median concentrations of the residues in all the samples tested, ranged from 4-4'DDE 0.001 to 0.021 mg/kg. The highest residue levels of pesticides in the winter period anchovies were found in 4-4'DDE 0.021 mg/kg. The study suggests that the historical organochlorine pesticides pollutants are persistent in this area.

References

1 - Aktumsek, A., Kara, H., Nizamlioglu, F., Dinc, I., 2002. Monitoring of Organochlorine Pesticide Residues in Pikeperch, Stizostedion lucioperca L., in Beysehir Lake (Central Anatolia). Environmental Technology, 23: 391-394.

ELEMENTAL COMPOSITION OF BODY PARTS OF *HOLOTHURIA TUBULOSA*

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Abstract

Trace and major elements found in body parts of *Holothuria tubulosa*, which is economical and environmental important sea cucumber species, was determined. Data were collected in winter season and given in average at findings.

Keywords: Trace elements, Dardanelles, Monitoring, Metals, Bio-accumulation

Introduction

Sea cucumbers are economically livings which can take a high proportion in daily diet in Asian countries. Alongwith this, sea cucumbers are carrying an important role in ecological balance [1]. They live in bed of seas and mostly consume debris and degrading biological components [2]. Sea beds are recognized as reservoir of most chemical pollutants much more than sea waters [3]. In this case sea cucumber is an important indicator organism which can directly show us the information of metal contamination of seas. *Holothuria tubulosa* is one of the most abundant economic sea cucumber species found in Turkey seas.This species are mainly caught by scuba in Aegean and Marmara Seas and exported to Asian countries. This study summarizes the elemental composition of sea cucumber which indicates safety of products and pollution level of Çanakkale Strait sediment.

Materials and Methods

Holothuria tubulosa species were collected by scuba up to 15 meters depth from Southern Coasts of Çanakkale Strait in February 2015. Samples were divided into three groups and their body wall and viscera separated as body parts. Body walls were directly weighted and blended for analysis. Viscera of sea cucumberswere first separated from their mud-sands found in their intestinal. Then washed viscera were weighted and homogenized for analysis. The element analysis was done according to method of EPA [4-5].

Results and Discussion

Silver, bismuth, molybdenum, tungsten were lower than to detection limits in both parts of sea cucumber. While aluminum, lead and titanium were not found in body wall samples, arsenic and antimony couldn't detected in viscera samples. Silicon was found to be most abundant trace element at the level of 91136,02 µg/kg. Iron and aluminum were highest levels after silicon at the levels of 40008,74 µg/kg and 29703,88 µg/kg respectively (Table 1).

Tab. 1. Elemental composition of sea cucumber body parts

Element	Symbol	Units	Body Wall	Viscera
Silver	Ag	µg/kg	<6,89	<6,89
Aluminum	Al	µg/kg	<0,49	29703,88±3019,67
Arsenic	As	µg/kg	475,98±22,99	<1,38
Boron	B	µg/kg	2726,46±156,30	1178,33±67,78
Bismuth	Bi	µg/kg	<10,43	<10,43
Cadmium	Cd	µg/kg	69,70±6,80	208,50±13,96
Cobalt	Co	µg/kg	20,68±1,90	117,86±6,15
Chromium	Cr	µg/kg	86,76±2,09	285,16±14,89
Copper	Cu	µg/kg	839,69±35,03	963,40±32,41
Iron	Fe	µg/kg	548,20±26,10	40008,74±2247,34
Manganese	Mn	µg/kg	81,74±4,80	1092,78±36,01
Molybdenum	Mo	µg/kg	<7,37	<7,37
Nickel	Ni	µg/kg	56,27±4,22	550,12±8,37
Lead	Pb	µg/kg	<17,00	2115,25±135,66
Platinum	Pt	µg/kg	4,98±0,25	162,51±10,99
Antimony	Sb	µg/kg	17,38±1,49	<6,01
Selenium	Se	µg/kg	306,77±5,93	180,54±11,75
Silicon	Si	µg/kg	9861,49±253,31	91136,12± 4789,22
Tin	Sn	µg/kg	554,57±14,29	325,67±11,96
Titanium	Ti	µg/kg	<1,20	1105,40±60,60
Tungsten	W	µg/kg	<10,09	<10,09
Zinc	Zn	µg/kg	2173,60±154,76	5277,24±208,98
Mercury	Hg	µg/kg	175,99±8,06	122,42±4,45
Phosphorous	P	mg/kg	48,75±2,88	202,28±9,40
Sulfur	S	mg/kg	543,48±24,48	540,73±11,45
Sodium	Na	mg/kg	3902,93±78,37	1212,46±69,67
Magnesium	Mg	mg/kg	431,24±13,97	189,26±6,37
Potassium	K	mg/kg	443,64±20,04	80,16±5,20
Calcium	Ca	mg/kg	2807,70±74,74	460,47±29,79

In general, it was observed that viscera of *Holothuria tubulosa* accumulate elements more than body wall. Nearly all detectable trace elements were found higher levels in viscera samples than body wall samples. Main reason of this can be explained with feeding behavior of sea cucumber. Consuming sediment components such as bacteria, microalgae and dead organic matter of plant and animal origin is thought to be major reason of this situation.

Conclusion

Sea cucumbers are good indicator of sea pollution due to their life style and feeding behavior. The element levels given in this study were found to be in normal ranges, however, some of dangerous metals should be closely monitored.

References

1 - Birkeland C., 1988. The influence of echinoderms on coral-reef communities. *In:* Jangoux M. and Lawrence J.M. (eds.), Echinoderm Studies. Balkema, Rotterdam, pp 1–79.
2 - Uticke S., 2001. Nutrient regeneration by abundant coral reef holothurians. *J. Exp. Mar. Biol. Ecol*., 265:153-170.
3 - Bryan G.W. and Langston W.J., 1992. Bioavailability, accumulation and effects of heavy metals in sediments with special reference to United Kingdom estuaries: a review. *Environ. Pollut.*, 76:89-131.
4 - EPA, 1998. Microwave assisted acid digestion of sediments, sludges, soils, and oils. Method 3051A. http://www.epa.gov/sites/production/files/2015-12/documents/3051a.pdf (visit date Dec. 2015)
5 - EPA, 2000. Inductively coupled plasma - mass spectrometry. Method 6020A. http://www.epa.gov/sites/production/files/2015-07/documents/epa-6020a.pdf (visit date Dec. 2015).

EVALUATION DE LA CONTAMINATION PAR LES MÉTAUX TRACES DU PAGEOT (*PAGEOT ERYTHRINUS)* ET DU ROUGET DE VASE (*MULLUS BARBATUS*) DU GOLFE DE GABÈS.

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Abstract
Le golfe de Gabès constitue la zone maritime la plus importante de la Tunisie. Depuis les années 80, nous observons une perturbation de cet écosystème par les rejets déversés par les industries implantées dans les régions de Sfax, de Gabès et de Skhira. Les métaux traces sont des composés rejetés dans ce milieu et qui peuvent s'accumuler au niveau des poissons qui y vivent. Dans cette étude, nous avons évalué les teneurs du Cd et du Hg au niveau du muscle et du foie de deux poissons benthiques : le Rouget de Vase (*Mullus barbatus*) et le Pageot (*Pageot erythrinus)* et ceci afin d'identifier l'espèce qui accumule davantage les éléments étudiés ainsi que l'organe. Les résultats ont montré que le Pageot accumule davantage les métaux étudiés que le Rouget de Vase et que le foie est le site préférentiel d'accumulation du Cd et du Hg.

Keywords: Bio-accumulation, Tunisian Plateau, Cadmium, Fishes, Mercury

Introduction
Le golfe de Gabès constitue un écosystème marin de haute importance économique grâce à sa richesse halieutique. Durant ces dernières décennies, les polluants issus des activités anthropiques exercent une pression croissante sur l'environnement de ce golfe. Les métaux sont parmi les éléments rejetés dans ce milieu marin. Les poissons benthiques sont en relation étroite avec le sédiment, qui est considéré comme réservoir majeur des polluants dans le milieu marin, accumulent davantage les métaux traces que les espèces pélagiques [1]. Ceci nous a incité à étudier l'accumulation de deux métaux toxiques (le Cadmium (Cd) et le Mercure (Hg)) au niveau de deux tissus (muscle et foie) du Rouget de vase (*Mullus barbatus*) et du Pageot (*Pageot erythrinus*) du golfe de Gabès.

Matériel et Méthodes
Les échantillons du Rouget de Vase et du Pageot ont été pêchés durant l'année 2013. Chaque poisson va subir une dissection afin de prélever le foie et des morceaux de chair sur les flancs du côté dorsal. L'analyse du Cd a été réalisée par Spectrophotométrie d'Absorption Atomique à four graphite. Pour le Hg elle a été réalisée à l'aide d'un analyseur directe.

Résultats et Discussion
L'étude de la variation des concentrations des métaux toxiques (Cd et Hg) dans les organes du Rouget de Vase et du Pageot a montré que ce dernier accumule davantage les métaux toxiques considérés et que le foie est le site d'accumulation préférentiel chez les deux espèces étudiées.

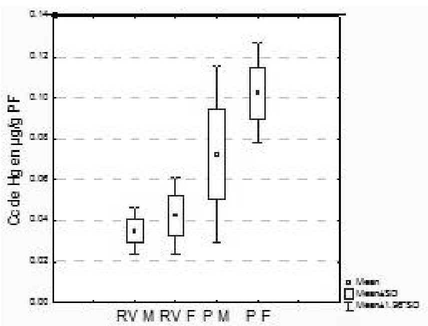

Fig. 1. Concentration du Hg dans le Rouget de Vase et le Pageot.

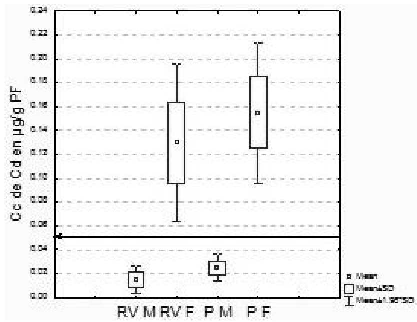

Fig. 2. Concentration du Cd dans le Rouget de Vase et le Pageot.

Certains auteurs ont démontré [2] [3] que la cause principale de l'accumulation des métaux chez les poissons est l'alimentation. Le Pageot,espèce carnivore, accumule davantage le Cd et le Hg au niveau de ses tissus. En effet, ce poisson est considéré comme espèce prédatrice d'animaux benthiques. Son régime alimentaire est principalement constitué de Polychètes, de Crustacés et d'Echinodermes [4]. Le Rouget de Vase est une espèce démersale, se nourrissant principalement d'épi et d'endo organismes benthiques [5]. Les concentrations maximales du Cd et du Hg dans le muscle du Rouget de Vase et du Pageot sont nettement inférieures à la norme tunisienne. Donc, le muscle qui est la principale partie du poisson consommée par l'homme, des deux poissons étudiés ne présente pas un risque sur la santé du consommateur.

Conclusion
D'après cette étude, le Pageot du golfe de Gabès accumule davantage le Cd et le Hg que le Rouget de Vase. Toutefois, les teneurs maximales enregistrées au niveau du muscle des deux espèces ne présentent aucun risque vis-à-vis du consommateur.

References
1 - Kljakovic Gaspic Z., Zvonaric T., Vrgoc N., Odzak N. and Baric A., 2002.Cadmium and lead in selected tissues of two commercially important fish species from the Adriatic Sea. *Water Research.,* 36 : 5023-5028.
2 - Fowler SW. 1986.,Trace metal monitoring of pelagic organisms from the open Mediterranean Sea. *Environ Monitor Asses.,* 7:59-78.
3 - Romeo M. and Amiard J.C., 1992.Devenir et effets des éléments traces chez les organismes marins. *Analysis Magazine.,* 20 : 42-44.
4 - *Bouain A. and Ghorbel M., 1991 . Régime alimentaire du Pageot, Pagellus Erythrinus, du golfe de Gabès. Bull. Inst.Natn.Scient.Tech.de la Mer.,* 18 : 39-54.
5 - Jardas I. 1996.,Adriatic ichtiofauna (original in croatian). *Skolska knjiga Zagreb, Zagreb, 536pp.*

INVESTIGATION OF RELATIONSHIP BETWEEN ^{210}PO AND ACCUMULATION OF MALONDIALDEHYDE (MDA), PROLIN AND H_2O_2 IN MUSSELS AND COMMON SOLE

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Abstract

In this study, mussels (*Mytilus galloprovincialis*) and fish (*Solea solea*) were collected seasonally in Inciralti, Izmir, Turkey. ^{210}Po, malondialdehyde (MDA), H_2O_2 and prolin levels were investigated in different tissues (gills, hepatopancreas and muscle) of mussels and fish. The highest activity concentrations of ^{210}Po were found as 75 ± 3 and 252 ± 14 Bq kg^{-1} in hepatopancreas of mussels and fish, respectively. The highest levels of MDA, H_2O_2 and prolin in mussels and common sole were also measured in hepatopancreas. These levels were determined between 50-150 nmol g^{-1} fw, 16-40 µmol g^{-1} fw and 300-370 µmol g^{-1} fw for MDA, H_2O_2 and prolin in mussels and fish in hepatopancreas, respectively.

Keywords: Aegean Sea, Fishes, Radionuclides, Mollusca

The objectives of the study are to obtain concentration data on ^{210}Po in liver and gills of mussels (*M. galloprovincialis*), and fish (*Solea solea*) and to determine the seasonally correlation between the concentrations of ^{210}Po and lipid peroxidation (LPO), hydrogen peroxide (H_2O_2) and prolin levels as oxidative stress bio-markers.

Aegean region is highly industrialized and there exist many large cities. Furthermore, there are intense agricultural activities with dense use of fertilizer and many rivers (Bakirçay, Gediz and Menderes) and stream carrying industrial and agricultural residues into the sea. The main industries in the region are food processing, oil, soap and paint production, chemical industries, paper and pulp factories, textile industries, and metal processing (Kontas et al., 2004; Kucuksezgin et al., 2006).

The mussel and fish samples were collected seasonally from 2008 to 2009 at Inciralti station, Izmir (Figure 1).

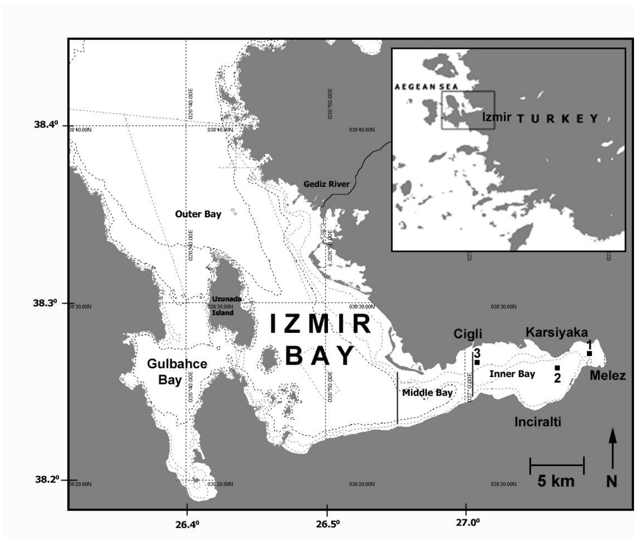

Fig. 1. The sampling station

The radioachemical procedure for mussel samples is given elsewhere (Ugur, 2011). Measurements of ^{210}Po were realized by its 5.30 MeV alpha particle emission, using ^{209}Po as the internal tracer. Polonium was spontaneously plated onto silver discs in 0.5 M HCl in the presence of ascorbic acid to reduce of Fe^{3+} to Fe^{2+}. Polonium alpha activities were measured by Ortec Octete Plus spectrometer. Proline content was determined according to the modified method of Bates et al. (1973). The hydrogen peroxide content was determined according to Jana and Choudhuri (1981). MDA content was determined spectrophotometrically as described by Heat and Packer (1968).

For mussels, the highest ^{210}Po and H_2O_2 activities were found in winter, while the highest LPO and prolin levels were found in spring.

In this study, in winter period it was observed that stress indicating parameters was lower than expected. This result can be attributed that the detoxification mechanisms are more active in this period.

For fish, the highest ^{210}Po activities were found in winter, while the highest LPO and prolin levels were found in spring. In liver the H_2O_2 levels are higher in spring than in winter. In gills the H_2O_2 levels are higher in winter than in spring. In conclusion, this is the first study on the relationship between the ^{210}Po levels and stress parameters in mussels and fish collected from Inciralti, Izmir, Turkey. In addition to the stress parameters we measured, it could be useful to evaluate the antioxidant enzymes activities, PCBs, PAH, phenols and heavy metal levels in the mussel and fish samples from Inciralti. Madeira et al. (2013) found that the relationship between the lipid peroxidation and temperature changes due to the fish species, therefore for future studies it would be benefical to investigate this parameter.

References

1 - Bates, L.S., Waldren, R.P. and Teare, I.D, 1973. Rapid determination of free proline for waterstress studies. Plant Soil. 39:205-207.

2 - Heat, R.L. and Packer, L, 1968. Photoperoxidation in isolated chloroplasts. I. Kinetics and toichiometry of fatty acid peroxidation. Arch. Biochem. Biophys. 125:189-198.

3 - Jana, S. and Choudhuri, M.A., 1981. Glycolate metabolism of three submerged aquatic angiosperms during aging. Aquat Bot. 12:345-354.

4 - Kontas, A., Kucuksezgin, F., Altay, O., Uluturhan, E., 2004. Monitoring of eutrophication and nutrient limitation in the Izmir Bay (Turkey) before and after Wastewater Treatment Plant. Environmental International, 29: 1057-1062.

5 - Kucuksezgin, F., Kontas, A., Altay, O., Uluturhan, E., Darilmaz, E., 2006. Assessment of marine pollution in Izmir Bay: Nutrient, heavy metal and total hydrocarbon concentrations. Environment International, 32: 41-51.

6 - Madeira, D., Narciso, L., Cabral, H.N., Vinagre, C., Diniz, M.S., 2013. Influence of temperature in thermal and oxidative stress responses in estaurine fish. Comparative Biochemistry and Physiology, Part A. 166:237-243.

7 - Ugur, A., Özden, B., Filizok, I., 2011. Spatial and temporal variability of ^{210}Po and ^{210}Pb in mussels (*Mytilus galloprovincialis*) at the Turkish coast of the Aegean Sea. Chemosphere, 83: 1102-1107.

CIESM Congress Session : Bioaccumulation - monitoring assessment

Moderator : Elke Fries, Osnabrück Univ., Germany

Moderator's Synthesis

This session focused on the monitoring of environmental pollution by using biota. In relation to natural and anthropogenic sources metals, radionuclides and organic xenobiotics occur ubiquitously in the environment. Such compounds tend to accumulate in organisms living in polluted environments.

Important data and results were presented for the occurrence of Pb, Cd, Cu, Zn, As, Fe, Mn, Al, Hg, Ni, PCB, DDT and 210PO in marine sediments and a variety of marine species. In the case of metals it is useful to consider the dependence of compounds´ bioavailability according to different speciation. Compounds that are key elements in the metabolism of organisms (e.g. Cu) appear less appropriate for biota monitoring since their concentrations are mainly controlled by the organisms themselves.

The need of a continuous biota monitoring in the marine environment of Mediterranean countries like Greece, Turkey, Tunisia and Algeria was highlighted during the session several times. In this context, the added value of linking biota monitoring and chemical surveys was mentioned. It was remarked that background contamination of soils and sediments should be determined at regional scales by taking into account the geological situation. Finally, the combination of monitoring and fate modeling was seen as a powerful tool to an integrated assessment of the quality status of the marine environment, without losing track of the damaging aspects of bioaccumulation.

CONTAMINATION OF HEAVY METALS IN *MULLUS BARBATUS* LINNAEUS, 1758 FROM THE SOUTHERN OF THE BLACK SEA COASTS AND POTENTIAL RISKS TO PEOPLE HEALTH

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Abstract
The aim of this study is to conduct a health risk of Al, As, Cu, Zn, Hg, Fe, Cd, Pb, Mn and Ni attributed to consumption of common edible fish *Mullus barbatus* available for consumers. The estimated weekly and daily intakes showed that the heavy metals in Red mullet have no health problems for consumers.

Keywords: Metals, Black Sea

Introduction
The coasts of the Black Sea, Turkey are important fish source for people. The Black Sea is impacted principally by anthropogenic activities. The pollution of heavy metals is a serious threat because of their toxicity, long persistence, bioaccumulation and bio-magnifications in the food web. Heavy metals are accumulated in fish therefore can be transferred to people as a consumer. Marine Strategy Framework Directive of European Union (MSFD-EU) is also focused on the concentrations of heavy metals in fish in order to check for those hazards for human health [1]. Nowadays, fishing is still largely conducted by fishermen from the Black Sea coast of Turkey. The metal contamination in the coastal water can be harmful to human health, it is necessary to understand the hazard levels of pollution in seafood particularly in fish. *M. barbatus* is highly commercial fish and preferred consumed in the southern of the Black Sea and it is marketed mainly fresh. This study, therefore, was to evaluate their hazard level in relation to the maximum residual limit for people consumption.

Material and methods
Red mullet were caught from the southern coasts of the Black Sea during fishing season in 2014 among four sampling stations namely Igneada, Sinop, Samsun and Trabzon coast of the Black Sea (Fig. 1). Metal analysis in muscles of fish was performed using m-AOAC 999.10- ICP/MS (Inductively Coupled Plasma – Mass Spectrometer) method by accredited ÇEVRE Industrial Analysis Laboratory Services Trade Company (TÜRKAK Test TS EN ISO IEC 17025 AB-0364-T). EN 15763 European Standard methods was applied.

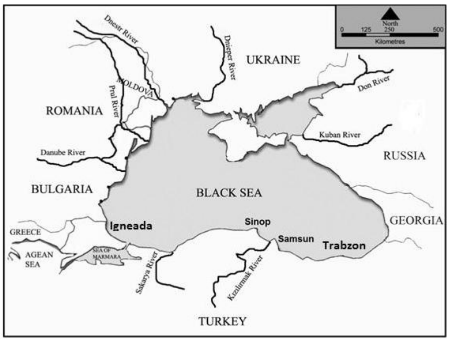

Fig. 1. Study area.

Results and Discussion
There are high levels of Zn at a significant level ($P<0.05$) in Red mullet, followed by the Fe. Hg, Cd, Pb and Al in the muscles were below the detection limits from all stations (0.02 for Hg; 0.05 for Cd; 0.05 for Pb and 0.5 for Al). Rest of the metal values are below the limitations for the fish tissues [2,3]. Cu (1.73 mg/kg wet wt.), As (0.39 mg/kg wet wt.), Zn (9.4 mg/kg wet wt.) and Ni (1.35 mg/kg wet wt.) levels in the Red mullet from Trabzon coast were higher than those in other coasts of cities from the southern of the Black Sea. Whereas Fe (7.2 mg/kg wet wt.) and Mn (1.78 mg/kg wet wt.) levels in Samsun coast were high. Cu, As, Fe and Mn levels were found 0.69, 0.09, 2.8 and 0.66 mg/kg wet wt., respectively in Red mullet of Sinop coasts, except Zn (6.1 mg/kg wet wt.) and Ni (0.61 mg/kg wet wt.). Minimum Zn 5.6 mg/kg wet wt.) and Ni (0.47 mg/kg wet wt.) levels were determined in fish from Igneada. Average daily and weekly intakes of metals per person was estimated on the basis of the concentrations measured in fish muscle and daily fish consumption rate (17.3 g/day for Turkey, this is equivalent to 121.1 g/week) [4] and presented in Table 1. Average Turkish body weight was assumed to be 70 kg. The values of EDI and EWI for metals in muscles of Red mullet are well below their corresponding permissible tolerable daily intake for 70 kg person values. In case of consumption of Red mullet from the southern of the Black Sea is no risk of people's health.

Tab. 1. Estimated Weekly Intakes (EWI) and Estimated Daily Intakes (EDI) of heavy metals in edible tissues of Red mullet from the southern Black Sea coasts [5].

Metals	PTWI[a]	PTWI[b]	PTDI[c]	EWI[d]	EDI[e]
Zn	7	490	70	0.678-1.138	0.097-0.163
Fe	5.6	392	56	0.339-0.872	0.048-0.124
Mn	2-5	140-350	20-50	0.080-0.216	0.011-0.031
Ni	0.035	2.45	0.35	0.057-0.163	0.008-0.023
Cu	3.5	245	35	0.084-0.210	0.012-0.030
As	0.015	1.05	0.15	0.011-0.047	0.002-0.007
Pb	0.025 [f]	1.75	0.25	Below Detection Limit	
Cd	0.007 [g]	0.49	0.07	Below Detection Limit	
Al	1	70	10	Below Detection Limit	
Hg	0.004	0.28	0.04	Below Detection Limit	

[a]PTWI (Provisional Tolerable Weekly Intake) in mg/week/70 kg body wt.
[b]PTWI for 70 kg adult person (mg/week/70 kg body wt.)
[c]PTDI (Permissible Tolerable Daily Intake) (mg/day/70 kg body wt.)
[d]EWI (Estimated Weekly Intake) (mg/week/ kg body wt.)
[e]EDI (Estimated Daily Intake) (mg/day/ kg body wt.)
[f]The current PTWI of 0.025 mg/kg body wt. is no longer be considered health protective.
[g]The Committee withdrew the PTWI of 0.007 mg/kg body wt. and established a PTMI of 0.025 mg/kg body wt.

Conclusion
It is well known that fish species in polluted coastal regions may accumulate substantial metals in their tissues which sometimes exceeded the maximum acceptable levels. Red mullet were not contaminated with the heavy metals which are below the maximum tolerable levels of EU standards. However monitoring of coastal waters following the MSFD is a requirement for further heavy metal contamination control that affects the aquatic life of the fish from the Black Sea.

References
1 - Official Journal of the European Union. Directive 2008/56/EC of the European Parliament and of The Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (MSFD).
2 - Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs.
3 - Official Journal of the European Union Directive 2013/39/EU of The European Parliament and of the council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.
4 - TUIK, Turkish Fishery Statistics. 2015. Available from: http://www.tuik.gov.tr/
5 - WHO 2011. Evaluation of certain food additives and contaminants: seventy-third report of the Joint FAO/WHO Expert. (no. 960). 2010, Geneva, Switzerland. Available from: http://apps.who.int/iris/bitstream/10665/44515/1/WHO_TRS_960_eng.pdf

UTILISATION DES HERBIERS DE POSIDONIES COMME BIO-INDICATEUR ET ARCHIVE DE LA POLLUTION MÉTALLIQUE MARINE AU NIVEAU DU GOLFE DE GABÈS, TUNISIE

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Abstract

Dans le présent travail, quatre métaux en trace (Cd, Cu, Pb et Zn) ont été analysés au niveau de trois tissus vivants (racines, rhizomes et feuilles) ainsi qu'à différents niveaux d'une carotte de matte morte (de 150 cm de longueur) de la plante marine *Posidonia oceanica*, échantillonnée au sud de la ville de Gabès. Les résultats des tissus vivants montrent que la majorité des métaux analysés (Cd, Cu et Zn) se concentrent surtout dans les feuilles ; tandis que le Pb semble s'accumuler surtout dans les racines. Les concentrations des quatre métaux analysés au niveau de la matte indiquent un gradient croissant en allant de la limite inférieure (-150 cm) vers la limite supérieure (-30 cm) de la carotte, mettant en évidence une étroite corrélation avec l'accroissement des quantités de phosphogypse rejetées en mer depuis 1972.

Keywords: Posidonia, Metals, Pollution, Gulf of Gabes

L'industrialisation rapide et non contrôlée qui s'est produite dans les années 1970, au niveau de la zone côtière de la ville de Gabès, a abouti au bouleversement considérable de l'environnement marin au niveau de la partie centrale du Golfe de Gabès. En effet, depuis l'installation du plus grand complexe chimique tunisien à Ghannouch, d'importants rejets industriels sont déversés directement en mer ouverte sans traitement préalable. Parmi ces rejets, le phosphogypse, un sous-produit de la fabrication d'acide phosphorique, constitue l'une des plus grandes menaces pour les écosystèmes côtiers vu sa composition chimique et les énormes quantités rejetées quotidiennement en mer (>10 000 tonnes/j). Cette étude a été menée dans ce contexte, afin d'évaluer le niveau de la pollution métallique et retracer son historique dans le Golfe de Gabès, en utilisant la phanérogame marine *Posidonia oceanica*. Des échantillons de racines, rhizomes et feuilles de cette plante ont été collectés à partir d'un herbier situé à Kettana, à 18 Km (vers le sud) de la source des rejets du complexe industriel de Gabès-Ghannouch. En parallèle, une carotte de 150 cm de long a été prélevée au niveau de la matte du même herbier. Les concentrations de quatre métaux en trace (Cd, Cu, Pb et Zn) ont été déterminées aussi bien au niveau des échantillons des différents tissus vivants qu'au niveau de la matte de *P. oceanica* par ICP-MS. Les résultats obtenus montrent que les fortes concentrations de Cd, Cu et Zn ont été enregistrées dans les feuilles de *P. oceanica*, alors que celle de Pb ont été notées au niveau des racines (Fig.1).

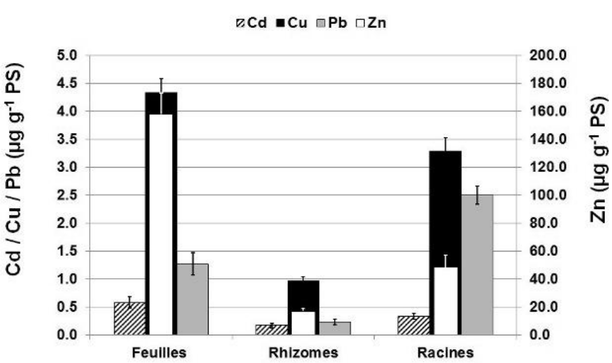

Fig. 1. Concentrations moyennes (± écarts-types) des métaux en trace (µg g^{-1} PS) analysés dans les différents tissus vivants (feuilles, rhizomes et racines) de *P. oceanica*, collectée de Kettana (partie centrale du Golfe de Gabès).

D'autre part, les teneurs en métaux de la matte morte ont indiqué une augmentation progressive en allant de la base (-150 cm) vers la surface (-30 cm) de la carotte, témoignant ainsi de l'accroissement de la contamination métallique de l'environnement marin au cours des dernières décennies suivant l'industrialisation de la zone côtière de Gabès (Fig.2).

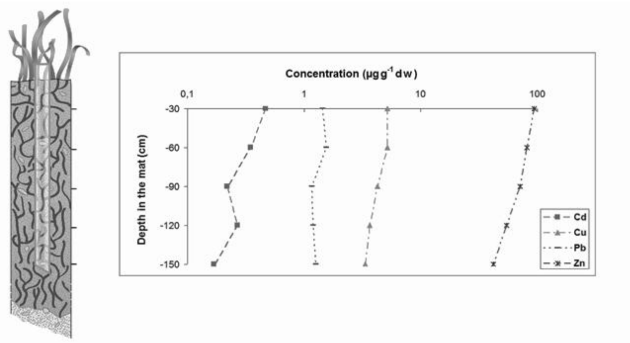

Fig. 2. Variations des concentrations (µg g^{-1} PS) des métaux en trace analysés le long de la carotte prélevée au niveau de la matte de *P. oceanica*, à Kettana (partie centrale du Golfe de Gabès).

Il apparaît que les rejets de phosphogypse, déversés directement en mer ouverte, constitue la source principale d'enrichissement du Golfe de Gabès en métaux, plus particulièrement au niveau de la partie centrale de cette région [1]. La présente étude confirme l'utilité de *P. oceanica* non seulement comme bio-indicateur de 'l'état de santé' de l'environnement marin mais aussi comme outil d'archivage de l'évolution des niveaux de contamination métallique des habitats côtiers.

References

1 - El Zrelli R., Courjault-Radé P., Rabaoui L., Castet S., Michel S. and Bejaoui N., 2015. Heavy metal contamination and ecological risk assessment in the surface sediments of the coastal area surrounding the industrial complex of Gabes city, Gulf of Gabes, SE Tunisia. *Mar. Poll. Bull.*, 101: 922-929.

ARSENIC SPECIATION AND ECOLOGICAL RISK ASSESSMENT IN MARINE SEDIMENTS OF IZMIR BAY, EASTERN AEGEAN SEA, TURKEY

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Abstract

Total arsenic, As(III) and As(V), Fe, and Mn were measured in 17 surface sediment samples from Izmir Bay. ΣAs ranged from 8.87 to 28.3 μgg^{-1} dry weight (96.5-99.9% as inorganic As). Arsenite (As(III)) was the most dominant form followed by As(V), while organic arsenic represented a minor constituent (0.03 to 3.49%). The highest concentration of ΣAs was observed at Gediz River estuary and exceeded threshold effects level (TEL). Besides, the levels of As were >TEL and <PEL at all stations, suggesting that As may not currently impose ecologically dangerous impacts in the sedimentary environment of Izmir Bay.

Keywords: Sediments, Chemical speciation, Geochemistry, Pollution, Izmir Bay

Introduction

Today, our knowledge of arsenic cycling and speciation in marine sediments is limited. Most studies of arsenic in sediments have centered on determining total arsenic concentrations and not the concentrations of arsenic species present. Both natural and anthropogenic sources of As have led to elevated levels in the environment [1]. Therefore, determining the level of As in sediment is an important method of assessing As contamination and risk in aquatic environments. Izmir Bay (Eastern Aegean) is one of the great natural bays of the Mediterranean Sea. The Gediz River, which flows into the outer part of Izmir Bay, is the second biggest river along the Eastern Aegean coast and includes extensive agricultural lands and numerous industrial areas. The objective of this study was to quantitatively estimate the distribution of As with its speciation, to evaluate factor(s) that affect spatial distribution of As and its species, and to assess potential risks for arsenic contamination in sediment samples. To the best of our knowledge, this is the first report on the characterization of As in sediments from the Eastern Aegean.

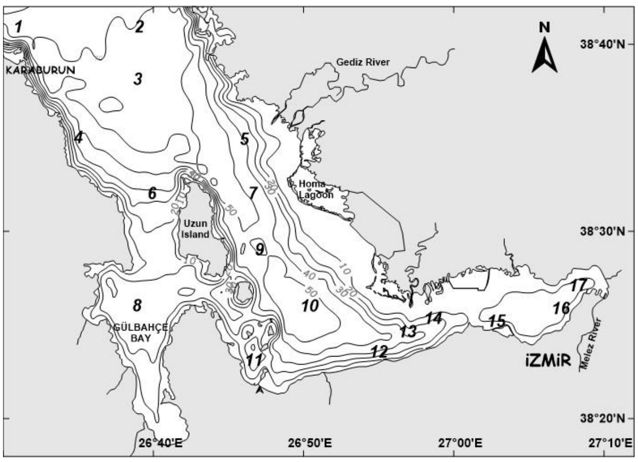

Fig. 1. Sampling stations in marine sediments from Izmir Bay

Material and Methods

In April 2014, sediment samples were collected from Izmir Bay using a Van-Veen Grab sampler. 17 sampling points were distributed along the Izmir Bay as shown in Figure 1. ΣAs concentrations were measured in ICP-MS. Accuracy of ICP-MS and validity of the processes tested with a reference material (IAEA-433). As(III), As(V) and organic arsenic concentrations were determined in sediment samples by ICP-MS, following the EPA 1632A method [2].

Results and Discussion

ΣAs concentrations in sediments are 8.87-28.3 μgg^{-1} dry wt. High levels of As at the mouth of the Gediz River suggested that discharge from this river was one of the major sources of anthropogenic input into Izmir Bay. The strong correlation between ΣAs concentration and Fe concentration ($p<0.01$, $r=0.79$) corroborated the hypothesis that natural sources of As were important. The present findings also endorse the phenomenon where inorganic As exclusively predominate in the sediments (98-100%), with only a trace amount of organic arsenic in all of the samples, suggesting a relatively low biotransformation due to microorganism activity. Moreover, due to the reducing conditions of the sediment, As(V) represented less than 26% of the ΣAs concentration, and As (III) was the predominant species, representing between 74 and 84% of ∑As present in sediments. ΣAs levels in the sediment were significantly and positively correlated with the levels of As(III), As(V), Fe, Mn, and clay ($p<0.01$), indicating that Fe, Mn, and clay retained As in the sediment. According to the established sediment quality guidelines [3], the levels of As were in the intermediate category (>TEL and <PEL) at all stations.

Conclusions

As(III) and As(V) were the most common arsenic species in sediments. The results showed that As(III) was the dominant species, which is more toxic and more mobile than As(V). Nevertheless, at the mouth of Gediz River, arsenic concentrations were higher than the other stations. Thus, it is possible that at least part of the arsenic in the Izmir Bay is also derived from anthropogenic sources due to Gediz River inputs. Eventually, it may be summarized that As will not impose ecologically hazardous impacts in the sedimentary environment of Izmir Bay at the present.

References

1 - Chilvers D.C. and Peterson P.J., 1987. Global cycling of arsenic. In: Hutchinson TC, Meema KM (eds) Lead, mercury, cadmium and arsenic in the environment. Wiley, New York, 279-301.
2 - EPA Method 1632A, 2001. Chemical speciation of arsenic in water and tissue by hydride generation quartz furnace atomic absorption spectrometry.
3 - National Oceanic and Atmospheric Administration (NOAA), 2004. Screening quick reference tables. Hazmat Report, vol. 99, no. 1. National Academy Press, Washington, 601.

BIOSURVEILLANCE SAISONNIERE DES METAUX TRACES A TRAVERS LA MOULE *MYTILUS GALLOPROVINCIALIS* DANS LE BASSIN SUD-OUEST MEDITERRANEEN (ALGERIE)

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Abstract
Ce travail vise à évaluer la qualité des eaux côtières du littoral méditerranéen occidental algérien, en utilisant une approche multi - marqueurs basée sur l'estimation des teneurs en métaux traces (Pb, Zn et Cu) chez la moule *Mytilus galloprovincialis*. Notre échantillonnage a été effectué dans trois sites au cours d'une année (décembre 2013 – août 2014). Les concentrations en ces métaux ont été déterminées par spectrophotométrie d'absorption atomique. Les résultats révèlent que le niveau de contamination des côtes algériennes par le Cu et le Zn est dans les normes. Par contre, nos résultats montrent que toutes les moules analysées sont contaminées par le Pb (concentrations 2 fois plus élevées que la limite recommandée).

Keywords: Monitoring, Bivalves, Trace elements, Metals, South-Western Mediterranean

Introduction
La présente étude porte sur l'évaluation des variations géographiques et saisonnières de la contamination métallique au niveau de la moule *Mytilus galloprovincialis.* Cette espèce a été sélectionnée pour sa capacité reconnue à bio-concentrer les métaux traces et ses qualités de bioindicateur de contamination métallique [1].

Matériels et méthodes
Zone d'étude, prélèvement et échantillonnage - Les sites de prélèvement sont localisés à Sidi Mejdoub, Willis (Mostaganem) et Bateau cassé (Alger). Dans chaque site, trente individus ont été prélevés à chacune des saisons de l'année : décembre 2013 (automne), février 2014 (hiver), mai 2014 (printemps) et août 2014 (été). Chacun des sites sélectionnés abrite une importante population de moules *Mytilus galloprovincialis.*

Préparation d'échantillons et analyses chimique - Le traitement des échantillons a été réalisé selon la méthode de l'UNEP/ IAEA [2]. La teneur en métaux traces a été déterminée par spectrophotométrie d'absorption atomique (Thermo scientific).
L'indice de condition de la moule (IC) a été déterminé en calculant le rapport entre le poids sec des chaires et le poids sec des coquilles [1].

Résultats et discussion
La comparaison des concentrations en plomb mesurées dans les chaires des moules prélevées aux quatre saisons avec les classes de qualité [1], permet de conclure que la concentration moyenne en plomb dans les trois sites dépasse la valeur limite 3,6 (µg/g en poids sec P.S.). Au printemps, les concentrations en Pb dans les moules du site de Sidi Mejdoub augmentent fortement (facteur 2), ce qui pourrait être en relation avec la proximité du Port de Mostaganem (Tab. 1).

Tab. 1. Variation spatio-temporelle des concentrations en Pb, Cu et Zn dans les chaires de la moule *Mytilus galloprovincialis.*

Sites	Métal (µg/g) P.S	(2013) Automne	(2014) Hiver	Printemps	Eté
Sidi Mejdoub (Mostaganem)	Pb	12,85 ± 5,93	10,32 ± 1,19	24,11 ± 0,75	12,02 ± 6,01
	Cu	6,65 ± 1,10	6,61 ± 2,05	3,48 ± 1,69	6,23 ± 1,93
	Zn	151,18 ± 18,64	156,80 ± 19,84	263,48 ± 18,62	178,57 ± 17,15
Willis (Mostaganem)	Pb	14,45 ± 3,61	13,96 ± 4,47	13,67 ± 3,69	12,96 ± 3,76
	Cu	6,83 ± 1,80	6,59 ± 1,47	6,46 ± 1,70	8,93 ± 1,61
	Zn	196,64 ± 19,00	176,00 ± 19,97	224,39 ± 19,94	196,13 ± 18,70
Bateau cassé (Alger)	Pb	12,54 ± 0,89	12,38 ± 0,89	12,27 ± 1,17	13,27 ± 0,78
	Cu	9,47 ± 1,55	9,35 ± 1,53	6,36 ± 1,74	6,27 ± 1,49
	Zn	146,78 ± 18,98	174,31 ± 19,63	209,90 ± 19,50	105,93 ± 19,58

Les teneurs en cuivre ne varient pas de façon significative au cours des saisons (entre 6 et 7 µg/g P.S. ; $p > 0{,}05$) (Tab. 1). Selon les critères des classes de qualités [1], la concentration moyenne en cuivre dans les moules de Sidi Mejdoub est située dans la gamme de sécurité (< 6,9 µg/g P.S.). Par contre, les teneurs en ce métal ont des valeurs élevées (< 9,4 µg /g P.S.) dans les moules de Willis et de Bateau cassé. Les moules ne sont pas considérées être de bons indicateurs de la contamination par le cuivre. En effet, ce métal est un élément clé du métabolisme des moules et ses teneurs internes sont fortement contrôlées par ces organismes [3, 4]. Toutefois les valeurs élevées mesurées à Willis et à Bateau cassé semblent témoigner d'une contamination du milieu [5].
Par comparaison avec les classes de qualités [1] on conclut que la concentration moyenne en zinc dans les chaires des moules provenant de Sidi Mejdoub et de Bateau cassé est située dans la gamme de référence (< 191 µg/g P.S.). Par contre, les teneurs de zinc dans les moules provenant de Willis, ont des concentrations reflétant la gamme de sécurité. Il a également été observé que l'IC a un effet de dilution uniquement sur la concentration en Zn dans les chaires des moules (la diminution de l'IC se traduit par une augmentation des teneurs en Zn ; Fig. 1).

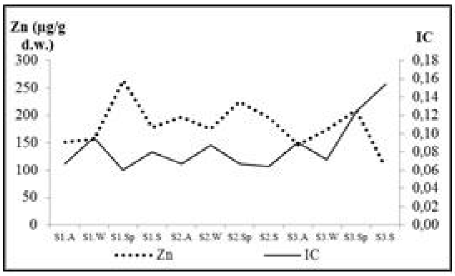

Fig. 1. Variation spatiale du Zn avec l'indice de condition chez la moule *Mytilus galloprovincialis.*

Conclusion
Nos résultats montrent que toutes les moules analysées sont contaminées par le Plomb. Par contre, M. galloprovincialis contrôle fortement son contenu en Cuivre. Les concentrations en Zinc sont quant à elles inférieures au seuil de sécurité.

References
1 - Kantin R., Pergent-Martini C., 2007. Monitorage de la qualité des eaux et de l'environnement marin - Rapport final – Région Corse. Ifremer publ., La Seyne : 1-222.
2 - UNEP/IAEA, 1986. Determination of total chronium in marine sédiments by flameless atomic absorption spectrophotometry. (Draft) Reference Methods for Marine Pollution Studies, N°38, UNEP.
3 - Alzieu C., Abarnou A., Bassolullet A., Boutuer B., 1999. Dragage et environnement marin : Etats des connaissances. Plousane : Edition Ifremer. 223p.
4 - RNO, (1995). Surveillance du Milieu Marin. Travaux du RNO. Edition 1995. Ifremer et Ministère de l'Aménagement du Territoire et de l'Environnement. 32 p.
5 - Andral B., Tomasino C., 2010. Réseau Intégrateurs Biologiques : résultats de la campagne 2009. RINBIO/RST.DOP/LER-PAC/10-15. Nov. 2010, 88 p.

CONCENTRATION DU ^{210}PO DANS LA MOULE *MYTILUS GALLOPROVINCIALIS* DANS LA BAIE D'ALGER: CONTRIBUTION À LA DOSE REÇUE PAR INGESTION

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Abstract

Le ^{210}Po est un radionucléide hautement radiotoxique, il est l'un des principaux contributeurs à la dose efficace engagée par ingestion. Cinq kilogrammes de moules *Mytilus galloprovincialis*, ont été recueillies sur deux sites de moules d'élevage dans la baie d'Alger. Les échantillons ont été conditionnés au laboratoire du CRNA, et analysés par la technique développée au Laboratoire MEL de l'AIEA (Monaco). La mesure de la concentration du Po a été effectuée par spectrométrie α. Ces activités varient de (189,72 - 652,84) Bq Kg^{-1}$_{(\text{poids sec})}$ et sont comparables avec celles enregistrées dans le basin méditerranéen. Pour calculer la dose chez les humains, nous avons utilisé un coefficient de conversion de dose de 1,2μSv.Bq^{-1}. La dose par individu due au Po estimée sur la base de nos données varie entre (34.14-113.7) μSv.an^{-1}.

Keywords: Bio-indicators, Bivalves, Radionuclides, Algerian Basin

Introduction

La bio-surveillance repose sur l'utilisation d'organismes marins comme bioindicateurs, vu leur capacité à concentrer les contaminants. Une quantité de cinq kilogrammes de moules de type *Mytilus galloprovincialis,* de taille variant de 3 à 7 cm, a été collectée au niveau de la baie d'Alger (Fig.1) dans deux sites de Mytiliculture : le premier à Ain Taya, situé à l'Est d'Alger et le second à Ain Tagouraït, à l'Ouest d'Alger. Un autre échantillon d'environ un kg de moules sauvages de petite taille (≈ 3 cm) a été prélevé au niveau du port d'Alger. Les différents échantillons ont été conditionnés au niveau du Laboratoire de l'Environnement du CRNA et traités par séparation radiochimique selon la technique développée par le Laboratoire de l'Environnement Marin de l'AIEA (Monaco) [1] afin d'évaluer, par spectrométrie alpha, la concentration du Po dans ces bivalves. Dans ce papier on s'est intéressé au Po qui est un radionucléide produit naturellement dans l'environnement marin. C'est également un élément de très haute toxicité. La concentration du ^{210}Po dans les moules consommées par l'homme serait à l'origine d'une dose variant de 5 à 10 μSv par année et par personne et contribuerait à environ 80 % de la dose collective reçue par une population consommant ces organismes marins [2].

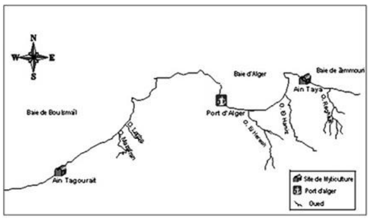

Fig. 1. Localisation des sites de prélèvement.

Matériels et Méthodes

Après avoir rincé les moules avec l'eau douce, le byssus a été enlevé et la partie molle récupérée. Cette dernière a été séchée à l'étuve à 80°C et broyée. Une aliquote de 1 g a été mise dans un bécher en pyrex avec 16 ml de HNO concentré et 1 ml de Po comme traceur radioactif. La digestion s'est faite en utilisant du HNO3 concentré et du HCl concentré et à 0.6 M. Un système de déposition spontanée en téflon a été utilisé pour fixer le ^{210}Po sur un disque d'argent pur à 99.99%. La mesure du disque a été effectuée sur une chaine de spectrométrie alpha utilisant les détecteurs PIPS d'une efficacité de 25%. Les rendements chimiques obtenus se situent entre 80 à 90 %.

Résultats et discussion

A la lumière des résultats obtenus, les concentrations du ^{210}Po dans la baie d'Alger, montrent une variation entre les différents sites de prélèvements (Fig.2).

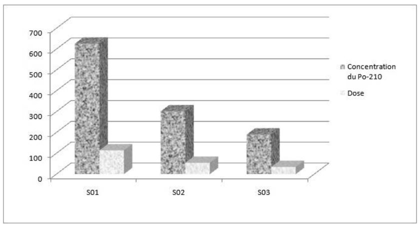

Fig. 2. Concentration du ^{210}Po (Bq.Kg^{-1})$_{sec}$ et Dose due à la consommation des moules (μSv.an^{-1}).

Celle ci peut être due, d'une part à l'influence des paramètres du milieu dont: la température, le pH, la salinité, la nature du site et son degré de pollution, et d'autre part, à la nature du bioindicateur utilisé tel que : l'âge, le sexe et le phénomène de discrimination. Néanmoins les résultats obtenus semblent satisfaisants en comparaison avec ceux des pays du bassin méditerranéen. Sur la base de ces résultats, la dose reçue par un adulte suite à la consommation des moules a été estimée, en appliquant un facteur de conversion de dose par unité d'ingestion (Ingestion Coefficient Dose) de 1,2 μSv Bq^{-1} [3]. La consommation annuelle moyenne des moules en Algérie par habitant a été estimé à 0.5kg, sachant que la population consomme peu ce type de fruit de mer. La contribution du Po à la dose reçue par un individu suite à la consommation des moules en Algérie a été estimée entre (34.14-113.70) μSv.an^{-1} [4].

Conclusion

Sachant que la CIPR recommande une dose maximale de 1000 μSv.an^{-1} pour le public [3]. Les Niveaux d'exposition associés à l'ingestion des moules représentent à peu prés 10% de la dose recommandée par la CIPR ce qui ne présente pas d'impact sur la santé humaine.

References

1 - Report on the Worldwide intercomparaison exercice AIEA-437. Radionuclides in Mediterranean Mussel, Monaco 2007.

2 - Aarkrog, M.S. Baxter, A.O. Bettencourt, R. Bojanowski, A. Bologa, S. Charmasson, I. Cunha, R. Delfanti, and al, " A comparison of doses from ^{137}Cs and ^{210}Po in marine food, a major international study", *J. Environ. Radioact.* **34** (1) (1997), pp. 69–90.

3 - UNSCEAR, 2000, Sources and Effects of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 2000, report to the general assembly with scientific annexe, United Nations, New York (2000).

4 - O. Connan*, P. Germain, and al. " Variations of ^{210}Po and ^{210}Pb in various marine organisms from Western English Channel: contribution of ^{210}Po to the radiation dose.. ". *J. Radiol. Prot.* **97** (2007), pp. 168-188.

LEVELS AND TEMPORAL TRENDS OF ORGANOCHLORINE COMPOUNDS IN MARINE ORGANISMS FROM GREEK WATERS

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Abstract
The levels and temporal trends of organochlorine compounds (DDTs and PCBs) were investigated in two edible fish species (the red mullets *Mullus barbatus* and the bogues *Boops boops*) collected from different locations in Greece during a twenty year period 1994 - 2014. A decrease of DDTs levels was observed for both species but in the same period the levels of PCBs do not follow any significant temporal trend. All organochlorine concentrations measured in the red mullets were always clearly higher than those in the bogues.

Keywords: Bio-accumulation, Mediterranean Sea

Introduction
Organochlorine compounds, including the DDT group and the polychlorinated biphenyls (PCBs) are persistent environmental contaminants with a high capability for bioaccumulation in the fatty tissues of marine oganisms through the food chain. The aim of this work, is to study the levels and the temporal trends of DDTs and PCBs in two fish species belonging to different ecotypes (the demersal red mullets Mullus barbatus and the pelagic bogues Boops boops and collected from eight marine locations in Greece during the period 1994-2014.

Methodology
The analytical method used included freeze drying of the fish flesh, Soxhlet extraction with a mixture of hexane-dichloromethane, clean-up and fractionation on an alumina column and determination by ECD gas chromatography [1]. The quantified compounds included the p,p'-DDT and its metabolites p,p'-DDE and p,p'-DDD and seven PCB congeners (101, 105, 118, 138, 153, 156 and 180).

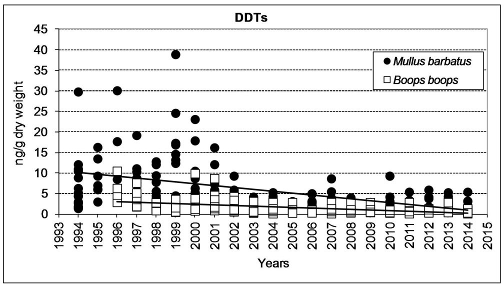

Fig. 1. DDTs concentrations during 1994-2014

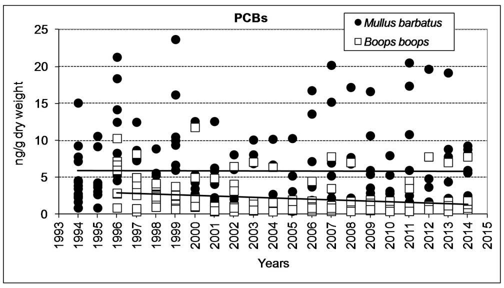

Fig. 2. PCBs concentrations during 1994-2014

Results and Discussion
All the organochlorine concentrations during 1994-2014 are presented in figures 1 and 2.In all the samples the organochlorine concentrations in the fish samples were quite low compared with those found in other Mediterranean regions [2] and never exceeded human health limits [3]. The highest values of DDTs and PCBs were found in the red mullet (mean DDTs values: 10.4 ng/g in the red mullets and 1.6 ng/g in the bogues, mean PCBs values: 5.9 ng/g in the red mullet and 2.1 ng/g in the bogues). These differences is probably attributed to the higher lipid content of the red mullets (1.5 % in the bogues, 3.3 % in the red mullets) and/or to the different feeding conditions of the two species. It is known that the orgnochlorines are accumulated in the fat tissues of the organisms and therefore their concentrations are positively related with the lipid content. In order to reduce this inter-species variability the results were normalized to the fat content and expressed in ng/g fat units. Then, for the PCBs there is no differentiation between the two species (mean PCBs values: 269 ng/g fat in red mullets and 221 ng/g in bogues) but the DDTs concentrations continue to be significantly higher in the red mullets (mean DDTs values: 424 ng/g fat in the red mullets and 152 ng/g fat in the bogues). This preferential bioaccumulation of DDTs in the red mullets might be related to the different dietary intake of these sea bottom feeders. The spatial distribution of DDTs and PCBs was generally homogeneous for both fish species and only in fishes collected from Saronikos gulf higher PCBs values in comparison with the other marine areas were recorded, probably attributed to inputs from industrial activities from the greater area of Athens. As it can be seen from Figure 1, a decreasing temporal trend for DDTs during the twenty years of the survey is evident. On the contrary, PCBs levels seems to remain constant, especially in red mullets, during these years, probably suggesting continuous PCBs inputs despite the banning of these compounds. The ratio PCBs/DDTs takes its greatest values in the bogues (mean value: 1.3 in bogues, 0.7 in red mullet), further evidencing the different behaviour of the two fish species in relation to their ability to biomagnify the organic pollutants.
The most abundant compound of the DDT family was always the main DDT metabolite p,p'-DDE, in percentages above 80%, suggesting no recent inputs of DDTs in the areas studied. The predominant PCB congeners were the hexachlobiphenyls 151 and 138, in accordance with the common congener distribution pattern encountered in marine organisms.

References
1 - Satsmadjis J., Georgakopoulos-Gregoriadis E. and Voutsinou- Taliadouri F.,1988. Separation of organochlorines on alumina. J. Chromatogr., 437: 254-259
2 - Pastor D., Boix J., Fernandez V. and Albaiges J., 1996. Bioaccumulation of organochlorinated contaminants in three estuarine fish species (Mullus barbatus, Mugil cephalus and Dicentrarcus labrax). Mar. Pollut. Bull., 32: 257-262
3 - Roach AC. and Runcie J., 1998. Levels of selected chlorinated hydrocarbons in edible fish tissues from polluted areas in the Georges/Cooks river and Sydney harbour, New South wales, Australia. Mar. Pollt. Bull., 36: 323-344

EVOLUTION DES TENEURS EN NUTRIMENTS, DU PH ET DE L'OXYGÉNATION DE LA CÔTE ALGÉROISE DE 1999 À 2015

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Abstract

L'anthropisation accélérée de la zone côtière algéroise entraine une perturbation des flux de nutriments et de matière organique du continent vers la mer. Ceci provoque une altération des rapports stoechiométriques des sels nutritifs accompagnée d'une désoxygénation des eaux ainsi que d'une tendance à la diminution du pH sur les deux baies d'Alger et de Bou Ismaïl entre 1999 et 2015.

Keywords: Coastal waters, Algerian Basin

Les activités humaines ont fortement perturbé les flux de certains éléments ou de certaines matières du continent vers la zone côtière. Les flux d'azote de phosphore ont ainsi été multipliés par deux par rapport à la période pré–industrielle [1]. Ce flux vers la zone côtière peut dépasser les capacités d'un milieu à dégrader de façon aérobie la matière organique qu'il contient, provoquant une eutrophisation du milieu. La côte algéroise a connu une anthropisation accélérée sur les deux dernières décennies avec une augmentation de la démographie et un développement d'unités industrielles côtières. L'objectif de ce travail est d'analyser sur une période de 15 ans, les modifications de la qualité de ces eaux côtières du point de vue des concentrations en nutriments et de la désoxygénation. Plus récemment (2011-2015), des mesures des paramètres du système des carbonates nous permettent également d'analyser les variations observées en pH. Deux baies de Bou Ismail et d'Alger ont été échantillonnées à des saisons différentes entre 1999 et 2015. Des mesures in-situ de température et de salinité, des données d'oxygène dissous, de pH et de sels nutritifs ont été collectées. Dans la baie de Bou Ismaïl, une diminution de la saturation en oxygène d'environ 15% est notée entre les deux périodes 2002-2003 et 2014-2015 (Figure 1).

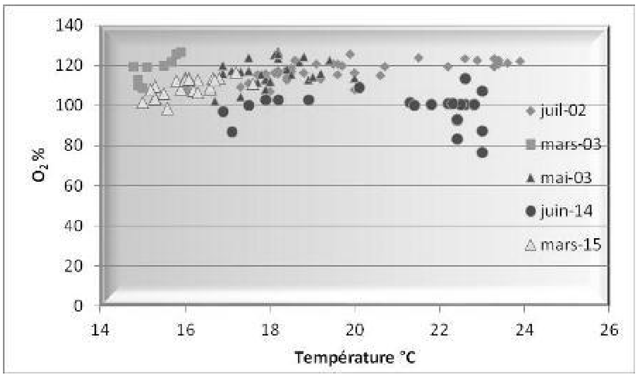

Fig. 1. Evolution du degré de saturation en oxygène dissous en fonction de la température dans la baie de Bou-Ismail (2002, 2003, 2014 et 2015).

Ces diminutions d'oxygène s'accompagnent d'une augmentation d'un facteur de trois des teneurs en phosphate pour la période printanière, ce qui peut être dû aux déversements directs des eaux usées domestiques dans la baie et à une augmentation des débits des oueds sur la baie entre ces deux périodes (Figure 2).

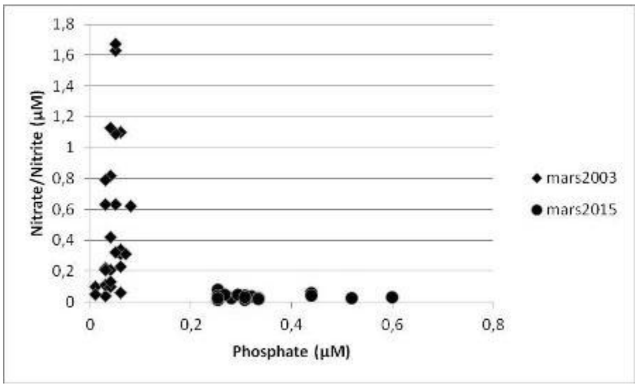

Fig. 2. Evolution des teneurs de phosphates et d'azote dans la baie de Bou-Ismail (Mars 2003 et 2015).

Dans la baie d'Alger, une diminution de pH de 8,2 à 8,07 en moyenne est observée entre les périodes 1999-2000 et 2014. La période de juin 2014 montre une très forte sursaturation d'oxygène (> 140%) dans les eaux du creux de la baie, associée à un bloom alors que la période de début juillet 2000 montre une oxygénation proche de la saturation des eaux de la baie. Les modifications des différents paramètres étudiés sont discutés à la lumière de l'évolution des apports et rejets sur ces deux baies et des conditions météorologiques avant et au moment des échantillonnages.

References

1 - Smith S.V., Swaney D.P., Talaue-McManus L.,Bartley J.D., Sandhei P.T., McLaughlin C.J., Dupra V.C., Crossland C.J., Buddemeier R.W., Maxwell B.A., Wulff F. 2003. Humans, hydrology, and the distribution of inorganic nutrient loading to the ocean. BioScience 53, 235–245.

COMITÉ 4

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Microbiologie et Biotechnologie marines

Président : Frank Oliver Glöckner
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CIESM Congress Session : Microbial diversity

Moderator : Alex Kraberg, Div. of Biosciences , AWI, Helgoland, Germany

Moderator's Synthesis

The session on microbial ecology began with several flash presentations that demonstrated the diversity of topics and methodologies in use in current microbial ecology/diversity research. This diversity formed the backdrop for the ensuing discussion. Discussion topics revolved around the enormous potential of new technologies such as molecular tools in the study of microbial diversity. Such techniques allow much more detailed studies (even in very remote areas) than would be possible with conventional techniques. However, with the diversity of methods developing (not just molecular) there are also issues with the comparability of data sets between different studies but also within long-term studies at the same sites.

High throughput techniques are also heavy on IT resources (although some good, stable database systems are now available) and are still costly, financially beyond the means of a number of researchers. The participants agreed that one needs to take a pragmatic approach to the assessment of microbial diversity and ecology in general. Not every study can deliver the greatest possible detail but different studies might still be comparable if data sets are compared at a lower taxonomic resolution for instance. Participants agreed that there is a need for improved communication between research communities and a need for multidisciplinary approaches applying a number of skills -from taxonomy, via molecular approaches to IT and data management.

THE OCCURRENCE OF *AEROMONAS HYDROPHILA* IN VARIOUS MARINE ENVIRONMENTS IN TURKEY

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Abstract
In this study, the occurrence and distribution of *Aeromonas* species in sea water and sediment samples were reported regarding the studies conducted in various marine areas (the Sea of Marmara, Aegean Sea and Mediterranean Sea) of Turkey at different time periods between 2002 and 2014. The marine areas isolated *Aeromonas s*pp. were evaluated with respect to the environmental conditionals, human and ecosystem health.

Keywords: Aegean Sea, Bacteria, Marmara Sea, Mediterranean Sea, Pollution

Introduction
Aeromonas hydrophila is found in diverse habitats, including soil, water, and is pathogenic to warm and cold-blooded animals. Aquatic environment along with seafood is thus important potential source for the transmission of *Aeromonas hydrophila* resulting in human infections. *Aeromonas* infections are one of the most common bacterial diseases diagnosed in marine and cultured freshwater fish. Virulence in *Aeromonas hydrophila* is multifactorial which consists of aerolysins, hemolysins, enterotoxins, and proteolytic enzymes which play significant role in pathogenesis. EPS, (exopolysaccharides) also play very important role in the interaction between bacteria and their environment. Despite their importance, very few studies have been done on chemical characterization of EPS produced by *Aeromonas hydrophila*. It was also used to construct a semi-specific biosensor to estimate biochemical oxygen demand (BOD) in high fat and grease content wastewaters. A. hydrophila cells were grown in fat containing medium to induce necessary enzymes for transport and degradation of fatty substances.

Materials and Methods:
In this study, the occurrence and distribution of *Aeromonas* hydrophila was investigated in the coastal areas of the Eastern Mediterranean the Sea of Marmara, Straits of Çanakkale and Istanbul, the northern part of the Aegean Sea and also the southern parts of Gokceada and Thasos Island, Güllük Bay, Gulf of Antalya as well as the Mediterranean (Figure 1). The samples used in the analysis were collected in a Nansen bottle that had been cleaned with acid (10% HCl in distilled water), sterilized with alcohol (50:50, v/v), and rinsed with sterile water. The sea water samples were taken in sterilized glass bottles, serial dilutions of 10^{-5} were prepared in 9-mL amounts of sterile seawater (artificial seawater, Sigma) and inoculated (0.2 mL) in duplicate on marine agar (Difco), and the plates were incubated for 5 days at 22 ± 0.1°C . The identification of the isolateswere carried out using VITEK 2 Compact 30 (bioMérieux, France).

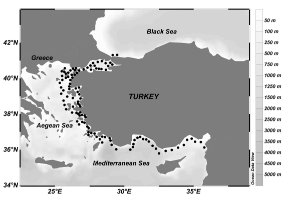

Fig. 1. Location of sampling sites in various marine areas of Turkey.

Results and Discussion
The presence of *A. hydrophila*in the 80 units of seawater samples, which were taken from 22 stations in the Southern part of the Sea of Marmara, was analyzed in 2006-2007 [1].The occurrence of *A.hydrophila* in the 22 units of seawater samples from coastal areas in the Aegean Sea and 14 units of seawater samples from the Eastern Mediterranean, Turkey were investigated during the months of August in 2007 and 2008 [2]. The occurrence of *A. hydrophila*was investigated in the 83 units of seawater samples which were taken from various depths ranging from 0-30 cm to 500 m in the northern part of the Aegean Sea in 2006 and 2007. Seven unit samples were taken from the offshore areas extending from the eastern part of Andros Island to the southern part of Gokceada and Thasos Island in 2007 and 2008 [3]. The occurrence of *A. hydrophila*was investigated in the 175 units of seawater and 86 sediments samples which were taken from various depths ranging from 0-30 cm to 50 m Güllük Bay and coastal areas part of the Aegean Sea in 2012 and 2013 [4]. The presence of *A. hydrophila* in the 304 units of seawater samples which were taken from 82 stations in the Sea of Marmara, Turkey were investigated in 2008 and 2014 [5,6]. The occurrence of *A. hydrophila*was investigated in the 144 units of seawater samples which were taken from various depths ranging from 0-30 cm to 200 m Gulf of Antalya part of the Mediterranean in 2009 and 2010 [7]. Occurrences of pathogenic bacteria have potential negative effects on the ecosystem and also on human health. Terrestrial sourced pollution, over-use of living aquatic resources and habitat destruction have been considered as the three greatest menaces to the world’s oceans. The occurrence and distribution rate of the A. hydrophila showed that the areas sampled under the influences of sewage-contaminated waters. Aeromonas is predominant in waters with high levels of fecal pollution and it has therefore been claimed that the presence of Aeromonads can assist in assessments and predictions of aquatic system deterioration or recovery.

References

1 - Altug, G., Çardak, M., Çiftçi, P. S, Gürün, S., 2012, First records and micro-geographical variations of culturable heterotrophic bacteria in an inner sea (the Sea of Marmara) between the Mediterranean and the Black Sea, Turkey *Turkish Journal of Biology* DOI: 10.3906/biy-1112-21.
2 - Altug G., Çardak, M., Gürün S., Çiftçi P., Saad A.,A., Ibrahim, A.,Fakhri, M.,2010, Biodiversity of Culturable Aerobic Heterotrophic Bacteria in the Coastal Areas of Syria, Lebanon and the Offshore Areas of the Northern Aegean Sea and the Mediterranean, INOC-Tischreen University, International Conference on Biodiversity of the Aquatic Environment, Syria, 2010.
3 - Altug, G., Aktan, Y., Oral, M., Topaloglu, B., Dede, A., Keskin, Ç., Isinibilir, M., Çardak, M., Çiftçi, P.S, 2011, Biodiversity of the northern Aegean Sea and southern part of the Sea of Marmara, Turkey. *Marine Biodiversity Records*, 4, 1-17. 65.
4 - Altug, G., Balkis N., Çardak, M., Gürün S., Çiftçi, P.S, Kalkan, S., Hulyar, O., 2013, Güllük Körfezi Ekosisteminin Bakteriyolojik Analizlerle Arastirilmasi,TUBITAK, 110Y243, Scientific report, (in turkish).
5 - Altug, G., Gurun S., Cardak, M., Ciftci, P. S., Kalkan S.,2012, The Occurrence of Pathogenic Bacteria in Some Ships’ Ballast Water Incoming from Various Marine Regions to the Sea of Marmara, Turkey, *Marine Environmental Research*, 81, 35-42.
6 - Çardak, M., Altug, G., Türetken Çiftçi P. S., 2014, Variations Of Culturable And Metabolicallyactive Bacteria in a Stratified Water Column: The Example Ofistanbul and Çanakkale Straits, Turkey, *International Journal Of Environmental Research*, 9: (4), 1334-1340.
7 - Çardak, M., Özgür Özbek, E., Kebapçioglu T., 2015, Seasonal Abundance And Diversity Of Culturable Heterotrophic Bacteria In Relation To Environmental Factors In The Gulf of Antalya, Eastern Mediterranean, Turkey, *World Journal Of Microbiology And Biotechnology*, 31: (4)., 569.

CHARACTERIZATION OF THE EUKARYOTIC MICROBIOME BY 18S RRNA METABARCODING DATA ANALYSIS AND ASSESSMENT OF THE RELATIVE RESOLUTION OF V4 AND V9 REGIONS

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Abstract
The V4 and V9 hypervariable regions of 18S rRNAs are both generally used for exploring the eukaryotic plankton diversity in oceans. The aim of this investigation is to compare the performance of these two barcode regions in the taxonomic characterization, at qualitative and quantitative level, of the eukaryotic microbiome from 30 metagenomic samples collected in the 2014 OSD summer campaign. Here, preliminary results show how the inferred biodiversity is strongly dependent on the specific marker used in the study. Probably this is due to: the biased sequence coverage in the reference database, with the V4 regions much more represented than the V9 region; the variable efficiency of primer annealing in the considered taxonomic range; and the different V4 and V9 amplicon length that undoubtedly affects their genetic discrimination power.

Keywords: Biodiversity, Mediterranean Sea, North Atlantic

Microbes are ubiquitous in marine habitats, playing a crucial role in biogeochemical processes and food networks and there are increasing evidence that decrypting their biodiversity is crucial for understanding the biotic roots of the entire Earth system [1,2]. Nowadays, technological advancements and decreasing sequencing costs allow exploring biodiversity at a global genomic scale. In this framework, a number of initiative were launched, from the first pilot sampling project in the Sargasso Sea by the J Craig Venter Institute to the marine biodiversity studies of Tara Ocean project [1] and Micro B3 project [2], the latter pioneering the idea to orchestrate a simultaneous sampling campaign of the world's oceans which takes place in the summer solstice day. Amplicon-target and Metagenomics approaches are the main protagonists of this scientific revolution. Actually, both the V4 and V9 hypervariable regions of 18S rRNAs are generally used for exploring the eukaryotic plankton diversity in oceans [1,2]. To assess the discrimination power for eukaryotic planktonic species of these barcode regions, we compare their performance at qualitative and quantitative level by analysing 18S amplicon V4 and V9 sequence data produced according to the standard NE08 OSD protocol from 30 metagenomic samples collected in the 2014 OSD campaign undertaken under the support of Lifewatch Italy (ENA project-id: ERP009703). At the same time, in order to have an idea of both PCR NE08 primers efficiency in capturing eukaryotic species diversity and of V4 and V9 coverage in SILVA [3] database, an in silico PCR by means of PrimerSearch tool in the EMBOSS package [4] was carried out. About 75% (35,311) of SILVA reference sequences resulted to include a complete V4 region compared to only 17% (8,185) for the complete V9 region. Based on the PrimerSearch amplicon data, the Shannon diversity index (H) was calculated for both V4 and V9 obtaining similar estimations. The samples were processed for library preparation and high-throughput sequencing as described in Manzari et al. [5]. Both V4 (about 400 bp long) and V9 (about 200 bp long) 18S rRNA metabarcode amplicons were sequenced by using the Illumina Miseq platform and a median number of 372,000 V4 PE reads (2x250 bp) and 418,000 V9 PE reads (2x150 bp) per sample were obtained. In order to evaluate the alpha diversity, the V4 and V9 sequences were clustered into OTU (Operational Taxonomic Unit) by applying QIIME [6] and the normalized OTU counts were used to infer the Shannon index for each sample. The inferred indices shows a tight correlation between V4 and V9 data (estimated Pearson correlation 0.91, $p < 10^{-12}$). The BioMaS pipeline [7] was then applied to denoise and process the PE reads produced from each sample, to map them on the 51,553 eukaryotic sequences contained in the release 119.1 of the SILVA database and finally to infer their taxonomic origin. Sequences matching against SILVA with an identity percentage of at least 97% were directed to species labelling, while those matching with an identity percentage between 90% and 97% were classified at higher taxonomic ranks. BioMaS was able to classify about the 94% and 79% of V4 and V9 sequences, respectively. Considering all the analysed samples a total of 3,873 species, 2,432 genera and 1,167 families were detected. As expected, a higher number of taxa were detected by V4 than V9, but quite unexpectedly a remarkable number of taxa was detected by V9 only. In order to make comparable the number of reads assigned to each taxonomic rank across samples, the read counts were converted in RPM (reads per million) by the formula RPM = assigned reads/(total assigned reads at the rank level/1.000.000). The RPMs of V4 and V9 were compared at family, genus and species level by plotting their number (Fig.1).

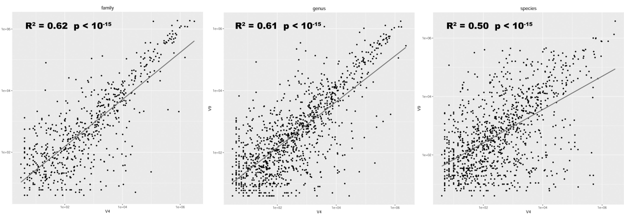

Fig. 1. *Scatter plot reporting V4 and V9 RPMs for families, genera and species.*

Taxa coverages obtained from V4 and V9 were significantly correlated (estimated Pearson correlations are: 0.50 (species), 0.61 (genus) and 0.62 (family) with $p<10^{-15}$ in all cases) although with decreasing correlation values from family to species. In conclusion, qualitative (number of taxa) and quantitative (taxa abundance) biases observed comparing V4 and V9 barcode data are likely related to the different size and representation of these two barcode regions in the reference database. Therefore, the combined use of the two regions could be the most effective solution for a deep and widespread assessment of the marine microbial eukaryotes diversity. Of course, further investigations on mock samples with known diversity at qualitative and quantitative level are necessary to fully address this issue.

References

1 - De Vargas C, Audic S, Henry N, Decelle J, Mahe F, Logares R, Lara E, Berney C, Le Bescot N, Probert I et al: Ocean plankton. Eukaryotic plankton diversity in the sunlit ocean. Science 2015, 348(6237):1261605.

2 - Kopf A, Bicak M, Kottmann R, Schnetzer J, Kostadinov I, Lehmann K, Fernandez-Guerra A, Jeanthon C, Rahav E, Ullrich M et al: The ocean sampling day consortium. GigaScience 2015, 4:27.

3 - Pruesse E, Quast C, Knittel K, Fuchs BM, Ludwig W, Peplies J, Glockner FO: SILVA: a comprehensive online resource for quality checked and aligned ribosomal RNA sequence data compatible with ARB. Nucleic acids research 2007, 35(21):7188-7196.

4 - Olson SA: EMBOSS opens up sequence analysis. European Molecular Biology Open Software Suite. Briefings in bioinformatics 2002, 3(1):87-91.

5 - Manzari C, Fosso B, Marzano M, Annese A, Caprioli R, D'Erchia AM, Gissi C, Intranuovo M, Picardi E, Santamaria M et al: The influence of invasive jellyfish blooms on the aquatic microbiome in a coastal lagoon (Varano, SE Italy) detected by an Illumina-based deep sequencing strategy. Biol Invasions 2015, 17 (3):923-940.

6 - Caporaso JG, Kuczynski J, Stombaugh J, Bittinger K, Bushman FD, Costello EK, Fierer N, Pena AG, Goodrich JK, Gordon JI et al: QIIME allows analysis of high-throughput community sequencing data. Nature methods 2010, 7(5):335-336.

7 - Fosso B, Santamaria M, Marzano M, Alonso-Alemany D, Valiente G, Donvito G, Monaco A, Notarangelo P, Pesole G: BioMaS: a modular pipeline for Bioinformatic analysis of Metagenomic AmpliconS. BMC bioinformatics 2015, 16:203.

ANTIMICROBIAL POTENTIAL OF *JANIA RUBENS* EXTRACTS AND EPIPHYTIC BACTERIA

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Abstract
Red alga *Jania rubens* and its epiphytic bacteria were investigated for their antimicrobial potential. Organic crude extracts of the alga collected seasonally were tested against 18 indicators bacteria and the yeast *Candida albicans*. Else, culturable epiphytic bacteria were isolated and tested for activity against the same indicators microorganisms. Pronounced antimicrobial activities were obtained for alga extracts with seasonally variation. The summer period seems to be the appropriate period for secondary metabolites production especially against *Streptococcus* sp. and *Staphylococcus aureus*. Besides a collection of nineteen culturable epiphytic bacteria were isolated from the alga surface and seven of them showed antimicrobial activities. The whole alga isolates were resistant to their host extracts.

Keywords: Algae, Antibiotics, Bacteria, Mediterranean Sea

Introduction
In response to environmental pressures most epiphytic micro and macro-organisms in marine ecosystem produce secondary metabolites (Mayer et al., 2013). These compounds are with useful bio-applications mainly in pharmaceutical industry (Armstrong et al., 2001).

Materials and methods
Samples of *J. rubens* were sampled seasonally from the northern coast in Tunisia. For each sample, organic crude extracts were prepared by dichloromethane (D) and dichloromethane/methanol (D/M) solvents and antimicrobial activities were tested against 18 bacteria and the yeast C. albicans using disc diffusion method (Casida, 1986). Epiphytic bacteria were isolated from the alga using Marine agar medium and tested for their antimicrobial activity by drop method (Rao et al., 2005). For active isolates the 16S rDNA sequences were identified and submitted to the DNA GenBank and had the following accession numbers: J2 (JN391161), J9 (JN391168), J11 (JN391170), J13 (JN391172), J16 (JN391175), J17 (JN391176) and J18 (JN391177) (Ismail-Ben Ali et al., 2012).

Results and discussion
J. rubens showed a pronounced antimicrobial potential with large inhibitory spectrum especially during summer followed by spring, winter and it is almost inactive during autumn as shown in figure 1.

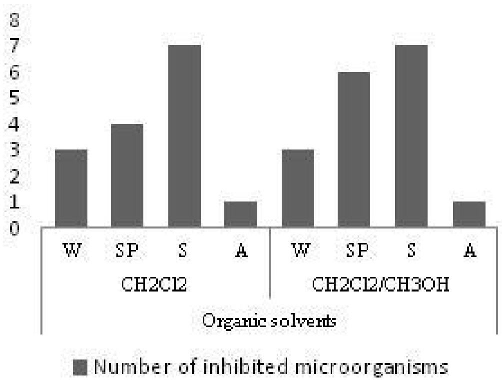

Fig. 1. Figure 1: Variation of inhibition rate with season. Dichloromethane and dichloromethane/methanol. Extract of Jania rubens were used. W: winter, SP: spring, S: Summer, A: autumn.

Extracts with moderate polarity solvents (D/M) were more effective. Previous studies on alga antimicrobial activities also noted a clear variation with season and geographic location (Salvador et al., 2007; Ismail-Ben Ali et al., 2010). *J. rubens* was active only against Gram-positive bacteria while no activity was recorded against Gram-negative one. Nineteen culturable bacteria (J1-J19) were isolated from *J. rubens* surface. Seven amongst the 19 isolates (J2, J9, J11, J13, J16, J17 and J18) were active especially against *S. aureus*, *Micrococcus sp. Pseudomonas cepacia*, *Streptococcus sp*., and *Enterococcus feacalis*. These active isolates were identified as closely related to genus *Bacillus* (J2), *Aquimarina* (J9), *Pseudomonas* (J11 and J13), *Paracoccus* (J16) and *Pseudoalteromonas* (J17 and J18) (Ismail-Ben Ali et al. 2012). Our results agree with previous research in which *Pseudomonas*, *Pseudoalteromonas* and *B. pumilus* species isolated from *Laminaria saccharina* were found to produce antibacterial substances (Wiese et al. 2009).The whole isolates were resistant to their host extracts. This suggests that *J. rubens* epiphytic bacteria were adapted to local environment and to antibacterial substances produced by their host. Else, alga inhibitory effect is selective, since all epiphytic isolates can live in close association with the host while it prevents pathogenic bacteria from colonizing the alga.

Conclusion
Summer seem to be the best period to collect *Jania rubens* for antimicrobial secondary metabolites production. Isolates from *J. rubens* which are closely related to genus *Bacillus*, *Aquimarina* and *Pseudomonas* were significantly active against indicator bacteria. Since bacteria cultivation is easy, these bacteria may be of considerable interest by producing bioactive compounds. This would allow the exploitation of seaweed as a natural source of potential antimicrobial substances while preserving its natural stock.

References
1 - Armstrong E, Yan L, Boyd KG, Wright PC, Burgess JG. 2001. The symbiotic role of marine microbes on living surfaces. Hydrobiologia 461: 37-40.
2 - Casida L.E. 1986. Industrial Microbiology, Wiley Eastern Limited, New Delhi. 106-107.
3 - Ismail-Ben Ali A, El Bour M, Ktari L, Bolhuis H, Ahmed M, Boudabbous A and Stal LJ. 2012. Jania rubens associated bacteria: molecular identification and antimicrobial activity. J. Appl. Phycol 24: 525–534.
4 - Ismail-Ben Ali A, Ktari L, Boudabbous A, El Bour M (2010). Seasonal variation of antibacterial activity of the brown alga Padina pavonica (L) Thivy collected from northern coast of Tunisia. Bulletin de L'Institut National Des Sciences et Technology de la Mer de Salammbô 37: 127-132.
5 - Mayer AMS, Rodríguez AD, Taglialatela-Scafati O, Fusetani N (2013). Marine pharmacology in 2009-2011: Marine compounds with antibacterial, antidiabetic, antifungal, anti-inflammatory, antiprotozoal, antituberculosis, and antiviral activities; affecting the immune and nervous systems, and other miscellaneous mechanisms of action. Mar Drugs 11(7): 2510-2573.
6 - Rao D, Webb JS, Kjelleberg S. 2005. Competitive interactions in mixed-species biofilms containing the marine bacterium Pseudoalteromonas tunicata. Appl Environ Microbiol 71:1729-1736.
7 - Salvador N, Garreta AG, Lavelli L, Ribera MA. 2007. Antimicrobial activity of Iberian macroalgae. Sci Mar 71(1): 101-113.
8 - Wiese J, Thiel V, Nagel K, Staufenberger T, Imhoff JF. 2009. Diversity of antibiotic-active bacteria associated with the brown alga Laminaria saccharina from the Baltic Sea. Mar Biotechnol. 11:287-300.

USE OF MOLECULAR TOOLS FOR THE IDENTIFICATION OF CRYPTIC *CERTAOMYXA* SPECIES INFECTING THE GALLBLADDER OF THE BOGUE *BOOPS BOOPS* IN TUNISIAN COASTS

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Abstract
During a study on fish parasites in the Gulf of Gabès 'GG' (SE Tunisia), two *Ceratomyxa* (Myxozoa: Bivalvulida) parasites were identified using molecular techniques in the gallbladder of *Boops boops* (Sparidae) : *C. pallida* Thélohan, 1894, a poorly described parasite infecting *B. boops* gallbladder and *C. gabesiensis*, a new cryptic species in GG. As *C. gabesisnes* was never observed solely, it was firstly considered as a morphotype of *C. pallida* which was encountered as a single infection or in association with *C. gabesiensis*. Monthly surveys showed the occurrence of the two parasites throughout the year with a mean prevalence of 23% and 64% for *C. gabesiensis* and *C. pallida,* respectively. Molecular analysis using the SSU rDNA partial sequence, allowed us to distinguish the two *Ceratomyxa* species

Keywords: Gulf of Gabes, Pathology, Parasitism, Mediterranean Sea

The bogue, *Boops boops* (Linnaeus, 1758) is a small benthopelagic sparidae species distributed in the Mediterranean, Eastern Atlantic and rarely in the Black Sea. It has an important commercial value in various countries including Tunisia. Studies on *Ceratomyxa* parasites infesting the gallbladder of *B. boops* are very ancient and limited to the single record of *C. pallida* in the Mediterranean off France, Croatia and Monaco [1]. The present work was conducted in this regard. One hundred and eighty fresh bogues were collected between July 2013 and August 2014 from the GG, SE Tunisia. Gallbladders were removed and examined for the presence of coelozoic Myxozoan parasites under a Leica DM1000 microscope equipped with a digital camera (Leica D-LUX3). Mature spores and vegetative stages were photographed and were morphometrically identified following the guidelines adopted by Lom and Arthur [2]. DNA was extracted from gallbladders filled with mature spores and preserved in absolute ethanol. A partial sequence of the SSU rDNA was amplified by PCR using the MyxospecF 18R primers [3]. Gallbladders with unique types of myxospores were directly sequenced using the same primers as used for the PCR. For gallbladders with two morphological types of myxospores, we inserted the purified PCR products into the pGEM®-T Easy Vector system (Promega) and cloned them into competent XL1-Blue *Escherichia coli* cells. From each cloned PCR product, 2 positive clones were selected for sequencing in both directions using the universal M13 primers. Obtained sequences were used for molecular comparison and phylogenetic analysis. Based on the infected host species and shell valve measurements; we considered that the thicker *Ceratomyxa* species could be identical to *C. pallida*. The measurements of the thickness of the shell valves (28.5 ± 2.45 (26-33) µm) and length (6.0 ± 0.12 (5-8) µm) are in the range of previously-published values [1]. The second morphotype occurs less frequently in the same host species and had mature spores with a relatively small size compared to those of *C. pallida* (Figure 1).

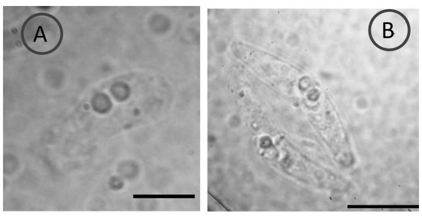

Fig. 1. *Ceratomyxa gabesiensis* n. sp (A) and *Ceratomyxa pallida* (B) from the glalblader of *Boops boops.* Scale-bars = 5 µm (A) and = 10 µm (B)

This morphotype is different compared to *C. pallida,* and was then considered a potential new species. This latter species is characterized by its thinner and asymmetrical shell valves. Phylogenetic analysis using the Maximum Likelihood (ML) and Bayesian inference methods yielded grouping of *C. gabesiensis, C. pallida, C. tunisiensis* and *C. leatherjacketi* in the same clade with the highest statistical support (Figure 2).

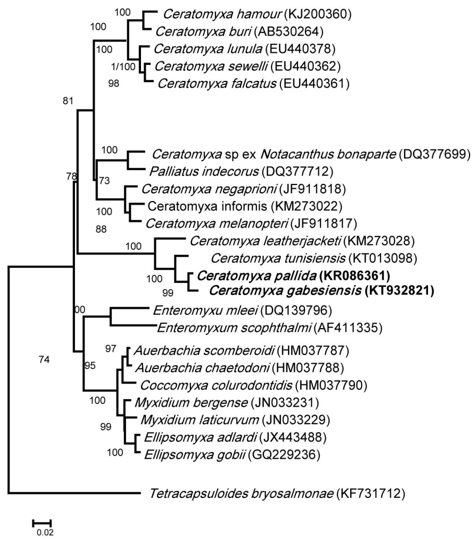

Fig. 2. Phylogenetic tree of *Ceratomyxa* spp, resulting from maximum likelihood analysis using the SSU rRNA dataset showing the position of *C. gabesiensis* n. sp. and *C. pallida*

The obtained results confirmed the necessity of the use of molecular tools for an accurate identification of *Ceratomyxa* parasites up to the species level, particularly in cases of co-infection. The new described parasite (*C. gabesiensis*) is the second species of the genus *Ceratomyxa* recorded and described in the Gulf of Gabes, after *C. tunisiensis* [3].

References
1 - Thélohan P., 1984. Recherches sur les myxosporidies. *Bull. Sci. Fr. Belg.*,5: 100-394.
2 - Lom J. and Arthur J.R., 1989. A guideline for the preparation of species descriptions in *Myxosporea. J. Fish. Dis.*,12: 151-156.
3 - Thabet A., Mansour L., Al Omar S.Y. and Tlig-Zouari S., 2015. *Ceratomyxa tunisiensis* n. sp. (Myxosporea: Bivalvulida) from the gallbladders of two carangid fish caught off the coast of Tunisia. *J. Eukaryot. Microbiol.*, 63: 86-92.

ISOLATION AND CHARACTERISATION OF ACTINOMYCETE ISOLATED FROM SEDIMENT AND WATER AT THE MONTH OF OUED CHELIFF IN MOSTAGANEM (ORAN)

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Abstract
The emergence of drug resistance among pathogenic bacteria due to the excessive uses of antibiotics has made the search for novel bioactive compounds from natural and unexploited habitats a necessity. The objective of this study is the isolation and characterization of an actinomycete strain by their 16S rRNA sequences. Eight isolates of actinomycetes were isolated from sediment and water at the month of oued Cheliff in Mostaganem. DNA was extracted and the 16S rDNA gene of the eight isolates was amplified by polymerase chain reaction (PCR). The sequences obtained were compared for similarity with genomic database banks, using the NCBI BLAST.

Keywords: Bacteria, Algerian Sea, Genetics, Estuaries

Estuaries are the most productive ecosystem on earth. They contain more organic material than most other types of environments. All of this organic matter creates a nutrient-rich ecosystem which promotes the development of a large diversity of microbial community including actinomycetes. They are filamentous, antibiotics producing bacteria and are found in soil, freshwater and marine water habitats [1]. Aquatic actinomycete produce several novel bioactive compounds. Species of Streptomyces, account for more than 70% of the total antibiotic production and Micromonospora was less than one-tenth as many as Streptomyces [2]. Eight actinomycetes were isolated from sediment mud and water at the month of oued Cheliff (fig 1).

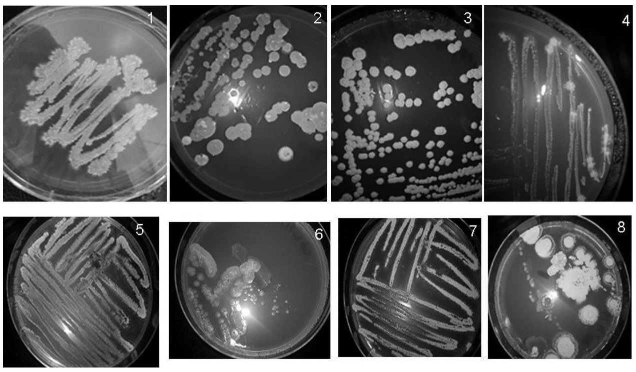

Fig. 1. Eight isolated strains of actinomycetes from Oued Cheliff. 1, ,2, 3, 4 & 5: *Streptomyces sp*. – 6: Isolate SSO – 7: isolate SS V – 8: Nocardia sp.

It's located in North West coast of Mostaganem and is the longest river in Algeria.The chromosomal DNA of each isolates was extracted using different methods (CTAB, boiling with CTAB, boiling with TE, simple boiling) 3].The 16S rRNA genes (1500 bp, partial sequence) of 5 representative isolates from morphologically different groups were analyzed by PCR method with 2 pairs of primers 9F (5'GAGTTTGATCMTGGCTCAG3') and SQ6 (5'CGGTGTGTACAAGGCCC3') [4].The PCR product obtained was sequenced. The same primers as above were used for this purpose. The sequence was compared for similarity with the reference species of bacteria contained in genomic database banks, using the NCBI BLAST. The 16S rRNA sequences allow us to identify 4 *Streptomyces sps* and one is *Nocardia sp*.The sequences obtained were compared with the corresponding sequences of other strains obtained from the GenBank database to evaluate phylogenetic diversity and taxonomic position of these isolates (fig 2).

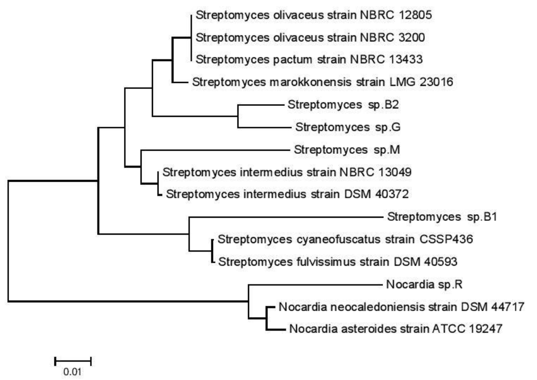

Fig. 2. Phylogenetic tree based on 16S RNA sequences.
Tree was constructed using the Neighbor Joining method. Strains B1, B2, G, M and R were isolated from sediments mud and fresh water.

References
1 - Fenical W., Jensen P. R., 2006. Developing a new resource for drug Discover Lam ks. Discovery of novel metabolites from marine actinomycete. *Curr opin Microbia*l. 9:245-251.
2 - Lam KS., 2006. Discovery of novel metabolities from marine actinomycetes. *Curr Opin Microbiol*; 9: 245-251.
3 - Cook A. E. and Meyers P.R. 2003. Rapid identification of filamentous actinomycetes to the genus level using genus-specific 16S Rrna gene restriction fragment patterns. *Interna. Jour. of System. and Evolu. Microbio*., 53:1907–1915.
4 - Weisburg W.G., Barns S. M, pelletier D. A., and LANE D. J., 1991. 16S Ribosomal DNA Amplification for Phylogenetic Study. *Jour. Bac*., Vol. 173, 2 :697-703.

DIVERSITÉ BACTÉRIENNE AU COURS D'UNE ATTÉNUATION NATURELLE: DÉVERSEMENT PÉTROLIER DANS LES CÔTES TUNISIENNES

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Abstract
Notre objectif était d'étudier la diversité et d'élucider les éventuels changements dans la composition des populations bactériennes au cours d'un processus d'atténuation naturelle. Nous avons suivi la dynamique bactérienne *in situ* suite à un accident pétrolier qui a eu lieu sur les côtes Nord-Est tunisiennes. Pour ce faire deux banques de gène ont été construites durant les années 2005 et 2006 (K1-5 et K1-6). Cette étude a montré l'effet d'un déversement pétrolier dans la sélection de phylotypes adaptés aux degrés et à la nature des hydrocarbures présents appartenant essentiellement aux *Gammaproteobacteria* et aux *Actinobacteria*.

Keywords: Biomass, Biodiversity, Petroleum, Pollution, Tunisian Plateau

Introduction La bioremédiation repose sur l'utilisation des capacités naturelles de certains organismes à métaboliser les polluants [1]. La connaissance des microflores locales des sites contaminés et de leurs capacités intrinsèques de biodégradation est essentielle pour pronostiquer les chances d'atténuation naturelle du site pollué. Plusieurs études concernant la biodégradation de produits pétroliers, sur site ou au laboratoire, ont été effectuées [3]. En effet un des derniers défis que se sont lancés les recherches actuelles consiste à établir un lien entre diversité et fonction afin d'accéder à l'écophysiologie des microorganismes pour améliorer encore les rendements de décontamination par compréhension de leurs principaux acteurs. Ce travail est la première étude menée, suite au déversement pétrolier dans les côtes de kourbous, tunisie, pour suivre la dynamique des populations bactérienne.

Méthodologie L'échantillonnage d'eau de mer a été réalisé pendant les années 2005 et 2006. Suite à une extraction de l'ADN génomique total, deux banques ADNr16S ont été construites et notées K1-5 et K1-6. Les séquences obtenues ont étés soumises à une analyse de type BLAST contre la base de données GenBank. L'analyse fine de la diversité et la construction d'arbres phylogénétiques se fait ensuite grâce à la base de données ARB.

Résultats et discussion Un total de 156 et de 172 clones est obtenu respectivement pour K1-5 et K1-6 (Tab.1). Ces séquences ont montré un pourcentage de similarité variant de 89 à 100 % avec les plus proches parents. Cette étude a montré l'effet de la pollution par les hydrocarbures dans la sélection de phylotypes adaptés aux degrés et à la nature des polluants présents appartenant essentiellement aux *Gammaproteobacteria* et aux *Actinobacteria*.

Tab. 1. Caractéristiques des banques K1-5 et K1-6.

Banque	Nbre de clone	Nbre d'OTUs	Indice de diversité: Simpson	Chao	Shannon
K1-5	156	63	71,2	2,1	0,06
K1-6	172	84	67,1	2,83	0,1

La comparaison des deux banques (Fig. 1) montre que les changements au sein du domaine Bacteria se manifeste tant par des disparitions et des apparitions de phylum, d'une sous-division ou une division bactérienne. Ainsi nous avons enregistré comme changement majeure au sein des groupes bactériens, l'apparassion de la sous-division des *Actinobacteria* dans K1-6, non détectée au sein de la microflore K1-5 et qui devient majoritaire. A côté des *Actinobacteria* on note l'apparition dans K1-6 de groupes bactériens minoritaires comme : *Betaproteobacteria*, *Bacilli*, *Clostridia*, Unclassified_Bacteria et Genera_incertae_sedis_TM7. Par ailleurs la sous-classe des unclassified_Bacteroidetes qui est bien représentée dans la microflore K1-5 (26 clones) est non détectée dans K1-6. D'autres groupes bactériens minoritaires ont aussi disparu dans K1-6 à savoir : les *Bacteroidetes* et les *Verrucomicrobiae*. D'autres sous-divisions ont été détectées dans les deux microflores mais avec des proportions différentes dans le sens d'une diminution c'est le cas des *Gammaproteobacteria* et des *Flavobacteria*. Aussi d'autres sous-divisions ont été détectées dans les deux banques en gardant une même ampleur d'abondance comme les *Alphaproteobacteria*, les *Deltaproteobacteria* et les *Sphingobacteria*. Ainsi on peut dire que suite à un déversement pétrolier la diversité bactérienne tend vers la sélection des taxons impliqués dans la dégradation des hydrocarbures correspondant. Mais un retour à l'équilibre du départ tend à s'établir vers la fin de l'atténuation naturelle. L'identification de ces phylotypes présentant un intérêt en bioremédiation permet d'établir un lien entre la diversité microbienne et le fonctionnement en relation avec la nature du milieu et les conditions naturelles des écosystèmes. Cette étude réalisée in situ exprimera l'effet des paramètres physico-chimiques et biotiques affectant la dynamique des populations microbiennes en milieu marin, durant le processus de bioremédiation. Cette application de l'écologie moléculaire pourrait ainsi clarifier notre compréhension de la réponse des microflores natives suite à leur exposition au stress polluant.

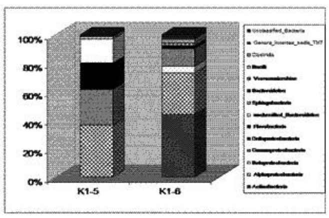

Fig. 1. Dynamique des populations bactériennes au cours de l'atténuation naturelle in situ de l'eau de mer de Kourbos.

Conclusion Cette étude pourra permettre à terme de caractériser plus facilement la dynamique et les interactions des consortia avec leur environnement et de déterminer les différents groupes bactériens impliqués dans la dégradation des hydrocarbures. Un tel suivi de la dynamique bactérienne serait l'étape primordiale dans la compréhension des procédés de bioremédiation in situ pour une meilleure application et une meilleure efficacité.

References
1 - Harayama S., Kishira H., Kasai Y. & Shutsubo K. 1999. Petroleum biodegradation in marine environments. J Mol Microbiol Biotechnol. 1(1): 63-70.
2 - Hamamura N., Olson S.H., Ward D.M. & Inskeep W.P. 2006. Microbial population dynamics associated with crude-oil biodegradation in diverse soils. *Appl Environ Microbiol*. 72: 6316-6324.
3 - Salanitro J.P. 2001. Bioremediation of petroleum hydrocarbons in soil. *Adv in Agron.* 72: 53-105.

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MICROBIAL ABUNDANCES AND METABOLIC FUNCTIONS OF SPONGE MICROBIOMES

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Abstract
Marine sponges are known to harbor dense and diverse microbial communities. In spite of considerable insights into the microbial diversity of marine sponges, quantitative information on microbial abundances and community composition as well as the functional gene repertoire remain scarce. Here we present our recent research contributions to the specific quantification of sponge microbes and to the elucidation of their possible functions.

Keywords: Porifera, Symbiosis, Microbiota, Mediterranean Sea, Red Sea

To gain quantitative numbers of sponge associated microorganisms, we established qPCR assays for the specific quantification of four bacterial phyla of representative sponge symbionts as well as the kingdoms *Eubacteria* and *Archaea*. We showed that the 16S rRNA gene numbers of *Archaea*, *Chloroflexi*, and the candidate phylum *Poribacteria* were 4-6 orders of magnitude higher in HMA (high-microbial-abundance) than in LMA (low-microbial-abundance) sponges. The actinobacterial 16S rRNA gene numbers were 1-2 orders higher in HMA over LMA sponges, while those for *Cyanobacteria* were stable between HMA and LMA sponges. Fluorescence *in-situ* hybridization (FISH) of *A. aerophoba* tissue sections confirmed the numerical dominance of *Chloroflexi*, which was followed by *Poribacteria*. Archaeal and actinobacterial cells were detected in much lower numbers (Fig. 1). By the use of fluorescence activated cell sorting (FACS) and whole genome amplification (WGA) as a primer- and probe-independent approach, the dominance of *Chloroflexi*, *Proteobacteria*, and Poribacteria in *A. aerophoba* was confirmed [1].

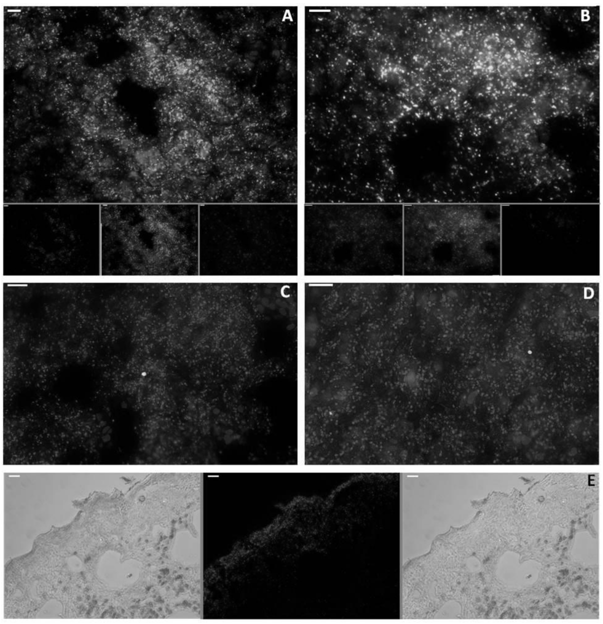

Fig. 1. Fluorescence in-situ hybridization on *A. aerophoba* sections for visualization. (A) *Poribacteria* using probe POR1130 (red), EUB338 probe mix (green) and DAPI staining (blue); (B) *Chloroflexi* with probe GNS934 (red); EUB338 probe mix (green) and DAPI (blue); (C) *Archaea* using probe Cren537 (green) and (D) *Actinobacteria* with probe HGC 237 (green), EUB338 probe mix (red) and DAPI; (E) light microscopy and cyanobacterial auto fluorescence in *A. aerophoba*. All red probes were cy3-labeled and the green probes were fluorescein-labeled. Additionally, DAPI was used for DNA-staining. Scale bars: 10µm (A-D), 50µm (E).

Secondly, the GeoChip 4 functional gene array was employed to interrogate the microbial functional gene repertoire of sponges (HMA and LMA) and seawater collected from the Red Sea and the Mediterranean. Altogether 20,273 probes encoding for 627 functional genes and representing 16 gene categories were positively identified. Minimum curvilinear embedding (MCE) analyses revealed a clear separation between the samples. Except for few documented specific differences (Fig. 2), the functional gene repertoire between the different sources appeared largely similar [2]. Our studies contribute to a better understanding of the HMA/ LMA dichotomy, provide new quantitative insights into sponge microbiology, and suggest that sponge-associated and seawater microorganisms may have most of their functional gene repertoire in common.

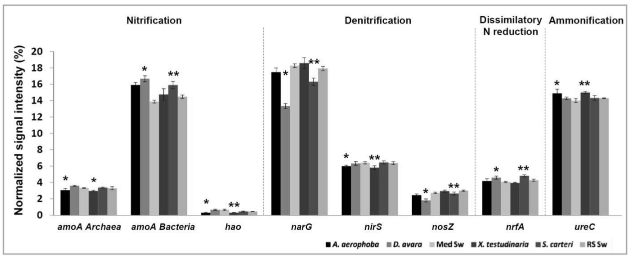

Fig. 2. Normalized average signal intensities of genes involved in nitrogen cycling. The microbial processes and corresponding genes are as follows: nitrification (archaeal and bacterial *amo*A encoding ammonia monooxygenase, *hao* for hydroxylamine oxidoreductase); denitrification (*nar*G for nitrate reductase, *nir*S for nitrite reductase, *nos*Z for nitrate reductase); dissimilatory N reduction to ammonium (*nrf*A for c-type cytochrome nitrite reductase); ammonification (*ure*C for urease). Data are presented as the mean ± SE. **: P<0.01, *: P<0.05. “Med Sw” and “RS Sw” stand for Mediterranean and Red Sea seawater.

References
1 - Bayer K, Kamke J, Hentschel U (2014) Quantification of bacterial and archaeal symbionts in high and low microbial abundance sponges using real-time PCR. FEMS Microbial Ecology 89, 679–690.
2 - Bayer K, Moitinho-Silva L, Brümmer F, Cannistraci CV, Ravasi T, Hentschel U (2014) GeoChip-based insights into the microbial functional gene repertoire of marine sponges (HMA, LMA) and seawater. FEMS Microbiology Ecology 90: 832–43.

ENZYME EXPRESSION PROFILES OF HETEROTROPHIC BACTERIA & NUTRIENT LEVELS IN SEA WATER, GÖKÇEADA ISLAND, AEGEAN SEA, TURKEY

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Abstract
The relationships between heterotrophic bacterial enzymes profiles and nutrient levels were investigated in the sea water samples taken from coastal and off-shore areas of the Gökçeada Island in the period between March 2012 and November 2013. Our results showed that the level of nitrate ($N–NO_3^-$), nitrite ($N–NO_2^-$), ammonia ($N–NH_4^+$), and phosphate ($P–PO_4^{3-}$) and chlorophyll-*a* have an influence on bacterial communities.

Keywords: Bacteria, Biodiversity, Nutrients, Aegean Sea

Introduction
Heterotrophic bacteria play a key role in marine biogeochemical cycling and food webs because of the wide diversity of their metabolic properties. The nutrient inputs offer dynamic media to bacteria that shape bacterial activity both in eutrophic and oligotrophic environment. In addition, the microbial community structure changes in terms of primer envrionmental variable parameters. The basic bio-geochemical processes in the water column is associated with the activity of heterotrophic bacteria (1).
In this study, enzyme expression profiles of the heterotrophic bacteria and nutrient levels in sea water around Gökçeada Island, Aegean Sea, Turkey were investigated regarding variations of bacterial ecto-enzymes and the trophic levels of the region with respect to nutrient levels.

Materials and Methods
The sea water samples were collected from 19 stations chosen from the coastal and off-shore areas of Gökçeada Island (Fig. 1). The samples were collected as seasonally for the autumn, winter and spring as monthly for the summer in 12 times in total between March 2012 and November 2013.

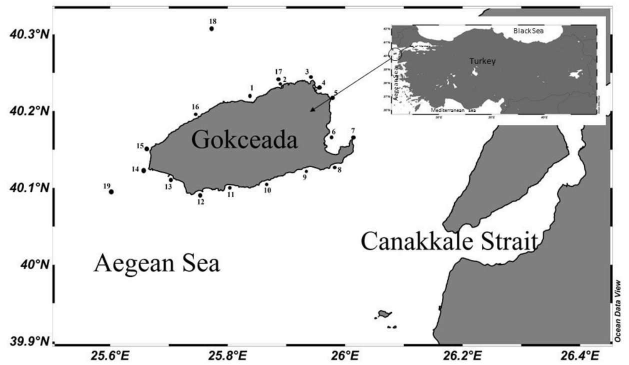

Fig. 1. Map of studying area (Schlitzer, 2014)

The bacterial isolates and enzymatic properties were identified with the automated micro identification system VITEK 2 Compact 30 (bioMerieux, France) (2). The nutrients and chlorophyll-*a* analyses were carried out by spectrophotometric method (3).

Results and Discussion
126 bacterial isolates belonging to fermenting and non-fermenting Gram negative bacilli (GN - 53.17%), Gram positive spore forming bacilli (BCL - 37.30%), Gram positive cocci and non-spore forming bacilli (GP-9.53%) identified during the study period. The bacterial isolates found in this study include species that are able to secrete large quantities of ectoenzymes. The Gram-negative (GN) isolates have been identified to be involved in destruction of Tyrosine (76% Tyrosine ARYLAMIDASE positive), glucose (64% D-Glucose positive), phosphate (52% phosphatase positive), mannose (51% D-Mannose positive) and the chemical bond of aryl-amide (51% L- Proline Arilamidase positive). The results showed that the GN isolates have lypolitic and proteolytic enzymes acitvities. It was found that the identified GP isolates can degrade the natural disaccharide (83% D-trehalose, D-Maltose positive). The 67% of GP isolates was recorded to be hydrolise the arginine and break down the aryl-amide chemical bond of the L-Pyrrolidonly. 50% of GP isolates was found as the glucose, mannose and saccarose positive. The defined Bacillus (BCL) isolates' biochemical characteristics react positively in the range between 50% - 98% showed sufficient enzyme activity for possible dissolved carbohydrates inputs of these areas. The isolates that have lipolytic and proteolytic enzym activities were detected to be the most abundant bacteria in the sea water. The enzymatic reactions of bacterial isolates offer us "warning signs" for understanding marine ecosistem functionings. For instance, the knowledge obtained showed that oligotrophic structure of the study area (for oligotrophic parts of the study areas) support natural enzyme activity of bacterial communities. Since nutrients and chlorophyll-*a* values were recorded between class I and IV (according to "Water Pollution and Control Regulation, 2004), our results imply that certain bacteria species isolated have potential importance in organic matter turnover in especially coastal part of studied areas. It was also recorded that percentage of the heterotrophic enzyme activity was higher in the coastal areas in summer seasons due to the fact that recreational activities. The percentage of bacterial enzymatic activity is associated with the positive correlation between heterotrophic bacteria and nutrients levels. This situation implied that the possible increases of pollution/nutrient inputs induce bacterial enzymatic activity. The data obtained related to bacterial enzyme profiles of the several parts of the study region showed that the region close to a fragile line and current state of the study region must be protected in the long term.

Acknowledgement This work was supported by Research Fund of the Istanbul University as a PhD thesis project (project no.17653).

References
1 - Danovaro, R., Tselepides, A., Otegui, A., Della Croce, N., 2000. Dynamics of meiofaunal assemblages on the continental shelf and deep-sea sediments of the Cretan Sea (NE Mediterranean): relationships with seasonal changes in food supply Prog. Oceanog., 46: 367– 400.
2 - Pincus D.H. 2005. Encyclopedia of Rapid Microbiological Methods. Volume 1. Ed. Miller, M. J. Chapter 1 Microbial Identification using the Biomérieux VITEK® 2 System Biomérieux, Inc. Hazelwood, MO USA PDA/DHI 1-32.
3 - APHA. 2000. Standard Methods for the Examination of Water and Wastewater 20th Edition. Clesceri, L.S., A.E Greenberg and A.D Eaton (eds). American Public Health Association, American Water Works Association and Water Environment Federation. Washington, D.C.
4 - Schlitzer R. 2014. Ocean Data View. http://odv.awi.de

SYMBIOTIC CALCIFYING BACTERIA ACROSS SPONGE SPECIES AND OCEANS

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Abstract
In this study, we pursued to analyze the microbiome of phylogenetically and geographically distant sponge species, which harbor calcareous spherules of a purported bacterial origin. The analyzed sponges were spread along the circumtropical belt. The results showed the dominance of proteobacteria in all the species examined but two. The targeted calcibacterium was retrieved in *H. columella, H. arabica, C. viridis* and *C.alloclada*. However, other bacteria also produced calcareous spherules in *Hemimycale sp*. (Mediterranean) *Crella cyathophora* (Red Sea), Cinachyrella sp. (Caribbean) what indicates that calcifying symbioses between sponges bacteria are widespread. The results reinforce the hypothesis on bacteria involvement, through symbiotic associations, in skeletonization processes of early Metazoans.

Keywords: Mediterranean Sea, Red Sea, Symbiosis, Bacteria, Porifera

Introduction

Sponges are important members of benthic ecosystems in terms of both abundance and diversity [1]. They harbor huge amounts of symbiotic bacteria within their tissues, which have been reported to play several roles in nutrient cycles, production of secondary metabolites or sponge protection from predators [2]. The latter function has been recently documented for an abundant endosymbiotic bacterium found in the mesohyle of the Atlanto-Mediterranean sponge *Hemimycale columella*. The bacterium calcifies within vacuoles of a particular sponge cell (calcibacteriocyte) forming a calcareous envelope, which is easily visible through light microscope [3]. Hundreds of calcibacteria envelopes accumulate at the sponge periphery forming a kind of rudimentary exoskeleton. Recently this bacterium has been identified as an alphaproteobacterium, representing up to 67% of the sponge microbiome [4]. The aim of this study was to seek out the presence of calcibacteria in sponges other than *H. columella*, which have been observed through light microscope to contain calcareous spherules in high amounts and to compare the microbial communities of these sponge species across Seas.

Methods

The spherule bearing sponges analyzed were: *Hemimycale columella*, *Hemimycale sp., Cliona viridis* (Mediterranean Sea), *Hemimycale arabica*, *Crella cyathophora* (Red Sea), *Crella cyathophora* (Indian Ocean), and *Cinachyrella sp.* and *Cinachyrella alloclada* (Caribbean Sea). Three individuals per species were sampled by SCUBA diving and tag-pyrosequenced using a 454 Roche platform. Data obtained from pyrosequencing were analyzed using QIIME 1.4.0 pipeline [5].

Results and Discussion

The microbiome of the sponges harboring calcareous spherules was species-specific. Proteobacteria was the dominant (relative abundances ≥70%) phylum in all the species analyzed but *Cinachyrella sp.* and *C. alloclada*.

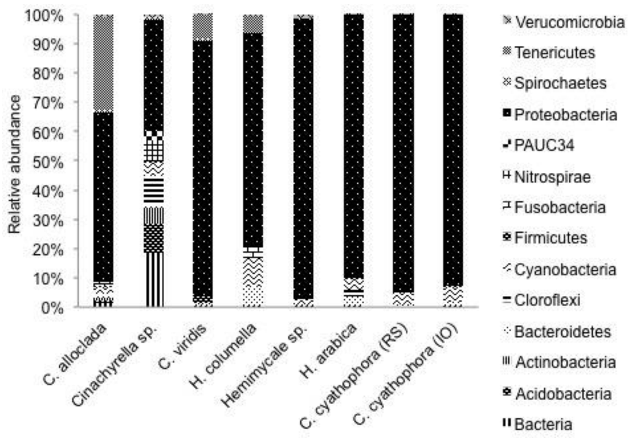

Fig. 1. Relative abundance of bacteria Phyla in the sponge species studied (OTUs with relative abundances ≤1% in a given sponge species were removed).

Furthermore, the calcibacterium of *H. columella* proved not to be species-specific but has also been recorded in *C. alloclada, H. arabica* and *C. viridis*. However, intracellular calcification is also produced by different bacteria in *Hemimycale sp*. (Mediterranean) *Crella cyathophora* (Red Sea) and *Cinachyrella sp.* (Caribbean) what indicate that the symbioses between sponges and calcifying bacteria are more widespread than previously believed. This particular type of symbiosis, which was totally unknown until 2012 [3], appears to be widespread among warm water sponges. These results support the hypothesis on the involvement of intracellular bacteria in the formation of calcareous skeletons in Early Metazoans.

References
1 - Bell J.J., 2008. The functional roles of marine sponges. Estuar. Coast. Shelf. Sci., 79: 341-353.
2 - Garate L., Blanquer A. and Uriz M.J., 2015. Calcareous spherules produced by intracellular symbiotic bacteria protect the sponge *Hemimycale columella* from predation better than secondary metabolites. Mar. Ecol. Prog. Ser., 523: 81-92.
3 - Uriz M.J., Agell G., Blanquer A., Turon X. and Casamayor E.O., 2012. Endosymbiotic Calcifying Bacteria: A New Cue To The Origin Of Calcification In Metazoa? Evolution (NY), 66: 2993–2999.
4 - Blanquer A., Uriz M.J. and Galand P.E., 2013. Removing environmental sources of variation to gain insight on symbionts vs. transient microbes in high and low microbial abundance sponges. Environ. Microbiol., 15: 3008–3019.
5 - Caporaso JG., Kuczynski J., Stombaugh J., Bittinger K., Bushman FD, et al., 2010. QIIME allows analysis of high-throughput community sequencing data. Nat. Meth., 7: 335-336.

THE OCCURRENCE OF *SPHINGOMONAS PAUCIMOBILIS* AND *S. THALPOPHILUM* IN VARIOUS MARINE REGIONS OF TURKEY

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Abstract
In this study occurrence and distribution of *Sphingomonas paucimobilis* and *S. thalpophilum were investigated* in the various marine areas of Turkey. The samples were collected from Turkish Strait System (TSS: The Sea of Marmara, Istanbul Strait/Bosphorus, Çanakkale Strait/Dardanelles), around Gökçeada Island and the Güllük Bay, Aegean Sea-Turkey at different time periods between 2002 and 2013. The isolates were analyzed by using the automated micro identification system VITEK 2 Compact 30 (Biomereux, France). The isolates were evaluated regarding isolated areas, pathogenicity and industrial potential.

Keywords: Bacteria, Biodiversity, Marmara Sea, Aegean Sea

Sphingomonadaceae are a family belonging to the *Alphaproteobacteria* class. They are Gram negative and commonly found in marine habitats, freshwater, soils and plants. They can produce exopolysaccharides such as sphingans which are useful for food and pharmaceutical sector and other industrial applications. Some species are able to degrade xenobiotic and aromatic compounds of various origins. Certain species of *Sphingomonas* were reported to be an interesting source of environmental bioremediation applications ([1], [2]).
In this study the sea water samples were collected from the Sea of Marmara, Istanbul Strait and Canakkale Strait (2002-2011), Güllük Bay (2011-2013) and Gökçeada Island (2013) (Figure 1). Samples were transported in cold chain to the Istanbul University Aquatic Microbial Ecology Laboratory between different time periods 2002 and 2013 ([3], [4], [5], [6]).

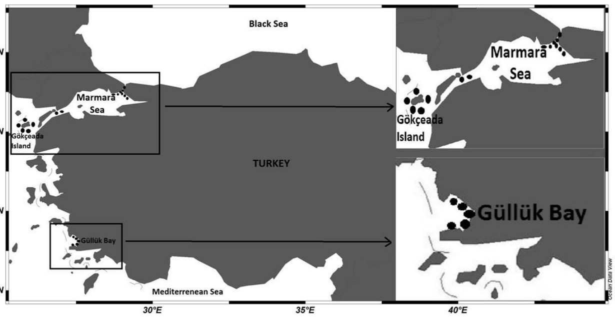

Fig. 1. Sampling sites in different marine regions of Turkey.

Regarding to Gram straining results isolates were identified using GN (Gram-negative fermenting and non-fermenting bacilli) cards in the automated micro identification system VITEK 2 Compact 30 (Biomereux, France) [7].
Two species were identificated as *Sphingomonas paucimobilis* and *S. thalpophilum* belonged to *Sphingomonadaceae* family. *S. paucimobilis* was isolated in the sea water samples taken from Istanbul Strait, the Sea of Marmara, Güllük Bay and Gökçeda Island (sea water and sponges). *S. paucimobilis* was also reported in the ballast water samples taken from the ships coming from various marine areas of the world to the Sea of Marmara [8]. *S. thalpophilum* was isolated in sea water samples taken from the Güllük Bay and around Gökçeada Island (Table 1).

Tab. 1. The Distribution of *S. paucimobilis* and *S. thalpophilum* in various marine areas of Turkey.

	Around Gökçeada Island (Sea water)	Around Gökçeada Island (Sponge)	The Sea of Marmara	Istanbul Strait	Güllük Bay, Aegean Sea
S. paucimobilis	+	+	+	+	+
S. thalpophilum	-	+	-	-	+
References	[5]	[4], [5]	[3]	[3]	[6]

Sphingomonadaceae family contain rare human pathogens but also have industrial potentials. However, *S. thalpophilum* was not reported neither pathogen, nor suitable for industrial applications. In this study, *S. thalpophilum* was isolated in the sea water samples taken from Güllük Bay and sponge samples collected from Yelkenkaya, Gökçeada, Aegean Sea, Turkey. *S. paucimobilis* was reported as a rare human pathogen. But also it was documented that *S. paucimobilis* is a useful strain for industrial applications ([1], [2]). In this study, both *S. thalpophilum* and *S. paucimobilis* were isolated to be sponge-associated bacteria. *S. paucimobilis* was recorded to be more common than *S. thalpophilum* in all marine areas of Turkey . *S. paucimobilis* was recorded in the Sea of Marmara, Istanbul Strait and Aegean Sea. The percentage of the frequency *Sphingomonadaceae* members among epibiotic bacteria was over than %50. These strains were stocked for further analyses.

References
1 - Laeser S., Kämpfer P., 2014. The family sphingomonadaceae. In: Rosenberg E, De Long E, Lory S, Stackebrandt E, Thompson F, editors. *The prokaryotes* SE–302. Berlin Heidelberg: Springer; pp 641–707.
2 - David L., Balkwill J. K., Fredrickson M. F., 2006. *Romine:Sphingomonas and Related Genera In: The Prokaryotes, A Handbook of the Biology of Bacteria*. Volume 7: Proteobacteria: Delta and Epsilon Subclasses. Deeply Rooting Bacteria ISBN 978-0-387-33493-6.
3 - Altug G., Çardak M., Çiftçi P. S, Gürün S., 2012. First records and micro-geographical variations of culturable heterotrophic bacteria in an inner sea (the Sea of Marmara) between the Mediterranean and the Black Sea, Turkey, *Turkish Journal of Biology*, vol.37, pp184-190.
4 - Altug G. Çiftçi Türetken P.S., Gürün S., Kalkan S., 2012. Topaloglu B., Screening of Potential Anti-bacterial Activity of Marine Sponge Extracts from Gökceada Island Aegean Sea, Turkey Ed. C. Turan, *First National Workshop On Marine Biotechnology and Genomics*, pp 39-53.
5 - Çiftçi Türetken P. S., Altug G., 2016. Bacterial pollution, activity and heterotrophic diversity of the northern part of the Aegean Sea, Turkey, *Environmental Monitoring And Assessment*, vol.188, pp 1-12.
6 - Altug G., Balkis N., Aksu A., Cardak M., Gürün S., Ciftci P. S., Kalkan S., Hulgar O., 2013. Investigation Bacteriological Analysis Of The Ecosystem Of The Gulf Of Güllük, *The Scientific and Technical Research Council of Turkey*. 110Y243 Technique Report.
7 - Pincus D. H., 2005. Encyclopedia of rapid microbiological methods. In: *Miller, M.J. (Ed.), Chapter 1 Microbial Identification Using the Biomérieux VITEK 2 System Biomérieux*, Inc., vol. 1. PDA/DHI, Hazelwood, MO USA, pp 1e32.
8 - Altug G., Gurun S., Cardak M., Ciftci P. S., Kalkan S., 2012. The Occurrence of Pathogenic Bacteria in Some Ships' Ballast Water Incoming from Various Marine Regions to the Sea of Marmara, Turkey, *Marine Environmental Research*, 81, pp 35-42.

FIRST REPORT OF *LEPTOLYNGBYA* (CYANOBACTERIA) SPECIES ASSOCIATED WITH MARINE SPONGES IN THE AEGEAN SEA

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Abstract
Sponge associations with cyanobacteria have been poorly investigated in the eastern Mediterranean. Herein, the marine sponges *Acanthella acuta, Chondrilla nucula, Dysidea avara,* and *Petrosia ficiformis* from the Aegean Sea were found associated with cyanobacteria of the genus *Leptolyngbya,* using culture-dependent methods. Four *Leptolyngbya* strains with distinct morphology and phylogeny, were isolated.

Keywords: Porifera, Symbiosis, Systematics, Aegean Sea, Algae

Introduction The association between cyanobacteria and sponges is thought to be one of the oldest microbe-metazoan interactions [1]. To date, cyanobacteria symbionts have been recorded in at least 100 sponge species [2]. Cyanobacteria species involved in such symbioses belong to the genera *Synechococcus*, *Synechocystis*, *Aphanocapsa*, *Oscillatoria*, *Cyanobacterium*, and *Prochlorococcus* [3]. Moreover, *Halomicronema* and *Leptolyngbya* species have been recently found in association with the sponge *Petrosia ficiformis* [4,5]. Although cyanobacteria may comprise 25-50% of sponge volume, we still lack a clear picture of their diversity and ecological role as sponge symbionts [2] especially in the eastern Mediterranean Sea. The present study is part of a broader research aiming to investigate the diversity of cyanobacteria associated with sponges in the Aegean Sea, on which no information exists.

Material and Methods Sponge samples were collected by Scuba diving at depths between 5-20 m, in October 2014. An 1 cm^3 portion of each sponge sample was briefly rinsed in 70% ethanol and rapidly transferred to sterile sea water. Each tissue was cut into thin sections and homogenised. Serial dilutions of the suspension were prepared in liquid MN medium. The cultures were incubated at 22 ± 1.0 ^oC under white fluorescent light and a light cycle of 12:12 hours. Morphological examination of cyanobacteria isolates were performed using a Zeiss Axio imager z2 microscope. The 16S rRNA gene was amplified from genomic DNA using cyanobacteria specific-primers 106F (5?-CGG ACG GGT GAG TAA CGC GTG-3?) and 23S30R (5?-CTT CGC CTC TGT GTG CCT AGG-3?). Partial 16S rRNA sequence data were obtained from cyanobacteria strains and compared with other sequences available in GenBank using Blastn. The phylogenetic tree was constructed by the maximum likelihood method using Mega 6.06 [6], applying a GTR + G + I model of nucleotide substitution.

Results and Discussion Four cyanobacteria strains (denoted AUTH 0915, 1215, 1015, and 1115) were isolated from the sponges *P. ficiformis*, *C. nucula*, *D. avara,* and *A. acuta*. *Morphology*. Filaments were densely and irregularly entangled, joined in clusters. Sheaths were mostly diffluent, rarely distinct and colourless. Cells were longer than wide in three stains (AUTH 0915, 1015, 1215), whereas in AUTH 1011 strain they were shorter than wide. Trichomes had pink or pale purple colour. The four isolates exhibited all the typical features of *Leptolyngbya* [7] but none of them had all the morphological characters of any species of the genus. *Phylogenetic analysis*. Strains AUTH 0915, 1015, and 1115 formed a separate subcluster close to the marine *L. ectocarpi* cluster, whereas strain AUTH 1215 was placed outside this clade (Fig. 1). Strains AUTH 0915 and 1015 showed 98% pairwise sequence similarity with *L. ectocarpi* strains, whereas strains AUTH 1115 and 1215 showed 97% similarity. This is the first record of filamentous cyanobacteria (*Leptolyngbya*) living in association with the sponges *C. nucula*, *D. avara,* and *A. acuta*. Previously, *Leptolyngbya*-likestrains have been isolated from the sponge *P. ficiformis* [4], one of them being the novel species *Halomicronema metazoicum* [5]. The observed differences in morphology, phylogeny, and ecology suggest that the *Leptolyngbya* strains isolated in this study could be new species, but further investigation is required. For the time being, the strains were assigned to the taxon *Leptolyngbya* sp.

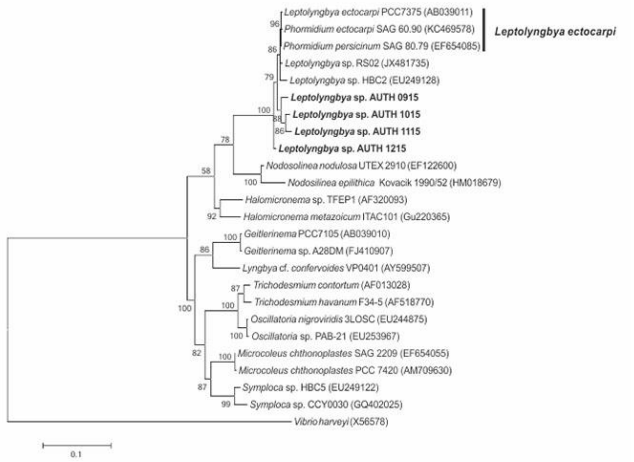

Fig. 1. Phylogenetic tree based on 16S rRNA gene sequences and reconstructed using the maximum–likelihood (ML) analysis. Numbers above branches indicate the bootstrap value (as percentages of 1,000 replications). Strains of the present study are indicated in bold, GenBank accession numbers are indicated in brackets. Bar represents 0.1 nucleotide substitutions per site.

References
1 - Taylor M.W., Radax R., Steger D. and Wagner M., 2007. Sponge-Associated Microorganisms: Evolution, Ecology, and Biotechnological Potential. *Microbiol. Mol. Biol. Rev.*, 71: 187-190.
2 - Thacker R. and Freeman C. J., 2012. Sponge-microbe symbioses: Recent advances and new directions. *In*: Becerro M.A. (ed.), Advances in Marine Biology. Academic Press, pp 57-111.
3 - Usher K.M. 2008. The ecology and phylogeny of cyanobacterial symbionts in sponges. *Mar. Ecol.*, 29: 178-192.
4 - Pagliara P. and Caroppo C., 2011. Cytotoxic and antimitotic assessment of aqueous extracts from eight cyanobacterial strains isolated from the marine sponge *Petrosia ficiformis. Toxicon*, 57: 889-896.
5 - Caroppo C., Albertano P., Bruno L., Montinari M., Rizzi M., Vigliotta G. and Pagliara P., 2012. Identification and characterization of a new *Halomicronema* species (Cyanobacteria) isolated from the Mediterranean marine sponge *Petrosia ficiformis* (Porifera). *Fottea Olomouc* 12: 315-326.
6 - Tamura K., Stecher G., Peterson D., Filipski A. and Kumar S., 2013 MEGA6: Molecular evolutionary genetics analysis version 6.0. *Mol. Biol. Evol.*, 30: 2725-2729.
7 - Komárek J. and Anagnostidis K., 2005. Cyanoprokaryota-2. Teil/2nd Part: Oscillatoriales. *In*: Büdel B. (ed.), Süsswasserflora von Mitteleuropa 19/2. Elsevier/Spektrum, Heidelberg, pp 759.

THE "HIDDEN" BIODIVERSITY: MEDITERRANEAN SPONGES AS UNIQUE HABITATS FOR SYMBIOTIC MICROBIAL COMMUNITIES

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Abstract
Mediterranean sponges are important components of benthic ecosystems in terms of biodiversity, function (i.e. nutrient cycles) and service (e.g., as sources of bioactive compounds). Most of these functions are mediated by ways of symbiosis with complex microbial communities. Sponges and their microbes are vulnerable to environmental as well as climate-related perturbations and have recently experienced episodes of mass mortalities in the Mediterranean Sea. Assessing the natural variability in microbial diversity within and between Mediterranean sponge species and understanding whether the microbiota affects the susceptibility/resistance of the animals to abnormal environmental conditions are key aspects for protecting these interactions.

Keywords: Porifera, Microbiota, Symbiosis, North-Western Mediterranean, Warming

Marine sponges establish symbiosis with a complex consortium of microbes [1,2]. Recent and on-going international efforts to characterize the microbiota of sponges haverevealed a core microbiota in phylogenetically and geographically distant sponges. Furthermore, a sponge-host specific microbial signature was identified, indicating that each sponge species harbors its own distinct microbiome (Fig. 1). To date, few studies have assessed the dynamics of the microbiota in Mediterranean sponges over spatial and temporal scales or how the symbionts respond to stressful environmental conditions.

The results discussed here derive mainly from studies on the sympatric Mediterranean sponges of the genus *Ircinia*: *I. oros*, *I. variabilis* and *I. fasciculata* [3-5]. The host species signature of the symbiotic community is present also in these sympatric closely-related species. Host species specificity of *Ircinia* microbiota is maintained at different locations in the Western Mediterranean Sea (up to 600 km apart) and temporally stable despite seasonality in sea water conditions, as characterized by T-RFLP and Sanger sequencing of 16S rRNA gene. Within the same species, some intraspecific variability was detected, particularly within *I. variabilis* [2]. However, this variation did not mask the species signature.

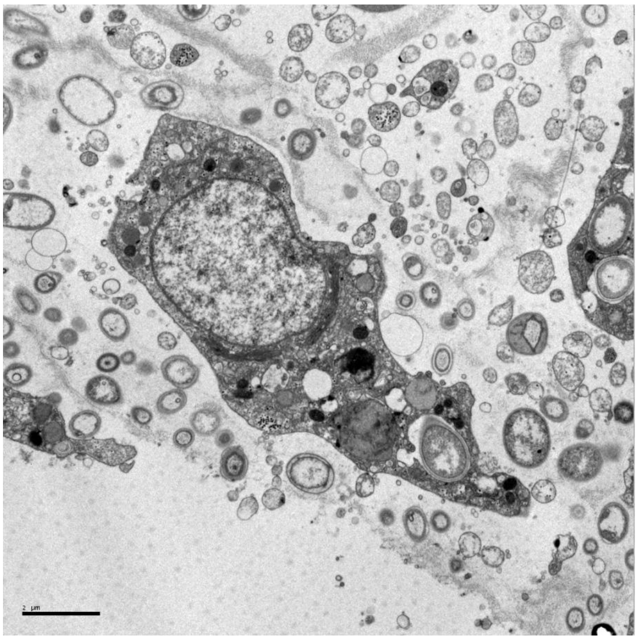

Fig. 1. Electron micrograph of *I. fasciculata* microbiota. Numerous and diverse morphotypes of microbial cells appear in the vicinity of animal host cells.

The recent episodes of mass mortalities in Mediterranean sponges, coinciding withat periods of abnormally warm and long summers (i.e., high temperatures during several weeks and longer period of stratification of seawater column), had different incidences among sympatric species [5]. It can be hypothesized that shifts in symbiotic communities may allow more plasticity and better response of the animals to changing environmental conditions [6], and also serve as early alarm of stress in the sponges. However, experiments in aquaria have shown that under stress-induced conditions in *I. fasciculata* (affected by episodic mortalities) and *I. oros* (unaffected) specimens a significant turnover of sponge microbiota was not detected over one month at the sponge individual level [4]. Symbiotic communities in sponges may thus endure under climate-related perturbations unless sponge health host is already compromised.

With respect to the high microbial diversity in Mediterranean Sea sponges, high-throughput sequencing has shown that each sponge species harbors a host-specific community and constitutes a unique microbial habitat [1]. The host-specificity as well as temporal/geographic stability of microbial communities within sponges may be favored by host mechanisms to prevent cheating by the symbionts. Whether the low individual flexibility in symbiotic dynamics is counter balanced at the population level by certain intraspecific variability in microbial composition is a hypothesis that needs to be tested. More extensive sampling efforts and long-term experiments under controlled conditions are needed towards this goal. A better understanding of sponge population connectivity and symbiosis establishment will help to assess the vulnerability of particular species and their populations in the Mediterranean Sea and allow the development of strategies to conserve the biodiversity and function provided by these organisms and their intimately associated microbes.

References

1 - Schmitt S, Tsai P, Bell J, Fromont J, Ilan M et al. (2012). Assessing the complex sponge microbiota: core, variable and species-specific bacterial communities in marine sponges. ISME J 6:564-576.
2 - Hentschel U, Piel J, Degnan SM, Taylor MW (2012) Genomic insights into the marine sponge microbiome. Nature Reviews Microbiology 10(9): 641-654.
3 - Pita L, Turon X, López-Legentil S and Erwin PM (2013). Host rules: spatial stability of bacterial communities associated with marine sponges (*Ircinia* spp.) in the Western Mediterranean Sea FEMS Microb Ecol 86:268-276.
4 - Erwin PM, Pita L, López-Legentil S and Turon X (2012) Stability of sponge-associated bacteria over large seasonal shifts in temperature and irradiance. Appl Environ Microbiol 78:7358-7368.
5 - Pita L, Erwin PM, Turon X, López-Legentil S. (2013) Till death do us part: stable sponge-bacteria associations under thermal and food shortage stresses. PloS One 11:e80307.
6 - Cebrian E, Uriz MJ, Garrabou J,Ballesteros E (2011) Sponge mass mortalities in a warming Mediterranean Sea: are cyanobacterial-harboring species worse off? PLoS One 6: e20211.

PLANKTON-BENTHOS CYCLE OF *SCRIPPSIELLA ACUMINATA* (THORACOSPHAERACEAE, DINOPHYCEAE) IN THE MAR PICCOLO OF TARANTO (SE ITALY)

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Abstract

The resting stage encystment-germination cycle has been investigated for the dinoflagellate *Scrippsiella acuminata* in the confined coastal basin of the Mar Piccolo of Taranto (South East Italy). The selected species is one of the most abundant in the basin, and, in the study period, it co-existed with other 46 phytoplankton *taxa* (mainly dinoflagellates) in the water column, and 76 resting stages (morphotypes) in the sediment. Two functional types of resting stages have been recognized, to permain in such a variable and crowded system.

Keywords: Plankton, Dinoflagellates, Sediments, Ionian Sea, Mediterranean Sea

Introduction

Resting stage production by planktonic organisms represents an adaptation to fluctuations of the environment on seasonal and/or pluriannual scales. In the muddy bottoms of confined marine areas, where conditions are more variable, high densities of plankton resting stages are present as an insurance against unforeseen events. Coastal systems are sometimes crowded by different species, but only few of them are active at each time. The competition for the exploitation of resources in the water column is resolved with the possibility to rest, waiting for a more favourable situation. The deriving network of interactions of biotic and abiotic environment with resting stages has been indicated under the term of Resurrection Ecology [1], and it is understandable only through an integrated approach of sampling and analysis both of pelagic (active plankton) and benthic (resting plankton) communities [2]. The Mar Piccolo of Taranto, a confined coastal basin in Apulia (South East Italy), is one of the most studied environments in the field of resting stage ecology. It hosts a well structured resting stage community, reaching densities of millions of cysts m^{-2} of bottom, with more than 180 morphotypes, representing dinoflagellates, ciliates, rotifers and copepods. The basin is being studied since more than 15 years about the presence and distribution of resting stages and their ecological role in plankton dynamics. Recently a research program has been launched to ascertain the diversity of life cycles of the most important species. Here is presented the first investigation, on a single *taxon*.

Materials and Methods

A study of the pelagos-benthos exchanges in the plankton of the Mar Piccolo has been planned at a single pilot station. Four collection methods have been contemporaneously executed (in brackets the sampled items): Niskin bottles and plankton nets (active stages in the water column); sediment traps (cyst production rate from the water column); sediment cores (cyst accumulation in the sediment); inverted traps, Niskin bottles very close to the sediment (cyst germination from the sediment). The study was carried out in two times: autumn 2010, and spring-summer 2011 to observe the cyst production/germination cycles and their consequences on the abundance of active populations. Data here presented refer only to *Scrippsiella acuminata* complex (Ehrenb.) Kretschmann, Elbr., Zinssmeister, S. Soehner, Kirsch, Kusber & Gottschling, one of the most abundant and common dinoflagellate *taxon* of the basin.

Results and Discussion

Only for phytoplanktonic *taxa*, a total of 76 resting stages morphotypes, and 47 active stages species have been found in the whole sampling set. *S. acuminata* was collected by all the sampling devices. The species presence in the water column (active stages) diminished from 140 x 10^3 to 5 x 10^3cells L^{-1} in autumn (September – December 2010), and grew in spring up to a pike of 145 x 10^3 cells L^{-1} in July 2011 (Fig. 1). The production of resting stages (cysts) and their sink to the bottom was strictly dependent by the active cell abundance in the water column, and showed a pike of 63±32 x 10^3 cysts m^{-2} d^{-1} in summer 2011 (July). The abundance of resting stages in the sediment, however, was relatively constant during autumn 2010, notwithstanding the production from the water column. Such a sinking flow determined a significant maximum of presence in the sediment, during spring 2011 (June) with 419±83 cysts g^{-1} dw. The inverted traps showed a certain activity of germination during autumn 2010. In fact, cells identified as *Scrippsiella* sp. were continuously detected from September to November 2010, but planomeiocytes of *S. acuminata* were observed only in July 2011. This explains the constancy of cyst concentration in the sediment during autumn, and its decrease, starting from June 2011, in correspondence of a growth of the active population in the water column. From these findings, it can be concluded that *S. acuminata* is a species complex, with a high intraspecific diversity [3]. In fact, it seems that at least two types of cysts are produced. One has a short time of rest and is responsible of the fast encystment-excystment cycle observed during autumn, while a second type has a longer mandatory resting period, ensuring the constancy of the cyst reservoir in the sediments, and it is subjected to a mass germination at the end of spring, that triggers the summer population bloom.

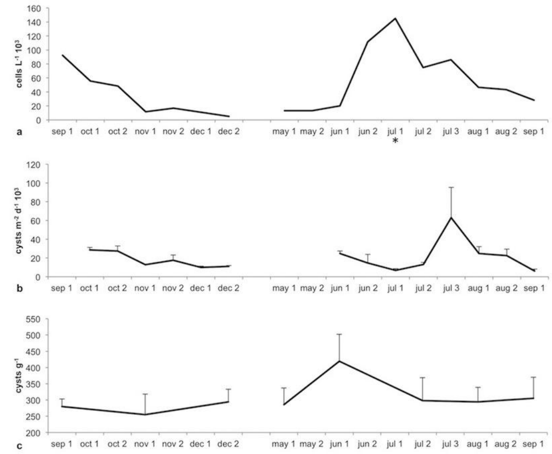

Fig. 1. The pelagos-benthos exchanges of the dinoflagellate *Scrippsiella acuminata* in the Mar Piccolo of Taranto (September 2010 - September 2011) a) active stages in the water column; b) resting stage production rates; c) resting stage dynamics in the sediment

References

1 - Kerfoot W.C and Weider J.W., 2004. Experimental paleoecology (resurrection ecology): Chasing Van Valen's Red Queen hypothesis. *Limnol. Oceanogr.*, 49: 1300-1316.
2 - Rubino F., Saracino O.D., Moscatello S. and Belmonte G., 2009. An integrated water/sediment approach to study plankton (a case study in the southern Adriatic Sea). *J. Mar. Syst.*, 78: 536–546. doi:10.1016/j.jmarsys.2008.12.023.
3 - Montresor M., Sgrosso S., Procaccini G. and Kooistra W., 2003. Intraspecific diversity in *Scrippsiella trochoidea* (Dinophyceae): evidence for cryptic species. *Phycologia*, 42: 56–70.

CIESM Congress Session : Phytoplankton I

Moderator : Martin Pfannkuchen, Center for Marine Research, Ruder Boškovic Inst., Rovinj, Croatia

Moderator's Synthesis

Acknowledging that phytoplankton taxonomy (like almost all taxonomy) is a still developing construct, research on phytoplankton is in great need of gathered and accessible information on phytoplankton species and morphological concepts. Current literature (books) is not up to date and does not cover the entire known range of species for the Mediterranean. Dynamic solutions like “algaebase” appear to be desirable. More effort to complete the dataset is greatly needed to help taxonomic research and education as well as to help unifying taxonomic concepts around the Mediterranean, not in the least as basis for the further exploration of genetic diversity.

A distinct lack of well annotated genomes of phytoplankton organisms is noted. This slows down the transgression towards postgenomic methods in phytoplankton research. We identified a lack of experimentally backed up knowledge about the physiology of phytoplankton species. This knowledge is key to further our understanding of Mediterranean ecosystem functioning as well as for using taxonomy based analyses for ecosystem analysis and predictive studies.

The power for ecological predictions and analyses of phytoplankton datasets is by far not fully employed in current monitoring setups.

DIATOM COMMUNITY IN THE DEPTHS OF THE SOUTH ADRIATIC: AN INJECTION OF CARBON BY BIOLOGICAL PUMP

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Abstract

Vertical distribution patterns of marine planktonic diatoms and the particulate organic carbon (POC) were investigated in the South Adriatic Pit in winter 2015. Diatoms were found in aphotic zone up to 400 m of depth, probably due to the phenomenon of the open sea vertical convection, but not followed by increased concentration of POC.

Keywords: South Adriatic Sea, Deep waters, Diatoms, Carbon

Introduction

Marine diatoms are the key players in the ocean carbon cycle and the sinking of cells after intensive bloom episodes is one of the proposed mechanisms for carbon injection by the biological pump. There is evidence of ubiquitous presence of healthy photosynthetic active diatoms across the global oligotrophic ocean at bathypelagic depths down to 4000 m [1]. Their vertical transportation rate is estimated to 124 - 724 m/day, i.e. time of few days to few weeks to reach the depths of the dark ocean [1]. A range of biological mechanisms can accelerate diatom cell sinking rates in situ such as formation of cell aggregates or by zooplankton faecal pellets, but also much faster physical mechanisms such as downwelling or wind-induced deep convection events. The general objective of this study was to analyse the distribution patterns of particulate organic carbon (POC) and couple it with diatom abundances in well mixed and highly dynamic situation during winter in the southern Adriatic Sea.

Methods

Sampling was carried out in March 2015 at 4 stations in the eastern part of the South Adriatic Pit: P600 42°24' N, 17°55' E; P1000 42°21' N, 17°47' E; M1000 42°21' N, 17°47' E; M600 42°27' N, 17°22' E. At each station CTD probe (SEA-Bird Electronics Inc., USA) casts were performed. The probe was additionally equipped with WET Labs FLNTU and Sea-Bird photosynthetically active radiation sensor (PAR). FLNTU was used to measure chlorophyll *a* (Chl *a*) fluorescence and turbidity that was converted to optical particulate backscattering (b_{bp}) needed for estimation of POC [2]. Water samples were collected by Niskin bottles at sampling depths indicated in Fig. 1A, determined *in situ* based on respective CTD profile. Sub-samples (200 mL) for phytoplankton analyses were preserved with hexamine-neutralized formaldehyde (final concentration of 1.4%). Cells were identified and enumerated using the Utermöhl protocol with the Zeiss Axiovert 200 inverted microscope.

Results and discussion

The surveyed area demonstrated circulation dependent high patchiness in distribution of surface Chl *a*. The analyses of satellite measurements obtained from MODIS satellite show a drop in surface chlorophyll for 20%, from Feb 20th to Mar 3rd 2015. The phenomenon of the open sea vertical convection, known for the South Adriatic Pit, is important due to the transport of nutrients from the deep reservoir into euphotic zone, enabling high phytoplankton production. Conversely, these events transport surface organic particles, including phytoplankton cells, to the deep sea at much faster rate than by regular sinking mechanisms. In our study, Chl *a* signal was detected up to 400 m depth (Fig. 1B), indicating recent subduction of the surface water. The measured PAR depths ranged from 66.5 to 74.5 m therefore the convective event brought phytoplankton cells down to the aphotic zone. The phytoplankton community at these depths was strongly dominated by diatoms found up to 500 m (Fig. 1A), corroborating findings from recent study by Batistic et al. [3]. These diatoms are referred to as "shade flora", a part of larger, deep dwelling phytoplankton community found up to 500 m of depth. Species of South Adriatic Pit "shade diatom flora" found at depths greater than 250 m are mostly large colonial forms such as *Pseudo-nitzschia pseudodelicatissima* (P600) with abundances up to 1900 cells L^{-1}, *Asterionelopsis glacialis* (M600) with 4500 cells L^{-1} and *Thalassionema frauenfeldii* up to 380 cells L^{-1} at M100 an
d M600. However, high number of different single-celled pennate species was present in deep samples, preliminary identified as *Navicula* cf. *distans*, *N.* cf. *directa* and species belonging to *Nitzschia* cf. bicapitata complex. Most of the members of “shade flora” found at great depths appeared in good physiological/ morphological state indicating their recent origin from shallow waters as diatom cell viability can range from 6.8 – 24 days [1]. Such diatom cells would eventually die due to the lack of light necessary for photosynthetic processes, but their carbon load was transported to depths. The results from optical measurements showed that POC was generally low, but with a peak at 300 m depth at M600, not corresponding with either Chl *a* concentration or diatom abundances. These results indicate that the sources of POC are either heterotrophic organisms or marine snow aggregates. Herbivorous zooplankton was rather abundant in the surveyed area (D. Lucic, pers. comm.) and most likely consumed the great portion of the diatom biomass. These further enhanced the diatom transfer to depths via packaging in faecal pellets, and injecting the diatom carbon and silica to the bottom layers of the water column in the South Adriatic Pit.

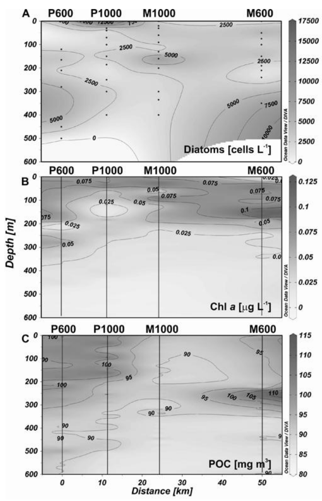

Fig. 1. Vertical distribution of: A) diatom abundances (sampling depths indicated with dots), B) chlorophyll *a* and C) POC.

Acknowledgements

This work has been supported by Croatian Science Foundation under the project BIOTA UIP-11-2013-6433.

References

1 - Agusti et al. (2015). Ubiquitous healthy diatoms in the deep sea confirm deep carbon injection by the biological pump. *Nature Comm.*, 6. 7608
2 - Cetinic, I. et al. (2015) A simple optical index shows spatial and temporal heterogeneity in phytoplankton community composition during the 2008 North Atlantic Bloom Experiment. *Biogeosciences*, 12, 2179-2194.
3 - Batistic et al.(2012) Biological evidence of a winter convection event in the South Adriatic: A phytoplankton maximum in the aphotic zone. *Cont. Shelf Res.* 44, 57-71

IN DEPTH CHARACTERIZATION OF MARINE CYANOBACTERIA COMMUNITY: TARGETING OF *PROCHLOROCOCCUS* ECOTYPES

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Abstract

Molecular tools are used in order to investigate ubiquitous marine cyanobacteria *Prochlorococcus* ecotype diversity and distribution patterns and its ecology is extensively studied in different oceanic regions. Still, little is known about *Prochlorococcus* microdiversity in the oligotrophic Adriatic Sea. In this study, by using ITS (internal transcribed spacer) as a molecular marker, presence of 2 *Prochlorococcus* populations corresponding to HLI (*P. marinus* MED4) and LLI ecotype (*P. marinus* NATL1A), were confirmed, showing high patchiness throughout the water layer.

Keywords: Cyanobacteria, Genetics, South Adriatic Sea

Introduction: *Prochlorococcus* is the most ubiquitous and important picocyanobacteria and the smallest photosynthetic organism of oligotrophic marine environments. It has an important ecological function as major contributor to primary production and carbon cycle [1]. Two major groups of *Prochlorococcus,* also known as ecotypes, inhabit different layers of the marine photic zone: (i) high-light or HL (clades HLI – HLIV), adapted to higher light intensities and (ii) low-light or LL (clades LLI – LLIV), adapted to lower light intensities. HL- and LL ecotypes also differ by their temperature acquirements and nutrient acquisition, both correlated to specific genome size and presence/absence of genes [1]. Presence of the genus *Prochlorococcus* in the Adriatic Sea is well known, but certain environmental ecotypes, as well as their vertical and horizontal distribution, are still not determined. The ongoing identifications of novel clades across the oceans indicate that the whole diversity of *Prochlorococcus* has not been fully recovered and increase the chances of new discoveries, especially in under-sampled areas of Adriatic Sea. Thus, the main aim of this study was to use molecular tools based on the marker gene for 16S-23S rDNA ITS region [2] in order to analyze genetic diversity and distribution patterns of *Prochlorococcus* populations in the vertical profile of the northeastern peak of southern Adriatic Sea water column.

Material and Methods: In March 2015 a cruise was conducted in the Southern Adriatic Pit. For the specific molecular analyses water samples were collected by Niskin bottles at 3 different depths (20, 80, 140 m) at the station P150A (42.33°N, 17.58°S) and immediately filtered (filters stored at -20 °C). Total genomic DNA was extracted from filters by using phenol-chloroform protocol [2]. Clone libraries were generated by PCR amplification of the 16S-23S rRNA ITS using the 2F-ITS and 3R-ITS primers [2] and subsequent cloning into pGEM®-T vector. In total, 96 positive clones from all depths were sent for Sanger sequencing (Macrogen, Netherlands). Retrieved sequences were edited and checked manually and compared to the NCBI Genbank database using Blast tool. Multiple sequence alignments were performed with ClustalX 2.1 and BioEdit softwares, with default parameters. MEGA 6 software was used to perform phylogenetic analysis, both Neighbour Joining (NJ) and Maximum Likelihood (ML). Bootstrapping was based on 1000 replications. ML tree was chosen as best suited for phylogenetic display.

Results and Discussion: From the total number of sequences analyzed in the dataset 69% belonged to the HL I clade / eMED4 while 23% belonged to the LL I clade / eNATL2A (8% belonged to the uncultured Cyanobacteria; Fig. 1). To our knowledge this is the first record of *Prochlorococcus* clades diversity in the Adriatic Sea. Results are comparable to the total distribution of *Prochlorococcus* communities found across water column of the Red Sea (80% of analyzed sequences belonged to HL-adapted and 20% to LL-adapted clade) [2]. In vertical profile, HL I clade-affiliated sequences were found at all depths, including 140 m. This was expected as HL I clade / MED4 is known to dominate in the Mediterranean where it was found up to 100 m depth due to adaptation to low amounts of phosphorous in the oligotrophic water environment [3]. LL I clade-affiliated sequences (23% of total sequences) were only found at higher depths (80 and 140 m) that correspond to intermediate water layer [2] while were absent at 20 m (Fig. 1). All analyzed LL clade-affiliated sequences clustered only with LL I / NATL2A ecotype, suggesting it as the predominant LL *Prochlorococcus* clade in the Adriatic Sea. In conclusion, diversity study of *Prochlorococcus* in the South Adriatic suggested that certain *Prochlorococcus* ecotypes occupy specific water depth while for other overlapping light-intensity niches were found. HL I clade/ MED4 was shown to dominate *Prochlorococcus* community throughout the water column, similar as reported for the Mediterranean. In contrast to this, the diversity at higher depths (80 and 140 m) exhibited varied compositions of both HL I and LL I / NATL2A clades. Ongoing research will reveal exact diversity and the abundance of *Prochlorococcus* community in the Adriatic Sea.

Acknowledgments: This work has been supported by Croatian Science Foundation under the project BIOTA UIP-11-2013-6433.

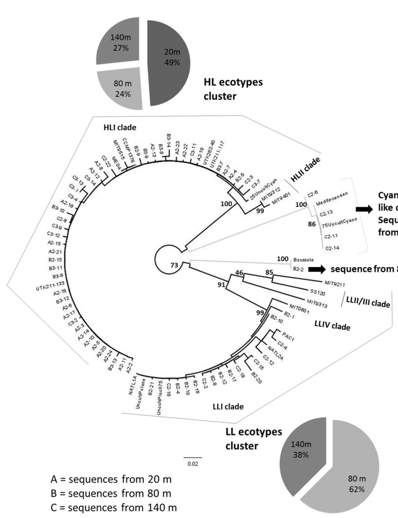

Fig. 1. ML phylogenetic tree showing the relationships of *Prochlorococcus* HL and LL ecotypes and clades, as well as the Cyanobacteria-like cluster. Branch support values of >75% are indicated.

References

1 - Biller et al. (2015) *Prochlorococcus*: the structure and function of collective diversity. *Nature Rev Microbiol* 13.1: 13-27.

2 - Shibl et al. (2014) Distribution and diversity of *Prochlorococcus* ecotypes in the Red Sea. *FEMS Microbiol Lett* 356: 118-126.

3 - Garczarek et al. (2007) High vertical and low horizontal diversity of *Prochlorococcus* ecotypes in the Mediterranean Sea in summer. *FEMS microbiology ecology* 60.2: 189-206.

TACKLING EXTREME BLOOM EVENTS IN THE MEDITERRANEAN SEA WITH THE COUPLED MITGCM-BFM NUMERICAL MODEL

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Abstract

Extreme algal blooms in the Mediterranean Sea were investigated using the MIT General Circulation Model coupled online with the Biogeochemical Flux Model, at a resolution of 1/12°x1/12°, with 75 vertical levels. Daily chlorophyll fields were analyzed with oxygen, nutrients and the main physical variables, to characterize the distribution of the blooms, at the surface and in the whole photic layer. A suitable definition of extreme blooms has been developed from the spatiotemporal probability density functions of the phytoplankton chlorophyll, considering peaks over thresholds, depending on the spatial location and the two ranges of depth. Preliminary results from a short run (years 1979-1981) are shown, in view of a longer simulation (1979-2012), which will provide both a suitable statistics and a climate value to the present study.

Keywords: Blooms, Phytoplankton, Models, Mediterranean Sea

Extreme events have been widely studied in hydrology and atmospheric sciences for several decades, whereas in the ocean sciences they have been analyzed only in more recent years, focusing mainly on wave height and sea level variability [1]. Investigating extremes in the ocean biogeochemistry is currently a new field of research, and it constitutes a major challenge in the characterization of the non-linear dynamics interconnecting the ecosystems biota and the physical environment. Three-dimensional coupled hydrodynamic-biogeochemical models are valuable instruments to describe the vertical processes in the ocean (e.g. the Ekman pumping, which brings the nutrients from the deeper layers up to the photic zone, 0-200 m), overcoming the limitation of the satellite data, which refer only to the first meters of the water column. Moreover, numerical models reproduce the spatial and the temporal dynamics of those biogeochemical properties that cannot be readily measured in wide areas at high frequency. This work aims to investigate extreme blooms in the Mediterranean Sea for the period 1979-2012 using the MIT General Circulation Model (MITgcm, [2]) coupled online with the Biogeochemical Flux Model (BFM, [3]). Our MITgcm implementation solves the incompressible Navier Stokes equations of the ocean on an Arakawa C-grid characterized by an horizontal resolution of 1/12°x1/12° and 75 vertical z-levels, forced at surface by the atmospheric fields (hflux, water flux and wind stress) dynamically downscaled (12 km) from the ERA-Interim reanalysis [4]. The BFM describes the mass fluxes of N, P, C and Si among the lower trophic level compartments, considering also chlorophyll, oxygen and other constituents in the plankton compartments, in the detritus and in the water dissolved phase. We forced BFM with the Era-Interim shortwave radiation [4] and with atmospheric ([5]) and riverine ([6]) inputs.

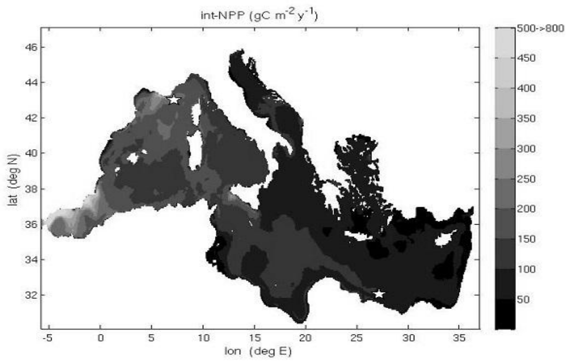

Fig. 1. Vertically integrated net primary production in the Mediterranean Sea derived by the MITgcm-BFM model for the 1981 year (gC m-2 y-1). Locations indicated by the white stars are a reference for the Figure 2.

Preliminary results from a short run were used to test the proper definition of the extreme events (i.e. suitable statistics to assess the extremes distributions and the temporal scale for climate evaluations), which will be used in the 1979-2012 run. The phytoplankton blooms were identified from the daily chlorophyll signals, triggered by the temperature, salinity and mixed layer depth dynamics and related to the nutrients and oxygen profiles and to the net primary production (Figure 1). In each horizontal grid point, the probability density functions (PDFs) of the chlorophyll integrated in the first 10 meters and in the photic layer were derived in order to provide a dataset comparable with satellite imagery and a complete description of the blooms, respectively. Extreme blooms were defined as peaks over the 99th percentile thresholds of the PDFs, depending on the horizontal location and on the two ranges of depth (Figure 2). Extreme blooms in the whole period considered will be finally mapped in space and time and investigated in connection with the external forcings, in order to evaluate how these latter can affect the extremes in the marine biogeochemistry.

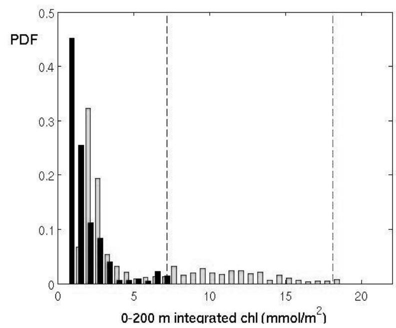

Fig. 2. PDFs of the model-derived chlorophyll integrated in the photic layer at 27°2' E, 32°5' N (black bars) and 7°29' E, 43°9' N (light gray bars) locations (white stars in the Fig.1), with dashed lines referred to the 99th percentile thresholds, for the years 1980-1981.

References

1 - Seneviratne S.I. et al, 2012. Changes in climate extremes and their impacts on the natural physical environment. In: A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, pp. 109-230.

2 - Marshall, J et al.1997. A finite-volume, incompressible Navier Stokes model for studies of the ocean on parallel computers. J. Geograph. Res. 102 (C3): 5753–5766.

3 - Vichi M., et al.,2015. The Biogeochemical Flux Model (BFM): Equation Description and User Manual. BFM version 5.1. BFM Report series N. 1, Release 1.1, , Bologna, Italy, http://bfm-community.eu, pp. 104.

4 - Med-CORDEX database (www.medcordex.eu).

5 - Ribera d'Alcalà et al.,2003. Nutrient ratios and fluxes hint at overlooked processes in the Mediterranean Sea, J. Geophys. Res. 108: 7/1-7/16.

6 - Ludwig W. et al.,2009. River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades? Progress in Oceanography, 80: 199-217.

RESPONSE OF MARINE PHYTOPLANKTON TO P-LIMITATION

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Abstract
Phytoplankton abundance in the northern Adriatic during the summer 2008 indicated that the system was productive, in spite of low orthophosphate (PO_4) concentrations. Mechanisms by which phytoplankton adapted to PO_4 deprivation during the summer stratification were studied.

Keywords: Phosphorus, North Adriatic Sea, Organic matter, Plankton, Enzymes

A number of studies in the northern Adriatic (NA) evidenced that this region is currently P-limited [2]. This shallow (up to 50 m) coastal sea receive high amount of freshwater nutrients, mainly from the Po River. However, river waters provides a strongly unbalanced nitrogen (N) versus phosphorus (P) supply (inorganic N:P atomic ratio about 84:1) [2] for phytoplankton requirements (16:1). The state of the art presented in this work derives from five cruises performed from June to October 2008. During the summer phytoplankton (~10^5-10^6 cells l^{-1}) induced high alkaline phosphatase activity (APA; Fig. 1) to obtain P from the dissolved organic pool (DOP), and the P turnover by phytoplankton APA was very short (2 min-1.5 h). A combination of high affinity enzymatic activity (K_m 0.41-2.55 µmol l^{-1}) and high hydrolysis rates (V_{max} 0.5-36.4 µmol l^{-1} h^{-1}) enabled metabolic flexibility to the phytoplankton in this heterogeneous and fluctuating environment. Low APA in October (Fig. 1) suggests that phytoplankton did not use DOP to obtain P, probably to the constant supply of PO_4 from the bottom.

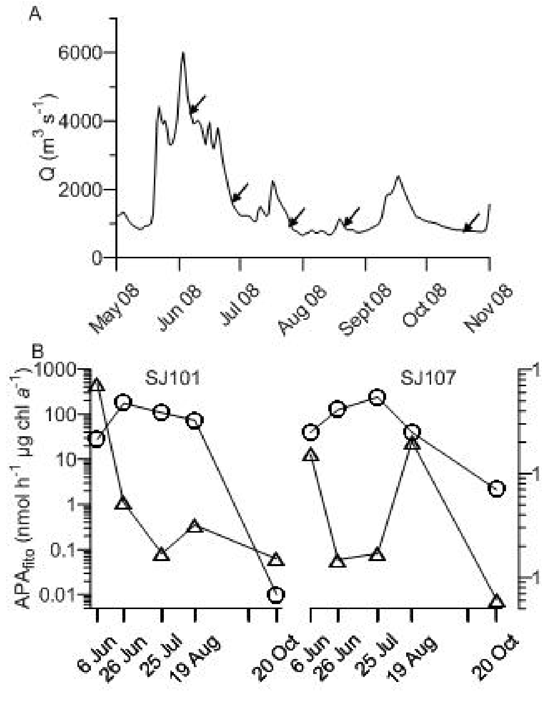

Fig. 1. (A) Daily mean of the Po River discharge rate (Q) with cruise dates denoted by arrows. (B) Changes of phytoplankton APA (open circle) and micro:nano ratio (open triangle) at surface of SJ101 and SJ107 during the year 2008.

A preferential synthesis of non-phospholipids (phospho:non-phospho lipid ratio; 0.4-0.7), which lasted still until October, indicated that the system was P stressed all the time. Only during the following winter months a preferential synthesis of phospholipids was observed (ratio about 1.5). Another possible mechanism of adaptation to the PO_4 deficit during the summer was a shift towards smaller cells. A higher nano:micro ratio was found during the summer than in October when microphytoplankton dominated or approached nanophytoplankton prevalence (Fig. 1). The highest ratios (up to 73.2) were found during the unbalanced nutrient freshwater supply. The smaller nanophytoplankton, supported by higher surface:volume ratios, were presumably able to produce more alkaline phosphatase, (ectoenzyme bound to the cell surface), and consequently were more successful in overcoming the P limitation. The PO_4 deficit during the summer could also contribute to changes in the microphytoplankton community. At the beginning of June this community was dominated by large diatoms and dinoflagellates (assemblage 1; Fig. 2).

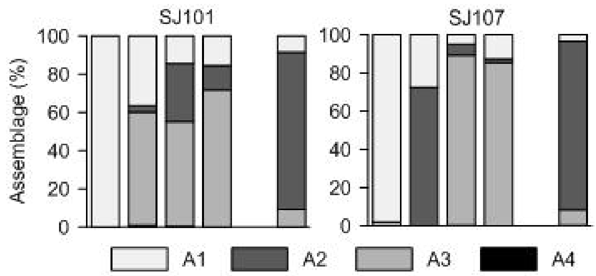

Fig. 2. Contribution of different assemblages in microphytoplankton community at surface of SJ101 and SJ107 during the year 2008.

During the summer the microphytoplankton was generally dominated by small species of Pseudo-nitzschia (assemblage 3). In October a shift towards bigger cells and a domination of assemblage 2 consisting of species of varying size, but larger than those of summer assemblage 3, was observed. The contribution of assemblage 4 with bentho-pelagic life-style in the microphytoplankton community was generally low. Preliminary results during the 2013 indicated that in P-limited conditions all species with considerable contributions to the microphytoplankton community expressed APA, rendering APA to be a very important prerequisite for success in the NA.

References
1 - Ivancic, I., Godrijan, J., Pfannkuchen, M., Maric, D., Gašparovic, B., Đakovac, T. and Najdek, M., 2012. Survival mechanisms of phytoplankton in conditions of stratification induced deprivation of orthophosphate: Northern Adriatic case study. *Limnol. Oceanogr.* 57:1721-1731.
2 - Cozzi, S. and Giani, M., 2011. River water and nutrient discharges in the Northern Adriatic Sea: Current importance and long term changes. *Cont. Shelf. Res.*, 31: 1881-1893.

COMPARING METHODS IN PICOPLANKTON ABUNDANCE ESTIMATION

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Abstract
In order to test and compare different methods for picoplankton abundance estimation, a 20-day growth experiment of marine *Picochlorum* sp. was conducted. Cells were harvested daily and its abundance was estimated using three methods (i) counting cells with Birken-Türk haemocytometer, (ii) flow cytometry and (iii) estimation of biomass through Chlorophyll *a* concentrations. Chl *a* concentration showed more similar trend as haemocytometer count suggesting the need for optimisation of each method when higher densities are considered.

Keywords: Analytical methods, Biomass, Chlorophyll-A, Phytoplankton, South Adriatic Sea

Introduction
Picochlorum sp. is a unicellular halotolerant picoalga (Trebouxiophyceae) that has been used multiple times for investigations of its biotechnological properties and potential usage in industry [1]. Importance of marine picoalgae in general have been recognized since their discovery in late 1970's as the "missing link" in the controversial carbon supply since they can contribute greatly to global carbon cycling, biomass and productivity in the sea [2]. Since their importance and challenges in its detection and biomass estimation due its size, we performed a study using *Picochlorum* sp. as model organism to distinguish the best-fit method for accurate estimation of its abundance/biomass during long term cultivation.

Material and Methods
Picochlorum sp. was isolated from south-eastern Adriatic Sea, Croatia and taxonomically identified using nuclear 18S rDNA and chloroplast 16S rDNA phylogeny. Xenic strain PMFPPE4 was used for laboratory growth rate experiment during 20 days. Growth was maintained in Guillard's F2 Marine Water Enrichment Solution (Sigma-Aldrich, United Kingdom) under constant conditions: temperature – 22°C to 22.5°C; light – 30 µmol photons m^{-2} s^{-1} with photoperiod of 16 h of light: 8 h of dark; continuously shaking on Orbital Shaker OR100 (Cole Parmer, UK) at the shaking frequency 80 rpm for 12 h during the day. Starting inoculate of Picochlorum sp. (cca. 10^6 cells mL^{-1}) was established in 200 mL Erlenmeyer flasks in triplicates. Cells were harvested daily and analysed with three different methods. For abundance estimation, cells were examined under inverted light microscope (Olympus BX51TF (Olympuse corporation, Japan) equipped with camera ARTCAM-300MI (Artray Co. Ltd, Japan) and counted using Birken-Türk haemocytometer chamber. Additionally, 1 mL of each triplicate from fresh culture was preserved with 0.1% glutaraldehyde (final conc.), deep frozen in liquid nitrogen, stored at -80°C and analysed with FACSCalibur flow cytometer (Becton Dickinson, San Jose, California). The samples were diluted to approx. same densities with F2 to avoid coincidence, and count was kept below 800 events/s. Number of cells mL^{-1} was then calculated and standard deviation (SD) was included in generating the growth rate graph. For HPLC analysis 1 mL of culture filtered through 0.7-µm-pore-size GF/F filters with syringe and a filter holder (Whatman, United Kingdom) and flesh frozen in liquid nitrogen. Chl *a* concentration was determined by reversed phase HPLC following the protocol of Barlow et al. [3]. Extracts were mixed 1:1 (v/v) with 1 M ammonium acetate and injected into an HPLC system equipped with 3 mm Thermo-Hypersil column MOS2 (C-8, 120 A pore size, 150 × 4.6 mm) (Thermo-Hypersil-Keystone).

Results and Discussion
Growth curve of *Picochlorum* sp. during 20-day experiment is shown in Fig 1. *Picochlorum* sp. showed acclimatization and steady growth during first 7 days of culturing after which entered exponential phase of growth that lasted until day 14. Afterwise stationary phase occurred with day 15, when cells started to aggregate on the bottom of Erlenmeyer flasks. Average daily growth was $1 \times 10^6 \pm 3 \times 10^5$ cells mL^{-1} (haemocytometer counts) and $2 \times 10^6 \pm 4 \times 10^5$ (flow cytometer counts). Average daily abundances in acclimatization ($9 \times 10^6 \pm 6 \times 10^5$), exponential ($3 \times 10^7 \pm 2 \times 10^6$) and stationary ($4 \times 10^7 \pm 2 \times 10^6$) phase according to haemocytometer counts were higher than those counted by flow cytometer: $2 \times 10^6 \pm 5 \times 10^5$ (stationary), $2 \times 10^7 \pm 3 \times 10^6$ (exponential) and $3 \times 10^7 \pm 5 \times 10^6$ (stationary). According to Chl *a* concentrations, daily concentrations in batch cultures during acclimatization phase were 5.84×10^4 ng L^{-1} after which concentrations increased during exponential phase (2.15×10^5 ng L^{-1}), and stabilized (5.14×10^5 ng L^{-1}) in stationary phase. Likewise, large peaks in Chl *a* concentrations after day 12 (as observed in haemocytometer counts) can be explained different behaviour of cells observed in older cultures (i.e. cultures that are in stationary/dying phase). The standard deviation of data obtained from triplicate by flow cytometer counts increases after 12 days, when cell densities are higher. This suggests that in spite of the sample dilution prior to analysis, the abundance counts are more accurate in lower cell densities in this instrument. To conclude, all tested methods give more accurate counts during exponential phase. So, that's not just the method, but the culture growth phase that needs to be considered.

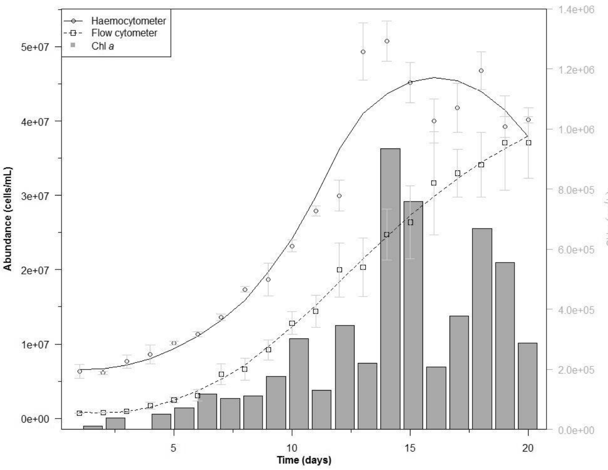

Fig. 1. The growth curve of *Picochlorum* sp. presented through three different methods (haemocytometer, flow cytometer and Chl *a* values) for three replicate cultures.

Acknowledgments
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References
1 - Zhu & Dunford (2013) Growth and biomass characteristics of Picochlorum oklahomensis and Nannochloropsis oculata. J Am Oil Chem Soc 90.6: 841-849.
2 - Li (1994) Primary production of prochlorophytes, cyanobacteria, and eucaryotic ultraphytoplankton: measurements from flow cytometric sorting. Limnol Oceanogr 39.1: 169-175.
3 - Barlow et al. (1997) Pigment chemotaxonomic distributions of phytoplankton during summer in the western Mediterranean. Deep-Sea Res Pt II 44: 833-850.

CIESM Congress Session : Phytoplankton II
Moderator : Paul Nival, LOV, France

Moderator's Synthesis

From the presentations and further discussions it appears a strong demand about taxonomy and as evidenced by the talks introducing the posters other questions were raised:

1 - Maintaining and promoting taxonomic approach for large phytoplankton cells along with counting (cytofluorimetry) and molecular biology methods.
Large diatoms species (like *Chaetoceros*) are making the phyto- biomass during the early phase of spring bloom. Processes underlying the species succession are not correctly documented and explained.
Important in the studies of impact of human activity on primary producers (dumping of sediments, waste water, etc.)

2 - Promoting genetic approach of phytoplankton not only to detect phylogenic structure but to analyse open sea processes.
Understanding the list of OTUs and its modification in time and space. Understanding the status of rare species as well as of the few dominant ones during blooming periods in the year.

3 - Promoting physiological studies of the dominant species involved in primary producers. An effort to develop some activity and skills on the cultivation of diatoms and dinoflagellates in the laboratory following the efforts done on *Ostreococcus*.
Most of dominant species are not yet cultivated (spring bloom diatoms, summer species) should become target species for research (example of the research effort on *Emiliana huexleyi*).

4 - Promoting research studies about the mechanisms of organic matter assimilation by phytoplankton species in oligotrophic waters.
This appears to be a key process in the primary producers development (summer conditions, succession of species, East Mediterranean environments).

5 - Promoting the use of mesocosms studies such as to complement laboratory methods and make the conditions of observation of processes closer to the *in situ* conditions than in small volume conditions.
Mesocosms are large tanks enclosing a water mass which might be continuously sampled and which is isolated from the physical processes of transport and diffusion.

6 - Need for developing some theoretical approach using modeling methods to complement the analysis of processes or events from the field or from mesocosms experiments.
Simple models of biological and chemical processes are useful and necessary to design experiments, to find the optimal conditions for sampling in open sea or mesocosms conditions.

General comment
« Phytoplankton » is used to indicate photosynthetic species. The size range of phytoplankton species is 0.2 to 200 mm. Three groups are usually considered according to size: pico, nano, micro-phytoplankton.

Small cells of picoplancton appear to lack specific morphological structures. They are detected by particle counting methods and molecular biology ones. On the opposite side of the size range, microphytoplankton cells wear specific structures. They can be observed either with a microscope in samples or with a flowcam in a continuous flow of water. They were collected with plankton net and a taxonomic expertise was based on their morphology. Image analysis could not completely replace experts. The impact on the food web structure of some processes such as species succession during bloom events is not completely understood. The expertise from phytoplankton taxonomists should be funded and developed.
The understanding of the conditions for a shift from multivorous food web to microbial food wed needs strongly such expertise on morphological taxonomy as a prerequisite to further biol. mol studies on focused species (toxic, harmful species, etc.).

Point de vue personnel :

Les milieux ou peuplements à protéger
Par ailleurs, je pense que le CIESM est l'organisme qui peut permettre une réflexion sur deux ou trois « case studies » permettant une approche intégrée d'un système naturel, zone marine de dimension fixée, couvrant une structure hydrodynamique à définir (tourbillon, frontière hydrodynamique, bassin, golfe, etc.) dont la dimension doit être fixée par les événements qui doivent être compris et dans laquelle l'homme est inclus comme espèce prédatrice (top prédateur), avec les effets collatéraux du continent. Préparation théorique dans le but de mettre en évidence, d'abord, le mode de travail et de mesure en mer. L'organisation d'un travail in situ devait alors s'inspirer de l'approche modèle, protocoles, base de données qui devrait sortir de cette période de préparation.

A partir de telles études, des suggestions de corridors permettant aux peuplements de se soutenir peuvent émerger. Existe-t-il une estimation de la dynamique de répartition spatiale d'une espèce à partir d'une source ? L'aventure de la *Caulerpa taxifolia* importée suggère la dynamique benthique et humaine à la fois. Poissons, méduses, cténophores, crabes, offrent d'autres modèles de distribution. Le thème « exotic species » a été un effort de connaissance et d'action par la CIESM remarquable.
Les corridors ou voies de transport, sont des éléments de base de l'organisation des métapopulations. Population dispersées sur des lieux différents mais échangeant des individus reproducteurs ou des propagules. Certains lieux disparaissent tandis que d'autres continuent des échanges et survivent. La génétique peut ici être un outil déterminant pour décrire pour une espèce, les éléments dispersés d'une métapopulation.
La connaissance de l'hydrodynamique, des capacités de reproduction et de la capacité de compétition avec un envahisseur donné, peut permettre de prévoir la solidité d'une bonne proportion des sites de la métapopulation. On peut alors estimer un certain degré de résilience du peuplement ou de l'espèce considérée, par les échanges entre les sites. L'homme intervient souvent en faisant décroitre la capacité de résistance de la métapopulation.
Toute place laissée libre, parce que l'activité humaine a éliminé un peuplement, sera colonisée par une espèce exogène (aliens), un nouveau peuplement, surtout si c'est l'activité humaine qui le transporte (propagules, larves dans le « ballast water »). La création de milieux artificiels, de réserves, peut être une solution pour compenser la mortalité induite par l'homme. Cependant c'est difficile pour les espèces planctoniques.
Sujet tout à fait intéressant qui forcément associe la Nature et l'Economie, avec les deux facettes de l'humain, la conservation et l'exploitation (économie de la conservation et économie de la production).

Taxonomie - phylogénie
La connaissance taxonomique qui disparaît était souvent mise en évidence dans les discussions. Disparaît-elle vraiment ?   Nouveaux outils, jeunes scientifiques.
Le coefficient d'impact des journaux scientifiques ne met pas en avant la reconnaissance des espèces. La signature génétique des espèces ne semble pas suffisante pour aborder les problèmes de dynamique des peuplements. La liste détaillée des espèces ou OTU (operational taxonomic unit) est seulement le premier pas à faire. La quantification des espèces, adultes et stades de développement est nécessaire pour prévoir l'évolution de chaque espèce d'un peuplement.
L'approche génétique est très utile pour préciser la classification des espèces et leurs rapport au cours de l'évolution, ainsi qu'identifier des « sous-espèces » impossibles à différencier à l'œil, en particulier dans les groupes sans morphologie spécifique (bactéries, pico, nano phytoplancton).
Existe-t-il un catalogue des compétences en taxonomie (plancton, benthos, poissons) dans les laboratoires méditerranéens ou extérieurs ?

SPATIAL AND TEMPORAL DISTRIBUTION OF DIATOMS IN SHELLFISH FARMS IN BOKA KOTORSKA BAY (SOUTH-EASTERN ADRIATIC SEA)

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Abstract
The spatial and temporal distribution of planktonic diatoms was analyzed in Boka Kotorska Bay. Results of water samplings conducted from November 2014 to April 2015 at three positions are presented. Maximum abundance of diatoms was 2.78 x 10^5 cells L^{-1}. Potentially toxic diatom genus, *Pseudo-nitzschia* spp. was one of the most frequent. Species indicators of nutrients enriched waters were dominant.

Keywords: Aquaculture, Diatoms, South Adriatic Sea

Introduction

Boka Kotorska Bay is an area located in the southeastern Adriatic Sea. There are 18 marine aquaculture farms located in the Boka Kotorska Bay area [1]. Shells, especially mussels are efficient filter feeders which feed on phytoplankton, among other groups, and because of such method of feeding, can accumulate toxins from toxic phytoplankton. Some species from genus Pseudo-nitzschia can produce the neurotoxin domoic acid that belongs to Amnesic Shellfish Poisoning (ASP). Growing of these species can cause problems in the ecosystem functioning and public health. The aim of this paper was to assess spatial and temporal distribution of diatoms on shellfish farms in the Boka Kotorska Bay.

Materials and methods

Sampling was performed from November 2014 to April 2015, on montly basis, at 2 positions in the inner part (Kotor Bay) of Boka Kotorska Bay and at one reference position in the open sea – Žanjic (Fig.1). Samples were taken using 5l Niskin bottles at four depths (0m, 2m, 4m and bottom). Phytoplankton cells were enumerated using Leica inverted microscope following Utermöhl [2].

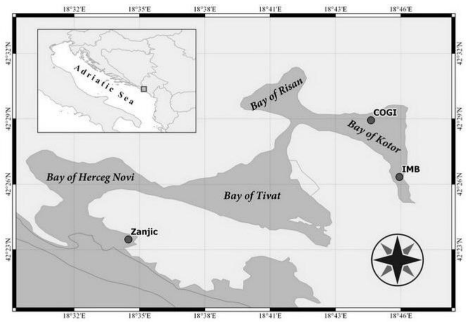

Fig. 1. Investigated area.

Results

Abundance of diatoms reached values on the order of 10^5 cells L^{-1} and highest abundance was in November on 2 m depth (2.78 x 10^5 cells L^{-1}) at the IMB position. Most of these dominant and frequent diatom species (*Chaetoceros affinis, Leptocylindrus mediterraneus, Proboscia alata, Pseudo-nitzschia* spp., *Thalassionema nitzschioides)* preferred nutrients enriched conditions [3]. In the current study, the frequently (with frequency of 89.85%) registered diatom genus, *Pseudo-nitzschia* spp., is considered potentially toxic (highest abundance was 1.85 x 10^5 cells L^{-1}).This potentially toxic diatom presented most of the microplankton. Diatoms belonging to the genus *Pseudo-nitzschia* are generally considered to be dominant in the phytoplankton of the Adriatic Sea [4]. The total list of planktonic diatoms found during investigated period in the Boka Kotorska Bay comprises 40 entries (Tab. 1).

Tab. 1. List of diatoms species found in the Boka Kotorska Bay during investigated period (max-maximum abundance; Fr(%)- frequency of appearance)

Taxon	Max (cells L^{-1})	Month	Position	Fr (%)
Diatoms				
Achnanthes brevipes	1200	Nov, Dec, Jan, Feb, Mar, Apr	IMB,COGI, Zanjic	20.29
Amphora ostrearia	120	Nov, Apr	IMB, COGI, Žanjic	8.69
Amphiprora sulcata	40	Feb, Mar	IMB, Zanjic	4.35
Asterionellopsis glacialis	200	Feb	COGI	1.45
Bacteriastrum hyalinum	69080	Nov, Feb	IMB,COGI	10.14
Bacteriastrum delicatulum	29045	Nov	IMB, COGI	2.90
Cerataulina pelagica	80	Dec	Žanjic	1.45
Chaetoceros affinis	39250	Nov, Dec, Feb, Mar	IMB, COGI	11.59
Chaetoceros spp.	4710	Feb, Apr	IMB, COGI, Zanjic	2.90
Cocconeis scutellum	160	Nov, Dec, Jan, Feb, Mar, Apr	IMB, COGI, Žanjic	26.09
Coscinodiscus perforatus	3140	Dec, Jan, Mar	IMB,COGI, Zanjic	15.94
Cylindrotheca closterium	40	Feb	Žanjic	1.45
Diploneis bombus	240	Nov, Dec, Jan, Feb, Mar, Apr	IMB, COGI, Zanjic	24.64
Grammatophora oceanica	680	Feb, Apr	IMB, Žanjic,	5.80
Hemiaulus hauckii	80	Dec, Feb, Mar	Zanjic	5.80
Hemiaulus sinensis	120	Feb, Mar	COGI, Žanjic	2.90
Leptocylindrus mediterraneus	1280	Nov, Dec, Feb, Mar	COGI, Zanjic	13.04
Licmophora paradoxa	240	Nov, Feb, Mar, Apr	IMB, COGI, Žanjic	14.49
Licmophora flabellata	240	Jan, Feb, Mar, Apr	COGI, Zanjic	15.94
Lioloma pacificum	320	Nov, Dec, Jan	IMB, COGI, Žanjic	13.04
Lithodesmium undulatum	1280	Jan, Feb, Mar, Apr	IMB, COGI, Zanjic	13.04
Melosira nummuloides	1920	Nov, Dec, Jan, Feb, Mar	IMB, COGI, Žanjic	24.64
Navicula spp.	1400	Nov, Dec, Jan, Feb, Mar, Apr	IMB, COGI, Zanjic	91.30
Nitzschia incerta	520	Dec, Feb, Mar, Apr	IMB, COGI, Žanjic	11.59
Nitzschia longissima	200	Nov, Dec, Mar	IMB, COGI, Zanjic	10.14
Neocalyptrella robusta	80	Mar	COGI	1.45
Odontella mobiliensis	40	Jan	COGI	1.45
Paralia sulcata	160	Nov	COGI	1.45
Pleurosigma angulatum	120	Nov, Dec, Jan, Feb, Mar	IMB, COGI, Zanjic	24.64
Pleurosigma elongatum	960	Nov, Dec, Jan., Feb, Mar	IMB, COGI, Žanjic	8.69
Pleurosigma formosum	920	Nov, Dec, Jan, Feb, Mar, Apr	IMB, COGI, Zanjic	15.94
Proboscia alata	800	Nov, Dec, Mar	IMB,COGI Žanjic	11.59
Pseudosolenia calcar avis	80	Nov, Dec, Feb, Mar, Apr	IMB, COGI Zanjic	14.49
Pseudo-nitzschia spp.	185260	Nov, Dec, Jan, Feb, Mar, Apr	IMB, COGI, Žanjic	89.85
Rhizosolenia imbricata	120	Nov	Zanjic	2.90
Rhizosolenia setigera	80	Nov, Feb	IMB, COGI	2.90
Synedra crystallina	80	Feb, Mar, Apr	COGI, Zanjic	5.80
Thalassiosira eccentrica	19625	Jan, Feb, Mar, Apr	IMB, COGI, Žanjic	15.94
Thalassionema fraunfeldii	240	Mar, Apr	IMB, COGI, Zanjic	7.25
Thalassionema nitzschioides	76930	Nov, Dec, Jan, Feb, Mar, Apr	IMB, COGI, Žanjic	100

Conclusion *Pseudo-nitzschia* spp. is only diatom genus known to produce a potent toxin which bioaccumulates in shellfish, impacting mussel aquaculture and contaminating farmed species with amnesic shellfish poisoning (ASP) toxin and which in the case of species that are highly toxic my result in significant consequences to the human health. However, several species of this genus are nontoxic or produce extremely low concentrations of toxin per cell [5]. Records of higher values of potentially toxic diatom genus *Pseudo-nitzschia* spp. indicates the necessity of continuous monitoring of this area, especially due to the fact that all Montenegrin mussel production is concentrated in the investigated area.

Acknowledgement This work has been supported by the Ministry of Science of Montenegro and HERIC project trough the BIO-ICT Centre of Excellence (Contract No. 01-1001).

References

1 - MONSTAT 2014. Statistical Office of Montenegro. *Year Book*. Podgorica.

2 - Utermöhl C.,1958. Zur Vervollkommnung der quantitativen Phytoplankton Methodik. *Mitt. Int. Ver. theor. angew. Limnol.*9*:1-38.*

3 - Revelante N. and Gilmartin M., 1985: Possible phytoplankton species as indicators of eutrophication in the northern Adriatic Sea. *Rapp.Comm. int. Mer Médit*.(CIESM), 11-19 October, Lucern, Switzerland, 29:89–91

4 - Vilicic D., Đakovac T., Buric Z. and Bosak S., 2009. Composition and annual cycle of phytoplankton assemblages in the northeastern Adriatic Sea. Botanica Marina 52, 291–305.

5 - Rhodes L., Scholin C. and Garthwaite I., 1998. Pseudonitzschia in New Zealand and the role of DNA probes and 402 L. L. Rhodes et al. immunoassays in refining marine biotoxin monitoring programmes. Natural Toxins, 6: 105–111.

MECHANISMS OF PHYTOPLANKTON SUCCESSION ACROSS STEEP SPATIO-TEMPORAL NUTRIENT GRADIENTS IN THE NORTHERN ADRIATIC.

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Abstract
The northern Adriatic (NA) is an ideal basin to study the adaptive strategies of plankton to a variety of conditions along steep spatio-temporal gradients. Earlier studies identified P-limitation as one of the key stresses within the NA that shape the biological response in terms of biodiversity and metabolic responses. A wide range of reports support the notion that P-limitation is a globally important phenomenon in marine ecosystems. In this study, microscopic analysis allowed the determination of phosphorus (P) stress of marine phytoplankton at species level along a trophic gradient in the NA. In P-limitation all species with considerable contributions to the phytoplankton community expressed alkaline phosphatase activity (APA).

Keywords: Phytoplankton, North-Eastern Mediterranean, Phosphorus, Nutrients, Enzymes

Growing evidence suggests that P is the limiting nutrient in several coastal systems and oligotrophic oceans. Furthermore, it is believed that the open ocean, far from continental inputs of nutrients, should evolve towards P-limited conditions due to N2 fixation, while P is a non-renewable limiting nutrient. The rise in N2 fixation and the simultaneous disappearance of P stocks observed in the subtropical North Pacific Ocean between 1989 and 2004 is an illustration of this phenomenon. Therefore, the importance of alkaline phosphatase activity (APA) with regard to the transformation and turnover of organic compounds in marine environments has been investigated with growing attention. A number of studies in the northern Adriatic (NA) evidenced that this region is currently P-limited. This shallow (up to 50 m) coastal sea is characterized by significant freshwater input, mainly from the Po River. Although in the Po River waters both nitrogen and phosphorus concentrations are more than one order of magnitude higher than in the NA waters, the inorganic N:P atomic ratio provides a strongly unbalanced N versus P supply for phytoplankton requirements. Earlier studies showed that in this area organic phosphorus concentrations markedly exceeded orthophosphate (PO4) concentrations, representing an important source of P for microbial communities. In the present study an AP substrate with insoluble fluorogenic product (ELF Endogenous Phosphatase Detection Kit (E6601) (Thermo Fisher Scientific, Waltham, USA)) was used to investigate how the APA status varies among phytoplankton species along the trophic gradient across the northern Adriatic. In a previous study we found that gradients in phosphate concentrations can modify the structure of plankton communities and can constrain phytoplankton distribution. We sampled (bimonthly) phytoplankton along a transect between Rovinj (Croatia) and the River Po mouth (Italy).

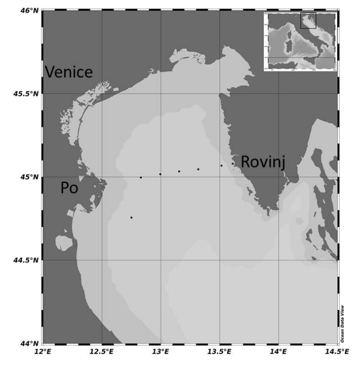

Fig. 1. The sampling area with sampling stations

We analyzed nutrient concentration, phytoplankton community structure and abindnces, bulk APA and species specific APA as well as further oceanographic conditions. Overall, in P-limited conditions all species with considerable contributions to the diatom community, with only a few exceptions, expressed APA, while only few dinoflagellate species expressed APA. Diatoms usually dominated the phytoplankton community, rendering APA to be seemingly a very important prerequisite for success in the NA. The observation of species in very low relative abundances that nevertheless did express APA, shows that APA expressing species do not necessarily dominate the phytoplankton community. This suggests that APA is also an important strategy for species to survive and maintain active metabolic state outside of their mass abundances or blooms. This allows them to immediately react on short term nutrient availability (e.g. riverine input). This feature appears to be very beneficial in a complex and fast changing environment with steep gradients of nutrient availability and point sources for nutrient input. Findings of co-dominating species in the diatom community that did not express APA, let presume that those species store P intracellularly, especially at the western site (close to the Po plume), and at the sampling time still lived on those pools. Other species did not express APA themselves, however bacteria attached to those cells did show APA. For these species a symbiotic relationship could be supposed, where the larger host diatom cell makes use of the APA expressed by the attached bacteria. Overall we found an astonishingly high within-species homogeneity of the ELF-signal. Species that did not show any ELF-signal did actually never (within one sample) show ELF-signal. While species that did show ELF-signal did show this signal in 97% to 100% of the observed intact cells. Additional in vitro experiments show an even more complex set of metabolic adaptations. The methods employed in this study increased taxonomic resolution with respect to earlier studies and allowed cellular localization of APA. These improvements uncovered a rather complex set of strategies to compete in P-limited conditions within the marine microphytoplankton community. This study also confirms the role of P-limitation as a shaping factor in marine ecosystems.

References
1 - Ivancic, I., Godrijan, J., Pfannkuchen, M., Maric, D., Gašparovic, B., Đakovac, T., Najdek, M. (2012) Survival mechanisms of phytoplankton in conditions of stratification induced deprivation of orthophosphate: Northern Adriatic case study. Limnol Oceanogr 57:1721-1731.
2 - Ivancic, I., Fuks, D., Radic, T., Lyons, D. M., Šilovic, T., Kraus, R., Precali, R. (2010) Phytoplankton and bacterial alkaline phosphatase activity in the northern Adriatic Sea. Mar Environ Res 69: 85-94.
3 - Hoppe, H.-G. (2003) Phosphatase activity in the sea. Hydrobiologia 493:187-200.
4 - Ivancic , I., Radic , T., Lyons, D.M., Fuks, D., Precali, R., Kraus, R. (2009) Alkaline phosphatase activity in relation to nutrient status in the northern Adriatic Sea. Mar Ecol Progr Series 378: 27–35.
5 - Pfannkuchen, M.,Schlesinger S., Fels A. and Bruemmer F.,2010, Microscopical techniques reveal the in situ microbial association inside Aplysina aerophoba, Nardo 1886 (Porifera, Demospongiae, Verongida) almost exclusively consists of cyanobacteria. Journal of Experimental Marine Biology and Ecology. 390(2): p. 169-178.

THE EFFECT OF WELL-AMELIORATION BRINE ON COASTAL MICROBIAL POPULATIONS IN THE SE MEDITERRANEAN SEA

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Abstract

This study investigates the role of well amelioration brines (WAB) on phytoplankton and heterotrophic bacterial abundance and production rates in the coastal SE Mediterranean Sea (SEMS) water - one of the most oligotrophic marine environments in the world. For that, we manipulated surface SEMS with N or WAB using mesocosms during summertime. Our results demonstrate that once added with N-rich additives, autotrophic biomass and production immediately increases, suggesting they are N limited. This is opposite to the open SEMS where autotropic microbes are co-limited by N and P. Contrary to autotrophs, heterotrophs remained unchanged; suggesting they are limited by other chemical constitutes than N. This information is essential to better understand the impact of nutrient loads from land-based sources in this oligotrophic environment.

Keywords: Primary production, Bacteria, Nutrients, Levantine Basin

Introduction

The Israeli Mediterranean coastal waters are characterized by low nutrient and chlorophyll levels (Raveh et al., 2015). Anthropogenic inputs of nitrate-rich well-amelioration brines (WAB) may greatly affect microbial populations by altering the community composition, production rates, nutrients recycling, etc. and hence the ecology of the coastal waters. In this study, we conducted several mesocosm (1-m^3 tank each) experiments that examined the short to medium term effect(s) of nitrate and WAB on ambient coastal SE Mediterranean Sea waters.

Material and Methods

Acid-washed polyethylene bags (1-m^3) supported by cylindrical plastic frames were deployed within a continuously circulating seawater to maintain ambient temperature of the experimental water during July 2015. Surface (2 m deep) coastal seawater from Haifa (Israel) was pumped and distributed homogenously between the mesocosm bags. Seawater was sampled for algal biomass (Welschmeyer, 1994), heterotrophic bacterial abundance (Vaulot and Marie, 1999), primary production (Steemann-Nielsen, 1952) and bacterial production (Simon et al., 1990).

Results and Discussion

Our results show that both the autotrophic populations and the primary production rates were significantly enhanced by the addition of either nitrate alone or WAB (Figure 1A,B, P<0.05), corresponding to the nitrogen-limiting conditions. Contrarily, the heterotrophic bacterial abundance and production rates were, overall not affected by any of these supplements (Figure 1C,D, P>0.05), suggesting that other limiting factors affect bacteria in this coastal system, possibly trace elements (Fe, Al, Cu), carbon, or the simultaneous limitation of several components. Lastly, the current ongoing and future plans for the expansion of brackish groundwater desalination will result in significant nitrogen loads along the coast. The results of this study will enable us to apply a better, science-based environmental policy.

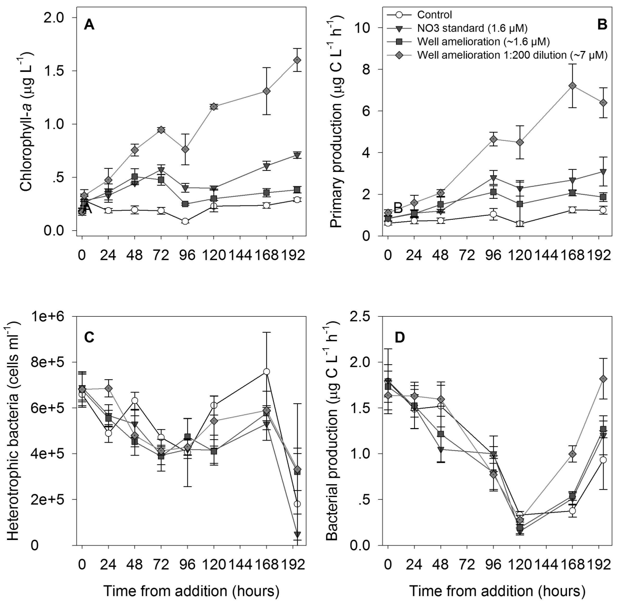

Fig. 1. Temporal changes in autotrophic biomass (A), primary production (B), bacterial abundance (C) and bacterial production (D) following the addition of well amelioration brine during July 2015.

References

1 - Raveh, O., David, N., Rilov, G., and Rahav, E. (2015). The temporal dynamics of coastal phytoplankton and bacterioplankton in the Eastern Mediterranean Sea. Plos One 10, e0140690. doi:10.1371/journal.pone.0140690.

2 - Simon M, Alldredge A, and Azam F. 1990. Bacterial carbon dynamics on marine snow. *Marine Ecology Progress Series* **65**: 205–11.

3 - Steemann-Nielsen E. 1952. On the determination of the activity for measuring primary production. *J Cons Int Explor Mer* **18**: 117–40.

4 - Vaulot D and Marie D. 1999. Diel variability of photosynthetic picoplankton in the equatorial Pacific. *Applied and environmental microbiology* **104**: 3297–310.

5 - Welschmeyer NA. 1994. Fluorometric analysis of chlorophyll a in the presence of chlorophyll b and pheopigments. *Limnology and Oceanography* **39**: 1985–92.

EFFECT OF DREDGED MATERIAL DUMPING INTO LOCAL (PICO-) PHYTOPLANKTON GROUPS OF NE MEDITERRANEAN

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Abstract
Dumping of dredged materials from coastal zone into the sea is a common threat to existing marine ecosystems. Less contaminated sediments from Samandag harbor and more polluted sediments from Mersin harbor were added in different amounts into coastal and off-shore plankton communities of NE Mediterranean. Chlorophyll developments show a stronger increase of biomass in the Mersin sediment added microcosms. The results indicate that long-term dumping activities may lead to result in biomass enhancement in the coastal zones and enclosed water bodies having limited exchange rates with the open sea, due to long lag-phases of biomass development.

Keywords: Phytoplankton, Mersin Bay, Mediterranean Sea

This study aims at assessing the combined effect of nutrients, and metals and organics extracted from sediments to seawater on the production and biomass enhancement of coastal and offshore plankton communities in the Mersin Bay, NE Mediterranean Sea. High and low harbor sediment concentrations of Samandag (4.5 g/L and 0.75 g/L) and Mersin (9 g/L and 1.5 g/L) were added to local coastal and off-shore phytoplankton communities sampled off Erdemli (Mersin Bay). Every 24 to 48 hours, chlorophyll-a, phytoplankton and nutrients were sampled and measured. Limited light penetration by suspended matter (Gameiro *et al*., 2011) might have inhibited photosynthesis leading to lower chl-a concentrations in the high sediment treatments; the results are illustrated in Figure 1. Enhancement of phosphate, silicate and nitrate+nitrite concentrations by sediment in the off-shore communities led to selective uptake of reactive –P in the treated communities within the first 72 hours (not shown), indicating P-limited algal production (Tüfekçi *et al*., 2013). Similar picture appeared in the silicate uptake rate for the on-shore communities, perfectly mirroring the chlorophyll-a increase, indicating diatom dominated on-shore communities.

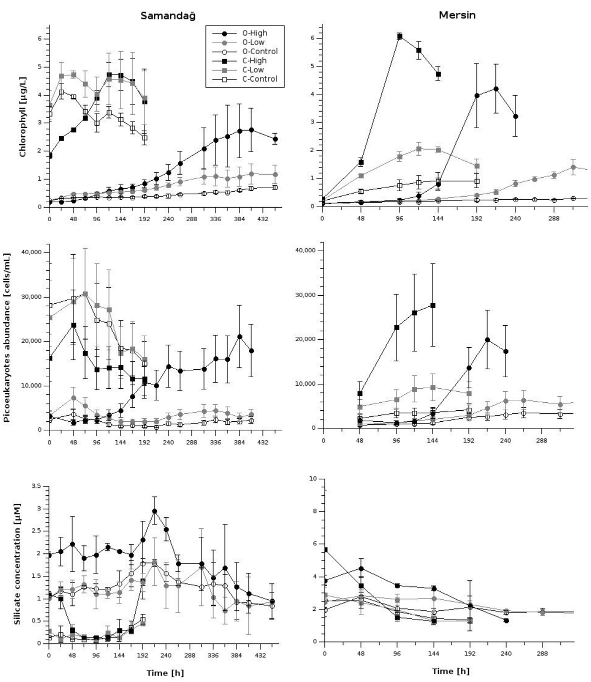

Fig. 1. Time-dependent development of chlorophyll and silicate concentrations, Picoeukaryote abundances in the Samandag (left) and Mersin (right) sediment added communities taken from the off-shore (O) and squares and the coastal zone (C) and circles of Mersin Bay off Erdemli; black-filled = high and gray-filled = low concentration, white=control

Oligotrophic off-shore communities are dominated by heterotrophic bacteria and small celled cyanobacteria, Synechococcus and Prochlorococcus (Agawin *et al*., 1998). Flow-cytometric analyzes clearly show marked enhancement in Synechococcus with the increased amouns of sediments added to the natural seawater samples. However, no Prochlorococcus enhancement was observed in the samples. Picoeukaryotes increase followed chlorophyll changes in the treatments.

All metal and total carbon (TC) concentrations were higher in Mersin sediment (Table 1) respectively to Samandag sediment whereby total organic carbon (TOC) and total nitrogen (TN) were higher in Samandag sediment. Higher TOC concentration might be the result of a higher productive area and thus higher POM export to the bottom. Even the concentrations are higher in Samandag sediment, the ratio of TOC/TN with 11.18 for Samandag and 12.9 for Mersin are within normal values and both higher than the Redfiel-ratio, suggesting that more labile fraction of POM in sediment already degraded by biochemical processes and limited inputs of labile organic pollutants into water column during dumping activities. However, metal contents of sediments might have a negative effect on algal production. For example, a significant toxicity of similar copper concentrations on phytoplankton and bacterial production was observed (Nayar *et al*., 2004).

Tab. 1. Metals components, total carbon, organic carbon and nitrogen concentrations in the sediments

Parameter per unit sediment	Cr [mg/kg]	Mn [mg/kg]	Fe [g/kg]	Co [mg/kg]	Ni [mg/kg]	Cu [mg/kg]	Zn [mg/kg]	Cd[mg/kg]	Pb [mg/kg]	Al [g/kg]
Samandağ	297	577	30,7	32,6	384	17,4	40,8	0,194	4,98	17,7
Mersin	372	644	45,7	35,2	683	24,7	76,7	0,38	22,8	38,8

Parameter per unit sediment	TC [mmol/g]	TOC [mmol/g]	TN [mmol/g]
Samandağ	3,48	1,01	0,09
Mersin	4,52	0,37	0,03

Comparison of these results indicates that dumping of dredged material into nutrient-rich coastal areas are expected to have limited contribution to the pelagic phytoplankton community as compared to its effect on the offshore community. Further, a lag-time of 96-144 hours in biomass increase appears to limit the effect on bigger celled species of one-time sediment dumping due to dilution of nutrients dissolved from dumped materials via regional currents.

Acknowledgment: This research was supported by TUBITAK/111G152 and TUBITAK BIDEB 2215

References
1 - Agawin, S.R., C.M. Duarte, S. Agustí, 1998. Growth and abundance of Synechococcus sp. In a Mediterranean Bay: seasonality and relationship with temperature. Mar. Ecol. Prog. Ser., 170: 45-53
2 - Gameiro C., J. Zwolinski, V. Brotas, 2011. light controle on phytoplankton production in a shallow turbid estuarine system. Hydrobiologica, 669: 249-263
3 - Nayar, S., P.B.L. Goh, L.M. Chou, 2004. Environmental impact of heavy metals from dredged and resuspended sediments on phytoplankton and bacteria assessed in in situ experiments. Ecotoxicology and Environmental Safety, 59: 349-369
4 - Tüfekçi, V., E. Kuzuyaka, H. Tüfekçi, G. Avaz, A.S. Günay, S. Tugrul, 2013. Determination of limited nutrients in the Turkish coastal waters of the Mediterraneanand Agean Seas. J. Black Sea/Mediterranean EnvironmentVol. 19, No. 3: 299-311

TEMPORAL DISTRIBUTION OF PHYTOPLANKTON IN CARDAK ESTUARY (DARDANELLES, TURKEY)

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Abstract

The study contains evaluation of the data collected (15 days intervals) during the samplings between 18 January and 22 December 2006, in the framework of a National project of TUBITAK-105Y103. Average cell concentrations of dinoflagellates, diatoms and other phytoplankton groups were $6.17\times10^{6}\pm4.06\times10^{7}$ cell L^{-1}, $7.13\times10^{6}\pm1.23\times10^{7}$ cell L^{-1} and $1.59 \times 10^{7}\pm7.32\times10^{7}$ cell L^{-1}, respectively. Average phytoplankton density was $1.81\times10^{7}\pm5.39\times10^{7}$ cell L^{-1} in the study period. Chlorophyll a and nutrient concentrations in the lagoon were higher than previous average concentrations in the Dardanelles.

Keywords: Toxic blooms, Dardanelles, Estuaries, Phytoplankton, Aquaculture

Çardak Lagoon is localized in Lapseki, Dardanelles (Fig.1). This lagoon is connected with a channel having average 4 m depth and 6.00 cm/sn water flow speed, but current speeds in lagoon inside are under 6.00 cm/sn except for near stations to the channel. The Dardanelles is located between the Aegean Sea and the Sea of Marmara.

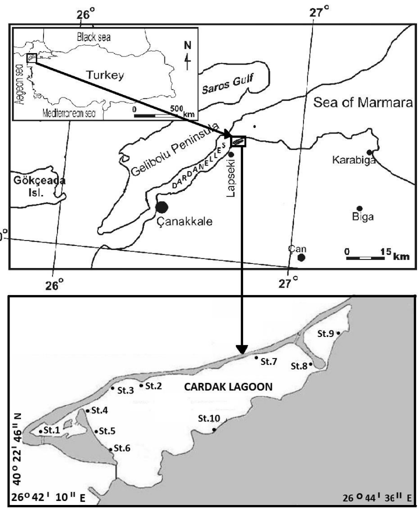

Fig. 1. Sampling stations in Cardak Lagoon (Dardanelles, Turkey)

This data were collected during the samplings between Jan. 18 and Dec. 22, 2006 (15 days intervals), in the framework of a national project of TUBITAK-105Y103. CTD parameters, nutrient and chlorophyll a were also measured by using YSI 556 MPS, autoanalizor and spectrophotometer, respectively [1]. Phytoplankton census were realized to Hasle [2].

While temperature, salinity, DO and pH varied from 2.92 °C to 30.2 °C, from 8.56 to 31.1 ppt, from 3.45 mg L^{-1} to 12. 8 mg L^{-1}, from 7.65 to 9.30, respectively. DIN, TP, IP, silicate, chla varied between 0.01 and 60.3 µM, 0.02 and 12.5 µM, 0.01 and 0.67 µM, 0.14 and 33.8 µM, 0.32 and 24.9 µg L^{-1}, respectively [3].

Dinoflagellates, diatoms and other phytoplankton groups varied between 0 and 4.70×10^{8} cell L^{-1} (average: $6.17\times10^{6}\pm4.06\times10^{7}$ cell L^{-1}), between 0 and 8.50×10^{7} cell L^{-1} (average: $7.13\times10^{6}\pm1.23\times10^{7}$ cell L^{-1}) and, between 0 and 9.43×10^{8} cell L^{-1} (average: $1.59\times10^{7}\pm7.32\times10^{7}$ cell L^{-1}), respectively in the lagoon. Total phytoplankton varied from 0 to 4.84×10^{8} cell L^{-1} (average: $1.81\times10^{7}\pm5.39\times10^{7}$ cell L^{-1}) during the study. It is clear that diatoms were more dominant than others in January-March and July-September periods. In the spring period, picoplankton such as coccoid cyanobacteria and coccolithophores were denser than others especially in April and May. It is important rise in the picoplankton abundant particularly at Sts. 7, 8 and 9 in autumn period. While dinoflagellates were abundant in May and June, diatoms were denser in winter-spring and August periods (Fig.2). Regarding cell density, while regional similarity varied from 23.8 to 76.2, temporal similarity varied from 31.5 to 73.0 according to Bray-Curtis analyses.

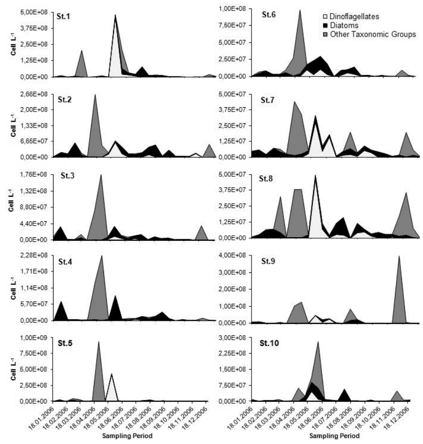

Fig. 2. Phytoplankton distributions in the Cardak Lagoon (Dardanelles)

In the lagoon, 1-2 unknown taxa from cyanophytes, 8 taxa from dinoflagellates (*Ceratium furca, C.fusus, Cylindrotheca closterium, Gymnodinium* sp., *G.spinifera, Oxytoxum rampii, Prorocentrum micans, P.minimum and Scripsiella trochoidea*), one taxon (*E.huxleyi)* from coccolithophores, 12 taxa from diatoms (*Dactilosolen fragilissimus, Grammatophora marina, Leptocylindrus* spp., *Navicula* spp., *Proboscia alata, Pseudo-nitzschia pungens, Rhizosolenia delicatula, R.setigera, Sceletonema costatum, Thalassionema nitzschioides and Thalassiosira* spp.) control community structure. Particularly, some dinoflagellates create excessive HABs in different periods and also create a high risk with regard to aquaculture. Except April-June, the dominancy of diatoms to other phytoplankton was important for feeding and aquaculture of carpet clam (Tapes decustatus). Although diatoms were dominant (66.8%) to dinoflagellates (23.3%) and others (26.1%), cyanophytes were denser than others especially in the second period of March and April. Extreme dinoflagelate density in May and June and substantially to be supported by the toxic ones showed that the lagoon was under very high risk especially in late spring and early summer in view of aquaculture. But, results showed that the lagoon is suitable in view of aquaculture fisheries, except for high risk periods, due to the high algal biomass, especially high diatom density.

References

1 - Strickland J.D.H. and Parsons T.R., 1972. A Practical handbook of seawater analysis, 2nd ed. Canada.

2 - Hasle G.R., 1978. Using the inverted microscope. *In:* Sournia A. (ed.), Phytoplankton Manual. Unesco, Pp. 191-196.

3 - Onal U., Buyukates Y., Turkoglu M., Celik I., Inanmaz O.E., Erdal H., 2008. Determination and optimization of production potantial of Ruditapes decussatus with characterization of ecosystem parameters in Çardak Lagoon (Lapseki, Çanakkale). *Tubitak Project Final Report,* TUBITAK-105Y103.

CIESM Congress Session : Harmful Algal Blooms (HABs)

Moderator : Anouk Blauw, MCI, Deltares, Delft, Netherlands

Moderator's Synthesis

Harmful algal blooms (HABs) can potentially have large negative impacts on human health and the introductory talk focused on the quantification of such impacts and their possible mitigation. Shellfish testing for algal toxins has prevented many cases of shellfish poisoning. However, it is unclear how many cases of shellfish poisoning could not be prevented, due to wild-picking of shellfish. The flash presentations showed new findings on the distribution and toxicity of potentially harmful algae species in Turkish, Lebanese and Tunisian waters, particularly of *Pseudo-nitzschia* and *Ostreopsis*. Furthermore progress was shown on Q-PCR measurements of *Ostreopsis* across Mediterranean waters and on the vulnerability of *Pseudo-Nitzschia* to pollution with polycyclic aromatic hydrocarbons.

We discussed present knowledge gaps that hamper the understanding and mitigation of human health impacts of HABs. One important issue is that many symptoms of shellfish poisoning, like diarrhoea, fever and vomiting can also be due to other causes and are therefore likely not to be recognized by patients and doctors. Many people are even unlikely to visit a doctor when they experience these symptoms. And if they do, the doctors will not report these cases to databases for research. Therefore, it is hard to estimate the human health impact of HABs and how it can be reduced. Another aspect is that we often do not know the distribution of harmful algal species in coastal waters and how toxins are transferred through the food-web. We discussed how fast Q-PCR methods can help to get more and cheaper measurement on the distribution of harmful algal species to enable reliable early warnings. The advantage of Q-PCR is that if you want to analyse many samples of a specific species, it is cheaper and faster than traditional analyses with the microscope. However, if you are also interested in other species and have relatively few samples, using a microscope is cheaper and more informative.

MONITORING OF BENTHIC HARMFUL ALGAL BLOOMS OF *OSTREOPSIS SP.* IN NAQOURA SOUTH OF LEBANON (EASTERN MEDITERRANEAN)

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Abstract

Within the framework of the ENPI-CBCMED program, project M3-HABs, funded by the European Union, a sampling campaign was established at the National Council for Scientific Research in Lebanon in order to monitor the development of Harmful Algal Blooms, in particular those of *Ostreopsis sp.* in Lebanese coastal waters. Planktonic water samples and benthic macroalgae samples were collected, with other parameters. In this present work, results obtained in Naqoura (South of Lebanon), from June 2014 to December 2015. will be shown. Air temperature ranged between 17.5°C and 36.3 °C, water temperature between 17.5°C and 31°C and salinity between 36.203 and 39.123. In both years, two yearly blooms were observed, with *Ostreopsis sp.* density reaching 228257 cell/g f in October 2014, and 264064 cell/g f in June 2015.

Keywords: Toxic blooms, Mediterranean Sea, Dinoflagellates

The occurrence of Harmful algal blooms (HABs) is a well-studied phenomena in the Mediterranean Sea (MS), due to its negative effects on economic sectors (aquaculture, fishing, and tourism), its environmental impact on aquatic ecosystems and risk to public health. In recent years, more attention has been accorded to the study of BHABs (Benthic Harmful Algal Blooms), due to increased occurrence of these events in recent years caused by species of genus Gambierdiscus, Prorocentrum and Ostreopsis (Fraga *et al*, 2012). In particular, Ostreopsis produces palytoxin-like metabolites, and has been linked to ecological impact and health problems, including skin irritations and respiratory difficulties (Lemée *et al.,* 2012). Its presence was first recorded in Western Mediterranean Sea in 1972 (Villefranche Bay, France) and in 1979 in Lebanese waters concerning the Eastern Basin (Abboud-Abi Saab, 1989). During the last decade, *Ostreopsis* species have been responsible of 3 important blooms in the Mediterranean Sea (Spain, Italy and Morocco), each time impacting more than 200 persons. In the aim of dealing with BHABs in the MS, with special reference to the genus *Ostreopsis*, a 2 year project the "M3-HABs" has been funded by the European Union within the framework of the ENPI-CBCMED program. The project partner from Lebanon was National Council for Scientific Research, National Center for Marine Sciences (NCMS), along with partners from France, Italy and Tunisia and other associated partners from Mediterranean countries. A preliminary sampling campaign was established at the NCMS starting June 2014. The objective was to monitor the development of harmful blooms of toxic benthic dinoflagellates along Lebanese coastal waters, with special emphasis on *Ostreopsis sp*. Five out of the initial 11 scanned sites, were chosen, covering the Lebanese Coast. Monthly sampling was conducted in all sites.

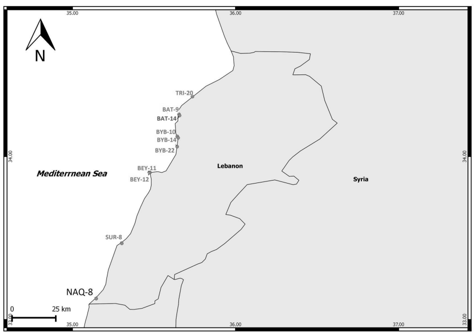

Fig. 1. Sampling sites of *Ostreopsis sp*. in Lebanese coastal waters

Ostreopsis sp. being an epiphytic species, both benthic (macroalgae) and planktonic (water) samples were collected at 50 cm and 30 cm depth respectively. Climatological (Air temp., wind speed and wind direction), Hydrological (Salinity, water temp), Biological (chlorophyll *a*) and Hydrobiological (nitrates, nitrites and orthophosphates) were also analyzed. Macroalgae was separated from the water, and *Ostreopsis sp*. cells were counted using a 1 ml Sedgwick-Rafter counting chamber. Ostreopsis concentrations were expressed as number of cells/g of fresh macroalgae (cell/g f) for benthic samples and cells/L for planktonic samples. Preliminary results of Ostreopsis sp. concentrations from June 2014 till December 2015 in benthic macroalgae samples in Naqoura (NAQ-8) at Southern borders of Lebanon will be presented. The site was chosen as it is considered a reference site unexposed to pollution.

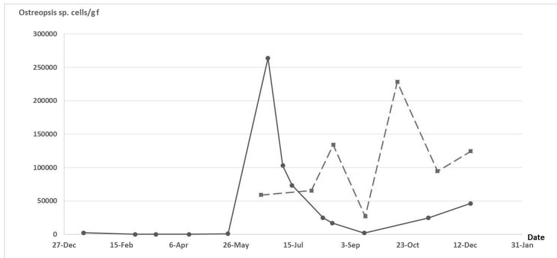

Fig. 2. Variation of benthic *Ostreopsis sp.* cell densities in NAQ-8 (cells/g f) in 2014 (dashed) and 2015 (line)

During this period, recorded air temperature varied between a min of 17.5°C (April 2015) and max of 36.3°C (May 2015). Recorded water temperature varied between a minimum (min) of 17.5°C (February 2015) and maximum (max) of 31°C (August 2015). Salinity varied between a min of 36.203 (January 2015) and a max of 39.123 (July 2014). In benthic macroalgae samples, *Ostreopsis sp.* was found year round in NAQ-8, except for February. This could be explained by the drop in sea water temperature (min 17.5°C), as *Ostreopsis sp.* is a thermophilic species. In 2014, the onset of the bloom occurred in the spring, thus preceding the start of the sampling campaign, with cell density of 59062 cell/g f in June, increasing gradually until the summer bloom reached its max cell density in August with 133864 cell/g f. The summer bloom was followed by a drop in cell densities in September, and a major autumn bloom in October with a max cell density of 228257 cell/g f. In 2015, the summer bloom occurred earlier compared to 2014, with max cell density reaching its highest of both years, of 264064 cell/g f in the June. It was also followed by a drop in cell densities in October, and a minor autumn bloom with a max of 46275 cells/g f in December

References

1 - Abboud-Abi Saab, (1989). Les Dinoflagellés des eaux côtières libanaises. Espèces rares ou nouvelles du phytoplancton marin. Leb. Sci. Bull., 5 (2): 5-16.

2 - Fraga S., Rodríguez F., Bravo I., Zapata M., Marañón E., (2012). Review of the main ecological features affecting benthic dinoflagellate blooms, Cryptogamie, Algologie, 2012, 33 (2): 171-179

3 - Lemée R., Chiantore M., Mangialajo L., (2012). Proceedings of the International Congress on Ostreopsis Development (ICOD, April 2011, France), Cryptogamie, Algologie, 2012, 33 (2): 79-80.

POTENTIALLY TOXIC PHYTOPLANKTON SPECIES AND ITS RELATIONSHIP WITH THE ENVIRONMENTAL FACTORS IN THE GEMLIK GULF (MARMARA SEA, TURKEY)

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Abstract
This study was carried on the toxic phytoplankton species and its relationship with the environmental variables in the Gemlik Gulf. The toxic phytoplankton assemblages related to environmental factors were investigated monthly at totally 5 stations and 7 different depths (0.5-50 m) between June 2010 and May 2011. The surface nutrient concentrations increased especially at the stations located inside of the gulf. The limiting effect of silicate for diatoms was observed in early, mid-summer and early winter periods while the nitrogen is the limiting nutrient in the gulf during the whole sampling periods.

Keywords: Phytoplankton, Marmara Sea

Excessive growth of phytoplankton which is called as “red tides” and “harmful algal bloom” (HAB) in a particular marine habitat is seasonally observed as population blooms in relation to environmental variables such as water temperature, nutrient availability, etc. The Gemlik Gulf is located in the south-eastern part of the Marmara Sea which is occupied by two distinctly different water masses; Black Sea originated upper layer (10-15 m thick, 22-26 psu) and Mediterranean originated deeper layer (38.5-38.6 psu) which are separated from the former by a sharp interface (pycnocline) about 10-20 m thick [1] (Fig.1).

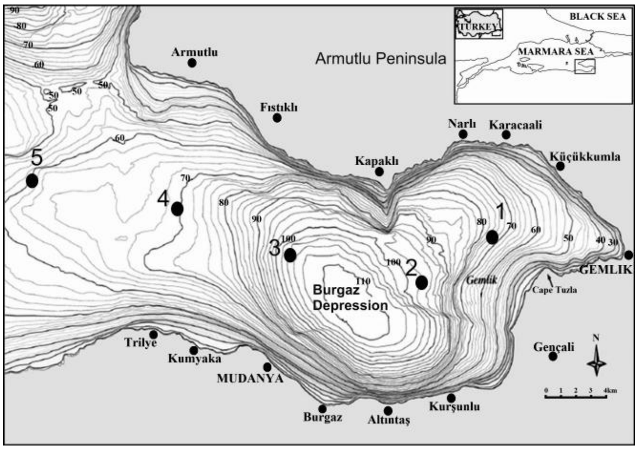

Fig. 1. Sampling stations in the Gemlik Gulf, Marmara Sea (bathymetric map by Kusçu et al. [2].

Twenty-one potentially toxic phytoplankton species were detected at the samples collected between June 2010 and May 2011 from 5 stations at the gulf. There are two highest potentially toxic phytoplankton abundances which were recorded as 233600 cell/L (*Prorocentrum micans*) and 73600 cell/L(*Pseudo-nitzschia pungens*) in the study. Canonical Correspondence Analysis (CCA) was computed in order to relate the change in potentially toxic phytoplankton species with environmental variability (Fig. 2).

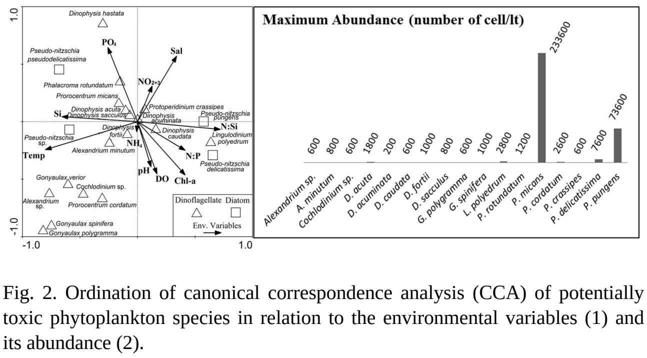

Fig. 2. Ordination of canonical correspondence analysis (CCA) of potentially toxic phytoplankton species in relation to the environmental variables (1) and its abundance (2).

The distribution pattern of the potentially toxic species indicated that most of species favored in high temperature (Temp), salinity, (Sal) PO_4-P, N:Si, SiO4-Si, N:P, Chlorophyll a (Chl-a), and Dissolved Oxygen (DO)i while favored in low pH, NO_{2+3}-N and NH_4 in the diagram. *D. hastata* and *P. rotundata* among dinoflagellates were highly associated with PO_4-P. *Pseudo-nitzschia* sp. *P. pseudodelicatissima* was associated with SiO_4-Si availability, while *P. pungens* with N:Si ratio. Dinoflagellates that belong to the genera Dinophysis spp. were scattered around the center of the CCA diagram. Balkis and Aktan [3] recorded 11 toxic phytoplankton species in the Sea of Marmara. Tas and Yilmaz [4] reported potentially 23 harmful and/or bloom-forming microalgae (14 dinoflagellates, 4 diatoms) and of which nine taxa have been confirmed to be toxic elsewhere in the world in the Golden Horn, a eutrophic estuary in the Sea of Marmara (Turkey). In the resent study [5] which carried on resting dinoflagellate cyst in the Gemlik Gulf, it was reported that the cyst abundance of potentially toxic dinoflagellates (74%–92% of total cysts cm^3) was higher than nontoxic species. The locally small patches of visible red tide events were detected especially in the gulf, although the phytoplankton bloom had not been observed. The current study which represented the presence of the toxic phytoplankton species could be used as reference for determining the changes that may occur in the region in future.

Acknowledgements: This work was supported by the Research Fund of Istanbul University, (P. No: 6857).

References

1 - Ünlüata, U., T. Oguz, M. A. Latif and E. Özsoy, 1990. On the physical oceanography of the turkish straits. In: The physical oceanography of sea straits. (ed. L.J. Pratt), Kluwer, Dortrecht, Netherlands, pp. 25-60.
2 - Kusçu, I., M. Okamura, H. Matsuoka, K. Yamamori, Y. Awata, & S. Özalp, 2009. Recognition of active faults and stepover geometry in Gemlik Bay, Sea of Marmara, NW Turkey. Marine Geology 260: 90-101.
3 - Balkis, N. and Aktan, Y., 2004. Toxic phytoplanktonic species in the Sea of Marmara. 37th CIESM Congress, 2004, Barcelona, Spain, 37:486.
4 - Tas, S. and Yilmaz, I.N. 2015. Potentially harmful microalgae and algal blooms in a eutrophic estuary in the Sea of Marmara (Turkey). Medit. Mar. Sci., 16/2, 432-443.
5 - Balkis, N., Balci, M., Giannakourou, A., Venetsanopoulou, A. and Mudie, P. 2016. Dinoflagellate resting cysts in recent marine sediments from the Gulf of Gemlik (Marmara Sea, Turkey) and seasonal harmful algal blooms. Phycologia, 55 (2), 187-209.

MONITORING TOXIC *OSTREOPSIS* CF. *OVATA* IN RECREATIONAL WATERS USING A QPCR BASED ASSAY

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Abstract
Ostreopsis sp. is a toxic benthic dinoflagellate that causes high biomass blooms involving risks for human health, with negative impacts on marine biota, aquaculture activities and coastal seawater quality. This study reports the application of a rapid and sensitive qPCR method to determine *Ostreopsis* cf. *ovata* abundance in seawater and macroalgal washing seawater samples collected from different Mediterranean coastal sites. *O.* cf. *ovata* quantification is based on site-specific environmental standard curves.

Keywords: Toxic blooms, Monitoring, Dinoflagellates, Mediterranean Sea

Introduction
The dinoflagellate *Ostreopsis* sp. is an epi-benthic microalga including *Ostreopsis* cf. *ovata* known to produce potent non-protein toxins (palytoxin-like compounds and various ovatoxins). Recently, massive blooms dominated by this microalgae, have become frequent also in the Mediterranean Sea [1]. Molecular technologies based on PCR and qPCR were developed for identification and enumeration of *Ostreopsis* spp. in marine environmental samples. These methods have proved to be a fast, specific and sensitive way to confirm taxonomic identity at species level by amplifying target genes [2]. In this study, environmental samples collected at various Mediterranean beaches, were analyzed by a qPCR assay, using site-specific environmental standard curves, to quantify *O.* cf. *ovata* cells [3].

Materials and methods
A total of 18 macroalgae and 16 seawater samples were collected during the summer of 2011, 2012 and 2013 at different Mediterranean beaches: Llavaneres (Spain), Civitavecchia, Trieste, Passetto-Portonovo, Genova, Bari and Taormina (Italy). Samples were fixed, immediately lysed to obtain crude extracts containing genomic DNA or stored at +4 °C until molecular analyses. Seven qPCR site-specific LSU rDNA environmental standard curves (LSU-STD), one for each sampling site, were constructed amplifying 204 bp fragment specific for *O.* cf. *ovata*.

Results
Environmental samples of macroalgea and surface seawater were analysed by both qPCR assay and light microscopy. As LSU rDNA copy number per cell of *O*. cf. *ovata* was different in environmental samples at each of the seven sampled Mediterranean coastal site, to make *O*. cf. *ovata* cell quantification feasible, seven different site-specific LSU-STD curves were used. *O.* cf. *ovata* cells were quantified in all macroalgal samples with the exception of two samples collected at Llavaneres (Spain) in June 2011, where no cells were found. The higher concentration of *O.* cf. *ovata*, $1.18\times10^{6} \pm 6.33\times10^{5}$ cells g^{-1}fw, was found in a sample from Genova (N Tyrrhenian Sea, Italy), while a sample from Taormina (Ioniana Sea, Italy) showed the minimum abundance (772±41 cells g^{-1}fw) by qPCR (Table 1).

Tab. 1. QPCR assay and microscopy analysis of *Ostreopsis* cf. *ovata* abundance from macroalgae samples collected in 2011, 2012 and 2013 at various Mediterranean coastal sites.

Sample No.	Locality	Abundance (cells g^{-1}fw ± SD)	
		qPCR	Microscopy
1	Llavaneres (Spain)	n.d.	n.d.
2	Llavaneres (Spain)	n.d.	n.d.
3	Llavaneres (Spain)	98,677 ± 1091	169,120 ± 2039
4	Llavaneres (Spain)	342,459 ± 43,691	484,086 ± 3913
5	Civitavecchia15888 (Italy)	49,484 ± 3688	36,548 ± 2673
6	Civitavecchia15892 (Italy)	5408 ± 115	6793 ± 1708
7	Trieste Canovella 1 (Italy)	212,797 ± 66,631	241,067 ± 28,706
8	Trieste Canovella 2 (Italy)	208,733 ± 23,336	240,816 ± 6136
9	Trieste Canovella 3 (Italy)	265,722 ± 16,939	239,811 ± 34,194
10	Ancona, Portonovo (Italy)	850 ± 232	1173 ± 774
11	Ancona, Passetto 1 (Italy)	415,062 ± 29,170	417,572 ± 15,025
12	Ancona, Passetto 2 (Italy)	673,835 ± 42,287	689,281 ± 40,586
13	Genova a (Italy)	473,598 ± 30,455	455,607 ± 71,592
14	Genova c (Italy)	1,180,043 ± 63,326	1,143,652 ± 125,136
15	Genova e (Italy)	661,039 ± 10,950	656,814 ± 9676
16	Genova g (Italy)	965,409 ± 79,188	925,962 ± 97,907
17	Taormina St.1 (Italy)	2286 ± 111	1734 ± 270
18	Taormina St. 2 (Italy)	772 ± 41	713 ± 59

Generally, cell concentrations in seawater were lower than on macroalgae samples with the only exception of a sample from Bari (Ionian, Italy) ($1.90\times10^{6} \pm 8.45\times10^{5}$ cells l^{-1}). Interestingly, one sample from Ancona (N Adriatic Sea, Italy), negative by microscopy for *O*. cf. *ovata*, showed 1106 ± 426 cells l^{-1} by qPCR (Table 2).

Tab. 2. QPCR assay and microscopy analysis of *Ostreopsis* cf. *ovata* abundance in seawater samples collected in 2011 and 2013 at various Mediterranean coastal areas.

Sample No.	Locality	Abundance (cells l^{-1} ± SD)	
		qPCR	Microscopy
19	Civitavecchia 15,887 (Italy)	1832 ± 90	1260 ± 85
20	Llavaneres (Spain)	n.d.	n.d.
21	Llavaneres (Spain)	56,320 ± 10,478	97,667 ± 12,503
22	Llavaneres (Spain)	28,405 ± 5226	66,000 ± 5657
23	Ancona, Portonovo (Italy)	1106 ± 426	n.d.
24	Ancona, Passetto (Italy)	92,600 ± 8414	98,400 ± 19,819
25	Genova b (Italy)	44,353 ± 4590	14,500 ± 2121
26	Genova d (Italy)	17,000 ± 1044	23,500 ± 707
27	Genova f (Italy)	58,000 ± 7071	29,778 ± 5441
28	Genova h (Italy)	17,500 ± 707	11,776 ± 1275
29	Bari, Trullo 1 (Italy)	115,750 ± 19,363	142,000 ± 19,305
30	Bari, Trullo 2 (Italy)	135,250 ± 27,476	154,000 ± 26,969
31	Bari, S. Spirito 1 (Italy)	1,077,265 ± 34,479	542,250 ± 148,572
32	Bari, S. Spirito 2 (Italy)	1,907,088 ± 84,540	1,198,750 ± 226,729
33	Bari, Giovinazzo 1 (Italy)	357,255 ± 24,375	131,000 ± 26,255
34	Bari, Giovinazzo 2 (Italy)	841,710 ± 39,675	256,250 ± 25,617

Significant positive correlations between *O*. cf. *ovata* cell densities on macroalgal samples and in water column (n=16, Spearman r=0.8386, $p < 0.0001$) and between abundance determined by light microscopy and qPCR assays (n=16, Spearman r=0.9808, $p < 0.0001$ and n=15, Spearman r=0.9263, $p < 0.0001$ for macroalgae and surface seawater samples, respectively) were found.

Conclusions
Monitoring programs of *Ostreopsis* spp. events provide insight into the dinamics of these marine microbes and can help use to develop new strategies to mitigate their impacts on human health, economic activities and ecosystem functioning. In this study, LSU rDNA gene was used to accurately quantify *Ostreopsis* spp. abundance in natural samples by qPCR method based on the generation of environmental site-specific standard curves. This application allowed a rapid and correct quantification of *O.* cf. *ovata* in field assessing beach water quality during the monitoring activity of the study period.

References
1 - Penna A., Fraga S., Battocchi C., Casabianca S., Riobò P., Giacobbe M.G., Vernesi C., 2010. A phylogeography study of the toxic benthic genus *Ostreopsis* Schmidt. *J. Biogeogr.*, 37: 830-841.
2 - Perini F., Casabianca A., Battocchi C., Accoroni S., Totti C., Penna A., 2011. New approach using the real-time PCR method for estimation of the toxic marine dinoflagellate *Ostreopsis* cf. *ovata* in marine environment. *PLoS ONE* 6: e17699.
3 - Casabianca S., Perini F., Casabianca A., Battocchi C., Giussani V., Chiantore M., Penna A., 2014. Monitoring toxic *Ostreopsis* cf. *ovata* in recreational waters using a qPCR based assay. *Mar. Pollut. Bull.*, 88: 102-109.

IMPACT OF POLYCYCLIC AROMATIC HYDROCARBON (PAHS) MIXTURE ON *PSEUDO-NITZSCHIA MANNII*

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Abstract
The impact of PAHs cocktail on *Pseudo-nitzschia mannii*, isolated from Tunisian northern waters, was assessed during 144 h exposure to increasing concentrations of pollutants. Physiological measurements were performed daily on *Pseudo-nitzschia* cells using fluorescent probes. Biomass and cell density were determined daily. The responses of the Chl *a* and cell concentrations as well as the Fv/Fm to PAHs cocktail were dose-dependent. The efficiency of PSII was more sensitive to PAHs than the biomass.

Keywords: Diatoms, Pah, Mediterranean Sea

Introduction
Coastal marine ecosystems are often contaminated by PAHs and the biota is affected by this pollution. The toxicity and lethality of PAHs have been assessed for a variety of marine organisms such as fish, zooplankton and amphipods [1]. Several works have also shown the toxicity of these pollutants on primary producers, as they can affect algal biomass, physiology and specific composition [2]. However, the effect of PAHs on harmful and toxic phytoplankton species, are scare, despite the fact that these algae have high occurrence in coastal waters, where chemical contamination was confirmed. The objective of this study was to elucidate the potential toxic effects of complex mixtures of PAHs on the growth and the physiology of a potentially toxic *Pseudo-nitzschia mannii,* isolated from the lagoon of Bizerte, which received several pollutant, as PAHs.

Materials and Methods
Strains of *P. mannii*, isolated from Bizerte Lagoon, were grown in f/2 medium, at 20°C, 100 µmol photons m^{-2} s^{-1} and 12:12 h light:dark cycle. Exponential cultures were used to perform six treatments during 144 h: a control without DMSO (C), control with DMSO (0.05 % v/v) (C_{DMSO}) and four contaminated treatments, which received respectively 0.1% (C1), 0.5% (C2), 1% (C3) and 4% (C4) of a PAHs cocktail. This later was prepared by dissolving into DMSO (0.05%, v/v) 15 pure PAH molecules that were present in the Bizerte Lagoon (Ben Othmen Raboudi, 2014).In each treatment, dissolved and particulate PAHs, Chl *a* levels, growth kinetic and physiology (Fv/Fm: the maximum quantum yield of photochemistry) were measured on each day of incubation.

Results and discussion
Daily measurement of dissolved PAHs in treatments C3 (i.e. 1%) showed a gradual decline in concentrations from the beginning (28.5 µg l^{-1}) to the end (5.1 µg l^{-1}) of incubation. Despite this decrease in PAHs cocktail, the growth of *P. mannii* was maintained in this treatment until the end of the experiments. In contrast, particulate PAH showed an increase from the beginning (0.5 µg l^{1}) to the end (15.5 µg l^{-1}) of incubation. This indicates the ability of species to accumulate the PAHs. Chl *a* andcell concentrations were not significantly (p>0.05) different between C and C_{DMSO} during the entire of incubation, indicating that DMSO used at 0.05% v/v was no toxic for cells. In short term (after 48 h exposure), the decreased of Chl *a* was more pronounced when the level of the contamination increased. Similarly, growth rates were low, relatively to the control, in the C1 and C2 treatments, but the lowest was observed at high contamination (i.e. C3 and C4 treatments). This suggest that the PAH effect on biomass and growth of *P. mannii* was dose-dependent. The Fv/Fm variable was unaffected by all treatments, except the C4 contamination. In this treatment, its value decreased by 20% relatively to control after 48 h and then it sharply fall to zero. The results revealed the negative impact of PAHs on the growth of *P. mannii*, as was previously shown for other algal species [3]. However, the species was able to accumulate the pollutants. It appeared that the physiology of the *P. mannii* was more sensitive to pollutants than its biomass.

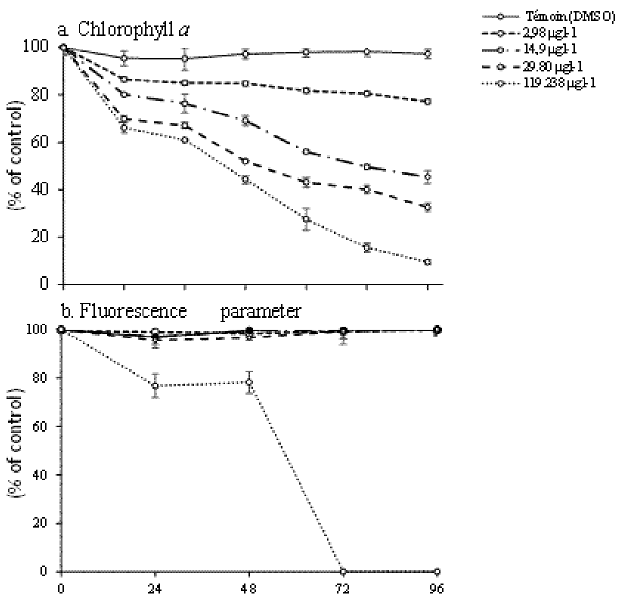

Fig. 1. Evolution of chlorophyll a concentrations (µg Chl a l^{-1}) and the efficacity of PSII (Fv/Fm) in different treatment along the day of the experiment (mean ± SD)

References
1 - L. Mhadhbi, M. Boumaiza, R. Beiras, A standard ecotoxicological bioassay using early life stages of the marine fish Psetta maxima, Aquat. Living Res. 23 (2010) 209–216.
2 - Ben Othmen Raboudi (2014).Sensibilité aux hydrocarbures aromatiques polycycliques du phytoplancton lagunaire (lagunes de Thau (France) et de Bizerte (Tunisie) et en culture Thèse Doc. Faculté des Sciences de Bizerte.
3 - Echeveste, P., Agusti, S., Dachs, J., (2010). Cell size dependent toxicity thresholds of polycyclic aromatic hydrocarbons to natural and cultured phytoplankton populations, Environ. Pollut., 158 :299–307.

DIVERSITY AND TOXICITY OF *PSEUDO-NITZSCHIA* FROM TUNISIAN WATERS (SW MEDITERRANEAN)

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Abstract
The occurrence of potentially toxic diatoms was investigated in the northern Tunisian waters from 2011 to 2013. These microalgae were present over almost all the sampling period and exhibited pronounced blooms in spring, summer or autumn. Several species of *Pseudo-nitzschia* (*P. calliantha, P.* cf *seriata* and *P. mannii)* were identified as the causative organisms of the blooms. Some *Pseudo-nitzschia* species (*P. fryxelliana, P. hasleana and P.* cf. *seriata*) were observed for the first time in Mediterranean waters. The ability of identified strains to produce domoic acid in culture was assessed by LC-MS/MS. The toxicity of *P. calliantha* was confirmed whereas our investigation represents the first report that *P. hasleana* and *P. mannii* produce DA, bringing the total number of toxic *Pseudo-nitzschia* species to 21

Keywords: Biodiversity, South-Western Mediterranean, Blooms, Diatoms, Toxins

Introduction
Toxic and potentially toxic (PT) diatoms that mainly belong to the genus *Pseudo-nitzschia* have received considerable scientific attention, because 19 of the 45 known species can produce the potent neurotoxin, domoic acid (DA) [1]. Blooms of toxic diatoms are increasing in frequency and magnitude in several coastal Mediterranean waters and thus, may harm human health and represent a serious threat to the economy of aquacultured and wild shellfish industries. Therefore, the occurrence of toxic diatoms, their diversity and toxicity were investigated in economically important shellfish culture areas in the northern Tunisia

Materials and Methods
Diatom samples were collected monthly, from August to October 2011 and from March 2012 to April 2013 in the Lagoon, the Bay and the Channel of Bizerte. Several strains of PT diatoms were isolated, from seawater, and cultured in f/2 medium. The batch cultures were maintained at 20 °C, 100 µmol photons m^{-2} s^{-1} and 12h light:12h dark. The isolated strains were examined by ETM. Furthermore, in some cases strains were characterized molecularly. DA analyses were carried out on stationary-phase cells of strains established in culture, using the rapid resolution LC-MS/MS method (detection limit @0.02 ng DA ml^{-1}).

Results and discussion
Blooms of PT diatoms were found in spring (April), summer (July) and autumn (September or October), with pronounced peak (10^5–10^6 cells l^{-1}), as was previously observed in French and Italian coastal waters. Five *Pseudso-nitzschia* species were distinguished. *P. calliantha* dominated the blooms in September 2011(>10^5 cells l^{-1}). The species has a widespread distribution in the Mediterranean Sea, where it has been shown to be toxic. Our investigations confirm also its toxicity (1.56 ng DA L^{-1}). *P. fryxelliana* and *P. hasleana* were reported in September and January 2012, respectively, but at relatively low concentrations (10^3 cells l^{-1}). Both species have not been reported previously in Mediterranean waters, thus expanding our knowledge of their distribution. *P. mannii,* which was newly observed along the Catalan coast of Spain [2], was observed only in spring 2012. The LC-MS/MS technique revealed the toxicity of *P. hasleana* (1.28–7.29 ng DA l^{-1}) and *P. mannii* (5.73 ng DA l^{-1}). Previously, both species have been reported as non-toxic [2; 3] Thus, this is the first report that *P. hasleana* and P. mannii are toxigenic, bringing the total number of toxic *Pseudo-nitzschia* species to 21. The presence of *P.* cf *seriata* in Tunisian waters was unexpected, as the species is associated with cold waters [1]. P. cf. *seriata* has bloomed at Bizerte Bay in April 2013 (>10^5 cells l^{-1}), when the temperature was low (@10ºC). Although the species had been found to be toxic in others areas, no DA was detected by LC-MS/MS in strains isolated from northern Tunisian waters.

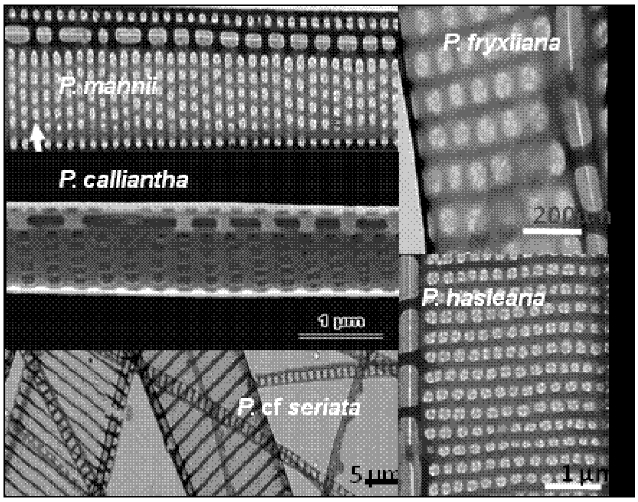

Fig. 1. *Pseudo-nitzschia* species identified in northern Tunisian waters

References
1 - Lelong, A., Hégaret, H., Soudant, P. and Bates, S.S. 2012. "*Pseudo-nitzschia* (Bacillariophyceae) species, domoic acid and amnesic shellfish poisoning: revisiting previous paradigms." *Phycologia* 51:168–216
2 - Amato, A. and Montresor, M. 2008. "Morphology, phylogeny, and sexual cycle of *Pseudo-nitzschia mannii* sp. nov. (Bacillariophyceae): a pseudo-cryptic species within the *P. pseudodelicatissima* complex." *Phycologia* 47:487–497
3 - Lundholm, N., Bates, S.S., Baugh, K.A., Bill, B., Connell, L., Léger, C. and Trainer, V.L. 2012. "Cryptic and pseudo-cryptic diversity in diatoms – with descriptions of *Pseudo-nitzschia hasleana* sp. nov. and *P. fryxelliana* sp. nov." *Journal of Phycology* 48: 436-454

CIESM Congress Session : Megasequencing projects

Moderator : Frank Oliver Glöckner, Max Planck Inst. & Jacobs Univ., Bremen, Germany

Moderator's Synthesis

The introduction outlined the huge interest worldwide in exploring the marine ecosystem in terms of fundamental biodiversity and functional research, as well as biotechnology and applications. Following the footsteps of the Global Ocean Sampling (GOS) expedition to “shotgun the ocean” the Tara Expeditions and Malaspina cruise have opened the black box of microbial diversity through all size classes as well as from the surface to the deep sea. As a recent addition Ocean Sampling Day (OSD) and the citizen science project MyOSD, complemented the circumnavigations by excluding the time parameter in restricting sampling to the 21st of June 2014, 2015, 2016. This resulted in a worldwide snapshot of microbial diversity and function on a single day. With over 90% of the sampling sites being costal, OSD has pioneered addressing the Nagoya protocol on “Access to Genetic Resources and the Fair and Equitable Sharing of Benefits (ABS) Arising from their Utilization”. By creating the CIESM charter on ABS, a morally binding, light-weight solution for the fair and equitable exchange of results and expertise has been filed and signed by the Mediterranean OSD participants.

Five communications were presented and followed by an intense discussion. Three of the talks focussed on the functional site of the marine metagenome researched by comparatively exploring the OSD and Tara Oceans datasets. A striking result is the fact that the microbiomes of OSD and Tara Oceans are distinct but complementary. This shows that the coastal influence on the microbial communities is strongly reflected in their genomic repertoire. The dynamic and heterogeneous nature of the coastal environments is underlined by their high amounts of genes for transport, replication, translation and energy production. Research on the nitrogen biogeochemical cycle showed a wide distribution of genes involved in N-fixation and denitrification. Research on Biosynthetic Gene Clusters in the marine environment revealed a common distribution and that they can lead as indicators for anthropogenic influences. This is in line with the contribution researching changes in phytoplankton assemblage structure in the Mediterranean Sea by human pressure. The 18S rRNA analysis shows that sites under heavier human impact expose significantly lower diversity but higher abundances of e.g. single species like *Skeletonema*. Finally, the last talk showed that the involvement of citizen scientists in the production of data and knowledge is advantageous by significantly expanding not only the amount but also quality of samples.

The discussion started with practical aspects of handling the Nagoya protocol and what needs to be done as a researcher to get the corresponding permits from the governments. It expanded towards exchange, comparability and interoperability of data. It finally turned back to the added value of OSD for the participants as a stimulated self-organisation of marine stations to exchange and comply with protocols and standards to allow getting the “big picture” of microbial actions in the marine environment. The wish to continue OSD was mentioned in this respect.

In the debriefing session ample interest was expressed, since many participants from the north and south shore of the Med (Croatia, Italy, France, Turkey, Tunisia, Portugal) see an added value of continuing the exchange of expertise, protocols as well as data and results to explore continuing OSD in the Mediterranean as "OSD-Med". The open spirit of OSD has turned to be a strong incentive to generate excellent science together. It was therefore suggested to organise a workshop under the umbrella of CIESM to that effect, in particular with the goal to explore a scientific common objective for OSD-Med.

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EXPLORING THE FUNCTIONAL SIDE OF THE OCEAN SAMPLING DAY METAGENOMES

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Abstract
In June 2014 the first Ocean Sampling Day took place with the objective to simultaneously sample the world's coastal oceans and provide insights into fundamental patterns in microbial diversity and function. In combination with a rich set of environmental and oceanographic measurements, 150 metagenomes were sequenced. OSD added more than three million genes to the Ocean-Microbial Reference Gene Catalog including data from mega-surveys like TARA Ocean expedition and Global Ocean Survey. The ongoing analysis of these metagenomes increases our knowledge of the Ocean Microbiome, and allows identifying hotspots of novelty in terms of function. Furthermore, with OSD we can now investigate the impact of human activities on oceans coastal areas where an intimate interaction between dense human populations and the marine world is ongoing.

Keywords: Coastal systems, Biodiversity, Biotechnologies, Mediterranean Sea

The Ocean Sampling Day (OSD) [1] is a simultaneous, collaborative, standardized, global mega-sequencing campaign to analyze marine microbial community composition and functional traits. 150 metagenomes were sequenced from the first OSD in June 2014 including a rich set of environmental and oceanographic measurements. Unlike other ocean mega-surveys such as Global Ocean Sampling (GOS) [2] or the TARA Oceans expedition [3] that mostly sampled open ocean waters most of the OSD samples are from coastal sampling sites, a previously not well studied area. Additionally, with the repetition of OSD in 2015 and beyond, these cumulative samples, related in time, space and environmental parameters, will provide insights into fundamental rules describing microbial diversity and function and contribute to the blue economy through the identification of novel ocean-derived biotechnologies.

The Ocean Sampling Day and the Ocean Microbiome
With 40,154,822 genes the Ocean Microbial-Gene Reference Catalog (OM-RGC) -- compiled for the TARA Oceans expedition data analysis -- is the largest marine gene dataset to date. It includes genes from different sources like the GOS, the Pacific Ocean Virome study [4] and from ocean microbial reference genomes [3] among others. Despite its extensive oceanic coverage, coastal waters are still underrepresented in OM-RGC. OSD is complementing this by providing metagenomics data from 124 coastal sampling sites (less than 10 km to the shore) (Figure 1).

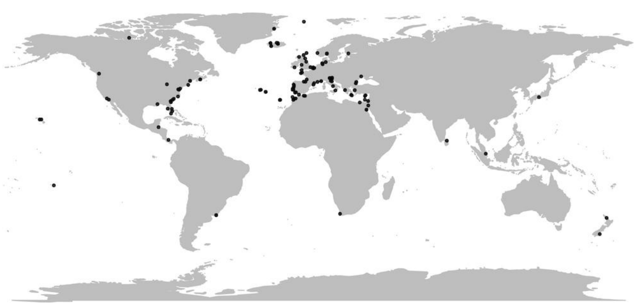

Fig. 1. Figure 1. Geographical distribution of the Ocean Sampling Day metagenomes

Coastal environments are a thin boundary between mainland and the ocean waters; they are highly dynamic environments receiving a high load from terrestrial environments, natural or human-based. This geographical heterogeneity is indicated by the low level of similarity in the raw genetic distances between the different OSD metagenomes. The dynamic and heterogeneous nature of the coastal environments is again underlined by exploring the functions based on the orthologous groups of genes (OG) classification defined by eggNOG [5]. A total of 60,644 OGs were identified on the 150 OSD metagenomes, but only 189 OGs were shared between all OSD metagenomes The low amount of OGs conforming the core of the OSD reinforce the idea of the heterogeneity in coastal environments. Analyzing the functional annotations for the exclusive OSD genes, the orthologous groups showing higher abundances are those related to the categories: "Amino acid transport and metabolism", "Energy production and conversion", "Replication, recombination and repair" and "Translation, ribosomal structure and biogenesis". These functional categories suggest that the organisms habiting in the OSD coastal sites are specialized and adapted to live in a changing environment, although we cannot assess the level of activity without metatranscriptomic data [6]. With one single sampling point in time we show the existence of a high geographic heterogeneity at the geographic level, and with the future OSDs we will be able to study the dynamics of the coastal environments in a global scale, allowing us to gain more insights about their resilience and be able to observe predictable patterns [7].

References

1 - Kopf, Anna, Mesude Bicak, Renzo Kottmann, Julia Schnetzer, Ivaylo Kostadinov, Katja Lehmann, Antonio Fernandez-Guerra, et al. 2015. The ocean sampling day consortium. *Gigascience* 4:27.
2 - Rusch, Douglas B, Aaron L Halpern, Granger Sutton, Karla B Heidelberg, Shannon Williamson, Shibu Yooseph, Dongying Wu, et al. 2007. The sorcerer II global ocean sampling expedition: Northwest atlantic through eastern tropical pacific. PLoS Biol 5 (3): e7.
3 - Sunagawa, Shinichi, Luis Pedro Coelho, Samuel Chaffron, et al. 2015. Structure and function of the global ocean microbiome. Science 348 (6237): 1261359.
4 - Hurwitz, Bonnie L, Li Deng, Bonnie T Poulos, and Matthew B Sullivan. 2013. Evaluation of methods to concentrate and purify ocean virus communities through comparative, replicated metagenomics. Environ Microbiol 15 (5): 1428-40.
5 - Powell, Sean, Kristoffer Forslund, Damian Szklarczyk, Kalliopi Trachana, Alexander Roth, Jaime Huerta-Cepas, Toni Gabaldón, et al. 2014. EggNOG v4.0: Nested orthology inference across 3686 organisms. Nucleic Acids Res 42 (Database issue): D231-9
6 - Gifford, Scott M, Shalabh Sharma, and Mary Ann Moran. 2014. Linking activity and function to ecosystem dynamics in a coastal bacterioplankton community. Front Microbiol 5:185
7 - Fuhrman, J. A., Cram, J. A., & Needham, D. M. (2015). Marine microbial community dynamics and their ecological interpretation. Nature Reviews. Microbiology, 13(3), 133-46

DISTRIBUTION AND ENVIRONMENTAL CONTROLS ON MARINE NITROGEN BIOGEOCHEMICAL FUNCTIONS

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Abstract
Nitrogen is one of the basic elements of life, and microbial communities play crucial roles in all transformation pathways of the nitrogen biogeochemical cycle. In the Oceans, fixed nitrogen is one of the most important growth-limiting nutrients for photosynthetic organisms and serves as an important energy source or as an oxidant for marine bacteria and archaea. The nitrogen cycle includes a multitude of complex processes which occurs through the coordinated functioning of several genes from polyphyletic group of microorganisms (prokaryotes and fungi). In this study we used the metadata and metagenomic data generated from the 2014 OSD initiative to determine global patterns regarding distribution, interrelationships and environmental controls on key Nitrogen pathways in a large spatial scale covering different marine ecosystems.

Keywords: Nutrients, Bacteria, Mediterranean Sea, Open sea

Prokaryotes dominate most global biogeochemical cycles and for the last decade, microbial metagenomics has provided invaluable insights into prokaryotic systems, allowing us to go one step forward towards the linkage between biodiversity and ecosystem function. The marine nitrogen (N) cycle controls the productivity of the oceans and these new methodologies have uncovered new processes and microorganisms involved, complicating the already complex picture of oceanic N biogeochemistry (Zehr et al. 2011). Global oceanic sampling campaigns (OSD and Tara Oceans) covering a wide range of marine environments using standardized methods not only enabled the comparison of results, but also the discovery of global trends. In this study, we leveraged publicly available datasets from the OSD 2014 initiative and applied state of the art bioinformatics and statistical tools to perceive worldwide N-related trends with a view to better understand the drivers and dynamics of the global marine N cycle and the microorganisms that mediate it. We compared the abundance of genes associated with the main nitrogen cycling pathways (IPR) identified within the 150 metagenomes of the global 2014 OSD database, to identify interrelationships between them and relate their distribution of those genes with the contextualized environmental data available. We performed all analyses using R (R Development Core Team, 2008) and a series of R specific packages. From the lower taxonomic level OTU table generated from SILVAngs we selected OTUs representing individual ammonia-oxidizing bacterial (AOB) and archaea (AOA) and bacterial nitrite-oxidizing.

Among the 150 global OSD sites, a high differentiation was found between the levels of occurrence of specific genes related to the enzymes involved in the different key N biochemical pathways (Figure 1).

While specific genes related to ammonia oxidation (the first step of nitrification mediated by AOA and AOB) were found to be less abundant in the IPR data set, genes involved in N-fixation (nitrogenase enzyme), and in nitrate, nitrite and nitrous oxide reduction pathways (denitrification) were found to be widely distributed along the OSD data set. Results consistently showed that sites with similar frequency of the genes involved in N processes (included in the same cluster) are distributed across the OSD map; thus the distribution of the genes involved in the marine N machinery was found to be latitudinal and longitudinal independent. Results showed a high degree of interrelationships between the genes involved in the different pathways (e.g between the different steps of the denitrification pathway; nitrate reduction - nitrite reduction - nitrous oxide reduction) and within the same pathway (e.g. ammonia oxidation; nitrate reduction).

Few strong relationships were observed between the abundance of the different genes related to N enzymes and the metadata available. However, fluorometer values were clearly and positively related with the majority of the genes involved in the denitrification step and a tendency for negative relations was observed with the genes involved in ammonia oxidation and N fixation. The same trend was observed for nitrate and ammonia concentrations in the water, suggesting that the occurrence of some N genes are connected with high abundance of primary producers and fixed N availability, whereas other N genes are associated with low N and Chl*a* levels. We believe that the addition of the 2015 data, with an anticipated richer metadata set, will add the temporal scale to our analyses and will allow us to draw more robust conclusions regarding the environmental controls on N related pathways in the ocean. Genes involved in ammonia oxidation (a widely distributed pathway in marine environments) were surprisingly under-represented among the OSD sites. Interestingly, this finding seems to be confirmed when we cross IPR dataset with the 16S rRNA gene dataset, as OTUs affiliated with archaeal and bacterial ammonia oxidizers showed relatively low frequencies of occurrence and a generally confined distribution. In contrast, nitrite oxidizing bacteria (NOB) were the most abundant and widely distributed nitrifiers within the 16s rRNA gene OSD dataset. The recent discovery of the presence of both ammonia and nitrite oxidation steps in NOB strains (*Nitrospira* genus) (Daimes et al. 2015, van Kessel et al. 2015) may explain this paradox, supporting the hypothesis that NOB are the main players in driving complete nitrification in the ocean (ammonia oxidation plus nitrite oxidation) with a new type of amoA gene as yet undetected in our analysis. This study expanded our knowledge regarding the N biogeochemical cycle across multiple marine ecosystems, and provided an enriched perspective on how marine N biogeochemistry and the microbial communities involved respond to environmental changes.

References

1 - Zehr J. P. and Kudela R. M. (2011). Nitrogen cycle of the open ocean: from genes to ecosystems. Ann. Rev. Mar. Sci. 3: 197–225 .

2 - Murtagh F. and Legendre P. (2014). Ward's hierarchical agglomerative clustering method: which algorithms implement Ward's criterion? Journal of Classification, 31

3 - Daims H., Lebedeva E.V., Pjevac P., Han P., Herbold C., Albertsen M., Jehmlich N., Palatinszky M., Vierheilig J., Bulaev A., Kirkegaard R.H., von Bergen M., Rattei T., Bendinger B., Nielsen P.H., Wagner M. (2015). Complete nitrification by Nitrospira bacteria. Nature 528: 504-509

4 - Maartje A. H. J. van Kessel, Daan R. Speth, Mads Albertsen, Per H. Nielsen, Huub J. M. Op den Camp, Boran Kartal, Mike S. M. Jetten, Sebastian Lücker (2015). Complete nitrification by a single microorganism. Nature 528: 555-559

CHANGES IN PHYTOPLANKTON ASSEMBLAGE STRUCTURE DRIVEN BY HUMAN PRESSURES IN THE MEDITERRANEAN SEA THROUGH THE METAGENOMIC 18S RRNA APPROACH

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Abstract

Environmental barcoding based on 18S rRNA revealed a broad genetic diversity of primary producers in a wide range of ecosystems. Environmental drivers can select species and functions of microalgal assemblages. Human activities and climate change are now potent new drivers that significantly alter the functioning of coastal and offshore ecosystems also in the Mediterranean Sea, which is a critical marine ecosystem. Within the framework of OSD (Ocean Sampling Day) campaign 2014 of EU MicroB3 Project, this study elucidated the relationships between composition of phytoplankton assemblages and human impact on Mediterranean Sea, highlighting the potential of a metagenomic 18S rRNA approach in combination with appropriate data analysis techniques.

Keywords: Phytoplankton, Pollution, Mediterranean Sea, Genetics

Introduction. The Mediterranean Sea is a critical marine ecosystem for many reasons, because it is a hot-spot of biodiversity, resource exploitation, maritime traffic and coastal urbanization with high density population pressure. Microalgal diversity composition, in terms of taxonomical hierarchies, and its variations over spatial scales, represents a useful tool to quantify the consequences of the anthropogenic perturbation on marine ecosystem health. The metagenomic analysis of phytoplankton communities based on 18S rRNA sequencing already demonstrated to be a useful tool for genetic diversity knowledge in marine ecosystem.

Materials and methods. All sampling sites were located in the Mediterranean Sea. Samples were collected at different depths within the activity of Ocean Sampling Day (OSD) of EU MicroB3 Project. The metagenomic data set was 18S rDNA workable obtained from LGC (Germany). As for Mediterranean autotrophic plankton, it included 32 samples and 350 OTUs. The whole taxonomical classification data set associated to 18S rDNA sequences was processed to extract the list of unicellular eukaryotic phototrophs (primary producers) exclusively. Data about estimated human impact were obtained from Halpern et al. [1]. Dissimilarities between autotrophic plankton assemblages were computed on the basis of OTUs abundances using the Morisita-Horn index [2].

Results. The structure of autotrophic plankton assemblages varied revealing a biogeographic pattern in the Mediterranean Sea, but, this was not dependent of basin-wide patterns (Mantel test, R=0.016, p=0.408). To reduce the complexity of the available data, only 82 OTUs found in more than 5 samples were kept in the final reduced data set, thus preserving only the most reliable information provided by the full data set. In fact, the relationship between Morisita-Horn dissimilarity and geographical distance was still not significant (Mantel test, R=0.006, p=0.455), and the reduced data set showed a higher correlation to human impact relative to that of the full data set (Mantel test, R=0.266, p=0.008). A Principal Coordinates Analysis (PCoA) was the performed on the same Morisita-Horn dissimilarity matrix (Fig. 1) and the first and second principal axes accounted for 26.8% and 13.6% of the overall variance, respectively. In accordance with the outcome of the Mantel tests, no biogeographical structure emerged from the ordination, while the largest human impact values were associated to samples found in the positive half-plane defined by PCo2. PCo2 scores were highly variable at sites with low to intermediate human impact score (i.e. ≤20), but, they were clearly larger at more disturbed sites, as Messina, Italy (OSD42), Venice, Italy (OSD47), Porto Marghera, Italy (OSD69 and OSD70), Patras (OSD90), Greece. An Indicator Species Analysis [3] was performed on normalized OTU abundances to find out what OTUs based on 18S rRNA metagenomic data set were more frequent and/or abundant at disturbed sites (human impact score >20). It was evident that only ME-Euk-DBT116 and the diatom genus *Skeletonema* were associated to the more disturbed group showing a significant preference for sites under heavier human impact.

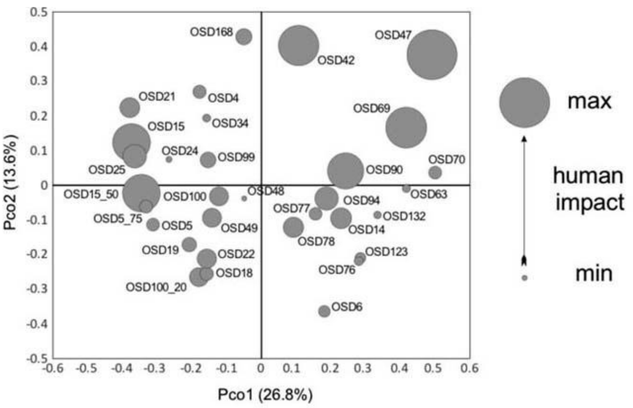

Fig. 1. Principals Coordinates Analysis of the Morisita-Horn dissimilarity matrix based on the reduced data set (82 OTUs, 32 samples). Symbol size is proportional to the human impact score obtained by Halpern et al. [1].

Conclusions. The available data showed significant relationships between autotrophic plankton assemblage structure and human impact. Sites under heavier human impact were significantly associated with assemblages whose recurrent features were low diversity and high dominance. As for the responses of single OTUs, i.e. *Skeletonema*, was significantly more frequent or abundant under heavier human impact, whereas other OTUs showed less clear responses. As for sites where the human impact scores was lower than 20, but still moderate, higher diversity was possibly related to the effects of intermediate disturbance on the autotrophic plankton assemblage.The analysis of metagenomic 18S rRNA, V4 marker, is still to be improved, especially by solving uncertainties in OTU identification and defining an ecologically meaningful level of resolution in that process, but it clearly has a potential, especially if leveraged by appropriate statistical methods.

References

1 - Halpern B.S., Walbridge S., Selkoe K.A., Kappel C.V., Micheli F., D'Agrosa C., Bruno J.F., Casey K.S., Ebert C., Fox H.E., Fujita R. 2008. A global map of human impact on marine ecosystems. *Science*, 319: 948-952.

2 - Morisita M. 1959. Measuring of interspecific association and similarity between communities. *Mem. Fac. Sci. Kyushu Univ. Series E*, 3: 65-80.

3 - Dufrêne M., Legendre P. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecol. Monogr.*, 67: 345-366.

BIOGEOGRAPHY OF BIOSYNTHETIC GENE CLUSTERS IN THE MARINE ENVIRONMENT

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Abstract

Marine microbial communities produce a high diversity of natural products encoded by Biosynthetic Gene Clusters (BGCs). So far most of this metabolic diversity remains unknown, due to technical limitations in studying microorganisms. Metagenomics represents a powerful approach to access the metabolic potential of microbial communities. In this work, we used the metagenomic data from the TARA Oceans and Ocean Sampling Day sequencing campaigns, in order to study the biogeography of BGCs in marine environments. These datasets offer a valuable opportunity to explore the unknown world of BGCs of marine microbial communities, and the underlying mechanisms that structure the composition of these genes in the environment. It represents the first biogeographic analysis of BGCs on marine environments on a global scale.

Keywords: Biogeography, Mediterranean Sea

The secondary metabolism (SM) of microorganisms comprises a large diversity of functions and compounds. SM plays an important role in the ecology and physiology of microbes. Many aspects of their lifestyle are affected by their SM, including nutrient scavenging, chemical synthesis and environmental sensing. Additionally, SM produces a variety of products that are highly valuable for industrial and medical applications, like vitamins, antibiotics, bioplastics among others. The genes involved in these metabolic pathways are commonly organized in Biosynthetic Gene Clusters (BGCs): physically clustered genes that encode the biosynthetic enzymes for a pathway.

Metagenomic data provides an opportunity to access this reservoir of microbial functional diversity. Although some of the biggest metagenomic sequencing efforts are from the ocean (e.g. Global Ocean Sampling Expedition [1]; TARA Oceans [2] and Ocean Sampling Day [3]), to our knowledge, there are no comprehensive surveys exploring BGCs composition in this environment.

In this work, we study the biogeography of BGCs in marine environments. That is to say, study their patterns in space, in time and along environmental gradients, and understand the processes generating and maintaining such distribution patterns. In turn, these analyses will allow us to explore the unknown universe of BGCs in the ocean and contribute to the discovery of new bioactive compounds. All data were taken from the TARA Oceans and Ocean Sampling Day campaigns. The majority of the samples from these data sets correspond to open ocean and coastal environments, respectively. In total, we analyzed 392 metagenomic samples. Based on 66,531,749 contigs from the assembly of these metagenomes, we identified 13,137 BGCs, belonging to 49 different classes. For this task, we first used the UproC tool [4] to extract contigs with signatures proteins or protein domains of BGCs. The resulting subset of contigs was classified with antiSMASH [5]. Additionally, the corresponding 16S ribosomal DNA amplicon sequences from these samples were extracted using SortMeRNA [6], refined and classified by the SILVAngs pipeline [7]. Finally, the BGC and taxonomic annotations were integrated with the environmental data. Applying a series of biogeographic exploratory analyses, we aim to study the association between the BGCs and taxonomic distributions, and the environmental parameters.

Those biogeographic analyses will contribute to the understanding of the factors determining the diversity and patterns of BGCs as well as their taxonomic origin, i. e. exploring the differences between coastal and open ocean environments (Fig. 1). Furthermore, this study helps to understand the ecological and evolutionary processes that shape the relationship between marine microbial communities and the environment. Last but no least, the biogeographic analyses of BGCs can be useful for identifying hotspots of biosynthetic diversity and guide the discovery of novel bioactive natural products in the future.

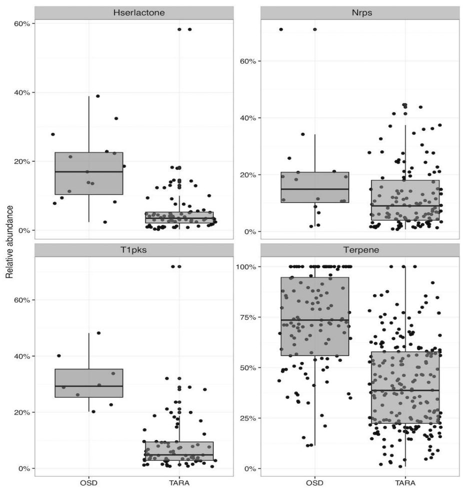

Fig. 1. Boxplot of the BGC distributions of the OSD and TARA datasets of four different classes. Hserlaconte: Homoserine Lactone Synthase, Nrps: Nonribosomal Peptide Synthetase, T1pks: Type I Polyketide Synthase and Trepene: Terpene Synthase.

References

1 - Rusch DB et al. (2007) The Sorcerer II Global Ocean Sampling expedition: northwest Atlantic through eastern tropical Pacific. PLoS Biol 5 (3):e77

2 - Karsenti E et al. (2011) A holistic approach to marine eco-systems biology. PLoS Biol 9(10):e1001177

3 - Kopf A et al. (2015) The ocean sampling day consortium. GigaScience 4:27

4 - Meinicke P. (2014) UProC: tools for ultra-fast protein domain classification. Bioinformatics 31(9):1382–8

5 - Blin K et al. (2013) antiSMASH 2.0--a versatile platform for genome mining of secondary metabolite producers. Nucleic Acids Res 41(Web Server issue):W204–12

6 - Kopylova E, Noé L, Touzet H (2012) SortMeRNA: fast and accurate filtering of ribosomal RNAs in metatranscriptomic data. Bioinformatics 28 (24):3211–7

7 - Quast C et al. (2013) The SILVA ribosomal RNA gene database project: Improved data processing and web-based tools. Nucleic Acids Res 41 (D1):D590–6

MYOSD: MARINE MICROBIOLOGY MEETS CITIZEN SCIENCE

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Abstract
The Ocean Sampling Day (OSD) is a global sampling campaign, conducted regularly on the 21st of June with the aim to generate a worldwide snapshoot of the marine microbial diversity and function. The first OSD took place in 2014 and researchers all around the world contributed with standardized samples. As citizens expressed a strong interest in participating in OSD, citizen scientists have become a key part of OSD and are coordinated through the MyOSD project. In 2015, a special MyOSD sampling kit, to make the sampling possible for citizen scientists, was developed and participants collected 192 samples, doubling the amount of OSD samples gathered in the previous year. Consequently, their combined efforts generated the largest standardized, open-access microbial data set derived from samples collected on a single day.

Keywords: Biodiversity, Bacteria, Mediterranean Sea, Sampling methods, Surface waters

Marine microbiology research plays a fundamental role in marine science. Nevertheless, in the broad public the importance or even existence of marine microorganisms is often hardly known. Therefore, the general public was invited to join the Ocean Sampling Day (OSD) with the MyOSD initiative, not only to enlarge the OSD dataset but also to raise awareness about marine microbiology. The OSD was initiated within the EU FP7 funded project Micro B3 (Marine Microbial Biodiversity, Bioinformatics, Biotechnology) to analyze the marine microbial diversity and their genetic potential. Since 2014 it embraces a global network of scientists to collect water samples on one single day, the 21st of June. Already from the beginning, citizen scientist contributed environmental data to the OSD dataset in the citizen science initiative MyOSD. Citizens scientists measured water temperature, salinity and additional environmental parameters and sent them via the smartphone application "OSD Citizen App" directly to the OSD server [1]. After a positive evaluation of the data received from citizen scientists in 2014 [2] and their strong request to also sample marine microbes, the MyOSD project was developed further. For MyOSD 2015, we created a special sampling kit (Figure 1) based on the same protocol used by OSD scientists, which gives citizen scientists the possibility to sample marine microbes and work hand in hand with professional scientists.

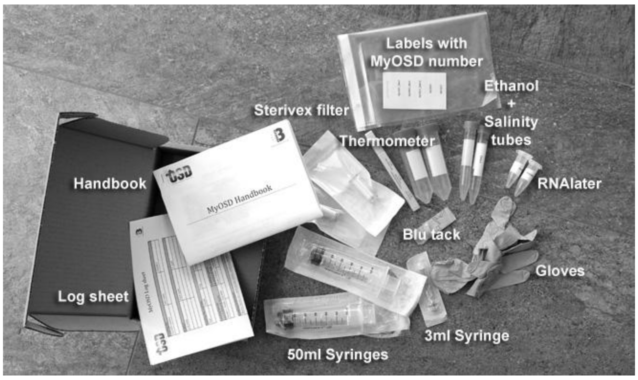

Fig. 1. Content of the MyOSD sampling kit. Each kit had a unique MyOSD number to keep better track of the collected sample and its contextual data.

To be in compliance with the Nagoya Protocol on Access and Benefit Sharing for Marine Genetic Resources, as well as with the Convention on Biological Diversity, legal permits to ship biological material across borders were required for some countries [1]. Therefore, we built up a network of MyOSD hubs holding those permits. These hubs distributed the sampling kits to citizen scientists in their country, collected them afterwards and sent them to the Max Planck Institute for Marine Microbiology in Bremen, Germany, for centralized DNA extraction and sequencing. In total, 270 sampling kits were produced, and distributed by 31 MyOSD hubs located in 19 different countries (Figure 2). Next to marine samples also samples from rivers were accepted. In total, 192 samples were returned (71% of initial distributed sampling kits) and with this doubling the amount of OSD samples (191 OSD samples in 2014).

Fig. 2. Locations of the 192 MyOSD samples (white pins) collected by citizen scientists all around the world in 19 different countries. Visualization was done with Google maps and the tool MapAList.

Out of 192 MyOSD samples, 167 were used for 16S rRNA gene amplicon sequencing due to insufficient amounts of DNA or missing of legal permits. In total 13,958,128 read pairs were sequenced, resulting in an average of 83,581 sequences per sample. These sequences are currently analyzed for obvious contaminations during the sampling procedure to assure that citizen scientists provide valuable data for marine microbiological studies. Once approved, the MyOSD samples will become an integral part of the OSD dataset for global marine microbial diversity analysis. The next challenge is to analyze and visualize the data in a meaningful way for citizen scientists with further information about the microbes found in their samples.

References

1 - Kopf, A. *et al.* The ocean sampling day consortium. *GigaScience* **4,** (2015).
2 - Schnetzer, J. *et al.* MyOSD 2014: Oceanographic Data Measurements by Citizen Scientists for the Ocean Sampling Day. *Journal of Microbiology & Biology Education* (2016 *in press*).

CIESM Congress Session : Microbial techniques and applications
Moderator : Balbina Nogales, Balearic Islands Univ., Palma, Spain

Moderator's Synthesis

This session included presentations on the use of different methodological approaches in applications such as antimicrobial discovery, biodegradation of polyaromatic hydrocarbons, interference with biofilm development and ecological impact of pollution. There was an active discussion with the speakers and the audience about different technical approaches and their limitations. With respect to antimicrobial discovery, which is a "hot" topic in terms of microbial applications, there was a general concern on the danger of exploitation of producing species (i.e. sponges, etc.), specially protected ones. As an alternative, the use of sustainable sources such as by-products from fish industry was presented in the session. A second concern in antimicrobial discovery evidenced in the discussion was the limitation caused by techniques from disciplines outside microbiology such as the determination and prediction of chemical structures of bioactive compounds.

From a broader perspective, the audience discussed the importance of genomic and metagenomics methods and the need to develop methods that allow us to assess the confidence level of the results and conclusions provided by these methods. This can be made extensive to other "omics" methods. The need for collaboration between specialists in different microbial techniques was pointed out as important for developing applications, given the high specialization level of the different available techniques. Finally, it was suggested that an effort should be made to develop microbial applications that anticipate or prevent problems and not only applications to solve problems. The audience was positive about the current status of microbiological techniques and the opportunities for future applications.

ENHANCEMENT THE BIODEGRADATION OF NITROGEN POLYAROMATIC HETEROCYCLIC COMPOUNDS BY ASSEMBLING MAGNETIC NANO-SORBENTS ON MICROBIAL CELL

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Abstract
Microbial cells of Gram +ve *Bacillus clausii* BS1 were coated by magnetic MFe_3O_4 nanoparticles (MNPs), which have good adsorption capacity towards carbazole (CAR) 95 µmol/g. The transmission electron microscope (TEM) analysis showed that the MNPs were efficiently assembled and adsorbed on the microbial cells. The coated cells not only showed higher biodegradation capabilities towards CAR, but could be also reused for four successive cycles, characterized by high storage and operational stabilities and have the advantage of magnetic separation.

Keywords: Petroleum, Pollution, Bacteria, Biotechnologies, Mediterranean Sea

Introduction
The persistent organic pollutants; nitrogen polyaromatic heterocyclic compounds (NPAHs), including CAR and its derivatives are released into the environment from oil spills, wastes and effluents of several industrial activities; oil drilling, refining and storage, coal tar processing, chemical manufacturing and wood preservation. CAR is known to be mutagenic, toxic and readily undergoes radical chemistry generating the genotoxic hydroxynitrocarbazole [1]. Microbial degradation can be safely applied to remediate these pollutants. However, one of the major drawbacks of bioremediation is being a lengthy process. Not only this, but the stability, reusability and separation of the applied microorganisms after the process completion are also drawbacks that should be solved. This work aims to solve these problems by applying the large surface to volume ratio and low toxic MFe_3O_4 NPs.

Experimental work
The previously prepared MFe_3O_4 NPs [2] were used to decorate a Gram +ve *Bacillus clausii* BS1 previously isolated for its ability to degrade CAR [1]. A comparative kinetic study was performed to follow up the biodegradation (BD) of 1000 ppm CAR in batch aqueous systems over a period of 7 days at room temperature and 150 rpm, using free and coated cells. High Performance Liquid Chromatographic (HPLC) analysis was used to quantitatively estimate the CAR-BD.

Results and discussion
The MFe_3O_4 NPs (9 nm) were efficiently assembled on the surface of the microbial cell (0.43 µm x 1.96 µm) (Figure 1), because of the large specific surface area of the prepared MNPs (≈110.5 m^2/g) and its high surface energy [2,3]. Due to the superparamagnetic properties of Fe_3O_4 [2], the MFe_3O_4-coated cells were easily separated by applying external magnetic field (Figure 2), recycled and reused for four successive cycles without losing its BD-efficiency. The MNPs expressed non-toxic effect on the *B. clausii* BS1. Approximately complete removal of CAR was achieved and the CAR-BD rate was doubled using coated cells. CAR-BD process followed the first order kinetic model ($R^2 > 0.92$), with rate constant (k = 0.0221 and 0.0107 h^{-1}) and half-life ($t_{1/2}$ = 31.36 and 64.78 h) for coated and free cells batch processes, respectively. The coated cells could be stored for 30 days at 4^{o}C without losing its CAR-BD activity. Not only this, but it could be also used over 672 h without losing its CAR-BD efficiency. While the free cells could be used only once, lost half of its activity after storage for 30 days at 4^{o}C and could be only separated by centrifugation or filtration. The inhibition effect of the toxic intermediates; anthranilic acid (ANA) and catechol (CAT) was also studied. The free cells were highly affected by ANA and CAT. But, the coated cells retained its maximum CAR-BD efficiency up to 370 ppm of ANA and CAT, which were further faster degraded to cis,cis muconate, that would enter into the bacterial TCA cycle.

Conclusion
The new technique of applying a magnetized-nano-biocatalyst for the biodegradation process is very promising as it has the advantages of magnetic separation, easy recovery, high storage and operational stabilities, can be reused for successive times, overcome the toxicity and inhibition effects of the byproducts, appears not to experience a mass transfer problem, and increases the rate of biodegradation of the recalcitrant high molecular weight NPAHs.

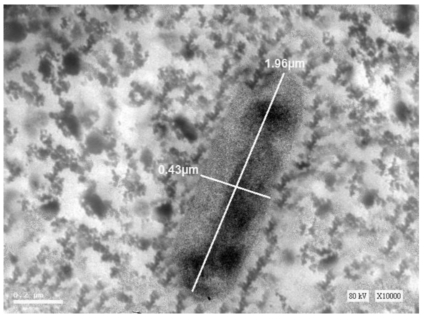

Fig. 1. TEM image of MFe_3O_4 coated *B. clausii* BS1.

Fig. 2. Collecting coated cells suspension by application of external magnetic field.

References
1 - Zakaria B.S., Nassar H.N., El-Gendy N.Sh. and El-Temtamy S.A. and Sherif S.M. 2015. Denitrogenation of carbazole by a novel strain *Bacillus clausii* BS1 isolated from Egyptian coke (Accepted in press).
2 - Zaki T., Saed D., Aman D., Younis S.A. and Moustafa Y.M. 2013. Synthesis and characterization of MFe_3O_4 sulfur nanoadsorbents. *J. Sol-Gel Sci. Technol.*, 65: 269–276.
3 - Saed D., Nassar H.N., El-Gendy N.Sh., Zaki T., Moustafa Y.M. and Badr I.H.A. 2014. Enhancement of pyrene biodegradation by assembling MFe_3O_4 nano-sorbents on the surface of microbial cells. *Energ. Source. Part A.*, 36: 1931–1937.

RESPONSE SURFACE METHODOLOGY AND BOX-BEHNKEN DESIGN FOR THE OPTIMIZATION OF ANTIMICROBIAL ACTIVITY FROM THE THERMOHALOPHILIC ACTINOMYCETE SMBG3

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Abstract
Actinomycetes are the most economically and biotechnologically prokaryotes for their ability to produce novel second metabolites [1]. The halophilic actinomycetes are noteworthy for their potential to produce novel bioactive compounds [2]. Among them, the production of antimicrobial compounds is greatly influenced by various fermentation parameters such as available nutriment, mineral salts, pH and temperature [3]. In the present study, we report the statistical optimization of antibacterial activity of Thermoactinomycete strain SMBg3 isolated from sediment solar saltern of Sfax in Tunisia.

Keywords: Antibiotics, Tunisian Plateau

Introduction
Actinomycetes are the most economically and biotechnologically prokaryotes for their ability to produce novel secondary metabolites [1]. The halophilic actinomycetes are noteworthy for their potential to produce novel bioactive compounds [2]. Among them, the production of antimicrobial compounds is greatly influenced by various fermentation parameters such as available nutriment, mineral salts, pH and temperature [3]. In the present study, we report the statistical optimization of antibacterial activity of Thermoactinomycete strain SMBg3 isolated from sediment solar saltern of Sfax in Tunisia.

Materials and Methods Strain isolation
SMBg3 was isolated from sediments solar saltern of Sfax in Tunisia and selected among a group of actinomycetes that has the capability of producing antibiotic against a range of pathogenic bacteria. The strain SMBg3 was isolated on steptomyces agar medium and was maintained on Bennett's medium supplemented with 10% NaCl.

Optimization of nutritional and cultural conditions by Taguchi and Box-Behnken
First, the screening for essential medium components of suitable medium using Taguchi Design was employed for screening the most eight significant medium components for growth and antimicrobial compound production by SMBg3. Second, the optimization of selected ingredients was effected by Response Surface Methodology (RSM). RSM was used with Box-Behnken design to optimize the selected media constituent and conditions (% of MgSO4, pH, and temperature) for enhanced growth and antibiotic production in SMBg3.

Results and Discussion
SMBg3 strain was isolated from sediments solar saltern of Sfax in Tunisia on pond M1. The phenotypic, chemotaxonomic and molecular characteristic based on the basis of 16S rRNA gene sequencing and % G+C showed that the SMBg3 strain is a new member of the *Thermoactinomycetaceae* family. SMBg3 strain exhibited a very strong activity against tested Gram-positive and Gram-negative bacteria in Bennett medium which was selected as suitable medium for optimization of growth and antimicrobial activity. Taguchi design was performed to evaluate the effects of eight variables according to the orthogonal matrix L18 [4]. Statistical analyses showed that temperature, pH and % of salt solution were the most influential and significantly parameters affected the antibacterial compound production. The RSM was applied with Box-Behnken and were found to be very effective in selecting and optimizing the medium components. These optimized values of the three factors were validated in a tow runs maximize to 47% for the growth, 44% for the antimicrobial activity against *E. coli* strain. The coefficient of determination (R^2) were found to be 0.8 for the growth and the antimicrobial activity models, value closer to 1.00 indicates the goodness of the models in accurate prediction of the response.

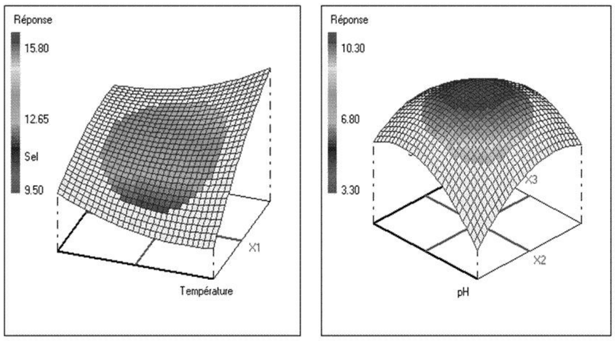

Fig. 1. Isoresponse curve of biomass (on the right) and antitibacterial activity against *E.coli*. (on the left).

References
1 - Adinarayana G. Venkatesan M. Saisha V. Bapiraju V.V.S.N. Sujatha K. Premkumar P., 2007. Resistoflavine, cytotoxic compound from a marine actinomycete, Streptomyces chibaensis AUBN 1/. Microbiol Res., 162:322-7.
2 - PO Pass A. J. and Solomon R. D. J., 2012. Phylogenetic diversity of actinomycetes cultured from coastal multipond solar saltern in Tuticorin, India Aquatic biosystems., 8(1), 1.
3 - Subramani R. and Albersberg W., 2012. Marine actinomycetes: An ongoing source of novel bioactive metabolites. Microbilogical Research., 167: 571-580.
4 - Jose, P. A., and Jebakumar, S. R. D., 2012. Unexplored hypersaline habitats are sources of novel actinomycetes. Frontiers in microbiology, 5.

WHAT HAPPENS TO PLANKTON FOOD WEB AFTER RESUSPENSION OF SEDIMENT IN COASTAL WATERS

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Abstract

Two trophic network models were developed to characterize the structure and the functioning of plankton food web in natural marine water and after addition of sediment elutriate in the Bizerte Lagoon (SW Mediterranean). Elutriate was obtained by resuspension of contaminated sediment with the release of nutrients, dissolved organic matter and chemical contaminants. Modeling showed that the trophic network control water was multivorous pathways in wish herbivorous and microbial activities coexist together. After elutriate addition, the food web switched to a microbial pathway, where microzooplankton exerted sever grazing pressure on bacterial and algal production.

Keywords: Models, Inverse methods, Food webs, Mediterranean Sea

Introduction

Coastal waters receive various types of contaminants, which are mainly concentrated in the sediment. However during mixing event, contaminants and nutrients can be released from sediment into water column. Sediment resuspension can thus result in pulsed exposures of complex mixtures of contaminants and nutrients which can impact planktonic organisms. Effectively, several studies have reported significant effects of resuspension of contaminated and nutrient-rich sediments on the biomass and structure of plankton communities [1]. However, the ecological consequences of resuspension of coastal sediment on the structure and functioning of the plankton food web stay until now unclear.The aim of the study was modeling the pelagic food webs of the lagoon of Bizerte by applying the Monte Carlo Markov chain Linear Inverse Modeling (LIM-MCMC) and to compare the food pathways in natural conditions and after exposure to a contaminant-nutrient mixture.

Materials and Methods

Sampling was carried in the lagoon at different depths (0.5, 2.5, 5/6 and 8/16 m) during spring 2012. The Sediment elutriates were prepared from sediment and water collected from the sampling station following the method described in [1]. Samples were used for determination of dissolved and particular organic carbon concentrations (DOC and POC), and carbon stocks of three size classes of phytoplankton (picophytoplankton: < 2 µm, nanophytoplankton: 2 – 10 µm, microphytoplankton: 10 – 200 µm), bacteria and microzooplankton. Two nets (200 µm and 700 µm) were towed vertically to determine carbon biomass of mesozooplankton and to estimate their grazing impact on phytoplankton by the method of gut pigment content [2]. Vertical fluxes of carbon particles were measured with sediment traps. Production rates of phytoplankton as well as consumption rates of bacteria and microzooplankton were estimated from dilution method [3]. Nutrients and contaminants (trace metals, HAPs, PCBs and organotins) were analysed in the elutriate. Field data were used to construct plankton food web model that quantitatively illustrate carbon pathway in study site. Since the unknown flows outnumbered the known flows, the linear inverse method Monte Carlo Markov chain method "LIM-MCMC" [4], derived from the LIM of Vezina and Platt [5] , was adopted to reconstruct food carbon flows through the pelagic food web.

Results and Discussion

In the Lagoon, the main carbon input was supported by the primary production (PP = 1234.24 mg C m^{-2} d^{-1}) and was mainly performed by microalgae (70% of total PP). Microzooplankton, composed mainly of heterotrophic dinoflagellates and ciliates, removed daily half of the total PP. These micrograzers consumed the pico- and the nanophytoplankton as well as the microalgae. Grazing on bacteria was equivalent to 35% of their production. Mesozooplankton grazed only on micro/nanophytoplankton and removed 8% of their production. This trophic pathway corresponds to a multivorous food web in wish microbivorous and herbivorous grazers can act together in channelling the biogenic carbon. After addition of sediment elutriates, which were rich in N-nutrients (especially NH_4^+, 40 µM) and in trace metals (especially Zn, As, Cu, Ni and Pb: 1 - 17 ug l^{-1}), the growth and the production of picophytoplankton noticeably increased and these picoalgae became the main C producers, representing 64% of total PP. The biogenic carbon entered to a plancktonic foodweb mainly by the microzooplankton grazing on picophytoplankton (half of its PP was grazed) and on bacteria (82% of their production were consumed). The micrograzers removed also an important fraction of nano- and microphytoplankton. Despite the mesozooplankton grazed 28% of the nano/microalgal production, it contributed only weakly in the channel of C, since the > 2 phytoplankton had low contribution to PP. This new C pathway, in which micrograzers play the significant role in channeling the biogenic C *via* their high microbivory, corresponded to the microbial food web. These results revealed that during mixing event in shallow water ecosystems, trophic interactions among plankton components can be strongly affected by sediment resuspension. The modelling exercise showing theses change provoked severe consequences in the structure and the functioning of plankton foodweb of the Bizerte Lagoon.

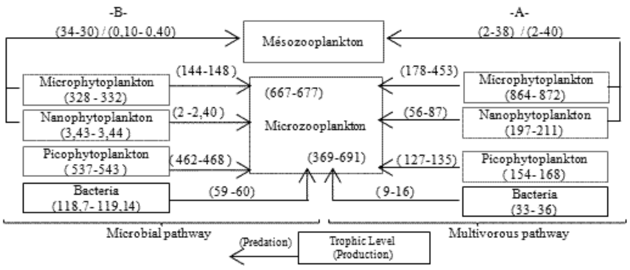

Fig. 1. Interval of possible values (Production and Predation: mgC m^{-2} d^{-1}) derived from the inverse analysis solution for the lagoon. A: Food web in natural water , B: Food web after elutriate addition.

References

1 - Lafabrie ,C., Hlaili, A.S, Leboulangern,C., Tarhouni, I.,Othman, H.B, Mzoughi,N., Chouba, L., Pringault, O., 2013 Contaminated sediment resuspension induces shifts in phytoplankton structure and function in a eutrophic Mediterranean lagoon. kmae.journal. 410, 05.

2 - Landry, M.R., Hassett, R.P., 1982. Estimating the Grazing Impact of Marine Micro-zooplankton. Mar. Biol. 67, 283-288.

3 - Slaughter, A. M., Bollens, S.M., Bollens, G. R., 2006. Grazing impact of mesozooplankton in an upwelling region off northern California, 2000–2003. Deep-Sea Res (II) 53, 3099-3115.

4 - Van den Meersche, K., Soetaert, K., Van Oevelen, D., 2009. xsample(): An R Function for Sampling Linear Inverse Problems. J. of Stat. Soft. 30, 1-15.

5 - Vézina, A.F., Platt, T., 1988. Food web dynamics in the ocean. I. Best estimates using inverse methods Mar Ecol Prog Ser 42, 269-287.

EFFECT OF AMORPHOUS AND CRYSTALLINE TITANIUM DIOXIDE NANO-MATERIAL ON *BACILLUS SUBTILIS* BIOFILM DEVELOPMENT

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Abstract

This study aims to compare the anti-biofilm activity between amorphous titanium oxide nano-powder and crystalline (anatase) titanium oxide nanoparticles. Both titanium oxide forms were prepared by sol-gel method and tested against fluorescently labelled *Bacillus subtilis*. Here, surface coated by amorphous titanium oxide and anatase titanium oxide nanoparticles showed reduced biovolume of attached cells to almost negligible to $5x10^{-2}$ $\mu m^3/\mu m^2$ and $0.01x10^{-2}$ $\mu m^3/\mu m^2$; respectively, in comparison to the biovolume attached to the uncoated slide glass control samples $155x10^{-2}$ $\mu m^3/\mu m^2$. However the lower cost, amorphous titanium oxide nano-powder show lower anti-biofilm efficiently than its crystalline form.

Keywords: Bacteria, South-Central Mediterranean, Biotechnologies

Introduction

Microbes often form surface attached micro-communities called biofilms mainly to get protected against antimicrobials and other environmental stresses [1]. This is a major problem in medical, environmental and industrial settings as getting rid of these biofilms is not always easy. Coating surfaces with titanium oxide nanoparticles can be one of the ways to achieve this anti-bioflm property [2]. However its promising properties, researchers tend to use its amorphous form to overcome cost of thermal treatment for crystallization.

Methods

Glass slides were coated by nanoparticles to create an anti-adhesive surface against bacteria as a route for preventing bacterial-surface attachment and successive biofilm development. Nanoparticles were synthesized by sol-gel and used as amorphous (a-TiO_2) and crystalline (TiO_2 anatase) forms. Briefly, titanium isopropoxide as titanium precursor was added to isopropanol and then isopropanol was supplied drop by drop during continuous stirring at room temperature. The turbid solution containing the isopropoxide hydrolysate was dried at 100°C to obtain a-TiO_2. Thermal calcination process for dried powder was performed at 450°C for 2 h to prepare TiO_2 anatase [3]. For prepared powdered, the crystal phase were estimated by X-ray diffractometer. The morphology of the prepared nanomaterials was determined by Philips 200 transmission electron microscope. The hydrodynamic diameter and zeta potential of the prepared metal oxides were identified by dynamic light scattering. Cleaned glass slides were dipped in nano-suspensions then allowed to be dried. The anti-adhesive properties of the treated slides were tested by studying the attachment of *B. subtilis* strains after 24 hours of inoculation using confocal laser scanning microscope.

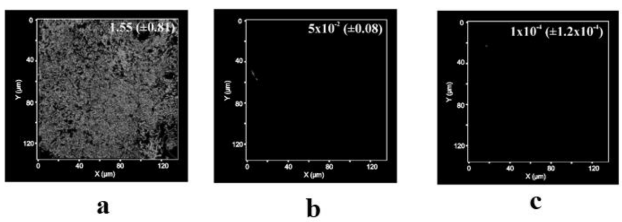

Fig. 1. Biofilm development on glass surfaces that were uncoated (A) or coated with amorphous titanium dioxide (B), crystalline titanium dioxide (C).

Results

Here, surface coated by a-TiO_2, TiO_2 anatase NPs showed reduced biovolume of attached cells to almost negligible to $5x10^{-2}$ $\mu m^3/\mu m^2$ and $0.01x10^{-2}$ $\mu m^3/\mu m^2$; respectively, in comparison to the biovolume attached to the uncoated slide glass control samples $155x10^{-2}$ $\mu m^3/\mu m^2$.

Acknowledgements

ESF (European Science Foundation), JSMC (Jena School for Microbial Communication), Marie Curie Career Integration Grant (PheHetBacBiofilm), Deutsche Forschungsgemeinschaft (DFG), BacFoodNet COST Action, Thüringer Ministerium für Bildung.

References

1 - Abee, T., Kovács, Á.T., Kuipers, O.P. and van der Veen, S. (2011) Biofilm formation and dispersal in Gram-positive bacteria. *Curr Opin Biotechnol* **22,** 172-179.

2 - Vargas-Reus, M.A., Memarzadeh, K., Huang, J., Ren, G.G. and Allaker, R.P. (2012) Antimicrobial activity of nanoparticulate metal oxides against peri-implantitis pathogens. *Int J Antimicrob Agents* **40,** 135-139.

3 - El-Shafei, A. et al. (2015) Eco-friendly finishing agent for cotton fabrics to improve flame retardant and antibacterial properties. *Carbohydr Polym* **118,** 83-90.

CARACTÉRISTIQUES DES PEPTIDES ANTIBACTÉRIENS DES VISCÈRES DE *SEPIA OFFICINALIS*

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Abstract
L'objectif de ce travail a été d'étudier les activités antimicrobiennes des peptides issus des co-produits de la pêche. L'hydrolysat généré à partir de l'hydrolyse avec la Pepsine a ainsi été fractionné selon la charge des molécules. Les peptides bioactifs sont de nature cationique et possèdent un bas poids moléculaire.

Keywords: Cephalopods, Enzymes, Antibiotics, Bacteria, Mediterranean Sea

Introduction

Actuellement les co-produits des industries de conditionnement et de transformation des ressources halieutiques sont essentiellement transformés en farines et huiles, destinés à l'alimentation animale [1]. Pourtant, ces co-produits constituent une source importante de molécules bioactives [2]. Cette étude s'intéresse au screening des propriétés antibactériennes des peptides des hydrolysats des viscères de la seiche *Sepia officinalis*. Une séparation par la charge des hydrolysats a permit de déterminer la relation entre l'activité des peptides antibactériens et la charge.

Matériel et méthodes

Les viscères de *Sepia officinalis* ont subi une hydrolyse de deux heures en bioréacteur enzymatique par la Pepsine à échelle pilote (20 L). L'hydrolysat final (50g/L de concentration protéique) est fractionné sur des cartouches SPE échangeuses de cations (SCX) et d'anions (SAX). Les souches bactériennes testées sont celles des pathogènes humains et de la flore de contamination des produits halieutiques. La méthode de diffusion en puits de gélose a été adoptée. Un témoin antibiotique (Polymyxine B et lysozyme 1 mg/mL). Les antibiogrammes ont été réalisés en triplicats. Les prélèvements effectués pour les tests sont de 60µL avec une concentration peptidique de 3 mg/mL.

Résultats

Les résultats du screening de l'activité antibactérienne sont présentés dans le Tableau 1.

Tab. 1. Antibiogramme réalisé avec les 3 fractions issues de la séparation par la charge sur les colonnes SCX et SAX de l'hydrolysat. *CA : fraction cationique ; AN : fraction anionique ; NR : fraction non retenue (-) : pas d'inhibition*

	Zone d'inhibition (mm)			
	CA	AN	NR	Témoin (+/-)
Bacillus megaterium	20,2 ± 1,2	-	-	15 ± 0,2
Escherichia coli	18,6 ± 2,0	5,1 ± 2,8	-	16,3 ± 1,3
Lactococcus graviae	15,6 ± 0,4	-	-	17,6 ± 0,2
Micrococcus luteus	8,5 ± 0,1	-	-	15,2 ± 1,2
Vagococcus salmonarium	19,3 ± 1,1	-	-	17 ± 0,1

Les résultats montrent l'absence d'activité antibactérienne dans les fractions anionique et non retenue et une forte présence de cette activité inhibitrice dans la fraction cationique. Une très faible inhibition (d = 5,1 ± 2,8) est cependant observée au niveau de *E.coli* mais au niveau d'un seul antibiogramme, expliquant le fort écart-type obtenu. Pour la fraction cationique, toutes les souches de bactéries testées sont sensibles à l'hydrolysat fractionné. Le plus diamètre d'inhibition de l'hydrolysat fractionné est toujours supérieur au témoin gram+/gram-sauf pour les souches *L. graviae* et *M. luteus*. Pour cette bactérie uniquement, l'inhibition est particulièrement faible vu que d < 6 mm. Toutefois, l'inhibition est remarquablement forte au niveau des autres souches qui sont sensibles à cette fraction cationique. En effet, les diamètres des zones d'inhibition varient entre 15 et 20 mm, la souche bactérienne la plus sensible semble être *B. megaterium* (20,2 ± 1,2 mm).

Les résultats précédents ont été confirmés par les CMI (Concentrations Minimales Inhibitrices) [3]: aucune activité antibactérienne n'a été détectée aussi bien dans la fraction anionique que dans la fraction non retenue. C'est la fraction peptidique cationique qui est active particulièrement contre *B.megaterium* avec une CMI de 75 µg/ml.

En se basant sur des concentrations protéiques, toutes les autres CMI sont inférieures à 200 µg/mL, ce qui confirme que les peptides cationiques sont très actifs. Les profils chromatographiques (Figure 1) ont mis en évidence des différences entre la fraction CA et la fraction NR. La plupart des peptides qui se retrouvent dans la fraction CA sont supérieurs à 1000 Da alors que la fraction NR comprend les peptides de petite taille.

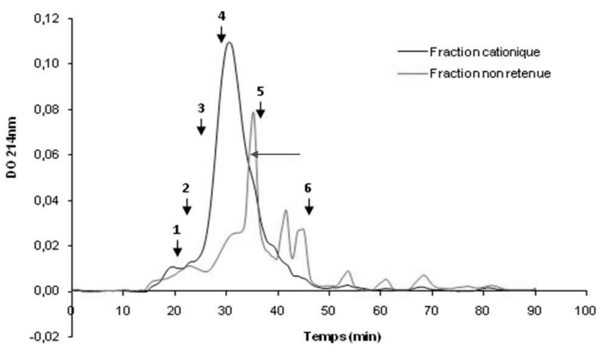

Fig. 1. Profils chromatographiques de la fraction active cationique et de la fraction non retenue (Calibrations : 1= 7330 Da ; 2 = 3142 Da ; 3 = 2168 Da ; 4 = 1040 Da ; 5 = 496 ; 6 = 250 Da).

Discussion et conclusion

Dans ce travail, la fraction CA a été très active contre les deux groupes de bactéries pathogènes. La nature cationique des peptides bioactifs est vérifiée. Les profils ont montré que la fraction antimicrobienne active possède un PM compris entre 2000 et 250 Da. Un travail complémentaire de fractionnement par ultrafiltration sera utilisé comme stratégie de prépurification.

References
1 - Benjakul, S., Morrissey, M.T. (1997) Protein hydrolysates from Pacific Whiting solid wastes. *J. Agric. Food Chem*. 45 (9): 3423-3430.
2 - Ravallec-Plé R., Charlot, C., Pires, C., Braga, V., Batista, I., Van Wormhoudt, A., Le Gal, Y., et Fouchereau-Péron, M. (2001) The presence of bioactive peptides in hydrolysates prepared from processing waste of sardine (*Sardina pilchardus*). *J. Sci. Food Agric.*1120-1125.
3 - Du Toit E.A., Rautenbach M. (2000) A sensitive standardized micro-gel well diffusion assay for the determination of antimicrobial activity. *J Microbiol Methods*. 42(2):159-65.

CIESM Congress Session : Blue Biotech (marine invertebrates and extremophile microbes)

Moderator : Antje Labes, GEOMAR, Kiel, Germany

Moderator's Synthesis

Marine biotechnology explores and uses marine bioresources as the target for or origin of technological applications, which are used for the production of products and services. As such, the field is very broad with respect to resources, basic research needed to describe and protect the biodiversity but also in terms of developing sustainable processes for the broad variety of application fields, spanning from drug production, industrial process development to ecosystem management and many more. Marine invertebrates and the microbes of extreme marine environments have been very much in the discovery and development focus, leading to a number of success stories but also illustrating the bottlenecks in the development. This was reflected in the flash presentations of the session and was actively discussed along these questions:

- How to increase diversity for discovery?
- Any forerunners and best practices for sustainable blue biotech?
- Hottest technologies to be taken up by the field?
- Most difficult obstacle for blue biotech?
- What will the next generation of blue biotech scientists need?

The main directions of the discussions were along the multidisciplinarity of the topic, which often leads to “language” problems, even between different subcategories of one field. As an example, it was highlighted that a systems biologist could provide the insights into substrate binding properties enzymes, which a marine biotechnologist is desperately looking for. However, in their normal community they do not necessary meet and talk to each other. It was stated that so many disciplines could contribute to the development of the promising potential of marine biological resources. In terms of approaches, it was recommended to especially use geographical differences as an advantage, as environmental conditions strongly influence the product spectra of (marine) organisms. Last but not least, the role of integrated training for the next generation of blue biotechnologists was emphasized.

AMINO ACIDS COMPOSITION AND QUALITY IN BYSSAL THREADS AND DISCS *OF MYTILUS GALLOPROVINCIALIS*

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Abstract

The objective of the present study is to characterise biochemically the byssus of *Mytilus galloprovincialis* for further valorisation. Byssal threads are 67.07±2.59 percent water by weight. The proximate composition expressed as percent dry weight (DW) included ash (9.01 ± 2.13), total nitrogen (13.50 ± 0.24), lipids (1.94 ± 0.27) and carbohydrates (0.84 ± 0.05). Amino acid analysis showed that there is a considerable difference in amino acid composition between the threads and the discs of the byssus with high amounts of amino acids specific to collagen sequences.

Keywords: Chemical analysis, Bivalves, Lagoons, Mediterranean Ridge

Introduction

Survival of sessile marine invertebrates depends mainly on the performance of their attachment strategies [1]. *M. galloprovincialis* binds to the surfaces of various substrates by producing a large number of byssal threads. An investigation on this single biological adhesion system will be useful in the development of bioadhesives and related products used in medical and industrial fields. The purpose of this study was the biochemical characterization of *M. galloprovincialis* byssus with a purpose of valorisation.

Material and methods

The mussels were harvested in a farm located in the lagoon of Bizerte (North of Tunisia). Samples (approximately 150 individuals) were collected monthly from March to May 2015. The mussels were separated by carefully slitting their byssus, and then transferred to an aquarium of 50 l of filtered seawater taken from the sampling site. Every two days the byssus threads produced by each mussel were cut and collected individually, then stored at -80°C until biochemical analyzes. Analysis of variance (ANOVA) was used to identify differences in the different amino acids content between the thread and the disc of the mussel's byssus.

Results and discussion

Proximate chemical composition of *M. galloprovincialis* byssus is shown in Table 1. In this study, high ash content reflecting mineral levels was found in mussel's threads. It is well established that the byssal threads mineral contents is related to the geochemical nature of the environment [2].

Tab. 1. Compositional analysis of *M. galloprovincialis* byssal threads. The amounts of ash, carbohydrates, lipids and total nitrogen are expressed per g/100g of the dry weight (DW) ± SE.

Byssal thread analysis	
Moisture	67.07±2.59
Ash	9.00 ± 2.13
Carbohydrate	0.87 ± 0.05
Lipids	1.94 ± 0.27
Total nitrogen	13.50 ± 0.24

The relative higher percentage of ash found in *M. galloprovincialis* byssus compared to other studies carried out in different environments [1,2] can be explained by the difference of environmental factor such as the higher salinity of the lagoon of Bizerte. Carbohydrate content in mussel byssus has not been much studied, the amount measured in this study can be explained by the presence of glycoproteins [2]. Data on the lipid content of mussel byssus are scarce. The structural role of these lipids is unknown. Our results reveal a higher concentration of lipids compared to other species and other environments [3]. The percentage of relatively large lipid byssus is probably due to the characteristic of the Tunisian mussel which has a particularly strong reproductive effort. Indeed, in the lagoon of Bizerte, sexual cycle *M. galloprovincialis* is spread throughout the year. The storage of fat including in the byssus could be then continuous.

The different amino acids concentrations in the thread and the disc of mussel byssus are shown in figure 1.

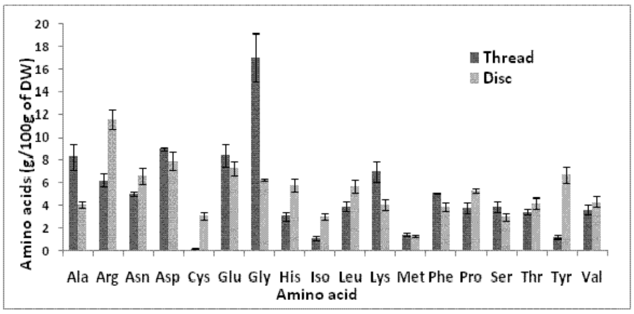

Fig. 1. Amino acid composition (g/100g DW± SE) of mussel's byssus

Statistical analysis (ANOVA) showed a significant difference ($p<0.05$) in amino acid between the threads and the discs of byssus except glutamine, methionine and valine (figure 1). This could be related to a differencein protein composition between these two parts. Such heterogeneity has been reported in other species of Mytilidae [4]. Byssus contains high amounts of amino acids that are characteristic of collagen. The amino acids of the *Mytilus galloprovincialis* are comparable to that of *Mytilus edulis* and *Mytilus californianus* especially as regards the large amount of glycine which form collagen [4].

Conclusion and Future perspective

The byssus is a natural fiber very complex and still unwell understood, this research present a primary understanding that can be useful to researchers that explore potential applications from the adhesion of mussels, including the development of biomimetic adhesives. Considerable progress has been made in this area, but the biochemistry of proteins responsible for the strong adhesion of the mussel and adhesion mechanisms have not been fully investigated. Indeed, the identification and characterization of the adhesive mussel proteins will improve our understanding of their biological roles in the adhesion mechanisms and advance research biomimetic products.

References

1 - Coombs T. L. and Keller P. J., 1981. *Mytilus* byssal threads as an environmental marker for metals. *Aquat. Toxicol.*,1: 291–300.
2 - Waite J. H., Vaccaro E., Sun C. and Lucas J. M., 2002. Elastomeric gradients: a hedge against stress concentration in marine holdfasts? Phil. Trans. R. Soc. Lond., 357: 143-153.
3 - Hennebicq G .F., Pellerin C.H., Isabelle Marcotte I., Bruno Myrand B. and Tremblay R., 2012. The effect of spawning of cultured mussels (*Mytilus edulis*) on mechanical properties, chemical and biochemical composition of byssal threads Remy. Aquaculture.,410:11-17.
4 - Bdolah A. and Keller P.J., 1976. Isolation of collagen granules from the foot of the sea mussel, Mytilus californianu. Comp Biochem Physiol B., 55:171-4.

ANTIMETASTATIC ACTIVITY OF *HOLOTHURIA POLII* TRITERPENE GLYCOSIDES FROM TURKISH COASTLINE

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Abstract
Sea cucumbers have special secondary metabolites called triterpene glycosides. These metabolites show some important bioactivities. In the present work, triterpene glycosides from *Holothuria polii* were isolated by using HPLC and characterized by MALDI-TOF/MS. Antimetastatic activity of partially isolated triterpene glycosides was carried out. Triterpene glycosides could be alternative natural anti-metastic agents to current synthetic agents.

Keywords: Biotechnologies, Aegean Sea, Echinodermata

Introduction
Holothuria polii Delle Chiaje, 1823 is a common, white spot sea cucumber which is widely distributed in the Mediterranean sea from 0 to 250 m deep [1]. Holothurians secrete so called glycoside based triterpenes as secondary metabolites. The structures of these molecules are changeable from species to species and from region to region. Antifungal, antiproliferative, anti-inflammatory, anti-thrombotic, antibacterial, apoptotic, cytotoxic, hemolytic, cytostatic and immunomodulatory properties of triterpene glycosides have so far been reported in scientific papers [2]. Metastasis, which is known as permeation of cancer cells away from the origin, is the most effective factor on both cancer progression and deaths. Tumor metastasis which includes cell proliferation, proteolytic digestion of extracellular matrix, cell migration to circulatory system and tumor growth in metastatic regions, is a multistep and complex process [3]. Novel treatment methods by using natural compounds are of great importance for metastasis process. In this study, it was aimed to investigate the antimetastatic activity of *H. polii* triterpene glycosides on T84 cell line.

Materials and Method
H. polii samples were collected from Dikili (Aegean Sea, Turkey) at a depth of 0-2 m. After the samples were transfered to laboratory within the fresh-sea water, they were freezed at -18 ºC to kill [4]. In order to isolate the triterpene glycosides, the body walls of the *H. polii* were homogenized and extracted and semi-purified by using the method of Bondoc et al. 2013. Finally, the isobutanolic phase was evaporated and pH 7.4 HPLC grade water was added. The chromatographic separations were performed with Shimadzu LC-20 HPLC system connected to SPD-20A UV detector. Fractination of triterpene glycosides was performed on Inertsil C18 HPLC column (GL Sciences), (250 mm x 4.6 mm, 5 µm). The analytes were eluted by using non-linear gradient of methanol (A) and water (B) (0 min, 10% A; 6 min, 60% A; 13 min, 60% A; 15 min, 10% A) at a flow rate of 1 mL/min. Column temperature was 27ºC [5]. Also, the fractions were analysed by using MALDI-MS/MS on positive ion mode. In order to determine the total saponin concentrations in each fraction, vanillin-sulfuric acid colorimetric method [6] was carried out. xCELLigence Real-Time Cell Analysis (RTCA) was used in cell migration-invasion assays on T84 cell line. Data analysis was carried out with RTCA software vs. 1.2.1.

Results
HPLC chromatogram of semi-purified triterpene glycosides was given in Figure 1. The retention times of fraction A, B, C and D were 9.6, 10.6, 11.7 and 13.4 min, respectively. In fractions, total saponins were found as 296.797 mg/L, 391.892 mg/L, 236.737 mg/L and 341.842 mg/L for fraction A, B, C and D, respectively. Although in fraction C contains both holothurin A (1243.50 m/z) and a novel isomer (1127.50 m/z), fraction D contains only the novel isomer. According to the antiproliferation results of fraction A-D on T84, IC_{50} values were found as 38.92±6.03, 37.99±3.81, 21.46±1.49 and 17.64±1.10 mg/L, for fraction A, B, C and D, respectively. The most effective fraction on antiproliferation for T84 cell line was found as fraction D. Also, the invasion and migrasion result reveals that 35 and 10 ppm of *H. polii* extract show antimetastatic activity on T84 cell line.

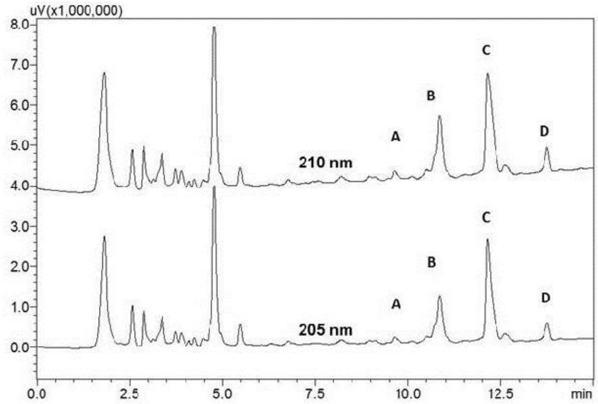

Fig. 1. A sample HPLC chromatogram of semi-purified triterpene glycosides at 205 and 210 nm.

Conclusion
Triterpene glycosides are important bioactive metabolites which are drug candidates against metastasis. Thus, *H. polii* could be evaluated as a novel, promising antimetastatic agent source.

Acknowledgement
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References
1 - Mercier A., 2013. *Holothuria poli*. The IUCN Red List of Threatened Species 2013: e.T180295A1612001. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T180295A1612001.en. Downloaded on 08 March 2016.
2 - Bordbar S., Anwar F. and Saari N., 2011. High-value components and bioactives from sea cucumbers for functional foods—a review. *Mar. Drugs*, 9: 1761-1805.
3 - Hanahan D. and Weinberg R.A., 2000. The hallmarks of cancer. *Cell*, 100: 57-70.
4 - Bondoc K.G.V., Lee H., Cruz L.J., Lebrilla C.B. and Juinio-Meñez M.A., 2013. Chemical fingerprinting and phylogenetic mapping of saponin congeners from three tropical holothurian sea cucumbers. *Comp. Biochem. Phys. B*, 166: 182-193.
5 - Van Dyck S., Caulier G., Todesco M., Gerbaux P., Fournier I., Wisztorski M. and Flammang P., 2011. The triterpene glycosides of *Holothuria forskali*: usefulness and efficiency as a chemical defense mechanism against predatory fish. *J. Exp. Biol.*, 214: 1347-1356.
6 - Hiai S., Oura H. and Nakajima T., 1976. Color reaction of some sapogenins and saponins with vanillin and sulfuric acid. *Planta Med.*, 29: 116-122.

VALORISATION DES HYDROLYSATS PROTEIQUES DE LA CARAPACE DU CRABE INVASIF *LIBINIA DUBIA* DU GOLFE DE GABES

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Abstract
A l'aide d'une protéolyse acide de la carapace du crabe *Libinia dubia*, récolté dans le golfe de Gabès, on a pu obtenir une phase soluble riche en minéraux (70%), contenant 15 acides aminés dont deux essentiels pour l'alimentation des espèces aquatiques à savoir la méthionine (0,02±0,02 g/100g MS) et la lysine (0,07 ±0,02 g/100g MS). Plus de 60% des peptides résultant de cette protéolyse ont des poids moléculaires inférieurs à 200 Dalton (Da) avec presque 10% de peptides à poids moléculaires compris entre 5 et 1 kDa. Le pouvoir antibactérien de ces peptides a été testé. Ces derniers ont inhibé partiellement la croissance de certaines bactéries comme *Morganella morganii* et *Vagococcus salmonarium.*

Keywords: Gulf of Gabes, Invasive species

Introduction

Libinia dubia, crabe originaire de l'Atlantique, a été signalé en Tunisie dans le golfe de Gabès depuis 1997 [1]. Cette espèce non indigène, introduite en Tunisie probablement via le transport maritime (eaux de ballasts), s'est rapidement acclimatée et a quasiment envahi l'ensemble du golfe de Gabès. Elle constitue actuellement une véritable nuisance sans précédent pour la pêche artisanale en Tunisie à cause des dégâts qu'elle inflige aux captures des pêcheurs et à leurs engins. L'éradication de ce crabe n'étant pas envisageable, une stratégie d'adaptation a été mise en place de façon à tirer profit de cette espèce invasive par la voie de la valorisation alimentaire et biotechnologique par extraction de molécules bioactives à forte valeur ajoutée comme les peptides antimicrobiens.

Matériel et méthodes

Les spécimens mâles et femelles récoltés, ont subi un décorticage,un parage, puis un séchage des carapaces (15 °C ventilé et 50 % HR) [2]. Ensuite, ces derniers ont été broyés pour obtenir une fraction fine(entre 300 µm et 1 mm) qui a subi une protéolyse acide pendant 6h à l'aide de l'enzyme Acid Stable Protéase (ASP) (3,000 SAPU/G ; Bio-Cat Inc) [2]. Après neutralisation par la soude et inactivation de l'enzyme, l'hydrolysat protéique soluble obtenu a été lyophilisé dans le but de sa caractérisation biochimique (matière sèche, matière minérale, lipides [3], acides aminés), et l'analyse de son poids moléculaires (par HPLC) et de son potentiel d'activité antibactérienne contre 4 souches pathogènes aquacoles et 4 d'altération alimentaire. Les résultats ont faits l'objet d'une analyse ANOVA et l'effet du sexe a été étudié en utilisant le test LSDmeans.

Résultats et discussion

La composition biochimique est indépendante du sexe (pas de différence significative : $p > 0,05$). L'hydrolysat lyophilisé est composé de 70% minéraux, 3% d'acides aminés et le reste est constitué de traces de lipides et autres (Tableau 1).

Tab. 1. Composition biochimique moyenne de l'hydrolysat protéique de la carapace de *Libinia dubia* (Base sèche).

	Mâles	Femelles	ESM	Pr>F
MS*	99.3±0.14^a	99.59 ± 0.37^a	0.159	0.062
Lipides*	0.3±0.06^a	0.27 ±0.05^a	0.069	0.242
AAT*	3.4±0.17^a	3.27 ±0.48^a	0.207	0.615
Cendres*	69.8±0.25^a	69.36 ±0.99^a	0.419	0.192

*Les données en colonnes suivies par des lettres identiques ne sont pas significativement différentes au seuil p<0.05 ; MS : matière sèche ; AAT : acides aminés totaux ; *moyenne (g/100 g MS) ± écart type*

De même, pour les acides aminés, il n'existe pas de différence significative entre la teneur moyenne de chaque acide aminé pour les deux sexes ($p > 0,05$). L'hydrolysat comporte 15 acides aminés (Ala, Gly, Val, Leu, Ile, Thr, Ser, Pro, Asp, Met, Glu, Phe, Lys, His et Tyr) avec des teneurs qui varient entre 0,02±0,02 pour la méthionine et 0,39 ±0,05 g/100g MS pour l'Acide aspartique, sachant que la méthionine et la lysine (0,07 ±0,02 g/100g MS) sont essentielles pour l'alimentation des espèces aquatiques [4] et [5]. Les variations du poids moléculaire de l'hydrolysat protéique lyophilisé montrent une prédominance des peptides à faibles poids moléculaires <1300 Da (Figure 1).

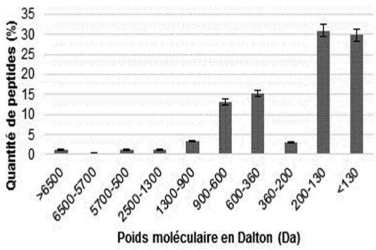

Fig. 1. Poids moléculaire des peptides solubles produits par l'hydrolyse enzymatique.

L'activité antimicrobienne des peptides est confirmée pour ceux dont les poids moléculaires se situent entre 5 et 1 kDa [6]. Dans cette étude, cette catégorie représente environ 10 % des peptides. Les résultats obtenus mettent en évidence un faible pouvoir antibactérien se traduisant par un ralentissement de la croissance de 2 souches testées à savoir *Morganella morganii* (bactérie d'altération alimentaire) et *Vagococcus salmonarium* (bactérie pathogène aquacole) (Figure 1).

References
1 - Enzenross R.,Enzenross L., 2000. Non-Mediterranean crustaceans in Tunisian waters (Decapoda, Macrura and Brachyura). *Crustaceana*,73:187-195.
2 - Leroux K., 2012. Purification de la chitine par hydrolyse enzymatique à partir de coproduits de crevette *Penaeus vannamei*. Caractérisations des produits et optimisation du procédé. Thèse de doctorat. Univ. de Nantes, 198p.
3 - Folch J, Lees M, Sloane-Stanley GH., 1957. A simple method for the isolation and purification of total lipides from animal tissues. *J. Biol. Chem*., 226:497-509.
4 - Li, P., Mai, K., Trushenki, J. and Wu, G. 2009. New developments in fish amino acid nutrition: Towards functional and environmentally oriented aquafeeds. *Amino Acids*, 37: 43–53.
5 - Mach, D. T.N., Nguyen, M. D. and Nortvedt, R. 2010. Effects on digestibility and growth of juvenile cobia (*Rachycentron canadum*) fed fish or crab silage protein. *Aquaculture Nutrition*, 16: 395–312.
6 - Zo R., 2011. Valorisation biotechnologique des co-produits de crevette : utilisation de la protéolyse enzymatique pour des applications avicoles à Madagascar. Thèse de doctorat. Université d'Antananarivo, 187p.

IN VITRO GROWTH INHIBITORY ACTIVITIES OF NATURAL PRODUCTS FROM IRCINIIDAE SPONGES AGAINST CANCER CELLS: A COMPARATIVE STUDY

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Abstract

Blue biotechnology includes the natural chemical diversity's exploration to develop new pharmaceuticals drugs. Among marine sponges, which have provided a rich supply of interesting bioactive substances, sponges belonging to the family Irciniidae contain bioactive furanosesterterpene tetronic acids (FTAs) and prenylated hydroquinones (PHCs), which are known to be toxic against human tumor cell lines. In the present study, a chemical investigation of Irciniidae sponges collected along Tunisian coasts led to the purification of both three different FTAs, and three PHCs, the activity of which has been evaluated under the same conditions against a panel of cancer cell lines and displayed various levels of sensitivity to pro-apoptotic stimuli.

Keywords: Porifera, Biotechnologies, Cell, South-Central Mediterranean

Sponges belonging to the genera *Ircinia* and *Sarcotragus* (Porifera: Dictyoceratida: Irciniidae) provided a variety of bioactive natural products which have attracted attention as promising drug candidates. Two major classes of compounds from irciniidae sponges have especially attracted the attention of chemists and pharmacologists: (a) linear terpenes containing both a furan ring and the tetronic acid moiety (FTAs), and (b) hydroquinones with a terpenoid portion (PHCs). Although it is not always clear whether the compounds are of dietary origin, produced by symbionts, or de novo biosynthesized by the sponges themselves, a panel of bioactivities with pharmaceutical potential, including cytotoxic, anti-inflammatory, antioxidant, and antimicrobial properties, have been attributed to both classes of compounds [1]. It is worth mentioning, however, that compounds belonging to the two different groups of compounds have not yet been compared in the same study using the same procedures, thus preventing to establish reliable differences in their efficacy against the same *in vitro* cellular models.

In the course of our investigation on secondary metabolites from irciniidae sponges from Tunisian coasts, we have isolated the known FTAs ircinin 1 (1), sarcotin A (2), and variabilin (3), along with the known PHCs 4-6. The isolated compounds were identified by comparison with NMR and mass spectral data available in the literature [2-4].

Subsequently, the in vitro growth inhibitory activity of compounds 1-6 has been investigated on the MCF7 mammary adenocarcinoma and the Hs683 oligodendroglioma, both displaying actual sensitivity to pro-apoptotic stimuli, the A549 non-small-cell lung cancer (NSCLC), the SKMEL-28 melanoma , and the U373 glioblastoma cell lines, the latter three lines showing various levels of resistance to pro-apoptotic stimuli. The compounds were also tested on murine B16F10 cells, a well-established tumor model for melanoma growth. Surprisingly, FTAs and PHCs exhibited very different inhibitory activities, with potencies varying by one to two orders of magnitude in favor of the PHCs in all cell lines (manuscript in preparation). The obtained comparative results are discussed in the light of a better selection of drug candidates from natural sources.

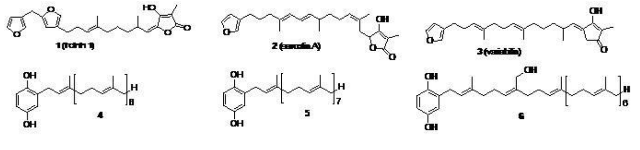

Fig. 1. Structures of compounds 1-6 extracted and purified from sponges samples.

References

1 - Mehbub MF, Lei J, Franco C. and Zhang W., 2014. Marine Sponge Derived Natural Products between 2001 and 2010: Trends and Opportunities for Discovery of Bioactives. Mar. Drugs, 12, 4539-4577; doi:10.3390/md12084539.

2 - Cimino, G.; De Stefano, S.; Minale, L. Prenylated quinones in marine sponges *Ircinia* species. Experientia 1972, 28, 1401-1402.

3 - Cimino, G.; De Stefano, S.; Minale, L. Polyprenyl derivatives from the sponge *Ircinia spinosula*: 2-Polyprenylbenzoquinones, 2-polyprenylbenzoquinols, prenylated furans and a C-31 difuranoterpene. Tetrahedron 1972, 28, 1315-1324.

4 - Faulkner, D.J. Variabilin, an antibiotic from the sponge, *Ircinia variabilis*. Tetrahedron Lett. 1973, 14, 3821-3822.

DIVERSITY OF MARINE MICROBES – A PROMISING SOURCE FOR NEW ANTIBIOTICS

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Abstract

Microorganisms from marine habitats, living in a stressful habitat, are of great interest as new promising sources of biologically active products. In order to find new compounds exhibiting antibiotic activities, bacteria and fungi affiliating to a broad range of phylogenetic diverse taxa were investigated. Among them, a representative of the fungal genus *Stachybotrys* was shown to produce the new metabolites, stachyin A and stachyin B. Stachyin B showed a strong inhibitory effect on the growth of methicillin-resistant *Staphylococcus aureus* (MRSA).

Keywords: Biodiversity, Fungi, Bacteria, Antibiotics, Worldwide

Considering the tremendous biodiversity of marine microorganisms and the gap in our knowledge in particular regarding their potential of natural product biosynthesis, they are expected to represent a treasure box of new products for marine biotechnology. Emphasis was put on the analysis of the microbial diversity of selected habitats and on the evaluation of the secondary metabolite production of a phylogenetically diverse selection of fungi and bacteria from different marine environments [1, 2].

Among the antibiotic producers there was a member of the fungal genus *Stachybotrys*. Marine isolates of *Stachybotrys* spp. have been gained from various marine environments as the rhizosphere of mangroves, soil and mud of the intertidal zone, intertidal pools, brackish waters, marine sediments and sponges, marine algae, and sea fans. The analyses of *Stachybotrys* sp. MF347 which was originated from a marine driftwood sample, revealed two new compounds, stachyin A (**1**) and stachyin B (**2**) (Fig. 1).

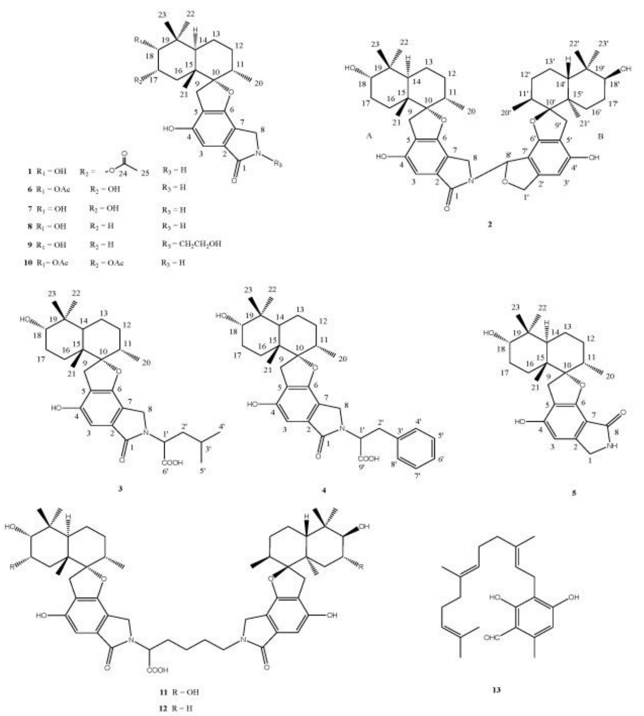

Fig. 1. Structures of compounds **1** - **13** [3].

Strain MF347 produced also the known spirocyclic drimanes stachybocin A (**12**) and stachybocin B (**11**) featured by two sesquiterpene spirobenzofuran structural units connected by a lysine residue; the known spirocyclic drimanes chartarlactam O (**5**); chartarlactam K (**6**); F1839A (**7**); stachybotrylactam (**8**); stachybotramide (**9**); and 2α-acetoxystachybotrylactam acetate (**10**); as well as ilicicolin B (**13**), a known sesquiterpene. Compounds **3** and **4** are two known spirobenzofuranlactams.

Spirocyclic drimanes with two sesquiterpene-spirobenzofuran structural units (compounds **2**, **11**, and **12**) showed antibacterial activity against the clinically relevant methicillin-resistant *Staphylococcus aureus* (MRSA) causing severe human diseases (table 1). The inhibition effect was comparable with the well-known antibiotic chloramphenicol (*Bacillus subtilis* IC_{50} 1.45 (±0.13) µM, *Staphylococcus* epidermidis IC_{50} 1.81 (±0.04) µM and S. aureus MRSA IC_{50} 2.46 (±0.4) µM). The spirocyclic drimanes with one sesquiterpene-spirobenzofuran structural unit **1**, **3**-**10** exhibit no activities. It is tentatively implied that the structural feature of two sesquiterpene-spirobenzofuran units with either a N-C or a N-N linkage of spirocyclic drimanes is important for antibiotic activity.

Tab. 1. Antibiotic activities of the compounds **2, 11**, **12**, and **13**. The IC_{50} values are given in µM [3].

No.	*B. subtilis*	*S. epidermidis*	*S. aureus* MRSA
2	1.42 (±0.07)	1.02 (±0.09)	1.75 (±0.09)
11	1.77 (±0.32)	4.44 (±0.28)	3.94 (±0.53)
12	2.03 (±0.23)	2.84 (±0.35)	3.71 (±0.22)
13	1.06 (±0.11)	3.18 (±0.33)	0.74 (±0.12)

The discovery of new natural products against antibiotic-resistant bacteria is a great issue. The WHO stated that 25,000 persons die each year due to infections with antibiotic resistant bacteria in 29 European countries [4]. Especially methicillin-resistant *S. aureus* (MRSA) strains are causing infections with high mortality rates and a growing rate of resistance [5]. Stachyin B (**2**) is an interesting new structure, which would provide opportunities to design and synthesize new analogs that could improve the antibiotic activity.

References

1 - Imhoff, J.F., Labes, A. and J. Wiese. 2011. Bio-Mining the microbial treasures of the ocean: New natural products. *Biotechnol. Adv.* 29: 468-482.
2 - Imhoff, J.F. 2016. Natural products from marine fungi – still an underrepresented resource. *Mar. Drugs,* 14, 19; doi:10.3390/md14010019.
3 - Wu, B., Oesker, V., Wiese, J., Malien, S., Schmal-johann, R. and Imhoff, J.F. 2014. Spirocyclic drimanes from the marine fungus Stachybotrys sp. strain MF347. *Mar. Drugs.* 12: 1924-1938
4 - European strategic action plan on antibiotic resistance. World Health Organization. Regional Committee for Europe 2011, EUR/RC61/14.
5 - Drebes, J., Künz, M., Pereira, C.A., Betzel, C., and Wrenger, 2013. MRSA infections: from classical treatment to suicide drugs. C. *Curr. Med. Chem*. 21: 1809-1819.

EXTREMOPHILIC ENZYMES FOR NOVEL SYNTHETIC METHODOLOGIES IN SUSTAINABLE CHEMISTRY

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Abstract
Novel synthetic methodologies using extremophilic enzymes for catalysing O-phosphorylation, water elimination, reduction and hydrolysis reactions will be discussed. The preparation of kinases from extremophiles enabled novel biocatalytic asymmetric phosphorylations of small molecules using the phosphoenolpyruvate-pyruvatekinase-system for ATP cofactor regeneration. The selective enzymatic elimination of water from sugar acids is another area where extremophilic enzymes are of interest and is described in the one-step biocatalytic route to 2-keto-3-deoxy-D-gluconate from D-gluconate using an extremophilic gluonate dehydratase. Finally, novel synthetic methodologies from the classes of biocatalytic reduction and hydrolysis reactions are described.

Keywords: Enzymes, Biotechnologies, Phosphorus, Bacteria, Mediterranean Sea

Resource efficiency combined with selectivity and robustness are common goals for the biosynthetic machinery of extremophiles in nature as well as for sustainable chemical processes in industrial manufacturing. Complete conversion in a reaction step, the waste per reaction step and the number of reaction steps are key factors for reaching these goals. Highly selective, protecting group-free and sustainable processes have the potential to reduce the number of reaction steps and therefore also to improve the efficiency of processes, reagents, and tools. The replacement of stoichiometric by catalytic methods leads to mass and energy savings, selectivity improvements, safety, health and environment benefits. Biocatalytic methods have become well established in a large number of industrial applications and have even become the first choice for certain reaction classes in the process design and the route selection [1]. Extremophilic enzymes from marine environments catalyzing the synthesis of the required molecules of life along the fascinating metabolic pathways under extreme conditions provide a blueprint from nature for synthesis and are of much interest in the development of novel synthetic methodologies towards sustainable chemical processes.

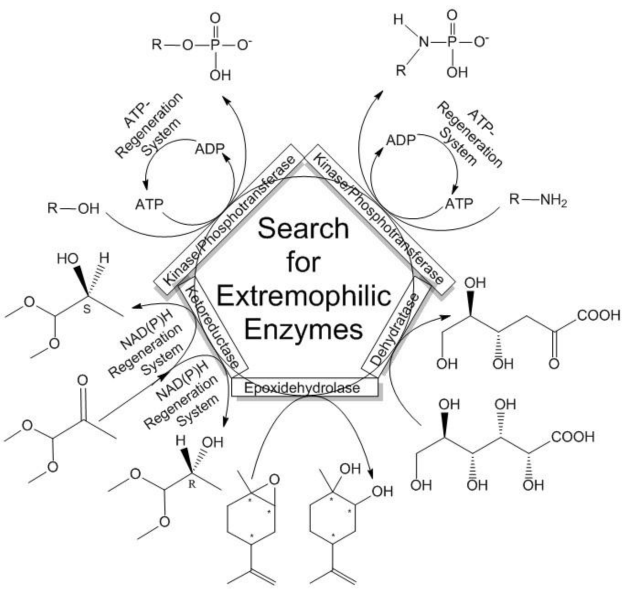

Fig. 1. Novel extremophilic enzymes for catalyzing phosphorylation, water elimination, hydrolysis and reduction reactions

Phosphorus is an important element for life on our planet and occurs in living cells as part of many key biochemical constituents such as nucleic acids, phospholipids, phosphoproteins, carbohydrates or various metabolites, where the element phosphorus is mainly present in the O-P-bonds, but also in N-P-, S-P- or C-P-bonds and needs to be introduced by phosphorylation reactions. Among these the majority are O-phosphorylation reactions, but also N-phosphorylation, S-phosphorylation and C-phosphorylation reactions play a role. As phosphorylation reactions are therefore of major importance in natural biological processes, a large number of enzymes catalyzing the transfer of phosphogroups from one compound to another have been discovered in nature. This biodiversity is also of much interest in synthetic production processes in industry, because classical chemical phosphorylation reactions lack selectivity [2]. A variety of kinases catalyzing O-phosphorylation reactions from extremophiles have been produced and analyzed. These kinases have been sucessfully applied in a number of biocatalytic asymmetric phosphorylations of small molecules like mevalonate [3], glyceraldehyde [4] and glycerate [5] using the phosphoenolpyruvate-pyruvatekinase-system for ATP cofactor regeneration. The selective enzymatic elimination of water from sugar acids is another area where extremo-philic enzymes are of interest, as moving from fossil-based raw materials towards biobased raw materials needs, instead of introducing functional groups into highly reduced raw materials, selective defunctionalisation of highly oxidized raw mate-rials like carbohydrates. The one-step biocatalytic route to 2-keto-3-deoxy-D-gluconate from D-gluconate using an extremophilic gluconate dehydratase offers higher enantiomeric purity, step economy, safety, health and environment benefits [6]. Selective biocatalytic reductions have become an indispensable synthetic methodology as cofactor regeneration is a routine task and novel biocatalytic reductions of keto-groups to (R)- and (S)-hydroxygroups are discussed [7-8]. The large class of extremophilic hydrolases has been well established for hydrolysis as well as acylation. Novel enzymes and applications have been discovered in the case of the epoxidehydrolase-catalyzed resolutions of cis-/trans-mixtures of limonene epoxides and the synthesis of chiral limonene diols [9-10]. In summary, highly efficient and selective extremophilic enzymes have been developed for biocatalytic phosphorylations, dehydrations, reductions, hydrolyses and applied in synthetic methodologies with complete conversions. The rich biodiversity and metabolic capabilities of extremophiles in marine environments has a tremendous potential for novel enzyme developments. Therefore the outlook for extremophilic enzymes from marine environments looks promising if combined with a clear focus on reaction classes where synthetic methodologies need to be developed.

References

1 - Meyer H.P. et al., 2013. *Catal. Sci. Technol.*, 3: 29-40
2 - Gauss D. et al.,2016. in: *Applied Biocatalysis - From Fundamental Science to Industrial Applications* ISBN: 978-3-527-33669-2, Wiley-VCH
3 - Matsumi R. et al., 2014. *RSC Advances* 4: 12989-12994
4 - Gauss D. et al., 2014. *Carbohydrate Research* 389: 18-24
5 - Hardt N. et al., 2016. manuscript in preparation
6 - Matsubara K. et al., 2014. *Journal of Biotechnology* 191: 69-77
7 - R. Wohlgemuth, 2014. in: *Synthetic Methods for Biologically Active Molecules: Exploring the Potential of Bioreductions*, Wiley-VCH
8 - Vogel M.A.K. et al., 2016. Reaction Chemistry & Engineering, DOI:10.1039/C5RE00008B
9 - Ferrandi E.E. et al., 2015. *FEBS Journal* 282:2879-2894
10 - Ferrandi E.E. et al., 2015. ChemCatChem 7:3171-3178

COMITÉ 5

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Ressources vivantes et écosystèmes marins

Co-Présidents : Jamila Ben Souissi, Salud Deudero
et Tamara Shiganova
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CIESM Congress Session : Cartilaginous fish I
Moderator : Alen Soldo, Split Univ., Croatia

Moderator's Synthesis

The session discussion focused (a) on the threat of extinction facing a number of shark species worldwide and (b) on new genetic tools available for their identification. Throughout geological history, catastrophic events have radically changed the Earth's environment, resulting in the extinction of a significant percentage of species. Sharks as a group have survived five major mass extinction episodes in the 450 million years of their evolutionary history, undergoing two major adaptive radiations. The worse such event happened at the end of the Paleozoic, 251 million years ago, killing more than 90% of the species, but leaving relatively intact the early representatives of elasmobranchs – the ancestors of modern sharks and rays. Recent evidence suggests that the sixth mass extinction of wildlife is now under way, killing off large ocean dwellers.

Sharks and other cartilaginous fish are particularly threatened, due to the impact of destructive fisheries that reach deeper and deeper and to the slow growth characteristics of these species. The problem is global: due to the overexploitation of the teleost fish stocks, fisheries now increasingly target sharks and rays. The Mediterranean characterized by multispecies fishery where many sharks and rays constitute an important bycatch of commercial fisheries targeting teleost fishes, and where management measures are grossly inadequate, is much affected. Many Mediterranean cartilaginous species are now considered rare or missing, i.e. not seen anywhere in the region for at least one decade. The rarity of catch data, of species-specific landing data, of CPUE data, fishing effort, species biological and ecological data etc, is dramatic.

Scientists and fisheries managers worldwide are struggling with a lack of basic information for many shark and ray species, often wrongly identified. The identification problem is exacerbated by the common fishery practice of removing the head, tail, and most fins from landed sharks while still at sea. Removing the major morphological identifying characters of the sharks prevents precise species identification and management. The recent emergence of various genetic techniques will facilitate the identification of species, subspecies, populations, strains, hybrids and individuals. However, these techniques are “young”, not widely used, and it is still a challenge to describe accurately the distribution of species or stock boundaries.

LENGTH-WEIGHT RELATIONSHIP OF SANDBAR SHARK *CARCHARHINUS PLUMBEUS* (NARDO,1827) IN ISKENDERUN BAY (NORTH-EASTERN MEDITERRANEAN SEA)

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Abstract

In this study, Lenght-Weight relationships (LWR) of sandbar shark were examined for the first time in a population of the North-eastern Mediterranean Sea. The LWR estimated for combined sexes was: W= 0.01*$TL^{2.865}$ (r^2=0.915, SE_b=0.174). LWR for females was W= 0.0034*$TL^{3.101}$ (r^2=0.912, SE_b =0.278) and for males W= 0.0039*$TL^{2.662}$ (r^2=0.915, SEb =0.231). The type of growth for all sexes and males were negative allometric growth (b < 3). The type of growth for females were positive allometric growth (b > 3).

Keywords: Fisheries, Population Dynamics, Fishes, North-Eastern Mediterranean, Iskenderun Bay

Introduction

Sandbar shark, *Carcharhinus plumbeus* (Nardo,1827) inhabits on sandy or muddy substrate but occasionally rise to surface to feed. It has world-wide tropical and temperate distribution except for the eastern Pacific (Golani *et al.,* 2006). There is no information on the Lenght-Weight relationships (LWR) of this species in the North-eastern Mediterranean Sea. However, sandbar shark in the other areas of the Mediterranenan were studied satisfactorily on the distribution, systematic, age, growth and feeding habits by some researchers during recent years (Basusta and Erdem, 2000; McElroy et al., 2006; Lipej et al., 2008; Dragicevic et al., 2010) . In this study, Lenght-Weight relationships (LWR) of sandbar shark were examined for the first time in a population of the North-eastern Mediterranean Sea.

Materials and Methods

C. plumbeus individuals were caught accidentally by pelagic long-lines and commercial trawling from depths of 25 and 125 m of Mersin Bay and Iskenderun Bay, eastern Mediterranean Turkish coasts between August 2010 and March 2014. The samples were transferred to the ecophysiology laboratory where it was identified, sexed and photographed. Total lengths (TL) were measured to the nearest 1 mm and the weight of each specimen was determined with a digital scale nearest to the 0.01g. Total lengths and weights were fitted to the length-weight equation: $W=aL^b$, by using least square methods with Statistica software. In the length-weight equation *a* and *b* are intercept and the slope (=exponent) of the length-weight curve, respectively (King,1995; Can et al., 2002) The *b* value for this species was tested by a *t*-test at the 0.05 significance level to verify if it was significantly different from 3. LWRs for sandbar shark were calculated separately according to the sex.

Results Discussion

A total of 55 specimen were used for this study. Females ranged between 63.5-190.98 cm TL and 1303- 45678 g and males ranged between 54.5-129.9 cm TL and 870- 13268 g. The samples were composed of 49.1% females, 50.9% males. Maximum total length and maximum weight of *C. plumbeus* were 190.98 cm and 45.678 g respectively in this study. The length-weight relationship was estimated for combined sexes was: W= 0.01*$TL^{2.865}$ (r^2=0.915, SE_b=0.174).

LWR were found for females W= 0.0034*$TL^{3.101}$ (r^2=0.912, SE_b =0.278) and for males W= 0.0039*$TL^{2.662}$ (r^2=0.915, SEb =0.231). The type of growth for all sexes and males were negative allometric growth (b < 3). The type of growth for females were positive allometric growth (b > 3).

References

1 - Basusta, N., Erdem, U., 2000. A study on the pelagic and demersal fishes in Iskenderun Bay. Turkish J. Zool. supp. **24:** 1-19 (in Turkish with English abstract).

2 - Can, M. F., Basusta, N., Cekic, M., 2002. Weight-length relationships for selected fish species of the small-scale fisheries off the south coast of Iskenderun Bay. Turk. J. Vet. Anim. Sci. **26:** 1181-1183.

3 - Dragicevic, B., Dulcic, J., Lipej L.,2010. On the record of the sandbar shark *Carcarhinus plumbeus* Nardo, 1827 (Carcharhiniformes: Carcharhinidae) in the middle Adriatic Sea. Acta Adriatica, 51 (2): 227-232.

4 - Golani, D., Ozturk, B., Basusta, N., 2006. *Fishes of The Eastern Mediterranean*. Turkish Marine Research Foundation, *Istanbul, Turkey*. Pub. Number: 24, 259p.

5 - Lipej, L., Mavric, B., Dobrajc, Z., Capapé, C., 2008. On the occurence of the sandbar shark *Carcarhinus plumbeus* Nardo, 1827 (Carcharhiniformes: Carcharhinidae) in the middle Adriatic Sea. Acta Adriatica, 49 (2): 137-145.

6 - King, M., 1995. *Fisheries Biology Assessment and Management*. Fishing News Books, Oxford, UK., Pages: 382.

7 - McElroy, W.D., Wetherbee, B.M., MostelloC.S., Lowe, C.G., Crow, G.L., Wass, R.C., 2006. Food habits and ontogenetic changes in the diet of the sandbar shark, *Carcharhinus plumbeus*, in Hawaii. Environ Biol Fish 76: 81-92.

ANALYSE DES STRUCTURES DE TAILLE DE *SQUALUS BLAINVILLEI* (CHONDRICHTHYES: SQUALIDAE) DANS LA RÉGION EST DU BASSIN ALGÉRIEN

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Abstract

Un suivi a été réalisé au niveau des différents carreaux de la pêcherie d'Alger, en 1996-1997 et 2012-2013. Ces données complétant celles de 1982, ont permis d'établir les distributions de fréquence des longueurs totales de *Squalus blainvillei*, petit requin benthique. Six cents quatre vingts dix neuf individus (448 femelles et 251 mâles) provenant de la région Est du bassin algérien ont été mesurés. Les paramètres de croissance ont été déterminés par analyse des structures de taille, pour les femelles et les mâles.

Keywords: Fisheries, Algerian Basin, Growth, Elasmobranchii

Introduction

Squalus blainvillei (Risso, 1826), l'aiguillat-coq, est un petit requin benthique à large répartition verticale (50m – 600m). L' espèce représente une part non négligeable des pêches chalutières ciblant d'autres espèces démersales à grande importance économique. Sur la côte algérienne, il existe des informations sur les peuplements d'élasmobranches ([1] ; [2]; [3]). Des recherches se rapportant à la systématique et à la biologie de *S. blainvillei* ont concerné principalement les populations de Méditerranée occidentale et centrale ([4]; [5]; [6]; [7]). Dans le but d'une connaissance plus approfondie de l'aiguillat-coq nous avons entrepris une première étude relative aux paramètres biologiques permettant de modéliser sa croissance linéaire.

Matériel et Méthodes

Les données relatives à *Squalus blainvillei* proviennent de la campagne Thalassa de 1982, dans le bassin algérien et d'observations pendant les périodes 1996-1997 et 2012-2013, au niveau de la grande poissonnerie d'Alger. Les individus capturés dans la région Est, ont été mesurés et pesés. La longueur totale (LT) est exprimée en cm; le poids éviscéré (Pe) est exprimé en grammes. Les données ont été analysées par la méthode ELEFAN I ([8]), programmée sur FISAT II ([9]).

Résultats et Discussion

Au total, 699 individus (448 femelles et 251 mâles) de *S. blainvillei* ont été mesurés. Les polygones des fréquences de taille par saison (figure 1) mettent en évidence des modes autour de 40cm, 50,60 et 70cm.

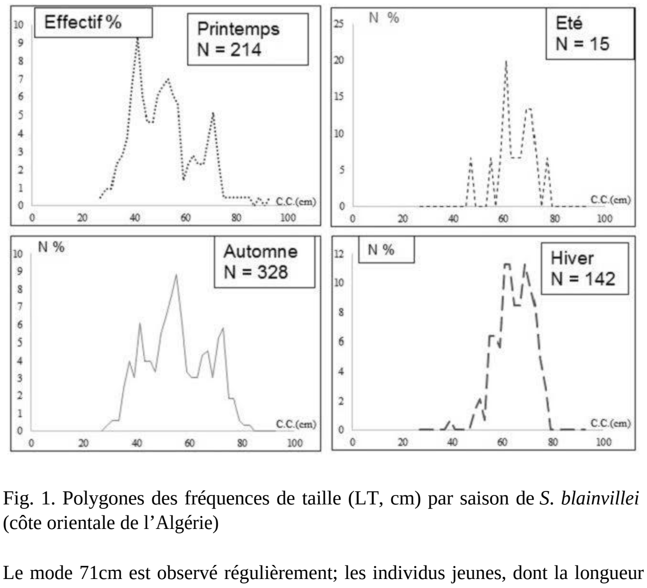

Fig. 1. Polygones des fréquences de taille (LT, cm) par saison de *S. blainvillei* (côte orientale de l'Algérie)

Le mode 71cm est observé régulièrement; les individus jeunes, dont la longueur totale (LT) est inférieure à 40cm sont observés au printemps et en automne. Les femelles dominent dans les classes de taille supérieures à 60 cm; aucun mâle n'a été observé dans les classes de longueurs supérieures à 80 cm. Plusieurs auteurs cités par [10] confirment ce résultat. La valeur calculée de l'écart réduit (ε) est supérieure à la valeur théorique pour un risque de 5 %: la différence entre les tailles moyennes des mâles et des femelles est significative.

Les couples de valeurs K/L∞ pour les femelles et les mâles de *S. blainvillei* sont représentés dans le tableau 1. Ces résultats concordent avec les paramètres estimés par [6] pour les femelles (L∞= 118.27cm et K = 0.11/an). Pour les mâles capturés dans la région algérienne orientale, la taille maximale atteinte semble plus importante que celle des mâles de Sicile [6]: L∞= 96 cm; K = 0.14/an. Les poids asymptotiques (Pe∞) ont été déterminés.

Tab. 1. Paramètres de croissance de *S. blainvillei* (par analyse des structures de taille)

Sexe	L∞(cm)	K/an	t_0	Pe∞(gr)
Femelles	120.00	0.11	0	8830
Mâles	106.50	0.16	0	7870

Conclusion

Ce travail réalisé pour la première fois devant la côte algérienne, est une approche relative à la croissance d'une espèce de requin d'intérêt économique. Une gestion rationnelle des captures de *S. blainvillei* doit être mise en place rapidement pour éviter une déstabilisation des stocks. Ainsi, l'étude de la croissance est un premier pas vers ce type de gestion rendue difficile par les caractères K-sélectifs de l'espèce (maturité sexuelle tardive, durée de gestation longue, fécondité ovarienne et fécondité utérines peu élevées).

References

1 - Dieuzeide R., Novella M., Roland J., 1953. Catalogue des poissons des côtes algériennes. Squales, Raies, Chimères. Bull. St. Aqua, pêche, Castiglione I (ns), H, [1953]: 425p

2 - Lalami Y., 1971. Contribution à l'étude systématique, biologique, écologique et statistique des poissons de la pêcherie d'Alger. Pelagos. Bull., Inst. Océnogr. d'Alger. Vol III, Fasc. 4. 150p

3 - Hemida F., 2005. Les Sélaciens de la côte algérienne : biosystématique des requins et des raies ; écologie, reproduction et exploitation de quelques populations capturées. Thèse de Doctorat d'état, USTHB : 233p

4 - Quignard J.P., 1971. Recherches sur la biologie de *Squalus blainvillei* (Risso, 1826). Trav. Lab. Biol Halieutique Univ. Rennes, 5: 125-l 41

5 - Capapé C. and J.P. Quignard 1980. Recherches sur la biologie de *Squalus blainvillei* (Risso, 1826) (Pisces, Squalidæ) des côtes tunisiennes: Relations taille-poids du corps, du foie et des gonades. Coefficients de conditon. Rapports hépato et gonosomatique. Coefficients de condition. Cycles sexuels femelles. Arch. Inst. Pasteur, Tunis, 57(4): 47-65

6 - Cannizaro L., Rizzo P., Levi D., Gancitano S., 1995. Age determination and growth of *Squalus blainvillei* (Risso, 1826). Fish. Res., 23: 113-125p

7 - Sion L., D'Onghia G., Tursi A., 2003. First data on distribution and biology of *Squalus blainvillei* (Risso; 1926) from the Eastern Mediterranean sea. J. North. Atl. Fish. Sci. Vol 31 : 213-219

8 - Pauly D. and Moreau J., 1997. Méthodes pour l'évaluation des ressources halieutiques. Collection Poly-Tech. (Éd) CEPADUÉS

9 - Gayanilo Jr. F. C., Sparre P., Pauly D., 1985. The FAO-ICLARM stock assessment tools (FISAT) User's guide. FAO Computerized information series (Fisheries) N°8, Rome, FAO: 129

10 - Kousteni V. and Megalofonou P., 2011. Reproductive biology and embryonic development of *Squalus blainvillei* in the eastern Mediterranean Sea. Sci. Mar. 75:237–249p

CEPHALOPOD PREY OF TWO SKATE AND FIVE SHARK SPECIES CAUGHT BY LONGLINE IN THE EASTERN IONIAN

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Abstract

The cephalopod component in the stomach content of 5 shark (*Centrophorus granulosus, Etmopterus spinax, Scyliorhinus canicula,Squalus acanthias, S. blainvillei*) and 2 skate species (*Raja clavata, R. oxyrhynchus)* caught during experimental fishing with bottom long-lines over depths 385-800m, was investigated. Cephalopod remains occurred at over 20% of non-empty stomachs for examined species. Eight cephalopod species, belonging to 5 families have been identified, including 5 oegopsid squids, 2 octopods and 1 sepiolid.

Keywords: Deep waters, Cephalopods, Elasmobranchii, Ionian Sea

Understanding of the food-web structure and functioning is essential for an ecosystem-based management of fisheries, presupposing the knowledge of component key species, their spatio-temporal, abundance and interactions in a certain ecosystem of which the fisheries resource is a part.

Cephalopods are frequently found in the diet of both pelagic and demersal species of elasmobranchs, accounting for about 80% of the diet of some teuthophagus species and consumed in large quantities even by species characterized as generalist predators. Despite the underlined significance of cephalopods in the diet of several marine species from the Mediterranean Sea, data on the cephalopod prey specific composition are still poor [1]. The present study is aiming to contribute to the identification of key cephalopod species in the food-web at the north-eastern Ionian upper slope.

Specimen of examined elasmobranches were collected during experimental fishing with bottom long-lines carried out off south-western coasts of Cephalonia Island in 2010, within the framework of the E.U. project CoralFISH (http://www.eusem.com/body/CE/ EUproj/CE21.htm). Cephalopod beaks sorted out from stomach and intestine contents were assigned to species based on comparison with beaks of the IMBRIW-HCMR reference collection. Lower/upper rostral lengths (LRL, URL) and lower/upper hood lengths (LHL, UHL) of beaks from decapod and octopod cephalopods respectively, were measured to the nearest 0.01 mm on the digital images. To reconstruct mantle length (ML) of cephalopod prey individuals, equations previously published or developed in IMBRIW-HCMR were used.

Tab. 1. Elasmobranch predator species: Total length (TL) range, number of specimen with non- empty stomachs and percentage of non-empty stomachs in which cephalopod remains occurred.

Predator		TL range	No non-empty	Cephalopod
Code	Species name	(mm)	stomachs	occurrence %
(A)	*Centrophorus granulosus*	750-910	5	40
(B)	*Etmopterus spinax*	270-393	16	19
(C)	*Raja clavata*	514-550	2	50
(D)	*Raja oxyrhynchus*	750-980	10	30
(E)	*Scyliorhinus canicula*	460	1	
(F)	*Squalus acanthias*	785-930	10	40
(G)	*Squalus blainvillei*	357-780	75	27

Cephalopod remains were found in 34 of the 119 non-empty stomachs, representing over the 20% of stomachs analysed by predator species (Table 1). Identified beaks belonged to mesopelagic and benthopelagic cephalopod species (Table 2) and occurred at over 20% of non-empty stomachs for examined species (Table 1).

Heteroteuthis dispar was the most frequently preyed species, consumed by 4 predator species and being the single cephalopod species among preys of *Etmopterus spinax*. The ommastrephids *I. coindetii* and *T. eblanae* participated only in the diet of *Centrophorus granulosus,* whereas *Pyroteuthis margaritifera* only in that of *Raya clavata*.

Tab. 2. Cephalopod prey species: Number and mantle length (ML) range of specimen identified from beak remains found among stomach contents of elasmobranch species examined.

Prey species name	ML range	Predator species code						
	(mm)	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Abralia veranyi	26-37					1		1
Abraliopsis pfefferi	13.4-16.3							3
Pyroteuthis margaritifera	30			1				
Illex coindetii	162	1						
Todaropsis eblanae	117	1						
Heteroteuthis dispar	17-21		3		6	4		5
Pteroctopus tetracirrhus	44-71				2			
Scaeurgus unicirrhus	22.6-38.5						1	2

Heteroteuthis dispar, although very rarely caught by bottom trawl seems to be quite abundant over the upper slope of the Mediterranean Sea, as it is among the most frequently found cephalopods so in the diet of demersal chondrichthyans [2,3], large pelagic fish [4,5] and dolphins [6] as in among catches of experimental mesopelagic trawls and macroplankton devices [7,8].

References

1 - Romeo T., Battaglia P., Pedà, C., Perzia P., Consol, P., Esposito V. and Andaloro F., 2012. Pelagic cephalopods of the central Mediterranean Sea determined by the analysis of the stomach content of large fish predators. *Helgoland Marine Research*, 66: 295-306

2 - Bello G., 1997. Cephalopods from the stomach contents of demersal chondrichthyans caught in the Adriatic Sea, *Vie Milieu*, 47: 221-227.

3 - Lefkaditou E., 2007. II.4. Review of Cephalopod fauna in Hellenic waters. In: State of Hellenic Fisheries, Papaconstantinou C., Zenetos A., Vassilopoulou V. and G. Tserpes (eds), pp. 62-69. Athens: HCMR Publications.

4 - Bello G., 1991. Role of cephalopods in the diet of the swordfish, *Xiphias gladius*, from the eastern Mediterranean Sea. *Bull. Mar. Sci.*, 49(1-2): 312-324.

5 - Bello G., 1999. Cephalopods in the diet of albacore, *Thunnus alalunga*, from the Adriatic Sea. *J. Moll. Stud*., 65: 233-240.

6 - Orsi Relini, L. and Relini, M., 1993. The stomach content of some common dolphins (*Delphinus delphis* L.) from the Ligurian Sea. European research on cetaceans, 7: 99-102.

7 - Lefkaditou E., Papaconstantinou C. and Anastasopoulou A., 1999. Juvenile cephalopods collected in the midwater macroplankton over a trench, in the Aegean Sea (northeastern Mediterranean). *Isr. J. Zool*., 45: 395-405.

8 - Roper C.F.E., 1974. Vertical and seasonal distribution of pelagic cephalopods in the Mediterranean Sea. Preliminary report, *Bull. Amer. Malacological Union*, May 1974: 27-30.

GENETIC BARCODING OF ELASMOBRANCHES IN MALTA (CENTRAL MEDITERRANEAN)

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Abstract
The correct identification of species constitutes the first step in accurate fisheries data collection and sustainable management. DNA barcoding of a standardized sequence of the COI gene has proven to be a powerful tool in assisting conventional taxonomic methods in species identification, especially when considering species from taxa that are difficult to identify down to the species level. This paper presents work on a total of 77 elasmobranch specimens collected during commercial fishing activities between 2012 and 2013 within the 25 nautical mile Fisheries Management Zone around the Maltese Islands.

Keywords: Elasmobranchii, Genetics, Fisheries, Conservation, South-Central Mediterranean

Introduction

The Mediterranean Sea hosts around 75 species of elasmobranches. On a regional scale, 31 are within threatened categories, including 14 Critically Endangered, 9 Endangered and 8 Vulnerable, with some of them being in a worse conservation status when compared to their global conservation status [1].

Materials and Methods

Seventy-seven elasmobranch specimens were sampled to assess the efficacy of genetic barcoding as an identification tool across a selection of species landed in Malta during study period 2012-2013. The shark species analysed comprised: *Centrophorus granulosus; Heptranchias perlo; Hexanchus griseus; Mustelus asterias; Mustelus mustelus; Mustelus punctulatus; Prionace glauca; Scyliorhinus canicula; Scyliorhinus stellaris; and Squalus blainville,* and the ray species comprised*: Dasyatis centroura; Dasyatis pastinaca; Dasyatis tortonesei; Dipturus oxyrinchus; Leucoraja circularis; Raja clavata; Raja polystigma;* and *Raja radula*. As *R. clavata* specimens exhibited polychromatism (variety of colour patterns on their dorsal surface) and differences in the number of thorns, specimens of each form noted were collected to analyse these forms genetically. In this study, five of the seven different colour patterns known [2] were analysed, including uniform, spotted, ocellated, reticulated and marbled specimens. All specimens were anatomically identified using identification keys and diagnostic features [3,4]. Genomic DNA was extracted using the standard proteinase K, phenol-chloroform extraction method and a partial sequence of the COI gene was amplified and sequenced in both directions using universal fish primers [5].

Results

Different primer pairs were used to amplify different species, therefore a 610 bp sequence homologous to all taxa was used for the genetic analyses. All sequences obtained were run via Blastn to genetically confirm the species identity with already available genetic barcodes for each species. All sequences matched with >99% identity to already available sequences, confirming the species' identity. A total of 245 bp positions (40.2%) exhibited genetic differences. Using the K2P model [6], mean genetic divergence within species was found to be 0.22%; while within genus the genetic divergence ranged between 4.23% (between *D. pastinaca; D. tortonesei*) to 9.86% (*S. canicula; S. stellaris*). Genetic analyses of *R. clavata* have shown that there were no genetic differences between the different forms analysed, and only two haplotypes were identified, with the least common haplotype appearing only in one specimen. Moreover, this analysis presents the first two definite records of *D. tortonesei* in Maltese fisheries landings. This species differed from its morphologically similar congener D. pastinaca by a K2P divergence of 4.23%, that is well beyond the intraspecific variation threshold [5], further confirming that *D. pastinaca* and *D. tortonesei* are two separate species rather than two synonyms [7].

This study was the first to use DNA barcoding of the COI gene in Malta to analyse the polychromatism noted in *R. clavata* and to genetically confirm the presence of various elasmobranch species including, *H. griseus, P. glauca, D. centroura, D. pastinaca, D. tortonesei, L. circularis, R. polystigma* and *R. radula* within the Maltese Fisheries Management Zone. The latter two species being of higher conservation value since they occur only in the Mediterranean Sea. Results show that DNA barcoding clarified morphological identifications, even when polychromatism was noted. It was also possible to confirm the identity of different species especially within the genus *Mustellus, Dasyatis* and *Raja* as these genera contain a number of morphologically similar species. These results illustrate the importance of using more accurate reliable tools to enhance taxonomic identification of species facilitating species-specific monitoring and management for sustainable fisheries and conservation.

Acknowledgments

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References

1 - Abdul Malak D., Livingstone S.R., Pollard D., Polidoro B.A., Cuttelod A., Bariche M., Bilecenoglu M., Carpenter K.E., Collette B.B., Francour P., Goren M., Hichem Kara M., Massutí E., Papaconstantinou C. and Tunesi, L. (2011). Overview of the conservation status of the marine fishes of the Mediterranean Sea. Gland, Switzerland and Malaga, Spain: IUCN, p. 61.

2 - Mnasri N., Boumaiza M., Mourad Ben Amor M., and Capape C. (2009). Polychromatism in the thornback ray, Raja clavata (Chondrichthyes:Rajidae) off northern Tunisian coast (central Mediterranean). Pan-American Journal of Aquatic Sciences, 4(4): 572–579.

3 - Serena F. (2005). Field Identification Guide to the Sharks and Rays of the Mediterranean and Black Sea. Rome: FAO Species Identification Guide for Fishery Purposes. p. 97

4 - Capapé C. 1977. Les espèces du genre Dasyatis Rafinesque, 1810 (Pisces, Rajiformes) des côtes tunisiennes. Cybium 3: 75–105.

5 - Ward R.D., Zemlak T.S., Innes B.H., Last P.R. and Hebert P.D.N. (2005). DNA barcoding Australia's fish species. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 360: 1847-1857.

6 - Kimura M. (1981). Estimation of evolutionary distances between homologous nucleotide sequences. Proceedings of the National Academy of Sciences, 78(1): 454-458.

7 - Bradaï M.N., Saidi B. and Enajjar S. (2012). Elasmobranchs of the Mediterranean and Black Sea: status, ecology and biology (bibliographical analysis). Rome: FAO. p104.

VNTRS IN THE MTDNA CONTROL REGION OF THE BLUNTNOSE SIXGILL SHARK, *HEXANCHUS GRISEUS*.

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Abstract

In most shark species the mtDNA control region is approximately 1070bp. However, genetic analyses of *Hexanchus griseus* specimens collected from different locations, have led to the identification of a long mtDNA control region, ranging between 1570bp and 1752bp. This exceptionally long region contains a number of 45bp repeats which lead to the formation of VNTRs that are not evenly distributed globally but rather by geographical locations.

Keywords: Elasmobranchii, Deep waters, Conservation, Genetics, Mediterranean Sea

The mtDNA control region is the main non-coding sequence of the mtDNA which resides between tRNA-Pro and tRNA-Phe genes. The expected length of the control region in most shark species is around 1070bp, nonetheless in species such as *Rhincodon typus* [1], *Carcharodon carcharias* [2] and Hexanchiformes [3,4], this region is even longer.

To study the complete control region of *Hexanchus griseus*, 146 specimens of the species were collected from different geographical locations (see acknowledgments for list of locations), with the majority being of Mediterranean origin (n=126). The sequence between the 3' of cytochrome b gene to the 5' of 12S rRNA gene has been amplified and sequenced in 2012 (Accession numbers: KF894454-90), using both forward and reverse primers, to ensure the inclusion of the complete control region in the analyses. The sequences obtained were aligned to the mtDNA control region of other shark species to confirm neighbouring genes through homology.

Although different specimens exhibited different lengths for this locus, no length heteroplasmy was noted in the *H. griseus* specimens studied, as only one PCR product was noted per individual. A search for the repeated motif has yielded a 45bp sequence that was imperfectly repeated up to eleven times within domain 1 of the control region (Figure 1). The imperfect repetition of the motif has yielded 14 motif sequences which differed from each other solely through transitions. Analysis of each motif sequence has shown that when single stranded most of them, especially the most common ones, can fold on themselves to form highly stable secondary structures leading to the conclusion that such sequences are probably the result of repeated strand slippage during DNA replication through stem-loop formation [5].

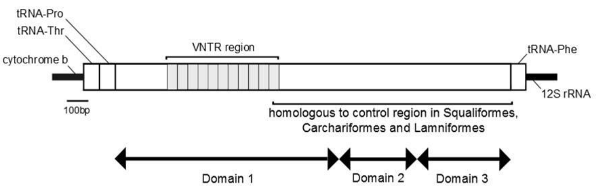

Fig. 1. The mtDNA control region and neighbouring genes for *H. griseus*, with Mediterranean specimens exhibiting a maximum of 11 repeats in the VNTR region.

The specimens collected from the Mediterranean Sea exhibited the longest VNTR region containing 9 (4.76%), 10 (91.27%) and 11 (3.97%) copies of the repeat. No significant difference was detected between the number of repeats recorded from the eastern, central and western Mediterranean specimens. Specimens from the Eastern Atlantic Ocean (n=11) exhibited 10 repeats, while those from the Pacific Ocean (n=9) exhibited 7 repeats. When the specimens from the Pacific Ocean were analysed against those from the Atlantic Ocean, a significant difference ($P < 0.001$) in the number of repeats was noted. This indicates that the global distribution of the number of repeats is linked to specific geographical regions.

The patterns observed with the VNTRs together with analyses of point mutations strengthen the fact that even though *H. griseus* is widely distributed throughout all oceans, its population is subdivided into genetically distinct units. Thus highlighting the need to consider each group separately when designing managment plans for the conservation of this species.

Acknowledgments:
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References

1 - Castro ALF., Stewart BS., Wilson SG., Hueter RE., Meekan MG., Motta PJ., Bowen BW. and Karl S. 2007. Population genetic structure of Earth's largest fish, the whale shark (*Rhincodon typus*). Molecular Ecology, 16: 5183-5192.
2 - Gubili C., Bilgin RR., Kalkan E., Karhan SU., Jones CS., Sims DW., Kabasakal H., Martin AP. and Noble LR., 2010. Antipodean white sharks on a Mediterranean walkabout? Historical dispersal leads to genetic discontinuity and an endangered anomalous population. Proceedings of the Royal Society B: Biological Sciences, 278: 1679-1686.
3 - Tanaka K., Shiina T., Tomita T., Suzuki S., Hosomichi K., Sano K., Doi H., Kono A., Komiyama T., Inoko H., Kulski JK. and Tanaka S. 2013. Evolutionary relations of Hexanchiformes deep-sea sharks elucidated by whole mitochondrial genome sequences. BioMed Research International, 2013, doi:10.1155/2013/147064
4 - Vella N., 2013. Conservation genetics of the bluntnose sixgill shark, *Hexanchus griseus*, in the Mediterranean. Ph.D. Thesis, University of Malta, p246.
5 - Ray DA., and Densmore LD., 2003. Repetitive sequences in the crocodilian mitochondrial control region: Poly-A sequences and heteroplasmic tandem repeats. Molecular Biology, 20: 1006-1013.

CIESM Congress Session : Cartilaginous fish II

Moderator : Farid Hemida, ENSSMAL, Algiers, Algeria

Moderator's Synthesis

L'évolution du climat et de l'anthropisation du milieu provoquent l'altération rapide de la biodiversité en Méditerranée. Pour les poissons cartilagineux, le cycle apparition-disparition est évident, très perceptible en Méditerranée par l'intrusion d'immigrants qui réussissent à s'établir et à se reproduire, voire se perpétuer. Le requin tigre, supposé absent de cette mer, a été signalé au large de la côte libyenne alors que la présence de la raie manta, une nouvelle espèce, est confirmée dans les eaux turques où l'on signale la capture de près de 80 individus - informations qui seront publiées bientôt selon les auteurs présents.

Il a été signalé que beaucoup d'espèces d'élasmobranches ne sont pas conformes aux descriptions des ouvrages spécialisés. Comme beaucoup sont vulnérables et en danger de disparition, la conservation de ces espèces est encore plus d'actualité. Une révision majeure de la taxonomie des requins et des raies fréquentant les eaux méditerranéennes est nécessaire et urgente. On préconise de ne pas se limiter à la zoologie moléculaire et son outil génétique qui passent pour infaillibles, mais de tenir compte des réalités du terrain en combinant d'autres méthodes phénétiques comme la morphométrie et l'ostéologie.

L'accent a été également mis sur le renforcement des systèmes d'information nationaux avec une promesse de collaboration entre différentes équipes de recherche de différents pays de Méditerranée (Liban, Turquie, Malte, Algérie...). Il sera intéressant et enrichissant à l'avenir de comparer les phénomènes affectant les Elasmobranches des deux mers intérieures si différentes que sont la Méditerranée et la Baltique, compte tenu de l'influence IndoPacifique majeure pesant sur notre *mare nostrum*.

Le projet Méditerranée – Mer Noire, élargi à l'ensemble des régions du bassin et à la Russie, se renforcera de manière certaine avec la participation des pays de la Baltique.

WILD SPATIAL BEHAVIOR AND PERSONALITY TRAITS: A COMPARISON STUDY FOR JUVENILE LEMON SHARKS.

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Abstract

In recent years, information on animal behavioral traits and consistent individual differences within species and/or populations has been expanding; yet, several aspects, such as the influence of personality on wild behavior, have not been addressed. This study focuses on the influence of personality on the natural space utilization and movement metrics of a free ranging predator species, the lemon shark, *Negaprion brevirostris* (Poey, 1868). Here, 12 juvenile lemon sharks were preliminarily subjected to a novel open-field test in a semi-captive environment before being released and acoustically tracked in their nursery area. Preliminary observations suggest a trend relating personality traits to space utilization in juvenile lemon sharks around Bimini Islands, Bahamas.

Keywords: Behaviour, Elasmobranchii, Monitoring, Remote sensing, Western Atlantic

The investigation of inter individual differences in behavior, called personality, is a well-documented topic in a wide range of taxa. Noticeable individual differences in the ecology (e.g. behavior, habitat and space use) of seals, sharks, tunas, and several fish have been detected in different investigations over the last decades, mostly reported via the use of telemetry methods [1]. However, in these studies, it remains challenging to determine whether the reported variations are influenced by environmental conditions or whether they are related to the individual personality traits, that is to say, if they are the result of consistent inter-individual differences in behavior across time and context. Understanding personality is an emerging field of considerable relevance and contribution to the development of a new insight in the ecological (e.g. the relationship between the individual, its environment, its con-and heterospecifics) and evolutionary implications personality traits might have for organisms and populations [2]. For practical purposes, most research has tended to involve small species of relatively short life history traits, usually captive bred, eluding the ultimate causes and consequences of personality [3]. Yet, it is acknowledged that personality in the wild is likely to have evolutionary implications, for instance in regulating the individual adaptive potential through tradeoff thresholds. It may influence the fitness of the individual, its habitat use, the size of its home range as well as its exploratory behavior [4]. This study focuses on the link between individual variations, expressed in movement, habitat and space use, and personality traits of a marine predator species of elasmobranch. The lemon shark, *Negaprion brevirostris*, is a coastal tropical shark species belonging to the Carcharhinidae family. Bimini Islands are perceived as important hotspots, encompassing diverse nursery areas of juvenile lemon sharks [5]. This species represents a relevant model for large marine predators, showing a peculiar adaptation and resilience to captivity [6]. Previous research on the movement ecology of *N. brevirostris* in the Bahamas has documented small home ranges in juveniles, which facilitate the tracking process [7]. Preliminary research on lemon shark's personality has been carried out in mesocosms around Bimini Islands, Bahamas, for the past few years, revealing evidences of consistent individual differences in behavior in lemon sharks (unpublished data). In 2015, a total of 36 juveniles were exposed to a novel open field test (widely recognize in the behavioral field of research). Each individual performance was scored. The current research intends to establish whether natural movement ecology is a reflection of the reported personality features. A subset of 12 individuals from the 36 tested in 2015 were acoustically tagged and released at their respective capture location. In order to determine the extent to which personality traits predicts natural space use, movement patterns and spatial use were monitored over an eight months period, between August 2015 and April 2016, using a passive monitoring array of 15 Submersible Ultrasonic Receivers (SUR, ©Sonotronics) and a weekly active tracking survey (Fig. 1).

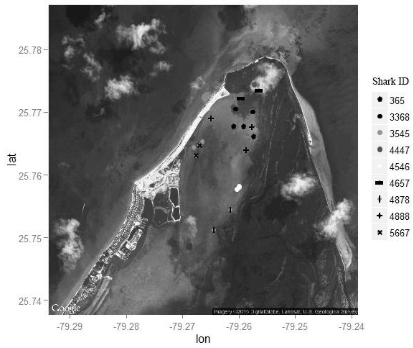

Fig. 1. Results from an active tracking effort (one day). A total of 9 juvenile lemon sharks were detected in their nursery area.

Detection range testing was performed, with results indicating that acoustic telemetry was an efficient and reliable tool for this research. To elucidate the question, the individual scores obtained from the novel open field test were considered for comparison with spatial metrics data. A first overview revealed a potential trend, relating movement patterns and habitat use to the personality traits exhibited in captivity. The current approach appears to shed light on personality traits in a long lifespan marine predator, tracked in its natural environment.

References

1 - Vaudo JJ, Wetherbee BM, Harvey G, Nemeth RS, Aming C, Burnie N et al. Intraspecific variation in vertical habitat use by tiger sharks (Galeocerdo cuvier) in the western North Atlantic. Ecology and evolution. 2014;4 (10):1768-86.

2 - Sih A, Bell A, Johnson JC. Behavioral syndromes: an ecological and evolutionary overview. Trends in ecology & evolution. 2004;19(7):372-8.

3 - David M, Auclair Y, Cézilly F. Assessing Short-and Long-Term Repeatability and Stability of Personality in Captive Zebra Finches Using Longitudinal Data. Ethology. 2012;118(10):932-42.

4 - Réale D, Garant D, Humphries MM, Bergeron P, Careau V, Montiglio P-O. Personality and the emergence of the pace-of-life syndrome concept at the population level. Philosophical Transactions of the Royal Society B: Biological Sciences. 2010;365(1560):4051-63.

5 - Franks BR. The spatial ecology and resource selection of juvenile lemon sharks(Negaprion brevirostris) in their primary nursery areas. vol 11. 2007.

6 - Brown CA, Gruber SH. Age assessment of the lemon shark, Negaprion brevirostris, using tetracycline validated vertebral centra. Copeia. 1988:747-53.

7 - Morrissey JF, Gruber SH. Habitat selection by juvenile lemon sharks, Negaprion brevirostris. Environmental Biology of Fishes. 1993;38(4):311-9.

OCCURENCE OF JUVENILE AND ADULT FEMALE OF *GALEUS MELASTOMUS* RAFINESQUE, 1810 FROM THE NORTH-EASTERN MEDITERRANEAN SEA

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Abstract

Galeus melastomus have been captured as by-catch from commercial trawl fishing at 300-410 m and 360-400 depths, in the international waters of North-eastern Mediterranean (between 36º 06'200 N -35º35'432 E and 36º 03'795 N -35º 29'098 E) and (between 36º06'004 N -35º23'821 E and 36º 06'152 N -35º 36'966 E). The presence of juvenile individual in May and adult female of *G. melastomus* in the same area one month later, suggests that there is egg laying and nursery in the North-eastern Mediterranean and, therefore, to improve our knowledge of egg laying areas providing useful data for conservation and management plans.

Keywords: Fishes, Fisheries, Spawning, Iskenderun Bay, North-Eastern Mediterranean

Introduction

Blackmouth catshark, *Galeus melastomus* is one of the benthic small shark inhabiting muddy substrate at depths of 200-1500m. Females lay usually two rectangular eggs of 3x5cm at a time. They reach sexual maturity at size of 35cm. Juveniles inhabit shallower depths of the species range [1]. Blackmouth catsharkis assessed as least concern (LC) species in the Mediterranean sea by IUCN [2]. This paper reports the existence of juveniles and adult females of *G. melastomus* captured off the Iskenderun Bay, North-eastern Mediterranean.

Materials and Methods

Firstly, on 4th May 2015 at 360 - 400 m depth, one juvenile blackmouth catshark specimen has been captured off the Iskenderun Bay, North-eastern Mediterranean as by-catch from commercial trawl fishing (between 36°06'004 N -35°23'821 E and 36°06'152 N -35°36'966 E) and secondly, on 6th June 2015, an adult female of *G. melastomus* has been captured at 300-410 m depth in the same area (between 36°06'200N -35°35'432 E and 36°03'795 N -35° 29'098 E).The samples were transferred to the ecophysiology laboratory where it was identified, sexed and photographed. Total lengths were measured to the nearest 1 mm and the weight of each specimen was determined with a digital scale nearest to the 0.01 g. The specimens were preserved at the Museum of Fisheries Faculty, Firat University (FFM-FISH/2015-07 and FFM-FISH/2015-13).

Results Discusssion

Total length and weight of juvenile *G. melastomus* specimen were 22.6 cm and 36.11 g (Figure 1) and gravid female were 55.7cm and 559.11g respectively (Figure 2).

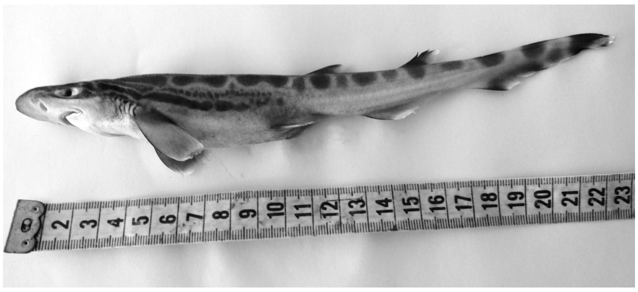

Fig. 1. Juvenile *G. melastomus* from North-eastern Mediterranean, *TL*= 22.6 cm.

Fig. 2. Adult female of *G. melastomus* from North-eastern Mediterranean, *TL*= 55.7 cm.

Four egg capsules were found inside female and their lengths were 4.5-5.0 cm. Güven *et al.* [3] reported the smallest individuals belong to *G. melastomus* (11.5-11.7 cm) from Antalya Bay. Thus, off the Iskenderun Bay may be second egg laying and nursery areas for this species. According to Castro [4], the decision regarding the study area classified as a nursery by a given species was made considering the presence of neonates, small juveniles and gravid females. The presence of juvenile individual in May and gravid female of *G. melastomus* in the same area one month later, suggests that there is egg laying and nursery in the North-eastern Mediterranean and, therefore, to improve our knowledge of egg laying areas providing useful data for conservation and management plans.

References

1 - Golani, D., Oztu¨rk, B., Basusta, N., 2006. Fishes of the eastern Mediterranean. Turkish Marine Research Foundation, Istanbul, Turkey. Pub. Number: 24, pp. 259.

2 - Abdul Malak, D.,Livingstone, S.R., Pollard, D., Polidoro, B.A., Cuttelod, A., Bariche, M., Bilecenoglu, M., Carpenter, K.E., Collette, B.B., Francour, P., Goren, M., Kara, M.H., Massutí, E., Papaconstantinou, C., Tunesi, L., 2011. Overview of the conservation status of the marine fishes of the Mediterranean Sea. Gland, Switzerland and Malaga, Spain: IUCN. vii + 61pp.

3 - Güven, O., Kebapçioglu, T., Deval, M.C., 2012. Length-weight relationships of sharks in Antalya Bay, eastern Mediterranean. J. App. Ichthyol. 28: 278-279.

4 - Castro, J.I., 1993. The shark nursery of Bulls Bay, South Carolina, with a review of the shark nurseries of the southeastern coast of the United States. Environmental Biology of Fishes, 38: 37- 48.

MEDITERRANEAN OCCURRENCE OF *MOBULA JAPANICA* (CHONDRICHTHYES: MOBULIDAE) WITH FIRST RECORD FROM THE ALGERIAN COAST

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Abstract

The authors report the occurence of the spinetail devilray *Mobula japanica* (Müller and Henle, 1841) off the Algerian coast. The captures, considered as Herculean immigrants from the eastern tropical Atlantic, confirm the occurrence of the species in the mentioned area. The article discusses and comments on the establishment of a sustainable population in the area and further in the Southern Mediterranean.

Keywords: Alien species, Elasmobranchii, Migration, Algerian Basin

Introduction

Studies on elasmobranch species from the Algerian coast were conducted since 1996 to date and allow reporting the occurrence of about 50 species in the area ([1]). The giant devil ray *Mobula mobular* (Bonnaterre, 1788) was the single species belonging to the family observed in the area ([2]). Recently, [3] and [4] recorded a close relative species *M. japanica* (Müller and Henle, 1841) off the northern Tunisian coast, close to the Algerian border. [3] and [4] noted that they were the first records of the species in the Mediterranean and suggested that it was an Herculean migrant (sensu [5]), originated from the eastern tropical Atlantic which entered the sea through the Strait of Gibraltar. Such discoveries induced us to consider the possible occurrence of the species in the Algerian waters. Therefore, investigations were recently conducted in the region to support such hypothesis.

Material and Methods

Observations were mainly carried out in the fishmarket of the city of Algiers where are landed fish species caught throughout the Algerian coast. Concomitantly, documents such as photographs and reports were also consulted to point out that such hypothesis could not be totally ruled out. Consequently, we were informed by experencied local fishermen that a specimen of devil ray (s.l.) was captured off the Algiers coast and landed at the same fishmarket.

Results and Discussion

A specimen caught off Algiers in 2014, was photographed (fig. 1), but we were not able to measure it due to the fact that it was dressed and cut out into pieces by retailers and rapidly sold.

Another specimen captured in the eastern part of the Algerian coast, cut in two pieces, was observed in the fish market of Algiers (fig. 2).

Fig. 1. Female of *Mobula japanica* captured from off Algiers in 2014

However, both figure 1 and figure 2 clearly show the white tip on dorsal fin, and in figure 1, dorsal fin is in a little in advance of the beginning of pelvic fins, which are considered as the main morphological characteristics allowing to distinguish *M. japanica* from *M. mobular*. In this latter species, there is no white tip on dorsal fin, and the dorsal fin is behind the posterior margin of pectoral fins.

Fig. 2. Male of *Mobula japanica* captured in the eastern part of the Algerian basin in 2006

Therefore, this record is the third known to date for the Mediterranean Sea, and the first for the Algerian coast, even if it appears evident that the species reached the Algerian coast prior to reach the Tunisian coast. This record is a new step wich allows confirming the successful establishment of a population of *M. japanica* in the southwestern Mediterranean Sea. Unfortunately, as other elasmobranch species, *M. japanica* is highly vulnerable due to its *k*-selected characteristics, and therefore it is considered at present as a threatened species ([6]). The recent increasing of catches in both Algerian and Tunisian waters needs urgent local measures of conservation and a fishing management to avoid a possible extinction of the species in the area.

References

1 - Hemida F., 2005. Les Sélaciens de la côte algérienne : biosystématique des requins et des raies ; écologie, reproduction et exploitation de quelque populations capturées. Thèse de Doctorat d'état, USTHB : 233p.

2 - Hemida F., Mehezem S. and C. Capapé, 2002. Captures of the giant devil ray, *Mobula mobular* Bonnaterre, 1788 (Chondrichthyes: Mobulidae) off the Algerian coast (southern Mediterranean). Acta Adriatica, 43 (2): 69-76.

3 - Capapé C., Rafrafi-Nouira S., El Kamel-Moutalibi O., Boumaïza M. and Reynaud C., 2015. First mediterranean records of spinetail devil ray, *Mobula japonica* (Elasmobranchii: Rajiformes: Mobulidae)

4 - Rafrafi-Nouira S., El Kamel-Moutalibi O., Ben Amor M.M. and Capapé C., 2015. Additional records of spinetail devil ray *Mobula japanica* (Chondrichthyes: Mobulidae) from the Tunisian coast (Central Mediterranean). Annales · Ser. hist. nat. · 25 · 2015 ·2: 103-108

5 - Quignard, J.-P. and J.A. Tomasini, 2000. Mediterranean fish biodiversity. Biol. Mar. Mediterr. 7(3):1-66.

6 - White W.T., Clark T.B., Smith W.D. and J.J. Bizzarro, 2006. *Mobula japanica*. The IUCN Red List of Threatened Species 2006: e.T41833A10576180.
http://dx.doi.org/10.2305/IUCN.UK.2006.RTLS.T411833A10576180.
Downloaded on 17 September 2015.

OCCURRENCE OF BASKING SHARK, *CETORHINUS MAXIMUS* (ELASMOBRANCHII: LAMNIFORMES: CETORHINIDAE), OFF THE SYRIAN COAST (EASTERN MEDITERRANEAN)

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Abstract
The authors report in this paper the first record of basking shark, *Cetorhinus maximus* (Gunnerus, 1765), off the coast of Syria (eastern Mediterranean). The specimen was an adult female, 690 cm total length and weighing approximately 2.5 t. It was a pregnant female at the beginning of gestation and contained 34 egg cases. The first description of *C. maximus* egg case is provided with short comments on the reproductive biology of the species.

Keywords: Elasmobranchii, Fishes, Systematics, Biodiversity, Latakia Basin

Basking shark, Cetorhinus maximus (Gunnerus, 1765), is a large shark, distributed worldwide, generally found in boreal to warm temperate waters, frequently sighted in open seas, and which often enters into enclosed bays where it is usually captured; additionally, some dead specimens are found stranded on the beach [1]. The presence of basking shark is known in the Mediterranean, but most of the reported captures were from western and central areas [2], especially off the Maghreb coast [3] and the Adriatic Sea [4, 5]. Conversely,C.maximus appears to be less frequently captured in the eastern Mediterranean basin, from the Turkish coast [6, 7, 8] to Levant Basin [9]. It has hitherto not been reported off Lebanon [10, 11] and Syria, where through surveys conducted from January 2000 to date, 42 elasmobranch species have already been identified [12, 13]. During these surveys, a female C. maximus was captured on 20–21 April 2012 by gill-net, spread from the beach to 150 m in the sea, at a depth of approximately 10 metres, off Raas Albassit, city located in northern Syria (35°50′50″N, 35°48′16″E. The specimen was a female measuring 6.90 m in total length and weighing 2.5 t (Fig. 1). Its identification was aided by Bigelow and Schroeder [14], Compagno ([1] and Quero [15], based on: 5 extremely huge gill-slits virtually encircling the head, gill arches with bristle-like rakers, pointed snout, large sub-terminal mouth with numerous minute hooked teeth, caudal peduncle with strong lateral keels, lunate caudal fin nearly asymmetrical. Measurements were carried out directly at Lattakia fishmarket, following methodology of Compagno [1] for sharks, and recorded to the nearest cm. The absolute values were also related to the percentage of total length. The female was cut up in a hurry by fishermen and rapidly sold, the abdominal cavity was opened and 34 egg cases were found in the body liquids. Unfortunately, a single egg case could be collected; it was deposited in the Ichthyological Collection of the Marine Sciences Laboratory, Agriculture Faculty, Tishreen University of Syria, under the catalogue number 251 M.S.L. This large female C. maximus contained egg cases in the uterus, was at the beginning of the gestation, and it could be considered as a pregnant specimen, the second recorded to date. The first record was made by a Norwegian fisherman who caught a female ready to give birth to large near-term embryos [16]. Catches of basking sharks exclusively concern non-pregnant females (17, 18]. Matthews [19] recorded a nonpregnant female C. maximus having large number of small eggs in their ovaries. Compagno [1] and Kunzlik [20] suggest that the species is ovoviviparous and has uterine cannibalism like other lamnoids, with embryos feeding on the small eggs. Such hypothesis is not suitable due to the fact that the species exhibits minute teeth and is planktonophagous. Additionally, the eggs found in this female—rather large and heavy—showed that C. maximus is unable to assume this reproductive strategy. On the other hand, C. maximus is not a true ovoviviparous elasmobranch species such as whale shark, Rhincodon typus Smith, 1828, in which embryo development is protected by a rigid capsule in female uterus [21]. At maturity, female basking sharks reach the size of 8.1–9.8 m [1]. The specimen described in the present paper showed that females could mature at smaller-size, which would be consistent with Bigelow and Schroeder [22] who noted that they matured between the length of 457 and 610 cm. Gilmore [23] noted that parturition size occurred when the embryos reached 150 cm total length and the smallest free-swimming specimen was 165 cm total length. Compagno [1] noted that gestation period of basking shark lasted between 12 and 36 months. The small size and low weight of eggs collected and—on the contrary—the large size of neonates (observed elsewhere) suggest a substantial transfer of nutrients from the mother to the embryos. Such transfers probably require a long period of time. The length of this period, however, still remains obscure and requires further records to be clearly assessed. The presently reported fecundity per litter (34 eggs) does not appear very low for an elasmobranch species, for instance, Capape [24] recorded a minimum fecundity of one specimen per litter in gulper shark, Centrophorus granulosus [25]. This first record of C. maximus off the Syrian coast confirms the rarity of the species throughout the Mediterranean Sea. The capture of a pregnant female in shallow coastal waters is probably occasional, but remains also questionable with special regard to an isolate and declining population still existing in the region

Fig. 1. Pregnant female of *Cetorhinus maximu*s captured off the coast of Syria. Entire specimen loaded on a truck.

References

1 - Compagno L.V.J. 1984. FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of sharks species known to date. Part 2. Carcharhiniformes. FAO Fisheries Synopsis No. 125, Volume 4, Part 1. FAO, Rome, Italy

2 - Mancusi C., Clò S., Affronte M., Bradaï M.M., Hemida F,. Serena F., Soldo A., Vacchi M. 2005. On the presence basking shark (Cetorhinus maximus) in the Mediterranean Sea. Cybium 29 (4): 399–405.

ABUNDANCE AND DISTRIBUTION ELASMOBRANCHS IN SAROS BAY, NORTH AEGEAN SEA

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Abstract
The aim of this study is to identify elasmobranch species present in the Saros Bay, to describe their abundance and distribution. The trawl surveys were carried out from September 2006 to September 2008. During the trawl surveys a total of 22 elasmobranch species belonging to the Scyliorhinidae, Squalidae, Squatinidae, Rajidae, Dasyatidae, Triakidae, Myliobatidae, Torpedinidae, Gymnuridae and Oxynotidae were recorded. The data showed that, the catch per unit area (CPUA, kg/km^2) of belonging to Scyliorhinidae and Rajidae family were the dominant groups in the Saros Bay.

Keywords: Aegean Sea, Saros Bay, Biomass, Elasmobranchii

Due to their vulnerable life cycle characterized by slow growth rates, late maturity and low fecundity, elasmobranch fishes are highly susceptible to fishing mortality In these animals, overexploitation can occur even with low levels of fishing mortality once they begin to decline, populations may need decades to recover [3]. In the Mediterranean, elasmobranch landings have decreased from 25 000 tonnes in the 1980's to 7 000 tonnes in recent years and there is evidence that elasmobranchs are declining in abundance and diversity [1]. In Turkey, indicates that Elasmobranch landings reduced from 1535 tonnes in 2005 to 300 tonnes in 2014 with 43% of landings coming from the Aegean Sea [5]. The North Aegean Sea elasmobranch species have been investigated with respect to their occurrence and biology while very little is known on their distribution and assemblages. Our study aimed to determine the species composition, catch per unit effort (CPUE)(kg/h), catch per unit area (CPUA)(kg/km^2) and to described the depth related trends, the distributions of the most abundant species in Saros Bay, the North Aegean Sea. The sampling was carried out by using commercial bottom trawl between September 2006 and September 2008 in the Saros Bay (40° 30'0" N-26 °30'0" E), the North Aegean Sea. A total of 175 bottom trawls were carried out at depths at ranged in average from 0 to 500 m. The trawl was equipped with a 44 mm stretched mesh size net at the cod-end. Trawl times lasted for approximately 30 minutes with trawl speeds moderated to 2.5 knots. The species identification of all specimens refers to the FNAM keys [4] and to the taxonomic organization proposed by [2]. For all the captured skates the catch per unit effort (CPUE) and the catch per unit area (CPUA), expressed by kg/h and kg/km^2 respectively, were calculated. Our results indicated that especially depth and season were the key determinants of the presence of the examined species. During the study a total of 22 elasmobranch species, belonging to the Scyliorhinidae, Squalidae, Squatinidae, Rajidae, Dasyatidae, Triakidae, Myliobatidae, Torpedinidae, Gymnuridae and Oxynotidae (Table 1) were identified.

Tab. 1. Species caught from the Saros Bay (the North Aegean Sea) between depths of 0 m. and 500 m. C:Catch amount (kg), CPUE: Catch Per Unit Effort (kg/h) and C: Catch Per Unit Area (kg/km^2) are shown by species for each.

Family	Species	C (kg)	CPUE (kg/h)	CPUA (kg/km^2)
Scyliorhinidae	*Galeus melastomus*	94.07	0.90	16.58
	Scyliorhinus canicula	1056.92	15.07	191.03
	Scyliorhinus stellaris	103.34	1.04	19.80
Squalidae	*Etmopterus spinax*	0.25	0.00	0.05
	Squalus acanthias	177.99	1.90	30.13
	Squalus blainvillei	10.39	0.26	3.81
Squatinidae	*Squatina squatina*	3.64	0.04	0.79
Rajidae	*Dipturus oxyrinchus*	70.39	0.74	13.45
	Leucoraja naevus	1.16	0.01	0.20
	Rostroraja alba	225.57	3.45	45.32
	Raja clavata	143.53	1.71	27.16
	Raja radula	98.37	3.08	19.31
	Raja miraletus	13.84	0.36	2.74
Dasyatidae	*Dasyatis centroura*	31.48	0.34	6.85
	Dasyatis pastinaca	127.21	2.39	26.36
Triakidae	*Mustelus asterias*	14.79	0.15	2.65
	Mustelus mustelus	65.59	1.02	14.13
Myliobatidae	*Myliobatis aquila*	42.38	0.34	6.24
	Pteromylaeus bovinus	1.45	0.02	0.31
Torpedinidae	*Torpedo marmorata*	5.71	0.04	0.77
Gymnuridae	*Gymnura altavela*	9.65	0.11	2.09
Oxynotidae	*Oxynotus centrina*	5.42	0.05	1.02

The data indicated that, the CPUA of 3 species (*Galeus melastomus*, *Scyliorhinus canicula*, *Scyliorhinus stellaris*) belonging to Scyliorhinidae family increased in relation to depth; whereas the CPUA of the members of the Rajidae family decreased as a factor of depth (Figure 1). *Scyliorhinus canicula* (CPUE: 15.07 kg/h; CPUA: 191.03 kg/km^2) and *Rostroraja alba* (CPUE: 3.45 kg/h; CPUA: 45.32 kg/km^2) are the dominant species in the captures and well distributed in the whole area. The two species was followed by *Squalus acanthias,* Raja clavata and *Dasyatis pastinaca* with CPUE of 1.9 kg/h; 1.7 kg/h and 2.4 kg/h and CPUA of 30.1 kg/km^2; 27.2 kg/km^2 and 26.4 kg/km^2, respectively. During years 2006-2008, the mean CPUA of elasmobranchs was 421.42 kg/km^2 in Autumn. In winter, the mean CPUA of elasmobranchs was 466.23 kg/km^2, in spring the mean CPUA 436.50 kg/km^2 was composed of elasmobranchs. In summer, elasmobranchs were determined as 434.71 kg/km^2. Also, winter is the most abundant season for elasmobranchs.

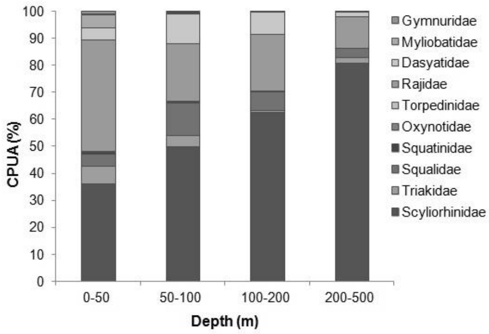

Fig. 1. The percentage of CPUA (kg/km^2) index for elasmobranchs by depths.

This study provides a base for future research on elasmobranchs in the North Aegean Sea in order to prevent the extinction of species before we understand their full importance in the marine ecosystem.

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References
1 - Bradai M.N., Saidi B. and Enajjar S., 2012. Elasmobranchs of the Mediterranean and Black sea: status, ecology and biology. Bibliographic analysis. Studies and Reviews. General Fisheries Commission for the Mediterranean. No. 91. Rome, FAO. 103 pp.

2 - Compagno L.J.V., 1999. Checklist of living Elasmobranchs. In Sharks, Skates, and Rays, the Biology of Elasmobranch Fishes (Hamlett, W. C., ed.), pp. 471-498. Baltimore, MD: John Hopkins University Press.

3 - Echwikhi K., Saidi B., Bradai M.N. and Bouain A., 2013. Preliminary data on elasmobranch gillnet fishery in the Gulf of Gabés, Tunisia. Journal of Applied Ichthyology, 29: 1080-1085.

4 - Stehmann M. and Bürkel D. L., 1984. Rajidae. In Whitehead P.J.P., & M.-L. Bauchot, J.-C. Hureau, J. Nielsen, E. Tortonese eds. FNAM. Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris, 1: 163- 196.

5 - Yigin C.C., Ismen A., Önal U. and Arslan Ihsanoglu M., 2015. Cartilaginous Fishes and Fisheries in the Aegean Sea. In: Katagan T., Tokaç A., Besiktepe S. and Öztürk B. (Eds.). The Aegean Sea Marine Biodiversity, Fisheries, Conservation and Governance. TUDAV, ISTANBUL. ISBN-978-975-8825-33-2.

CIESM Congress Session : Fish biology / early stages

Moderator : Timo Arula, Marine Inst., Tartu Univ., Estonia

Moderator's Synthesis

Since the session speakers focused on various aspects of fish early life, the discussion following the presentations also covered a diversity of subjects from eggs to stock recruitment processes, for instance how different salinity levels affect sprat eggs and embryos in the Mediterranean Sea and in the brackish Baltic Sea.

The general discussion covered in a large extent what has caused the collapse of the sprat stock in the Mediterranean Sea and whether salinity condition actually control recruitment formation via sprat embryonal survival. A second axis of the general debate concerned larval fish habitat quality and the optimal prey conditions in larval fish habitats. To the question of how can better feeding conditions during larval stage result in lower growth rates, the response was ad libitum feeding conditions probably support the survival of genetically weaker individuals that would starve in „normal" prey conditions. Therefore, generally lower growth rates were observed in cohorts during the years of high prey abundance.

In concluding, it was stated that while extensive effort has been invested into larval fish studies over a century, the results often remain far remote from practical use and therefore have not been applied to fish stock recruitment dynamics analyses.

HISTOLOGICAL DEVELOPMENT OF THE DIGESTIVE TRACT OF BLACK SEA TROUT (*SALMO TRUTTA LABRAX* PALLAS, 1811) DURING LARVAL ONTOGENY

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Abstract
In this study, development of the digestive tract of the Black Sea Trout (*Salmo trutta labrax* PALLAS, 1811) which is endemic and also endangered species in their natural habitat was identified in early larval stages. For this reason, fish larvae breeding in fresh water recirculating aquaculture system (RAS) were examined by histologically from hatching to fish larvae consumed their yolk sac. Finally, the digestive system of Black Sea trout which is endemic and also endangered species in their natural habitat was determined.

Keywords: Aquaculture, Black Sea, Fishes

Introduction
In Europe, some Salmonidae species especially Norwegian Salmon is cultured extensively for a long time [1,2]. Black Sea trout (*Salmo trutta labrax* PALLAS, 1811) which is endemic subspecies of Salmonidae is distributing naturally in the northeastern rivers of Turkey and the Black Sea [3]. Also, they culture being widespread recent years in Turkey [4]. Despite expanding aquaculture, scientific researches about physiology of this species are not enough.

Material and Method
For this reason; Black Sea trout was cultured in fresh water recirculating aquaculture system (RAS) at 10°C first and later their evolution of digestive system was examined by histologically. The sampling was carried out randomly with ten individuals for each day from hatching to the consumption of yolk sac through 30 days. The samples were fixed in Bouins solution (10% neutral-buffered formalin) until further processing. Subsequent to sampling, the samples were dehydrated with ethanol (70%, 70%, 80%, 90%, 95%, 100% respectively) and embedded in paraffin as a whole body. After that, fish larvae were crosscut throughout the whole body with microtome (Leica RM2135) and obtained sections were stained with haematoxylin-eosin. Finally, stained sections were examined under the light microscope and development of the digestive system of Black Sea trout was specified [5].

Result and Discussion
According to the Figure 1; trout larvae grew consistently throughout sampling period while yolk sac consumed till 30th day.

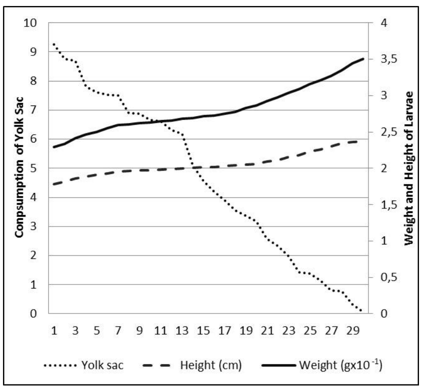

Fig. 1. Height, weight and yolk sac consumption of Black Sea trout larvae trough 30 days.

According to the results; mouth was open in the first day. Taste buds being apparent in 12th day and covered surface of the tongue till the 28th day. Stomach and esophagus were observed clearly in the first day and also stomach wall became thicker and more developed till the 29th day. The intestine was started to be observed in the fifth day, the mucosal folds were clearly observed in the 7th day and it grew and expanded through to the intestine until the 25th day. In the 15th day, separation of mid and distal intestine structures was seen. Pancreas and liver cells were started to be observed in the 5th day, they improved till the 18th day and liver and pancreatic tissues were observed clearly in the 29th day (Figure 2).

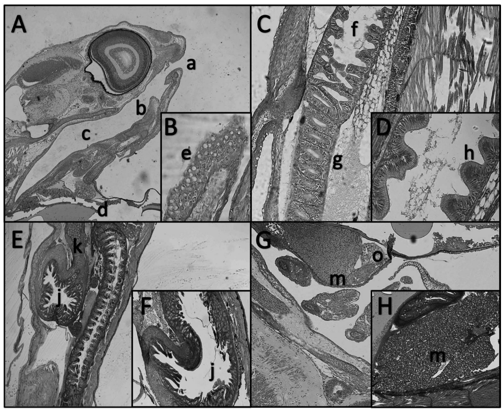

Fig. 2. **A:**Head of Black Sea trout larvae in first day, a:mouth, b:tongue, c:esophagus, d:yolk sac; **B:**Tongue of larvae in 28th day, e:mucus cells and taste buds; **C:**Segments of intestine during 15th day, f:mid intestine, g:distal intestine; **D:**Section of mid intestine in 29th day, h:mucosal folds;**E-F:**Digestive tract between 23-28th day, j:stomach, k:pyloric ceca; **G-H:** liver and pancreatic tissues beetween 5-29th days, m:liver, o:panceas.

In this research, development of the digestive tract of the Black Sea Trout was determined and basic data of its anatomy was revealed in larval stages. These results will shed light on further studies.

References
1 - Elliot, J.M., 1994. Quantitative ecology and the brown trout. Oxford univ. press, Oxford, 286s.
2 - Sahlmann C., Gu, J., Kortner, T.M., Lein, I., Krogdahl, A., Bakke, A.M., 2015. Ontogeny of the digestive system of atlantic salmon (*Salmo salar* L.) and effects of soybean meal from start-feeding. journal of plosone, 1-23. DOI:10.1371/journal.pone.0124179
3 - Aydin, H., Yandi, I., 2002. The general status of spawning areas of Blacksea trout in the East Blacksea regions (*Salmo trutta labrax* Pallas, 1811). E.U. Journal of Fisheries & Aquatic Sciences, 19 (3-4): 501 – 506.
4 - Cakmak, E., Aksungur, N., Firidin, S., Cavdar, Y., Kurtoglu, I.Z., Bascinar, N.S., Akbulut, B., Savas, H., Ustundag, E., Alkan, A., Ergun, H., Erteken, A., Zengin, B., Serdar, S., Fidan, D., Ozkan B., 2013. Expandability of Black Sea trout (*Salmo trutta labrax* PALLAS, 1811) to private sector. Project book (in Turkish), 147s.
5 - Harris, T., Leaven, T., Heidger, P., Kreiter, C., Duncan, J., Dick, F., 2001. Comparison of a virtual microscope laboratory to a regular microscope laboratory for teaching histology, the anatomical record (New Anat.) 265:10–14.

SIZE DEPENDENT GROWTH IN LARVAL FISH IS NOT AN ISSUE IN A WORLD OF PLENTY

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Abstract
Nutritional situation, and consequently larval fish growth rates, are of paramount importance for larval survival rates. On the basis of 6 consecutive spring seasons biochemically derived growth rates of larval herring originated from Kiel Canal (western Baltic Sea) were analyzed to evaluate size dependent growth, a phenomenon which has been observed in several species. For each season the slope of the regression line of G_i versus larval standard length was calculated and compared to seasonal mean prey abundance. We found decreasing size effects on larval growth with increasing prey abundances. We conclude that large larvae are more successful at meeting their food requirements at suboptimal prey abundances compared to small larvae, while no differences between small and large larvae at high prey abundances exist.

Keywords: Growth, Ichthyoplankton, Zooplankton , Baltic Sea, Brackish water

Introduction. Generally, it is acknowledged that the nutritional conditions fish larvae experience are of crucial importance concerning larval survival rates. Bigger larvae suffer from lower mortality rates as they are further developed and more effective to cope with suboptimal conditions, leading to lower predation rates [1]. The larvae´s RNA:DNA ratio is a condition index with short reaction times [2], which ensures comparability between the prey field observed during sampling and the nutritional condition of the larvae analyzed. Size dependent growth has been reported for larvae of several fish species, including Atlantic herring, Argentinean hake, Atlantic anchovy, red drum, and European pilchard [3]. In the present study, we tested the relationship between size dependent growth and prey availability for herring larvae from the field.

Material and Methods. Time series analyses of six consecutive spring seasons (2007 to 2012) in Kiel Canal at a station 13 km inland to the open Baltic Sea (54°20'45 N, 9°57'02 E) were conducted. RNA and DNA concentrations of whole individual larval Atlantic herring (*Clupea harengus* L.) were fluorimetrically measured [4]. Instantaneous growth rates of larval herring were calculated using the best-fit multi species growth model [5] and analyzed in relation to prey abundance (sampled with WP2-net, 200 µm mesh-size), consisting of copepods and cirriped nauplii.

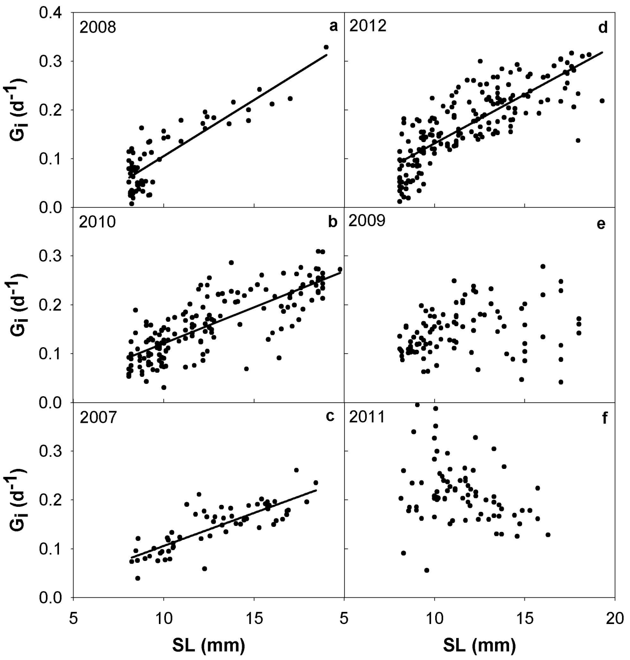

Fig. 1. Instantaneous growth rate (Gi) vs. standard length (SL). The graphs are arranged with respect to mean seasonal prey abundance from (a) lowest to (f) highest prey abundances observed.

Results and Conclusions. Our results show a decreasing trend in size dependency in larval growth rates with increasing prey abundances (Fig. 1) reflected by a decreasing slope (Fig. 2). While at low to intermediate prey abundances a linear positive relationship (Fig. 1 a-d) was observed, at high prey abundances no relationship existed (Fig. 1 e, f). This illustrates that size dependent growth of larval fish does not occur when prey availability is high, indicating that small larvae are able to feed well in such situations, despite worse swimming and hunting capabilities compared to large larvae. Therefore, if size dependency is observed, this might point to suboptimal nutritional situations for larval fish.

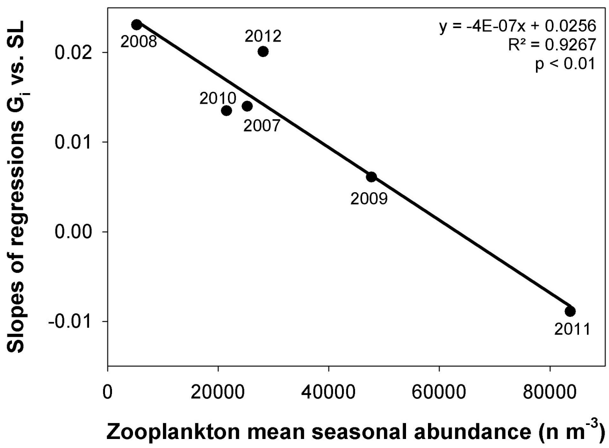

Fig. 2. Slopes of regressions (instantaneous growth rate (Gi) vs. standard length (SL)) versus mean seasonal zooplankton prey abundance.

References
1 - Houde E. D., 2008. Emerging from Hjort´s shadow. *J. Northwest Atl. Fish. Sci.* 41, 53-7.
2 - Clemmesen C., 1994 The effect of food availability, age or size on the RNA/DNA ratio of individually measured herring larvae - laboratory calibration. *Mar. Biol.* 118, 377-382.
3 - Díaz E., Txurruka J. M. and Villate F., 2011. Growth maximization in early sardine larvae: a metabolic approach. *Mar. Biol.* 158, 1135-1148.
4 - Malzahn A. M., Clemmesen C. and Rosenthal H., 2003. Temperature effects on growth and nucleic acids in laboratory-reared larval coregonid fish. *Mar. Ecol. Prog. Ser.* 259, 285-293.
5 - Buckley L. J., Caldarone E. M. and Clemmesen C., 2008. Multi-species larval fish growth model based on temperature and fluorometrically derived RNA/DNA ratios: results from a meta-analysis. *Mar. Ecol. Prog. Ser.* 371, 221-232.

EFFECTS OF REDUCED SALINITY CONDITIONS ON ADRIATIC SPRAT (*SPRATTUS SPRATTUS PHALERICUS*) EARLY LIFE STAGE DEVELOPMENTAL SUCCESS

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Abstract

Sprat (*Sprattus sprattus phalericus*) is considered a remnant sub-species of boreal cold biota in the Mediterranean Sea showing a dramatic decrease in stock size since the late 1980´s for reasons poorly understood. For North Adriatic sprat eggs and yolk sac larvae a laboratory study was conducted simulating 8 salinity levels between 5-37.2 psu, to detect potential effects associated with reduced salinity levels as locally predicted to decline in the future. Egg buoyancy, survival, malformation and developmental rates of eggs and yolk sac larvae were assessed. In conclusion, a general high plasticity in development and survival has been observed. A small decrease in surface salinity during sprat spawning season might impact egg and larval survival, although the effect may be countered if positive egg buoyancy is maintained.

Keywords: Global change, Fishes, Larvae, Salinity, Mediterranean Sea

Introduction: European sprat (*Sprattus sprattus*) are small pelagic fish with high ecological and economic importance and North-eastern Atlantic distribution. An isolated sub-species of this "cold adapted species" inhabits the North Adriatic Sea, where it supported local commercial fisheries with a mean annual catch of about 3000t during 1979-1988 [1]. In the late 1980's however the species showed a sharp declining trend in reported landings with an estimated stock size of <1000t in the Eastern Adriatic in 2004. Underlying reasons of such decline remain so far elusive. As it is well known that early life stages (ELSs) of fish (eggs and larvae) are strongly influenced by abiotic factors like temperature or salinity, unfavorable conditions may account for a substantial variability in survival and therefore affect recruitment success. Former studies on Adriatic sprat ELS are restricted to egg abundance, distribution or larval otolith analyzes, while experimental studies are hitherto lacking. The Gulf of Trieste in the North Adriatic Sea is characterized by annual mean±SD surface salinities of 35.3±1.1 and 37.2±0.4 at about 10m depth, respectively [2]. However, the seasonal variability can be substantial leading to regional surface salinities of 29 to 37 [2]. Climate change projections forecast salinity conditions down to almost 30 by 2100 [3]. Here we assess the impact of different salinity conditions on the egg and yolk sac larval buoyancy, developmental duration, malformations and survival.

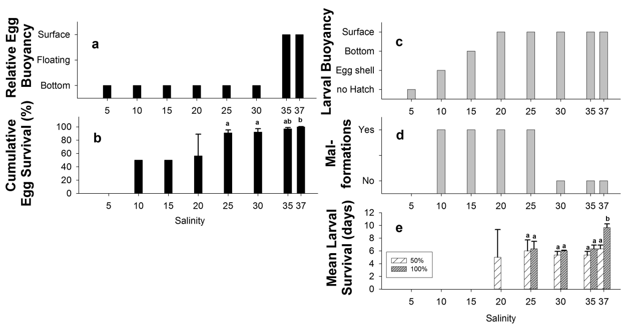

Fig. 1. Relative egg buoyancy (a), cumulative egg survival (b), larval buoyancy (c), occurrence of malformation (d), 50%, 100% mean larval survival duration (e)

Material & Methods: Sprat in spawning condition were caught at night by purse seine fishing in January 2007 in the Gulf of Trieste, Northern Adriatic Sea. They were artificially fertilized (in 37 psu water) onboard and incubated at 11.3 °C in the NIB Marine Biological Station in Piran. Eggs from three females were checked for regular cleavage patterns and pooled at egg development stage IB (12 hours post fertilization) prior to transfer into 250 ml glass beakers filled with 0.2 µm filtered artificial seawater of 5, 10, 15, 20, 25, 30, 35 and 37.2 psu in triplicates. All observations, handlings, removal of dead eggs and larvae as well as water exchange (ca. 50%/day) were made daily (every 24 hours). Egg development duration was followed until >50% of larvae had hatched. The vertical location of eggs and the position of hatched yolk sac larvae were recorded categorically (bottom, floating, surface), termed "relative egg buoyancy" for the egg and "larval buoyancy" for the larval stage. Cumulative egg survival was defined as the number of eggs surviving from loading the beakers until hatch. Categorical occurrence ("yes/no") of malformations for each salinity treatment was recorded.

Results and Conclusion: Positive egg buoyancy is important for marine fish eggs in the sea to survive and disperse, while negative buoyancy may enhance egg mortality due to e.g. hypoxia. Measured positive neutral egg buoyancy at salinities of 35 and 37.2 (Fig 1a) mirrored the salinity range measured in the field during sprat spawning seasons in the Northern Adriatic Sea [2]. However, eggs were negatively buoyant between 30 and 35 psu – reflecting the forecasted salinity range for parts of the Northern Adriatic coastal area by 2100 [3] - which could be increasingly problematic for sprat reproduction in the future. Egg development time in salinities from 10 to 37.2 psu was 4 days, which revealed that time-to-hatch was not influenced by different salinity levels, as shown for other fish species, including Baltic Sea sprat. Successful egg development required salinities exceeding 5 psu (Fig 1b). Cumulative egg survival was significantly different (ANOVA, $p<0.045$) between salinities from 25 to 37.2. Highest mean survival was observed at 37.2 (100%), while it was significantly reduced at 25 and 30 psu (90 and 92% survival) (Fig 1b). Although embryos developed into viable larvae at salinities >10 – 25, a significant contribution of these larvae to recruitment is unlikely, since a large proportion already failed in emerging from the egg shell or showed deformations which handicapped swimming performances (Fig 1 d). These handicaps impact in two ways since the larvae have to accomplish compensation of negative buoyancy (Fig 1 c), hence have to invest more energy to prevent sinking and to balance osmotic differences. The sum of these additional physiological expenses is potentially expressed in the longer survival time of larvae raised at the highest salinity, where those costs are absent (Fig 1 e). We conclude that salinity influences egg buoyancy and survival, but not the egg development duration. In addition, a decrease in surface salinity during spawning season might impact egg and larval survival; although the effect is considered to be of minor importance as long as positive egg buoyancy remains.

References

1 - Grbec B., Dulcic J., Morovic M. (2002) Long-term changes in landings of small pelagic fish in the eastern Adriatic-possible influence of climate oscillations over the Northern Hemisphere. C*limate Res.*, 20: 241-252.
2 - Malacic V., Celio M., Cermelj B., Bussani A., Comici, C. (2006) Interannual evolution of seasonal thermohaline properties in the Gulf of Trieste (northern Adriatic) 1991-2003. *J. Geophys. Res.*, 111: 1-16.
3 - Rizzi J., Torresan S., Critto A., Zabeo A., Brigolin D., Carniel S., Pastres R., Marcomini A. (2015) Climate change impacts on marine water quality: The case study of the Northern Adriatic sea. *Mar. Pollut. Bull.* doi:10.1016/j.marpolbul.2015.06.037

CIESM Congress Session : Fish biology / adults

Moderator : Rainer Froese, GEOMAR, Kiel, Germany

Moderator's Synthesis

In his introduction, the moderator stressed the importance of biological data to estimate "the most important population trait" for conservation and fisheries management, namely the intrinsic rate of population growth (r_max). This trait is highly correlated with natural mortality, longevity, somatic growth rate, generation time, and annual fecundity. A new routine in FishBase shows estimates of r_max for already 1000 species, with more to come as data are added. This presentation was meant to inspire colleagues to not cease their efforts in estimating and reporting basic life history properties.

The session then continued with altogether 10 short presentations about age, growth, length frequencies, length-weight relations, diet composition, mortality, fecundity, biometrics and identification. The final discussion considered three topics:

(1) How is r_max affected if a species changes sex, e.g. from male to female? In such case, all life history traits have to be taken for the larger and older sex (here: the female) and r_max can be expected to be lower because of later female maturation.

(2) How would such sex change affect the somatic growth curve? We don't know, but since sperms have lower metabolic cost than eggs, producing sperms before eggs should not have too much impact on overall growth.

(3) Studying adult biology is not rewarding and many international Journals do not accept such papers. Participants replied that knowledge about basic biology remained essential, and the *Journal of Applied Biology* and *Acta Ichthylogica* et *Piscatoria* explicitly accept such papers as short communications, which are then channeled for encoding in FishBase.

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LENGTH-WEIGHT RELATIONSHIP OF *APHANIUS FASCIATUS* (VALENCIENNES, 1821) FROM HOMA LAGOON (AEGEAN SEA)

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Abstract

A total of 224 *A. fasciatus* individuals with 151 females and 73 males were collected by beach seine from Homa Lagoon (Aegean sea coast of Turkey) in October-November 2013. Minimum and maximum total length with a mean total length of females were 2.4, 5.3 cm and 3.8 ± 0.616 cm, respectively. For males minumum and maximum total length with a mean total length were 2.9, 4.8 cm and 3.8 ± 0.376 cm. Length-weight relationships were determined as $W = 0.0103L^{3.267}$, $W = 0.0098L^{3.281}$ and $W = 0.0098L^{3.279}$ for males, females and combined sex, respectively.

Keywords: Fishes, Lagoons, Teleostei, Aegean Sea

Data of length and weight is useful and standard consequences in avariety of studies including estimation of growth rates, age structure and other related parameters applied in fish population dynamics. Moreover, length-weight relationships are widely used in fisheries biology in order to compare life processes and morphology of fish populations which inhabit in a variety of geographies.[1] The aim of the study is to determine the length-weight relationships for female and male individuals and combined individuals of *Aphanius fasciatus* species from Homa Lagoon in 2013.

The study area covers Turkish Aegean sea waters off Homa Lagoon in Izmir Bay. A total of 224 fish specimens (151 females and 73 males) were collected between October and November in 2013 using a beach seine. The length of wings in the beach seine is 10 m each and the bag is 2.5m and its 1m. The net used in both bag and wings is made of tulle curtain fabric with a mesh opening of 1mm. The samples were carried to the research lab in plastic bags to measure their length and weight. The total lengths were measured to the nearest 0.1cm and body weight to the nearest 0.01g by means of a balance. The length-weight relationships for weight were calculated using the equation,$W=aL^b$ [2] where is a coefficient related to body form and b is an exponent indicating isometric growth when equal to 3. The statistical significance level of r^2 was estimated by linear regressions on the transformed equation, LogW=loga+b.logTL.

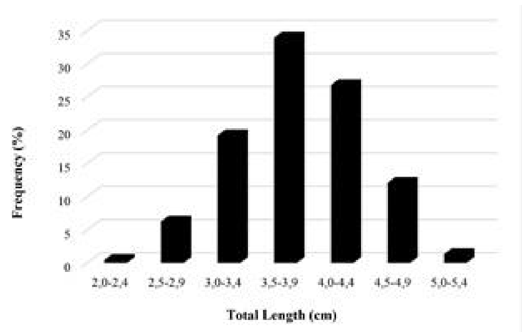

Fig. 1. Distribution of length-frequency of specimens of *A.fasciatus* in combined sex.

The present study considered the total length a parameters. The recorded minimum and maximum lengths were 2.4 and 5.3 cm in females and 2.9 and 4.8 cm in males, respevtively. On the other hand, the minimum and maximum weights were 0.17 g and 2.30 g in females and 0.34 g and 1.77 g in males, respectively. Figure 1. shows length- frequency distribution of *A. fasciatus* in combined sex. All individuals in the total length frequency distributions 3,5 – 3.9 cm in length range of 33.9 % has been found that in the first place. Length-weight relationships (LWRs) for males, females and the total sample population were determined as $W = 0.0103L^{3.267}$, $W = 0.0098L^{3.281}$ and $0.0098L^{3.279}$ respectively. LWRs of *Aphanius fasciatus* presented in Figure 2 shows that the calculated allometric coefficients female, male and combined were 3.281, 3.267 and 3.279 respectively. It was observed that the values of 'b' were higher in females than those of males.

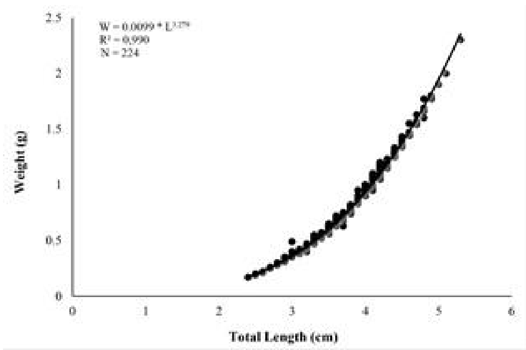

Fig. 2. Length-weight relationship of *A. fasciatus* samples collected from Homa Lagoon.

The LWR can be obtained from the length and weight measurements of the same fishes throughout their lives or from a sample of fish taken at a given time [3]. The parameters of the fish, LWRs are affected by a series of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health and preservation techniques [4,5]. All allometric coefficients (b) estimated in this study were within the expected range 2.3-3.5, and according, allometric coefficients (b) may range from 2 to 4. The result of the present study indicate that the value of b is more than 3. The values of b found in studies conducted on *A. fasciatus* in Homa Lagoon indicate positive allometry of growth.

References

1 - Pauly D. 1993. Fishbyte section editorial. Naga, the *ICLARM* Quarterly, 16: 26.

2 - Ricker WE., 1979. Growth rates and Models. In: Hoar WS, Randall DJ & Brett JR (eds), Fish Physiology Vol. VIII, Bioenergetics and Growth, Academic Press, 677-743.

3 - Wootton RJ., 1990. Ecology of teleost fishes. Chapman and Hall, London.

4 - Bagenal TB. and Tesch FW., 1978. Age and growth. *In*: Bagenal TB (ed), Methods for assessment of fish production in fresh waters, 3 rd edn. IBP Handbook No. 3, Blackwell Science Publications, Oxford, 101-136.

5 - Tesch W., 1971. Age and growth. In: Ricker WE (ed), Methods for assessment of fish production in fresh waters, 2nd edn. International Biological Programme, Oxford and Edinburgh, 97-130.

MORPHOMETRIC CHARACTERISTICS OF THE MOROCCO DENTEX *DENTEX DENTEX* VALENCIENNES, 1830 IN THE IZMIR BAY

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Abstract

The Morocco dentex, *Dentex maroccanus*, is an important demersal commercial sparid species inhabiting throughout the Mediterranean at the depths from 20 to 500 m. Morocco dentex ecologically prefers deep and higher salinity waters. In the Aegean Sea (Izmir Bay), a basin of the eastern-central Mediterranean, the sparids represent important components of the demersal fish stock and are generally caught by trawl, long line, and trammel nets. In this study morphometric measurements of the 52 Morocco dentex specimens obtained from fishermen trawling in the Izmir bay between April 2013 – March 2014 were examined. As a result, it has been revealed that females are greater than the males in all of the variables examined.

Keywords: Fishes, Teleostei, Aegean Sea

Sparidae family represented by 37 genuses and 178 species in the world seas includes 21 species of 10 genuses in Turkish seas [1]. Genuses of Pagellus, Pagrus and Dentex are called red seabream. Four species of Dentex (*Dentex dentex, D.gibbosus, D.macrophthalmus, D. Maraccanus*) occur across Turkish sea waters. Of total catch from Turkish seas amounting to 295167.9 tons, some 30142.7 tons were yielded from Aegean Sea. Catch of Sparidae species in Turkish seas is 5057 tons (1.71 %) and 3088,4 (10.2 %) from Turkish seas and Aegean sea, respectively [2]. The major studies on the Morocco dentex in the Mediterranean have been carried on its western basin and concerned the age, growth, feeding, reproduction, and distribution [3]. Studies on the species in Turkish sea are concerned with its length-weight relationships [4; 5; 6]. The first comprehensive biologic study was conducted in Saroz Bay (Nort Aegean Sea). The present study on morphometric characteristics of the species is expected to contribute to those to be performed on its biology. We studied 52 individuals from all length groups of a total of 439 fish collected from fishermen who catch fish using trawl boats from April 2013 to March 2014 across Foca – Mordogan.

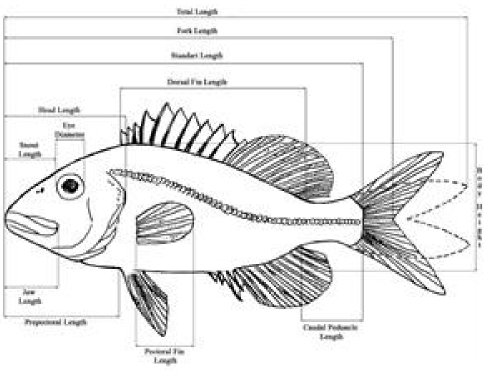

Fig. 1. Morphometric measurements

Their total, fork and Standard length were measured by 0.1 cm scale board and morphometric measurements made using a 0.01 cm – occuracy Mitutoyo digital callipers. Since species of great economicc value are target catches, present stocks are due to come into danger of extinction. It is a great importance to follow up stock lengths annually and determine reproduction, growth and devolopment of red seabream in order to preserve and sustain their stocks considering their economic value. Briefly, findings obtained from Marocco dentex fish across Izmir Bay will contribute to deteiled biologic studies to be made on the species.

Tab. 1. Morphometric values according to sexes

Parameters	Male (Mean) ± SE (mm)	Female (Mean) ± SE (mm)
Total Length	131.24 ± 2.66	151.36 ± 9.89
Fork Length	119.53 ± 2.64	136.18 ± 9.06
Standart Length	105.90 ± 3.15	122.82 ± 8.58
Body Height	39.38 ± 0.95	45.96 ± 3.20
Head Length	34.67 ± 0.84	40.68 ± 3.18
Snout Length	9.15 ± 0.29	11.20 ± 1.10
Eye Diameter	12.47 ± 0.28	14.56 ± 0.95
Jaw Length	13.72 ± 0.33	16.42 ± 1.36
Dorsal Fin Length	53.20 ± 1.17	60.53 ± 3.81
Pectoral Fin Length	32.09 ± 0.91	37.68 ± 2.90
Prepectoral Length	39.72 ± 0.95	45.67 ± 3.44
Caudal Peduncle Length	18.75 ± 0.42	20.65 ± 1.34

Acknowledgment The presently reported study was carried out with financial support of Ege University Scientific Research Project No. 2013-SUF-017.

References

1 - Bilecenoglu M., Kaya M., Cihangir B. and Cicek E., 2014. An updated checklist of the marine fishes of Turkey. *Turk J Zool,* 38: 901-929.
2 - TUIK, 2013. Fishery statistics, *Turkish Statistical Institute*, Publication Number 4349, Turkey, 75 pp.
3 - Mennes F. 1985. Multispecies assessment of fish stocks off the Western Sahara region with emphasis on the family Sparidae. *Fishbyte* 3 (3): 5–10.
4 - Karakulak F.S., Erk H. and Bilgin B. 2006. Length–weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. *J Appl Ichthy*., 22 (4): 274–278.
5 - Ceyhan T., Akyol O. and Erdem M. 2009. Length–weight relationships of fishes from Gökova Bay, Turkey (Aegean Sea). *T J Zool.*, 33 (1): 69–72.
6 - Ismen A., Ozen O., Altinagac U., Ozekinci U. and Ayaz A. 2007. Weight–length relationships of 63 fish species in Saros Bay, Turkey. *J Appl Ichthy.,* 23 (6): 707–708.

PRELIMINARY BIOLOGICAL DATA ON THE EUROPEAN CONGER *CONGER CONGER* (LINNAEUS, 1758) IN CANDARLI BAY

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Abstract
This study describes the length and weight frequency distributions, and length -weight relationships of *Conger conger* (Linnaeus, 1758) in Candarli Bay, Aegean Sea coast of Turkey. *C. conger* specimens were collected with fishing line during October 2015 – December 2015 from fishing port . Fish total lengths and weight ranged from 50.5 to 115.5 cm; 220 to 3550 g respectively. The length–weight relationship was determined for all fishes as $W = 0.004*L^{3.391}$. Sex determination and gonadal development were not possible from the direct observation of the gonads appearance in conger eels. For this reason five gonads were studied histologically. Stomach analyses indicated that the species feeds on three major groups of prey: Crustacea, Mollusca ve Teleostei.

Keywords: Fishes, Teleostei, Aegean Sea, Life cycles

The European conger eel *Conger conger* L., 1758 is distributed in the eastern Atlantic Ocean, from Norway to Senegal. It is also present in the Mediterranean and in the western part of the Black Sea [1]. European conger eel is an important benthic fish and represents a valuable fishery resource. Marketed as fresh and frozen. Eaten fried and baked. There are a few studies on population biology of *C. conger* in the Atlantic coast [2, 3]. European conger eel (*Conger conger*) is a common and widely distributed fish in the NE Atlantic and Mediterranean. Despite being a geographically widespread and important fisheries resource, knowledge of the population structure and ecology of *C. conger* is scarce and mainly concerns the early life history feeding ecology [4], and reproductive biology. On the other hand, no study is found about its population parameters in the Aegean Sea coast of Turkey and those in other Turkish. The purpose of this study is to investigate some biological characteristics of *C. conger* in Candarli Bay, Aegean Sea coast of Turkey.

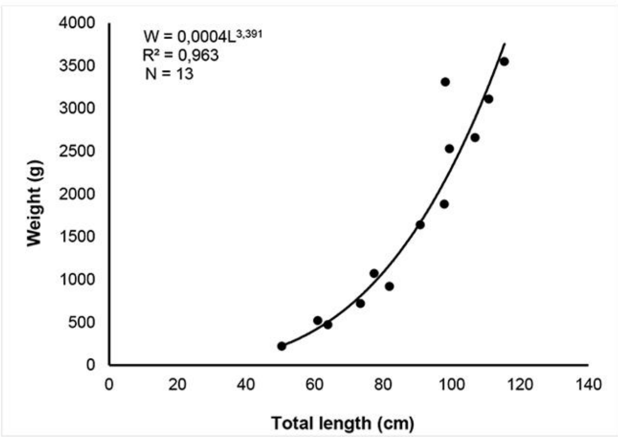

Fig. 1. Length-weight relationships of the *Conger conger*

A total of 13 specimens were caught with hand line from a fishing port in the area between October - December 2015. Total length (TL) and total weight (TW) were measured with 1cm and 0.01g precision, respectively. Sex determination and gonadal development were not possible from the direct observation of the gonads appearance in conger eels. For this reason gonads for histological studies were fixed in 10% buffered formalin solution. A portion of gonads was dehydrated through ethanol series, embedded in paraffin and sectioned 6 µm thin slices. The sections were stained with haematoxylin-eosin. Stomachs were removed from all fish soon after capture.

The length–weight relationship was determined for all fishes according to the equation $W = a*L^b$. Fish total lengths and weight ranged from 50.5 to 115.5 cm; 220 to 3550 g respectively (Table 1). The length–weight relationship was determined for all fishes equation; $W = 0.004*L^{3.391}$ (Figure 1). In the other studies, fish total length and weight range were 33-159 cm and 0.05-12.0 kg [2]; 38 - 173 cm and 125 – 14.553 g [3] respectively. From microscopical analysis of the gonad sections, all fishes were female and their stages were pre-vitellogenic and early vitellogenic. The contents of 13 *C. conger* stomachs were analyzed. Of the total number of stomachs examined, 23% were empty and 77% full. Considering the stomach content of the species in weight, teleostei was established as significant prey groups, followed by crustaceans and molluscs (Table 1). Similarly reported that the species feeds on teleosts followed by Natantia, Brachyura ve Cephalopoda in particular [4].

Tab. 1. Some biological data and diet composition of *Conger conger*

Sampling date	Fish no	TL (cm)	W (g)	GW (g)	Sex	Prey items
October 2015	1	115.5	3.550	154.23	Female	Crustacea
	2	64.0	470	1.35	Female	Cephalopoda
December 2015	3	61.0	520	2.81	Female	Crustacea
	4	99.5	2.530	49.45	Female	Empty stomach
	5	77.5	1.070	11.87	Female	Teleostei, *Liza saliens*
	6	50.5	220	0.81	Female	Teleostei
	7	111.0	3.110	160.00	Female	Teleostei
	8	91.0	1.640	26.52	Female	Teleostei
	9	107.0	2.660	125.78	Female	Teleostei
	10	98.0	1.880	40.00	Female	Empty stomach
	11	73.5	720	5.07	Female	Empty stomach
	12	82	920	7.80	Female	Teleostei
	13	98.3	3.310	188.15	Female	Teleostei

Acknowledgment This research was supported by the Ege University, Scientific Research Project No: 2015/SUF/002.

References

1 - Bauchot, M.-L. and L. Saldanha, 1986. Congridae (including Heterocongridae). p. 567-574. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. Vol. 2, Unesco, Paris.

2 - Sullivan, S.O., Moriarty, C., FitzGerald, R.D., Davenport, J., Mulcahy, M.F. 2003: Age, growth and reproductive status of the European conger eel, *Conger conger* (L.) in Irish coastal waters. *Fish. Res.*, 64: 55–69.

3 - Correia, A.T., Manso, S., Coimbra, J. 2009: Age, growth and reproductive biology of the European conger eel (*Conger conger*) from the Atlantic Iberian waters. *Fish. Res.*, 99: 196–202.

4 - Anastasopoulou, A., Mytilineou, CH., Lefkaditou, E., Kavadas, S., Bekas, P., Smith, C.J., Papadopoulou, K.N., Christides, G. 2013: The diet and feeding ecology of *Conger conger* (L. 1758) in the deep waters of the Eastern Ionian Sea. *Medit. Mar. Sci.*, 14(2): 365-368.

AGE, CROISSANCE ET MORTALITÉS DU ROUGET DE ROCHE *MULLUS SURMULETUS* (MULLIDAE) DES CÔTES DE L'EST ALGÉRIEN

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Abstract
L'âge, la croissance et la mortalité sont étudiés chez le rouget barbet de roche *Mullus surmuletus* (Linnaeus, 1758) des côtes est de l'Algérie. Une clé âge taille et une clé âge poids sont présentées à partir de 251 individus pêchés dans le Golfe d'Annaba. La lecture directe des *sagittae* a révélé que les âges varient entre 0+ et 4 années. La croissance en longueur des mâles et des femelles est la même jusqu'à l'âge de deux ans; à partir de trois ans les femelles montrent une croissance plus rapide. Les paramètres de von Bertalanffy sont $L\infty = 22{,}06$ cm, $K = 0{,}507$ an^{-1}, $t_0 = -0{,}209$ an pour l'ensemble de la population. La relation longueur totale-poids éviscéré est $We = 0{,}0039\ Lt^{3{,}315}$. Les coefficients de mortalité naturelle (M = 0,46/an) et par pêche (F = 0,31) sont relativement faibles.

Keywords: Growth, Mortality, Algerian Sea, Fishes

Introduction

Les premiers travaux sur la croissance individuelle de *M. surmuletus* ont été réalisés à partir des écailles [1]. Même si Bentes [2], dans ses travaux sur la croissance, a utilisé une approche mixte (otolithes, écailles), le choix de ces dernières paraît délicat. Ainsi, après les investigations menées sur son régime alimentaire sur les côtes d'Annaba [3], l'estimation de l'âge, la croissance et les mortalités de cette espèce sont abordées ici.

Matériel et méthodes

Au total, 251 individus de longueur totale comprise entre 13,5 cm et 22,2 cm, correspondant à des poids variant de 20,71 g à 116,68 g, ont été examinés. Ils ont été récoltés dans les poissonneries de la ville d'Annaba. La détermination de l'âge est réalisée par otolithométrie. La longueur totale correspondant à chaque âge est rétro-calculée par la méthode de Lee. Les croissances linéaire et pondérale sont ajustées au modèle de Von Bertalanffy. La relation taille-poids $W = aL^b$ est établie par sexe et pour l'ensemble de la population. Le taux annuel de mortalité (Z) est estimé par la méthode de Pauly [4]. La mortalité naturelle (M) est déterminée par la méthode de Djabali [5]. La valeur du coefficient de mortalité par pêche F, est déduite par la relation F = Z – M.

Résultats et discussion

L'âge a été estimé par la méthode du rétro-calcul après une confirmation de la forte corrélation entre la taille totale du poisson et le rayon total de son otolithe ($r = 0{,}93$, $p \leq 0{,}01$). Les mâles comme les femelles atteignent un âge maximum de 4 ans. La comparaison de nos résultats avec ceux des autres auteurs, obtenus dans diverses régions de Méditerranée, est donnée dans le tableau 1. La croissance linéaire est très rapide durant la première année. Son taux annuel diminue ensuite progressivement, surtout à partir de la deuxième année. Cependant, à âge égal, les femelles ont toujours une longueur légèrement supérieure à celle des femelles.

Tab. 1. Paramètres de l'équation de croissance de von Bertalanffy obtenus par différents auteurs pour le rouget *Mullus surmuletus*.

Auteur	Région	Sexe	L∞	K	t_0	Φ
Jabeur et al. (2000)	Golfe de Gabes	♀	21,20	0,43	-0,65	2,29
		♂	22,60	0,27	-1,07	2,14
N'DA et al. (2006)	Biscay Bay	♀	42,70	0,28	0,641	-
		♂	35,90	0,30	0,74	-
Mehanna (2009)	Egypte	-	31,74	0,47	-0,30	2,67
Arslan and İşmen (2013)	Mer Egée	♂	26,94	0,20	-2,34	2,16
		♀	28,38	0,19	-2,16	2,18
Présent travail	Golfe d'Annaba	♂	22,06	0,503	-0,227	2,29
		♀	22,52	0,508	-0,187	2,29

Le coefficient d'allométrie de la relation entre la longueur totale et le poids total est exprimée par la relation: $Pt = 3{,}9.10^{-5}\ Lt^{3{,}315}$. La valeur du coefficient d'allométrie (b = 3,315) indique une allométrie de croissance majorante (fig. 1)

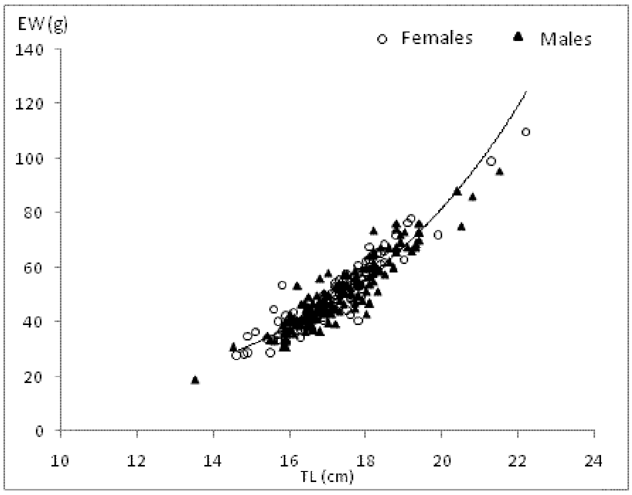

Fig. 1. Relation taille-poids de *Mullus surmuletus* des côtes de l'Est de l'Algérie.

Les valeurs de Z est de 0,77/an pour les mâles et 0,66/an pour les femelles. La mortalité naturelle (M) est de 0,46/an chez l'ensemble de la population (sexes confondus), ainsi que chez les mâles et les femelles séparément. La mortalité par pêche (F) est estimée à 0,31/an chez les mâles et 0,2/an chez les femelles.

References

1 - Bougis P., 1952. - Recherches biométriques sur les rougets (*M. barbatus* L., *M. surmuletus* L.). *Arch. Zool. Exp. Gén.*, 89(2): 57-174.

2 - Bentes L., 1996. - Age and growth, reproduction and feeding ecology of *Mullus surmuletus* L. 1758, red mullet, from the southwest coast of Portugal. Graduate thesis, 65 p. Faculty of Marine and Environmental Sciences, Univ. of the Algarve.

3 - Derbal F., Slatni S., Kara M. H., 2010. Variations saisonnières du régime alimentaire du rouget de roche *Mullus surmuletus* (Mullidae) des côtes de l'Est de l'Algérie. *Cybium*, 34(4): 373-380

4 - Pauly D., 1980. - A new methodology for rapidly acquiring basic information on tropical fish stock: Growth, mortality and recruitment relationships. In: Stock Assessment for Tropical Small Scale Fisheries. Proc. Workshop held in Kingston (Roe- del P.M. & S.B. Saila, eds), pp. 154-172. Univ. Rhode Island: International Center Maritime Resource Development.

5 - Djabali, F., Mehailia A., Koudil M., and Brahmi B. 1993. - Empirical equations for the estimation of natural mortality in Mediterranean teleosts. Naga ICLARM Q. 16: 1, p 35-37.

OTOLITH SHAPE ANALYSIS FOR THREE CLOSELY COMMERCIAL SPARID FISH IN MORPHOLOGICAL FEATURES FROM NORTHERN TUNISIA

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Abstract

Otolith shape analysis was used on three commercial Sparid fish characterized by a misleading morphological resemblance (*Pagellus acarne, Pagellus erythrinus* and *Pagrus caeruleostictus*), in order to evaluate the magnitude of form variation and to identify species. A combination of sagittal otolith shape descriptors and Wavelet coefficients are analysed by multivariate statistical procedures. Regarding the shape descriptors, the differences were best described by all variables principally between *Pagellus acarne* and the remaining species. Canonical discriminant analysis showed that fish were successfully discriminated with otolith shape data and gives more than 70% of classification rate.

Keywords: Mediterranean Sea, Teleostei, Analytical methods

Otolith shape examination and measurements are commonly used to differentiate fish stocks, but also to identify species and to evaluate the ontogeny and evolutionary relationship among them. Samples were captured from the Northern Tunisia and were obtained from commercial fishing landings during the spring over three years (2006-2008). A total of 20 *Pagellus acarne*, 47 *Pagellus erythrinus* and 7 *Pagrus caeruleostictus* were retained for this study. For each fish, standard length was measured to the nearest mm and then the sagittae were extracted for analysis. Digital images of otoliths were obtained in standardized conditions to minimize distortion errors. Each right otolith was placed on a dark background with the sulcus side facing down and the rostrum to the left in a horizontal line and digitized with a high-resolution video camera.

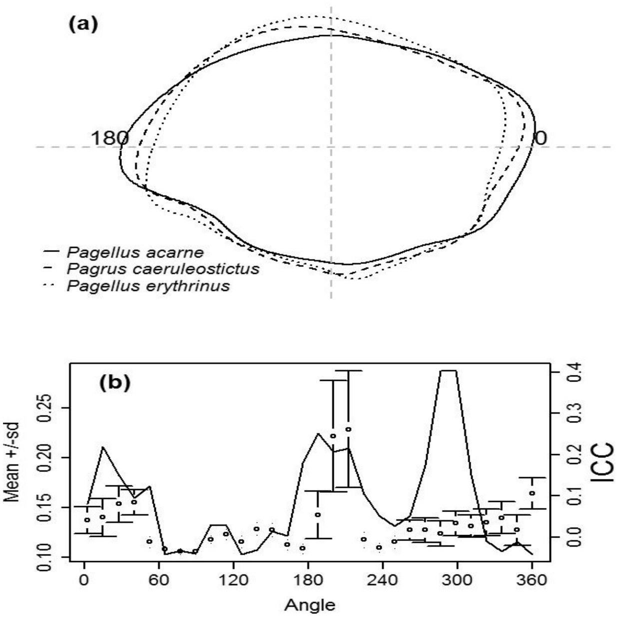

Fig. 1. (a) Mean shape of otoliths based on Wavelet reconstruction for the three sparid species collected from northern Tunisia. (b) Mean and standard deviation (sd) of the wavelet coefficients for all otoliths represented by the open circles and vertical whiskers respectively, and the proportion of variance within species or the intraclass correlation (ICC), which is illustrated by the solid line.

All statistical analyses were performed with R (R Core Team 2015) using shapeR package [1]. Four univariate sagittal descriptors including otolith length, width, perimeter and area were determined. Measurements were standardized in relation to the standard length to remove otolith size effect. To better describe the variation in sagittal shape among species, the mean and standard deviation of the Wavelet coefficients was plotted against the angle. The proportion of variation within species along the outline was summarized with intraclass correlation (ICC). Canonical analysis of principal coordinates (CAP) based on Wavelet coefficients was used to determine differences between species and an ANOVA-like permutation test to assess the significance of constraints using 1000 permutations. Linear discriminant analysis on the standardized Wavelet coefficients was performed to classify individuals to their sampling origin using cross-validation testing procedure.

The shape descriptors are considerably different among the three species. The lowest values for all variables were recorded in *Pagellus acarne*, which is significantly different from the others indicating the small size of the otolith in this species. However, no significant differences in otolith descriptors were observed between *Pagellus erythrinus* and *Pagrus caeruleostictus*. The mean shape and the proportion of variation within species groups along the outline summarized with ICC are illustrated in Figure 1. Plots of individuals on the first two axes of the CAP showed a clear separation between species and gave a cumulative percentage of the variance of more than 99% (Figure 2). This result is in accordance with that obtained by means of an ANOVA-like permutation test (F = 86.904, p = 0.001). Overall, the discriminating analysis with cross-validation procedure correctly classified 86% in combined species samples. The proportions of specimens correctly classified into their original population were as follow: 90% for *Pagellus acarne*, 87% for *Pagellus erythrinus* and 71% for *Pagrus caeruleostictus*.

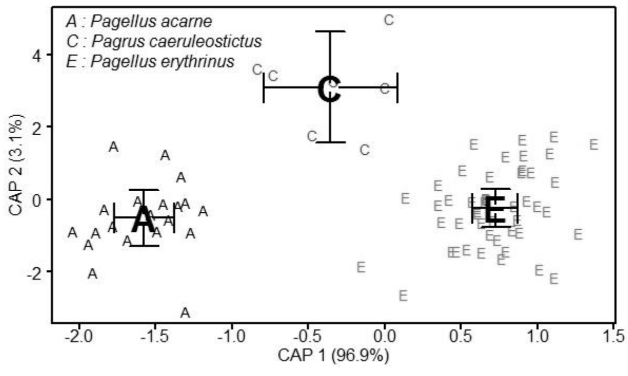

Fig. 2. Canonical Analysis of Principal coordinates based on Wavelet coefficients for the three sparid species collected from northern Tunisia.

This study summarizes the evidence in the otolith variations among the three morphological closely sparid species. The sagittal size and shape analysis as described in this study provides a technique capable to identify specimens at the interspecific scale.

References

1 - Libungan L.A. and Pálsson S. 2015. ShapeR: an R package to study otolith shape variation among fish populations. PLoS One, 10(3): e0121102.

LONG TERM SIZE EVALUATION OF EUROPEAN HAKE IN THE SEA OF MARMARA

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Abstract
Within this study, size data of European hake (*Merluccius merluccius*, Linnaeus,1758) from the Sea of Marmara in 20 years range was evaluated. A total of 5248 specimens were obtained via bottom trawling the from Sea of Marmara during the 2 different time period from 1995 to 1996 on a biannual basis and from 2009 to 2011 on the annual basis. Length-weight relationships and the length frequency distribution of European hake were determined.

Keywords: Fisheries, Stock assessment, Marmara Sea

The aim of this study is to determine the changes in length-weight relationship and the length frequency of European hake over time in the Sea of Marmara. European hake (*Merluccius merluccius*) is distributed Northeast Atlantic to Mediterranean [1]. The Sea of Marmara has 2 permanent water masses, one is the surface layer which constitutes lower salinity water comes from brackish waters of the Black Sea and the other one is bottom layer that is formed of saline Mediterranean waters [2].

Fish samples were collected on a biannual basis from 1995 to 1996 and on the annual basis from 2009 to 2011 with a commercial bottom trawl net at depths between 30 m to 150 meters. Total length (TL) and total body (W) were measured to the nearest 0.1 cm and the nearest 1 g respectively. The relation of total length (TL) to total weight (TW) was determined according to the allometric equation [3]. $W=a \times L^b$, where W is the total weight (g), L is the total length (cm) while a and b constants, *t*-test was applied to determine if the b value was significantly different from the isometric expected value of 3 [4].

A total of 5248 *Merluccius merluccius* specimens were collected ranged from 4.5 cm to 57 cm (1.0 g to 1387 g). Among the examined specimens for their reproductive state 4394 specimens 2071 (%47) were females (TL= 9.3 - 57 cm, TW=6 -1.387 g) and 1719 (%39) males (TL= 8.8 – 41 cm, TW= 5 - 589 g) and 604 (%13) were juvenile (TL= 5 - 22 cm, TW= 2 – 83 g).The sex ratio was calculated 1:1.2 males to females.The minimum and the maximum values of total weight and total length by years shown in Table 1.

Tab. 1. Descriptive statistics for length and weight by years of *Merluccius merluccius*

Years	N	Total Length [cm]		Total Weight [g]	
		Min-Max	Mean	Min-Max	Mean
1995	2049	4.5 - 43.7	17.45 ± 1.69	1 – 820.0	68.23 ± 1.92
1996	2348	7 – 57	21.33 ± 0.13	2 – 1.387	95.90 ± 1.95
2009	351	13.6 - 52	23.73 ± 0.22	27 – 1.180	108.27 ± 4.41
2010	244	5 - 45	18.76 ± 0.58	2 - 632	88.22 ± 6.75
2011	256	8.7 – 41.5	21.04 ± 0.48	5 – 481.0	93.47 ± 6.47

The total length-weight relations were detected $W=0.005x\ L^{3.079}$ (r^2=0.97) for females, $W = 0.007x\ L^{2.981}$(r^2=0.95) for males. Length weight relationship parameters presented according to years in Table 2.

Tab. 2. Length–weight relationship parameters of *Merluccius merluccius* over years.

Years	n	*a*	*b*	SE	R^2
1995	2049	0.007	2,99	0,011	0,97
1996	2348	0.005	3,10	0,008	0,98
2009	351	0.007	2,97	0,04	0,93
2010	244	0.025	2,61	0,03	0,97
2011	256	0.010	2,87	0,04	0,94

Acknowledgements: This study was financially supported by TUBITAK 115Y107. The authors would like to thank the crew of R/V ARAR.

References
1 - Froese, R. and Pauly, D. 2016. FishBase, version (03/2016). Available from: URL: www.fishbase.org.
2 - Besiktepe, S.T., Sur, H.I., Ozsoy, E., Latif, M.A., Oguz, T. and Unluata,U. 1994. The circulation and hydrography of the Marmara Sea. *Progr. Oceanogr*. 34: 285−334.
3 - Ricker W. E. 1975.Computation and Interpretation of Biological Statistics of Fish Population. *Bull. Fish. Res. Board*., Can. 382 p.
4 - Pauly, D. 1984. Fish Population Dynamics in Tropical Waters: a manual for use with programmable calculators. *ICLARM Studies and Reviews* 8. 325 p.

AGE, GROWTH AND REPRODUCTION OF PIPER GURNARD, *TRIGLA LYRA* IN SAROS BAY, THE NORTHERN AEGEAN SEA

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Abstract
The age composition, growth parameters, spawning season, length at first sexual maturity of piper gurnard, *Trigla lyra* caught in the Northern Aegean Sea (Saros Bay) from September 2006 to September 2008 were investigated. The total length ranged from 7,9 to 51,4 cm (mean 28,5±0,25) and from 4,4 to 3400 g (mean 213,4±6,03). Length–weight relationships were estimated as $W=0.0114*L^{2,87}$. The age data derived from otolith readings were used to estimate the growth parameters of the von Bertalanffy equation; L_∞=69,9 cm, K=0.13 and t_o=-0.89. The maximum age was 9 years. Males matured at a total length of 21,9 cm, while females matured at 22,7 cm. The monthly values of the gonadosomatic index indicated that spawning period occurred mainly between January and February. The male to female ratio is usually 1:3.

Keywords: Aegean Sea, Saros Bay, Growth, Reproduction

The piper gurnard (*Trigla lyra*) is commercially important demersal species, living mostly in sand and muddy bottoms at depths ranging from 100 m to 700 m. It is a Mediterranean-Atlantic species, distributed along the Mediterranean Sea, the Black Sea and the Eastern Atlantic Ocean from North of British Isles and North Sea to the west African coast.

Published information on the comprehensive biology and ecology of the piper gurnard in the Mediterranean Sea and especially the Aegean Sea and is scarce. [1] studied the age, growth in Saronikos Gulf, Greece. [2] provided some information on the feeding behaviour of the species in the Saronikos Gulf. [3] studied its reproduction and gonadal structure in the Costa Brava, Northwestern Mediterranean. [4], [5] [6] provided some informations on the age and growth of the species in the Aegean Sea. The present work is a contribution to our knowledge of the age and size distribution, growth, sex ratio and reproduction of the piper gurnard in the Saros Bay, in the northern Aegean Sea.

Monthly trawl surveys were carried out during daytime at depths ranging from 0 to 500 m between June 2005 and September 2008. Length-weight relationship was calculated by applying exponential regression $W=a \times L^b$, where W is the total weight (g), L is the total length (cm). Growth type (isometric and allometric) was determined by the student's t-test (P<0.05). The spawning season was determined following the monthly changes in the gonadosomatic index (GSI). Size at maturity (L_{50}) was defined as the size at which 50% of individuals were spawning [7]. Age was determined by counting the annual growth rings on sagitta otolith. Growth was expressed in terms of the von Bertalanffy equation: $Lt=L_\infty\ (1\text{-}e^{-K(1-t_0)})$. Growth parameters were estimated according to the non-linear method by using the FiSAT package program.

The total length of 1063 specimens caught in the Northern Aegean Sea (Saros Bay) ranged from 7,9 to 51,4 cm (mean 28,5±0,25) and from 4,4 to 3400 g (mean 213,4±6,03). The length-weight relationships were calculated including both sexes and juveniles, $W=0.0114*L^{2,865}$. The slope b was significantly different from 3.0 (t-test, P>0.05), indicating negative allometric growth.

Otoliths from 202 pipers were used for age determinations. Age classes ranged from 1 to 9 years. The estimated von Bertalanffy growth parameters for the piper gurnard were; L_∞=69,9 cm, K=0.13 and to=-0.89 for both sexes combined. The piper gurnard is a relatively long-lived species. In this study, the oldest specimen from Saros bay was was 9 years old (51.4 cm total length). [1] found the oldest specimen on the Saronikos Gulf to be 7 years old (46 cm fork length). [4] reported that the oldest specimen from Turkish waters of Aegean Sea was 8 years old (54.2 cm total length). Based on the derived length at age data, the asymptotic length of L_∞=69,9 cm in the present study is lower than the the asymptotic length for the Saronikos Gulf, L_∞=74 cm [1] and higher than the asymptotic length for the Turkish coast of Aegean Sea, L_∞=59,7 cm [4].The growth coefficient of *T.lyra* in the Saros Bay lies in the mid-range of those calculated by several authors for piper gurnard stocks inhabiting the Aegean Sea. The differences in growth rates and asymptotic lengths might be attributed to different bio-ecological conditions and food availability.

The overall male to female ratio was determined as 1:3. Examination of the male and female maturity stages indicated that males of *T. lyra* matured at about 23 cm total length and females at about 22 cm total length (Fig. 1).

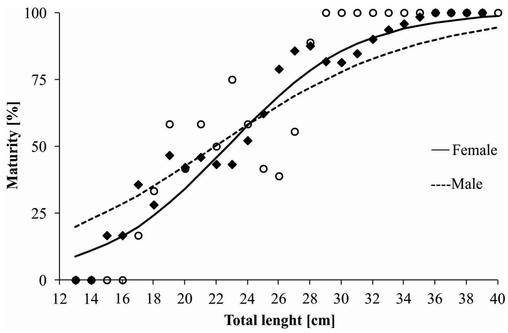

Fig. 1. Logistic regression model for the estimated percent of sexually mature of *Trigla lyra* as a function of the total length

The GSI results revealed that spawning occurred from January to March after the GSI for both sexes reached its highest level. [3] detected mature oocytes and postovulatory follicles in January and February and reported an prolonged spawning period of piper gurnard up to March. Also they stated that the standart length at first maturity was 20 cm for the females and 18 cm for males.

Acknowledgements This study was financially supported by TUBITAK 106Y035.

References
1 - Papaconstantinou C. 1981. Age and Growth of Piper, Trigla lyra, in the Saronikos Gulf (Greece). *Cybium*, 5 (2): 73-87.
2 - Caragitsou E, C Papaconstantinou. 1994. Feeding habits of piper (*Trigla lyra*) in the Saronikos Gulf (Greece). *J. Appl. Ichthyol.* 10**:** 104-113.
3 - Muñoz M., Sabat M., Mallol S., and Vila S., 2002. Gonadal Structure and Gametogenesis of *Trigla lyra* (Pisces: Triglidae). *Zoological Studies* 41 (4): 412-420.
4 - Içemer, A., 1994, Investigations of some biological characteristics of *Trigla lyra* (Linnaeus, 1758) in Aegean Sea. (MSc Thesis-in Turkish). D.E. Üniv. Fen Bilimleri Enstitüsü, 46 s.
5 - Uçkun 2005 Investigation of the age and growth characteristics of the species belonging to the family Triglidae in Edremit Bay. *E.U. Journal of Fisheries & Aquatic Sciences,* 22 (3-4): 363–369.
6 - Içemer A., Özaydin O., Kaya M., Benli H.A. 2003. Ege Denizi'nde Dagilim Gösteren Trigla lyra (Linnaeus, 1758) Türünün Biyolojisi. *E.U. Journal of Fisheries & Aquatic Sciences*, 20 (3-4): 517-522.
7 - Piñeiro, C. and Saínza, M. 2003. Age estimation, growth and maturity of the European hake, *Merluccius merluccius* (Linnaeus, 1758) from Iberian Atlantic waters. *ICES Journal of Marine Science,* 60: 1086 – 1102.

CARACTÈRES MÉTRIQUES DE *SOLEA AEGYPTIACA* DE GOLFE DE GABÈS.

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Abstract
Dans ce travail on s'intéresse à étudier la biométrie de *Solea aegyptiaca*. L'étude biométrique, se base essentiellement sur des approches statistiques, qui permettent de définir les caractéristiques de la population de cette espèce. On se basant sur des enquêtes et des opérations d'échantillonnages aux différents ports du golfe de Gabès (Sfax, Skhira, Mahrès, Gabès, Zarzis, Djerba…), ainsi qu'à l'aide des compagnes de pêches et de prospections on a pu déterminer les caractéristiques métriques de *Solea aegyptiaca*. Cette étude a montré que la plupart des caractères évoluent selon une allométrie minorante par rapport à la longueur totale.

Keywords: Gulf of Gabes, Fishes, South-Central Mediterranean, Growth

Le golfe de Gabès se caractérise par des particularités et des originalités dans le secteur de la pêche à l'échelle de la méditerranée et à l'échelle du Tunisie, il est connu par sa richesse en ressources halieutiques à haute valeur commerciale.

Solea aegyptiaca, est une espèce de la famille des Soleidae. Cette espèce est endémique de la Méditerranée [1]. Pour longtemps elle a été considérée comme sous espèce de *Solea vulgaris.* Les études génétiques ont montré qu'il s'agit de deux espèces différentes [2]. En Tunisie, elle a été mentionnée par [3] au Nord dans le golfe de Tunis, et par [4] et [5] au sud Est du pays. Elle a été signalée par [6] dans le lac d'Ichkeul et dans le secteur marin de Bizerte.

Durant les dernières années *Solea aegyptiaca* est régulièrement observée et pêchée dans le golfe de Gabès.

Cette étude a été réalisée sur un échantillon de 529 individus de longueur totale (LT) comprise entre 9,7 et 27,2 cm. Les caractères métriques étudiés ont été relevés au millimètre près à l'aide d'un ichtyomètre et d'un pied à coulisse électronique, les différents mensurations effectuées sont les suivantes : les longueurs totales (LT), standard (Lst), de la tête (T), de la nageoire dorsale (LD), de la nageoire anale (LA), de la nageoire pectorale (LP), de la nageoire ventrale (LV), la hauteur du corps (H), le diamètre de l'œil (Ø) et la distance inter orbitaire (IO) ont été également relevés.

Nous avons essayé de décrire les phénomènes de croissance relative des différentes parties du corps, en se basant sur la loi d'allométrie dont l'équation est la suivante :$y = a\ x^{b}$ ou y = longueur d'une proportion du corps, x = longueur de référence (LT), a : constante et b : taux de croissance relative. Ces dernières sont estimées par la méthode des moindres carrés. Les paramètres de relation entre les différents caractères métriques et la longueur totale sont résumés dans le tableau 1.

Tab. 1. Indices de proportionnalité et équations des relations entre les caractères métriques (Lst, T, LD, LA, LP, LV, H, Ø, IO) et la longueur totale chez *Solea aegyptiaca* de golfe de Gabès.

Caractères	$y = a\ X^{b}$	R^2	t_{cal}	t_{th}	Allométrie
LSt	Lst= 0,852 LT ^{0,999}	0,99	0,83	1,96	isométrie
T	T= 0,325 LT ^{0,797}	0,90	67,51	1,96	minorante
LD	LD= 0,805 LT ^{1,014}	0,98	8,27	1,96	majorante
LA	LA= 0 ,630 LT ^{1,030}	0,95	11,76	1,96	majorante
LP	LP= 0,65 LT ^{0,964}	0,75	5,45	1,96	minorante
LV	LV=0,104 LT ^{0,686}	0 ,53	40,98	1,96	minorante
H	H= 0,072 LT ^{0,946}	0,61	6,11	1,96	minorante
Ø	Ø= 0,069 LT ^{0,786}	0,66	32,91	1,96	minorante
IO	0,023 LT ^{0,903}	0,54	10,18	1,96	minorante

Nous avons montré que la plupart des caractères évoluent selon une allométrie minorante. Les deux caractères nageoire dorsale (LD) et nageoire anale (LA) évoluent avec une allométrie majorante, alors que la longueur standard (Lst) évolue isométriquement avec la longueur totale.

References
1 - Fredj G, and Mourin C., 1987. Les poissons dans les banques de données médifaune. Application à l'étude des caractéristiques de la faune ichtyologique méditerranéenne. *Cybium,* 11: 218-299.
2 - Kotulas G., Pasteur N., Berrebi P., Economidis P, and QUIGNARD J.P., 1988. Distribution biogéographique et statut systématique des taxons du groupe *Solea Vulgaris* / *aegyptiaca* / *senegalensis*. *Rapp. Comm. int. Mer médit.,* 31, 2 : 277 - 277.
3 - Goucha M., 1982. Etude morphologique, biologique, génétique et biochimique de trois espèces de soles du genre *Solea* QUENSEL, 1806 des côtes tunisiennes. Thèse de Doctorat de spécialité, 192p. Université de Tunis.
4 - Missih S., 1984. Contribution à la connaissance des Soleidés (Poissons téléostéens) du golfe du Lion. Systématique, écobiologie. Thèse Doct. 3ème cycle. 311 p. Univ.des sci. Tech.
5 - Fischer W., Shneider M, and Bauchot M.L., 1987. Fiches F.A.O. d'identification des espèces pour les besoins de la pêche. (Révision I). Méditerranée et Mer Noire. Zone de pêche 37. Volume. II. Vertébrés. Rome, F.A.O: 761-1530.
6 - Chaouachi B, and Ben Hassine O.K., 1998. The status of fish biodiversity in Ichkeul lagoon, Tunisia. Italian Journal of Zoology, 65: 303-304.

EVALUATION DES PARAMÈTRES DE CROISSANCE CHEZ LA POPULATION DE *HELICOLENUS DACTYLOPTERUS* DANS LA RÉGION NORD DE LA TUNISIE

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Abstract
L'étude de l'âge et de la croissance de la population de la rascasse de fond *Helicolenus dactylopterus* de la côte nord tunisienne, est fondée sur la lecture de 509 paires d'otolithes de spécimens dont la taille (Lt) est comprise entre 8 et 30,60 cm. Cette étude a permis d'estimer les paramètres de croissance selon le modèle de Von Bertalanffy. Pour l'ensemble des spécimens étudiés, la longueur asymptotique est estimée à 37,17cm, le coefficient K à 0,14 an et l'âge théorique t à -1, 67 ans. La distribution de fréquence des tailles et la lecture directe des otolithes ont permit d'affirmer la présence de 9 classes d'âge au niveau des échantillons de la population étudiée.

Keywords: Tunisian Plateau, Population Dynamics

Introduction
Pour une gestion rationnelle et durable des pêcheries, l'estimation des paramètres relatifs à l'écobiologie des différentes espèces exploitées devient indispensable. Le présent travail a pour objectif de déterminer les paramètres de croissance d'une population de Scorpaenidae : *Helicolenus dactylopterus* dans la région nord de la Tunisie. Cette espèce a été choisie en raison de son intérêt commercial, de son abondance le long des côtes tunisiennes et de l'absence de .données sur l'état de l'exploitation de sa population

Matériel et méthodes
L'étude de l'âge et de la croissance de la population de la rascasse de fond de la côte nord de Tunisie a porté sur 513 spécimens, de longueur totale comprise entre 8 cm et 30,60 cm et pesant entre 6,02g et 447,11g. La détermination de l'âge a été effectuée à partir de la lecture de l'otolithe *in toto*. La relation taille du poisson-rayon de l'otolithe a été réalisé. Pour valider la méthode de l'estimation de l'âge, l'allongement marginal a été suivi mensuellement. Les croissances linéaire et pondérale ont été transcrites conformément au modèle mathématique de croissance de Von Bertallanfy [1]. La longueur totale correspondant à chaque âge a été rétro calculée. Les relations morphométriques ont été établies pour l'ensemble des échantillons de la population [2].

Résultats et discussion
La distribution de fréquences des tailles de *Helicolenus dactylopterus* est plurimodale. Ces modes correspondent à neufs classes d'âge

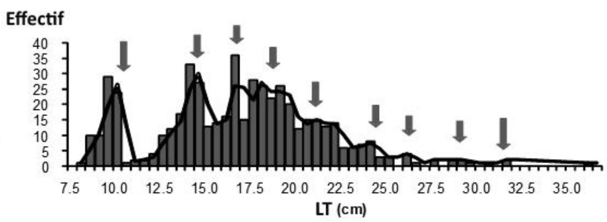

Fig. 1. Distribution des fréquences de tailles de la population de *Helicolenus dactylopterus* dans la région nord de la Tunisie
.

Les résultats de l'étude de la croissance relative chez 513 spécimens de *Helicolenus dactylopterus* ont montré que la croissance linéaire présente une allométrie majorante pour la relation longueur totale et la longueur standard, par contre elle est minorante pour la relation entre la longueur totale et la longueur à la fourche. La lecture directe des otolithes a permit de confirmer la présence de 9 classes d'âge dans les échantillons analysés. L'analyse des relations tailles-masse des sexes confondus ont montré que le poids croit proportionnellement plus vite que la longueur indiquant une allométrie majorante. Les mâles atteignent une taille (L_{∞} = 39,28cm) et un poids asymptotique supérieurs à ceux des femelles (L_{∞} = 36,46cm). La longueur asymptotique des spécimens examinée, sexes confondus est estimée à 37,17cm, le coefficient K à 0,14 an et l'âge théorique t à -1, 67 ans

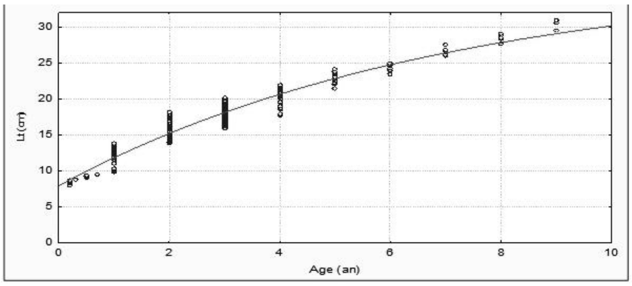

Fig. 2. Courbe de croissance en longueur chez *Helicolenus dactylopterus* de la côte nord de la Tunisie
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L'évolution mensuelle de l'allongement marginal moyen a montré que cette espèce possède un seul cycle de croissance par an avec un pic au mois de décembre correspondant à la période de ponte. La relation entre la longueur totale du poisson (Lt) évolue proportionnellement au rayon de l'otolithe (R) selon un modèle linéaire. Ces résultats sont en concordance avec ceux obtenues par plusieurs auteurs qui ont réalisé des investigations sur cette espèce [3] [4] [5] [6].

References
1 - Von Bertalanffy L., 1938. A quantitative theory of organic growth (inquiries on growth laws II). *Human Biol*., 10 (2): 181-213.
2 - Mili S., Jarboui O. and Missaoui H., 2008. Caractères biométriques de la squille *Squilla mantis* dans les eaux tunisiennes. *Bull. Inst. Natn. Tech. Mer de Salammbô*., 35 :1-14.
3 - Massuti E., Morales-Nin B. and Moranta J., 2000. Age and growth of bluemouth, *Helicolenus dactylopterus* (Osteichthyes: Scopaenidae), in the western Mediterranean. *Fish. Res.*, 46:165-176.
4 - Consoli P., Battaglia P., Castriota L., Esposito V., Romeo T., Andaloro F., 2010. Age, growth and feeding habits of the bluemouth rockfish, *Helicolenus dactylopterus* (Delaroche 1809) in the central Mediterranean (southern Tyrrhenian Sea). *Jour. of Appl. Icht.*, 26: 583-591
5 - Mendonça A., Isidro E., Menezes G., Pinho M. R., Melo O. and Estacio S., 2006. New contribution to the reproductive features of bluemouth *Helicolenus dactylopterus dactylopterus* from the northeast Atlantic (Azores Archipelago). *Scien. mar.,* 70: 679-688.
6 - Sequeira V., Figueiredo I., Munoz M. and Gordo L.S., 2003. New approach to the reproductive biology of Helicolenus dactylopterus. *J. Fish. Biol.* 62: 1206-1210.

BIOLOGY AND ECOLOGY OF THE TRANSPARENT GOBY *APHIA MINUTA* (RISSO, 1810) IN THE LAGOON OF NADOR (MOROCCO)

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Abstract

The transparent goby *Aphia minuta* is a fish (Pisces, Gobiidae) of small size (60-70 mm) and its geographical distribution is limited to the East of the Atlantic Ocean, from Gibraltar to the Norwegian coasts, also known from the Mediterranean including Black Sea and the Azov. This marine and brackish fish is a pelagic-neritic species inhabiting inshore and estuarine waters, over sand, mud and eel-grass. Adults feed on zooplankton, especially copepods, cirripede larvae and mysids. *A. minuta* is distinguished by a short life cycle, completed after less than one year and by early sexual maturation. The maximum size rarely exceeds 60 mm in the lagoon of Nador. The body is transparent, more or less reddish, with chromatophores along bases of median fins and on head. Males with longer dorsal and anal fins than females.

Keywords: Fishes, Reproduction, Lagoons, South-Western Mediterranean

Introduction - The aim of the study is to evaluate the total length of the populations of the transparent goby *Aphia minuta* in the lagoon of Nador during the period of the intense fishery on this fish: January-May 2015. Monthly samples were analyzed to calculate the first maturity for males and females. The species was studied in Portugal, Spain and Golfe de Lyon [1-6]. The methodology and the results were compared to the bibliography.

Material and methods - Fish samples were collected weekly from landings of the commercial small-scale fishery, during the fishing season (December to March-April 2015). A total of 1183 specimens of *A. minuta* were analyzed (Fig. 1). Total length (TL) was measured to the mm below. Fish wet weight was determined to the nearest 0.01 g. Sex was determined by observation of the gonads under the compound microscope at x40. Sex ratio was expressed as a percentage of males/females in the sample.

Results and discussion-The sex ratio is 1/1 and size of first maturity is 38 mm for females and 34 mm for males. Only one spawn after the age of 6-7 months and the breeding period lasts from December to April with a peak in March. During ontogeny, three phases characterize the species: a pelagic phase composed of larvae, an agglomeration phase consisting of juveniles congregate in shallow waters in the winter and a demersal phase composed of adults that migrate in spring and disperse funds close to sea. The structure of the population (Fig. 1) shows different sizes in the populations mixed with juveniles and adults. The relationship between size and weight is well correlated (Fig.2) compared to the results of [1].

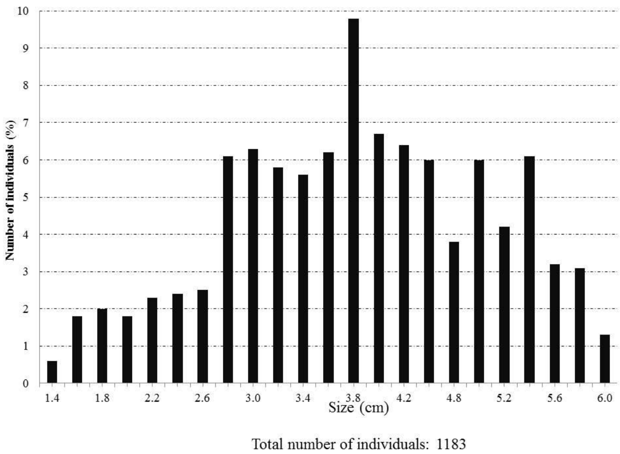

Fig. 1. Structure of the population of *Aphia minuta* in the lagoon of Nador during January-May 2015.

Conclusion- In the lagoon, the breeding season is relatively lengthy with only one spawn during the life cycle. Spawners die after giving eggs, probably as a consequence of the degeneration of the intestinal epithelium. The species is a prey for many fish species and cephalopods.Despite its small size, this species known among the fishermen as the chenquete, is largely exploited by artisanal fisheries developed in the lagoon. Fishing nets used are highly selective, with a very small mesh and are used seasonally. Seine nets and small trawls are used from January to May by 5-7 small fishing boats. The identification of the species requires genetic studies and the direct stock assessment requires more research to preserve the species.

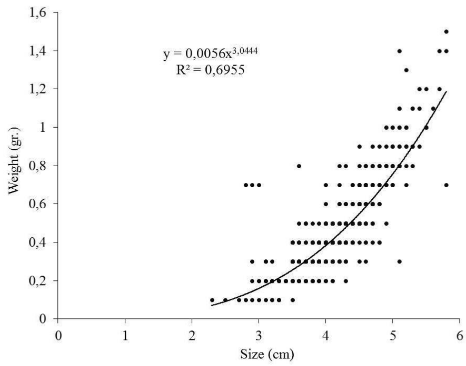

Fig. 2. Relation size-weight of *Aphia minuta* in Nador Lagoon.

Aknowledgement: The study is supported by the EU project CoCoNet and we are gratefull to the scientific leaders of this project.

References

1 - Iglesias M. and B. Morales-Nin. 2001. Life cycle of the pelagic goby *Aphia minuta* (Pisces: Gobiidae) SCI. MAR., 65 (3): 183-192.
2 - Bouchereau, J.L., J.P. Quignard, J.A. Tomasini, J.C. Joyeux and C.H. Capape., 1990. Cycle sexuel, condition et ponte de *Pomatoschistus minutus* (Pallas, 1770) (Gobiidae) du Golfe du Lion, France. Cybium 14 (3):251-267.
3 - Arruda, L.M., J.N. Azevedo and A.I. Neto., 1993. Abundance, age-structure and growth, and reproduction of Gobies (Pisces; Gobiidae) in the Ria de Aveiro Lagoon (Portugal). Estuar. Coast. Shelf Sci., 37: 509-523.
4 - Iglesias, M., E. Massutí, O. Reñones and B. Morales-Nin., 1994. Three small-scale fisheries based on the island of Majorca (NW Mediterranean). Boll. Soc. Hist. Nat. Balears, 37: 33-57.
5 - Iglesias, M., E.B. Brothers, B. Morales-Nin., 1997. Validation of daily increment deposition in otoliths. Age and growth determination of *A. minuta* (Pisces: Gobiidae) from the north-west Mediterranean. Mar. Biol., 129: 279-287.
6 - Froglia, C. and M.E. Gramitto., 1989. La pesca del Rossetto (*A. minuta*) nel medio Adriático. Nova Thalassia 10 (Suppl): 447-455.

CIESM Congress Session : Rocky shore ecology

Moderator : Louise Firth, Plymouth University, UK

Moderator's Synthesis

The introduction presented the importance of baseline data, historical data and sustained observations to inform and address current conservation challenges, with pointed questions such as:

- Are baseline and historical data available (and accessible) in the countries represented?
- Could these data be collated/managed by networks?
- Could data collection be sustained through participatory science projects?
- Are there any barriers to overcome?

It appeared from the general discussion that few countries featured in the session (e.g. Egypt, Tunisia, Turkey, Italy, Cyprus), disposed of a national monitoring system and database on marine biodiversity, as opposed to the UK where researchers have an excellent national database available for submitting and accessing data (National Biodiversity Network, www.nbn.org).

The presentation by Salud Deudero included a proposal to initiate a CIESM monitoring programme of key species in rocky areas. The discussion in our group provided evidence that such a programme is necessary and would be highly beneficial.

The remainder of our discussion circled around the idea of participatory ('citizen') science which is currently experimented in a number of projects in most countries. The sentiment was that these presented potential but also problems if data were collected for scientific purposes, due to recurrent identification problems.

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METAPOPULATION STRUCTURE OF A BENTHIC HARPACTICOID COPEPOD AND ENVIRONMENTAL FACTORS.

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Abstract

Tigriopus fulvus (Fischer, 1860) is a benthic harpacticoid copepod of the supralittoral environment, the study subject population is currently resident in Genova Nervi rockpools (Ligurian Sea, 44°22'52.561 N; 9°2'12.570 E).

Main environmental rockpools parameters were studied from March To September 2014. Salinity, temperature, pH, density, copepod abundance and rockpools trophism (Seston and Chlorophyll "a") were assessed, these parameters were chosen as more relevant for copepod population development.

Populations trends and occasional extinction events suggest, together with appropriate statistic treatment, a metapopulation structure for *T.fulvus*, even though a genetic evidence is required.

Keywords: Rocky shores, Ligurian Sea

Introduction

In the supralittoral environment rockpools, events extinction and colonization of *igriopus fulvus* (Copepoda: Harpacticoida) occurred. This factor, driven by biological and physical factors, determine patches occupation of such fragmented environment. Such structure, that led to a metapopulation determination, has been observed for T*igriopus californicus* [1] and *Tigriopus brevicornis* [2], but not for Mediterranean *Tigriopus fulvus*, particularly in the Genova Nervi study area, where this species has been studied before [3]. During a monitoring campaign that went from March to September 2014, three rockpools were studied monitoring environmental parameters and resident *T.fulvus* populations. Samplings kept a fortnightly cadence, salinity, temperature, pH, water density, Chlorophyll "a" and Seston were measured alongside copepod population samples. Rockpools were chosen at different heights and distances from the sea, covering most of the possible conditions.

Matherials and Methods

Salinity and temperature data were acquired with a multiparametric probe (YSI 30M/50 FT; 0.1°C and 0.1 psu resolution) while pH had a dedicated instrument (Etekcity 009, 0.1 resolution; 0.1 accuracy at 20°C). Density was measured with an hydrometer. Chlorophyll "a" pigments were analysed with a spectrophotometer following an overnight extraction in 90% (v:v) acetone solution [4]. Seston content was analysed with a water sample filtration on 45µ porosity Sartorius cellulose acetate filters. Both the analysis were performed on a 1l sample.Copepod population samples were collected with a 0.5l plastic bottle, sorting and counting was made under binocular microscope Nikon SM7-U (Zoom 1:1). *Tigriopus fulvus* is the only copepod living in this environment, identification is therefore obbligated. Number of individuals collected was then took to a correct measure unity (Ind/l) and the data were statistically elaborated.

Discussion

Tigriopus fulvus extinction events happened during drought event that occurred in upper rockpool and during low-nutrients periods in lower rockpool. One of the three rockpools never dried and the resident *T.fulvus* population never went through an extinction event. Moreover, the latter rockpool showed significantly reduced environmental parameters range, if compared to the other two. This seems to highlight a "sink and source" dynamic, where a more stable population is source of organisms for the others. Spearman rank correlations did not show any significant connection between the different populations, as expected for metapopulation structure (r_s: AvsB= 0.167, AvsC=0.336, BvsC=0.344). Preliminary data suggest a metapopulation structure for *Tigriopus fulvus*, despite the absence of the appropriate genetic analysis. This recalls what already discovered on *Tigriopus brevicornis* and *Tigriopus californicus* [1,2], but in a non-tidal environment where the main diffusion factor is therefore probably represented by rainfall and waves.

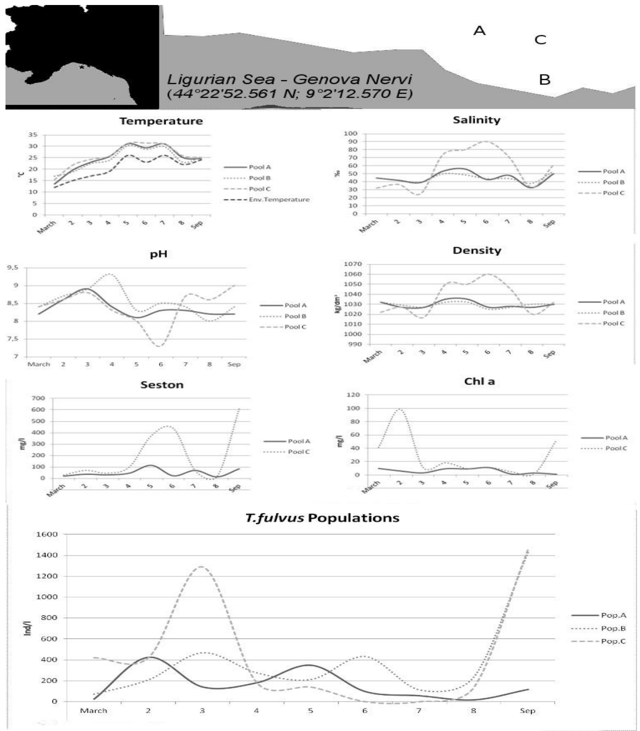

Fig. 1. Rockpools position, environmental parameters and *Tigriopus fulvus* populations.

References

1 - Altermatt F., Bieger A., Morgan S.G, 2012. Habitat characteristics and metapopulation dynamics of the copepod *Tigriopus californicus*. *Mar. Ecol. Prog. Ser.*, 468: 85-93.

2 - Johnson M.P., 2001. Metapopulation dynamics of *Tigriopus brevicornis* (Harpacticoida) in intertidal rockpools. *Mar. Ecol. Prog. Ser.*, 211: 215-224.

3 - Pane L., Feletti M., Carli A.M., 1996. Fattori ambientali e fluttuazioni della popolazione del copepode *Tigriopus fulvus* delle pozze di scogliera di Genova Nervi (Mar Ligure). S.It.E. Atti, 17:317-320.

4 - Strickland & Parsons, 1972. A practical handbook of seawater analysis, Fisheries and oceans, Ottawa, Ontario, Canada. 261-267.

EFFECT OF INDIVIDUALS' SIZE ON THE CONCENTRATION OF HEAVY METALS IN THE GASTROPOD *PHORCUS TURBINATUS* (BORN 1778)

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Abstract
This work is an estimation of the variation in the rate of five heavy metals (zinc; copper; cadmium; lead and mercury) in the individuals of *Phorcus turbinatus* species based on organisms' size and season. The results revealed that Kelibia station is more contaminated with lead than La Goulette station. This could be related to the nature of lead-rich discharges at this level. The increased of zinc and cadmium levels, denoted in summer, appears to be related to the filling of saline warm water of heavy metals. The decrease in the metals' concentrations according to the sizes could be explained by biological dilution phenomenon.

Keywords: Gastropods, Ecotoxicology, Zinc, Tunisian Plateau

Introduction
The increasing marine pollution, of anthropic origin, requires continuous control strategies in some benthic organisms. *P. turbinatus* (Born 1778) is a bio-indicator species which has been subject of several metallic pollution assessment works. However, no study has focused on the effect of organisms' size on the heavy metals concentrations. This deficiency of data led us to compare the concentrations of five heavy metals (Cd, Cu, Zn, Pb and Hg) belonging to three size classes of *P. turbinatus* individuals.

Materiel and methods
Three samples of 20 individuals each, belonging to three size classes were taken from two stations (La Goulette and Kelibia) during winter 2014 (cold season) and summer 2014 (warm season). The two selected stations are characterized by high metallic pollution. Indeed, La Goulette station represents a mooring area while Kelibia station has a large fishing harbor. The studied Size classes are: [<12.99 mm]; [13 mm - 19,99mm] and [> 20mm]. After drying and grinding, about 1 g of biological tissue was digested in a volume of HNO_3 and H_2O_2 [1]. Thereafter, concentrations of heavy metals (Cd, Cu, Zn, Pb and Hg) were estimated by atomic absorption spectrophotometry (mg / kg dry weight). The differences significance was tested by Kruskal-Wallis test.

Results
The comparison of the concentrations of analyzed metals (Tab. 1) revealed a significant difference in the lead rates between stations (higher in Kelibia). The contents of zinc and of cadmium increase significantly in summer in both stations. As for copper and mercury their concentrations were similar in the two stations and in both seasons.

Tab. 1. Kruskal-Wallis test to compare metal rates changes

	Between stations	Between seasons
Zn	p-value = 0.8880	**p-value = 0.0090**
Cu	p-value = 0.9554	p-value = 0.8076
Cd	p-value = 0.3031	**p-value = 0.0054**
Pb	**p-value = 0.0103**	p-value = 0.2197
Hg	p-value = 0.4809	p-value = 0.2634

The rates of the metals decline non-significantly with the increasing of the individuals' size (Fig. 1) (La Goulette winter p-value=0.878; La Goulette summer p-value=0.656; Kelibia winter p-value=0.714; Kelibia summer p-value=0.778).

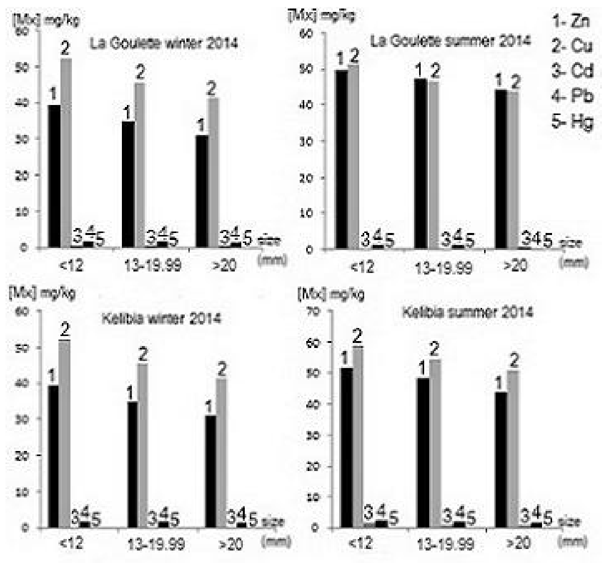

Fig. 1. Concentration of heavy metals according to size classes

Discussion and Conclusion
The results suggest that Kelibia station is more contaminated with lead than La Goulette. This seems to be related to the nature of lead-rich discharges of the fishing activity in the great harbor of Kelibia. The increasing of zinc and cadmium levels in warm period could be related to the evaporation and the filling of waters by salts and heavy metals that become more bio available for the organisms. Although the high level of metallic pollution in the two studied areas (fishing harbor / mooring area), a moderate decreasing in the metals' concentrations depending on size was observed. This seems to be linked to biological dilution phenomenon. Indeed, metals concentrations assimilated from the environment would be reduced in large-sized organisms.

References
1 - Vassiliki-Angelique C. and Flourou H., 2006. Study on the behavior of the heavy metals Cu, Cr, Ni, Zn, Fe, Mn and 137Cs in an estuarine ecosystem using *Mytilus galloprovincialis* as a bioindicator species: the case of Thermaikos gulf, Greece. *Journal of Environmental Radioactivity*. 86: 31-44.
2 - Roméo M., Hoarau P., Garello G., Gnassia-Barelli M. and Girard J.P., 2003. Mussel transplantation and biomarkers as useful tools for assessing water quality in the NW Mediterranean. *Environmental Pollution*. 122: 369-378.

ABUNDANCE, SIZE COMPOSITION AND BENTHIC ASSEMBLAGES OF TWO MEDITERRANEAN ECHINOIDS OFF THE EGYPTIAN COASTS: *PARACENTROTUS LIVIDUS* AND *ARBACIA LIXULA*

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Abstract

This study is concerned with the abundance, size composition and benthic assemblages of two echinoid species, the *P. lividus* and *A. lixula* in the Southeastern Mediterranean along the coast of Alexandria, Egypt. Four seasonal trips were made covering 55 km of the shore with depths ranging between 3-9 m. The sea urchin species composition, density and size were compared. Other associated fauna and flora with prominent presence and biomass were observed. The present results showed that *P. lividus* was more abundant (91%) than *A. lixula*. The dominant size class was the medium to large-sized classes for *P. lividus*. The commercial size for the edible *P. lividus* represented 33% of the sampled population. The most dominant macrobenthic assemblages beside the echinoid population were primarily oysters and sea cucumbers.

Keywords: Echinodermata, Levantine Basin, Zoobenthos, Density

Introduction

Studies are scarce on the status of echinoid populations of the southeastern Mediterranean basin off Egypt (Eissa, 1989; Elmasry et al., 2013). Soliman et al. (2015) made a genetic analysis in order to identify the five color morphs of the echinoid population that were found in the current study sites. The last authors confirmed that the echinoid population comprised only two species, the edible commercial urchin *Paracentrotus lividus* (Lamarck, 1816) and the non-edible black urchin *Arbacia lixula* (Linnaeus, 1758).

Materials and Methods

At all stations, sea urchin density , number of individuals per meter square (ind./m2),and size (without spines) were assessed. A 1 m × 1 m quadrat in size was used at each station. The quadrats were used along a 100 m × 100 m transect at the sampling points at depths between 3 and 9 m. Samples were collected taking into consideration individuals under rocks, on vertical walls and from crevices. The collection was seasonal and the specimens were kept in plastic containers filled with sea water from the sampling location. These sea urchins were transported to laboratory and processed live within 24 h from collection. All individuals were counted and test diameters (TD) were measured by means of a Vernier Caliper (0.05 mm accuracy). Sea urchin sizes were grouped in intervals of 0.5 cm (Figure 1). After measurements, sea urchins were kept in laboratory's tanks for further analysis (not published data)

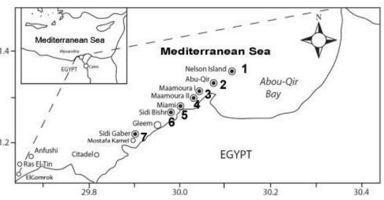

Fig. 1. Map showing the sampling sites, 1- Nelson Island, 2- Abu Qir, 3- Maamoura I, 4- Maamoura II, 5- Miami, 6- Sidi Bishr and 7- Sidi Gaber.

Results & Discussion

The present results showed that *P. lividus* was the dominant echinoid spatially and temporally (91% of the total sea urchin population). *A. lixula* showed frequent occurrence in sites 6 and 7 in the spring season. The most dominant size class was the medium to large-sized classes for *P. lividu*s (30-45mm) and large sized classes for *A. lixula* (40-60mm). The commercial size for the edible *P. lividus* represented 33% of the sampled population. Furthermore, the most dominant macrobenthic assemblages beside the echinoid population (49%) were primarily oysters (40%) and sea cucumbers (11%). Beside these, assemblages of seaweeds (red, green and brown macroalgae), Porifera, Cnidaria, Crustacea, other Echinodermata, Bivalvia, Gastropoda, Tunicata, Bryozoa and Annelida were found. The sizes of *P. lividus* ranged between 15 mm to 65 mm in test diameter (TD). As for *A. lixula*, the sizes ranged from 15 mm to 60 mm in test diameter (TD), in the different study sites. The commercial size for the edible *P. lividus* (i.e. >40 mm) amounted for 33% of the collected sample. The peak of densities recorded for *P. lividus* was observed between size classes ranging between (25-45 mm) test diameter. Site (4) showed the highest density of *P. lividus* of the size class 35-40 mm. As for *A. lixula*, the different size classes, from 15-60 mm test diameter, are represented with variable occurrence in all sites with much lower densities than that of *P. lividus*. The present study shows that the highest density of the echinoid population aggregated mainly in the east side of Alexandria city between depths 3 and 9 m. The density of the echinoid population ranged between 2-63 ind./m^2 along the study sites. In the present study the highest densities recorded for *P. lividus* were during autumn, spring and summer seasons (54-59 ind./m^2). Such high densities might be attributed to many factors such as the availability of many types of fleshy algae, which are the preferred food for *P. lividus*, shelter, water temperature and photoperiod. Furthermore, in the occasional low densities of *P. lividus*, in some of the study sites between different seasons, might be attributed to predation (such as some fish, crabs and octopus) or to immigration of *P. lividus* in long foraging trips to different locations in the process for searching either for food or shelter. Hence, more investigations are needed to study the extent of the action of predation and possible immigration of the echinoid population to different suitable or deeper locations along the coast of Alexandria. In Israel, a neighboring coast, Yeruham et al., (2015) reported that in past surveys, conducted in the seventies, the number of *P. lividus* individuals on their coasts ranged between (2 and 10 ind./m^2). Recently, between the years 2010-2014, they made other extensive survey over 80 km along the coast of Israel. Their results showed a drastic decrease in the abundance of *P. lividus* recording only a total number of 19 individuals. The results of the present study suggests interspecific competition between both echinoid species *P. lividus* and *A. lixula* favoring the dominance of *P. lividus* and thus suggesting its higher ecological adaptive plasticity than the black *A. lixula*. It appears that the study sites are well-structured habitat for the presence and recruitment of the edible *P. lividus*. The low presence of *A. lixula* is not currently of major concern as its co-occurrence appears not to inflict any threats on the edible population of *P. lividus*. Finally, it is recommended that this study should be extended to all the Egyptian coasts on the Mediterranean and Red Seas to know the status of the Egyptian sea urchin population in order to maintain such valuable wild resource.

References

1 - Eissa, S.H., 1989. Studies on sea urchins in Egyptian water. PhD thesis. Zoology Department, Tanta University. pp 153.

2 - Elmasry, E., Omar, H.A., Abdel Razek, F.A., El-Magd, M.A., 2013. Preliminary studies on habitat and diversity of some sea urchin species (Echinodermata: Echinoidea) on the southern Levantine basin of Egypt. Egypt. J. Aquat. Res. 39, 303–311.

3 - Soliman, T., Omar, H.A., Abdelrazek, F.A., El-Sayed, A.-F.M., Elmasry, E., Reimer, J.D., 2015. Phylogenetic characterization of two echinoid species of the southeastern Mediterranean, off Egypt. Egyptian Journal of Aquatic Research, 41, 359-365.

4 - Yeruham, E., Rilov, G., Shpigel, M., Abelson, A., 2015. Collapse of the echinoid *Paracentrotus lividus* populations in the Eastern Mediterranean - result of climate change? Nature, Scientific Reports, 5, 13479.

SPATIO-TEMPORAL VARIABILITY OF BIOEROSION IN THE EASTERN MEDITERRANEAN SEA

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Abstract

In order to investigate the spatio-temporal distribution and impact of carbonate bioeroding biota in the Eastern Mediterranean Sea, three settlement experiments were carried out from ½ to 14 years along a bathymetric transect from bathyal depths across the supratidal zone. The assessment of bioerosion rates and patterns was based on gravimetrical measurements, scanning electron microscopy, and micro-computed tomography. The results show that bioerosion in the Eastern Mediterranean Sea distinctly varies in context of time, light, water temperature, and nutrient supply.

Keywords: Algae, Mediterranean Sea, Porifera, Cyanobacteria, Erosion

Bioerosion is a key process during the recycling of carbonate substrate and the formation of calcareous sediments in the ocean [1]. Settlement experiments are an important tool for monitoring the impact of bioerosion under different environmental conditions. In the last years, a series of short-term experiments was carried out, providing a detailed picture on microbioerosion in different biogeographical settings, but long-term experiments on the succession of macrobioeroders were previously limited to the tropical realm [2]. In the Mediterranean Sea, bioerosion affects sensitive ecosystems such as limestone coasts, deposits of coralline algae, and cold-water coral reefs as well as molluscs in aquaculture, submerged man-made materials, and artefacts [3]. Ongoing eutrophication, pollution, warming, and ocean acidification are considered to magnify the intensity of bioerosion [3]. Taxonomical studies on bioeroding cyanobacteria and chlorophytes have been carried out in the Mediterranean Sea since the late 19th century, but experimental studies remain scarce and were mainly concentrated on the Marseilles region in the Western Mediterranean Sea [4-5].

Aim of this study was to collect first experimental data on bioerosion in the Eastern Mediterranean Sea. This was based on two short-term (½-2 years) and one long-term experiment (1-14 years), resulting in a bathymetric transect from bathyal depths across the supratidal zone. Scanning electron microscopy and micro-computed tomography yielded 44 bioerosion traces that were mainly produced by endolithic cyanobacteria, chlorophytes, fungi, and sponges. During the short-term experiments mostly microbioerosion traces were observed, but only initial macroborings and grazing traces.

The results indicated a distinct zonation of microbial endoliths according to the availability of light in the water column, which seasonally varied in context with water temperature and nutrient supply. The highest bioerosion activity of microbioeroders was recorded in 15 m up-facing substrates in the shallow euphotic zone (mean 83 g m^{-2} yr^{-1}), largely driven by phototrophic cyanobacteria, while towards the chlorophyte-dominated deep euphotic to dysphotic zone and the organotroph-dominated aphotic zone the intensity of bioerosion and diversity of bioerosion traces strongly decreased (mean 1.39 g m^{-2} yr^{-1} in 250 m). During the long-term experiment first distinct macroborings were developed after 2 years with initially very low macrobioerosion rates (1.5-85 g m^{-2} yr^{-1}), followed by an intermediate stage in year 6 to 7 when boring sponges matured and bioerosion rates increased (308-648 g m^{-2} yr^{-1}). After 14 years, 30 % of the block volumes were occupied by boring sponges, yielding maximum bioerosion rates of 900 g m^{-2} yr^{-1}, but a high spatial variability prohibited clear conclusions about the onset of macrobioerosion equilibrium conditions.

These findings highlight the impact of bioerosion in the Mediterranean Sea and underline the necessity of long-time exposure and high replication at various factor levels in order to better understand and quantify macrobioerosion in the marine realm.

References

1 - Neumann, A.C., 1966. Observations on coastal erosion in Bermuda and measurements of the boring rate of the sponge, *Cliona lampa*. Limnol. Oceanogr., 11: 92-108.
2 - Wisshak, M., 2006. High-latitude bioerosion: The Kosterfjord experiment. Springer, Berlin.
3 - Schönberg, C.H.L. and Wisshak, M., 2014. Marine bioerosion. In: Goffredo, S. and Dubinsky, Z. (eds.), The Mediterranean Sea. Springer, Netherlands, pp 49-68.
4 - Le Campion-Alsumard T., 1979. Les cyanophycées endolithes marines. Systématique, ultrastructure, écologie et biodestruction. Oceanol. Acta, 2: 143-156.
5 - Sartoretto S., 1998. Bioérosion des concrétions coralligènes de Méditerranée par les organismes perforants: essai de quantification des processus. C. R. Acad. Sci., Ser. IIa, 327: 839-844.

CLADOCORA CAESPITOSA CORALS IMPACTED BY EXTREME WINDSTORM GENERATED SWELLS, IN CYPRUS

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Abstract
Cladocora caespitosa, the emblematic endemic coral species of the Mediterranean has been shown to suffer from mortality events, due to temperature rising, for the last two decades. Recent monitoring work on a coral population in the island of Cyprus has identified yet another threat. In January 2015, an unusually strong wind-storm hit the southeast coast of Cyprus, with higher-than-normal wind speeds. The storm generated swells, which caused precarious boulders to drop off cliffs in an area abundant with *C. caespitosa* colonies. As a result, ~7% of the colonies in the area were affected, the first documented impact of an extreme event on *C. caespitosa.*

Keywords: Wind, Cyprus Basin, Erosion, Infralittoral, Cnidaria

Introduction
Cladocora caespitosa is the only endemic colonial zooxanthellate scleractinian coral species in the Mediterranean known to be able to form extensive banks. Highly susceptible to sea-surface temperature increases it has undergone a number of mortality events, in various areas in the Mediterranean, in the last 15 years [1,2]. In contrast to colonies found in the West and Central Mediterranean, colonies of *C. caespitosa* in Cyprus are almost always found at depths shallower than 5m, typically near the coastline. This makes them unequivocally vulnerable to coastal disturbances, such as erosion and sedimentation, which could be results of extreme climatic events and human activities. Effects of extreme events on coral reefs have been documented well in the tropics, but very little is known about the impact of extreme events on rocky benthic communities in the Mediterranean [3].

Methods
"Kryo Nero" field-site (SE Cyprus), holds a population of ~150 colonies within an area of ~100 m^2. Colonies (N=70) permanently tagged are being monitored on a monthly basis, since January 2014, with the use of photographic material. The extent of damage on the colonies was calculated with the use of Photoquad image analysis software. Boulder measurements taken in situ (length, width, height) were used to calculate their weight. Observed winds, from nearby meteorological stations (Meteorological Service of Cyprus), showed speeds fluctuating from 3 to 22 m s^{-1}, over a period of 72 hours (4-6 January, 2015). Operational forecasts (Oceanography Center, University of Cyprus WAM4 wave model) indicated unusually high waves of up to 4.4 m during the storm.

Results
Five (out of 70) of the tagged colonies showed obvious signs of mechanical damage from the storm (Fig. 1). Impacted colonies suffered reductions in live polyps ranging between 10 to 100 per cent. A substantial amount of boulders of various volumes were observed scattered around the locality, with large boulders found lying next to the damaged colonies. Empty sockets in the cliff formations directly above the coral communities indicated their detachment from the vertical walls, presumably by the force of the wind-generated waves from the storm (Wind speed vs Wave height; R^2=0,87, p<0,01). Erratic boulders (N=10) measured in the locality were estimated to vary in volume (MIN: 0,007 m^3, MAX: 0,942 m^3) and weight (MIN: 1 kg, MAX: 1900 kg).

Discussion and Conclusions
Coral communities in Cyprus, recently documented and monitored, are scarce. The naturally oligotrophic and warm waters surrounding the island form an inhospitable environment to sensitive organisms such as corals, yet still hold viable communities of the endemic *C. caespitosa*. Nonetheless, the extreme event of January 2015 had a serious impact on ~7% of the coral population at the monitored site. The storm indisputably left the colonies vulnerable to various potential after-effects, such as succession by macroalgae, exposure to bacterial infections and corallivory, hence the extent of damage could ultimately be much higher. Lack of long-term monitoring data in the Levantine Sea necessitates the need to study the ecological effects of extreme climatic events, which are largely expected to increase in severity on a global scale. Continuous monitoring is expected to identify the extent of the after-effect of the extreme event on the colonies.

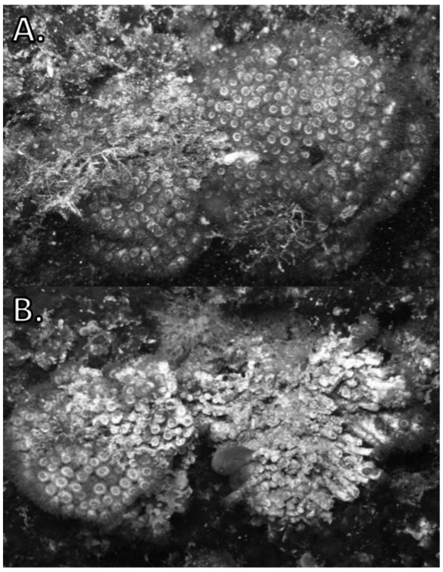

Fig. 1. *C. caespitosa* colony before (A) and after (B) the storm.

References
1 - Rodolfo-Metalpa R., Bianchi C.N., Peirano A., Morri C. 2005. Tissue necrosis and mortality of the temperate coral Cladocora caespitosa. Ital J Zool (Modena) 72:271–276. doi:10.1080/ 11250000509356685
2 - Jiménez C., Hadjioannou L., Petrou A., Nikolaidis A., Evriviadou M. & Lange M. 2014. Mortality of the scleractinian coral *Cladocora caespitosa* during a warming event in the Levantine Sea (Cyprus). *Regional Environmental Change*, doi: 10.1007/s10113-014-0729-2. pp. 1-11.
3 - Teixido´ N., Casas E., Cebria´n E., Linares C., Garrabou J. 2013. Impacts on Coralligenous Outcrop Biodiversity of a Dramatic Coastal Storm. PLoS ONE 8(1): e53742. doi:10.1371/journal.pone.0053742

HARD-BOTTOM MACROZOOBENTHIC INVERTEBRATES AND MACROPHYTA OF SINOP COASTS IN THE BLACK SEA

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Abstract

The aim of the present study was to describe the hard-bottom macrozoobentic invertebrates and macrophyta along the coasts of the Sinop Peninsula, Black Sea during May in 2013.

Keywords: Zoobenthos, Black Sea, Phytobenthos

Introduction: The Black Sea is the most isolated marine environment among all inland seas of the world, whose only tenuous link with other seas is with the Mediterranean through the narrow Turkish straits system. A relatively diverse marine fauna occurs in the Black Sea, despite its low salinity (17‰) and anoxic waters below depths of 180 m (with high levels of H_2S). Of the 3,800 fauna and flora species identified from the Black Sea, 42.9% belongs to fungi, algae and higher plants, 52.5% to invertebrates, 4.5% to fishes and 0.1% to marine mammals [1]. The benthos researches of the Turkish Black Sea coast have generally been focused on the sandy bottoms. There are few scattered studies due to numerous difficulties in collecting the quantitative samples. **Material Method:** Hard-bottom benthic macroorganism surveys were carried out, along the Sinop coasts (Fig. 1) during May in 2013. In order to analyze the benthic fauna related to the biocenosis of rocky habitats from shallow waters, 8 qualitative samples were taken by free diving during May 2013, from 8 stations along the Sinop Bay coast. Scraping technique is commonly employed to sample hard-bottom communities (animals and algae) with divers [2]. Three samples were taken from each station at depths 0 and 1m by scraping out the organisms from an area of 400 cm^2 with the help of a metal quadrate (20x20) and a spatula The scrape areas were chosen at random. The scraped biological samples were stored in a classic net; its hatch would close through a binder in order to prevent the loss of the samples in the water. The taxonomic identification was performed in its totality for the species.

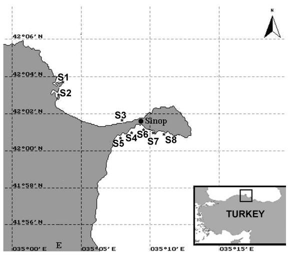

Fig. 1. Map of study area and sampling stations

Results and Discussion: A total of 42 species of hard-bottom macrobenthic species were identified. Table 1 shows species list of hard-bottom zoobenthic invertebrates obtained at May in 2013. During the diving surveys, based on the qualitative analysis, 13 taxa algae were identified. They are; Chlorophyta (*Cladophora laetevirens*, *Cladophora fracta*, *Cladophora glomerata*, *Cladophora sericea*, *Rhizoclonium tortuosum*, *Ulva intestinalis*); Rhodophyta (*Ceramium virgatum*, *Laurencia obtusa*, *Lomentaria clavellosa*, *Parviphycus antipai*, *Polysiphonia fucoides*, *Phyllophora crispa*); Heterokontophyta (*Cystoseira crinita*). The results of the faunistic and floristic analysis of the shallow-water rocky epibiont populations (0-1m), of the coastal sector of Sinop Bay, enabled us to highlight the following general conclusions: The qualitative diversity of the shallow-water rocky habitat populations is dominated by the crustaceans that include over 20 euconstant species forming a mature epibiont system. The analysis of populations' structure on specific taxonomic groups shows that the qualitative differences among the two levels of depth (0 and 1) are very reduced, and the biodiversity, slightly higher at the depth of 1 m. In spite of these taxonomic observations, the hard-bottom communities of the Black Sea is complicated, it is necessary to consider the developmental stage of various of the taxa here at issue, in order to reach the precise conclusions.

Tab. 1. Species list and abundance (ind.m^{-2}) of hard-bottom zoobenthic invertebrates

Taxonomic Groups	STATIONS							
	S1	S2	S3	S4	S5	S6	S7	S8
POLYCHAETA								
Eteone sp.		50			50		25	
Hediste diversicolor	275	50	825	325	775	1025	550	
Platynereis dumerilii		50		100		300		25
Polyophthalmus pictus	25		75		25	25		
Nereis zonata	525		425		300	125	275	125
Perinereis cultrifera	150		125	125	125		25	
Syllis armillaris	275	175	175	25		25		25
CRUSTACEA								
Alpheus sp.			25		175			275
Ampithoe ramondi	125	250	175	225	150	175	625	325
Apherusa bispinosa		50						50
Athanas nitescens	25	25	125	350	200	25	550	
Caprella liparotensis				250		25	300	325
Dexamine spinosa	475							
Ericthonius brasiliensis	550	575	1000	200		200	475	500
Ericthonius punctatus			50					
Gammarellus angulosus							100	325
Hyale crassipes	50							
Hyale pontica		300	25					
Idotea balthica	150	50		25	25	100		
Jassa marmorata	5025	100	500	275	50	525	800	5600
Jassa ocia		25	75			75	100	
Leptochelia savignyi		525	525	125	50	125	300	
Melita palmata	275	950	625	1750	900	2050		425
Microdeutopus gryllotalpa		300						
Monocorophium acherusicum	150		175	400	125	275	300	300
Monocorophium insidiosum		750	125			375		
Pachygrapsus marmoratus			50	175		50		25
Palaemon elegans				75		50		
Pilumnus hirtellus		75	25	250	100	125		125
Pisidia bluteli		50						
Pisidia longicornis		75	25	475	275	175	25	200
Siriella jaltensis		25						
Stenothoe monoculoides	650	1125	6250	1200	525	2325	1175	3500
Synisoma capito	25			100		25		25
Xantho poressa					50			
MOLLUSCA								
Mytilus galloprovincialis	625	825	1025	575	300	25		1125
Mytilaster lineatus	300	850		525		275	1100	300
Rapana venosa		75		25				25
Rissoa splendida	50	525	375		1125	75	50	
Tricolia pullus pullus	5325	1400		3375	1950		2450	1900
Bittium reticulatum	1625		1150	575	600	275	1900	2825

References

1 - Zaitsev Yu., Mamaev V. 1997. Marine Biological Diversity in the Black Sea: A Study of Change and Decline. GEF Black Sea Environmental Programme. United Nations Publications, New York, 208 pp.

2 - Kirkim F., Sezgin M., Katagan,T., Bat L., Aydemir E. 2006. Some Benthic Soft-Bottom Crustaceans along the Anatolian Coast of the Black Sea. Crustaceana, 79 (11): 1323-1332

CRYPTIC SPONGE SPECIES, MUCH MORE THAN WRONG TAXONOMICAL IDENTIFICATION

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Abstract
Sponges represent the earliest branching metazoans in Earth, with an estimated number of ca. 12,000 species at the end of the XXI century. Many of those species are morphologically cryptic and remain to be revealed by molecular markers. By analyzing three gene partitions in individuals of the so far know *H. columella* across the Mediterranean, we concluded that it consisted of at less two morphologically cryptic species. The deep Mediterranean populations of *Hemimycale* corresponded to the Atlantic *H. columella*, while the shallow Mediterranean populations belonged in a new species. Biological traits differentiate both species more than morphological traits.

Keywords: Rocky shores, Biodiversity, North-Western Mediterranean, South Adriatic Sea, North-Central Mediterranean

Introduction

Sponges are sessile, aquatic filter-feeders that represent the earliest branching metazoans in Earth, with a total of more than 8,000 accepted species and ca. 12,000 predicted to the end of the 21 century [1]. Many of those potential species remain hidden within supposed widespread morph-species [1]. Molecular markers are the tools of choice to reveal morphologically cryptic species. However, discovered new species should be also recognizable by phenotypic traits if their incorporation into taxonomy and biodiversity censuses is wanted [2]. Species that remain cryptic represent not only a drawback for sponge biodiversity assessment but to ecological and applied research projects as often they deeply differ in biological traits and thus interact in contrasting ways with other sharing habitat species.

Hemimycale columella (Demospongiae:Poecilosclerida) is a well known sponge, widely distributed across the Northeastern Atlantic and Mediterranean basins (http://www.marinespecies.org/porifera). [3] recorded that some shallow populations disappeared yearly after reproduction. However deep populations remain stable for years (authors obs.). Searching for the potential causes of these contrasting behaviors, we analyzed the species genetic differences across the Mediterranean by using three gene partitions (nuclear and mitochondrial).

Methods

Sampling of what was known as *H. columella* was performed by Scuba diving at six locations across the North, Central and East Mediterranean basins. COI, 18S and 28S gene partitions were amplified and sequenced in at least three randomly selected individuals per population. Phylogenetic trees were constructed under the Neighbor Joining (NJ), Bayesian Inference (BI) and Maximum likelihood (ML) clustering methods. Morphological traits of the sequenced individuals were carefully examined searching for between species, phenotypic differences. Spicules were observed and measured through Scanning Electron Microscope.

Results and discussion

The resulting phylogenies with the three gene partitions consistently separated two monophyletic groups of individuals. Those from deeper Mediterranean populations clustered with the Atlantic H. columella sequence downloaded from the Genbank, while sequences from shallower populations across the Mediterranean were identical and formed a well-supported distinct clade.

The spicules (anisostronglyles, exclusively) were similar in shape and size across populations. Only slight differences in external color tinges, sponge thickness and height of the ring that surrounds inhaling areas could be discerned.

The up to now known as *H. columella* is a complex of at least two morphologically cryptic species. Biological features differentiate both species more than morphological traits, as the Mediterranean clade has an annual life spam while *H. columella* is multiannual . Moreover both clades harbor contrasting microbiomes (Garate et al., this symposium).

References

1 - Van Soest R.W.M., Boury-Esnault N., Vacelet J., Dohrmann M., Erpenbeck D., De Voogd N.J., Santodomingo N., Vanhoorne B., Kelly M., Hooper J.N.A. 2012. Global Diversity of Sponges (Porifera). PLoS ONE 7: e35105

2 - Blanquer A. and Uriz M.J. 2008. 'A posteriori' searching for phenotypic characters to describe new cryptic species of sponges revealed by molecular markers (Dictyonellidae : Scopalina) Invertebrate Systematics 22:489-502

3 - Uriz M.J., Turon X. 2012. Sponge ecology in the molecular era. Adv Mar Biol 61:345-410

4 - Pérez-Porro A.R., González J., Uriz M.J. 2011. Reproductive traits explain contrasting ecological features in sponges: The sympatric Poecilosclerid *Hemimycale columella* and *Crella elegans* as examples. Hydrobiologia 687:315–330

CIESM Congress Session : Seaweeds and seagrasses
Moderator : Charles-François Boudouresque, Aix-Marseille Univ., France

Moderator's Synthesis

Insight into the current status of macrophytes within the Mediterranean and Black seas was presented by the moderator in his introductory talk. Seaweeds represent a highly polyphyletic ensemble of unrelated taxa, so that there is no definition of this set, morphological, physiological, ecological, cytological and/or biochemical. Some seaweeds (macroalgae) belong to the kingdom stramenopiles ('brown algae'), others to the kingdom Archaeplastida, subkingdom Rhodobionta ('red algae') and subkingdom Viridiplantae ('green algae'). As far as the seagrasses are concerned, they also belong to the subkingdom Viridiplantae. Brown algae (Phaeophyceae) were used as a model in analysing the status of seaweeds. The 1992 checklist encompassed 265 taxa (248 probably native, 17 probably non-indigenous). A quarter of a century later, 6 no-longer accepted taxa were removed, 31 taxa probably native were newly recorded or described, and 5 more non-indigenous taxa were recorded (unpublished moderator's data). Is this relatively weak increase, from 265 to 295 taxa, indicator of a well-known taxon (brown algae), or is it due to the much-dreaded extinction of taxonomists? Have some species become extinct? A very conservative analysis, excluding doubtful and poorly known species, shows that 5 % of the taxa have not been recorded in the past 50 years or more. In addition, local and/or functional extinctions (French Catalonia, French Riviera, Provence, etc.) have been reported, e.g. within the genera *Cystoseira* and *Sargassum*.

High quality contributions were presented during the session, giving rise to too many questions (therefore often postponed to the next poster session). The contributions and the questions contributed to illustrate, clarify sometimes readjust the introductory talk. A 'forgotten' *Cystoseira* species has been rediscovered in Algeria. The success story of the seagrass recovery (*Cymodocea nodosa* and *Zostera noltei*), within two emblematic coastal lagoons of Tunisia, was reported, illustrating the status of Mediterranean seagrasses, sometimes better than usually claimed. A promising low-cost method of mapping seagrass beds (*Posidonia oceanica*) has been tested and evaluated. The species composition of seaweed assemblages has been compared between impacted (nutrient enrichment and turbidity) and non-impacted sites; this leads to the identification of the discriminant taxa, prone to be used in the framework of biological indicators. The influence of the basibiont (the species supporting the epiphytic community) was also emphasized, and must be taken into account.

DISTRIBUTION AND BIOMASS OF *ZOSTERA NOLTEI* MEADOWS IN THE NORTHERN LAGOON OF TUNIS IN THE SUMMER OF 2014

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Abstract

Seagrass meadows of *Zostera noltei* Hornemann are widely distributed over the coasts of Tunisia. It plays key ecological roles in lagoon, estuarine and marine ecosystems. In the Northern lagoon of Tunis, *Zostera noltei* meadows represent relatively dominant populations especially after the plan of restoration that was implemented in the mid 1980's to deal with problems of eutrophication. *Z. noltei* meadows have gradually extended to the southern part where they are able to survive and to thrive. The total biomass in the North lagoon of Tunis was about 2512 tons of DW in June of 2014.

Keywords: Mediterranean Sea, Biomass

Introduction

The Northern lagoon of Tunis is a coastal Mediterranean lagoon located at the bottom of the Gulf of Tunis, on the Eastern side of Tunis City and communicates with the sea *via* kheireddine channel. Its average depth is about 1.5 m [1]. After the restoration project of this lagoon, completed in 1988, the biomass of the nitrophilous species (*Ulva* and *Cladophora*) has decreased progressively until it was totally replaced by other communities. Several species of Magnoliophyta such as *Ruppia cirrhosa*, *Cymodocea nodosa* and *Zostera noltei* found the favorable conditions for their Development [2]. The marine and brackish Magnoliophyta *Zostera noltei* forms relatively dominant populations in the Northern lagoon of Tunis. It was developed first in the North-east sector of the lagoon, the most influenced by trade with the Mediterranean sea, then gradually, it extended to the South-east sector. It seems to be the key species in understanding the ecological equilibrium of this restored ecosystem.

Materials and Methods

The observation of the phytobenthic communities was conducted during June 2014 at 125 stations distributed along 36 parallel transects spaced of 500m and covering the entire surface of the Northern lagoon [2]. The observations were obtained at each station by using a Glace Bottom Basket (GBB) or by diving and hand-collecting the macrophytes when transparency does not allow. The biomass was measured with its two components, above and below-ground, in 10 stations representative of the different types of seagrass meadows recovery (two replicas for each type of recovery) (Fig.1). The sampling of the biomass was done by diving and hand-collecting using 0.25 m² quadrat. After separating the *Zostera noltei* from the organic debris as well as from other vegetation present in the sample, the biomass as dry weight (DW) was determined by drying to a constant weight at 80ºC for 24 hours.

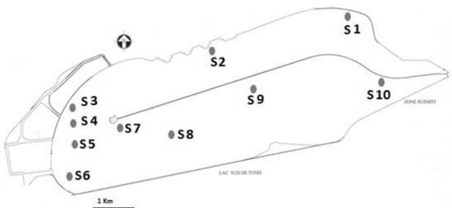

Fig. 1. Sampling stations for the biomass study of *Zostera noltei* in the Northern lagoon of Tunis in summer 2014

Results and discussion

Zostera noltei, observed on muddy and sandy-muddy bottoms, has a wide distribution spreading over 40% of the total area of the lagoon. It spread gradually to the Southern part of the lagoon but it was awfully absent in the South-East because of the relatively lower water quality. The total biomass in the North lagoon of Tunis was about 2512 tons of DW in June of 2014. Most of this biomass (48%) comes from dense beds with cover of 50 to 90%. Above-ground biomass is higher than the below-ground biomass for all depths in the lagoon (Fig.2). The evolution of the above-ground biomass shows fluctuations between stations ranging from a minimum of 63.4 g DW/ m² for the station S3 to a maximum of 450.4 g DW/ m² for the station S9 (the mean biomass is 213.2, g DW/ m², SD= 145.3). However the below-ground biomass is relatively stable for all stations. The ratio between below-ground biomass and above-ground biomass (g DW/m²) for all stations varies from 0.1 to 0.4. The small increase of below-ground biomass at this season is due to the increase of shoots density and thus to the biomass of leaves [3].

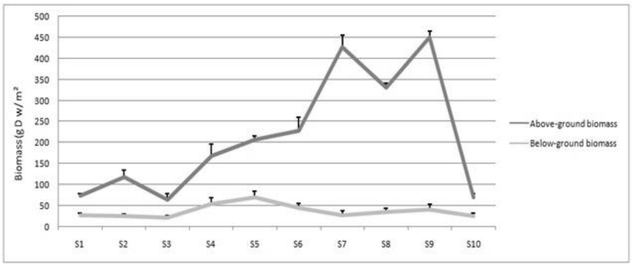

Fig. 2. Spatial variation of above and below-ground biomass (gDW/ m^2) of *Zostera noltei* in different stations (S1 to S10) of the Northern lagoon of Tunis (Summer 2014)

References

1 - Ben Maiz N., 1997. Le Lac Nord de Tunis : un milieu en mutation. In Gestion et conservation des zones humides tunisiennes. Actes de séminaire : 77-84.

2 - Shili A., 2008. Les peuplements à Ruppia (Monocotyledone, Ruppiaceae) des milieux lagunaires de Tunisie. Thèse. Doctorat. Univ. Aix-Marseille II, p.1-305 + annexes.

3 - Auby I., 1991. Contribution à l'étude des herbiers de Zostera noltii du Bassin d'Arcachon : Dynamique, production et dégradation; macrofaune associée. Thèse de l'Université de Bordeaux I, 234 p.

TESTING AND EVALUATING THE EFFICIENCY OF LOW-COST METHODS IN SEAGRASS MAPPING

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Abstract
The health and conservation of seagrass is irrefutably of great importance to the health of marine biodiversity. Its distribution is in a steady decline and there is a lack of studies and gaps which exist in cheap, easy and effective methods. Therefore, we aim to test and evaluate the efficiency of kayak-based surveys on the distribution of *Posidonia oceanica*. In conclusion, the most sufficient method to map the seagrass is to use a Go-Pro and Lowrance Elite-4 sonar on a two-person kayak.

Keywords: Posidonia, Mapping, Instruments and techniques, Aegean Sea

Seagrasses are one of the richest and most valuable coastal ecosystems on the planet, supporting a range of keystone and ecologically important marine species [1]. Therefore, its conservation is highly needed but how can we conserve something if we don't know its spatial distribution? The need for seagrass mapping is vital since knowledge of its known distribution is not on a satisfactory level; this is creating a conservation effort difficult and inefficient. There are many different approaches for sea grass mapping (e.g., direct and indirect; optical remote sensing and acoustic remote sensing, [2], but mostly they are rather expensive and additional knowledge gaps exist in cheap, easy and effective methods. Thus, this work sets out to test out two methods with different aims and to develop a cheap, easy and efficient means of reviewing and mapping the seagrass via using a two-person kayak. The methods used were conducted using optical remote sensing and acoustic remote sensing with kayak in the Mesokampos bay in Samos island, Greece.

The aim of the first study was to map the extent and coverage of *Posidonia oceanica*. Surveys were conducted using a two person kayak; the GPS device and compass were used to navigate the kayak parallel to shore through the study area. The surveys were conducted by moving through the 250m grid, visually assessing the *P. oceanica* percentage coverage for each square in the center of each grid cell. The coverage was recorded by studying the sea floor with the bathyscope and the depth was measured using the Echofish 300 sonar device. With the sonar transects it was able to map the areas and define the size of the patches of *P. oceanica* (Figure 1).

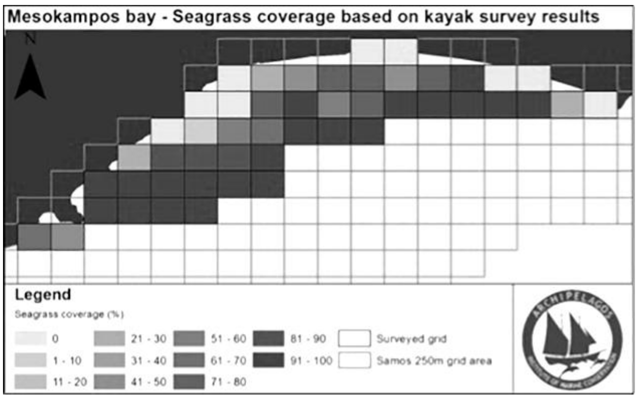

Fig. 1. Seagrass coverage map in the Samos create by the results of 1º methodology.

The second method was developed as a sequel of the first one and with the aim to also map the damage to *P. oceanica* that were caused by illegal trawling. Surveys were conducted using a two person kayak with a GoPro camera fitted into a case to help it glide through the water that could be adjusted height wise depending on the depth of the sea bed. A Lowrance Elite-4 sonar attached to the underside of the kayak stated the depth required to set the camera at, provided the GPS positioning, co-ordinates of the start and end points of the transect to enable easy navigation and observed the presence of seagrass by changes in the structure of the seabed. Beside mapping the seagrass, in most sonar images of the seagrass patches it was also possible to define the damage of illegal trawlers (Figure 2).

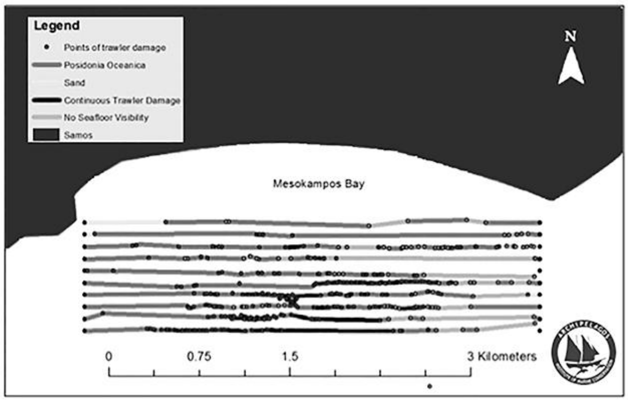

Fig. 2. Seagrass coverage map in the Samos create by the results of 2º methodology.

The first methodology was effective for measuring the seagrass coverage in the shallow waters(0-15m), even with the limitation of the equipment. As for the second methodology, it was more successful in displaying the extent of P. oceanica in the Mesokampos Bay since it was a follow-up of the first one. Also, areas of greater depth were able to be mapped and the trawling damage in the patches can be detected. Therefore, by using a two-person kayak with a Go-Pro camera and Lowrance Elite-4 sonar proved to be an effective low cost method which can give sufficient results in mapping the extent of the seagrass and ultimately help for its conservation. However, limitations within this study did exist, these include: limited visibility of the seabed along some transects; bad weather conditions forcing surveys to be conducted in sheltered bays; and the type of the sonar and camera with a live feed screen.

References
1 - Orth R.J., Carruthers T.J.B., Dennison W.C., Duarte C.M., Fourqurean J.W., Heck Jr K.L., Randall A.H., Kendrick G.A., Kenworthy W.J., Olyarnik S., Short F.T., Waycott M., Williams S.L., (2006). *A global crisis for seagrass ecosystems.* Bioscience 56, 978 – 996 pp.
2 - Teruhisa Komatsu, Chiaki Igararashi, Ken-Ichi Tatsukawa, Masahiro Nakaoka, Tomonori Hiraishi, Asahiko Taira (2002), Mapping of seagrass and seaweed beds using hydro-acoustic methods. Fisheries science, Vol. 68, No. sup1 P 580-583

PRELIMINARY DATA ON *CYMODOCEA NODOSA* MEADOWS IN A SOUTHERN MEDITERRANEAN LAGOON

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Abstract
The present work is a contribution to the characterization of *Cymodocea nodosa* (Magnoliophyta, Cymodoceaceae) in the South lagoon of Tunis, a Mediterranean coastal lagoon located in the North of Tunisia. The study deals with biomass analysis (total, above-ground and below-ground parts) of *Cymodocea nodosa*. For this aim we adopted a sampling plan composed of 6 parallel transects all along the lagoon. The results show that the mean total biomass in the south lake of Tunis is about 94.7 g/m^2 of DW (SD= 67.5) in June 2015. Most of the total biomass comes from dense beds with recovery > 80%.

Keywords: Biomass, Gulf of Tunis

The Seagrass *Cymodocea nodosa* (Ucria) Ascherson is widely distributed throughout the Mediterranean. It plays key ecological roles in lagoon, estuarine and marine ecosystems. In the coast of Tunisia, *Cymodocea nodosa* is abundant at shollow depths, it is usually found on sandy and muddy bottoms [1]. This study was conducted in the South lagoon of Tunis, located in the Southwest of the Gulf of Tunis. Its area is 710 hectares and its depth varied from 2 to 4.5 m. This lagoon used to be one of the most eutrophic lagoons of Tunisia where the phytobenthic communities were dominated by nitrophilous species of the genus *Ulva* and *Cladophora* [2]. However, after the restoration project the lagoon has evolved into a completely new ecosystem. The nitrophilous was totally replaced by other communities and *Cymodocea nodosa* is one of these species [3]. In the present work, the observation was realized during June 2015 at 19 stations distributed along 6 parallel transects covering the entire surface of the Southern lagoon (Fig. 1) and the sampling was carried out within a quadrat (0.25 m^2).

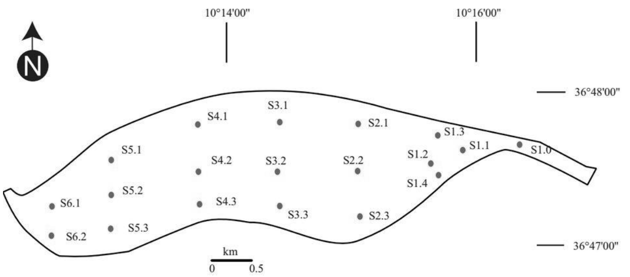

Fig. 1. The sampling stations in the southern lagoon of Tunis.

In the South lagoon of Tunis, *Cymodocea nodosa* is present in depths < 3m where it can develops either monospecic or mixed stands. It forms an extended dense meadow with coverage nearly 100% at the eastern part and they spread gradually to the west part where they are able to survive and to grow. Above-ground biomass shows fluctuations between stations ranging from a minimum of 4.3 g DW / m² for S6.2 station to a maximum of 125.4 g DW / m² for S1.1 station (Fig. 2), the average biomass is about 68.5 g DM / m² (SD = 52.3). Furthermore, the below-ground biomass varies between 10.2 and 52.7 g DW / m² with an average of about 26.2 g DM / m² (SD = 16.1). A total biomass of *Cymodocea nodosa* (above-ground and below-groud) ranged from 14.5 g DW / m² to 178.1 g DM / m².

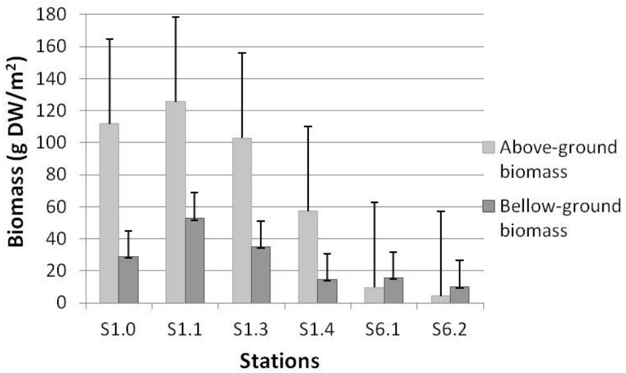

Fig. 2. Spatial variation of above and below-ground biomass (g Dw/m²) of *Cymodocea nodosa* in the Southern lagoon of Tunis (Summer 2015).

The average total biomass is lower than in other Mediterranean localities [4]. The difference between the results of this study and data from other sites are probably due to different local environmental factors. Below-ground biomass/above-ground biomass ratio varied from 0.26 (dense meadows) to 2.38 (sparse meadows), showing the highest values in the western of the lagoon. The below-ground and above-ground biomass depend on the conditions of hydrodynamics and the sediment granulometry. For each type of seagrass recovery, the biomass of *Cymodocea nodosa* was estimated. The total biomass of *Cymodocea nodosa* is in the order to 68 tons of DW. Most of the total biomass comes from dense beds with recovery > 80%.
After the restoration work, the study of one of the most dominant macrophyte species, *Cymodocea nodosa*, may elucidate the importance of this Seagrass as key species in the Southern lagoon of Tunis and its role in improving the ecological conditions in coastal ecosystems.

References
1 - Shili A., 2008. Les peuplements à *Ruppia* (Monocotyledone, Ruppiaceae) des milieux lagunaires de Tunisie. Thèse. Doctorat. Univ. Aix-Marseille II, p.1-305 + annexes.
2 - Shili A., Trabelsi E.B., Ben Maiz N., 2002. Seasonal dynamics of macroalgae in the South Lake of Tunis. J. Coast. Conserv. 8: 127-134.
3 - Shili A., Baccar L., Ben Maïz N, Boudouresque C.F., 2014**.** Dynamics of benthic Macrophytes in the southern Tunis Lagoon (Tunisia, Mediterranean Sea). Proceedings of the 5th Mediterranean Symposium on Marine Vegetation (Portorož, Slovenia, 27-28 October 2014). Langar H., Bouafif C., Ouerghi A. (éds.), RAC/SPA publ., Tunis: 172-177.
4 - Sghaier Y.R., Zakhama-Sraieb R., Charfi-Cheikhrouha F., 2011. Primary production and biomass in a Cymodocea nodosa meadow in the Ghar El Melh lagoon, Tunisia. Botanica Marina, 54: 411- 418.

INFLUENCE OF NUTRIENT ENRICHMENT AND TURBIDITY ON MACROALGAL SPECIES COMPOSITION OF FOULING ASSEMBLAGES IN THE MALTESE ISLANDS

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Abstract
The species composition of macroalgal assemblages was compared within and between impacted and non-impacted sites in a number of Maltese localities with different levels of of nutrient enrichment and turbidity. Species composition in non-impacted sites differed significantly from that in impacted sites, and impacted sites also differed significantly among themselves. Differences among impacted sites were due to the presence or absence of chlorophytes, geniculate coralline rhodophytes, and filamentous rhodophytes.

Keywords: Malta Channel, Algae, Fouling

Introduction
Macroalgal assemblages are considered to be sensitive to changes in water quality [1]. Studies on natural substrata have shown that as nutrient levels increase, sensitive species are replaced by stress-tolerant and opportunistic ones [2]. Therefore, the composition of macroalgal fouling assemblages is expected to be different in areas with high levels of nutrient enrichment and turbidity compared to that of non-impacted areas.

Method
Seven study sites around Malta (Central Mediterranean) were selected based on previously collected environmental data [3]. Principal components analysis (PCA) was used to order sites according to beam attenuation coefficient (BAC), and nitrate and phosphate concentration, in relation to a minimally impacted reference site. The abiotic data used were collected during a previous monitoring survey [3]. At each site, ten spherical buoys of circumference 70 – 90 cm and anchored to blocks of stone on the seabed were selected and all fouling macroalgal species were collected from each buoy. These were sorted under a stereomicroscope and identified to the lowest possible taxonomic level using standard keys and manuals. ANOSIM and SIMPER analyses based on species presence/absence data were used to identify patterns in species composition between sites.

Results and Discussion
Ordination of the study sites based on abiotic data (Fig. 1) indicated three groups: (i) Marsalforn (the reference site) and St. Paul's Bay; (ii) Isla, Kalkara, Manoel Island (S) and Manoel Island (N); and (iii) Birzebbuga. Groups (ii) and (iii) were characterised by higher levels of nitrates, phosphates and turbidity, and are therefore considered to be impacted, while group (i) is considered non-impacted. Component 1 of the PCA plot (Fig. 1) accounts for 65.0 % of the total variance of the dataset, while Component 2 accounts for 30.3 %.

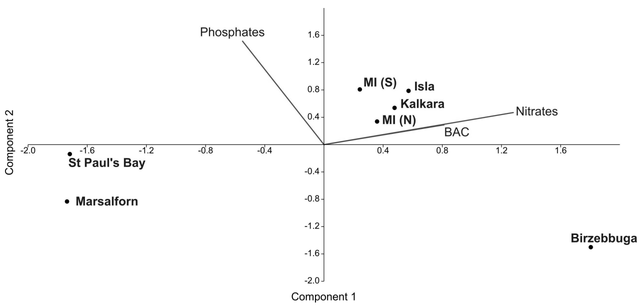

Fig. 1. PCA plot showing ordination of the study sites according to levels of dissolved nitrates and phosphates, and turbidity (as BAC). MI (S) and MI (N) refer to Manoel Island (S) and Manoel Island (N) respectively.

One-way ANOSIM showed that species composition does not differ significantly between the two non-impacted sites (p=0.0648) but as expected, the non-impacted sites differ significantly from all impacted sites (p<0.05); this appears to be due to the presence of *Lophosiphonia* spp. and other filamentous rhodophytes. However, the impacted sites also differ significantly among themselves in terms of species composition (p<0.05). SIMPER indicates that three main groups of macroalgae are contributing to this phenomenon: geniculate coralline rhodophytes, filamentous and sheet-like chlorophytes, and filamentous rhodophytes (Table 1). Kalkara and Manoel Island (S) present an abundance of geniculate coralline forms, with Manoel Island (S) also supporting numerous chlorophytes. Isla supports chlorophytes such as *Ulva* spp. and *Cladophora* spp., but is depauperate in comparison to other sites. Finally, Birzebbuga and Manoel Island (N) are characterised by filamentous rhodophytes such as *Polysiphonia* spp., along with chlorophytes. These variations in species composition do not appear to be related to differences in the abiotic variables considered here, and future studies should therefore be concerned with investigating the factors structuring macroalgal fouling assemblages in areas with some degree of environmental impact.

Tab. 1. SIMPER results showing the 10 genera that contributed most to the dissimilarity between the three functional groups tested.

Taxon	Avg. dissimilarity	Contribution %	Cumulative %
Polysiphonia	5.62	8.84	8.84
Ulva	5.30	8.33	17.17
Ceramium	5.29	8.32	25.49
Lophosiphonia	5.25	8.26	33.74
Cladophora	4.78	7.52	41.26
Lyngbya	4.45	7.00	48.26
Ellisolandia	4.12	6.49	54.75
Chaetomorpha	3.82	6.01	60.75
Amphiroa	3.36	5.28	66.03
Antithamnion	2.53	3.98	70.01

Acknowledgements
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References
1 - Sliskovic, M., Jelic-Mrcelic, G., Antolic, B., & Anicic, I. (2011). The fouling of fish farm cage nets as bioindicator of aquaculture pollution in the Adriatic Sea (Croatia). *Environmental Monitoring and Assessment*, 173, 519-532.
2 - Arévalo, R., Pinedo, S., & Ballesteros, E. (2007). Changes in the composition and structure of Mediterranean rocky-shore communities following a gradient of nutrient enrichment: Descriptive study and test of proposed methods to assess water quality regarding macroalgae. *Marine Pollution Bulletin*, 55, 104-113.
3 - Axiak, V. (2004). *Monitoring Programme for Coastal Waters, Seventh Report.* Malta Environment and Planning Authority, 70pp.

INFLUENCE OF MACROALGAL BASIBIONT MORPHOLOGY ON EPIPHYTE COMMUNITY STRUCTURE IN THE MALTESE ISLANDS

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Abstract
The aim of this study was to investigate the influence of basibiont morphology on macroalgal epiphytic communities in the Maltese Islands. The complexity of basibionts was characterised in terms of a number of variables related to the measured epiphyte species richness and total abundance. Species richness was mainly predicted by size of the host while total abundance was predicted by size and coarseness of the host.

Keywords: Malta Channel, Mediolittoral, Phytobenthos, Rocky shores, Algae

Introduction
Marine macroalgal host species vary in their suitability to support macroalgal epiphytic communities, with the epiphyton on more 'favourable' basibionts being characterised by higher species richness and abundances [1]. The factors that promote higher colonisation of a given basibiont by epiphytes are unclear, with surface characteristics and age being suggested as possible determinants by previous studies [1]. The present study was carried out to test the hypothesis that higher structural complexity of basibionts will also increase epiphyte species richness and abundances.

Method
Sampling was carried out at eight locations around Malta (Central Mediterranean). At each site, two 20 x 20 cm quadrats were placed in the mediolittoral zone and all macroalgae within them were collected and identified. For each basibiont, all epiphyte present were identified to the lowest taxonomic level possible, and their abundances estimated using a percentage cover scale. The morphology of each basibiont was characterised using seven factors: size, roughness, coarseness, degree of branching, order of branching, planes of branching and type of surface. Roughness and coarseness were both defined as measures of the deviation of the surface from a flat plane, with roughness measured at the millimetre scale and coarseness measured at the centimetre scale.

Results and Discussion
Epiphyte species richness was positively correlated to mean total epiphyte abundance (r = 0.874, p <0.05) (Fig. 1), which may indicate that these two variables are influenced by the same basibiont characteristics. Multiple linear regressions including all measured covariates indicated that the main predictor of species richness is the size of the basibiont (R^2 = 0.738), while total abundance is predicted by size and coarseness (R^2 = 0.664). The model obtained for species richness accounted for more variation in the dependent variable than the model obtained for total abundance; this may indicate that the factors influencing epiphyte abundances are more complex. The influence of basibiont size may be due to the relationship between size and surface area or between size and age of the basibiont. It was assumed that, within a species, the size of an alga may be considered as an indicator of its age [1]. As such, larger basibionts would also be older, providing more opportunities for colonisation than younger, smaller algae of the same species. While size of the basibiont alone predicts epiphyte species richness, total abundance is predicted by both size and coarseness. Therefore, it is possible that while the number of epiphyte species present on a basibiont is a result of how long the basibiont has been exposed to colonisation, the abundance of each species is affected by both age (using size as a proxy) of the basibiont and the surface area available (represented by coarseness).

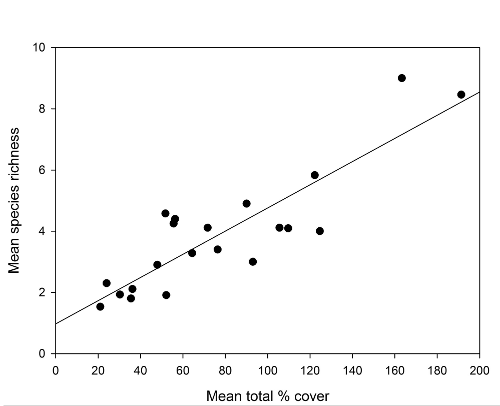

Fig. 1. Relationship between epiphyte species richness and mean total abundance (as % cover) (r = 0.874, p <0.05).

References
1 - Ballantine, D. L. (1979). The distribution of algal epiphytes on macrophyte hosts offshore from La Parguera, Puerto Rico. *Botanica Marina*, *XXII*, 107-111.

REDISCOVERY OF A FORGOTTEN SEAWEED FOREST IN THE MEDITERRANEAN SEA, THE *CYSTOSEIRA MONTAGNEI* (FUCALES) FOREST

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Abstract
Cystoseira montagnei is a brown alga (Fucales) described in the mid-19th century. Subsequently, it has been reduced to the status of doubtful taxon and crossed off from diversity lists. We have discovered near Algiers (Algeria) a dense and lush forest of *C. montagnei.* The taxon is well-characterized, deserves species status and its forests are in need a effective protection.

Keywords: Phytobenthos, Algerian Basin, Algae, Systematics

Seaweed forests of the wrack genera *Cystoseira* and *Sargassum* (Fucales, Phaeophyceae, Chromobionta, kingdom Stramenopiles) were once widespread in the Mediterranean Sea. However, since the 1950s, most of these species have become gradually rarer, and some of them are now locally extinct (i.e. extinct at the scale of a region) or functionally extinct (i.e. they no longer play their former functional role within the coastal ecosystems) [1, 2]. The proliferation of herbivorous species, such as the sea urchin *Paracentrotus lividus* and the teleost *Sarpa salpa* in the western Mediterranean, and the rabbit fish species *Siganus luridus* and *S. rivulatus*, introduced from the Red Sea, in the eastern Mediterranean, are the main causes of Fucales forest regression [2, 3]. Contrasting cases are represented by the shallow water species *Cystoseira amentacea,* still common in most regions [4] and the Port-Cros National Park in eastern Provence, where most species are still abundant [5].

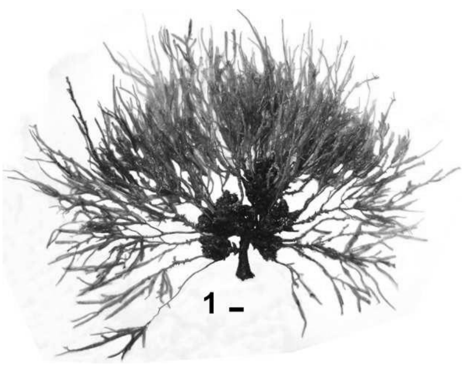

Fig. 1. Habit of *Cystoseira montagnei*. Specimen H8300 collected near Algiers (Algeria) on September 13, 2014. Scale bar = 1 cm.

Another contrasting case is represented by *Cystoseira montagnei*. This poorly known species, described from Algeria (southern Mediterranean) [6], was subsequently considered as a doubtful taxon [7]. We discovered, near Algiers (Algeria), a relatively dense (up to 10 individuals per m²) and lush forest of *C. montagnei* (Fig. 1). It thrives between 10 and 21 m depth, on gently sloping rocky reefs. The study of the specimens has established that they belong to a well-characterized species, *C. montagnei*, distinct from all other species of the genus: (i) non-caespitose species (Fig. 1); (ii) young tophules spinose (Fig. 2a left); (iii) old tophules spineless (Fig. 2a right); (iv) lower primary branches complanate with an inconspicuous median nervure and branching pattern alternate to irregular in one plane (Fig. 2b); (v) upper primary branches, cylindrical, branched with spaced short simple spinose branchlets (Fig. 2c); (vi) intercalary basal receptacles differentiated close to the tophules and diffuse distal receptacles with conceptacles differentiated in the base of spinose branchlets (Figs. 2d, 2e). The specimens, sampled by SCUBA diving, are preserved in the Verlaque Herbarium (HCOM) at Aix-Marseille University. *Cystoseira montagnei* is clearly a well-characterized taxon and its removal from the list of inquirenda species [7] is justified. The geographical range of *C. montagnei* needs to be clarified: is it endemic to the North African coasts? Or more widely distributed in the Mediterranean? The forests this species builds have a natural heritage value and deserve to be protected, before they meet the same fate as many other wrack Mediterranean forests. What are the putative threats and, if identified, how can they be to countered?

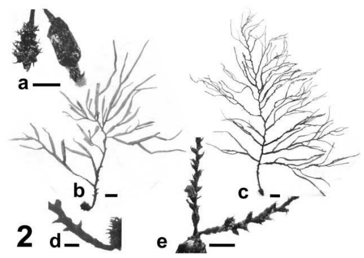

Fig. 2. Details of specimens H8288, H8290, H8300 of *C. montagnei* collected near Algiers (Algeria) on August 6, September 16 and September 13, 2014, respectively. a. Spinose (left) and spineless (right) tophules. b. Lower primary branch. c. Upper primary branch. d and e. Intercalary receptacles differentiated close to the tophule. Scale bars: a, d and e = 5 mm; b and c = 1 cm.

References
1 - Thibaut T., Pinedo S., Torras X., Ballesteros E., 2005. Long-term decline of the populations of Fucales (*Cystoseira* spp. and *Sargassum* spp.) in the Albères coast (France, North-western Mediterranean). *Mar. Poll. Bull.*, 50: 1472-1489.
2 - Thibaut T., Blanfuné A., Boudouresque C.F., Verlaque M., 2015. Decline and local extinction of Fucales in the French Riviera: the harbinger of future extinctions? *Mediterr. Mar. Sci.*, 16(1): 206-224.
3 - Bianchi C.N., Corsini-Foka M., Morri C., Zenetos A., 2014a. Thirty years after: dramatic change in the coastal marine ecosystems of Kos Island (Greece), 1981-2013. *Mediterr. Mar. Sci.*, 15(3): 482-497.
4 - Thibaut T., Blanfuné A., Markovic L., Verlaque M., Boudouresque C.F., Perret-Boudouresque M., Macic V., Bottin L., 2014. Unexpected abundance and long-term relative stability of the brown alga *Cystoseira amentacea*, hitherto regarded as a threatened species, in the north-western Mediterranean Sea. *Mar. Poll. Bull.*, 89: 305-323.
5 - Thibaut T., Blanfuné A., Boudouresque C.F., Cottalorda J.M., Hereu B., Susini M.L., Verlaque M., 2016. Unexpected temporal stability of *Cystoseira* and *Sargassum* forests in Port-Cros, one of the oldest Mediterranean marine National Parks. *Cryptog., Algol*. 37(1): 1-30.
6 - Montagne C., 1838. Cryptogames algériennes ou plantes recueillies par M. Roussel aux environs d'Alger. *Ann. Sci. Nat*., série 2, 10 : 268-279 + 2 plates.
7 - Ribera M.A., Gomez Garreta A., Gallardo T., Cormacci M., Furnari G., Giaccone G., 1992. Checklist of Mediterranean saeweeds. 1. Fucophyceae (Warming, 1884). *Bot. Mar.*, 35 : 109-130.

CIESM Congress Session : Biodiversity / global warming impact

Moderator : Harald Asmus, AWI, Sylt, Germany

Moderator's Synthesis

Where do you see the main focus of research on biodiversity and climate change in the Mediterranean Sea ? The audience was not definite about the answer, but clear that it was necessary to investigate all levels of organization from species level to system level. Science contributes with experiments, observation and models, but it is hardly seen where and if the results are used (for examples by decision makers) and where science can efficiently contribute to the improvement of the current situation that is mainly characterized by a biodiversity change (a loss of native species but an increase in invasive and thermophile species).

The lack of access to necessary infrastructure (for example: well-equipped research vessels) in a number of bordering Mediterranean countries was seen as a major problem for oceanographic monitoring. Research should be better linked to the problems that cause biodiversity change in addition to climate change, and communication with civil should be improved. Policy makers need to prioritize measures of climate change not only on global but also on regional and local level to prevent a further tropicalisation of the Mediterranean Sea .

More experimental work such as testing the tolerance of certain species to temperature and CO_2 change is needed. Investigation of competition between native and invasive species should be also increased. With even 'simple', low-cost but well-designed field experiments, countries with lower resources could also make valuable contributions to the current research. Mesocosm facilities are good experimental units for experiments on biodiversity/climate change, but they are available only in few places and should be made more accessible to more scientists .

The audience agreed that we need an integrated view on the biodiversity that provides information not only on the simple change in species numbers in a certain region, but also on functional changes. Models with high resolution on species level could tell us a lot on the consequences of biodiversity changes on functional changes. This could be also emphasized for experimental research.

PROVENCE AND MEDITERRANEAN WARMING: THE PARROTFISH *SPARISOMA CRETENSE* IS COMING

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Abstract
The parrotfish *Sparisoma cretense*, the only Scaridae native to the Mediterranean and a thermophilic species, has been observed and photographed for the first time in eastern Provence, in October 2014. This sighting confirms some scattered accounts of its presence in the north-western Mediterranean and constitutes new evidence of the spread of 'southern' species, most likely linked to the warming of the Mediterranean Sea.

Keywords: Global change, Teleostei, Ligurian Sea

The parrotfish *Sparisoma cretense* (Linnaeus, 1758) (Pisces, Scaridae) is a thermophilic teleost common along the Eastern Atlantic coasts from Senegal to Portugal and the southern and eastern parts of the Mediterranean Sea. It has also been recorded from south-eastern Italy [1], southern Adriatic Sea [2], and around Sardinia, Balearic Islands and Andalusia. To date, it was uncommon in the north-western part of the Mediterranean [3]. Primarily a herbivore, it lives on shallow rocky substrate where it can feed on macroalgae and small invertebrates [4, 5]. Adults reach usually 25-35 cm TL (Total Length).

Fig. 1. Juvenile of *Sparisoma cretense* (8 cm TL) with two colour patterns, observed on October 2014 at Bagaud Island. Above: pale colour pattern; Bottom: an individual with stripe colour pattern (foreground) and two *Symphodus tinca* labrids (background).

During a survey with UVC (Underwater Visual Census) [6], a 8-cm TL individual of *Sparisoma cretense* was observed by SCUBA diving, at 6-7 m depth, along the west coast of Bagaud Island (Port-Cros Archipelago, Port-Cros National Park, Provence, France) on the 8th and the 16th of October 2014 (Figure 1). This single juvenile was swimming along with about 20 juvenile labrids (*Symphodus tinca*), over *Posidonia oceanica* meadows, infralittoral rocky substrates with photophilous macroalgae (*Dictyota* spp., *Padina* sp., *Halopteris scoparia*, etc.) and pebbles. The colour pattern of parrotfish juveniles differs from that of the adult; the body is pale-grey with pink and yellow glints, and big yellow eyes. It can turn into white with two large horizontal and brown stripes when the fish is stressed (e.g. presence of divers, swell). Given the small size of the observed individual, its settlement occurred probably not far from this area.

This is the first observation of this species with photographic proof along the French continental Mediterranean coast. This sighting confirms some scattered accounts of its presence in the north-western Mediterranean, e.g. at Sugiton (V. Raimondino pers. comm.) and at Laurons Cove (F. Bachet, pers. comm.), near Marseille and in southern Corsica (J.M. Culioli, pers. comm.). The presence of the parrotfish along the Provence coast constitutes new evidence of the northwards spread of 'southern' species, most likely linked to the warming of the Mediterranean Sea [7, 8]. At the moment, the parrotfish individuals are scattered, and distant from the closest established population, so that the probability of these individuals surviving and finding congeners to reproduce is low. But that could change in the near future, with the arrival of new individuals and the increase in warming. The functional compartment of herbivorous teleosts, mainly represented to date, in the north-western Mediterranean, by *Sarpa salpa*, could then be considerably strengthened. Other herbivorous teleosts, the Red Sea invasive species *Siganus* spp., which are spreading westwards and northwards in the Mediterranean, could also strengthen, in the future, this functional compartment.

References

1 - Guidetti P. and Boero F., 2001. Occurrence of the Mediterranean parrotfish *Sparisoma cretense* (Perciformes: Scaridae) in south-eastern Apulia (south-east Italy). *Journal of the Marine Biology Association of the U.K.* 81(4): 717-718.
2 - Dulcic J. and Pallaoro A. 2001. Some new data on *Xyrichthys novacula* (Linnaeus, 1758) and *Sparisoma (Euscarus) cretense* (Linnaeus, 1758) from the eastern Adriatic. *Annales* 1: 35-42.
3 - Louisy P., 2015. *Guide d'identification des poisons marins, Europe et Méditerranée*. Editions Ulmer, 1-512.
4 - Quignard, J.-P. and Pras, A. 1986. Scaridae. In: P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds), *Fishes of the north-eastern Atlantic and the Mediterranean*, UNESCO, Paris, 943-944.
5 - Abecasis D., Bentes L., Ribeiro J., Machado D., Oliveira F., Veiga P., Gonçalves J.M.S. and Erzini K. 2005. First record of the Mediterranean parrotfish, *Sparisoma cretense* in Ria Formosa (south Portugal). *Marine Biodiversity Records* 1: e27.
6 - Harmelin-Vivien M.L., Harmelin J.G., Chauvet C., Duval C., Galzin R., Lejeune P., Barnabe G., Blanc F., Chevalier R., Duclerc J. and Lassere G., 1985. Evaluation visuelle des peuplements et populations de poissons : méthodes et problèmes. *Rev. Ecol. (Terre et Vie)*, 40: 467-539.
7 - Lejeusne C., Chevaldonné P., Pergent-Martini C., Boudouresque C.F., Perez T., 2010. Climate change effects on a miniature ocean: the highly diverse, highly impacted Mediterranean Sea. *Trends in Ecology & Evolution*, 25 (4): 250-260.
8 - Francour P., Boudouresque C. F., Harmelin J. G., Harmelin-Vivien M., Quignard J. P. 1994. Are the Mediterranean waters becoming warmer? Information from biological indicators. *Mar. Poll. Bull.*, 28(9): 523-526.

SHIFTED COASTAL COMMUNITIES AND ECOSYSTEM FUNCTIONS UNDER PREDICTED WARMING AND ACIDIFICATION

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Abstract

The effects of ocean warming and acidification on Eastern Mediterranean coastal benthic communities were studied in a long-term research using benthic mesocosms ('benthocosms'). Temperature and pH treatments complied with the near-past, present and predicted-future levels. While biodiversity indices did not change significantly with warming (+3ºC) and acidification (-0.5 pH units), community composition shifted from native to non-indigenous species dominance, and the abundance of calcifying species increased. In the summer, community functions presented a shift from autotrophic to heterotrophic system.

Keywords: South-Eastern Mediterranean, Biodiversity, Global change, Alien species

Ocean acidification and warming are causing profound changes to the marine environment. Previous studies mostly tested the short-term physiological response of species to these drivers, while long-term responses of communities, ecosystems and their functions have seldom been investigated [1]. In this study the effect of warming and acidification on the structure and function of coastal benthic communities was investigated in two consecutive 5 month seasonal experiments using benthic mesocosms ('benthocosms') [2]. Where, temperature and pH were offset from ambient diel variability according to the business-as-usual scenario for the end of the 21st century (RCP 8.5: warming +3ºC, pH -0.5) [3], and an additional cooling treatment (-2ºC) was applied to simulate the regional temperature three decades ago. At the beginning of each experiment, dominant representatives of the Eastern Mediterranean subtidal reef were collected and transplanted in each of the 16 1400-L benthocosm tanks. Continuous flow of non-filtered coastal waters supplied larvae of new species into the benthocosm tanks throughout the experiments. Changes in species composition, biodiversity, growth and recruitment, community photosynthesis, respiration, and calcification were monitored throughout each experiment.

Species richness and biodiversity were not significantly affected by temperature and pH (figure 1a, 1b), while species composition differed considerably between treatments (figure 1c, 1d). Where, warming increased the abundance of calcifying and non-indigenous (alien) species. Under low pH conditions, non-calcifying epiphytic algal growth increased, negatively affecting basiphytic algae when combined with warming. Invertebrate epifauna increased under warm and/or acidified conditions.

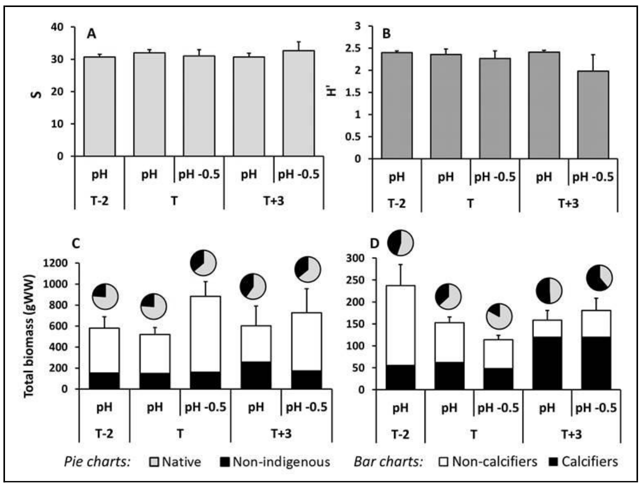

Fig. 1. Community composition in the five benthocosm treatments. T= ambient temperature; pH= ambient pH. A. Species richness (S). B. Biodiversity (Shannon-Weaver index, H'). C and D. Total biomass (g wet weight) of calcifying (black bars) and non-calcifying (white bars) species. Pie charts: relative abundance of native (grey) *vs*. non-indigenous (black) species. C. Winter experiment. D. Summer experiment. Means ±SE (n=3).

Community function rates were greater under cold and acidified treatments (figure 2). Warming in winter reduced the organic carbon sequestration capacity of the benthic community, while during the summer treatment the benthic community exhibited a heterotrophic balance (figure 2). Combination of warming and acidification in the summer led to negative net calcification (i.e., dissolution).

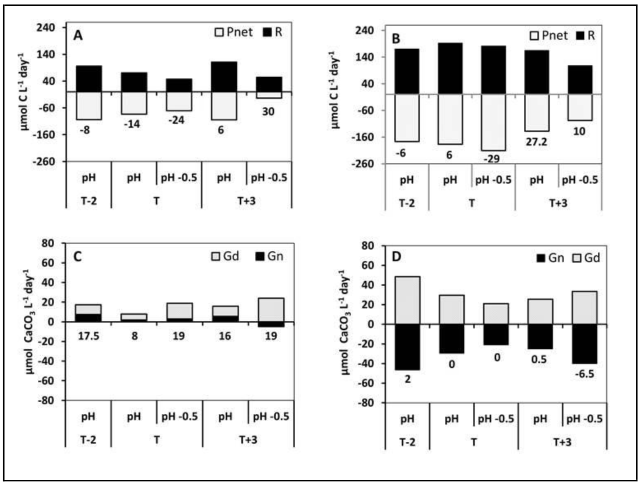

Fig. 2. Community functions. A, B. Diurnal daytime photosynthesis (P_n, grey bars) and nighttime respiration (R, black bars) as µmol Carbon L^{-1} in winter (A) and summer (B). C, D. Diurnal daytime calcification (G_d, grey bars) and nighttime calcification / dissolution (G_n, black bars) as µmol $CaCO_3$ L^{-1} in winter (C) and summer (D). The numbers below bars represent the diurnal net balance.

These results indicate that future conditions in the Eastern Levantine Basin will be more hospitable to non-indigenous carbonate producing organisms and the carbon sequestration of benthic communities will shift from organic to inorganic.

References

1 - Riebesell, U. and Gattuso, J.P., 2015. Lessons learned from ocean acidification research. *Nature Climate Change*, *5*(1), pp.12-14

2 - Wahl, M., Buchholz, B., Winde, V., Golomb, D., Guy-Haim, T., Müller, J., Rilov, G., Scotti, M. and Böttcher, M.E., 2015. A mesocosm concept for the simulation of near-natural shallow underwater climates: The Kiel Outdoor Benthocosms (KOB). *Limnology and Oceanography: Methods*, *13*(11), pp.651-663.

3 - IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

I LIKE IT WHEN IT'S WARM! OR NOT? EFFECTS OF WARM WINTERS ON SPONGE GROWTH

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Abstract
The sea temperature is rising with dreadful consequences for marine communities. Unfortunately, to prove the effects on marine inhabitants we need long or medium term monitoring which lacks in most of the cases. We monitored a population of *Dysidea avara* (Porifera) for more than a year now, to elucidate its population dynamics to have a baseline. We found, when comparing to environmental variables, that the high 2015-2016 winter temperatures together with reduced irradiance, higher salinity, reduced dissolved oxygen and finally changes in Chl-a quantities had modified the natural growth rates and population dynamics. Future monitoring will bring new insights on how lengthening of warm periods is affecting the communities, even before any signs of mass mortalities appear.

Keywords: Porifera, Growth, Temperature, Population Dynamics, North-Western Mediterranean

Background
Monitoring is the key to understand how populations are behaving as well as how they may change if the environmental conditions do so. Our planet is warming, and thus the sea temperature is changing and this leads to what has been termed as "tropicalization" in the Mediterranean. Under this condition, marine communities alter their life cycles or have to migrate to cooler or deeper areas. In the case of benthic communities migrating is not contemplated, so they must adapt or perish. As has happened in the past, when the summer conditions lengthen, mass mortalities of benthic communities occur [1]*, [2]. The years 2015-2016 are following, in the Northwestern Mediterranean, the steps of previous years in which mass mortalities have taken place (http://marine.copernicus.eu/, http://www.t-mednet.org/).

Methods
We monitored a population of Dysidea avara in the Catalonian coast since October 2014 by tagging and photographing 134 sponges monthly. We examined the population dynamics by image analysis, and searched for correlation of the sponge growth parameters with the environmental variables from an oceanographic buoy nearby (OCCS: http://www2.ceab.csic.es/oceans/index.html). OCCS registers water and air temperature, dissolved oxygen, salinity, pH, Chl-a, turbidity, winds, currents and radiation parameters, among others. Data were analyzed by PERMANOVA.

Results and discussion
After months of monitoring, the dynamism of this sponge population was evident: the abundance of fusions and fissions changed with seasons (p-value < 0.01) and were more abundant in the summer months compared to winter. During the last winter, December 2015-February 2016, the mean surface water temperature in the monitoring site was ca. 2ºC higher than the previous year (with a variance of 0.08). We would expect the species to grow mainly in winter and to decrease in summer [3] and this prediction was fulfilled the first study year (2014-2015). However, in January and February 2016, most of the monitored sponges did not grow, but decreased. Water temperature during the anomalous last winter was maintained at ca. 14ºC both at the sea surface and throughout the water column.

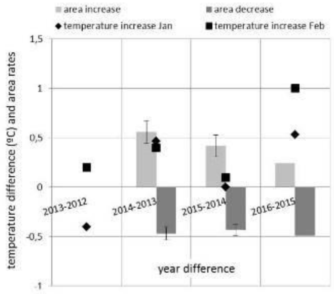

Fig. 1. Temperature differences across years and average area change rate of the monitored population of *Dysidea avara*. The temperature increase in winter 2015-2016 (December-February) resulted in reduced sponge growth, compared to previous cooler years.

Other environmental factors (irradiance, chlorophyll, salinity and dissolved oxygen) also co-varied with the temperature (Figure 1), triggering a spring-like season in winter (Figure 2).

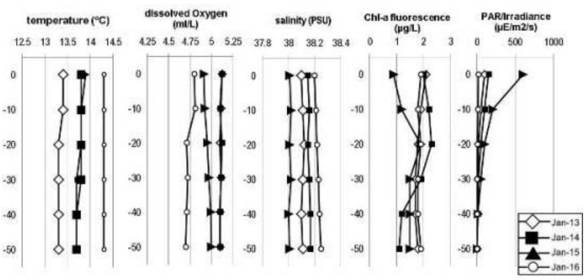

Fig. 2. Environmental water parameters purportedly affecting *Dysidea avara* growth in January, for the years 2013-2014-2015-2016.

On the other hand, the sponge dynamics, measured by number of fusions and fissions, also changed in the 2015-2016 winter compared to the 2014-2015 winter: only 2 individuals, out of the 134 sponges, fused and one divided during the 2015-2016 "winter" versus 15 fusions and 11 fissions recorded in the previous winter. We will continue monitoring this population to see future changes but, from the analysis conducted up to date, we can conclude that the dynamics of Dysidea avara in the studied population have changed with respect to that of previous years (p-values < 0.01 for the previous winter comparison). However, longer data series are necessary to confirm the correlation between winter temperature and growth found in our two-year study.

References
1 - * and within references Huete-Stauffer C., Vielmini I., Palma M., Navone A., Panzalis P., Vezzulli L., Misic C., Cerrano C. (2011) *Paramuricea clavata* (Anthozoa, Octocorallia) loss in the Marine Protected Area of Tavolara (Sardinia, Italy) due to a mass mortality event *Marine Ecology* 32 (Suppl. 1): 107–116
2 - Cebrián E., Uriz MJ.,Garrabou J., Ballesteros E. (2011) Sponge mass mortalities in a warming Mediterranean Sea: Are cyanobacteria-harboring species worse off? *PlosOne* 6(6):e20211
3 - De Caralt S., Bry D., Bontemps N., Turón X., Uriz MJ., Banaigs B. (2013) Sources of secondary metabolite variation in *Dysidea avara* (Porifera: Demospongiae): The importance of having good neighbors *Marine Drugs* 11(2):48

RECENT EVOLUTION OF THE MIXED LAYER ANOMALIES AND THEIR EFFECTS ON COSTAL ECOSYSTEMS IN THE MEDITERRANEAN SEA

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Abstract

This study aims at linking changes in the thermal stratification of the upper water column to the occurrence of mass mortalities of benthic invertebrates, which are increasingly reported in the Mediterranean Sea. We analyze changes of the mixed layer depth and of the mixed layer temperature for the period 1945-2011 by using all hydrographic temperature profiles available in the basin. Results show a widespread increase of thickness and temperature of the mixed layer. It is shown that most mass mortalities occurred when anomalously high mixed layer temperature and thickness has been observed.

Keywords: Mortality, Mediterranean Sea, Global change

Introduction

The reported frequency of mass mortality events of benthic invertebrates in the Mediterranean Sea has increase during the last decades and most of them are consistent with positive temperature anomalies at basin scale [1]. Several studies have also directly associated these events to sudden deepening of the mixed layer [2]. This layer is one of the most important upper ocean features and it is commonly estimated from temperature or density profile data. Our analysis considers the whole Mediterranean Sea for the period 1945-2011. It aims to identify the effect of MLD (Mixed Layer Depth) and MLT (Mixed Layer Temperature) on mass mortality events.

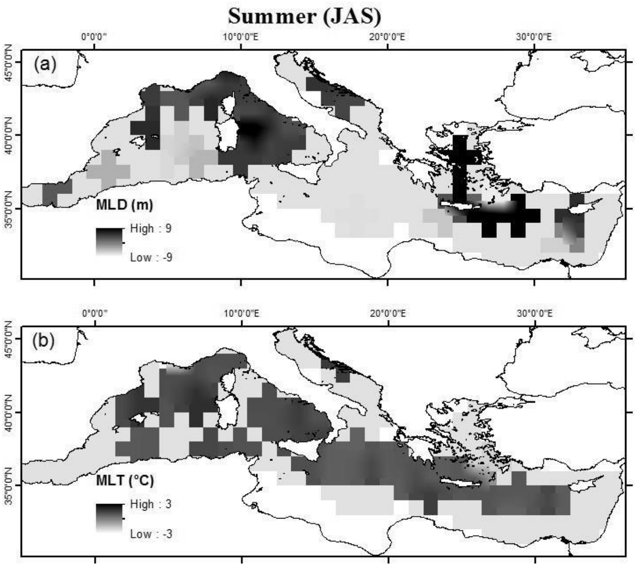

Fig. 1. Variations of MLD (a) and of MLT (b) in summer. Depth\temperature variations are computed as difference between average depth\temperature values in the period 1983-2011 and those in the period 1945-1982 in 1°lat x 1°lon cell.

Materials and methods

We analyzed a hydrographic temperature profiles in the Mediterranean Sea, including bottles, MBT, XBT and CTD, mainly extracting data from the MEDAR/MEDATLAS database [3]. Mass mortalities events have been identified on the basis of published studies. The "three segments profile" model has been selected among different procedures as it has been shown to yield robust results for most temperature profiles [4]. This method approximates the upper water column with three segments representing mixed layer, thermocline and deep layer. The parameter values defining these three segments are determined by an optimization procedure that minimizes the root mean square error of the idealized profile with respect to the observations.

Results and discussion

Changes in the stratification of the upper water column across the Mediterranean Sea have been assessed comparing mean values of the MLD and MLT for the periods 1983-2011 and 1945-1982, and their difference has been binned in boxes of 1°lat×1°lon. These two periods have been chosen because all reported mass mortalities occurred after 1983 (Fig. 1). Most cells show an increase of MLD (Figure 1a) with the exception of the Algerian and of the South Ionian Seas. A clear signal of MLT increase is evident for the whole basin (Figure 1b). In 12 out of 18 location where mass mortalities were reported, the MLT was higher than its mean over the period 1945-1982. Further, 10 events occurred when the MLD was deeper than its mean over the period 1945-1982 (Fig. 2).

Therefore, our results, extensively discussed in [4], show a widespread increase of thickness and temperature of the mixed layer in the last three decades (1983-2011) they support a recent warming of the upper water column and its link with mass mortality events.

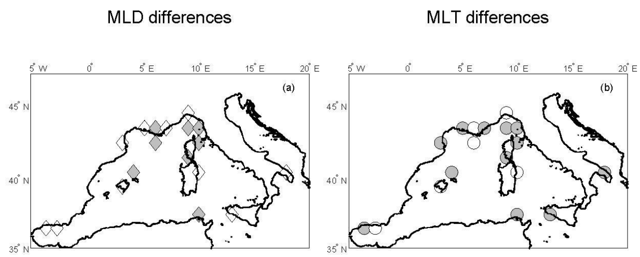

Fig. 2. MLD (a) and MLT (b) during mass mortality events. White/gray rhombus show that the MLD during mass mortality events was deeper/shallower than the mean MLD over the period 1945-2011. White/gray circles show that the MLT during mass mortality events was lower/higher than the mean MLT over the period 1945-1982.

References

1 - Rivetti, I., Fraschetti, S., Lionello, P., Zambianchi, E., Boero, F., 2014. Global Warming and Mass Mortalities of Benthic Invertebrates in the Mediterranean Sea. Plos One 9(12).

2 - Coma R. et al., 2009. Global warming-enhanced stratification and mass mortality events in the Mediterranean. P. Natl. Acad. Sci. USA, 106, 6176-6181.

3 - Fichaut M. et al., 2002. Eds., in Building the European Capacity in Operational Oceanography: Proceedings 3rd EuroGOOS Conference (Ser. 69 of Elsevier Oceanogr.), pp 645-648.

4 - Rivetti, I., Boero, F., Fraschetti, S., Zambianchi, E., Lionello, P., 2016. Anomalies of the upper water column in the Mediterranean Sea. Global and Planetary Change.

FOUR YEARS OF TROPICAL SIGNALS MONITORING IN THE MARINE PROTECTED AREA OF NEW TABARCA (SW MEDITERRANEAN)

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Abstract
The Marine Protected Area (MPA) of Tabarca is being monitored from 2011 to assess the tropicalization effects, into the 'Tropical Signals' Program of The Mediterranean Science Commission (CIESM). The main objective of this monitoring is to provide new insights in the diversity and dynamics of Mediterranean species and exotic ones in the framework of global change.

Keywords: Alien species, South-Western Mediterranean, Mortality, Global change

Introduction
The enclosed Mediterranean Sea is a miniature ocean, where the effects of the global warming are more evident than in other more open oceans [1]. Several studies have confirmed a rapid warming of the surface sea water temperature that has suffered an increase of 1.15ºC on summer average temperatures in the last three decades [2]. The rise in sea water temperature is favoring the bioinvasions from the Red Sea by thermophilic, mostly tropical, species. [3], and few species coming from the tropical parts of Atlantic sea. Simultaneously, an increase in the numbers of native warm-water ''vagrants'' that are also extending their range into the northern Mediterranean, has been also detected [3]. The warming of Mediterranean Sea has also been linked to mass mortality outbreaks in coastal ecosystems. The most large episodes were recorded in 1999 and 2003, affecting more than 30 invertebrate benthic species over hundreds kilometers in the NW Mediterranean coast [4, 5]. Heat stress not also affects invertebrates species, but it could be also related to the endemic seagrass *Posidonia oceanica* flowering that is considered a rare event [6].

Material and methods
Since 2012 we have carried out the monitoring of Tropical Signals Program in the Marine Protected Area of Tabarca, where sea water temperature has been registered at 5, 10, 25 and 40 meters depth by HOBO dataloggers. Each summer, 3 different sites were monitored in order to assess the "sentinel species", which are indicators of climate change.

Results and discussion
Previously to begin with the Tropical Signals monitoring a bleaching event related to the increase of sea water temperature that affected to the coral *Oculina patagonica* was observed in the Marine Protected Area of Tabarca in 2011 [7]. In the summer 2015 the largest mortality event recorded in the MPA was observed. During this event gorgonians, sponges and scleractinian corals showed tissue necrosis and more than 40% of the endemic coral *Cladocora caespitosa* population was affected. Together with mortality events, *Posidonia oceanica* flowering has been also observed in 2012, 2014 and 2015 in meadows between 3 and 10 meters depth, which could be indicating that exists a positive relationship between the prevalence and intensity of flowering of *P. oceanica* meadows and the increase of sea water temperature. Among the thermophilic species that could be extending their distribution range, we have observed an increase of *Percnon gibbesi*, firstly observed in the Tabarca harbour breakwater and nowadays also found in natural rocky habitats along the island. As the same form the coral *O. patagonica* has also increased its distribution in the MPA. Also, *Caulerpa cylindracea* has spread over maerl beds, between 30 and 33m deep.

Acknowledgements: To 'Tropical Signals' CIESM project founding and the Ministry of Agriculture, Food and Environment (Department for the Protection of Fishery Resources) by permits and facilitate the monitoring.We also want to thank Felio Lozano and the rest of MPA guards for help us during the sampling.

References
1 - Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Ben Rais Lasram, F., et al. (2010). The biodiversity of the Mediterranean Sea: estimates, patterns, and threats. *PloS one*,*5*(8), e11842.
2 - Marbà, N., Jordà, G., Agustí, S., Girard, C., Duarte, C. M. (2015). Footprints of climate change on Mediterranean Sea biota. *Frontiers in Marine Sciences 2*, 56-67.
3 - Galil, B. S. (2008). Alien species in the Mediterranean Sea—which, when, where, why? *Hydrobiologia*, *606*(1), 105–116.
4 - Cerrano, C., Bianchi, C. N., Cattaneo-vietti, R., Bava, S., Morri, C., Sara, G., Siccardi, A. (2000). A catastrophic mass mortality episode of gorgonians and other organisms in the Ligurian Sea (North western Mediterranean), summer 1999. *Ecology Letters*, 284–293.
5 - Garrabou, J., Coma, R., Bensoussan, N., Bally, M., Chevaldonné, P., Cigliano, M., Diaz, D. et al. (2009). Mass mortality in Northwestern Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Global Change Biology*, *15*(5), 1090–1103.
6 - Diaz-Almela, E., Marbà, N., Duarte, C. M. (2007). Consequences of Mediterranean warming events in seagrass (*Posidonia oceanica*) flowering records. *Global Change Biology*, *13*(1), 224–235.
7 - Rubio-Portillo, E., Vázquez-Luis, M., Valle, C., Izquierdo-Muñoz, A., Ramos-Esplá, A. a. (2014). Growth and bleaching of the coral *Oculina patagonica* under different environmental conditions in the western Mediterranean Sea. *Marine Biology*, 161:2333-2343.

ASSESSING BIODIVERSITY CHANGES IN CYPRUS – FIRST RESULTS FROM LONG TERM CIESM MONITORING PROGRAMMES

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Abstract
Cyprus is involved in the Tropical Signals and JellyWatch Programs of CIESM, providing data on marine biodiversity. Here, we present an update on our progress and some of our results from both programs, with an emphasis on alien species.

Keywords: Alien species, Cyprus Basin

Cyprus is the closest Mediterranean island to the Suez Canal, and has been extensively affected by Lessepsian migrants, especially during the last decades. Some of the alien species have already successfully established themselves in the coastal waters of Cyprus.

In the framework of the CIESM Tropical Signals project, which aims to study the tropicalization of the Mediterranean by observing and recording both native and alien species, six stations are being monitored: three in Ayia Napa (Southeast coast) and three in Larnaca (South-Southeast coast). At each station, the CIESM monitoring and recording protocol is being followed: each station is divided into two zones parallel to the shoreline (100m each) with 100m distance between them. Timed observations of 15 minutes were made both in the intertidal (the surf and swash zone, from 0 to 0.5m) and the subtidal zones (shallow waters, 0 to 3m) by snorkeling (Fig. 1). Preliminary results show a total number of 86 taxa of which 13 are alien (one macrophyte, six invertebrates and six fish). Ayia Napa presents higher total abundance and slightly higher percentage of alien species (17,74%) in comparison with Larnaca (15,51%). All alien species that were recorded are Lessepsian migrants.

Fig. 1. Selected sites in Cyprus for the monitoring of marine biodiversity in the framework of the Tropical Signals Program.

Anthropogenic impacts play an important role in the increasing occurrence of jellyfish blooms. Climate change, introduction of non-indigenous species, construction of breakwaters, overfishing and eutrophication, all affect the increase of jellyfish populations to varying degrees. In the framework of the JELLYWATCH Program of CIESM, we study *Medusae* by recording species of jellyfish that are found in all coastal areas of Cyprus. The first results from a four year study (2012-2015) indicate that 11 species of jellyfish occur in the waters of Cyprus, with *Mnemiopsis leidyi* and *Cassiopea andromeda* being the most abundant and most frequently reported species. The majority of jellyfish recorded observations were from the east coast of Cyprus in comparison with the west coast. This might be due to higher temperatures recorded in the east coast. This study gives the first insights for the abundance of jellyfish in Cyprus that will be used for the investigation of the parameters that affect the jellyfish populations.

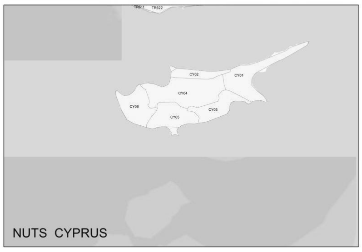

Fig. 2. NUTS areas in the coastal area of Cyprus for recording jellyfish data in the framework of the JellyWatch Program.

The monitoring of the abundance of alien species and the study of their impact on the native marine biodiversity is necessary for the management and protection of the marine environment of Cyprus. Further research is needed to identify the extent of the impact of each alien species to the native marine biodiversity and how their increasing numbers will affect the marine trophic web.

References
1 - Coll M, Piroddi C, Steenbeek J, Kaschner K, Ben Rais Lasram F, et al. (2010) The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. PLoS ONE 5(8): e11842, http://dx.doi.org/10.1371/journal.pone.0011842
2 - Katsanevakis S, Tsiamis K, Ioannou G, Michailidis N, and Zenetos A (2009) Inventory of alien marine species of Cyprus (2009). Mediterranean Marine Science 10/2, 109-133
3 - Zenetos A, Gofas S, Morri C , Rosso A, Violanti D, et al. (2012) Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union’s Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. Mediterranean Marine Science 13(2): 328–352, http://dx.doi.org/10.12681/mms.327

ROLE OF MARINE PHYTOPLANKTON BIODIVERSITY FOR COMMUNITY STRESS TOLERANCE (HEAT SHOCK AND SALINITY CHANGES)

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Abstract
Outdoor mesocosm experiments were conducted in Thessaloniki (Greece) and Kiel (Germany) in order to study the combined effect of warming and salinity stress on marine phytoplankton biodiversity. Phytoplankton species number and abundance decreased with warming in both experimental sites. Phytoplankton species number decreased with salinity changes in both sites while phytoplankton abundance showed different response.

Keywords: Phytoplankton, Thermaikos Gulf, Biodiversity

Predictions for climate warming support that the average global temperature will rise up to 6°C by 2100. Previous studies on marine primer producers showed a shift towards smaller species during increasing seawater temperature (Sommer and Lengfellner, 2008) as well as a decline in phytoplankton biomass (Sommer and Lewandowska, 2011).

In this study, we examined the effect of climate warming combined with increased/decreased salinity on marine phytoplankton biodiversity in two outdoor mesocosm experiments. The first was conducted in Thessaloniki, Greece on a natural phytoplankton community from Thermaikos Gulf-Mediterranean Sea (June-July 2015) and the second in Kiel, Germany on a natural phytoplankton community from Kiel Bight- Baltic Sea (October-November 2015). Twenty four mesocosms set up in each experiment, two phytoplankton communities (ambient and +6°C) in three salinity levels (ambient, -5psu, +5psu) and in four replicates for every treatment. The volume of the mesocosms was 15L. Mesocosms were filled with phytoplankton inoculums pretreated for six days at ambient temperature and heated shocked by 6°C warming. The mesocosms were placed outdoor in Thessaloniki and floating in seawater in Kiel. Thus, temperature and light imitate natural conditions at each study site.

Dinoflagellates (*Gymnodinium, Prorocentrum, Heterocapsa*) were the most diverse and abundant group within the summer phytoplankton community in Thermaikos Gulf in contrast with the dominance of diatoms (*Skeletonema, Thalassiosira* spp.) in the autumn phytoplankton community in Kiel Bight, giving us the advantage to study the response of different taxonomic phytoplankton groups under stress conditions (water temperature and salinity). Warming resulted in changes in species diversity and abundance of phytoplankton inoculums in both cases. The number of species decreased from 30 to 26 in the Thessaloniki experiment and from 31 to 25 in the Kiel experiment after applying the warming treatment (temperature changed from 19°C to 25°C and from 12.4°C to 18.4°C respectively). Large diatoms species such as *Rhizosolenia pungens* and *Guinardia delicatula* in the Thessaloniki mesocosms and large dinoflagellates species such as *Ceratium fusus* in the Kiel mesocosms were in disadvantage and were not recorded in heated shock treatments. Together with species loss, a decreased phytoplankton abundance was noticed for heated shock treatments. Changes in salinity were found to have a prominent impact upon biodiversity and abundance of phytoplankton communities in both experimental systems. The mesocosms with ambient temperature and salinity had the highest number of species and values of Shannon's diversity index H. The response of phytoplankton abundance to salinity changes differed between the two experiments. In Thessaloniki, ambient salinity supported the highest phytoplankton abundance while increased and decreased salinity lead to lower abundance. In contrast, in Kiel decrease of salinity lead to an increased phytoplankton abundance.

References

1 - Sommer U., Lengfellner K., 2008. Climate change and the timing, magnitude, and composition of the phytoplankton spring bloom. *Global Change Biology*, 14:1199–1208.

2 - Sommer U., Lewandowska A., 2011. Climate change and the phytoplankton spring bloom: warming and overwintering zooplankton have similar effects on phytoplankton. *Global Change Biology*, 17:154–162.

HYDROZOANS AS PIONEER COLONIZERS AFTER A MASS MORTALITY EVENT IN THE SEA OF MARMARA

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Abstract

A recent mass mortality of benthic suspension feeders was observed in the Sea of Marmara, in summer 2015. Hydrozoans colonizing dead organisms' skeletons and emptied habitats were sampled by scuba diving. Four species of benthic hydroids highly increased their density after the mass mortality. *Obelia dichotoma* and *Bougainvillia muscus* increased their abundance by almost 10 times. Future potential shifts of assemblages will be kept monitored in the Sea of Marmara.

Keywords: Hydroids, Zoobenthos, Marmara Sea

Introduction Recently, a mass mortality of benthic suspension feeders was observed in the Sea of Marmara, in summer 2015, affecting mainly massive sponges and gorgonians. A series of thermal anomalies recently affected benthic assemblages causing mass mortalities at some locations in the western Mediterranean Sea [1; 2]. After the outbreaks, ecosystem shifts due to the disappearance of long lived, slow growing suspension feeders and decreased complexity/resilience of bioconstructions were reported [3]. In the Sea of Marmara, shortly after the disappearance of massive sponges and gorgonians, fast-growing and highly tolerant hydrozoans were observed, proliferating on dead organisms' skeletons and emptied habitats. The aim of this study was to observe the colonization by hydroid colonies, determine the species and estimate the increase of their abundance.

Material and Methods Samplings for Hydrozoans were conducted in August and October 2015 at two sites that were mainly affected by the event (Fig.1). The depth strata of the mass mortality event included the area between the halocline layer [15-20 m] until 40 m. and this zone was surveyed for prevalent hydrozoan colonies colonizing a diverse range of substrates and dead organisms' skeletons. Hydroid colonies and fragments of substrates supporting hydrozoan colonies were collected. Sample collections were realized in duplicates, optimized by spending the same effort at the same depth gradient. Samples were fixed in 4% formaldehyde-sea water solution and later transferred to 70% ethanol and identified to species level in the laboratory. The great majority of hydrozoan colonies were of similar size, and thus the total number of polyps in each site was estimated for each sample by multiplying the amount of polyps in 40 colonies with the total number of colonies observed.

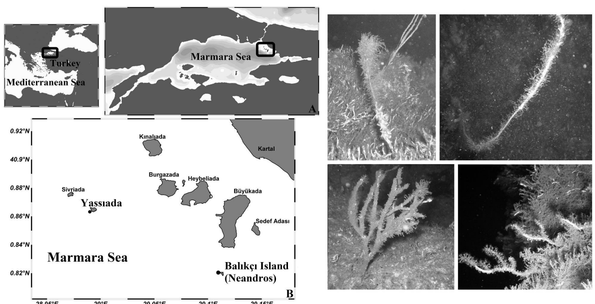

Fig. 1. On the left side; location of the mass mortality event (A) and, of sampling stations (B). On the right side, *Bougainvillia muscus*and *Obelia dichotoma* colonies on dead gorgonians, sponges and rocky substrates.

Results and Discussion Four species of benthic hydroids (Fig. 2) were highly abundant after the mass mortality event and were found colonizing dead sponge and gorgonian skeletons, mollusk shells, polychaete tubes and other rocky substrates. All colonies were found reproductive, with the highest values occurring in October. *Bougainvillia muscus* and *Obelia dichotoma* are common and abundant species in the northern Sea of Marmara (Topçu unpubl. data) but their abundances were highly increased in October, compared to previous samplings, particularly on dead gorgonians, sponges and polychaete tubes (Fig. 1) while most other hydrozoan species were absent or became less prevalent.

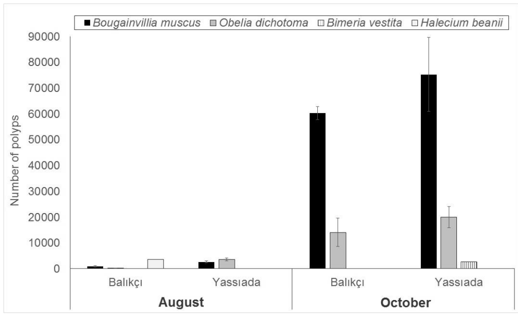

Fig. 2. Mean number of polyps of different species at each station in August and October. Error bars are standard deviations.

Obelia dichotoma appeared as a species highly tolerant to disturbances and was previously reported to increase its coverage by 46% in disturbed communities at the Brazilian coasts [4]. Similarly *B. muscus* was not found on natural habitats along the southern Iberian Peninsula whereas it was a common species in commercial harbours [5]. These two species seem to have adopted an opportunistic behaviour vis-à-vis the emptied habitats and the available skeletons, while the disturbance eliminated less tolerant species in the northeastern Marmara Sea. *Obelia dichotoma* and *Bougainvilla sp.* were among the pioneer colonizers after a mass outbreak in the Adriatic Sea as well and contributed to the shift of the community from slow- to fast-growing organisms [3]. Potential shifts of assemblages will be kept monitored in the Sea of Marmara.

References

1 - Cerrano C., Bavestrello G., Bianchi C.N., Cattaneo-vietti R., Bava S., Morganti C., Morri C., Picco P., Sara G., Schiaparelli S., Siccardi A., Sponga F., 2000. A catastrophic mass-mortality episode of gorgonians and other organisms in the Ligurian Sea (North-western Mediterranean), summer 1999.*Ecol. Lett.* 3:284-293.

2 - Garrabou J., Coma R., Bensoussan N., Bally M., ChevaldonnÉ P., Cigliano M., ..., Cerrano C., 2009. Mass mortality in Northwestern Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Glob. Change Biol.* 15:1090-1103.

3 - Ponti M., Perlini R.A., Ventra V., Grech D., Abbiati M., Cerrano C., 2014. Ecological Shifts in Mediterranean Coralligenous Assemblages Related to Gorgonian Forest Loss. *PLoS ONE* 9: e102782.

4 - Contardo Jara V., Myamoto J., Da Gama B.A., Molis M., Wahl M., Pereira R.C., 2006. Limited evidence of interactive disturbance and nutrient effects on the diversity of macrobenthic assemblages.*Mar. Ecol. Progr. Ser.* 308:37-48.

5 - Megina C., González-Duarte M., López-González P., Piraino S., 2013. Harbours as marine habitats: hydroid assemblages on sea-walls compared with natural habitats. *Mar. Biol.*160:371-381.

CIESM Congress Session : Biodiversity / fishing impact

Moderator's Synthesis

Not available

DISCARDS AND SURVIVAL OF MARINE BENTHIC INVERTEBRATES FROM THE TRAWL METIER FOR THE EUROPEAN HAKE

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Abstract
The issue of the fishery discards is of great interest in fishery management from the new policy of the European Union 2013 ((EU) No 1380/2013) which proposes a gradual reduction of discards. In the framework of the European project "Science, Technology, and Society Initiative to minimize Unwanted Catches in European Fisheries" MINOUW (H2020-SFS-2014-2) a seasonal study between the years 2011-2012 was conducted in order to assess the discard composition and the invertebrate survival coming from the trawl metier for hake in the Catalan Coast (Palamós Port). Some of the main species discarded were *Alcyonium palmatum* and undersize *Merluccius merluccius*. Sessile invertebrates as *Alcyonium palmatum* showed high rates of survival, while species of echinoderms as *Astropenten irregularis* or crustaceans as *Pagurus excavatus* displayed lower rates.

Keywords: Trawl surveys, Mortality, Fisheries, North-Western Mediterranean

Four seasonal fishing samples were carried out in the fishing grounds adjacent of the Palamós port. In order to characterize the discards, species composition, abundance and biomass were directly assessed on board; the survival assessment, instead, were performed transferring invertebrates, coming from the fishing samples of Winter, Autumn and Spring, from the boat to an area of experimental aquariums, where the specimens were maintained in captivity during a 96 hours evaluation period (Wassenberg and Hill, 1993).

The most abundant discarded species was the soft coral *Alcyonium palmatum* with 128,75 animals/hour, followed by the crinoid *Antedon mediterranea*, 126,57 animals/hour, *Merluccius merluccius* 62,85 animals/hour and the starfish *Astropecten irregularis* 34,43 animals/hour.

The ascidian *Diazona violacea* and the shark *Scyliorrinus canicula* were the ones with the higher contribution to the discard biomass with 2366 gr/hour and 1474 gr/hour respectively, followed by the *Alcyonium palmatum* (1177,8 gr/hour) and the *Merluccius merluccius* (1070,36 gr/hour).

Simper analysis was carried out to assess the contribution of each species to the similarity in the composition of discards in four sampled season. (Table 1).

Tab. 1. Simper analysis of discard composition in the four seasons

Average similarity: 37,70

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Alcyonium palmatum	11,08	12,13	5,73	32,19	32,1
Merluccius merluccius	6,53	3,81	0,87	10,12	42,3
Astropecten irregularis	5,06	3,57	1,62	9,46	51,7
Spicara sp.	3,77	2,22	0,91	5,89	57,6
Antedon mediterranea	7,07	2,04	0,9	5,41	63,0
Pteroide spinosum	1,83	1,95	3,18	5,18	68,2
Diazona violacea	4,29	1,93	0,72	5,13	73,3
Trigla sp.	2,3	1,46	0,89	3,87	77,2
Pagurus excavatus	2,46	1,45	1,82	3,85	81,1

;

The average similarity between samples based on the Bray-Curtis distance was 37.7. The species which contributed more to the similarity between seasons was *Alcyonium palmatum*, which, together with *Merluccius merluccius* and *Astropecten irregularis* contributed to more than 50 percent of the similarity.

Discarded *Merluccius merluccius* was undersized, therefore the fishing zone could be a nursery area and an Essential Fish Habitat, where the presence of cnidarians as *A. palmatum* could play an important role due to their recurrent findings. The identification of nursery grounds and EFHs of exploited stocks is a key requirement for the development of spatial conservation of populations and ecosystems (Colloca *et al*, 2015).

Tab. 2. Survival of benthic invertebrates. Species selected for the experimentation divided into groups ; the number of individuals selected per season (N Aut=Number of individuals in Autumn; N. Wint=Number of individuals in Winter; N Spr=Number of individuals in Summer); the number of surviving individuals per season after experimentation (N A96=Number of surviving individuals in Autumn; N W96=Number of surviving individuals in Winter; N S96=Number of surviving individuals in Spring); the total numer of individuals by species (Total Start); , the total number of surviving individuals (Total 96 h); the total percentage of survival by species (% total Survival).

Groups	Specie	N Aut	N A96 h	N Winr	N W96 h	N Spr	N S96 h	Total Start	Total 96 h	% total Survival
Sessiles and filter feeder's	*Phallusia mammillata*	0	0	9	9	0	0	9	9	100
	Alcyonium palmatum	13	13	15	15	5	5	33	33	100
	Diazona violacea	8	8	1	1	6	6	15	15	100
	Ascidia mentula	0	0	2	2	0	0	2	2	100
	Ascidia virginea	6	6	0	0	1	1	7	7	100
	Microscosmus sp.	2	2	1	1	0	0	3	3	100
	Pteroide spinosum	8	3	6	6	5	5	19	14	73,68
Molluscs	*Cassidaria thyrrena*	1	1	0	0	0	0	1	1	100
	Cassidaria echinofora	2	2	1	1	3	3	6	6	100
	Naticidae	5	5	0	0	0	0	5	5	100
	Calliostoma granulatum	5	2	2	2	1	1	8	5	62,5
Crustaceans	*Maja sp.*	0	0	1	1	0	0	1	1	100
	Macropodia longipes	0	0	1	1	0	0	1	1	100
	Liocarcinus depurator	1	1	6	1	1	1	8	3	37,5
	Pagurus excavatus	4	4	12	0	1	1	17	5	29,41
	Medoripe lanata	2	2	1	0	0	0	3	2	66,67
	Dardanus arrosor	2	2	12	10	0	0	14	12	85,71
	Astropecten irregularis	38	31	7	3	6	6	51	46	90,2
Echinoderms	*Echinus melo*	0	0	1	1	0	0	1	1	100
	Marthastheria glacialis	1	1	0	0	0	0	1	1	100
	Brissopsis lyrifera	1	1	0	0	0	0	1	1	100
	Astropecten aranciacus	1	0	5	5	0	0	6	5	83,33
	Ophiura texturata	0	0	23	10	0	0	23	10	43,48

;

Almost all sessile and filter feeder's species except *Pteroide spinosum* (73,68%), have a 100% of survival after 96 hours. Molluscs have similar results and only the *Calliostoma granulatum* have a survival less than 100% (62, 5%). On the other hand, crustaceans and echinoderms show highest mortality, exceeding the 50% in some species, e.g. *Liocarcinus depurator* or *Ophiura texturata.* (Table2).

Chi-square tests were performed to assess if the differences observed in terms of survival of each group in the three survival experiments (executed in different seasons and depths) were statistically significant. No differences ($p>0.05$) were found for all groups except for Crustaceans (p-value<0.001, chi-squared value=25.398, df=2) with the lower value of survival observed in Winter (40%).

References

1 - Regulation (EU) no 1380/2013 of the European Parliament and of The Council of 11 December 2013 on the Common Fisheries Policy.

2 - Wassenberg, t. J. & hill, b. J. 1993. Selection of the appropriate duration of experiments to measure the survival of animals discarded from trawlers. Fisheries research, 17, 343-352.

3 - Colloca, F., Garofalo, G., Bitetto, I., Facchini, M. T., Grati, F., Martiradonna, A., Mastrantonio, G., Nikolioudakis, N., Ordinas, F., Scarcella, G., Tserpes, G., Pilar Tugores, M., Valavanis, V., Carlucci, R., Fiorentino, F., Follesa, M. C., Iglesias, M., Knittweis, L., Lefkaditou, E., Lembo, G., Manfredi, C., Massuti, E., Pace, M. L., Papadopoulou, N., Sartor, P., Smith, C. J. & Spedicato, M. T. 2015. The seascape of demersal fish nursery areas in the north Mediterranean Sea, a first step towards the implementation of spatial planning for trawl fisheries. Plos one, 10.

EPIFAUNAL ASSEMBLAGES AND THEIR VULNERABLITY TO TRAWLING IN A COASTAL ECOSYSTEM (SOUTHERN BLACK SEA)

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Abstract

The epifaunal species composition was determined in a coastal ecosystem (Samsun Shelf Area). The community was categorized into functional groups according to their level of vulnerability to trawling. The relative abundance of functional groups were investigated for any significant difference among stations and correlated with the trawling intensity. It is found that the species with low vulnerability scores widely distributed along the shelf area and dominated other species in community. <\/div>

Keywords: Biodiversity, Coastal waters, Trawl surveys, Zoobenthos, Black Sea

Introduction

The trawling disturbance and its impact on benthic habitats had always been a major concern in understanding marine ecosystem degradation [1,2]. Benthic epifaunal communities are frequently used as a measure of ecosystem response to trawling disturbance both in temporal and spatial scale [3]. Several studies have been realized by using the biological traits of epifaunal organisms revealing their vulnerability to trawling [4]. In this study, we proposed the biological traits of epifaunal species as a measure of vulnerability to trawling and attempted to define the community distribution along Samsun Shelf Area (SSA) which is a major fishing ground exposed to high trawling disturbance for long periods in southern Black Sea.

Material and Method

The sampling was done with a beam trawl of 2.75 m and net in 12 mm mesh size at six stations. Depth range was 4-50 m along the sampling site. The hauls (2500 samplings at 185 operations) were standardized to 30 min. Five functional traits (position, feeding type, motility, size, and life span) indicating vulnerability to trawling were selected and scores were assigned to each trait with a gradient of 0-low vulnerability to 3-high vulnerability. Total scores ranging from 2 to 15 were assigned to five groups. The abundance of epifaunal species (57 species except *Rapana venosa* that is excluded from all analysis because of its strong domination on community) were normalized with log(x+1) transformation. The relative abundance of functional traits in five groups were analyzed by correspondence analysis (PAST 3.10) to reveal the ordination of samples correlated with six stations.

Results and Discussion

The analysis indicated that most of the species (52.6%) appeared in the groups (G1 and G2) with low vulnerability scores including fishes, crustaceans, gastropods, swimming crabs and burrowing bivalves all small in size, having short life spans, mostly scavenger and motile representatives of their own taxonomic groups. G4 and G5 as a measure of a healthier community had very few representatives (Table 1)

Tab. 1. Functional groups, assigned range of scores for vulnerability and representative taxa.

Groups	Scores	Organism groups	(e.g.)
G1	0-3	Small fishes	*Pomatotischus mamoratus, Arnoglossus kessleri, Callionymus sp.*
		Small crustaceans	*Brachynotus sexdentatus, Diogenes pugilator, Pilimnus hirtellus*
		Small gastropods	*Cyclope neritea, Nassarius reticulatus*
G2	4-6	Small fishes	*Gobius niger, Hippocampus hippocampus, Syngnathus sp.*
		Swimming crabs and small crustaceans	*Liocarcinus depurator, L. navigator, Crangon crangon, Palaemon elegans*
		Small burrowing bivalves	*Chamalea gallina, Spisula subtruncata, Abra sp., Donax trunculus*
G3	7-9	Fishes	*Uranoscopus scaber, Parablennius tentacularis, Pegusa nasuta*
		Large crabs	*Carcinus aestuarii, Eriphia verrucosa*
		Small ascidians	*Ascidia sp., Botryllus schlosseri*
		Small barnacles	*Balanus sp.*
G4	10-12	Large bivalves	*Anadara cornea, Mytilus galloprovincialis*
		Ascidians	*Corella eumyota*
G5	13-15	Sponges	Porifera

Correspondence analysis showed that axis 1 explaining 66.3% of the variance differentiated the functional groups from S6 and all the other stations (S1-S5) (Figure 1).

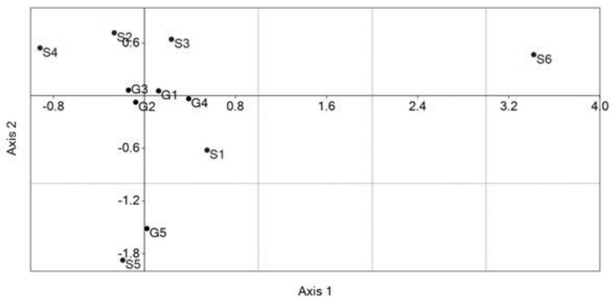

Fig. 1. Correspondance analysis based on the relative abundance of functional groups (G1-G5) within each sampling site (S1-S6).

Axis 2 responsible from 26.5% of variance indicated that S5 is characterized by G5. S1, S2, S3 and S4 are known as the fishing grounds highly trawled by both beam and bottom trawls and seemed to be positively correlated by the distribution of communities having low vulnerability scores (G1, G2 and G3). S5 and S6 having a patchy type of hard substratum and irregular depths especially on river mouth (S5) limits the trawling area to some extent and decreases the trawling pressure. This is reflected by the community structure (G5) with higher vulnerability scores. However, as a general outline, SSA can be assigned as a typical coastal area under high trawling impact showing a species composition of low vulnerability. It is obvious that large sessiles, emergent filter feeders, long live species and large predators disappear along this trawled area. The main query is that we still further to know that whether SSA is altered to the point which recovery of the ecosystem is no longer possible.

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References

1 - Rijnsdorp A.D., Buys A.M., Storbeck F.and Visser E.G., 1998. Microscale distribution of beam trawl effort in the southern North Sea between 1993 and 1996 in relation to the trawling frequency of the sea bed and the impact on benthic organisms. *ICES J. Mar. Sci* .55:403–19.

2 - Kaiser M.J. and Spencer B.E., 1996. The effects of beam-trawl disturbance on infaunal communities in different habitats, *J. Anim. Ecol.*, 65: 348-358.

3 - Thrush S.F. and Dayton P.K.,2002. Disturbance to marine benthic habitats by trawling and dredging: Implications for marine biodiversity, *Ann. Review Ecol. Syst.*, 33: 449−473.

4 - deJuan S., Demestre M. and Thrush S., 2009. Defining ecological indicators of trawling disturbance when everywhere that can be fished is fished:.A Mediterranean case study, *Mar. Policy*, 33: 472–478.

STUDY OF THE STRUCTURE OF MEGABENTHIC COMMUNITIES IN THE GULF OF GABES

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Abstract

In Tunisia, the gulf of Gabes is the main fishing ground for more than 300 benthic trawlers targeting various species of high commercial interest (shrimp, molluscs…). The aim of this work is to study of the spatial variability of the diversity and structure of the megabenthic communities of the gulf of Gabes. Samples were collected with a 2m beam trawl of 4mm mesh size. All the species captured were identified to the species level. 134 species were identified. Biomass (B), species richness (S) and abundance (A) were calculated. ABC Method was used to characterize the benthic megafauna communities. Granulometric analysis revealed the presence of four types of substrates. Furthermore we have identified 6 megabenthic assemblages. The Abundance-biomass comparison lead to determine the level of perturbation in the gulf of Gabes.

Keywords: Gulf of Gabes, Biodiversity, Biomass

The Gulf of Gabes is the main fishing ground in Tunisia, where benthic trawling is a very common activity due to the presence of sandy muddy ground (Hattab et al., 2013). This activity results in several physical effects on seabed and benthic communities, such as changes in benthic communities and the destruction of sea beds (Blanchard et al.,2004). Effects of fishing disturbance on community structure and diversity are then not only likely to depend on the intensity and frequency of fishing, but also on the initial condition of the habitat (Jennings et al., 2002). Benthic communities'assemblages are sensitive to such perturbations. Benthic megafauna are probably the most vulnerable and directly impacted by fishing gears (Blanchard et al., 2004), thus we can consider them as an efficient biological tool to assess the impact of fishing activity on biotope. The aim of this work is to study the diversity and structure of the megabenthic communities of the gulf of Gabes. For that, a stratified sampling that considers the substrate typology and depths (10-100m) was held in May and September 2015. Samples were collected with a 2m beam trawl of 4mm mesh size.The abundance-biomass comparison (ABC method, Warwick 1986) was adopted to detect disturbances (physical, natural, biological, chemical) in benthic communities (Le Loc'h, 2004). Benthic assemblages are therefore classified as: non-disturbed moderately disturbed and strongly disturbed (Blanchard et al.,2004). The comparison of the different parameters used, specific richness, the abundance and the biomass, makes it possible to detect the modifications in benthic structures.

We have identified through granulometric analysis, 4 types of substrates (Biogenous fine sands, Heterogeneous sands, Sandy muddy, Muddy). Hierarchical classification (based on specific Abundance) revealed 6 benthic assemblages and the assessment of S, A, B and the dominance index (DP) allowed characterizing these assemblages (Table 1). For the different assemblages, we have noticed that the abundance varies between 38 and 1474±94 (ind .1000m-^{2}) respectively for *Gobius niger* assemblage and *Pinctada radiata assemblage*. The lowest specific richness was observed *Gobius niger* assemblage (4) and the highest for *Pinctada radiata* assemblage (98) (Table1). The ABC method indicates that the relative biomass curve is above the abundance curve for *Pinctada radiata* assemblage inform about the non-disturbance of the region. The area of this assemblage is dominated by 2 species of large size like *Picnctada radiata* and *Paracentrotus lividus*. For the assemblage of *Astropecten irregularis* the biomass curve is slightly above the curve of abundance, we notice a slight dominance of *Paracentrotus lividus*, *Aporrhais pespelecani* and *Astropecten irregularis*. So the area seems to be slightly disturbed. For the other assemblages, we can conclude that the two curves intersect or are superposed, thus we are in a situation of a slightly disturbed assemblages or in an intermediate situation (Blanchard et al.,2004) (Figure 1). The gulf of Gabes is an important fishing area in Tunisia. Our investigations on megabenthic communities revealed that the northern part is less disturbed than the southern one. Regarding the specific richeness, a coastal-offshore gradient was observed except for *Corbula gibba* assemblage.

Tab. 1. Megabenthic communities assemblages in the gulf of Gabes

Assemblage	Type of substrate	Depth (m)	Number of stations	Species richness (S)	Abundance ±Standard deviation (ind.1000m-^{2})	Biomass ±Standard deviation (g..1000m-^{2})
Pinctada radiata Monodonta articulata, Paracentrotus lividus, Holothuria polii, Hallocynthia papillosa.	Sands covered with seaweed	20	3	98	1474±94	530±221
Gobius niger Pagellus erythrinus, Serranus hepatus, Payraudeantia intricata	Sandy muds	23	1	4	38	41
Corbula gibba, Eucrate crenata, Squilla mantis, Gobius niger, Citharus linguatula	sandy muds	32	4	24	301±227	106±191
Astarte fusca, Murex brandaris, Fusinus rostratus, Dentalium dentalis, Paguristes oculatus, Citharus linguatula, Astropecten aranciacus, Pteroeides spinosum,	Sandy muds	51	2	47	560	327
Murex brandaris, Fusiturris undatiruga, Fusinus rostratus, Dentalium dentalis, Paracentrotus lividus, Holothuria polii	sandy muds	47	3	42	396±243	208±46
Acanthocardia paucicostata, Aporrhais pespelecani, Paracentrotus lividus Astropecten irregularis	muds	65	2	20	209	2603

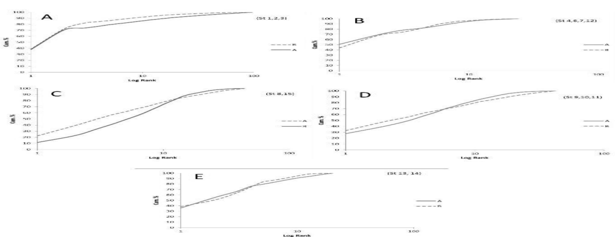

Fig. 1. Abundance- biomass curves of benthic megafauna communities in the gulf of Gabes. A: *Pinctada radiata*, B: *Corbula gibba* C: *Dentalium dentalis*, D: *Paracentrotus lividus*, E: *Astropecten irregularis.*

References

1 - Ayari R., Afli A., 2003. Bionomie benthique du petit Golfe de Tunis. Bull. Inst. Natn. Scien. Tech. Mer de Salammbô, 30: 79-90.

2 - Blanchard F., Le Loc'h F., Hily C., Boucher J., 2004. Fishing effects on diversity, size and community structure of the benthic invertebrate and fish megafauna on the Bay of Biscay coast of France. Mar Ecol Prog Ser 280: 249–260.

3 - Hattab T., Lasram F. B. R., Albouy C., Romdhane M. S., Jarboui O., Halouani G., Le Loc'h F., 2013. An ecosystem model of an exploited southern Mediterranean shelf region (Gulf of Gabes, Tunisia) and a comparison with other Mediterranean ecosystem model properties. Journal of Marine Systems, 128, 159-174. trawling disturbance on the production of infaunal communities. Mar Ecol Prog Ser 243: 251–260.

4 - Jennings S, Nicholson MD, Dinmore TA, Lancaster JE. 2002. Effects of chronic trawling disturbance on the production of infaunal communities. Mar Ecol Prog Ser 243: 251–260.

5 - Le Loc'h F., 2004. Structure, fonctionnement, évolution des communautés benthiques des fonds meubles exploités du plateau continental Nord Gascogne. Thèse De Doctorat de l'université De Bretagne Occidentale.378p.

6 - Warwick RM., 1986. A new method for detecting pollution effects on marine macrobenthic communities. Mar Biol 92: 557–562.

GHOST FISHING EFFECTS OF GILL NETS SUSPENDED ON ROCKS

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Abstract

In this study, for how long the continuation of fishing by gill nets which were suspended between two rock masses and for how many marine organisms to be killed by them were investigated. Lost nets were observed for 120 days. It was observed from the data that the lost nets continued to fishing for 90 days and 310 marine organisms from each panel were found to be death in that period of time.

Keywords: Fisheries, Iskenderun Bay, Mortality, North-Eastern Mediterranean

Ghost fishing refers to derelict fishing gear, either lost or abandoned, which continues to function in the water; continuing to induce mortality of aquatic organisms without human control (1). Not every lost fishing gear has an effect on ghost fishing. For example, active fishing gears such as trolls and seines will have lost their fishing capacity after being lost. However, passive fishing gears such as gill nets, trammel nets and pots will still have their fishing capacity for a time after being lost (2). Therefore the main topic of the ghost fishing consists of these fishing gears. However, the information about these gears on how long they continued to fishing and how many deaths that they have caused are extremely limited. In this study which was conducted at Iskenderun Bay, for how long the continuation of fishing by gill nets which were suspended between two rock masses and for how many marine organisms to be killed by them was determined experimentally. To this end, two panels of gill net dragged by a boat (as drifted by a storm) are attached to the rocks in the depths of 6-10 m. Then the changes on 24 hour catch with respect to time were monitored. In the days of the sampling, diving at 08:00 in the morning, the organisms that were found on the net were marked by plastic markers. Next day, diving again at 08:00, the species of the non-marked individuals were identified and their sizes were measured. Thus the number of individuals caught in 24 hours was determined. Using the length-weight relationships of the captured species, total biomass of the captured in 24 hours was calculated. Also in the days of sampling, around the area of the lost nets, commercial operations were conducted at night. For this, 5 panels of commercial gill nets were set at 17:00 and the next day they were hauled at 05:00 in the morning. Also the species of these organisms that were captured by these nets were identified and length and weight measurements were recorded. Thus an opportunity of a comparison on the changes of the catch by lost nets depending on the time and commercial nets was formed. In addition, the differences between the species compositions caught by lost nets and commercial nets were also observed. Lost nets were observed for 120 days. In this period, 24 hour catch was determined by underwater observations which were carried out for 25 times. In these observations, 120 individuals were captured by a panel of lost gill net and the total biomass of these individuals were calculated as 23070 g. At the same time, it was observed that a panel of commercial gill net was captured 240 individuals and the total biomass of these was calculated as 29309 g. The resulting data showed that the 24 hour catch of the lost nets was rapidly decreased depending on the time. However, in the first 15 day period, it was observed that the catch of a panel of lost gill net and commercial gill net was quite close to each other. On the 30th day of the study, it was determined that the catch of a lost gill net was 50% of the commercial gill net in terms of both numerically and biomass. This ratio was dropped below 30% in day 60, 15 % in day 75 and 5% in day 90. After the 90th day of the study, death of the lost nets was not observed. In figure 1, the changes on 24 hour catch with respect to time on lost and commercial nets were shown.

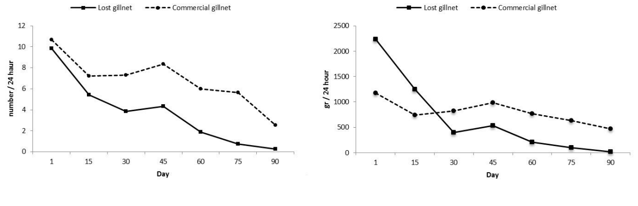

Fig. 1. The changes on 24 hour catch with respect to time on lost and commercial nets.

The changes on 24 hour catch with respect to time for a panel of lost gill net was fit with an exponential function (Figure 2). According to the calculation made by using this function, a panel of gill net in a 90 day period caused the death of 310 individuals. The total biomass of these was calculated as 53700 g.

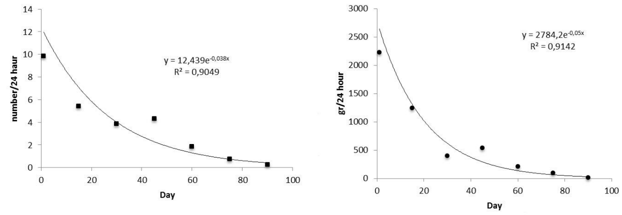

Fig. 2. The exponential model of the changes on 24 hour catch with respect to time.

During the study, the number of captured species to the lost and commercial nets was identified as 26. Of those species, 14 of them were captured by both net types, only 8 of them were captured by commercial nets and only 4 of them were captured by lost nets. Besides, it was observed that the amount of the captured groups by lost and commercial nets was also differed. For example, for Sparidae family species in teleosts; while 14% was observed in commercial nets, 41% was observed in lost nets. Similar situations were also observed with Crustaceans. For example, while the proportion of the *Callinectes sapidus* captured by commercial nets was 60% in the total crustaceans, it was 29% with the lost nets. For *Atergatis roseus*, it was determined that while the proportion was 5% with the commercial nets, it was 21% with the lost nets. Another determination with relation to crustaceans was that there seemed to be differences between the sizes of the species captured by lost and commercial nets. Another topic studied was that if there were any differences between the sizes of the species captured by both lost and commercial nets. The results that were obtained showed that there were statistically significant differences between the mean sizes of *Callinectes sapidus* and *Carcinus mediterraneus* ($p<0.01$). Despite that, it was found out that there was statistically no significant differences between the mean lengths of the teleost species captured by lost and commercial nets

References

1 - Matsuoka, T., Nakashima, T., Nagasawa, N., A. 2005. A riew of ghost fishing: scientific approaches to evalution and solition, Fiheries Science, 71, 691-702.

2 - Erzini, K., Monteiro, C. C., Ribeiro, J., Santos, M. N., Gaspar, M., Monteiro P., Borges T. C., 1997. An experimental study of gillnet and trammel net 'ghost fishing' off the Algarve (southern Portugal), Marine Ecology Progress Series, 158,257-265.

CIESM Congress Session : Assessing fish populations
Moderator : Konstantinos Stergiou, HCMR and Aristotle Univ. Greece

Moderator's Synthesis

Six communications were presented in this session. It was noted initially that only one of these six presentations (i.e. population dynamics of hake in NW Mediterranean) was based on long time series, bringing up for discussion the issue of the availability of long time series in the Mediterranean and raised the question of whether or not the situation has changed from that described in the CIESM workshop on time series (CIESM Workshop Monograph 22; 2003). Several participants noted that the availability of biological and, especially, of fish and fisheries-related time series in the Mediterranean is still relatively low, in particular for the southern sector and for Turkish waters. The situation has changed in the northern Mediterranean mainly because of the EU Data Collection Regulation and Framework (DCR and DCF) initiatives, in the years following the CIESM workshop. In spite of that, time series availability remains a problem for Greek waters where there is a gap in the collected DCF data for 2008-2013, mainly because of bureaucratic/administrative constraints.

It was also noted that only one out of the six presentations tested an ecological hypothesis (i.e. the bigger-deeper hypothesis). This brings the question of whether or not marine fisheries and ecology studies in the Mediterranean Sea have generally progressed from the descriptive to the hypothesis-testing stage. This was followed by discussions on the factors related to the bigger-deeper hypothesis (e.g. in deep waters fish benefit from higher lifespan and lower metabolism because of lower temperatures). In addition, several participants discussed the relation between exotic species and temperature (notably for *Upeneus*).

DISTRIBUTION AND POPULATION STRUCTURE OF GURNARD SPECIES (TRIGLIDAE) IN SAROS BAY (NORTH AEGEAN SEA, TURKEY)

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Abstract
Gurnard species are medium-size marine bottom fishes that live in tropical and temperate seas. Four genera (Aspitrigla,Chelidonichthys, Lepidotrigla, Trigla) and five species are found in the Saros Bay. Samples were collected by a commercial bottom trawler from depths ranging between 0 and 500 m, during June 2005 to July 2008 in the Saros Bay, North Aegean Sea. This study reported the CPUE, CPUA, catch rate and length-weight relationships for five gurnard species: *T. lyra, L. cavillone, C. lucerna, E. gurnardus*, and *T. lastoviza. T. lyra* has highest CPUE (3.13 kg/h) and CPUA (55.74 kg/km^2) values and *T. lastoviza* has lowest CPUE (0.12 kg/h) and CPUA (14.35 kg/km^2) values. The CPUE values varied with depth and season. *T. lyra* and *T. lastoviza* have the highest CPUE values in the 50-100 and 100-200m depth.

Keywords: Saros Bay, Aegean Sea, Population Dynamics, Biomass

Gurnards are bottom living fish found in tropical and temperate seas. Gurnard species inhabit the continental and insular shelves of tropical and temperate seas to depths of 500 m. They are found on sandy or muddy bottoms [1]. Some study describe the length weight relationship about Triglidae family members [2,3,4] and catch rate and biomass of Triglidae species [5] in the Aegean Sea. Despite the abundance and commercial importance of gurnards there is lack of knowledge on the exploited status of the stocks in the Mediterranean Sea [6].
This study describes some aspects of the biology of gurnard species in the Saros Bay, North Aegean Sea. In particular population structure, spatial distribution, length weight relationships are considered. 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 0-500 m depths, and there were 184 sampling station in the Saros Bay, North Aegean Sea. The CPUE (kg/h, catch per unit effort) was calculated for 1 hour, CPUA (kg/km^2, catch per unit area) was estimated using the swept area method [7]. Length-weight relationships were determined according to the allometric equation [8]: $W = a*L^b$, where W is the total weight, L is the TL and a and b are the parameters of the equation. And length and weight parameters were calculated for each species. 5 of the Gurnard species were sampled: *Trigla lyra, Chelidonichthys lucerna, Lepidotrigla cavillone, Eutrigla gurnardus and Trigloporus lastoviza*.
In the sampling period the total catch was 18248 kg and 647.6 kg gurnard species obtained that were 3.4% of the total catch. The catch rate, CPUE and CPUA values were calculated as *T. lastoviza* 0.11%, 0.12 kg/h, 2.24 kg/km^2, *C. lucerna* 0.40%, 0.76 kg/h, 14.35 kg/km^2, *T. lyra* 1.93%, 3.13 kg/h, 55.74 kg/km^2, *L. cavillone* 0.85%, 1.21 kg/h, 23.04 kg/km^2, *E. gurnardus* 0.13%, 0.17 kg/h, 3.34 kg/km^2, respectively. *T. lyra* has highest CPUE (3.13 kg/h) and CPUA (55.74 kg/km^2) values and *T. lastoviza* has lowest CPUE (0.12 kg/h) and CPUA (14.35 kg/km^2) values. The CPUE values were high in the summer and low in the winter periods. The CPUE values by depths showed that most of the species have highly CPUE value in the 50-100 and 100-200m depth contour (Fig. 1).

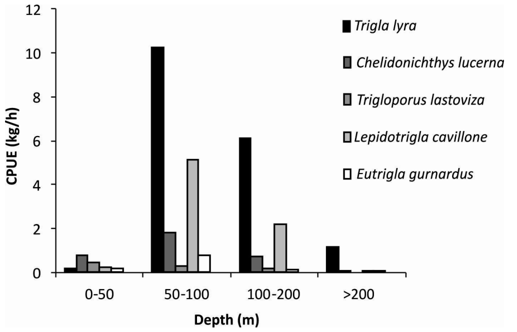

Fig. 1. Values of CPUE by depth in Saros Bay.

T. lyra and *T. lastoviza* have the highest CPUE values in the 50-100 and 100-200m depth. Most of the species occurred in 0-50, 50-100, 100-200 and >200 m depth contour only *T. lastoviza* has not been >200 m.
The estimated parameters of the length-weight relationship along with sample descriptive statistics (n, maximum, minimum and mean TL, standard error of mean TL, maximum, minimum and mean WT, parameters of the relationship (a, b, SE_b) are given in Table 1. A few study described length weight relationships about Triglidae family members in the Aegean Sea [2, 3, 4]. Our results showed that the other studies indicate less than in terms of the number of specimens. Also ecological and biological factors and regional differences may be responsible for the variations of the length-weight relationship parameters of the other studies.

Tab. 1. Descriptive statistics and estimated parameters of length-weight relationship ($W = a*L^b$)

Species	N	Length Characteristics (cm)		Weight Characteristics (g)		a	b	SE (b)
		Min-Max	Mean	Min-Max	Mean			
Trigla lyra	935	9.5-51.4	28.46±0.27	4.41-1052.38	209.40±5.58	0.011	2.87	0.140
Lepidotrigla cavillone	3154	6.2-17.5	10.91±0.02	2.60-37.95	16.57±0.09	0.016	2.89	0.019
Chelidonichthys lucerna	332	9.0-78.5	23.47±0.60	3.80-4110.00	218.0±28.5	0.008	3.01	0.036
Eutrigla gurnardus	327	8.9-30.3	16.41±0.16	5.11-209.49	40.39±1.53	0.006	3.09	0.035
Trigloporus lastoviza	284	9.4-26.8	16.16±0.15	11.34-230.90	49.34±1.48	0.024	2.71	0.068

Acknowledgements This study was financially supported by TUBITAK 106Y035.

References
1 - Hureau, J. C., 1986: Triglidae. In: Fishes of the Northeastern Atlantic and the Mediterranean. P. J. P. Whitehead, M. L. Bauchot, J. C. Hureau, J. Nielsen and E. Tortonese (Eds). UNESCO, pp. 1230–1238.
2 - Karakulak S., Erk H. And Bilgin B. 2006. Length–weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. *J. Appl. Ichthyol.* 22: 274–278.
3 - Özaydin O. and Taskavak E. 2006. Length-weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey). *ACTA ADRIAT.*, 47 (2): 211 – 216.
4 - Bilge G., Yapici S., Filiz H. Cerim H. 2014. Weight–Length Relations For 103 Fish Species From The Southern Aegean Sea, Turkey. *Acta Ichthyologica Et Piscatoria*, 44 (3): 263–269.
5 - Akyol O. 2008. Fish by-catch species from coastal small-scale shrimp trammel net fishery in the Aegean Sea (Izmir Bay, Turkey). *J. Appl. Ichthyol*. 24: 339–341.
6 - Colloca F., Cardinella M., Ardizzone G. D. 1997. Biology, spatial distribution and population dynamics of*Lepidotrigla cavillone* (Pisces: Triglidae) in the Central Tyrrhenian Sea. *Fisheries Research*, 32 (1): 21-32.
7 - Sparre P., Venema S. C., 1998. Introduction to tropical fish stock assessment. Part I: Manual. FAO Fisheries Technical Paper, 306/1, rev. 2, DANIDA, Rome, FAO, 407 p.
8 - Sparre P., Ursin E., Venema S.C. 1989. Introduction to tropical fish stock assessment. Part I. Manual. FAO Fisheries Technical Paper No. 306. FAO, Rome.

USING PARASITES AS BIOLOGICAL TAGS FOR STOCK DISCRIMINATION OF THE ATLANTIC MACKEREL *SCOMBER SCOMBRUS* OFF THE COAST OF TUNISIA

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Abstract

Five helminth parasites were used as biological tags to discriminate the stock structure of *Scomber scombrus* from four fishing localities off the coast of Tunisia (Bizerte in the north, Kelibia and Mahdia in the center and Zarzis in the south). Discriminant and nonparametric analysis, used for the separation of this species, allowed for the identification of three stocks: one in the north, one in the center and one in the south. 57% of specimens from four localities were classified correctly in their origin regions. All selected parasites would be good biological tags to discriminate stocks. The discrimination among individuals in different areas could be a consequence of the different environmental factors and to changes in the prey availability of the intermediate hosts to the host fish.

Keywords: Fishes, Parasitism, Stock assessment, Tunisian Plateau

The Atlantic mackerel *Scomber scombrus* is one of the most abundant pelagic fish with great commercial and economic importance in Tunisia, with reported landings of about 4.725 tons in 2011 [1]. This species is widely distributed in Tunisian waters but with a geographical distribution varying between localities [2]. Discriminating between distinct populations of the same species of commercially exploited fish is essential to determine their dynamics and manage their long-term sustainability. In the present study, parasites were used as biological tags for stock discrimination. A total of 369 specimens of *S. scombrus* from 12 distinct fish samples were collected between at four fishing localities off the coast of Tunisia, Bizerte in the north, Kelibia and Mahdia in the center and Zarzis in the south.

Fig. 1. Map of the Tunisian coast showing the locations used to sample *Scomber scombrus*.

Each fish was examined to find all macroparasites. For each parasite species, prevalence and mean abundance were calculated [3]. Geographical variations of these parameters were tested by statistical tests X^2 and ANOVA. A discriminant analysis was performed to separate mackerels from different regions. Three ectoparasites; one copepod *Caligus* sp. and two monogeneans *Grubea cochlear* and *Kuhnia scombri* were recorded from gills. Four endoparasites; three digeneans, *Prodistomum orientalis*, *Opechona bacillaris* and *Lecithocladium excisum* and nematod anisakidae larvae were collected from digestive tract. All parasites with a prevalence >5% will be involved in the discrimination analyses except *Caligus* sp. with prevalence 1.11< 5%. Monogeneans *G. cochlear* and *K. scombri* and the digenean *P. orientalis,* were not found in specimens from Bizerte. Anisakidae larvae were not recorded in fish from Zarzis. Comparisons of the prevalence and mean abundance of all parasites showed significant differences between Bizerte and other localities ($P < 0.05$). Between Kelibia and Mahdia, infection parameters of all parasites do not show any significant differences ($P > 0.05$). The prevalence and mean abundance of some parasites vary between Zarzis and Mahdia and Kelibia ($P < 0.05$). The discriminant analysis separate *S. scombrus* from 4 regions in three stocks (Wilks' lambda = 9.34; $P < 0.01$): one in the north from Bizerte, one in the center regrouped specimens from Kélibia and Mahdia and one in the south from Zarzis.

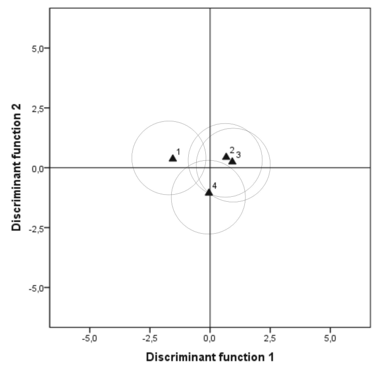

Fig. 2. Sample scores of the first two discriminant functions for specimens of *Scomber scombrus* in four zones of the Tunisian coast 1, Bizerte; 2, Kelibia; 3, Mahdia; 4, Zarzis.

All selected parasites species were good biological tags for stock discrimination. The discrimination among specimens in different areas could be a consequence of the different environmental conditions and to changes in the prey availability of the intermediate hosts to the host fish.

References

1 - Anonyme, 2011. Annuaires statistiques de la Direction Générale de la Pêche et de l'Aquaculture (D.G.P.A).
2 - Ben Abdallah, L. et Gaamour, A., 2004. Répartition géographique et estimation de la biomasse des petits pélagiques des côtes tunisiennes. Med Sud Med Technical Documents No 5. pp (28-38).
3 - Bush, A.O., Lafferty, K.D., Lotz, J.M., Shostak, A.W., 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. J. Parasitol. 83, 575–583.

RELATIONSHIP BETWEEN ANCHOVY (*ENGRAULIS ENCRASICOLUS*) RECRUITS AND ANCHOVY SPAWNERS ESTIMATED FROM ACOUSTIC SURVEYS IN NORTHWESTERN MEDITERRANEAN SEA

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Abstract

In this study we present the abundance and biomass of European anchovy (*Engraulis encrasicolus*) estimated by acoustic methods in the Northwestern Mediterranean Sea (GSA06). during two different seasons, winter, the anchovy recruitment season and summer, when the majority of the anchovy stock belongs to the spawner fraction of one year-old. Four standardized acoustic surveys carried out covering the study area during two consecutive years (every six months), two of them during the peak of anchovy recruitment and the other two during the peak of anchovy spawn, allow to observe changes in the anchovy stock abundance and biomass in this area. Acoustic data from summer and winter echo-surveys were analyzed in an effort to better understand the life cycle of anchovy in relation to the survival during its first year of life.

Keywords: Acoustics, Continental shelf, Pelagic, Fisheries, North-Western Mediterranean

Introduction

Small pelagics, such as anchovy, support large fisheries in the Mediterranean Sea [1]. Similar to other small pelagic species, anchovy is short-lived with high rates of natural mortality and high fecundity in which recruitment plays a major role in setting year-to-year changes in the level of the stock. When the stock is overexploited, the age classes usually decrease in number and it is important to understand the extent to which the year-to-year fluctuation of the population depends on recruitment or the 0 age class [2]. In the Spanish Mediterranean, anchovy spawning takes place from April to October with a peak in June-July [3] and the recruitment occurs from September to February with a peak in December [4]. For sustainable management of fish stocks, it is necessary to understand the dynamics of populations and their fluctuations over time. In the case of anchovy, this fact is crucial because most of the spawners come from the previous recruitment.

Material and methods

The study was carried out in the Spanish Mediterranean continental shelf (from 30 to 200 meters depth), corresponding to the GSA06 (Northern Spain) division adopted by the GFCM. Four acoustic surveys were performed in two different seasons, winter and summer (December 2008, June 2009, December 2009 and June 2010) then two anchovy live cycles was monitored (recruit-spawners-recruit-spawners). Acoustic data were recorded using an EK60 echosounder (Simrad) operating at five frequencies (18, 38, 70, 120 and 200 kHz). Acoustic sampling took place along parallel transects, perpendicular to the bathymetry and with a 4 or 8 nautical mile (nmi) distance from each other. Simultaneous to the acoustic sampling, fish samples were collected using a pelagic trawl (16 m vertical opening) to identify species composition and their relative abundance [5]. Anchovy individuals captured were sized to the 0.5 cm total length lower and weight-length relationship was fitted to an exponential model using the root mean square method. Sex and maturity were also recorded and otoliths were extracted for age study. Acoustic data were analysed using Echoview software (Myriax Ltd.). Anchovy abundance and biomass were estimated with the VBA software PESMA and the software ArcView 3.2 and ArGis 9.3.

Results and discussion

Anchovy abundance (Fig. 1) in number of individuals estimated in the study area in December 2008 was 5971 million corresponding the majority of them to anchovy recruits (age 0), with a length interval between 6 and 15.5 cm, and mode in 10-11 cm. Anchovy abundance dropped to 2489 million six months later (June 2009), nearly half of the abundance detected in December, with a length interval between 7 y 17 cm, and mode in 14 cm, being all of them spawners, one-year old. The same pattern was detected the following year, being the anchovy abundance estimated in December 2009, 4380 million (recruits), dropping to 1738 million individuals in July 2010, one-year old anchovy spawners. With regard to the anchovy biomass (in tons) estimated during these four acoustic surveys (Fig.1), it can be observed that differences between seasons are lower due to the growth of anchovy individuals by length and weight which compensates for the loss of individuals (abundance). In December 2009, 28547 tons of anchovy recruits were estimated, and six months later, in June 2009, the biomass estimated was 28090 tons, since although the number of anchovy individuals was almost half. The same pattern was observed the following year, 25791 tons of anchovy recruits estimated in December 2009 and 22306 tons of anchovy spawners estimated by acoustic methods in July 2010. For sustainable management of fish stocks, it is necessary to understand the dynamics of populations and their fluctuations over time. In the case of anchovy, our data could be a good indicator of the anchovy natural mortality in this area.

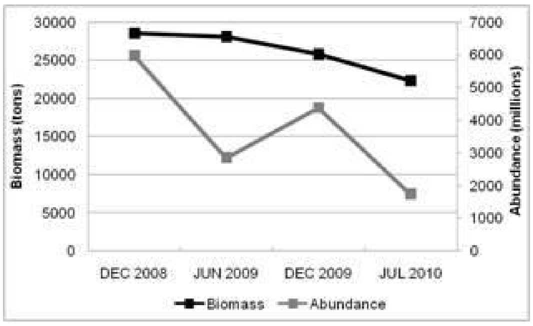

Fig. 1. Anchovy biomass (tons) and abundance (nº individuals) estimated by acoustic methods (four surveys) in Northern Spain (GSA06).

References

1 - LLeonart J. and Maynou F. 2003. Fish stocks assessments in the Mediterranean: state of the art. Scientia Marina, 67 (1): 37-49.

2 - ICES. 2010. Report of the Workshop on Age reading of European anchovy (WKARA), 9-13 November 2009, Sicily, Italy. ICES CM 2009/ACOM: 43. 122 pp.

3 - Palomera I. 1992. Spawning of anchovy *Engraulis encrasicolus* in the Northwestern Mediterranean relative to hydrographic features in the region. Marine Ecology Progress Series, 79: 215-223.

4 - Abad R., Miquel, M., Iglesias, M. and Alvarez F. 1998. Acoustic estimation of abundance and distribution of anchovy in the NW Mediterranean. Scientia Marina, 62 (1-2): 37-43.

5 - Simmonds E.J. and MacLennan D.N. 2005. Fisheries acoustics. (2nd ed.), Oxford: Blackwell Science Ltd.

HARVESTING AND POPULATION DYNAMICS OF EUROPEAN HAKE IN THE GULF OF LIONS (NORTHWESTERN MEDITERRANEAN)

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Abstract

The European hake (*Merluccius merluccius*) is one of the main resources of the demersal fishery in the Gulf of Lions. This stock is considered as a shared stock, exploited by both Spanish and French fleets. The objective of this work was to analyze its population dynamics and to assess its current state of exploitation. Data were obtained from both commercial monitoring and scientific surveys. Two different stock assessment models were considered, which showed similar results, with the recruitment and spawning stock biomass displaying a decreasing trend along the data series. This trend was also found in the average length in catches. The current fishing mortality estimates were higher than the reference points and the stock is considered to be overexploited. Adequate management measures are needed to improve the status of the stock.

Keywords: Stock assessment, Demersal, Fisheries, Population Dynamics, Gulf of Lyon

The European hake (*Merluccius merluccius*) is one of the main resources of the demersal fisheries in the Gulf of Lions, where it is considered as a shared stock since it is exploited by both French and Spanish fleets. Its annual catch has oscillated between 1100-2800 t between 1998-2014 (Figure 1), with the French trawl as the most important gear in catches (72%) followed by French gillnetters (14%), Spanish trawlers (9%) and Spanish longliners (5%). Catches of trawlers are mostly composed by small individuals, mainly recruits, whereas gillnetters and longliners catches are mostly constituted of larger individuals, mainly mature females. The analysis of data from 1988-1991 determined that the level of exploitation at that moment was far above the optimal sustainable level, and the stock was found to be overexploited [1]. The management measures applied in the last years included the substitution of the traditional diamond 40 mm mesh size in the codend for the square 40 mm or diamond 50 mm in 2010 for trawlers, temporal bans of 1 month for both French and Spanish trawlers and the frozen of the fishing effort at 2008 levels since 2009, in a High Sea Fishery Restricted area in the eastern part of the Gulf. However, since 2009, due to the large decline of small pelagic fish species in the area, trawlers fishing small pelagic species diverted their effort on demersal species, including hake.

The objective of the present work is to analyze the population dynamics of the European hake in the area and assess its current state of exploitation. Data were obtained from different sources, 1998-2014: (i) official catches by fleet; (ii) monthly or quarterly on-board and on-port sampling for the different gears, (iii) annual bottom-trawl surveys and (iv) individual biological samplings. Interannual trends of the annual average length by gear have been analyzed by linear regression. Growth parameters used were obtained from tagging experiments in the study area [2]. Maturity ogive was calculated using biological data collected over 2004-2014 and natural mortality was calculated as a vector. The stock assessment considered ages 0-5+, with the survey index as tuning fleet (ages 0-2). The models applied were Extended Survivor Analysis and a4a, with suitable parameters selected after running different sensitivity analysis and the robustness of the results tested by retrospective analysis. The yield per recruit analysis was used to estimate the reference points for the stock.

The investigation of catch data showed that annual average length has significantly decreased for both French gillnetters (from around 39 to 35 cm, $p<0.001$) and Spanish longliners (from around 59 to 43 cm, $p<0.001$, Figure 2) during the period analyzed. Average length for Spanish trawlers did not show any trend (around 24 cm, $p>0.05$) and for French trawlers a slightly increasing trend was detected (from 19 to 21 cm, $p<0.05$). The best a4a model showed similar results than XSA in terms of fishing mortality and spawning stock biomass (SSB), but gave higher estimates of recruitment, especially for the last year (Figure 1). Both recruitment and SSB show fluctuations along the data series, with a general decreasing trend and currently at low levels, with certain stabilization in 2014. Fishing mortality (F) has reached the highest levels of the time series. For XSA, the current F (1.75 as the average of ages 0-2 for years 2012-2014) showed values nearly 12 times higher than the reference point $F_{0.1}$ (as a proxy of F_{MSY}= 0.15). The stock is in an overexploitation status. The improvement of the stock would only be possible with an adequate observation of the management regulations already in force as well as the reduction of the current fishing mortality, which could also include adequate spatio-temporal closures for the protection of nursery and spawning areas.

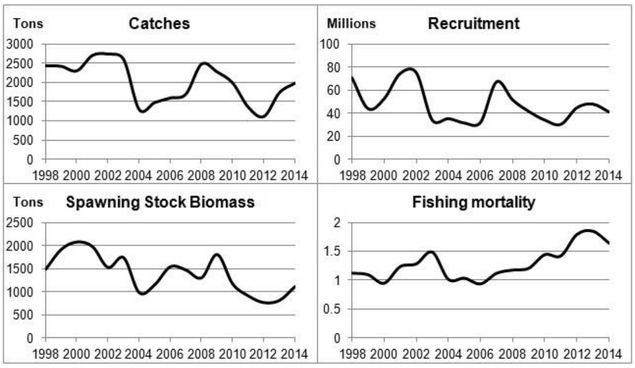

Fig. 1. Catches of European hake in the Gulf of Lions and results of the stock assessment model.

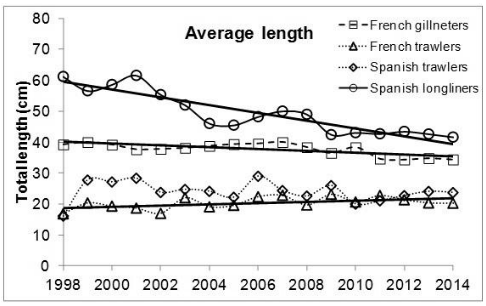

Fig. 2. Average length of catches of European hake by gear for the period analyzed. Black lines represent significant trends.

References

1 - Aldebert Y. and Recasens L., 1996. Comparison of methods for stock assessment of European hake *Merluccius merluccius* in the Gulf of Lions (Northwestern Mediterranean). Aquat. Living Resour., 9: 13-22.

2 - Mellon-Duval C., de Pontual H., Métral L. and Quemener L., 2010. Growth of European hake (*Merluccius merluccius*) in the Gulf of Lions based on conventional tagging. ICES J. Mar. Sci., 67: 62-70.

FIRST CONTRIBUTION TO THE KNOWLEDGE OF *MAJA CRISPATA* (RISSO, 1827A) ECO-BIOLOGY ALONG THE TUNISIAN COASTS

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Abstract
This work is a first contribution to the knowledge of the biology of the spider crab *Maja crispata* along the Tunisian coasts. The main results of this study showed that the Tunisian population of *M. crispata* is generally male-biased with some spatial variations of the sex-ratio. The comparative analysis of size structures of 6 studied subpopulations highlighted also some spatial variations, with a unimodal size distribution and a clear prevalence of individuals belonging to the size class 35-40 mm. The description of the intermoult-stage structure showed a preponderance of stage C-intermoult individuals (of hard carapace) followed by stage B-individuals. While the intermoult stage D was recorded in five out of six sites with very low proportions, stage A was encountered in only one site (Zarrat).

Keywords: Population Dynamics, Crustacea, Decapoda, Tunisian Plateau

In spite of its ecological interest, there is still a knowledge-gap about Tunisian *Maja crispata* (Risso, 1827)populations. Studies about this crab species are almost absent and little is yet known about its biology and ecology in Tunisia. The present study was carried out within this context, with the main objective is to describe the sex ratio, the size structure and intermoult-stage structure of Tunisian *M. crispata* populations. A total of 180 individuals of *M. crispata* were randomly collected from 6 sites (with a rate of 30 specimens from each site) belonging to the Gulf of Gabes (4 sites: *Zarrat*, *Tebelbou*, *Ghannouche* and *Kerkennah*) and Gulf of Tunis (2 sites: *Carthage Birsa* and *Carthage Salammbô*) between March and June 2015. In the laboratory, sampled individuals of *M. crispata* were classified into males and females and their maximal width of the carapace (CW, mm) was measured using aluminum Vernier calipers (accuracy of 0.01 mm). Intermoult stages (A, B, C and D) of the sampled spider crabs were determined macroscopically according to the methodology of carapace hardness described by [1]. The total sample (180 individuals) consisted of 113 males and 67 females. Both total samples of Gulf of Gabes and Gulf of Tunis showed that males were generally more abundant than females (χ^2 = 33.926; df = 5; p ≤ 0.001). Global sex-ratio was found to be 0.59 and the spatial variations of sex-ratio are presented in figure 1A. The lowest sex-ratio values were noted in *Kerkennah* (0.30) and *Carthage Salammbô* (0.50). In contrast, the highest records were found in *Zarrat* (4.00), *Ghannouche* (0.25), *Tebelbou* (2.75) and *Carthage Birsa* (1.14) (Figure 1A).

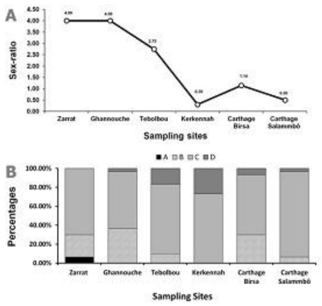

Fig. 1. Spatial variations of the sex-ratio (**A**) and intermoult-stage structures (**B**) of the six studied subpopulations of the spider crab *Maja crispata*.

The comparative analysis of intermoult-stage structures of the Tunisian *M. crispata* subpopulations revealed that the majority of spider crabs collected from both Gulfs of Gabes and Tunis are of hard carapace and belong to the intermoult stage C. Only two stage A-individuals were found in the total sample (in *Zarrat*). Individuals of stage B were encountered in all sites except *Carthage Birsa*. As for stage D-individuals, they were found in all sites except *Zarrat* with very low proportions (Figure 1B). With respect to length frequency distribution, we found that the total sample of *M. crispata* is mainly presented by crabs belonging to the size (carapace width) classes 35-40 mm (39 specimens), 30-35 mm (32 specimens) and 40-45 mm (31 specimens). The size classes presenting the lowest frequencies were found to be 15-20 mm (2 specimens) and 60-65 mm (4 specimens) (Figure 2). Similarly to the global sample, the size frequency distributions of separate samples were found to be unimodal showing, in most cases (*Ghannouche*, *Tebelbou*, *Kerkennah* and *Carthage Birsa*), the prevalence of one of the three dominating size classes (30-35 mm or 35-40 mm or 40-45 mm). In the case of *Zarrat* and *Carthage Salammbô*, prevalence was found with the size classes of 45-50 mm and 25-30 mm respectively. In all cases, smallest (15-20 mm) and largest (60-65 mm) spider crabs were very scarce (Figure 2).

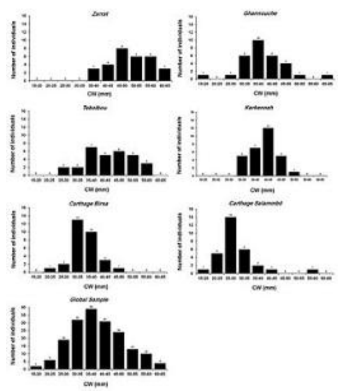

Fig. 2. Size (carapace width, CW) structuresof the spider crab *Maja crispata* in each of the six sampling sites (*n* = 30 each) and in the global sample (*n* = 180).

Similarly to the global sample, the size frequency distributions of separate samples were found to be unimodal showing, in most cases, the prevalence of one of the three dominating size classes (30-35 mm or 35-40 mm or 40-45 mm). In the case of Zarrat and Carthage Salammbô, prevalence was found with the size classes of 45-50 mm and 25-30 mm respectively. In all cases, smallest (15-20 mm) and largest (60-65 mm) spider crabs were very scarce (Fig. 2).

References

1 - Sampedro M.P., González-Gurriarán, E. and Freire J., 2003. Moult cycle and growth of *Maja squinado* (Decapoda: Majidae) in coastal habitats of Galicia, Northwest Spain. *J. Mar. Biol. Assoc. U. K.,* 83: 995–1005.

SPATIAL DISTRIBUTION OF THE FAMILY MULLIDAE IN THE ANATOLIAN COASTS

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Abstract
Mullids obtained by trawlers in 2014 – 2015 from two different locations in the Anatolian coast have been assessed in order to reveal the spatial distribution and the relationship between depth and individual size. The spatial distribution and depth – individual size relations have been compared in four depth contours.

Keywords: Fishes, Iskenderun Bay, Aegean Sea

The family Mullidae consists of widely distributed benthic fishes (Atlantic, Indian and Pacific Oceans), represented with six species in the Mediterranean Sea [1, 2]. Five of these species are present in the Turkish coasts: *Mullus barbatus* Linnaeus, 1758, *Mullus surmuletus* Linnaeus, 1758, *Parupeneus forsskali* (Fourmanoir & Guézé, 1976), *Upeneus moluccensis* (Bleeker, 1855) and *Upeneus pori* Ben-Tuvia & Golani, 1989 [3]. Although *P. forsskali* is reported in the last decade in Turkish waters [4], the other four species are commonly present. Besides their ecological significance, Mullidsare of economic value due to their high importance in fisheries. The study aims to provide information on spatial distribution of Mullids in two different areas in the Anatolian coasts; the Gökçeada Island (North Aegean Sea) and the Iskenderun Bay (Northeastern Levantine Sea). While the Iskenderun Bay inhabits all five mullid species, only the local species *M. barbatus* and *M. surmuletus* are present in the coasts of the Gökçeada Island. A total of 4711 Mullid individuals have been caught in the study areas, 2455 of these have been measured. Among the five Mullid species present in the Anatolian coasts, there have not been any *P. forsskali* individuals caught. The Mullids caught with trawlers were obtained from various depths. These depths have been categorized into 0 – 50 m, 51 – 100 m, 101 – 200 m and 200 – 500 m depth contours, and the relationship between their depth preferences and size has been analyzed. The distribution of Mullid species according to different depth contours for the Gökçeada Island is shown in Fig. 1a. Both *M. barbatus* and *M. surmuletus* species captured around the Gökçeada Island are mainly present at 0 – 100 m depth, nevertheless the number of both species decreases at depths greater than 200 m, which is a result that corresponds to the pertinent literature in the Mediterranean Sea [5, 6, 7]. Whereas in the Iskenderun Bay (Fig. 1b), *U. pori* seems to dominate the 0 – 50 m depth range among mullids, and has not been captured at greater depths than 100 m. *M. barbatus* and *U. moluccensis* are mainly present in the 50 – 200 m depth contour. It can be seen that the number of the *Mullus* sp. individuals in the Iskenderun Bay at the 0 - 100 m depth contour is considerably lower (especially *M.surmuletus*) (Fig. 1b) than the number of *Mullus* sp. individuals around the Gökçeada Island (Fig. 1a). This might be interpreted as an exotic pressure caused by the lessepsian *Upeneus* species on the local *Mullus* species.

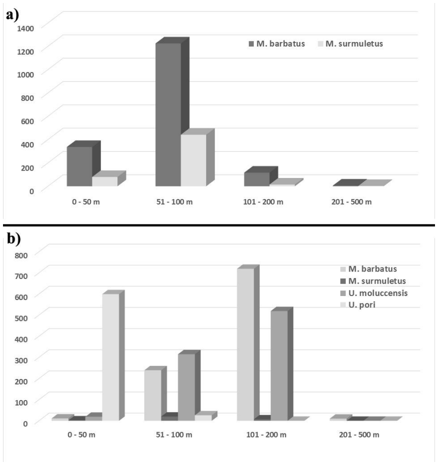

Fig. 1. Number of mullid individuals at different depth contours around Gökçeada Island (a), and Iskenderun Bay (b)

The relationship between depth and individual size for *M. barbatus* and *M. surmuletus* caught in the coasts of the Gökçeada Island is shown in Figure 2a,b. This relationship indicates a pattern where the total length of individuals of both species increases with depth around the Gökçeada Island. This pattern has not been observed in the Mullids of the Iskenderun Bay, which may be due to ecological overlaps of Mullid species.

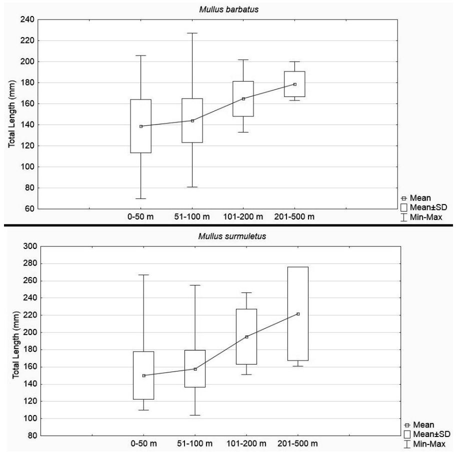

Fig. 2. Depth – Total Length relationship in *M. barbatus* (a) and *M. surmuletus* (b) around the Gökçeada Island

The Mullids obtained, except of *U. moluccensis*, have been found at anticipated depth ranges. Although the maximum depth of *U. moluccensis* has been reported as 120 m [2], in this study, the maximum depth *U. moluccensis* individuals have been caught from was 174 m.

References
1 - Golani D., 1994. Niche separation between colonizing and indigenous goatfish (Mullidae) in the Mediterranean coast of Israel. Journal of Fish Biology 45(3): 503–513

2 - Froese, R. and D. Pauly. Editors. 2016. FishBase. World Wide Web electronic publication. www.fishbase.org, (03/2016).

3 - Bilecenoglu, M., Kaya, M., Cihangir, B., Cicek, E., 2014. An updated checklist of the marine fishes of Turkey. Turkish Journal of Zoology 38: 901-929.

4 - Cinar, M.E., Bilecenoglu, M, Ozturk, B. ve Can, A., 2006. New records of alien species on the Levantine coast of Turkey. Aquatic Invasions 1(2): 84–90.

5 - Machias, A., Labropoulou, M., 2002. Intra-specific variation in resource use by red mullet, Mullus barbatus. Estuarine, Coastal and Shelf Science 55: 565-578.

6 - Tserpes, G., Fiorentino, F., Levi, D., Cau, A., Murenu, M., Zamboni, A. & Papaconstantinou, C., 2002. Distribution of Mullus barbatus and M. surmuletus (Osteichthyes: Perciformes) in the Mediterranean continental shelf: implications for management. Scientia Marina, 66(2): 39–54.

7 - Maravelias, C. D., Tsitsika, E. V. & Papaconstantinou, C., 2007. Environmental influences on the spatial distribution of European hake (Merluccius merluccius) and red mullet (Mullus barbatus) in the Mediterranean. Ecological Research, 22: 678–685.

CIESM Congress Session : Fisheries ecology
Moderator : Stefan Neuenfeldt, DTU Aqua, Charlottenlund, Denmark

Moderator's Synthesis

Fisheries Ecology is about the ecology of fish which are caught by man. Its aim is to seek out the processes which must be identified, described, measured, analysed and ultimately predicted in order to provide optimal management of exploited fisheries. The session has spanned over a wide range of species and systems in the Mediterranean, covering issues of productivity, marine protected areas, exploitation pressure, and gear selectivity and the technically non-trivial acquisition of time series on fisheries landings and catch per unit of effort data.

The following discussion revolved around two focal areas: (i) the applicability of the time series by merging the with time series on drivers and pressures from other sources, and (ii) the integration of the ecological findings in applied management of fish, molluscs and crustacean stock assessments and ecosystem management.

It has been concluded that the available time series have great potential to generate understanding of driver interactions and their forcing on exploitable resources, as well as predicting productivity in the face of climate change. Furthermore, there is an accumulating ecological knowledge that could constructively feed into stock assessments and management, as for example the effectiveness of closed areas to protect hake recruitment.

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ANALYSE DE L’ÉTAT DU STOCK ET DE L’ABONDANCE DU POULPE *OCTOPUS VULGARIS* DANS LES EAUX TUNISIENNES

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Abstract

L'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. Dans cette étude, nous avons réalisé une comparaison des indices d’abondance du poulpe *Octopus vulgaris* dans la région sud des eaux tunisiennes à partir des campagnes de pêche expérimentales associé à une analyse chronologique des statistiques des pêches de cette espèce. Les résultats ont montrés la présence de deux phases, l’une marquée par une hausse de la production (1988-1990) expliqué par l’augmentation de l’effort de pêche et l’autre par un déclin de la production (2008-2009) liée à l’état de surexploitation de cette ressource.

Keywords: Cephalopods, Tunisian Plateau, Fisheries, Density

Introduction

Le poulpe *Octopus vulgaris* est une espèce de grande importance économique particulièrement dans le sud tunisien qui procure à lui seul 80% de la production nationale [1]. Depuis plusieurs années, des fluctuations ont été enregistrées dans la pêche de cette ressource halieutique tout le long des côtes tunisiennes. C’est surtout dans la région sud où les débarquements en poulpe sont les plus importants que ces oscillations sont les plus manifestes.

Matériel et méthodes

Dans ce travail, nous avons réalisé une comparaison des indices d’abondance à partir des campagnes de pêche expérimentales annuelles à bord des bateaux de recherche de l’INSTM. Les opérations de pêche ont été réalisées au moyen du chalut benthique type crevettier dans la région Sud des côtes tunisiennes (Golfe de Gabès). De plus, nous avons étudié l’évolution de la production et des prises par unité d’effort de pêche du poulpe dans cette région sur une série chronologique de 33 ans (1977 à 2009).

Résultats et discussion

L’étude chronologique des statistiques des pêches du poulpe du golfe de Gabès (exprimé en tonne par an) montre des fluctuations distinguées par deux phases.

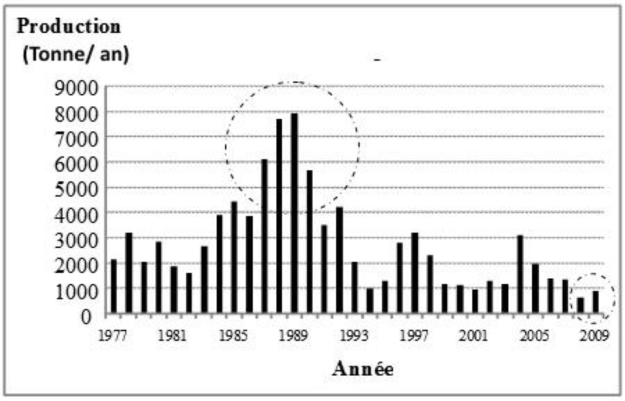

Fig. 1. Evolution de la production totale du poulpe *Octopus vulgaris* dans la région Sud de la Tunisie (1977-2009).

Une première phase caractérisée par un maximum de production durant les années 1988-1990 dont nous pourrons le lier à l’augmentation de la flottille à cette époque. En plus, la diminution du stock des prédateurs du poulpe représenté essentiellement par le mérou et le pagre dans le golfe de Gabès a favorisé de façon notable l’expansion de l’espèce [2]. La deuxième phase (2008-2009) est marquée par un effondrement de la production du poulpe résultant d’une surexploitation de l’espèce. Le changement du profil des prises en poulpe est également senti dans le rendement des pêches expérimentales dans le golfe de Gabès bien que les campagnes n’étaient pas étalées sur toute l’année pour donner une image plus fiable des rendements.

Tab. 1. Répartition bathymétrique du poulpe pêché au cours des campagnes de pêches expérimentales dans la région sud de la Tunisie

	Rendement (Kg/h)							
Année	**Campagne 1980**		**Campagne 1981**		**Campagne 1989-1990**		**Campagne 2008-2009**	
Strate (m)	Nombre de trait de chalut	R/h	Nombre de trait de chalut	R/h	Nombre de trait de chalut	R/h	Nombre de trait de chalut	R/h
< 20	3	0	5	1.5	6	1.48	6	0
20-50	4	0	7	19.75	8	0.72	14	0.69
50-100	8	1.57	11	5.32	14	0.00	12	1.54
> 100	7	0.17	9	0	12	1.66	10	0.07

En plus des facteurs halieutiques, d’autres d’ordre climatique, essentiellement la température sont aussi à l’origine de la variation significative de la production [3]. Les indices d’abondance obtenus ont confirmé les fluctuations notées dans la production et qui sont dues essentiellement à l’augmentation de l’effort de pêche dans la période de l’essor de la production et à la surexploitation du stock du poulpe dans la période de son déclin.

References

1 - D.G.P.A., 2013, Annuaire des statistiques de pêche en Tunisie de la Direction Générale de la pêche et l’Aquaculture, 116.

2 - Ezzzeddine-Najaï S. and El Abed A., 2002. Inventaire des Céphalopodes des eaux tunisiennes . *Bull. Inst. natn. Sci. Techn. Mer.*, 6: 5-7.

3 - Ezzeddine S., 2010. Etude discriminatoire du poulpe *Octopus vulgaris* des côtes sud tunisiennes (Méditerraznée centrale). *Rapp. MedSudMed FAO.*, 1-39.

THE EFFECT OF A FISHING BAN ON A HAKE NURSERY GROUND IN THE ROSES GULF (NW MEDITERRANEAN)

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Abstract

A hake nursery area has been closed during two years by the Roses fishermen association (NW Mediterranean Sea) in order to protect the recruitment of hake in the area. The aim of this study is to evaluate the effectiveness of this measure. Hake landings displayed marked fluctuations in the last 15 years although effort decreased. First results regarding the measure of closing the hake nursery area indicate that abundance and biomass of recruits were higher in the closed zone than in the surrounding fishing area, suggesting that this measure could contribute to protect significantly the hake recruitment.

Keywords: Recruitment, North-Western Mediterranean, Monitoring, Continental shelf, Fisheries

European hake (*Merluccius merluccius*) is one of the most important commercial species in the Mediterranean area and similarly to other main fishing target species in this area, it is overexploited [1]. The protection of nursery grounds in the North Mediterranean Sea has been defined as an important measure to improve fisheries management [2].

Our study area is located in the northern Catalan coast, in the Roses Gulf (NW Mediterranean). Hake is caught mainly by otter trawl fleet (90% of landings) while the small-scale catches are low. Aiming at the protection of the recruitment of hake, the fishermen association of Roses harbor defined an area of 70 km2 on the shelf, at 120-140 meters depth, which corresponds to a hake nursery ground, and a fishing ban was implemented from February 2014 to march 2016. In order to evaluate the effect of this measure a monitoring pilot project was conducted from March 2015 to March 2016. Monthly, four experimental fishing trawls, of 1 hour duration, were done, two in the closed area (C) and two outside this protected area in a neighboring fishing ground (F) at similar depth range. Swept area was calculated based on the haul initial and final positions, vessel speed and average horizontal opening of the gear. The net characteristics (OTMs, squared 40mm size mesh) were the same in all hauls (n=39). Data on hake abundance, biomass and length frequency distributions were obtained.

Annual landings and effort data of the Roses trawl fleet from 2000 to 2014 were taken from fishery statistics compiled by Fisheries Department of the Catalan Autonomous Government. Bottom trawl annual hake landings showed marked fluctuations between 130 and 323 tons without either increasing or decreasing trend, while fishing effort, expressed in fishing days, decreased gradually during this period (Fig. 1).

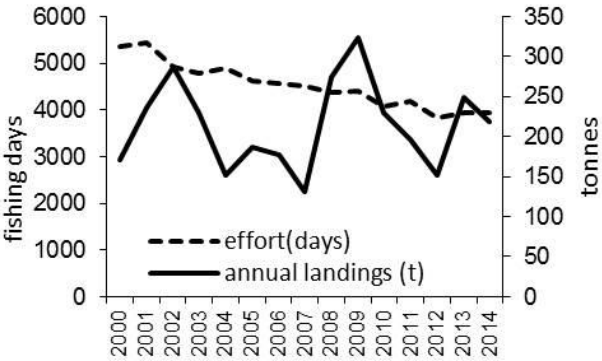

Fig. 1. Bottom trawl hake annual landings (t) at the Roses harbor and trawl fishing effort (fishing days) from 2000 to 2014

Concerning the monitoring of hake in the closed (C) and fished (F) areas, despite total abundance and biomass were higher in the closed area (C: 1171 ind/km2, 79 kg/km2; F: 764 ind/km2, 55.6 kg/km2), these differences were not significant (Wilcoxon test: W = 5535, p-value = 0.98). In contrast, the abundance and biomass of hake recruits (<20 cm total length TL individuals) showed a marked difference between closed and fished area, being the values in the closed area significantly higher (Wilcoxon test: W = 295, p-value = 0.35) and near twice those in the fished zone (C: 560 ind/km2, 11.5 kg/km2; F: 301 ind/km2, 6.2 kg/km2).

Length frequency distribution (Fig. 2) showed similar mean and modal lengths (TL) in the closed and fished zones (C: mean length = 18.4 cm, modal length = 14 cm; F: mean length = 19.9 cm, modal length = 14 cm). Nevertheless, in the closed area we found larger abundances of smaller and larger individuals. Recruits represented 66% of the total individuals in the closed zone, and 51% in the fished area. The abundance of largest adult hakes (>35 cm TL) was slightly higher in the closed area (C: 1.8% and F: 1.3%).

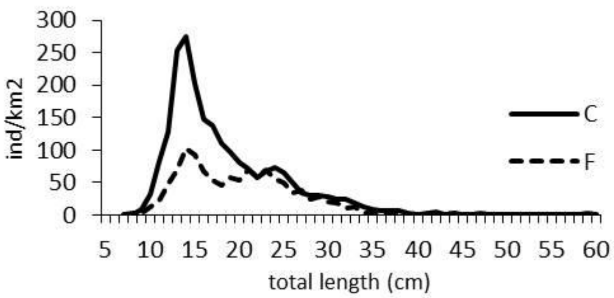

Fig. 2. Hake length frequency distribution. C: closed area; F: fished area

These preliminary results suggest that hake population respond favorably to the nursery protection measure adopted by the Roses fishermen association, enhancing the recruitment of this valuable species. Thus, the closure of this area could be an effective tool for hake management as it could act as a refuge for the recruits of this overexploited species.

References

1 - Vasiliakopoulos, P., Maravelias, C.D., Tserpes, G. 2014. The Alarming Decline of Mediterranean Fish Stocks. Curr.Biol., 24: 1643-1648.

2 - Colloca, F., Garofalo, G., Bitetto, I., Faccini, M.T., Grati, F., Martiradonna, et al. 2015. The Seascape of Demersal Fish Nursery Areas in the North Mediterranean Sea, a First Step Towards the Implementation of Spatial Planning for Trawl Fisheries. PLoS One, 10(3): e0119590.

RECONSTRUCTION OF SYRIA FISHERIES CATCHES FROM 1950-2010: SIGNS OF OVEREXPLOITATION

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Abstract
The quality of evaluations is therefore dependent upon the quality of the member country data, and by extension their national data collection and reporting systems. Syria's marine fisheries catch data are assembled from market assessment (i.e., the sales of commercial catches) from a subset of fish markets, therefore neglecting to account for non-commercial landings, direct marketing and sales by-passing major markets, and discards. The goal of the present study was to provide comprehensive estimates of total Syrian marine fishery catches for 1950-2010 by fishing sectors (industrial, artisanal, subsistence, recreational) and major discards, using a catch reconstruction approach.

Keywords: Fisheries, Time series, Trawl surveys, Economic valuation, South-Eastern Mediterranean

Introduction
Fisheries have been providing coastal populations with nutritional resources for millennia; however, with the onset of industrialization in the last century, these resources have generally been exploited faster than they can regenerate [1]. Global fish catches increased throughout the 1960s and 1970s, mostly due to increased sophistication of fishing vessels and global spatial expansion [2], peaked around 1990 [3], and thereafter were thought to 'stabilize' [4]. It is important for countries to understand the history of their fisheries resource exploitation, to provide a baseline for understanding the future potential of these resources. The Syrian Arab Republic, here referred to as 'Syria', became a charter member of the United Nations in 1945 and achieved independence from France in 1946. Syria's population, which was 3.5 million in 1950, increased to 21 million by 2010, the majority of which lives in a narrow strip of land between the Mediterranean Sea and the coastal mountain range. The coastline is interspersed with cities, towns and villages, all within 5-10 km of each other [5]. The population density is thus highest along the coast, with 405 people•km-2 in Latakia and 370 people•km-2 in Tartous [6].

Syria borders the Levantine Basin of the eastern Mediterranean Sea, which extends from southern Turkey to Egypt. The continental shelf is narrow (1-10 nautical miles wide) and measures approximately 960 km2 (www.seaaroundus.org), while Syria's Exclusive Economic Zone (EEZ) measures approximately 10,000 km2 (www.seaaroundus.org). Fisheries catches in the eastern Mediterranean are much lower than the western Mediterranean due to lower nutrient availability and the absence of a mixing mechanism such as upwelling. The Nile River had traditionally been the main source of nutrient input into the eastern Mediterranean, but since the construction, in 1970, of the Aswan Dam in Egypt, only a fraction of the previous nutrient-rich discharge reaches the Mediterranean. Hence, pelagic catches in Syria were noticeably reduced from the late 1960s onwards due to theAswan Dam completion [7].

Materials and Methods
All fishing sectors were assessed from 1950 to 2010, which includes the industrial (large-scale commercial), artisanal (small-scale commercial), recreational (small-scale non-commercial), and subsistence (small-scale non-commercial) sectors, as well as major discards. We conducted an extensive review of all published literature, grey literature and unpublished data from local experts to obtain a first comprehensive assessment for total Syrian fisheries catches (i.e., landings + discards) from 1950 to 2010. The total reconstructed data, by taxa, are then compared to the data reported by FAO, on behalf of Syria .

Results
The total reconstructed catch for the 1950-2010 time period (inclusive of reported data) is nearly 170,000 t, which is 78% more than the amount reported to the FAO. Importantly, by 2010, actual total catches are over 2 times higher than reported data suggest. The reconstruction added over 74,000 t of unreported catches, consisting of 38,600 t of previously unreported artisanal landings, over 16,000 t of unreported industrial landings, over 4,000 t of recreational catches, over 3,000 t of subsistence catches and around 12,000 t of discards. Syrian fisheries are dominated by the artisanal sector (accounting for 67% of total catches), while the industrial, recreational and subsistence catches account for 29%, 3% and 2%, respectively. Discards accounted for 7% of total catches .

Conclusion
Our reconstructed catch estimate for Syria's marine fisheries provides a first comprehensive account of likely total fishery removals by Syria for 1950-2010. This study also supports other observations that the state of the fisheries is indeed declining due to overexploitation, as suggested by the observed increase in fishing effort, declining CPUE and the amount of juvenile fish in the catches. More efficient management measures are urgently needed, to ensure Syrians can benefit more from their local fisheries now and into the future.

References
1 - Pauly, D., Christensen, V., Guénette, S., Pitcher, T. J., Sumaila, U. R., Walters, C. J., ... & Zeller, D. (2002). Towards sustainability in world fisheries. Nature, 418(6898), 689-695.
2 - Swartz, W., Sala, E., Tracey, S., Watson, R., & Pauly, D. (2010). The spatial expansion and ecological footprint of fisheries (1950 to present). PloS one, 5(12), e15143.
3 - Watson, R., & Pauly, D. (2001). Systematic distortions in world fisheries catch trends. Nature, 414(6863), 534-536.
4 - FAO 2010 FishStat fishery statistical collections: aquaculture production (1950–2008; released March 2010). Rome, Italy: Food and Agriculture Organization of the United Nations.
5 - Rees, A. F., Saad, A., & Jony, M. (2005, May). Marine turtle nesting survey, Syria 2004: discovery of a" major" green turtle nesting area. In Book of Abstracts of the Second Mediterranean Conference on Marine Turtles. Antalya, Turkey (pp. 4-7).
6 - United Nations Environment Program (UNEP) (2009), Independent Environmental Assessment: Beijing 2008 Olympic Games, U.N. Environ. Programme, Nairobi, Kenya.
7 - FAO 2004 FAO Nutrition's data. See www.fao.org.

POT FISHERY OF *NEPHROPS NORVEGICUS* (L.) IN THE CHANNELS OF THE EASTERN-CENTRAL ADRIATIC

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Abstract
Catches of pots used for Norway lobster (*Nephrops norvegicus*) fishery in Brac and Hvar channel in the central Adriatic Sea during different seasons were analysed. Data on fishing effort, qualitative and quantitative composition of total catch of 13 800 pot deployments, sex ratio, length-weight relationship and length distribution of Norway lobster were collected. Based on actual fisherman records of *N. norvegicus* catch long term trend was obtained.

Keywords: Decapoda, Central Adriatic Sea, Demersal, Fisheries

Introduction

Norway lobster is of major commercial importance in Croatia whose catch according to Croatian statistical data in 2013 amounted 300 tons. Earlier investigations of distribution and abundance of Norway lobster in Adriatic Sea [1] have shown it's widespread in the northern and central Adriatic where it's exploited with pots and bottom trawl nets at open sea and channel areas. According to the legislation total number of pots per license is 300. The Norway lobster is mainly targeted by bottom trawlers whose selectivity is poor. Due to the unselectivity of trawl alternative fishing methods targeting *N. norvegicus* like pot fishing are an important area of research.

Material and methods

The research was carried out in the Brac and Hvar Channel (Easter-Central Adriatic), at a depth of 69-90 meters from March till August 2014. All pots were immersed within 1.5 NM from the coast, and the period of immersion was usually one day. The pot's frame is made of iron wire with a diameter of 5 mm, covered by netting with mesh size of 40 mm. Dimensions of used pots are: length 70 cm, width 45 cm and height 27 cm. Pots were deployed in 10 series of 30 pieces and the distance between every single pot was 25 m. The pots were baited with horse mackerel and sandy swimming crab (*Liocarcinus depurator)* which is also a by-catch in pot fishery. Data of fishing effort, qualitative and quantitative composition of total catch of 13 800 deployed pots were standardized as average catch in kilograms per 100 pots. All sampled individuals of Norway lobster (N=2866) were sorted according to sex. TL for an each specimen was measured as the distance from the tip of the rostrum to the end of the telson to nearest 0.1 cm using a ruler. Based on actual fisherman records of *N. norvegicus* catch from 1988 till 2015 long term trend was obtained.

Results and discusion

Average total catch in the investigated period was 4.1 kg per 100 pots. The proportion of Norway lobster within total catch was 54,76% while the by-catch was dominated by nursehound (*Scyliorhinus stellaris*) and octopus (*Octopus vulgaris*), 10,95% and 8,29% respectively. Average catch of Norway lobster ranged from 1.41 in March to 2.86 kg in April. Earlier studies [2] showed similar data of catch composition but average catch of Norway lobster was 2.94 kg. Total length of all analyzed specimens ranged from 9.4 to 21.9 cm (14.65 ± 2,09) and the sex ratio was 1:1.1 in favor of females. Dominant length class was 13.5 cm (9.68%). TL of females ranged from 9.4 to 21.6 cm (14.24 ± 1.92), while TL of males ranged from 9.7 to 21.9 cm (15.10 ± 2.17). Females were mostly dominant in length class 13.5 cm (12.10%), while males within length class 14.5 cm (9.91%). There were no specimens with TL less than 9.0 cm (immature specimens), which proves high selectivity of this fishing. The length–weight relationship of analysed specimens showed positive allometry (b=3.2604). Similar growth pattern has been estimated in other areas of Adriatic Sea [3]. The average catch of *N. norvegicus* per unit of fishing effort shows a negative historical trend (Fig.1), as it points to a significant decline in 2001 while from 2004 until today ranges from 2.7 to 3.4 kg per 100 pots.

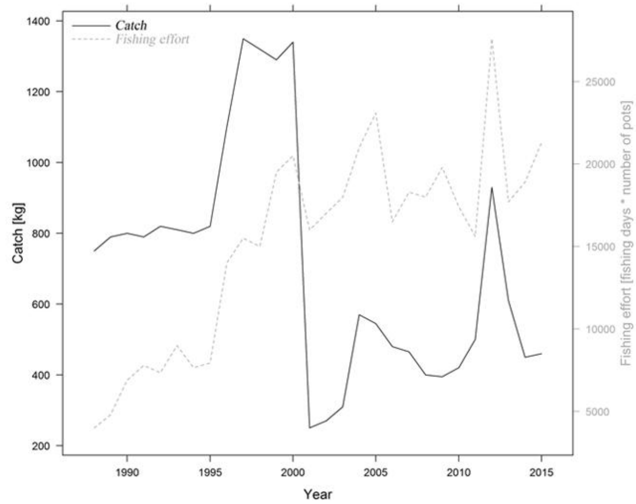

Fig. 1. The average catch of Norway lobster and fishing effort in Brac and Hvar channel based on actual fisherman records during the past.

References
1 - Marano G., Marsan R., Pastorelli A.M., Vaccarella R., 1998. Areale di distribuzione e pesca dello scampo, *Nephrops norvegicus* (L.), nelle acque del basso Adriatico. Biologia Marina Mediterranea, 5 (2): 284-292.

2 - Vrgoc N., Arnen E., Jukic-Peladic S., Krstulovic Šifner S., Mannini P., Marceta B., Osmani K., Piccinetti C., Ungaro N., 2004. Review of current knowledge on shared demersal stocks of the Adriatic Sea. FAO-MiPAF Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea. AdriaMed Technical Consultation, 12: 1-9.

3 - Soldo A, Cetinic P., Dulcic J., 1999. Catch of Norway lobster – *Nephrops norvegicus* (L:) in the Adriatic with lobster pot of different mesh size. Proceedings of the International Symposium on Responsible Fisheries & Fishing Techniques. *Ed*. J. Swiniarski & E. Ceronik, Insko-Poland 16-19 June: 281-288.

A SELECTIVITY STUDY ON THE BOTTOM TRAWL CODEND IN THE SOUTHERN BLACK SEA COAST (SAMSUN SHELF AREA, TURKEY)

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Abstract
In this study, experiments were carried out to test selectivity of trawl codend (40D) used by the commercial trawl fisherman and three meshes different in shape and size (40S, 36S and 40T90) for two target species; whiting (*Merlangius merlangus*) and red mullet (*Mullus barbatus*) in the southern Black Sea,Turkey. Results of the selectivity analysis show that presently used commercial 40 mm nominal mesh size is rather unselective to release sufficient amount of juveniles. The highest selectivity values were obtained in the 40S codend.
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Keywords: Black Sea, Fisheries, Trawl surveys

Introduction
The discard rate in bottom trawl fishing was determined high especially for red mullet and whiting by monitoring studies on trawl fishery in SSA [1]. Mesh size of codend used in bottom trawl nets in the Turkish Black Sea cannot be smaller than 40 mm. The range of age groups for whiting discard was 0-2 yr and 0-1 yr for red mullet [1]. This causes a great economic loss and has impacts indirectly on food web and on the benthic ecosystem. The high discard rate indicates that there is a heavy fishing pressure on red mullet and whiting populations in Southern Black Sea.

Material and Method
Selectivity trials were carried out onboard the commercial trawler (20 -27 Aug 2014). Trawling was carried out by using four different codends with a total of 21 valid hauls for red mullet and 20 valid hauls for whiting. We tried four codends different in mesh size and shape: 40 mm-diamond, 40 mm polyethylene material and T-90 (90º rotated 40D) 36 mm-square and 40 mm-square. They were attached to the end of funnel which have 300 meshes in its circumference and made of 40 mm mesh size PE netting. The hooped-covered codend method was used to collect selectivity data [2]. These parameters were calculated by maximum likelihood using the software CC 2000 [3]. Mean selectivity curves using EC Model software were estimated by taking into account the between-haul variation of the selectivity parameters according to [3].

Results and Discussion
Mean selectivity curves for red mullet for all codends are shown in Figure 1.

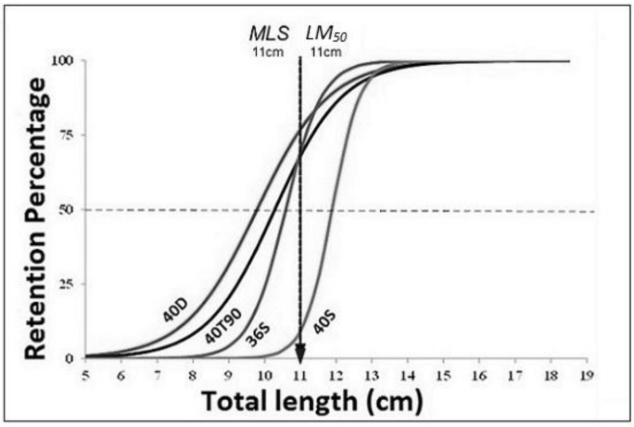

Fig. 1. Mean selection curves for red mullet for all codends.

MLS (minimum landing size) and estimated LM_{50} (length at first maturity) for red mullet is 11 cm. The highest rate of discard (18.1%) was determined in the conventional gear net (40 mm-diamond mesh 40D) still used by fishermen. The best selectivity results were obtained in the 40S codend. Estimated L_{50} (50% retention rate) values for 36S, 40S and 40T90 were higher than the values estimated for 40D. Mean selectivity curves for whiting for all codends are shown in Figure 2. MLS for whiting is 13 cm and LM_{50} is 14 cm. The highest rate of discard was 29.5% for the conventional gear net (40 mm-diamond mesh) still used by fishermen.

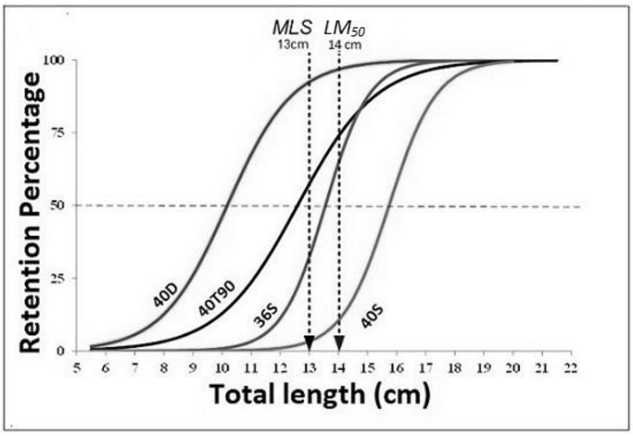

Fig. 2. Mean selection curves for whiting for all codends.

The best selectivity results were obtained in the 40S codend. Estimated L_{50} (50%retention rate) values for 36S, 40S and 40T90 were higher than the values estimated for 40D. It is reported that commercial trawl codend used in Turkey are rather unselective for these species [4]. Square mesh trawl codend had a positive effect on size selectivity of red mullet and whiting. The full square mesh codend in general improved the selectivity for round fish such as whiting and red mullet. Though the best result of selectivity values were obtained in the 40S codend, the trawl fisherman are not in favor of use of this codend (40S).

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References
1 - Zengin, M.,Gümüs, A., Süer, S., Van, A., Özcan Akpinar, I. and Dagtekin, M., 2014. *Discard trends of bottom trawl fishery along Samsun Shelf Area of the Turkish Black Sea coast.* ICES Symposium, Effects of fishing on benthic fauna, habitat and ecosystem function, June 16-19, 2014, Tromso, Norway. Abstracts Books, 69 p.
2 - Wileman, D.A., Ferro, R.S.T., Fonteyne, R. and Millar, R.B. (eds.), 1996. Manual of Methods of Measuring the Selectivity of Towed Fishing Gears. Copenhagen, ICES Cooperative Research Report No. 215, 126 pp.
3 - Fryer, R.J.,1991. A model of between-haul variation in selectivity. ICES J. Mar. Sci., 48: 281-290.
4 - Tokaç, A., Herrmann, B., Aydin, C., Kaykaç, H., Ünlüler, A.and Gökçe, G., 2014. Predictive models and comparison of the selectivity of standard (T0) and turned mesh (T90) codends for three species in the Eastern Mediterranean. Fish. Res. 150: 76-88.

CIESM Congress Session : Feeding ecology and physiology
Moderator : Carolina Giraldo, Lille Univ., France

Moderator's Synthesis

Following the presentations on feeding ecology and physiology of marine species (mainly fish) from the Mediterranean, the debate on main knowledge gaps, challenges and hot topics on the area highlighted these key points:

1. We have gathered information on dietary patterns and food web structure using different approaches, mainly from direct observation or biochemical markers (stomach content analysis, stable isotopes, fatty acids) and modelling. But how can we make them work together? There is a need to direct our efforts towards approaches that can integrate information coming from different methods and the scientific community would benefit from more collaboration between "experimental scientist", "theoretical scientist" and "modelers".

2. Feeding ecology and food webs are complex systems that we are generally forced to simplify by aggregating species into functional groups. By doing this we have successfully identified general patterns but we still need to further explore and evaluate the impact of individual variability on feeding patterns and their effect in overall food webs. Individual-based approaches appear as a fruitful avenue for this topic.

3. The concept of "trophic niche" is at the center of feeding ecology and food webs. Scientists should acknowledge that depending on the methods used, the inferences that we make are only "proxys" of this niche (e.g., isotopic niche vs trophic niche) and try to include in their analysis other environmental or biological interactions that can better translate the niche concept.

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MOLLUSCS AS FOOD SOURCES FOR SOME FISHES IN THE TURKISH AEGEAN SEA: A SYNTHESIS

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Abstract
Diet composition studies conducted in fishes contribute to the interpretation of the food chain in aquatic ecosystems. In this study, molluscs as a prey of fishes, have been dealing for the first time with a different approach to determine the importance of this group invertebrate in the diet composition of the fishes. With this purpose, totally 20 fish species distributed along the Turkish Aegean coast and previously studied for the diet composition were compared among them, regarding the index of relative importance percentage (IRI%) of molluscs. Among the subjected in the present study taxa, *Chimaera monstrosa* (IRI%=16.00) and *Belone belone* (IRI%=13.88) are the species mainly prefereing molluscs, while in the diet composition of *Sardina pilchardus*, and *Scomber japonicus* the part of molluscs was in trace amounts (IRI ≤0.01).

Keywords: Fishes, Mollusca, Food webs, Aegean Sea

The total number of fish species reported from the Turkish seas is 512, of which 449 species are distributed in the Aegean Sea followed by the Levantine Sea (441 species), the Sea of Marmara (257 species) and the Black Sea (154 species) [1]. With its special ecological and geo-morphological features, the Aegean Sea is an important feeding, breeding and growth area for many fishes, where inhabiting 88% of the species known to be distributed in the Turkish seas. The results of stomach content analyses of different fishes distributed in the Aegean Sea showed that many species are feeding especially on crustaceans and molluscs. Based on an exhaustive literature survey, we especially tried to delineate the importance of molluscs as a potential prey for fishes. Among the invertebrate taxa, the phylum Mollusca is one of the richest group, including about 50.000 marine living species in worldwide [2]. They are mostly benthic organisms inhabiting various habitats up to abyssal depths. In a recently published study, 1065 mollusc species were reported from the Turkish coasts, of which 825 species are known to be distributed along the Turkish Aegean coast [3]. Although the high species richness and wide distribution of molluscs in marine environements, the knowledge on their role in the Aegean Sea trophodynamics are very few. So it is the purpose of our study to compile the molluscs prey groups of the some fishes distributed along the Turkish coast of the Aegean Sea, and it would be the first attempt to summarize the available information about the molluscs as prey. A total of 20 fish species (5 species within 5 families of the classis Chondrichtyes and 15 species within 11 families of the classis Ostreichtyes) distributed in he Aegean Sea (Table 1 and 2), and for which were stated molluscs are prey, have been dealing with the present study. Some indices have been used to quantify the importance of different prey items in the diets of the investigated species. The main food items were identified using the index of relative importance IRI = F% * (N% + W%). The index was expressed as IRI% = (IRI / ∑ IRI) * 100. Among the subjected in the present study, *Chimaera monstrosa* Linnaeus, 1758 (IRI%=16.00) [4] and *Belone belone* (Linnaeus, 1761) (IRI%=13.88) [5] were found to be the most molluscs prefered species, while in the diet composition of *Sardina pilchardus* (Walbaum, 1792), *Syngnathus acus* Linnaeus, 1758 and *Scomber japonicus* Houttuyn, 1782 (Ostreichtyes) the part of molluscs was in trace amounts (IRI ≤0.01).

Tab. 1. Prey groups of cartilaginous fishes distributed along the Aegean Sea coast of Turkey (IRI% = Index of Relative Importance percentage)

Family/ Species	Prey groups	Mollusca (IRI%)
Scyliorhinidae *Galeus melastomus* Rafinesque, 1810	Decapoda, Cephalapoda, Gadidae, Macrouridae	2.98
Triakidae *Mustelus mustelus* (Linnaeus, 1758)	Polychaeta, Crustacea, Cephalapoda, Teleostei	2.20
Squalidae *Squalus blainvillei* (Risso, 1827)	Natantia, Cephalapoda, Cnidaria, Echinodermata, Argentinidae, Gadidae	10.27
Rajidae *Raja clavata* Linnaeus, 1758	Polychaeta, Mysidacea, Brachyura, Cephalapoda, Scyliorhinidae, Clupeiformes, Gadiformes, Gobiidae, Pleuronectiformes	0.37
Chimaeridae *Chimaera monstrosa* Linnaeus, 1758	Bryozoa, Cnidaria, Brachyura, Bivalvia, Gastropoda, Cephalapoda, Tunicata, Teleostei	16.00

Tab. 2. Prey groups of bony fishes distributed along the Aegean Sea coast of Turkey (IRI% = Index of Relative Importance percentage)

Family/ Species	Prey groups	Mollusca (IRI%)
Clupeidae *Sardina pilchardus* (Walbaum, 1792)	Polychaeta, Copepoda, Pteropoda, Appendicularia, Thaliacea	≤0.01
Clupeidae *Sardinella aurita* Valenciennes, 1847	Polychaeta, Malacostraca, Copepoda, Cirripedia, Bivalvia, Pteropoda, Chaetognatha, Tunicate, Teleostei	0.44
Engraulidae *Engraulis encrasicolus* (Linnaeus, 1758)	Siphonophora, Polychaeta, Cladocera, Copepoda, Cirripedia, Ostracoda, Malacostraca, Appendicularia, Gastropoda, Bivalvia, Thaliacea, Teleostei	3.88
Chlorophthalmidae *Chlorophthalmus agassizi* Bonaparte, 1840	Foraminifera, Copepoda, Malacostraca, Sepiolidae, Chaetognatha, Teleostei	0.09
Belonidae *Belone belone* (Linnaeus, 1761)	Polychaeta, Cladocera, Copepoda, Cirripedia, Ostracoda, Malacostraca, Pteropoda, Thaliacea, Belonidae, Clupeidae, Maenidae, Grylidae, Formicidae, Diptera	13.88
Syngnathidae *Hippocampus hippocampus* (Linnaeus, 1758)	Copepoda, Ostracoda, Cladocera, Malacostraca, Pycnogonida, Bivalvia, Teleostei	5.68
Hippocampus guttulatus Cuvier, 1829	Copepoda, Malacostraca, Pycnogonida, Gastropoda, Bivalvia, Teleostei	1.35
Nerophis ophidion (Linnaeus, 1758)	Copepoda, Ostracoda, Cirripedia, Malacostraca, Gastropoda, Cnidaria	12.63* *(W%)
Syngnathus acus Linnaeus, 1758	Ostracoda, Copepoda, Malacostraca, Cirripedia, Gastropoda, Bivalvia, Echinodermata, Insecta	≤0.01
Carangidae *Trachurus mediterraneus* (Steindachner, 1868)	Polychaeta, Ostracoda, Copepoda, Cladocera, Malacostraca, Gastropoda, Bivalvia, Cephalopoda, Chaetognatha, Teleostei	6.35
Trachurus trachurus (Linnaeus, 1758)	Polychaeta, Ostracoda, Copepoda, Cladocera, Malacostraca, Gastropoda, Bivalvia, Cephalopoda Chaetognatha, Teleostei	0.07
Sparidae *Dentex maroccanus* Valenciennes, 1830	Malacostraca, Ostracoda, Copepoda, Pteropoda, Gastropoda, Bivalvia, Teleostei	8.39
Scombridae *Scomber japonicus* Houttuyn, 1782	Hydrozoa, Polychaeta, Cladocera, Ostracoda, Cirripedia, Malacostraca, Gastropoda, Opistobranchia, Bivalvia, Cephalopoda, Chaetognatha,Thaliacea,Teleostei	≤0.01
Citharidae *Citharus linguatula* (Linnaeus, 1758)	Polychaeta, Copepoda, Malacostraca, Cephalopoda, Teleostei	0.13

References
1 - Bilecenoglu M., Kaya M., Cihangir B. and Cicek E., 2014. An updated checklist of the marine fishes of Turkey. *Turk J Zool*, 38: 901-929.
2 - Bouchet P., 2006. The magnitude of marine bodiversity. *In*: Duarte, C. M. (ed.), The exploration of marine biodiversity: scientific and technological challenges. Fundación BBVA, Bilbao, pp 31-62.
3 - Öztürk B., Dogan A., Bitlis Bakir B. and Salman A., 2014. Marine molluscs of the Turkish coasts: an updated checklist. *Turk J Zool*, 38: 832-879.
4 - Eronat E.G.T., 2016. Feeding ecology and trophic level of *Chimaera monstrosa* Linnaeus, 1758 (Holocephali: Chimaeridae) in the Eastern Mediterranean, *Zoology in the Middle East*, 62(1): 51-57.
5 - Sever T.M., Bayhan B., Bilge G. and Taskavak E. 2009. Diet composition of *Belone belone* (Linnaeus, 1761) (Pisces: Belonidae) in the Aegean Sea. *J Appl Ichthy*, 25(6): 702-706.

VARIATION DE LA COMPOSITION DES CATÉGORIES LIPIDIQUES DE LA RÉTINE DU LOUP DE MER SOUS L'EFFET DE LA TEMPÉRATURE DU MILIEU

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Abstract
A ce jour, on ne sait rien de l'impact de la température sur le profil en acides gras totaux et les catégories lipidiques dans la rétine des vertébrés poïkilothermes. Nous rapportons ici les premières données obtenues chez le loup de mer *Dicentrarchus labrax*. Il ressort que les températures élevées (>23°C) entrainent des remaniements significatifs au niveau des phospholipides et triacylglycérols ; les omégas 3 et 6 sont les plus impactés en particulier l'acide docosahéxaénoïque (DHA) et écosapentaénoïque (EPA) qui jouent un rôle essentiel dans la structure et la fonction des photorécepteurs en particulier et du processus visuel en général.

Keywords: Temperature, Global change, Fishes, Physiology, Mediterranean Sea

Introduction
La photopériode (alternance lumière et obscurité), la température et l'alimentation sont des facteurs importants du développement des poissons [1]. En aquaculture, la demande croissante conduit à rechercher la substitution d'aliments d'origine animale par ceux d'origine végétale. Ceci pose des problèmes car les compositions en acides gras de ces aliments diffèrent ; elles ne correspondent pas nécessairement aux besoins des poissons, en particulier au niveau du cerveau et de la rétine. Une composition inadaptée en acides gras implique des problèmes majeurs de vision et de transmission de l'information environnementale au cerveau. Par ailleurs, les poissons sont poïkilothermes et l'assimilation des aliments dépend fortement de la température [2]. Dans ce contexte, nous avons abordé l'étude de l'impact de la température sur la composition lipidique de la rétine chez le loup de mer, *Dicentrarchus labrax*.

Matériel et Méthodes
Les poissons ont été répartis en trois aquariums et acclimatés pendant 30 jours à, respectivement, 18°, 23° et 28°C. Six rétines ont été prélevées pour analyses des acides gras totaux dont trois ont servi pour l'identification et l'analyse des catégories lipidiques. Les lipides totaux ont été extraits par un mélange de solvants chloroforme/méthanol (2/1) selon la méthode de Folch et al. [3] et les catégories lipidiques ont été séparées par chromatographie sur couche mince [4] ; après méthylation selon la méthode de Cecchi [5] les esters méthyliques ont été analysés par chromatographie en phase gazeuse (HP 6890).

Résultats et discussion
Les acides gras totaux majoritaires identifiés dans la rétine voient leurs quantités fortement diminuées par les deux températures les plus hautes. Il s'agit des acides palmitique (C16:0 ; -40%), oléique (C18:1 ; -50%), linoléique (C18:2n-6 ; -66%), eicosapentaénoïque (EPA, C20:5n-3 ; -66%) et docosahexaénoïque (DHA, C22:6n-3 ; -35%). La quantité des acides gras totaux des différentes familles (saturés [SFA], monoinsaturés [MUFA] et polyinsaturés [PUFA]) a diminué avec l'augmentation de la température ; ceci est corrélé avec l'augmentation du rapport W3/W6 qui passe de 1,66 (18°C) à 2,7 (23 et 28°C). Enfin, nous notons que les lipides polaires augmentent avec la température, alors que les lipides neutres diminuent. Ceci est expliqué par la diminution des triacylglycérols avec l'augmentation de la température qui passent de 50,40% du total des lipides neutres à 30,53%, et par l'augmentation des phospholipides qui passent de 31,35% à 46,58% (Figure 1). Les données montrent pour la première fois que la température module la composition en acides gras de la rétine. Elles ouvrent la voie à des recherches sur les modalités de ces remaniements et leurs conséquences fonctionnelles en particulier, compte tenu du rôle de certains de ces acides, tel le DHA, dans le maintien de l'intégrité structurale et fonctionnelle de la rétine en général et des cellules photoréceptrices en particulier. Cette problématique prend de l'importance dans le contexte du changement climatique global et de l'élévation des températures.

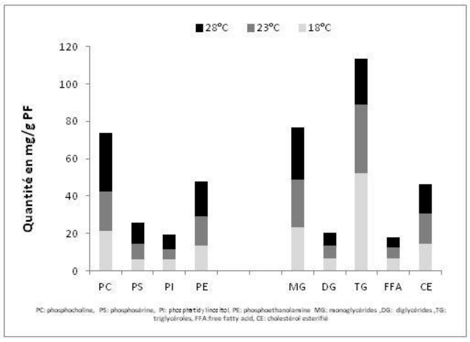

Fig. 1. Quantité des phospholipides et des lipides neutres en mg/g de PF aux 3 températures au niveau de la rétine chez *Dicentrarchus labrax*

References
1 - Boeuf G. and Falcón J., 2001: Photoperiod and growth in fish. Vie et Milieu, 51, 237-246.
2.El Cafsi, M. Romdhane, M. S. Chaouch, A. Masmoudi, W. Khériji, S. Chanussot, F. and Chérif, A., 2003: Qualitative needs of lipids by mullet, *Mugil cephalus*, fry during fresh water acclimation. Aquaculture, 225, 233-24
3.Folch J., Lees M. and Sloane-Stanley G.A., 1957: A simple method for the isolation and purification of total lipids from animal tissues. J Biol Chem, 226, 497-509.
4.Olsen and R. J. Henderson, 1989: The rapid analysis of neutral and polar marine lipids using double development HPTLC and scanning densitometry. J Exp Mar Biol Ecol, Vol. 129, 2,189-197.
5.Cecchi G., Basini S. and Castano C., 1985: Méthanolyse rapide des huiles en solvant. Rev Fr Corps Gras, 32, 163-164.

SEASONAL VARIATION OF LIPID CONTENT AND FATTY ACID COMPOSITION OF NOAH'S ARK (*ARCA NOAE*) FROM BIZERTE LAGOON (NORTHERN TUNISIA)

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Abstract

The aim of this work was to study the natural variations in lipid and fatty acid composition and their health-related lipid indices in the soft tissue of *Arca noae* seasonally sampled from Tunisian costs. The level of saturated fatty acid and unsaturated fatty acid showed significant variability during seasons. The polyunsaturated fatty acid, EPA (C20:5n-3) and DHA (C22:6n-3) were the most abundant (5.16-6.48 % and 8.12-11.50 %, respectively). Oleic acid (C18:1(n-9)) was the most abundant monounsaturated fatty acids (6.76-9.64%) and palmitic acid (C16:0) was the most abundant saturated acid (17.21-25.97 %). In comparison, with saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) constituted the highest proportion in *A. noae*.

Keywords: Bivalves, North-Eastern Mediterranean, Lagoons

Introduction

Biochemical studies of bivalve tissue are of considerable interest to assess their nutritional value in terms of energy units. Lipids represent an important energy reserve because of their high caloric contents; they are mainly used in chronic stress conditions. Noah's Ark (*Arca noae*) is a commercially edible epifaunal bivalve mostly harvested and exploited in Croatia (Adriatic Sea). However, the commercial exploitation of this ark shell in Tunisia is not yet denoted and still limited to the unregulated catches. To the best of our knowledge, this is the first investigation on the lipid content and fatty acids profile of the Tunisian *A. noae.*

Materials and methods

Ten mature specimens of *Arca noae* (40 mm – 60 mm) were collected monthly from Bizerte lagoon at a depth of 3 meters by scuba diving between October 2013 and September 2014. Lipids were extracted according to the method of Folch [1]. Lipid extracts were trans-esterified according to the method of cecci [2]. The fatty acid methyl esters (FAMEs) were analyzed by capillary gas chromatography. The evolution of the reproductive activity of *Arca noae* was followed through Condition index (CI). Data was analyzed using STATISTICA 8 according to the One Way Analysis of Variance method (ANOVA).The method used to discriminate between the means was Kruskal Wallis and the differences between samples were deemed to be significant at $p < 0.05$.

Results and discussions

Lipid content ranged between 2.98 and 7.14 %. Lower values of CI, were registered in summer and autumn 2014, probably correspond to the spawning period. During this season, high lipid levels in *A. noae* were noted, this indicates that lipids can play a role in the maturation of gametes; they increase during summer in sexually ripe animals and decrease in autumn and winter. Fatty acid composition of the soft tissue of *Arca noae* is shown in Table 1. The palmitic C16:0, oleic C18:1 (n-9) and palmitoleic C16:1 (n-7) acids dominated among the saturated (SFAs) and monounsaturated fatty acids (MUFAs), respectively, while among the polyunsaturated fatty acids (PUFAs), docosahexaenoic acid (DHA, C22:6n-3) and eicosapentaenoic acid (EPA, C20:5n-3) prevailed. These findings were in agreement with those reported by Radic et al. 2014 [3]. SFA and MUFA variations were similar during this study but inverse to that of PUFA. Results in Table 1 clearly showed that *A. noae* soft tissue were rich in (n-3) than (n-6) PUFA, nutritionally essential for growth and condition. The low values of AI (Index of Atherogenicity) and the very low TI (Index of Thrombogenicity) reveal a very interesting nutritional quality of this bivalve (Table 1). The fatty acid composition of *Arca noae* corresponds in general to a healthy marine mollusks pattern characterized by a high degree of unsaturation, being similar to those of other adult marine bivalves [3].

Tab. 1. Seasonal variation of Fatty acid composition (% of total fatty acids) in the soft tissue of A. noae. Results are given as mean ± SD (n=6).

I	Autumn 13	Winter 14	Spring 14	Summer 14	Autumn 14
C14:0	4.94±0.54	4.39±1.20	5.63±0.81	7.62±1.01	5.68±1.33
C15:0	1.03±1.03	0.66±0.42	0.63±0.35	0.86±0.08	0.45±0.40
C16:0	22.14±4.70	17.21±4.23	20.64±4.65	25.97±1.45	21.06±2.13
C18:0	6.35±0.16	4.87±0.88	5.10±0.19	5.68±0.05	6.36±1.07
C20:0	0.65±0.89	0.69±0.72	0.09±0.05	0.10±0.02	0.16±0.05
C22:0	0.26±0.04	0.38±0.19	0.70±0.36	0.63±0.30	0.63±0.57
C24:0	0.61±0.49	0.67±0.17	0.62±0.49	0.36±0.10	0.25±0.19
Σ *SFA*	**36.00±1.51**	**31.58±2.93**	**33.45±3.53**	**40.80±2.27**	**34.62±2.05**
C14:1	0.97±0.92	0.73±0.53	0.89±0.21	0.41±0.21	0.63±0.60
C15:1	0.77±0.48	0.70±0.11	0.54±0.17	0.64±0.12	0.50±0.30
C16:1n-7	7.20±0.19	6.11±1.89	5.61±1.57	7.51±1.63	6.74±1.65
C18:1n-9/n-7	7.99±4.42	6.76±1.34	7.81±1.30	9.64±0.21	8.09±1.77
C20:1n-9	4.58±0.94	4.49±1.69	2.32±0.12	3.22±0.70	5.20±0.85
C20:1n-7	2.92±2.58	3.15±1.96	3.15±2.16	1.76±0.81	1.47±0.63
C22:1n	0.35±0.36	0.32±0.26	0.21±0.09	0.13±0.06	0.17±0.11
C24:1n-9	0.27±0.12	0.38±0.14	0.47±0.36	0.21±0.09	0.18±
Σ *MUFA*	**25.08±1.22**	**25.48±2.88**	**21.04±0.46**	**24.00±3.10**	**23.01±2.45**
C16:2	2.19±0.49	1.93±0.68	1.56±0.24	1.74±0.19	1.72±0.16
C16:3	0.62±0.24	0.63±0.16	1.01±0.54	0.66±0.18	1.17±0.94
C16:4	0.33±0.04	0.65±0.57	1.28±0.86	0.95±0.27	1.14±0.65
C18:2n-6	2.96±1.17	2.64±0.81	3.06±0.53	3.00±0.18	2.20±1.73
C18:3n-6	0.33±0.14	0.34±0.10	0.51±0.42	0.86±0.27	2.22±3.54
C18:3n-3	2.31±0.54	2.47±0.93	3.18±0.68	2.87±0.62	1.60±0.34
C18:4n-3	3.41±4.33	3.93±2.89	1.45±0.78	1.03±0.77	1.23±1.13
C20:2n-6	0.83±0.48	0.61±0.14	0.77±0.28	0.56±0.27	0.42±0.18
C20:3n-6	0.15±0.04	0.10±0.01	0.06±0.01	0.05±0.01	0.11±0.02
C20:4n-6	2.88±0.37	2.68±0.77	2.50±0.51	1.84±0.48	4.34±1.10
C20:3n-3	0.52±0.52	0.49±0.49	0.14±0.00	0.09±0.04	0.07±0.02
C20:4n-3	0.32±0.07	0.25±0.04	0.26±0.02	0.25±0.09	0.25±0.03
C20:5n-3	6.46±0.23	5.48±1.39	6.48±1.24	5.16±0.95	5.78±0.76
C22:2i/2j	3.39±0.58	3.56±1.33	4.28±0.70	2.85±0.67	5.75±2.27
C21:5	0.81±0.05	0.82±0.26	1.68±0.77	1.00±0.05	1.25±0.21
C22:5n-6	1.29±0.34	1.34±0.44	3.23±1.49	2.03±0.36	2.20±1.01
C22:5n-3	1.49±0.40	1.39±0.28	2.48±0.81	1.67±0.20	1.89±0.46
C22:6n-3	8.51±2.61	8.12±2.75	11.50±0.81	8.50±0.75	9.86±1.66
Σ *PUFA*	**38.90±0.29**	**43.64±0.22**	**45.50±3.91**	**35.18±1.28**	**43.29±4.91**
Σ *UFA*	**63.99±1.51**	**69.13±3.11**	**66.54±3.53**	**59.19±2.27**	**66.30±3.18**
Σ *n-3*	**23.05±1.94**	**25.68±1.13**	**25.51±0.61**	**19.61±0.58**	**20.71±2.99**
Σ *n-6*	**8.47±0.82**	**9.16±0.71**	**10.15±1.34**	**8.35±0.37**	**11.52±2.46**
ω3/ω6	**2.74±0.47**	**2.85±0.31**	**2.63±0.21**	**2.38±0.08**	**1.87±0.45**
DHA/EPA	**1.32±0.36**	**1.53±0.20**	**1.69±0.74**	**1.72±0.46**	**1.72±0.35**
AI	**0.87±0.05**	**0.72±0.14**	**0.87±0.10**	**1.20±0.15**	**0.91±0.12**
TI	**0.39±0.06**	**0.30±0.04**	**0.34±0.05**	**0.51±0.027**	**0.41±0.05**

References

1 - Folch J., Less M., and Sloane-Stanley C.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem.*, 266: 497–509.

2 - Cecchi G, Basini S, & Castano, C. 1985. Méthanolyse rapide des huiles en solvant. Revue française des corps gras, n°4.

3 - I. Radic, M. Caric, M. Nadjek, N. Jasprica, J. Bolotin, M. Peharda and A. Cetinic. 2014. Biochemical and fatty acid composition of *Arca noae* from the Mali ston Bay, Adriatic sea. *Medi. Mar. Sci; 520-531.*

COMPARISON OF FEEDING HABITS OF SARDINE *SARDINA PILCHARDUS* (WALB., 1792) AND ANCHOVY *ENGRAULIS ENCRASICOLUS* (L.,1758) FROM THE EASTERN ADRIATIC SEA

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Abstract

In total 207 stomachs of small pelagic fish (sardine and anchovy) from Eastern Adriatic Sea were analysed from June 2014 to October 2015. Total lengths varied from 10.5 to 17.0 cm for sardine and from 13.0 to 17.5 cm for anchovy. Feeding habits of 130 sardines and 77 anchovies reviled 17 different taxa belonging to 10 prey groups.

Average prey numbers in the stomach was similar for both species: 15±47 (sardine) and 16±48 (anchovy). The main prey items for sardine were copepods. For anchovy, bigger prey occurred in the diet, as decapod larvae, amphipods, euphausids and adult copepods.

Keywords: Diet, Fishes, Food webs, Zooplankton , Central Adriatic Sea

Introduction Small pelagic species, as sardine and anchovy, are most abundant and the most important target species in the fisheries of the Eastern Adriatic Sea. Both species are mostly caught by purse seines and they represent 80% of the total fish landing in Croatia. The importance of low trophic levels, such as sardine and anchovy, is also in the functioning of the ecosystem due to their role in capturing energy and making it available to the higher trophic levels [1]. Environmental changes, especially changes in sea water temperature can influence the composition of plankton, which is the main food source of small pelagic fish [2]. Considering close relationship between the environment and small pelagic population dynamics, it is very important to expand the knowledge on feeding behaviour of such species. In this study we compared feeding habits of adult sardines and anchovy in the Eastern Adriatic Sea.

Material and methods

Feeding habits of 130 sardines and 77 anchovies were analysed from June 2014 to October 2015. All the samples were obtained from the commercial purse seine catches of the Eastern Adriatic Sea and measured to the nearest mm and weighed to the nearest g. The entire stomach from each specimen was removed and fixed with ethanol (95%). Identification of food particles in the stomach was performed under the stereomicroscope to the lowest taxon possible. Feeding incidence (FI) was calculated as the percentage of the total number of fish examined having at least one prey in the guts.

Results and discussion

A total length (LT) of 130 sardines varied from 10.5 to 17.0 cm, with an average value 14.22±1.24 cm. Total weight (W) was from 6.78 to 37.17 g. Total length (LT) of 77 anchovies was from 13.0 to 17.5 cm, average value was 14.83±1.15 cm, while total weight (W) varied from 11.11 to 33.32 g. In total 207 stomachs of sardines and anchovies were analysed and 17 different taxa were identified belonging to 10 prey groups (Table 1).

Tab. 1. Percentages of prey categories per fish stomach in terms of numbers (%n) of the sardine and anchovy in the Eastern Adriatic Sea

Prey main group	Prey taxon	Sardine	Anchovy
Bivalvia	Bivalvia larvae	0.10	0
Gastropoda	Pteropoda	0.10	0
Cladocera	-	0.13	0
	Evadne spp.	1.29	0.11
Copepoda	Unidentified calanoid adult	32.55	13.33
	Temora stylifera	3.54	0.82
	Clausocalanus spp.	1.32	0
	Macrosetella gracilis	0	0.04
	Goniopsyllus rostratus	0	0.11
	Centropages spp.	0	0.07
	Pareuchaeta spp.	0	0.07
	Oncaea spp.	0.65	0
	Corycaeus spp.	0	0.25
	Unidentified postnauplii	4.09	0.42
	Copepod eggs	20.15	1.87
Amphipoda	Hyperiidae	2.56	17.54
Isopoda	-	6.48	1.10
Euphausidae	-	0.73	14.69
Decapoda	Decapoda larvae	18.95	36.03
	Decapoda megalopa	0.44	8.60
Fish larvae	-	0.09	1.89
Fish egg	-	5.01	3.07

Average prey numbers in the stomach was similar for both species: 15±47 (sardine) and 16±48 (anchovy). However, the percentage of fish with food in the stomach (FI) was higher in anchovy (79.2%) than in sardine (65.4%). Sardines fed mainly on copepods and copepod developmental stages (>62%) with the main prey species being *Temora stylifera*, *Clausocalanus spp*. and *Oncaea spp*. On the contrary, bigger prey occurred in the diet of anchovy: amphipods, eupahusids and adult copepods, with decapod larvae dominating.

Analyses of composition of the diet and prey selectivity considered only adult specimens with total length from 10.5 to 17.0 cm for sardine and from 13.0 to 17.5 cm for anchovy. Previous records of sardine nutrition in the middle-eastern Adriatic where its diet was composed mostly of copepods (30.1%) and decapoda larvae (22.8%) are quite consistent with our results [3]. Anchovy diet was similar between juveniles and adults in the Adriatic Sea with preference for a few copepod species of small sizes [1]. On contrary, an ontogenetic shift from copepods towards decapods and amphipods as fish increased in size was recorded in Algeria, which is also confirmed with our findings of the adult specimens [4]. Although both co-occurring species consumed similar types of food, our results confirmed that sardine generally consumed smaller prey than anchovy. However, sardine specimens in this study were in general smaller than those of anchovies. Differences in feeding habits are a consequence of different feeding apparatus and feeding behaviour between sardines and anchovies [5]. Furthermore, knowledge of prey availability is essential in order to understand the relative importance of food categories and to assess prey selectivity which will also allow assessing possible competition between those two species for zooplankton.

References

1 - Borme D., Tirelli V., Brandt S.B., Fonda Umani S. and Arneri E., 2009. Diet of *Engraulis encrasicolus* in the northern Adriatic Sea (Mediterranean): ontogenetic changes and feeding selectivity. *Mar. Ecol. Prog. Ser*., 392: 193-209.

2 - Costalago D., Navarro J., Álvarez-Calleja I. and Palomera I., 2012. Ontogenetic and seasonal changes in the feeding habits and trophic levels of two small pelagic fish species. *Mar. Ecol. Prog. Ser.* 460:169-1.

3 - Vucetic T., 1963. Sur la nutrition de la sardine adulte (*Sardina pilchardus* Walb.) dans la partie moyenne de l'Adriatique orientale. *Acta Adriat.*, Vol. X No.2.

4 - Bacha M. and Amara R., 2009. Spatial, temporal and ontogenetic variation in diet of anchovy (*Engraulis encrasicolus*) on the Algerian coast (SW Mediterranean). *Estuar. Coast. Shelf. Sci.*, 85: 257-264.

5 - Van der Lingen C., Hutchings L. and Field J., 2006. Comparative trophodynamics of anchovy *Engraulis encrasicolus* and sardine *Sardinops sagax* in the southern Benguela: are species alternations between small pelagic fish trophodynamically mediated? *Afr. J. Mar. Sci.*, 28: 465-477.

TROPHIC OVERLAP BETWEEN EUROPEAN EEL AND COMMERCIAL FISHES COMMUNITY OF THE LAKE ICHKEUL USING STABLE ISOTOPE ANALYSES

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Abstract

Spatial and temporal variability of European eel *Anguilla anguilla* diet and its trophic overlap were studied and compared with five species of fish community in the Ichkeul Lake using stable isotopes ($\delta^{13}C$ and $\delta^{15}N$). *Anguilla anguilla* showed the smallest isotopic niche followed by *Dicentrarchus labrax*. The eel showed significant trophic overlap mainly with *Mugil cephalus* and *Barbus callensis*. Seasonal variability of stable isotopic compositions reveals a change in eating behavior. Variable prey sources with lacustrine and continental origins are used by *Mugil cephalus* and *Barbus callensis*, while *Liza aurata* and *Liza saliens* use mainly preys with lacustrine and marine origins.

Keywords: Fishes, Food webs, Estuaries, Stable isotopes, Mediterranean Sea

Material and Methods: Fish samples were conducted monthly between March 2011 and April 2012 to obtain seasonal sampling from 11 lacustrine sites using several fishing techniques. This work targeted commercial fish species (Anguillidae, Mugilidae, Moronidae), which were collected principally from the "Societé Tunisie Lagunes" catches. Fish muscle samples is used to examine the isotopic composition for $\delta^{13}C$ and $\delta^{15}N$ [1, 2]. Stomach content analysis completed the isotopic stable analysis according volumetric analysis approach. This latest was consisted of by points method [3, 4].

Result and discussion: A total of 57 fish specimens belonging to 6 species among them the eel *Anguilla anguilla* were analysed for stable isotopes compositions (Table 1). These fish are benthic feeders species, with detritivorous diet for barb and Mugilidae and carnivorous diet for eel and seabass. The fish assemblages showed a clear seasonal variability and a benthic feeder food affinity among fishes (Figure 1). Isotopic characterizations of trophic web allowed defining the fish isotopic niche and isotopic index. The Hierarchical Cluster Analysis (HCA) of fish classification according diet similarities (after stomach content analysis) [5] revealed 4 trophic groups which 3 were mono-specific. The main findings relative to the Ichkeul ecosystem functioning are related to kind of fishes and diet behavior, preys, trophic link and organic matter supplies. Zoobenthic invertebrates constitute the majority of prey ingested by higher levels consumers mainly by fishes (secondary and tertiary consumers).

Tab. 1. Mean values ± standard deviation (SD) of $\delta^{13}C$, $\delta^{15}N$ and trophic categories of Ichkeul lake fishes during wet and dry seasons (*Dicentrarchus labrax* in the wet season were juvenile, when it was adult in dry season).

		Wet season (December to May)		
Species	**n**	**$\delta^{13}C$ ± SD (‰)**	**$\delta^{15}N$ ± SD (‰)**	**C/N ± SD**
Anguilla anguilla	8	-23.64 ± 0.33	16.03 ± 0.33	7.81 ± 0.83
Dicentrarchus labrax	2	-19.90	9.80	3.96
Liza ramada	3	-22.98 ± 2.11	12.41 ± 0.46	3.36 ± 0.03
Liza aurata	2	-21.26	17.32	3.41
Mugil cephalus	3	-28.86 ± 3.22	17.65 ± 0.60	3.35 ± 0.21
Barbus callensis	6	-25.19 ± 1.09	16.42 ± 1.41	3.31 ± 0.06
		Dry season (June to November)		
Anguilla anguilla	7	-23.14 ± 1.02	16.24 ± 0.62	6.74 ± 1.02
Dicentrarchus labrax	6	-18.46 ± 0.22	15.68 ± 0.06	3.26 ± 0.10
Liza ramada	4	-20.15 ± 0.75	13.53 ± 2.21	3.15 ± 0.01
Liza aurata	5	-18.18 ± 3.67	14.80 ± 2.74	3.32 ± 0.20
Mugil cephalus	8	-20.74 ± 0.91	14.71 ± 0.56	3.45 ± 0.11
Barbus callensis	3	-21.30 ± 0.17	14.47 ± 0.35	3.32 ± 0.05

Those invertebrates preys have a major role to ensure transfer of organic matter (POM and SOM) and energy flows from the bottom to the top food web for several fishes alimentary chains. Eel appear as a key-species supporting food web functioning of the Lake Ichkeul (Figure 1). Trophic overlapping, low specific diversity index, overfishing, anthropization impacts on ecosystems, hydrobiological parameter changements and hydrological fragmentation were a real menaces which greatly influenced ecological position, stocks, functional role of *Anguilla anguilla*.

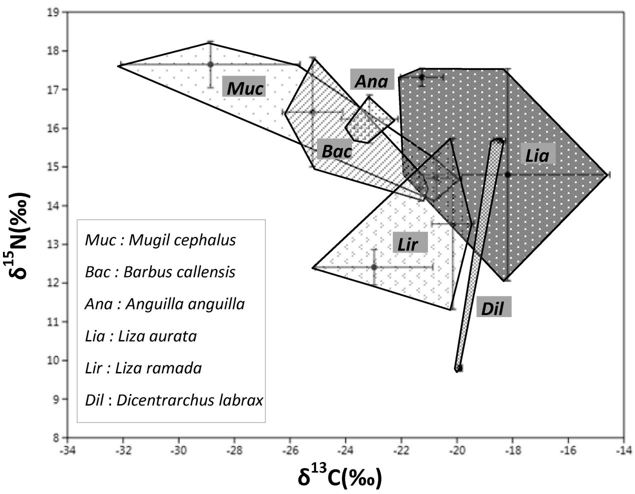

Fig. 1. Fish isotopic niches under δ-space ($\delta^{13}C$-$\delta^{15}N$) from Ichkeul Lake.

References

1 - Pinnegar J.K. and Polunin N.V.C. 1999. Differential fractionation of $\delta^{13}C$ and $\delta^{15}N$ among fish tissues: implications for the study of trophic interactions. *Funct. Ecol.*, 13: 225-231.

2 - Lorrain A., Savoye N., Chauvaud L., Paulet Y.M. and Naulet N. 2003. Decarbonation and preservation method for the analysis of organic C and N contents and stable isotope ratios of low-carbonated suspended particulate material. *Anal. Chim. Acta*, 491: 125-133.

3 - Rounsefell G.A. and Everhard W.H. 1953. Fisheries science: its methods and applications. New York, Wiley and Sons, pp 444.

4 - FAO 1974. Methods of Resource Investigation and their Application. *Manual of Fisheries Science Part 2. Fisheries technical paper*, 115: 115-255.

5 - Shaiek M., Romdhane M.S. and Le Loc'h F. 2015. Study of the ichthyofauna diet in the Ichkeul Lake (Tunisia). *Cybium*, 39 (3) : 193-210.

CIESM Congress Session : Food webs and trophic dynamics
Moderator : Ulrich Sommer, GEOMAR, Kiel, Germany

Moderator's Synthesis

The discussion concentrated on three issues: the role of pathogens and parasites, food chain length and a potential role of neutral models.

Pathogens and parasites: One participant asked whether food web studies consider the role of parasites. The discussion quickly expanded to pathogens and parasites in general. While their role is widely acknowledged in present day evolutionary biology, they still play an (almost) neglected role in empirical and modeling studies of food webs and biogeochemical cycles. A fundamental difference to classic predator-prey relationships was seen in the fact, that there is no 1:1 relationship between mortality of the prey and biomass consumption by the consumer, like in the case of big fish eating small fish. It was pointed out, that the same applies to some benthic resource-consumer relationship, e.g. when a sea urchin consumes only the holdfast of a kelp, while the entire plant is lost from the system.

Food chain length: We had an intense discussion about the conspicuous length difference between terrestrial and aquatic, in particular, pelagic food chains and the factors which control food chain length. Besides the classic hypotheses productivity, ecosystem size, productive space (the product of ecosystem size and productivity) also the issues predator-prey size ratios, role of unicellular vs. macro-organismic primary producers (and the subsequent differences in the renewal rate of consumed biomass) and the role of structural, hard to digest polymers in higher plants (cellulose, lignin, which reduce energy transfer in terrestrial herbivory) were discussed.

Neutral models: There was a discussion whether neutral models with species having randomly assigned traits could help to understand food web assembly, at least as a null hypothesis to which real food webs could be contrasted. This idea was counter-balanced by the argument that traits of organisms are not randomly assembled but shaped by foregoing natural selection.

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ELUCIDATING FOOD WEBS IN INFRALITORAL ROCKY COASTAL HABITATS INVADED BY *CAULERPA CYLINDRACEA* (SONDER 1845)

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Abstract
Invasive species including *Caulerpa cylindracea* affect coastal benthic communities inducing structural changes. To assess effects in rocky ecosystems, food webs have been depicted based on stable isotopic data collected from invertebrates and fishes at invaded and non-invaded coastal areas. Isotopic values of invertebrates were slightly higher in invaded than non-invaded habitats of Lampedusa Island, however no significant differences were found. Invasive fish *Siganus luridus* and native *Sparisoma cretense* had similar isotopic signatures indicating similar food sources.

Keywords: Food webs, Stable isotopes, NIS, Mediterranean Sea

Introduction-The Mediterranean is one of the most affected areas by invasive species and Lessepsian migrations are the major driving force for this bioinvasion (1) but other factors as globalization and international trade, climate change, anthropogenic activities (aquaculture, shipping and transportation) are also responsible. *C. cylindracea* colonization causes deterioration in sediment quality and seagrass decline impacting on food webs. Effects in trophic levels can be rapidly addressed with Stable Isotopes Analysis (SIA) (2). Accordingly, shifts in trophic structure are expected and therefore we examined changes in coastal benthic communities of invaded and non-invaded habitats.

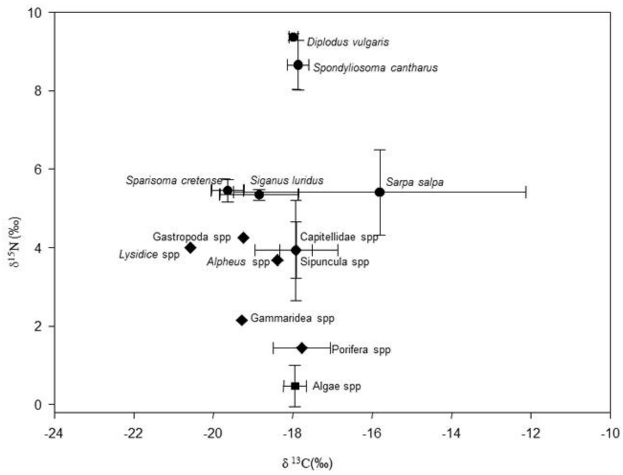

Fig. 1. Stable isotope signatures for macroalgae (squares), benthic invertebrates (rhombus) and fish (circles) in non-invaded habitats (mean ± SE).

Materials and Methods- Sampling was performed at Lampedusa Island in November 2013. One invaded (coverage > 90% of *C. cylindracea*) and one non-invaded (coverage > 90% native macroalgae) hard substrate were sampled by scuba divers and biological components were identified to the lowest taxonomic level in laboratory. In addition, 5 fish species (*Diplodus vulgaris*, *Spondyliosoma cantharus*, *S. luridus*, *S. cretense*, *Sarpa salpa*) were sampled to investigate indirect effects throughout the food web at higher trophic levels. Carbon and nitrogen SIA were performed in all biotic samples to describe changes in the trophic web.

Results- Values of δ^{13}C and δ^{15}N in primary producers and consumers were slightly higher in invaded than in non-invaded habitats by *C. cylindracea* (invaded; δ^{13}C mean = -17.94 ‰ and δ^{15}N mean = 3.60 ‰ and non-invaded; δ^{13}C mean= -18.48 ‰ and δ^{15}N mean = 3.14 ‰) (Fig. 1 and 2) but no significant differences were found (t-test $p > 0.05$). Macrobenthivore native fish *D. vulgaris* and *S. cantharus* were grouped together while the invasive fish, *S. luridus* had similar isotopic signals as native herbivore *S. cretense*.

Discussion- The lack of significant differences among δ^{15}N values in herbivorous, deposit and benthic invertebrates feeders of both habitats is probably linked to differences in movement capacity of these trophic groups and to their food selectivity (3). Similar isotopic signatures between invasive *S. luridus* and native *S. cretense* provide further evidence of feeding similarities and analogous δ^{15}N isotopic values among herbivore fish indicate that these feed at the same trophic level however spatial segregation according to δ^{13}C probably minimizes trophic interactions according to basal food sources.

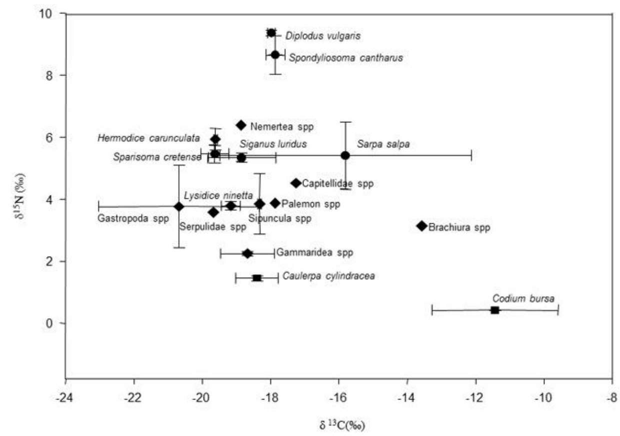

Fig. 2. Stable isotope signatures for macroalgae (squares), benthic invertebrates (rhombus) and fish (circles) in invaded habitats (mean ± SE).

Acknowledgments- This research was funded by Regione Sicilia within “CAULERPA” Project. We are grateful to S. D’Ippolito for helping in sampling and to UIB (B. Martorell), P. Sarriera and M.A. Nadal for SIA collaboration.

References

1 - Nunes A.N., Katsanevakis S., Zenetos A. and Cardoso A.C., 2014. Gateways to alien invasions in the European seas. Aquatic Invasions 9(2): 133–144.

2 - Deudero S, Box A, Vázquez-Luis M, Arroyo N.L., 2014. Benthic community responses to macroalgae invasions in seagrass beds: Diversity, isotopic niche and food web structure at community level. Estuarine, Coastal and Shelf Science, 142: 12-22

3 - Vázquez-Luis M., Sanchez-Jerez P., Bayle-Sempere J.T., 2009. Comparison between amphipod assemblages associated with *Caulerpa racemosa* var. cylindracea and those of other Mediterranean habitats on soft substrate. Estuarine, Coastal and Shelf Science, 84 (2): 161-170.

IS SIZE A “MASTER TRAIT” PREDICTING PHYTOPLANKTON RESPONSES TO GROWTH AND LOSS FACTORS?

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Abstract

Trait based approaches are recently being developed to investigate if they can be used as a new tool to forecast the ecosystem response to the constantly changing by anthropogenic stressors environment and the biodiversity losses. In this content, we review literature data and present experimental findings on the influence of phytoplankton colony/cell size on phytoplankton growth, sensitivity to nutrient limitation, sinking losses and grazing sensitivity. From the reviewed literature and the experimental findings, it is clearly shown that cell size is extremely important for nutrient utilization, and at the same time it can be a driving factor for sinking losses and vulnerability to grazing.

Keywords: Phytoplankton, Mediterranean Sea, Growth, Nutrients

In the “Metabolic Theory of Ecology” (1) body size is considered to be a “Master Trait” (2) providing the basis for predicting the performance of species and large scale patterns in ecosystems. Spanning 4 to 5 orders of magnitude in linear dimensions of cell- or colony size, phytoplankton are an ideal model system to test to feasibility of size as a non-taxonomic predictor of the environmental abilities and requirements of organisms.

Maximal growth rates (μ_{max}) of phytoplankton were found in many studies to decline with cell volume (V), however the exponent b of the relationship $\mu max = aV^b$ has usually been found less negative than the universal -0.25 scaling coefficient thought to be a general rule for the relationship size – specific metabolic rates (1). Recently, even claims for a unimodal relationship with a peak of μmax at ca. 100 μm^3 have been made (3). Small cells are better at uptake of nutrients at low concentrations, but under pulses of elevated concentrations large phytoplankton can build up bigger storage pools for subsequent reproduction under reduced uptake (4). In Fig. 1 collected data from various sources in the literature show this relationship between maximal growth rates and cell sizes.

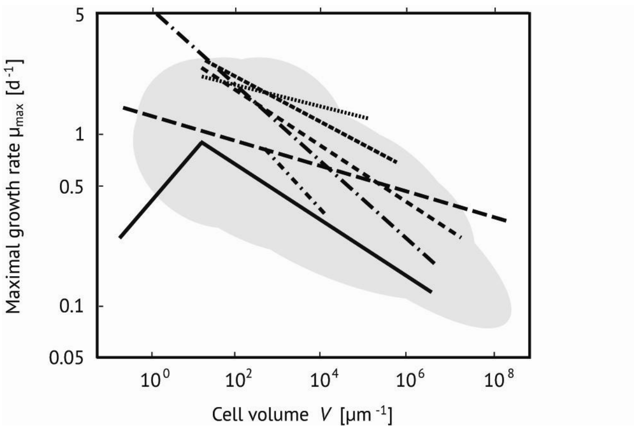

Fig. 1. Relationship between maximal growth rates and cell sizes of phytoplankton taken from various sources in the literature, measured at or recalculated for 20°C. Grey cloud: range of data assembled by Finkel et al. 2010, regression lines: square dots: Banse 1982, diatoms; dash-dot: Banse 1982, dinoflagellates; round dots: Sommer 1989; dash: Tang 1995; long dash: Finkel et al. 2010; long dash-dot: Edwards et al. 2012; black: Marañon et al. 2013

Larger phytoplankton have a bigger scope to exploit vertical nutrient and light gradients, be it by flagellar swimming (5) or by shifts between negative and positive buoyancy (6). When heavier than water, sinking velocity is proportional to the square of the diameter and the density difference between the water and the phytoplankton cell/colony. Under low turbulence, this becomes a selective disadvantage for immotile large algae, in particular for those large diatoms which cannot become lighter by ionic regulation.

Generally, larger herbivores prefer larger phytoplankton prey, however there are some exceptions, like heterotrophic protists feeding on phytoplankton of almost equal length or large pelagic tunicates filtering even the smallest picoplankton (7). Copepods feed on medium sized to moderately large phytoplankton (5 to 100 μm) conferring a selective advantage for smaller phytoplankton by simultaneously feeding on the protistan predators (8). In Fig. 2 the effect of grazing by the copepod *Acartia tonsa* on a phytoplankton community indicates the effect of extensive grazing on the size of the phytoplankton community, by suppressing an entire size class from the phytoplankton community.

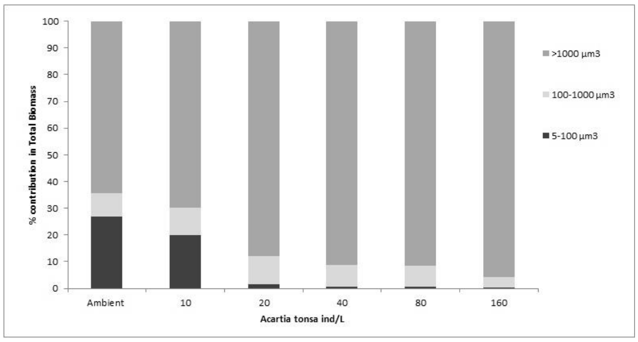

Fig. 2. *Acartia tonsa* (copepod) impact on phytoplankton size structure contribution to total biomass after 7 days of grazing. Plot of particle volume size classes: Black, 5-100μm3; Light grey, 100-1000 μm3, Dark grey, >1000 μm3

References

1 - Brown, J.H., Gillooly, J.F., Allen, A.P., Savage, V.M. & West, G.B. (2004) Toward a metabolic theory of ecology. Ecology, 85, 1771–1789.
2 - Litchman, E. & Klausmeier, C.A. (2008) Trait-based community ecology of phytoplankton. Annu. Rev. Ecol. Evol. Syst., 39, 615-639.
3 - Marañón , E. (2015) Cell size as a key determinant of phytoplankton metabolism and community structure. Ann. Rev. Mar. Sci., 7, 241-264.
4 - Edwards, K.T., Thomas, M.K., Klausmeier, C.A. & Litchman, E. (2012) Allometric scaling and taxonomic variation in nutrient utilization traits and maximum growth rate of phytoplankton. Limnol. Oceanogr. 57, 554–566.
5 - Sommer, U. (1988) Some size relationships in phytoplankton motility. Hydrobiologia, 161, 125 131.
6 - Villareal, T.A., Pilskain, C.H., Montoya, J.P. & Dennet, M. (2014) Upward nitrate transport by phytoplankton in oceanic waters: balancing nutrient budgets in oligotrophic seas. PeerJ, 2, e302
7 - Lambert, G. (2005) Ecology and natural history of the protochordates. Can. J. Zool., 83, 34-50.
8 - Sommer, U. & Sommer, F. (2006) Cladocerans versus copepods: the cause of contrasting top-down controls on freshwater and marine phytoplankton. Oecologia, 147, 183-194.

TROPHIC ECOLOGY OF THE MEDITERRANEAN HAKE *MERLUCCIUS MERLUCCIUS* IN THE SICILY STRAIT

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Abstract
The trophic ecology of the Mediterranean hake, *Merluccius merluccius* was analysed in the Sicily strait, based on both stomach content and stable isotope analyses of nitrogen and carbon. Overall results showed a preference for pelagic prey, especially small cephalopods (i.e. sepiolids), fishes (i.e., *Engraulis enchrasicolus* and *Gadiculus argenteus*) and crustaceans (mysids, euphausiids and natantian decapods). An ontogenetic shift in the diet was observed with small individuals mostly preyed on small crustaceans (the mysid *Lophogaster typicus* and the decapod *Chlorotocus crassicornis*) and cephalopods, and larger ones on fishes. Stable isotopes also evidenced such shift with adults displaying the greatest ð^{15}N and ð^{13}C values. This study contributes to elucidate the complexity of pelagic food webs, displaying great meso-scale variability.

Keywords: Food webs, Pelagic, Fishes, Stable isotopes, Sicily Channel

Introduction
The Mediterranean hake is one of the most important commercial species for Mediterranean fisheries. Although there is a plenty of information on different aspects of the biology and ecology of this species, spatial variations in prey availability call for specific studies in the different sub-basins of the Mediterranean sea. Surprisingly there are no data on the trophic ecology of this species from the Sicilian Strait (Central Mediterranean), notwithstanding the importance of this resource for the local fleet. Within this context the objective of this work is to elucidate the trophic ecology of the Mediterranean hake, *Merluccius merluccius*, by means of both stomach contents (SCA) and stable isotope analyses of nitrogen and carbon (SIA).

Materials and methods
Samples were collected in June 2011 by means of a midwater pelagic trawl net. Overall, a total of 134 specimens were analysed for SCA and 31 for SIA. Specimens ranged between 7.2 and 37.5 cm. Two main size classes were considered (class I: specimens < 16 cm; class II: up to 22 cm), with only 3 individuals of greater size (up to 37 cm). Fishes were dissected and stomachs and a piece of white dorsal muscle were analysed according to standard protocols for SCA and SIA (see Fanelli & Cartes, 2010).

Results and discussion
The analysis of 108 full stomachs evidenced a preference for pelagic prey, especially small cephalopods (i.e. sepiolids), fishes (i.e., *Engraulis enchrasicolus* and *Gadiculus argenteus*) and crustaceans (mysids, euphausiids and natantian decapods: Fig. 1).

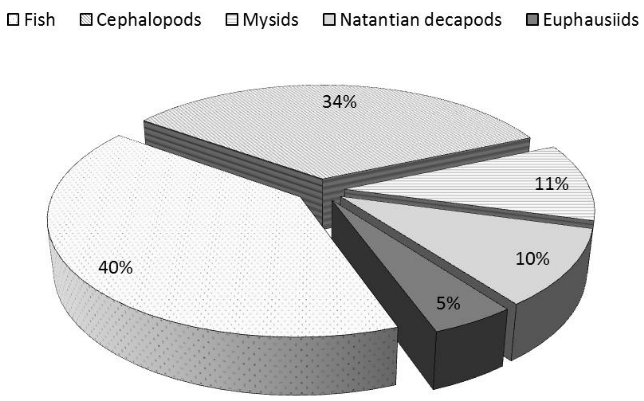

Fig. 1. Prey contribution (in terms of % by weight) to the diet of Mediterranean hake in the Sicily Strait

An ontogenetic shift in the diet was observed with small individuals mostly preyed on small crustaceans (chiefly the mysid *Lophogaster typicus* and the decapod *Chlorotocus crassicornis*) and small cephalopods (i.e. sepiolids), and larger ones on fishes and cephalopods (i.e. *Alloteuthis* spp.). These results partially confirmed previous findings from the Northern Sicily (Sinopoli et al. 2012) but highlighted differences in some food preferences (i.e. greater contribution of cephalopods to diet in the Sicily Strait) probably associated to local abundance of these prey in the area. Accordingly, stable isotopes showed significant variations in ð^{15}N values by size, pointing to diet changes during the life-span (Fig. 2). Still, significant differences were evidenced in ð^{13}C values by size (Fig. 2) with adults relying on prey with greater ð^{13}C, mostly linked to benthopelagic resources or food caught at deeper bottoms (Cartes et al. 2009).

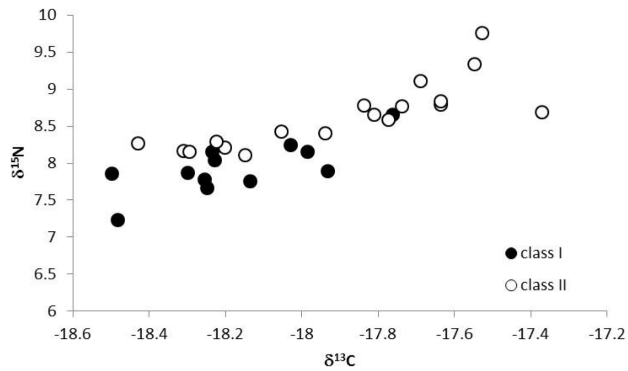

Fig. 2. ð^{15}N and ð^{13}C values vs. specimen size of Mediterranean hake in the Sicily Strait. Class I: specimens < 16 cm; class II: 17-22 cm.

References
1 - Cartes J.E., Hidalgo M., Papiol V., Massuti E., Moranta J., 2009. Changes in the diet and feeding of the hake Merluccius merluccius at the shelf-break of the Balearic Islands: Influence of the mesopelagic boundary community. Deep Sea Res. I 56:344-365.
2 - Fanelli E., Cartes J.E., 2010. Temporal variations in the feeding habits and trophic levels of deep-sea demersal fish from the Western Mediterranean Sea based on stomach contents and stable isotope analyses. Mar. Ecol. Prog. Ser. 402:213–232.
3 - Sinopoli M.,Fanelli E., D'Anna G., Badalamenti F., Pipitone C., 2012. Assessing the effects of a trawling ban on diet and trophic level of hake, *Merluccius merluccius*, in the southern Tyrrhenian Sea. Sci. Mar. 76:677-690.

HETEROTROPHIC PICO- AND NANO-FLAGELLATES: A FOOD WEB WITHIN PELAGIC FOOD WEBS

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Abstract

We performed a mesocosms experiment to analyze the response of a natural phytoplankton community from the Baltic Sea to ocean acidification and warming. Besides the other important functional groups of the plankton community (phytoplankton, bacteria, microzooplankton, mesozooplankton) we put especial emphasis on the heterotrophic picoflagellates (<3 µm) and nanoflagellates (3-15 µm), including a polyphasic species identification (microscopy and pyrosequencing). Microscopic evidence together with supporting information from the literature revealed a complex food web structure within this functional group which contradicts the widespread assignment of a single trophic role (feeding on bacteria and pico-phytoplankton).

Keywords: Plankton, Baltic Sea

We set up a mesocosms experiment to study the response of plankton communities to the combined impacts of warming and ocean acidification. Two temperature levels (9 and 15 °C) and two CO_2-levels (target values <500 ppm and 1400 ppm CO_2) were combined in a factorial manner. Each treatment combination was replicated three times. Plankton communities were samples 3 times per week. Heterotrophic flagellates were enumerated and size by epifluorescence microscopy. Taxonomic identification was performed by a combination of microscopy and Tag-pyrosequencing of the V4-V6 region of the 18S rRNA gene. Feeding relationships were established on micro-photographs and supported by evidence from the literature.

Flagellate biomass and community composition showed only a weak response to warming and no response to acidification, but strong responses to the temporal succession of phytoplankton (1; Fig. 1). When averaged over time, biomass and abundance were lower in the warm mesocosms (ANOVA: abundance: $F = 47.44$, $p<0.001$; biomass: $F = 180.7$, $p<0.001$), but there was no effect of acidification (ANOVA: $p>0.05$). Succession, warming and acidification effects on taxonomic composition were analyzed by perMANOVA. Successional period had a strong effect ($F = 49.8$, $p<0.001$, $r^2 = 0.615$), temperature a weaker, but still significant effect ($F = 3.65$, $p<0.05$, $r^2 = 0.045$) while there was no effect of CO2 and the pairwise and triple interactions of factors. Before the phytoplankton bloom, feeders of colloidal matter (e.g. *Picomonas*) and bacteria bacterivores (e.g. choanoflagellates) dominated and were followed during the phytoplankton bloom by feeders on the increasingly available algae. There was also an increasing tendency towards intraguild predation within the heterotrophic flagellate community. Several of the larger flagellates fed on all size classes from bacteria up to flagellates only slightly smaller than themselves, giving rise to 5-link food chains like bacteria – *Paraphysomonas – Telonema – Cryothecomonas – Quadricilia.* Thus, our results negate the assignment of a single trophic function (2) and support the idea of trophic complexity in this guild (3). In terms of response to Global Change, the heterotrophic flagellates did not respond significantly to ocean acidification and only slightly to warming, mainly by an acceleration of species succession.

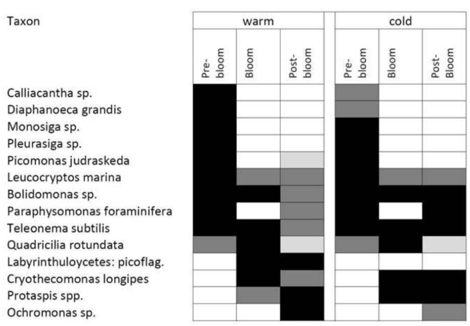

Fig. 1. Schematic representation of heterotrophic flagellate sucession in warm and cold mesocosms indicated by semi-quatitiative biomass-abundance scores, black: dominant, fark grey: common, light grey: rarte, white: not detectable

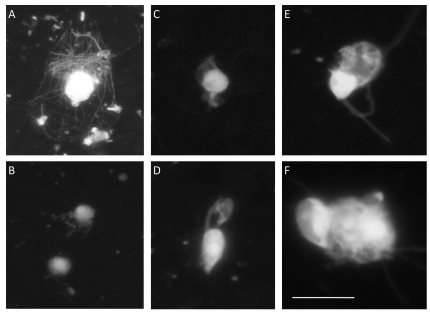

Fig. 2. **Micrographs of feeding.** Heterotrophic flagellates and their prey as seen by epifluorescence microscopy. Epifluorescence micrographs are taken by UV excitation for (A, D, F) DAPI-stained cells or by blue excitation for (B, C, E) Chl a red auto-fluorescence. Flagellates and their prey are (A) *Diaphanoeca*:several bacteria adhering on the cell at the flagellum basis; (B) *Paraphysomonas* in contact with bacterial clumps; (C) *Telonema* digesting a *Chrysochromulina* cell while another *Chrysochromulina* cell is attached at the posterior end of the cell;(D) *Leucocryptos*capturing *Plagioselmis*; (E) *Cryothecomonas*taking pico-chlorophytes; (F) *Quadricilia* beginning ingesting *Chrysochromulina* and a cryptophyte.Scale bar is 10 µm.

References

1 - Sommer U, Paul C, Moustaka-Gouni M (2015) Warming and ocean acidification effects on phytoplankton – from species shifts to size shifts within species in a mesocosm experiment, PLoS One 10:e0125239.

2 - Azam F, Fenchel T, Field JG, Gray JS, Meyer-Reil LA, Thingstad F (1983) The ecological role of water column microbes in the sea. Mar EcolProgrSer10:257-26.

3 - Boenigk J, Arndt H (2002) Bacterivory by heterotrophic flagellates: community structure and feeding strategies. Antonie van Leeuwenhook 81:465-480.

DRIVERS OF *CALANUS FINMARCHICUS*: THE TOP, THE BOTTOM, AND THE QUEST FOR A HOLISTIC APPROACH

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Abstract
Ecosystems dynamics are an integrated response of the ecosystem's biological components to drivers. A long, unsolved ecological question is whether top-down trophic drivers (i.e. predation) or bottom-up drivers (often intended as climate, hydrography, food) control populations and ecosystems. Current methods for analysing drivers of ecosystems can have varying degrees of bias, giving rise to conflicting views in published research. In this study, we use an unbiased approach based on Genetic Programming for selecting drivers of a key species, *Calanus finmarchicus*, in the North Sea. This species has been widely discussed due to its importance for the food chain and its link to an ecosystem-wide regime shift in the late 1980's. The results suggest that both bottom-up and top-down drivers are involved in driving this species abundance.

Keywords: North Atlantic, Zooplankton , Warming, Time series, Models

Abrupt changes in ecosystems, termed regime shifts, are the cumulative response to drivers, which act on and within the ecosystem. A holistic, unbiased method for determining drivers of marine regime shifts would greatly improve our understanding and future management capabilities [1].

Genetic Programming (GP) is a methodology capable of generating solutions to a given problem without any strong *a-priori* knowledge or assumptions about the problems solution, hence unbiased [2]. GP has been used successfully in a wide range of applications, including economics and robotics; however, analyses approaches based on GP are yet to be fully utilised within an ecological setting, although they have been used to investigate copepod variability in the English Channel [2].

The approach we propose is a statistical analysis of ecological data, based on a GP-symbolic-regression method coupled with a cross-validation framework. We used 26 variables, ranging from local to large scale, from climatic, hydrographic, to food and predation (Fig. 1), over the period 1972 to 2011, to validate and highlight the potential future use of the GP procedure. Our target species was *Calanus finmarchicus*, a key species in the North Sea food chain, which has seen a decline in abundance over the past 40 years [3].

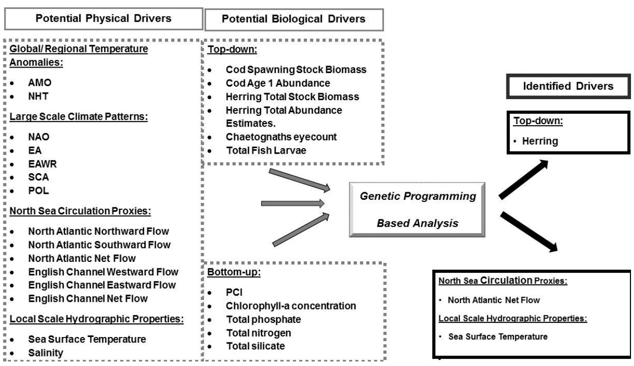

Fig. 1. Drivers of *Calanus finmarchicus*. On the left, in the gray dashed boxes, the potential drivers selected for this study, subdivided in physical and biological (bottom-up, top-down) drivers. On the right, in the black boxes, the drivers identified after Genetic Programming-based analysis.

The GP procedure, combined with a cross validation framework and with relevance analysis highlighted 9 statistically relevant variables for the approximation of *C. finmarchicus* abundance. Of these, 6 variables from 3 main groups: ocean circulation, sea surface temperature and predation (Fig. 1), were identified as likely drivers during the 40 years period [4]. This work highlights the complexity and multiplicity of population drivers and the need for analysing them without *a-priori* assumptions.

References
1 - Conversi A. et al., 2015. A holistic view of marine regime shifts. *Philosophical Transactions of the Royal Society B*, 370:20130279. http://dx.doi.org/10.1098/rstb.2013.0279.
2 - Marini S. and Conversi A., 2012. Understanding Zooplankton Long Term Variability through Genetic Programming. In: Giacobini M, Vanneschi L, and Bush W. (eds) Evolutionary Computation, Machine Learning and Data Mining in Bioinformatics, Springer, Berlin Heidelberg, pp. 50–61. DOI: 10.1007/978-3-642-29066-4_5.
3 - Alheit J., Moellmann C., Dutz J., Kornilovs G., Loewe P., Mohrholz V. and Wasmund N., 2005. Synchronous ecological regime shifts in the central Baltic and the North Sea in the late 1980s. *ICES J Mar Sci*:62(7):1205-15.
4 - Papworth D., Marini S. and Conversi A. Declining *Calanus*: What is driving *Calanus finmarchicus* abundance in the central North Sea? A new model based on Genetic Programming. Submitted to *PLOSone*, under revision (Apr 2016).

PRIMARY CHARACTERIZATION OF THE ICHKEUL LAKE (TUNISIA) FOOD WEB: FAVORED PATHWAY OF ORGANIC MATTER TRANSFER AND TROPHIC LINKS COMPLEXITY

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Abstract

Fish trophic structure of the Ichkeul Lake (northern Tunisia, southern Mediterranean) was studied to determine principal preys and consumers as trophic links between them that allows characterization of the food web structure. To realize this purpose, two complementary approaches were performed; stable isotopes ratios of carbon and nitrogen were used as trophic tracers, while stomach content analysis was used to determine ingested preys by fishes. The first method was applied to fishes, invertebrates and primary producers were analyzed in both wet and dry seasons and in two marked areas of the site study, eastern area (with more marine tendency) and western area (with more lacustrine tendency). The second method was concerned only consumers namely fishes.

Keywords: Food webs, Fishes, Stable isotopes, Mediterranean Sea

Material and Methods:

Preys and predators were defined under trophic web using two tracer tools: isotopic stable and stomach content. Each one of this latest use different scale time integration, short time scalling (several hours to several tens of hours, which is the mean time of digestion for ostechtyens) for the first and long one (from two to three month which is mean time to muscle cells renewal in fishes) for the second. Filtered water i.e. Particulate Organic Mater (POM), sedimentary Organic Mater (SOM), Fish and invertebrates samples were analyzed to define isotopic signatures for $\delta^{13}C$ and $\delta^{15}N$ [1, 2]. Stomach content analysis was used to support isotopic results. This guts study was performed according to volumetric analysis approach with the method of points [3, 4, 5].

Results and discussion:

Among main predators which structured the food web, fishes were totalised of 491 individuals belonging to 16 species which were analyzed. The Hierarchical Cluster Analysis statistical test was performed to define diet similarities. This latest showed 9 trophic groups from them 8 were mono-specific: *B. belone*, *E. encrasicolus*, *P. microps*, *S. typhle*, *S. acus*, S. abaster, *A. anguilla* and *D. labrax*. The remaining species constituted a large multispecific cluster, which grouped the four Mugilidae species *Mugil cephalus*, *Liza aurata*, *Liza ramada* and *Liza saliens* as well as *Barbus callensis*, *Atherina boyeri*, *Aphanius fasciatus* and *Solea senegalensis* [5]. The main ingested preys by fishes were identified according to spatio-temporal variations for each species. Those various compartments of food web were analyzed by isotopic analysis using $\delta^{13}C$ and $\delta^{15}N$ to define its trophic position. Fish alimentary diagnosis (content stomach analysis) coupled with fish isotopic analysis and trophic links routing showed the importance organic matter from basal carbon since POM relative to the other one from SOM (benthic inland and continental trophic web versus pelagic lagooner marine trophic web). Zoobenthic invertebrates constitute the majority of preys ingested by higher levels consumers mainly by fishes (secondary and tertiary consumers); its have a major role to ensure organic matter (POM and SOM) transfer and energy flows from the bottom to the top food web and for several alimentary chain for the majority of fish species (Figure 1). $\delta^{13}C$ was ranged from -25.59‰ for POM to-18.46‰ for SOM both in wet season. $\delta^{15}N$ of organic matter, were varied from 7.77‰ in dry season to 9.35‰ in wet season, both recorded for SOM. Primary producers $\delta^{13}C$ was ranged between -24.04‰ for *Polysiphonia sp.* to -15.49‰ for *Potamogeton pectinatus* both in wet season. $\delta^{15}N$ was varied from 9.28‰ to 13.89‰ both in dry season. The invertebrates $\delta^{13}C$ was ranged from -24.24‰ for *Mytilus galloprovincialis* in dry season and -24.05‰ for *Potamon algeriense* in wet season. The maximum of $\delta^{13}C$ reached -12.45‰ for *Haminoea sp.* in dry season. The $\delta^{13}C$ range was varied from 9.12‰ for *Gammarus sp.* from a maximum of 21.37‰ for *Atyaephyra desmarestii*, both in wet season. $\delta^{13}C$ of fishes was varied from -28.86‰ for *Mugil cephalus* in wet season to -13.20‰ for *Liza saliens* in dry season. $\delta^{15}N$ was ranged from 9.80‰ for *Dicentrarchus labrax* (juvenile) to 19.41‰ for *Gambusia affinis*, both in wet season. Benthic carnivorous fishes (eel, sea bass and probably sole) as detritivores omnivorous fishes (Mugilidae and barb) have an important functional role as Key-species assuring trophic structure stability and functioning of lacustrine food web ecosystem. Trophic links characterization related mainly fishes (as top consumers) and their preys confirm hypothesis of the importance of benthic trophic web relative to the pelagic one (Figure 1). Comparatively to the others ecosystems, the functioning pattern of the Ichkeul Lake and generally of coastal shallow waters ecosystems were closely similar to most Mediterranean ecosystems.

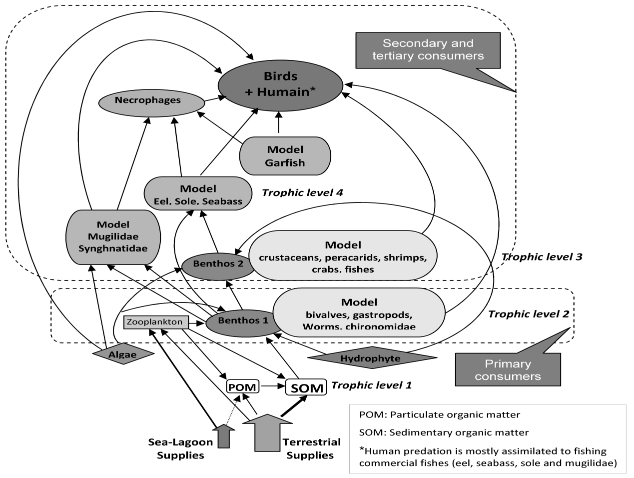

Fig. 1. Ichkeul food web lake characterization: Favored path of organic matter transfer (POM and SOM) under trophic web, functional role of groups and species and trophic links complexity.

References

1 - Pinnegar J.K. and Polunin N.V.C. 1999. Differential fractionation of δ13C and δ15N among fish tissues: implications for the study of trophic interactions. *Funct. Ecol.*, 13: 225-231.

2 - Lorrain A., Savoye N., Chauvaud L., Paulet Y.M. and Naulet N. 2003. Decarbonation and preservation method for the analysis of organic C and N contents and stable isotope ratios of low-carbonated suspended particulate material. *Anal. Chim. Acta*, 491: 125-133.

3 - Rounsefell G.A. and Everhard W.H. 1953. Fisheries science: its methods and applications. New York, Wiley and Sons, pp 444.

4 - FAO 1974. Methods of Resource Investigation and their Application. *Manual of Fisheries Science Part 2. Fisheries technical paper*, 115: 115-255.

5 - Shaiek M., Romdhane M.S. and Le Loc'h F. 2015. Study of the ichthyofauna diet in the Ichkeul Lake (Tunisia). *Cybium*, 39: 193-210.

DETECTION OF ZOOPLANKTON PREDATOR-PREY INTERACTIONS IN ALBORAN SEA BY COMBINING ACOUSTIC BACKSCATTER DATA AND DIFFERENT BIOLOGICAL SAMPLING SYSTEMS

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Abstract
Multifrequency acoustic technology was used to detect the summer epipelagic scattering layer associated with a heterogenic zooplankton community in Alboran Sea. Simultaneously, identification hauls by means of two different plankton net (bongo 40 equipped with 250 and 333 µm mesh and bongo 90 equipped with 500 and 2000 µm mesh) were performed to obtain taxonomical and quantitative characteristics of the zooplankton community. Collected data revealed a strong correlation between the abundance of small crustacean (prey) captured by the 250 µm mesh with the abundance of chaetognaths, siphonophores and fish larvae (predators) captured by 500 µm mesh.

Keywords: Zooplankton , Acoustics, Trophic relations, Alboran Sea, Mediterranean Sea

Introduction
In economic terms, the plankton may be less important than fish, but they are central to ecological research, being at or near the bottom of the food chain. Acoustic methods for the study of plankton in their natural environment have developed rapidly in recent years and are now well established as a remote-sensing and unobtrusive means of observation in biological oceanography. Plankton produce echoes by the same scattering laws as any other target. Since they are chiefly small to microscopic objects in close proximity to one another, the echoes overlap to form the diffuse cloud-like marks often seen on echograms (plankton layers). Some non-acoustic evidence, such as net samples, is normally required to determine the species composition of echo traces [1]. The choice of net mesh size is an important issue. No one single net is suitable to sample across a wide size range of zooplankton from small mesozooplankton forms to macrozooplankton [2]. The combined use of acoustic data and different net samplers let us study the zooplankton community through different trophic levels and move forward to the integrated pelagic ecosystem understanding.

Material and methods
The study was carried out in the Spanish continental shelf (from 30 to 200 meters depth) of Alborán Sea during the summer of 2013 and 2014. An EK60 scientific echosounder operating at five frequencies (18, 38, 70, 120 and 200 kHz) was employed to locate the zooplankton epipelagic community. In order to identify multiples trophic levels, two different nets with four different meshes were employed: a bongo 90 with a quadrangular mouth (90 cm) opening equipped with 500 and 2000 µm meshes, and a bongo 40 (40 cm diameter) with a 250 and 333 µm meshes. From every sample collected on the 36 tows (20 in 2013 and 16 in 2014) three subsamples were analyzed for zooplankton composition by microscope. For the purpose of this study and taking into account the acoustic properties of different types of scatterers [3], nine categories of zooplankton were considered: small crustaceans (smaller than 1.2 mm), big crustaceans (larger than 1.2 mm), chaetognaths, siphonophores, apendicularias, doliolids, fish eggs, fish larvae and heteropods. The number of individuals of each category per cubic meter of water was calculated according to the number of individuals caught and the volume of water filtered. Multiple Correlation analysis between the organism abundance captured by one net with the others was carried out to detect trophic interactions in the zooplankton community sampled.

Results and discussion
The smaller mesh sizes (250 and 333 µm) captured mainly small crustaceans and apendicularias, which represented the primary consumers. The 500 and 2000 µm mesh captured the largest and less common organisms (mainly big crustacean, chaetognaths, siphonorores and fish larvae) which could be understood as secondary consumers. The sample multiple correlation coefficient revealed a strong association between the small crustacean captured by the 250 µm mesh with the chaetognats ($r=0.74$, p-value=0.002), siphonophores ($r=0.67$, p-value=0.03) and fish larvae ($r=0.64$, P-value=0.05) captured by 500 µm mesh.

Tab. 1. Multiple correlation analysis between the organism abundances captured by Bongo 40 (250 µm mesh size) and Bongo 90 (500 µm mesh size). Ap: Apendicularias, Bc: Big crustaceans, Sc: Small crustaceans, Do: Doliolids, He: Heteropods, Eg: Fish eggs, La: Fish larvae, Ch: Chaetognaths, Si: Siphonophores.

		Bongo 40, 250 µm								
		Ap	**Bc**	**Sc**	**Do**	**He**	**Eg**	**La**	**Ch**	**Si**
Bongo 90, 500 µm	**Ap**	0.05	-0.05	-0.28	-0.35	0.14	0.04	-0.02	0.12	-0.07
	Bc	0.32	0.90	0.52	-0.13	-0.40	0.64	-0.15	-0.11	0.20
	Sc	0.06	0.18	-0.07	-0.11	-0.14	0.43	0.11	0.23	-0.12
	Do	0.29	-0.21	-0.03	0.81	-0.33	0.03	0.23	-0.06	0.01
	He	0.10	-0.23	0.35	-0.11	0.53	-0.36	0.63	0.74	0.34
	Eg	0.19	-0.20	-0.18	0.76	-0.45	0.17	-0.02	-0.32	-0.11
	La	0.42	0.24	**0.64**	-0.36	0.14	0.09	0.07	0.45	0.12
	Ch	-0.13	-0.08	**0.74**	-0.26	0.34	-0.13	0.42	0.86	0.29
	Si	0.02	-0.11	**0.67**	-0.16	0.25	-0.22	0.47	0.73	0.47

This study demonstrates that the summer epipelagic scattering layer is composed of a complex and heterogeneous zooplankton community in which, interactions between different trophic levels can be distinguished.

References
1 - Simmonds E.J. and MacLennan D.N. 2005. Fisheries acoustics. (2nd ed.). Oxford: Blackwell Science Ltd.
2 - Skjoldal H.R., Wiebe P.H., Postel L., Knutsen T., Kaartvedt S., Sameoto D.D. 2013. Intercomparison of zooplankton (net) sampling systems: Results from the ICES/GLOBEC seagoing workshop. Prog. Oceanogr., 108: 1−42.
3 - Martin L. V., Stanton T. K., Wiebe P. H. and Lynch J. F. 1996. Acoustic classification of zooplankton. ICES Journal of Marine Science, 53: 217–224.

CIESM Congress Session : Food web modelling
Moderator : Carlos Melian, EAWAG, Kastanienbaum, Switzerland

Moderator's Synthesis

Food webs represent who eats whom in a ecosystem. They are complex entities composed by hundreds of species and myriads of individuals interacting in many ways from competitive and antagonistic to mutualistic and cooperative interactions. In the last decade, there has been a large progress in understanding how food webs may be responding to human disturbances and environmental fluctuations. Yet, there are many emerging gaps and opportunities to improve our understanding of food webs and the biodiversity they sustain. In this meeting we discussed mostly three gaps that if explored further may produce a more accurate theory of food webs: 1) The inference gap, 2) The biogeography gap and 3) The interdependent networks gap. The inference gap concerns methods to compare outputs from a variety of models to data to infer the mechanisms predicting best the empirical data. This is currently a fast moving field with many new techniques coming from physics and computer science that are making the model-data comparison possible even for slow and complex models like the ones used in food webs. Our discussion in this area focused in how to compare simple and complex models and how this comparison enters in the well-known tractability-computational cost trade-off with the final aim to produce more accurate predictions under a variety of realistic scenarios like global warming and increasing the variance of environmental variables.

The biogeography gap is another emerging synthesis in food webs. There are many unknown questions in this gap. For example, how do the contacts between species from different biogeographic regions alter the stability properties of local food webs? Do dispersal dynamics synchronize population dynamics of resources and consumers? And does synchronization stabilize species fluctuations? Food webs are difficult to sample because there are many interacting species and factors driving their dynamics. This is a real challenge for the many existing biodiversity programs monitoring large ecosystems. Understanding the biogeography of food webs would require "high-resolution and spatially extended" sensor networks to monitor several variables at small and large spatial scales. This need connects to our last discussed gap -- the interdependent networks gap. Many species have several preys and predators but they are also composed by many occupied patches extended in space. This posits new challenges because understanding the biogeography of food webs is also coupling the dynamics of local networks to spatially extended networks. Are these two networks coupled? If so, which are the consequences for understanding the formation, evolution and dynamics of complex food webs?

A SPATIALLY ORIENTED ECOSYSTEM BASED MODEL TO EVALUATE ECOSYSTEM IMPACTS OF FISHERIES

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Abstract
The present study consists in the development of the first spatial model for the marine ecosystem of the Azores, situated in the mid North Atlantic Ocean. The main goal is to construct the spatially explicit version of the previous developed Ecopath with Ecosim (EwE) model to furthermore address fisheries-related management questions. The Ecospace model was built under the most recent EwE software capabilities.

Keywords: Fisheries, Models, Deep waters, Azores, North Atlantic

The implementation of ecosystem-based management (EBM) approaches via marine spatial planning (MSP) of human activities is widely recognized as an effective way to achieve sustainability of marine resources exploitation. Spatially oriented ecosystem based models, as Ecospace[1], are useful tools to support EBM, given its ability in assess temporal and spatial ecosystem dynamics and explore potential impacts of differential management scenarios at the ecosystem level. The present study aims to develop the first spatial model for the deep marine ecosystem of the Azores, located in the mid North Atlantic Ocean, to address fisheries related management questions. Therefore, we constructed the spatially explicit version of a previous built Ecopath with Ecosim model[2] for the same area to i) quantify the impact of foreign pelagic fleets fishing within 100nm of the Azores' Exclusive Economic Zone (EEZ), under a Common Fisheries Policy regulation (EC 1954/2003); ii) and evaluate the effect of the establishment of marine protected areas (MPA) for the main fishing fleet operating in the Azores, the bottom longline. Ecological statistics were derived from the Ecopath model to characterize the ecosystem of the Azores (Table 1).

Tab. 1. General ecosystem statistics calculated for the Ecopath model of the Azores exclusive economic zone

Sum of all consumption	354.05	t/km²/yr
Sum of all exports	1477.18	t/km²/yr
Sum of all respiratory flows	197.99	t/km²/yr
Sum of all flows into detritus	1558.16	t/km²/yr
Total system throughput	3587.37	t/km²/yr
Sum of all production	1760.42	t/km²/yr
Mean trophic level of the catch	3.95	
Calculated total net primary production	1675.17	t/km²/yr
Total primary production/total respiration	8.46	
Net system production	1477.18	t/km²/yr
Total primary production/total biomass	69.56	
Total biomass/total throughput	0.01	
Total biomass (excluding detritus)	24.08	t/km²
System Omnivory Index	0.22	
Ecopath pedigree index	0.53	

The Ecospace model was built under the most recent software capabilities (v6.5, beta), using the newly developed habitat foraging capacity model[3] and spatial-temporal data framework[4] that facilitates the direct input of environmental, human and legal spatial layers. The model entails 45 functional groups (a detritus group, two primary producer groups, eight invertebrate groups, 29 fish groups, three marine mammal groups, a turtle and a seabird group) and 12 fishing fleets (the deep bottom longline and handline, regional pelagic longline, Portuguese mainland pelagic longline, foreign pelagic longline, pole and line tuna - including the pole and line live bait fishery, small pelagic, drifting deep water longline, commercial coastal invertebrates, recreational fishing, bottom trawling and loligo). The area has approximately 1 million square kilometers and corresponds to the 200 nautical miles (nm) of Azores' EEZ. The first step in model development consisted of establishing the basemap, defining area boundaries and cells to include in the model and filling primary production and depth layers with geographic information system data available for the area. Since depth is identified as a potential factor influencing the spatial distribution of fish in the modeled area, four habitats were defined based on depth intervals (in meters): <350; <700; <1200; >1200, in which functional groups forage differently. Additionally, a marine protected area was designed to delineate the area wherein foreign fleets are not allowed to fish (100nm). Figure 1 shows the Ecospace depth map and the 100nm marine protected area designed for the foreign fishing fleets.

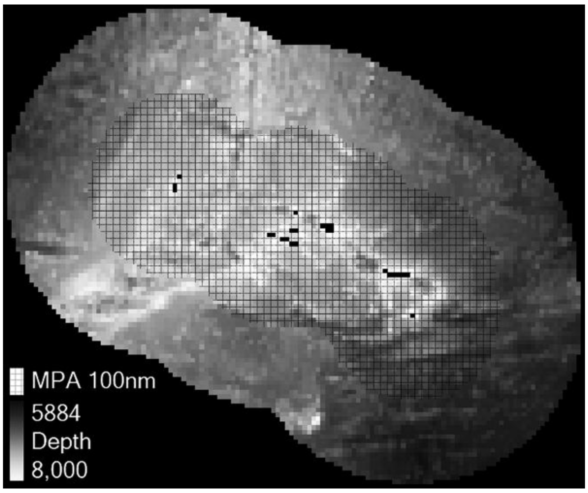

Fig. 1. Ecospace depth map of the modeled area (depth unit, meter), displaying the nine islands of the Archipelago (black cells) and the 100nm marine protected area for the foreign fishing fleets (grid)

The model was prepared to run after habitat parameterizations and the fishing fleets assigned to the created habitats. We believe the present study might constitute a step forward in the usage of spatially oriented ecosystem-based models to assist the implementation of EBM approaches in the Archipelago of the Azores, by exploring the outcomes of different management scenarios in the ecosystem dynamics.

References
1 - V. Christensen and C. J. Walters, "Ecopath with Ecosim: Methods, capabilities and limitations," Ecol. Modell., vol. 172, pp. 109–139, 2004.
2 - T. Morato, E. Lemey, G. Menezes, C. Pham, T. J. Pitcher, J. J. Heymans "Ecosystem model of the open-ocean and deep-sea of the Azores: what drives ecosystem dynamics?" (in preparation)
3 - V. Christensen, M. Coll, J. Steenbeek, J. Buszowski, D. Chagaris, and C. J. Walters, "Representing Variable Habitat Quality in a Spatial Food Web Model," Ecosystems, pp. 1397–1412, 2014.
4 - J. Steenbeek, M. Coll, L. Gurney, F. Mélin, N. Hoepffner, J. Buszowski, and V. Christensen, "Bridging the gap between ecosystem modeling tools and geographic information systems: Driving a food web model with external spatial-temporal data," Ecol. Modell., vol. 263, pp. 139–151, 2013.

MODELING THE STRUCTURE AND FUNCTIONING OF THE ISRAELI MARINE CONTINENTAL SHELF ECOSYSTEM: INSIGHTS OF THE IMPACTS OF INVASIVE SPECIES AND FISHERIES

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Abstract

In order to characterize the structure and functioning of the Israeli marine continental shelf (ICS) ecosystem and assess main changes with time, we developed two food web Ecopath models representing the earlier 1990's and the 2008-2012. Results highlighted the increasing impact of invasive species on the ecosystem between 1990's and 2012. Fishing activities had noticeable impacts during both analyzed time periods. The ICS ecosystem shared common features in structure and functioning traits with other Mediterranean marine ecosystems

Keywords: Food webs, Levantine Basin, Invasive species, Fisheries

Biological invasions and fishing activities are currently considered two of the most important direct drivers of biodiversity loss and pose a major pressure on marine ecosystems (1,2). The ecosystems of the Israeli Mediterranean coast have undergone significant changes in recent decades mainly due to species invasions, fishing activity and climate change (3-4).

Ecopath food web models of the ICS for two periods of time (1990-1994 and 2008-2012) were developed in order to characterize the structure and functioning and to assess the impacts of invasive species and fishing activity on the ecosystem over time. The models were composed of 41 functional groups, ranging from primary producers to top predator species, and included eight invasive groups encompassing several crustacean and fish species with various trophic positions in the ecosystem. This represents the first attempt to study the south-eastern Mediterranean ecosystem using a mass-balance Ecopath model. Since there is a large amount of invasive species in the area, this represented a major modeling challenge and an important step forward in relation to previous applications of Ecopath that modeled invasive species in the Mediterranean Sea (5).

The analyses of the biomass and catch of invasive and natives species showed that during the last two decades the ecosystem notably changed, with the explosion of invasive groups and the depletion of some native groups (Fig. 1). This caused important changes in trophic flows between food-web components.

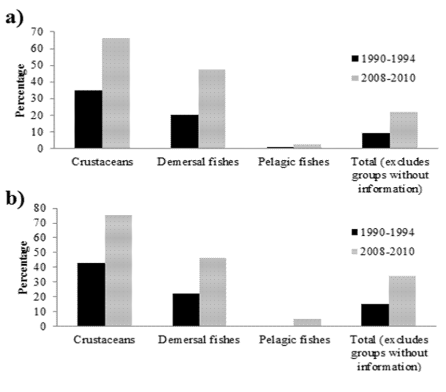

Fig. 1. Percentage of invasive species on the biomass (a) and catch (b) by different groups. Total biomass (excludes groups without information) includes all the groups with available information for to split between native and invasive species (fish, cephalopods and crustaceans (shrimps and crabs)). Planktonic groups, suprabenthos, polychaetes and benthic invertebrates are not included in this analysis.

Results highlighted a high impact of fishing activities during both analyzed time periods. For example, we observed high levels of gross efficiency of the fisheries and high requirements of primary production required to sustain the fisheries in both time periods. Additionally, although the total catch did not change, the % of discards increased dramatically (Table 1).

Despite productivity differences, the Israeli marine continental shelf ecosystem shares common features in structure and functioning traits with other Mediterranean marine ecosystems such as the important role of detritus, the dominance of the pelagic fraction in term of flows and the importance of the benthic-pelagic coupling.

Several hypotheses have been proposed to explain the extensive impact that invasive species have had on the ecosystem and the decline of native species (6,7). This includes, for example the cumulative impacts between invasive species, overfishing and climate change superimposed with the geological history and the environmental conditions of the Eastern Mediterranean Sea (6,7). Further developments of this work through spatial-temporal dynamic modeling will help to evaluate different hypothesis.

Tab. 1. Ecological indicators of the Israeli Mediterranean continental shelf (ICS) Ecopath food web model in two time periods.

Indicators	1990-1994	2008-2012	Units
Sum of all Consumptions (TQ)	155.30	150.38	$t \cdot km^{-2} \cdot year^{-1}$
Sum of all Exports (E)	188.65	184.26	$t \cdot km^{-2} \cdot year^{-1}$
Sum of all Respiratory Flows (TR)	57.79	56.35	$t \cdot km^{-2} \cdot year^{-1}$
Sum of all Flows to Detritus (TFD)	244.64	240.90	$t \cdot km^{-2} \cdot year^{-1}$
Total System Throughput (TST)	646.38	631.89	$t \cdot km^{-2} \cdot year^{-1}$
Total Biomass (excluding detritus) (TB)	8.69	8.80	$t \cdot km^{-2}$
Mean Trophic Level of the community (mTLco)	1.35	1.34	
Total Catches (TC)	0.94	0.93	$t \cdot km^{-2} \cdot year^{-1}$
Total landings	0.80	0.64	$t \cdot km^{-2} \cdot year^{-1}$
Total discards	0.14	0.29	$t \cdot km^{-2} \cdot year^{-1}$
Mean Trophic Level of the Catch (mTLc)	3.38	3.37	
Primary Production Required to sustain the fisheries (PPR, considering PP + detritus))	10.36	11.34	%
Gross Efficiency of the fisheries (GE)	0.004	0.004	
Mean Tranfer efficiency (TE)	18.90	19.00	%
Ecopath pedigree index	0.54	0.54	

References

1 - Mack, R.N., et al., *Biotic invasions: causes, epidemiology, global consequences, and control.* Ecological applications, 2000. **10**(3): p. 689-710.

2 - Jackson, J.B., et al., *Historical overfishing and the recent collapse of coastal ecosystems.* science, 2001. **293**(5530): p. 629-637.

3 - Goren, M., D. Shults, and A. Gafni, *The Current State of Fish and Israel's Fisheries in the Mediterranean Sea*, 2013.

4 - Galil, B.S., *Seeing Red: Alien species along the Mediterranean coast of Israel.* Aquatic Invasions, 2007. **2**(4): p. 281-312.

5 - Corrales, X., G. Gal, and M. Coll, *Modeling the alien species impacts in marine ecosystems,* in *Ecopath 30 Years conference proceedings: Extended Abstracts. Fisheries Centre Research Reports 22(3)* p. 154-155.

6 - Galil, B., *Alien species in the Mediterranean Sea—which, when, where, why?* Hydrobiologia, 2008. **606**(1): p. 105-116.

7 - Galil, B.S., *A sea under siege–alien species in the Mediterranean.* Biological Invasions, 2000. **2**(2): p. 177-186.

INDIVIDUAL BASED ANALYSIS OF THE FUNCTIONAL OVERLAP AMONG FOUR TEMPERATE FISH SPECIES

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Abstract
We conducted individual-based analyses of species' functional niches based on their microhabitat utilisation patterns during foraging and computed functional overlaps in terms of space partitioning and behavioural traits. The sampling took place on rocky reefs of Mallorca (Balearic Islands, Western Mediterranean) during May-June 2015. We sampled 328 fish belonging to four species representing different life history traits and feeding behaviours. All species studied demonstrated distinct patterns of spatial overlap and niche partitioning. The results of this study will help determine functional redundancy and complimentary of temperate fish species and thus better our understanding of the ecological characteristics and processes of shallow subtidal environments.

Keywords: Fish behaviour, Coastal systems, Teleostei, North-Western Mediterranean

How habitat influences the distribution of organisms is of central importance to ecology. Within the marine environment, species-specific microhabitat associations of fishes have been widely reported [1]. However, most studies to date measure the fundamental niche of an organism, while the functional niche is generally unaccounted for. We looked at individual-based patterns of: i) fish habitat partitioning as a function of the space occupied at any given moment; ii) behaviour traits, based on what the fish do while moving; and iii) microhabitat utilisation, based on where the fish eat. The sampling took place on the algal covered rocky reefs of South-Western Mallorca in the Balearic Islands, Western Mediterranean, over the course of May and June, 2015. The most commonly occurring species within the families expressing different life history traits and belonging to distinct feeding guilds were selected: *Symphodus tinca* (mesophagous), *Coris julis* (microphagous), *Diplodus vulgaris* (omnivorous) and *Sarpa salpa* (herbivorous). A randomly selected individual was followed underwater and its behaviour was continuously recorded [2]. The type of behaviour and the time for which it was expressed, as well as the surface type and the substratum type the fish interacted with for any of the defined behavioural traits were noted. The categories of behaviours included intraspecific and interspecific aggression, diffused, focused and water column feeding, searching, roaming, hovering, rubbing, cleaning and advertising. The surface types considered were exposed horizontal and vertical, underside and concealed surfaces, while the substratum types included rock, rubble, sand and *Posidonia*, as well as morphotypes of various algae (erect tree-like, filamentous, soft leaf-like, tubular, plumose, bulbous, leathery and turf). The total number of individuals sampled was 328.

The observational data across all species revealed a majority preference for the horizontal open space which in the case of *S. salpa*, was as high as 94% of the total observational time spent. The remaining three species demonstrated a small preference for open vertical areas spending on average 20% of the total time interacting with this surface type. The dominant behaviour for all four species was roaming. *D. vulgaris* demonstrated hovering, a behavioural characteristic that was unique to this species, as well as searching, also demonstrated by *C. julis*. With regards to the feeding modes, *S. salpa* was the only species to express the preference for focused, rather than diffused feeding. In terms of where the feeding occurred, turf and erect tree-like algal morphotypes were the preferential morphotypes chosen by all species. *D. vulgaris* and to some extent *C. julis* also demonstrated feeding within filamentous algae morphotype. While no other species spent any notable time feeding within *Posidonia* beds, *S. salpa* spent 35% of the total time feeding within this habitat (Figure 1). The analysis of similarity (ANOSIM), combining habitat preference, behaviour patterns and feeding microhabitat utilisation, revealed highly significant differences between all the species observed ($R=0.33$, $p<0.01$).

Although demonstrating similar preference for habitat partitioning each species can be characterised by distinct patterns of behaviour and microhabitat use during feeding. In addition, combining the habitat preference, behaviour patterns and feeding microhabitat utilisation points to spatial overlapping and niche partitioning between the species. The results of this study may have crucial consequences for the understanding of spatial overlapping and the niche partitioning of temperate fish species and may be useful to identify species' functional niche shifts in response to changing environments such as shallow temperate littoral systems.

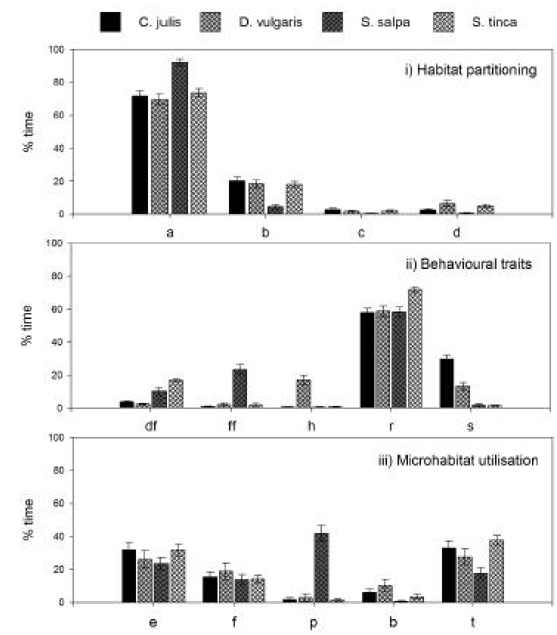

Fig. 1. I) Habitat partitioning patterns; a=open, horizontal, b=open, vertical, c=underside, d=concealed, ii) comparison of behavioural traits, df=diffused feeding, ff=focused feeding, h=hovering, r=roaming, s=searching iii) feeding microhabitat preferences expressed by the four species studied; e=erect tree-like and f=filamentous algal morphotypes, p=*Posidonia*, b=barrens, t=turf. Error bars show Standard Error of the Mean.

References
1 - Jones GP (1991) Postrecruitment processes in the ecology of coral reef fish populations: A multifactorial perspective. In: The Ecology of Fishes on Coral Reefs.p 294–328
2 - Brandl SJ & Bellwood DR (2014) Individual-based analyses reveal limited functional overlap in a coral reef fish community. J Anim Ecol, 83, pp.661-670

ECOSYSTEM AND PRIMARY PRODUCTION INTERACTIONS IN THREE CONTRASTING SITES IN THE NORTHERN LEVANTINE BASIN

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Abstract

To determine the effects of different nutrient dynamics in the Levatine Basin a 1-D multi component lower trophic ecosystem model is used and the carrying capacity and regulatory mechanisms of the nutrients on upper trophic levels at three contrasting marine sites in the Northeastern Mediterranean is assessed. Offshore waters of Mersin Bay, coastal sites of Erdemli and Rhodes Gyre is chosen as they represent distinctive characteristics in terms of nutrients dynamics. Model results suggest distinct mechanisms that drives the phytoplankton blooms in each region, for example in Rhodes Gyre highest productivity observed during late February, whereas the strongest bloom was during spring at Erdemli coasts. Offshore waters of Mersin Bay has the lowest productivity throughout the year with minor changes during winter and spring seasons.

Keywords: Levantine Basin, Primary production, Nutrients, Models

The nutrient inputs are limited both in terms of internal and external sources in the Mediterranean Sea. Primary production decreases further through the Eastern part of the Mediterranean and have been observed to be as low as 86.8 gCm-1yr-1 in the Levantine Basin (Antoine et al., 1995). In coastal areas, the production is induced by input through the river discharges and the nutrients introduced from aeolian deposits. Erdemli coasts of Mersin Bay receive important fresh water input through Göksu, Lamas, Seyhan, Ceyhan and Asi Rivers. Hence, Erdemli coastal waters are considered as a good case study where riverine and atmospheric deposition of nutrients are effective. Terrestrial and riverine inputs does not penetrate into the open Mersin Bay so it is chosen to represent the oligotrophic characteristics of Eastern Mediterranean water. Rhodes Gyre on the other hand represents a region where upwelling dominates the nutrient input mechanism. This region is known as the most productive area in Northern Levantine Basin with annual primary production of ~97 gCm2yr-1 (Napolitano et al., 2000). Climatological data are used to force and validate the model results for one-year using monthly averages of parameters of ~26 years data. Historical Erdemli Time Series (ETS) data obtained with biweekly cruises to 3 stations between 1997 – 2013 by METU-IMS. Offshore Mersin Bay and Rhodes Gyre data for years 1988 - 2014 are obtained from METU-IMS data inventory. For the Rhodes gyre stations were scarce especially for January and February due to harsh weather conditions in this area, so additional CTD data from CORIOLIS (http://www.coriolis.eu.org) is obtained and used.

To analyze the ecosystem dynamics, one-dimensional multicomponent lower trophic level ecosystem model developed by developed by SALIHOGLU, B. et al 2009 (NAGEM) oligotrophic and mesotrophic oceans adapted to specific conditions of these three sites. The model includes enough complexity to consider the limitations which differs among these three regions, while estimating the primary production.

5 algal groups included in the model which are cyanobacteria group. (Low and High Light adapted Prochlorococcus, Synecococcus) with cell size ~0.9*u*m, Autotrophic Eukaryotes ~2.5um, and Diatoms ~15um . Other than advected and regenerated nutrients, atmospheric nutrient input and nitrogen fixation are another nutrient sources. Model-data comparison shows that model skill is high for chemical variables and chl-a results. Mixed layer depth is observed to have the greatest impact on growth of the species. The model results of yearly distribution of primary production for each sites represented in Fig. 1. With the effect of mixing, primary production is at its highest levels during late February to early March. for all sites. Deep chlorophyll maxima occurs at the bottom of the euphotic zone (<~100m) consistent with available literature (e.g., Ediger, 2005). Since the deep waters with rich nutrient contents upwelling to the euphotic zone, nutricline is shallower in the in the center of the Rhodes Gyre. As phytoplankton carried deeper with the winter mixing, meeting the nutrients, more intense deep chlorophyll occurs in Rhodes Basin compared to the other sites. In May, vanishing of the winter mixing and nutrient input is introduced to coastal areas through increasing river runoffs, spring bloom occurs with higher intensity in ETS site compared to others. In Mersin Bay weak seasonal pulses also occur as a minor increase in winter and spring season, however this site has the lowest primary production and chl-a values amongst the other 2 regions.

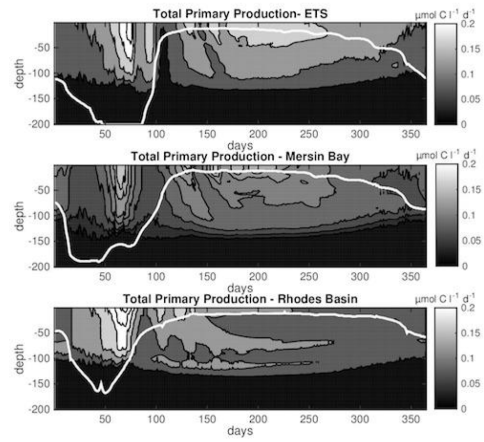

Fig. 1. Primary Production of 3 different sites inferred from model results -White lines indicate the Mixed Layer Depth at each day

References

1 - Antoine, D., Morel, A., Andre J.M. (1995). Algal pigment distribution and primary production in the eastern Mediterranean as derived from coastal zone color scanner observations. Journal of Geophysical Research, Vol. 100, No. C8, pp.16,193-16,209.

2 - Ediger, D., Tugrul, S., & Yilmaz, A. (2005). Vertical profiles of particulate organic matter and its relationship with chlorophyll-a in the upper layer of the NE Mediterranean Sea. Journal of Marine Systems, 55(3-4), 311–326. http://doi.org/10.1016/j.jmarsys.2004.09.003

3 - Koçak, M., Kubilay, N., Tugrul, S., & Mihalopoulos, N. (2010). Atmospheric nutrient inputs to the northern levantine basin from a long-term observation: Sources and comparison with riverine inputs. Biogeosciences, 7 (12), 4037–4050. http://doi.org/10.5194/bg-7-4037-2010

4 - Napolitano, E., Oguz, T., Malanotte-Rizzoli, P., Yilmaz, A., & Sansone, E. (2000). Simulations of biological production in the Rhodes and Ionian basins of the eastern Mediterranean. Journal of Marine Systems, 24(3–4), 277–298. http://doi.org/http://dx.doi.org/10.1016/S0924-7963(99)00090-1

5 - Salihoglu, B., Garçon, V., Oschlies, a., & Lomas, M. W. (2008). Influence of nutrient utilization and remineralization stoichiometry on phytoplankton species and carbon export: A modeling study at BATS. Deep Sea Research Part I: Oceanographic Research Papers, 55(1), 73–107. http://doi.org/10.1016/j.dsr.2007.09.010

CIESM Congress Session : Alien records

Moderator : Sergej Olenin, Klapeida Univ., Lithuania

Moderator's Synthesis

Seven papers were presented in this session, co-authored by researchers from 10 countries. The thematic of the presentations ranged from the records of alien species (an ascidian in Malta, the lion fish in Cyprus, coastal plant in Romania, red alga in Tunisia) and regional overviews of non-indigenous biota (status of invasive marine species in Libya, exotic fishes in Mediterranean) to public participation in invasive species detection through social networks. The following discussion was centered on three main questions: 1) What are the best methods for early detection and correct identification of alien species; 2) How to increase the level of certainty about the pathway/vector of introduction; and 3) What are the objective methods to measure losses and gains caused by introduction of alien species?

The participants expressed their opinion that in spite of rapid advent of molecular methods, it is important to support and develop the traditional taxonomic knowledge for proper identification of new non-indigenous species (NIS). Appropriately supervised 'citizen science' can provide through social networks important data on exotic species status (established, not established, rare, common, etc.), their secondary spread and impacts. Provided that data are scientifically validated and standardized, such method is especially useful for relatively large conspicuous species, such as fish. Community involvement is also an important instrument to raise public awareness on the problem of marine invasive species.

There are clear gaps in the knowledge on pathways and vectors of NIS introductions, which may impact the science advice to management. Especially it is vital to distinguish between the "Lesseptian migration" involving physical movement of species through the Suez Canal and introduction of aliens by ships (ballast water, hull fouling, etc), which are passing the Canal. Management options for these two pathways are different, involving different legal instruments and technological solutions.

Another important knowledge gap is the lack of data on losses and gains caused by introduction of alien species. It is not enough to record new and new NIS entering the Mediterranean Sea, it also is important to investigate that is their impact on biodiversity, environment, economy and human health. The solid evidence base on the bioinvasion impacts is needed for prioritization of environmental remediation measures, especially than funds for such remediation are limited.

It was agreed also that data on new species records, pathways and vectors of their spread, their biological traits and environmental tolerance limits as well as impacts, should be publically available through the scientifically verified and constantly updated open source databases. Ideally, such database(s) should cover not only the Mediterranean Sea, but also other regions of the world to make it possible interregional comparisons and exchange of data needed for management decisions.

THE CURRENT STATUS OF THE ALIEN ASCIDIAN *HERDMANIA MOMUS* IN MALTA

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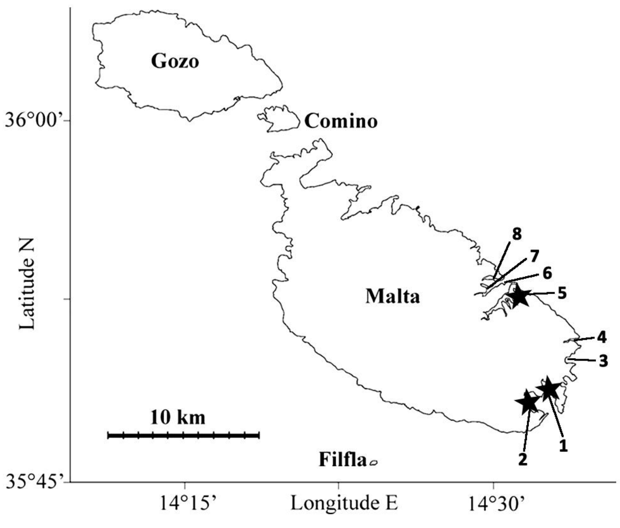
Abstract
The non-indigenous ascidian *Herdmania momus* was first recorded from the southeast coast of Malta at Marsaxlokk in 2013. Surveys at eight sites along the east coast of Malta revealed that it has since spread to another two sites, one of which is located *ca* 10 km north of Marsaxlokk. The ascidians remain largely restricted to artificial substrata in areas under anthropogenic influence, although a few individuals were observed on natural rock. The size distributions of the three populations reflect the likely propagation of the tunicates from the site of introduction. Four taxa of commensal crustaceans inhabiting Maltese *H. momus* were found, with the highest abundance of ascidicolous crustaceans recorded from the Marsaxlokk population.

Keywords: Alien species, Species introduction, Tunicata, Sicily Channel

Introduction
The solitary ascidian *Herdmania momus* is an Erythraean immigrant that was restricted to the eastern Mediterranean until 2013, when it was recorded from Marsaxlokk Bay on the southeastern coast of Malta [1]. The Marsaxlokk population was restricted to artificial substrata, but this ascidian can also colonise natural rocky bottoms [2], while its planktonic larval stage increases its potential for range expansion along the Maltese coast. The present study was undertaken to assess the current distribution and status of *H. momus* along the eastern coast of Malta.

Material and Methods
Field surveys were carried out at eight sites along the eastern coast of Malta in September-November 2015 (Fig. 1). At each site 2-4 stations with either a concrete or a natural substratum were sampled. At each station, 25 m of coastline were surveyed from 0 m to a depth of 1 m and the abundance of *H. momus* was recorded. Up to 25 individuals were collected at random from each station, narcotized and fixed. Body length of these individuals was measured from the base of the oral siphon to the base of atrial siphon along the mid-ventral line. The specimens were then dissected and the branchial sac was examined for the presence of commensals.



Mean (±SD) abundance per transect

	Artificial substratum	Natural substratum
Site 1 (Marsaxlokk)	42.5 ± 23.3	4.0 ± 5.6
Site 2 (Birzebbuga)	69.0 ± 26.9	12.5 ± 14.8
Site 5 (Rinella)	2	4

Fig. 1. Map of the Maltese Islands showing the location of sites surveyed for *Herdmania momus* (numbered 1-8). The mean abundances of *H. momus* (as individuals per 1 m x 25 m belt transect) from artificial and natural substrata at the three sites where populations were found (black stars) are also shown.

Results and Discussion
Herdmania momus was found at three of the eight sites investigated: in Marsaxlokk Bay (site 1), where the first record of *H. momus* in Maltese waters was originally made, at Birzebbuga (site 2) and in Rinella Bay (site 5), with the highest abundances recorded from artificial substrata at Birzebbuga (Fig. 1). The present data show that *H. momus* tends to establish populations in areas under anthropogenic impact, since all three sites are located in harbours characterised by intense human activities. It has been suggested that non-indigenous ascidians thrive particularly well on artificial surfaces but often fail to establish on natural substrata [3]. The present results show that in Malta *H. momus* remains largely restricted to artificial substrata, but a few individuals were also recorded from natural rocky bottoms indicating that it has the ability to also colonise natural substrata, as reported previously in Israel [2].

The size structure of the ascidian populations varied between sites. The Marsaxlokk population had the broadest size distribution with body lengths ranging from 18 mm to 129 mm, whereas no individuals larger than 102 mm were recorded from Birzebbuga or Rinella, suggesting that Marsaxlokk was colonized first. This pattern of size distribution likely reflects the propagation of the species from Marsaxlokk Bay to other sites along the coast. From the 145 ascidians dissected and examined for commensals, four different crustacean taxa were recorded: two copepod taxa (not identified further), one amphipod (*Leucothoe* sp.) and one tanaid (*Leptochelia savignyi*), with copepods accounting for more than 99% of all individuals. Commensal crustaceans were found in around half of the ascidians collected from artificial substrata in Marsaxlokk and Birzebbuga, while no commensals were observed in specimens from Rinella. The abundance of commensals was correlated with the mean size of the ascidian host and the probable 'settlement age', which is the time since the population was first established.

These results suggest that the *H. momus* populations are well established and this species may continue to spread along the coast of Malta, possibly invading communities on natural shores. Continued monitoring of the status of such immigrants is of high importance as interspecific interactions between alien and native biota can lead to niche limitation, displacement or local extinction [4].

Acknowledgements: We are grateful to Veronica Farrugia Drakard for assistance with field sampling.

References
1 - Evans J., Borg J.A. and Schembri P.J., 2013. First record of *Herdmania momus* (Ascidiacea: Pyuridae) from the central Mediterranean Sea. *Mar. Biodivers. Rec.*, 6: e134.
2 - Gewing M.T., Rothman S.B.S., Nagar L.R. and Shenkar N., 2014. Early stages of establishment of the non-indigenous ascidian *Herdmania momus* (Savigny, 1816) in shallow and deep water environments on natural substrates in the Mediterranean Sea. *BioInvasions Rec.*, 3(2): 77-81.
3 - Lambert G., 2002. Non-indigenous ascidians in tropical waters. *Pac. Sci.*, 56: 291-298.
4 - Galil B.S., 2007. Loss or gain? Invasive aliens and biodiversity in the Mediterranean Sea. *Mar. Poll. Bull.*, 55: 314-322.

ENHANCING EARLY DETECTION THROUGH SOCIAL NETWORKS: A FACEBOOK EXPERIMENT

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Abstract
The emergence of internet-based social media has made it possible for one person to communicate with a large number of people. Here we show that social media groups can spontaneously provide sound information on marine invaders and be used as powerful systems for early detection.

Keywords: Invasive species, Mediterranean Sea, Lessepsian migration

Introduction
Public participation in invasive species detection is a widely used tool for both scientific research and monitoring worldwide. It may be used alone or in combination with traditional (and often expensive) scientific surveys. Information gained through the public has just started to be considered by Mediterranean scientists, which are interested in expanding detection and monitoring of exotic species (Azzurro et al., 2013). Yet, the online social media, where internet users can connect with others and share information with a wide audience, have rapidly become an essential digital skill worldwide. Facebook is currently the most used social network where people can post and share comments, photos, videos and interact with them. This can be done at the individual level (friends) or through user groups that share common interest to a specific topic. Here we tested the potentiality of Facebook in detecting the occurrence and distribution of exotic marine species.

Materials and Methods
A public group on Facebook was created in October 2012 under the name of “Sea Lebanon”. It has been described as dedicated to the marine world and presented a forum for people to share pictures, information and curiosities on anything related to marine organisms in Lebanon. This group allowed anyone to ask questions or upload pictures taken on the beach, on the market or while scuba diving, angling, spearfishing, boating or any other marine related activity. A first, a bunch of members were encouraged to join by sending them an invitation by email. Once the posting started, more people were able to join by sending a simple click join requests. Sea Lebanon was administered by one of the authors (M.B.), who evaluated subscription requests, commented the posts, provided identifications, validated records and engaged people encouraging discussion. A testing period of two calendar years (2013-2015) was initially planned.

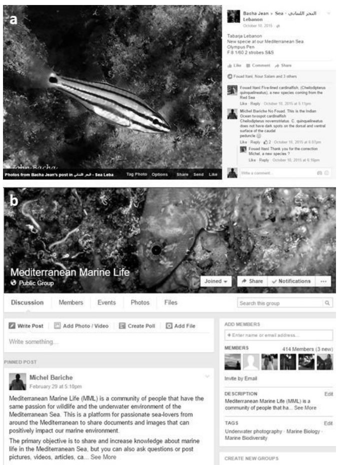

Fig. 1. Screenshots from Facebook groups (a) “Sea Lebanon”, showing a sample post and discussion (b) “Mediterranean Marine Life”, showing its cover page. Photo credits J. Bacha; V. Gerovasileiou.

Results and discussion
Since 2013, a total of 521 person joined “Sea Lebanon”. They are mostly scuba divers, spearfishers, anglers, fishermen or simply sea lovers. Overall, several hundreds of posts were received during the testing exercise (Fig. 1). They covered a wide array of pictures, videos, comments and discussion and included photos of animals, landscapes, and threats. Among the animal photos, records of exotic species were common and spanned a variety of organisms, mainly schyphozoans, molluscs, decapods and teleosts (Fig. 2). Other posts included rare or unfamiliar species (e.g. *Calappa granulata*, *Isurus oxyrinchus*, *Peristedion cataphractum*, *Dermochelys coriacea*, *Monachus monachus*). Remarkably the most interesting posts encouraged other members to upload their pictures on the same species or topic. That particularly applied to the exotic Lionfish (*Pterois miles*), firstly recorded in Lebanon in autumn 2012 (Bariche et al., 2013). In two years (2013-2014), a number of 107 pictures and 3 videos of Lionfish were posted, providing information on 47 individuals spotted across the entire Lebanese coast. This information, gained through Facebook, highlighted that a relatively large population of the Lionfish existed in the waters of Lebanon. Building upon the ‘Sea Lebanon’ success, a new public group “Mediterranean Marine Life” (414 members so far) was created in January 2015 (Fig. 1). It aims at covering the entire Mediterranean Sea and is currently accepting members. To increase its audience among Mediterranean countries, it gives the option to post in any of the common Mediterranean languages (Spanish, French, Italian, Greek, Arabic, and Turkish) in addition to English. These results provide a remarkable example of the potentialities of social media for exotic species monitoring and early detection. Mobile phones and internet technologies will soon have a role in Mediterranean research or elsewhere. They allow to collect large scale biodiversity data while trading ideas, sharing knowledge and promoting awareness for a wide audience.

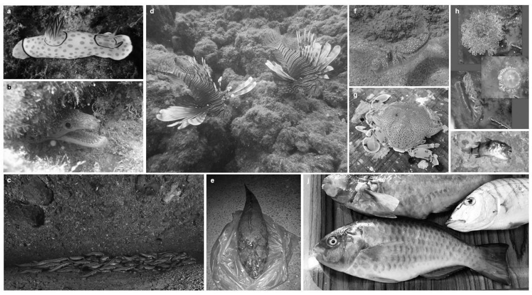

Fig. 2. Sample of exotic species that have been uploaded to “Sea Lebanon”. (a) *Goniobranchus annulatus* (b) *Enchelycore anatina* (c) *Plotosus lineatus* (d) *Pterois miles* (e) *Platycephalus indicus* (f) *Torquigener flavimaculosus* (g) *Matuta victor* (h) *Cassiopea andromeda* (i) *Apogon nigripinnis* (j) *Scarus ghobban*.

References
1 - Azzurro E., Broglio E., Maynou F. & Bariche M. (2013). Citizen science detects the undetected: the case of Abudefduf saxatilis from the Mediterranean Sea. Management of Biological Invasions, 4: 167-170.
2 - Bariche M., Torres M., Azzurro E., 2013. The presence of the invasive Lionfish Pterois miles in the Mediterranean Sea. Mediterranean Marine Science, 14: 292-294.

THE RED SEA MACROALGA *PALISADA MARIS-RUBRI* (RHODOBIONTA, ARCHAEPLASTIDA): FIRST RECORD IN TUNISIA

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Abstract

The Red Sea macroalga *Palisada maris-rubri* has already been reported from the Mediterranean Sea: Mar Minor Lagoon (Murcia, Spain) and Lachea Island (Italy). Here, we describe a specimen from a third locality, the hypersaline El-Biban Lagoon (Tunisia) and confirm its occurrence in the Mediterranean.

Keywords: Alien species, Algae, Tunisian Plateau, Lagoons, Lessepsian migration

The red macroalga *Palisada maris-rubri* (K.W. Nam et Saito) K.W. Nam (Florideophyceae, Rhodobionta, kingdom Archaeplastida) has been described from the northern Red Sea (Ras Muhammed, Sinai, Egypt), as *Laurencia maris-rubri* K.W. Nam et Saito [1, 2]. Subsequently, *P. maris-rubris* has been reported from 2 localities in the Mediterranean Sea: the hypersaline lagoon of Mar Menor (Spain) and Lachea Island (Italy) [3]. Red Sea species that entered the Mediterranean via the Suez Canal are called 'Lessepsian species' or 'Lessepsian migrants' [4, 5].

Fig. 1. Habit of the specimen of *Palisada maris-rubri* collected at Jdaria (El-Biban Lagoon, Tunisia). Preserved (H8310) in the Herbarium Verlaque (HCOM) at Aix-Marseille University. Scale bar = 1 cm.

On December 2015, we (CFB, JBS) collected a large specimen (~10 cm in diameter) of *P. maris-rubris* at Jdaria, in El-Biban Lagoon (southern Tunisia) (Fig. 1). El-Biban Lagoon is a hypersaline lagoon [6]. The collected specimen was dwelling on a rope, along a fishing pier, just below sea-level. The distinguishing characters of the species, which are exhibited by the collected specimen, are as follows:

- Axes cylindrical, up to 10-15 cm high, robust, rigid, cartilaginous, dark in color, attached to the substratum by a discoid holdfast;
- Main axes percurrent, 1–3 mm broad in the median parts, irregularly ramified, denuded in the proximal region but often with fascicles of young branches;
- Branching sparse, up to 3 to 4 orders of branches, irregularly alternate, subopposite, frequently subverticillate in medium parts, with the branches of a third order often unilateral;
- Ultimate branchlets cylindrical with truncate apices, (1) 2–3 mm long and 0.6–1 mm broad;
- Cortical cells palisade-like in transverse section and without secondary pit connections;
- Medullary cells in transverse section rounded without lenticular thickening.

Palisada maris-rubri has not been included in the CIESM Atlas of exotic species in the Mediterranean [7], because of minor differences in vegetative features between the Mediterranean material and the type material [3]. Here, we confirm the presence of this Lessepsian migrant within the Mediterranean Sea.

Because of the recent enlargement of the Suez Canal, the flow of Red Sea species (Lessepsian migrants) to the Mediterranean is expected to dramatically intensify [8].

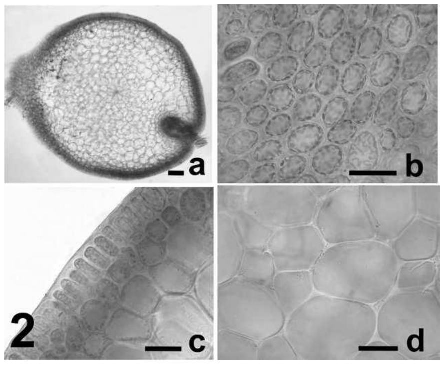

Fig. 2. A: Transverse section. b. Cortex in surface view. c: Transverse section, detail of palisade-like cortical cells. d: Transverse section, detail of medullary cells. Scale bars. a = 100 µm; b-d = 50 µm.

References

1 - Nam K.W. and Saito Y., 1995. Vegetative and reproductive anatomy of some *Laurencia* (Ceramiales, Rhodophyta) species with a description of *L. maris rubri* sp. nov. from the Red Sea. *Phycologia*, 34: 157-165.

2 - Nam K.W., 2007. Validation of the generic name *Palisada* (Rhodomelaceae, Rhodophyta). *Algae*, 22(2) : 53-55.

3 - Serio D., Cormaci M., Furnari G. and Boisset F., 2010. First record of *Palisada maris-rubris* (Ceramiales, Rhodophyta) from the Mediterranean Sea along with three proposed transfers to the genus *Palisada*. *Phycol. Res.*, 58 : 9-16.

4 - Por F.D., 1978. *Lessepsian migrations. The influx of Red Sea biota into the Mediterranean by way of the Suez canal.* Springer publ., Berlin: i-viii + 1-228.

5 - Boudouresque C.F. and Verlaque M., 2002. Biological pollution in the Mediterranean Sea: invasive versus introduced macrophytes. *Mar. Poll. Bull.*, 44: 32-38.

6 - Pergent G., Bessibes M., Djellouli A., El Abed A., Langar H., Mrabet R. and Pergent-Martini C., 2009. Le récif à *Neogoniolithon brassica-florida* de la lagune des Bibans (Tunisie). *Proceedings of the 1st symposium on the coralligenous and other calcareous bio-concretions of the Mediterranean Sea*, Tabarka, 15-16 January 2009, Pergent-Marini C., Brichet M (édits.), RAC/SPA publ., Tunis: 117-122.

7 - Verlaque M., Ruitton S., Mineur F. and Boudouresque C.F., 2015. CIESM Atlas of exotic species. 4. Macrophytes. Briand F. (edit.), CIESM Publisher, Monaco: 1-362.

8 - Galil B.S., Boero F., Campbell M.L., Carlton J.T., Cook E., Fraschetti S., Gollasch S., Hewitt C.L., Jelmert A., Macpherson E., Marchini A., Mckenzie C., Minchin D., Occhipinti-Ambrogi A., Ojaveer H., Olenin S., Piraino S. and Ruiz G.M., 2015. 'Double trouble': the expansion of the Suez Canal and marine bioinvasions in the Mediterranean Sea. *Biol. Inv*, 17(4): 973-976.

XANTHIUM STRUMARIUM SUBSP. *ITALICUM* (MORETTI) D.LOVE, AN INVASIVE ALIEN PLANT ON THE ROMANIAN BLACK SEA COAST

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Abstract
Native to North America, *Xanthium strumarium* subsp. *italicum* is an invasive plant with a high risk for environment in Eastern and Central Europe, inclusive on the Romanian Black Sea coast. Its spiny fruits are dispersed in many ways, but especially clinging to fur of animals or on the shoes and clothing of humans. Grazing cows and horses in the Danube Delta Biosphere Reserve, has facilitated the widespread of the rough cocklebur on the sand dunes where it replaces gradually the native psammophilous plants of the beaches. On the southern coast of Romania, this species is abundant in the disturbed habitats of the harbours of Midia and Constanta and on the sand dunes between Mamaia and Navodari.

Keywords: Coastal systems, Invasive species, Beach, Black Sea

The spread of invasive alien species poses a serious threat to the conservation of natural and semi-natural habitats (Weber, 2005). The invasive plants change the character, form or nature of ecosystems and they have a tremedous impact on the native floral communities. IUCN defines alien invasive species as "an alien species which becomes established in natural or semi-natural ecosystems or habitats, is an agent of change and threatens native biological diversity" (McNeely et al., 2001).

Xanthium strumarium subsp. *italicum (X. orientale subsp. italicum* (Moretti) Greuter; *X. italicum* Moretti) known as rough cocklebur is an annual plant native to North America, belonging to *Asteraceae* family. From America, it has been extensively naturalized elsewhere, including the Eastern and Central Europe. The burry fruits cling to the fur of animals and the clothing of humans, and are easily dispersed in this way. It has become invasive especially in disturbed habitats but also on the roadsides, along the riverbanks and on the sandy beaches (Fig. 1), where it replaces, gradually, the typical psammophilous species, some of which are rare plants.

Fig. 1. *Xanthium italicum* on the sand dunes between Mamaia and Navodari

In the Danube Delta Biosphere Reserve, *Xanthium italicum* is abundant within the plant communities *Elymetum gigantei* Morariu 1957 and *Cakilo euxinae-Salsoletum ruthenicae* Vicherek 1971, in the frame of the habitat types 2110 – Embryonic shifting dunes and 1210 - Annual vegetation of drift-lines. Large local populations with *Xanthium italicum* were observed on the beaches of Sulina, Sfantu Gheorghe, on Saraturile sandbank (between Sulina and Sf. Gheorghe), in Sacalin area, between Portita and Periteasca. Grazing cows and horses is a frequent activity in the Danube Delta Biosphere Reserve, especially close to villages and farms, and this fact facilitates the spreading of the spiny fruits of rough cocklebur on the sand dunes. Here, *Xanthium italicum* often develops large colonies, having a negative influence upon the floristic composition of the psammophilous plant communities, a typical behaviour of an invasive plant. South of Cape Midia, on the southern coast of Romania, *Xanthium italicum* is locally abundant in the area of the Midia and Constanta harbours (Fig. 2) and between Mamaia and Navodari (at approximately 5 km south from Midia harbour).

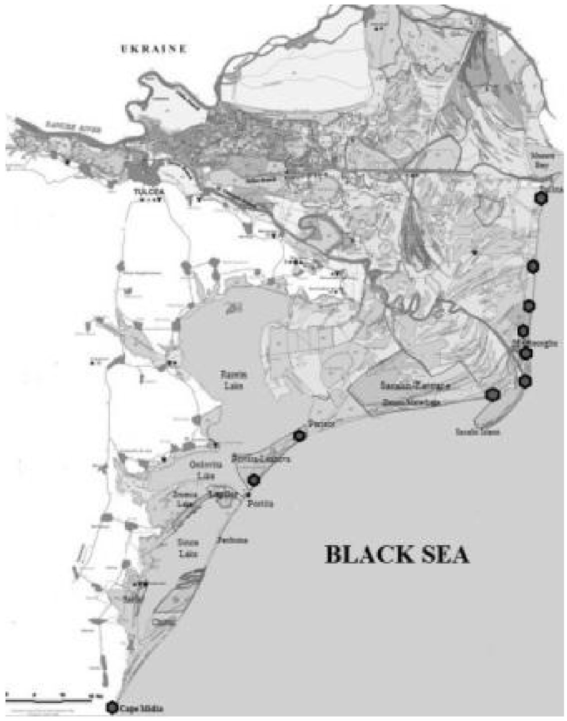

Fig. 2. Locations with large local populations of *Xanthium italicum* in the Danube Delta Biosphere Reserve

The harbours could be the main gate for the introduction of this taxa in the coastal area. In other locations, i.e. Constanta, Eforie Nord, Eforie Sud, Tuzla, Costinesti, Saturn, Mangalia, 2 Mai, Vama Veche, *Xanthium italicum* has been noticed only as a sporadic plant. On the northern coast of Bulgaria, *Xanthium italicum* grows abundantly on the sand dunes and has become co-dominant within the plant community *Xanthio italici-Leymetum sabulosi* Tzonev et al. 2005.

Field surveys were supported by the grant PN-II-PT-PCCA-2011-3.2-1427 of UEFISCDI, contract no. 69/2012 (project acronym ECOMAGIS).

References

1 - Weber E., 2005. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds, CABI Publishing, Oxon, UK.
2 - McNeely J.A., Mooney H.A., Neville L.E., Schei P.J., Waage J.K., 2001. Global Strategy on Invasive Alien Species. IUCN, Gland, Switzerland and Cambridge, UK.

EXOTIC FISHES IN THE MEDITERRANEAN – UPDATE, REAPPRAISAL AND TRENDS

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Abstract
As a quasi enclosed sea, the Mediterranean is particularly susceptible to the influence of exotic species. Since the last update of the CIESM Fish Atlas, in 2013, twenty exotic species were recorded. Many (13) of the newly reported taxa occur in the Red Sea and therefore can be considered as Lessepsian migrants.

Keywords: Alien species, Fishes, Lessepsian migrants, Eastern Mediterranean, Western Mediterranean

The phenomenon of alien species entering the Mediterranean continues without any sign of ceasing [1]. Since the last update [2], 20 new alien species have been recorded, including 13 recent Lessepsian (Red Sea origin) migrants which are: *Sardinella gibbosa* (Bleeker, 1849), *Encrasicolina gloria* Hata and Motomura, 2016, *Stolephorus indicus* (van Hasselt, 1823), *Bregmaceros nectabanus* Whitley, 1941, *Epinephelus areolatus* (Forsskåll, 1775), *Epinephelus geoffroyi* (Klunzinger, 1870), *Lutjanus fulviflamma* (Forsskål, 1775), *Plectorhinchus gaterinus* (Forsskål, 1775), *Parablennius thysanius* (Jordan and Seale, 1907), *Cryptocentrus caeruleopunctatus* (Rüppell, 1830), *Synchirops sechellensis* Regan, 1908, *Acanthurus chirurgus* (Bloch, 1787), *Zebrasoma xanthurum* (Blyth, 1852). The addition of these species brings the total number of Lessepsian fish migrants to over 100 [3].

The three other additions are recent migrants from the eastern Atlantic that have entered the Mediterranean via Gibraltar: *Taractes rubescens* (Jordan & Evermann, 1887), *Abudefduf hoefleri* Steindachner, 1881, *Zebrasoma flavescens* Bennett, (1828). Four species recently recorded in the Mediterranean are due to human intervention (e.g., aquarium or aquaculture escapees or from ballast water): *Chrysiptera cyanea* (Quoy & Gaimard, 1825), *Stegastes variabilis* (Castelnau, 1855), *Acanthurus coeruleus* Bloch and Schneider, 1801, *Balistoides conspicillium* (Bloch and Schneider, 1801). Unlike other marine taxa, fish species of alien origin in the Mediterranean rarely arrive via ballast water; if ballast water was a significant vector of alien fish, we would see in the Mediterranean many more species from non-adjacent regions.

The unprecedented influx of new fish species into the Mediterranean is clearly one of the major drivers of biodiversity change in this essential marine region.

References
1 - Golani, D. and B. Appelbaum-Golani, 2012. Red Sea fishes in the Mediterranean Sea – history and recent developments. In: *Life in the Mediterranean Sea: A look at habitat changes*. Stambler, N, (ed.). Nova Science Publishers, New York. 295-308 pp.
2 - CIESM, 2013. CIESM Atlas of Exotic Fishes in the Mediterranean Sea. Online website http://www.ciesm.org/atlas/appendix1.html (retrieved 18/11/2016).
3 - Seyhan, D., Irmak, E. and Fricke, R. (in press). *Diplogrammus* sp. (Pisces: Callionymidae), a new Lessepsian migrant recorded from the Mediterranean Sea. *Mediterranean Marine Science*.

VENI, VIDI, VICI: THE SUCCESSFUL ESTABLISHMENT OF THE LIONFISH *PTEROIS MILES* IN CYPRUS (LEVANTINE SEA)

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Abstract
A network of information set up in Cyprus in 2011 to monitor coral communities allowed for the establishment of the chronology of dispersion and abundance of the lionfish *Pterois miles*. Since localized first records in Autumn 2012, *P. miles* has successfully expanded to the rest of the island, except upstream, towards the eastern coast. Initially, solitary individuals were observed throughout the year at different stages of gonad maturation; during 2015, groups of up to five lionfish were frequently observed. There is an incipient consumption of lionfish flesh by locals.

Keywords: Alien species, Lessepsian migration, Levantine Basin, Suez Canal

Introduction

The Levantine Sea is among the Mediterranean basins mostly affected by exotic marine species. Not surprisingly, a large percentage of those are of Red Sea and Indo-Pacific origin, and their dispersion (as larvae or adults) is essentially through the Suez Canal. The dispersal and establishment of the emblematic lionfish (*Pterois miles* and *Pterois volitans*) in the Western Atlantic and Caribbean Sea during the last two decades have illustrated the capacity of exotic species to produce complex effects on local ecology. In the Mediterranean Sea, one single *P. miles* was observed in the early 1990s and only during the last three to four years its occurrence and abundance in the Levantine Basin has rapidly increased in what appears to be a "recent wave" [1] of very successful propagules.

Methods

By means of an island-wide network of collaborators in Cyprus (professional and recreational divers and fishermen, port and governmental authorities, volunteers and observers of opportunity) set up in 2011 initially to monitor coral communities and more recently lionfish, it was possible to acquire records of sightings, specimens and what is usually more difficult, a chronology of the dispersal and development of *P. miles* populations. Observers were asked to record or provide (by formulated interviews) a set of standard observations, such as number of individuals, estimated size, substrate, depth, locality, and, when possible, to capture specimens for taxonomic, morphometric, sexing (MEDITS protocol), genetic and stomach content analyses. Whenever possible, live specimens were kept in aquaria for observation.

Results

The taxonomy of nine specimens (14-29.4cm max. length; five males, stages 2 and 4; three females, stages 1 to 3; one not sexed) from different locations was resolved based on fin (dorsal and anal) ray meristics confirming that *P. miles* was found along the coast of Cyprus. Earliest records (Autumn 2012) were from the Southwestern area of Limassol (Fig. 1) of solitary juveniles (n=3, 5-10cm max. length) associated with rocky and coralligenous substrates between 20 and 35m depth. During the Winter 2012/13, other specimens (n=5, 10-25cm max. length, 15-20m depth) were observed at other rocky-coralligenous or artificial substrate locations of the Limassol and Cape Pyla areas (Fig. 1); two additional specimens were reported by local authorities in the national press. Sightings for the rest of 2013 (n=6, 15-20cm max. length, 10-30m depth) were restricted to those same areas. It is during 2014 that the number of lionfish specimens increased significantly (n=13, 8-30cm max. length, 10-25m depth) as well as the number of locations along the coast (Fig. 1). Noteworthy is the fact that until 2015 only solitary individuals were observed. In 2015, numerous reports (n=52, 8-30cm max. length, 2-35m depth) were made all over Cyprus except from the easternmost coast (Fig. 1); groups of 2 to 5 fish were observed. There are four independent reports of lionfish consumption by local fishermen. Spines and skin were carefully removed and the flesh grilled.

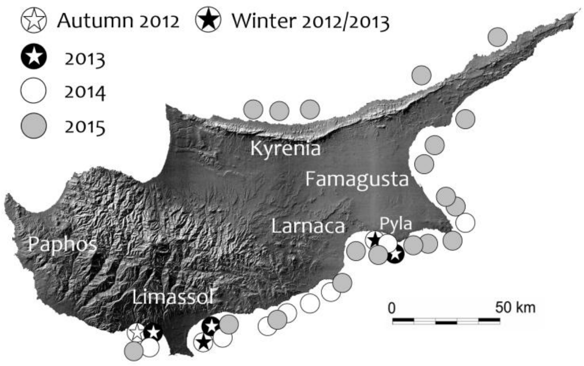

Fig. 1. Chronological distribution of lionfish reports in Cyprus.

Discussion and conclusions

Similar pattern of rapid increase in lionfish abundance and distribution has been observed elsewhere (e.g. Caribbean coast of Costa Rica). In Cyprus, initial reports were restricted mainly to two areas and in about three years *P. miles* started being observed along almost all coastal areas of the island. Currently, pairs or small groups of lionfish are known among local divers/fishers to be recruited to specific substrates (rocky and shipwrecks) in spite of high abundance of a known *P. miles* predator, the bluespotted cornetfish (*Fistularia commersoni*) [2]. The pattern of dispersal and abundance described here is not considered an artefact of sampling since lionfish are very conspicuous and hard to go unnoticed. Additionally, the same sampling effort occurs since 2011. These considerations suggest that for the lionfish in Cyprus, a "recent wave" of dispersal was followed by successful recruitment and survivorship is effectively in motion.

Acknowledgements

We thank the Cypriot community of fishermen and divers for reporting catches and sightings of lionfish from all around the island. Thanks are also due to the Department of Fisheries and Marine Research of Cyprus for their support to this study.

References

1 - Bariche, M., Torres and M., Azzurro, E., 2013. The presence of the invasive Lionfish *Pterois miles* in the Mediterranean Sea. *Mediterranean Mar. Sci.* 14: 292-294.
2 - Bernadsky, G. and Goulet, D., 1991. A natural predator of the Lion fish, *Pterois miles. COPEIA* 1: 230–231.

STATUS OF INVASIVE MARINE SPECIES IN THE LIBYAN COAST

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Abstract

Thirty five marine species have invaded the Libyan coast from the red sea and Atlantic Ocean. More than 71% are fishes, 17.14% Mollusca and 11.43% Crustaceans. Three fish species have recorded for first time in the Libyan coast (*Sphoeroides pachygaster, Seriola fasciata* and *Seriola rivoliana*). Many of these species are successfully adapted to the different topography and environments of Libyan coast. However, some of these species become commercially valuable.

Keywords: Invasive species, Lessepsian migration, Libyan Sea

Introduction

Invasive species increased regional marine biodiversity in Mediterranean Sea, however, may alter the evolutionary pathway of native species by competitive exclusion, niche displacement, predation and other ecological and genetic mechanisms [5]. According to [7], bathymetrically speaking three areas may be distinguished along the coast of Libya; all are closely associated with major structural features of the African continent. Migrant invasive marine species have had an enormous impact on the eastern Mediterranean ecosystem; there has been no thorough study to assess this impact [4]. Many invasive marine species have been recorded in Libyan waters [1,6]. The objectives of this study are to present the status, distribution and characterization of invasive marine species along the entire Libyan coast.

Results and Discussion

This study documented thirty five marine invasive species in the Libyan waters, fishes represent the highest percentage (71%) followed by Mollusca, and crustaceans 17.14%, and 11.43 % respectively (Fig. 1).

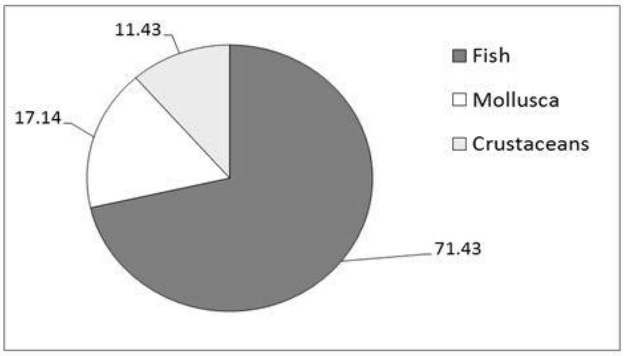

Fig. 1. Percentage of the invasive marine species in the Libyan coast.

Three fish species have been recorded for the first time in the Libyan waters: *Seriola rivoliana*, *Seriola fasciata* and *Sphoeroides pachygaster*. Most of the invasive migrants have been successfully adapted to the different topography and environments of Libyan coast [5]. As many invasive species, *Siganus luridus*, *S. rivulatus*, *Sphyraena chrysotaenia*, *S. flavicauda*, *Hemiramphus far* and *Fistularia commersonii* have become common along this coast, while other species such as: *Alepes djedaba*, *Upeneus pori*, *Upeneus maluccensis*, *Liza carinata*, *Sargocentron rubrum* and *Crenidens crenidens* were rare. The abundance of the invasive species differ according to the coastal main regions (Eastern, Sirt gulf and western), which may be due to a relation between the species' early arrival and the species abundance. [3] Suggested that there is a correlation between species that arrived earlier in the Mediterranean and their greater abundance. Most invasive migrant species are found in the coastal area and usually at depths of 1-50 m. As far as the distribution, most of the invasive species are concentrated in the eastern Libyan coast. For a better understanding of invasive immigration, additional taxonomic and biological investigations are required [2]. This study has shown that some of the invasive migrants have successfully adapted to the different topography and environments of Libyan coast and many species have become widespread along this coast, which means that they are contributing to the commercial fish catch in Libya.

Acknowledgements

We would like to thank the fishermen and the fishermen's union for their collaboration with us. Our thanks to the National Agency for Scientific Research (NASR) for support this project.

References

1 - Ben-Abdallah R., Alturky A., Fituri A. (2005) Records of exotic fishes in the Libyan coast. Libyan Journal of Marine Science 10: 1-8.
2 - Ben-Tuvia A. (1978) Immigration of fishes through the Suez Canal. Fishery Bulletin 76 (1): 249-255.
3 - Golani D. 1998. Impact of Red Sea fish migrants through the Suez Canal on the aquatic environment of the eastern Mediterranean. Bulletin of the Yale School of Forestry and Environmental Studies 103: 375-387.
4 - Golani D. 2002. Lessepsian fish migration-Characterization and impact on the Eastern Mediterranean. Pp. 1-9. In: Bayram Öztürk and Nuri Basusta (eds). Workshop on Lessepsian migration, 20-21 July 2002 Gökceada- Turkey.
5 - Mooney HA, Cleland EE (2001) The evolutionary impact of invasive species. Proceedings of the National Academy of Sciences of the United States of America, 98 , 5446 – 5451.
6 - Shakman E.A., Kinzelbach R. (2007). First record of the Sweeper fish *Pempheris vanicolensis* Cuvier, 1821 in the eastern part of the Libyan coast. Rostocker Meereskundliche Beiträge 18: 1-3.
7 - Sogreah E. (1977) Trawl fishing ground survey off the Tripolitania coast. Final Report. Part V: 1-44, and final report: Introduction and General Conclusions: 1-30.

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OCCURRENCE OF THE BLUE CRAB *CALLINECTES SAPIDUS*, RATHBUN, 1896, AND ITS FISHERIES BIOLOGY IN BARDAWIL LAGOON, SINAI PENINSULA, EGYPT

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Abstract

Callinectes sapidus, Rath. was firstly recorded in Bardawil Lagoon (BL) during the present study in 2015. It constitutes about 15% of the total catch while *Portunus pelagicus* is considered the major part in crab fishery in (BL). The size range of *C. sapidus* was from 65 mm to 155 mm (CW). The regression of width length relationship showed a marked deviation from isometric growth. Length–width and body weight regressions have also deviation from the isometric growth and the analysis of the covariance indicates that there is a significant difference between sexes with respect to length weight relationship.

Keywords: Crustacea, Levantine Basin, Fisheries, Lagoons

Introduction

The ecosystem of Bardawil Lagoon (BL) differs from the other Northern Delta Lakes of Egypt, as it is hypersaline and shallow in depth (Fig. 1).

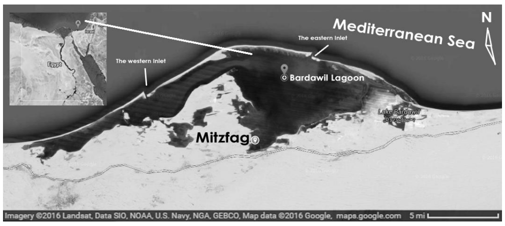

Fig. 1. A map showing the location of Bardawil Lagoon and the selected fishing area.

Crabs and shrimps are considered recently as one of the most important crustacean fishery resources in (BL) (Ameran, 2004; Ameran et al., 2009; Abdelrazek et al., 2006 & 2008; Mohamed and El-Aiatt, 2012). The increasing of crab production continued from 2000 to 2009 to reach about 38% of the total lagoon fisheries. By 2014 this production decreased to be 19% after fisheries regulations done during 2015 by preventing the use of the fishing trawl (Kalsa). Thus, crab catch increased to be 42% of the total lagoon production (Fig. 2) (GAFRD, 2015).

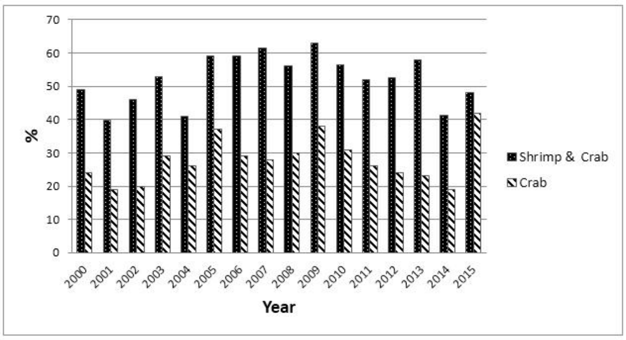

Fig. 2. Crustacean Fisheries in Bardawil Lagoon between the years 2000 - 2015.

Callinectes sapidus (Rath.) was firstly recorded in Lake Manzala, Egypt in 1940 and then in Lake Edku (Banoub, 1963). Ramadan and Dowidar (1972) mentioned that *C. sapidus* production was greatly affected by the high dam construction and decreased completely in the northern lakes as well as in the Mediterranean marine catch. In the present study, *C. sapidus* was recorded in (BL) from May to December (2015). The catch of *C. sapidus* is about 15% of total crab production while the remaining 85% is of the *Portunus pelagicus*. Materials and Methods: During the fishing season 2015 from May to December a monthly sample of crab catch from (BL) was collected from Mitzfag (Fig. 1). The sample was frozen and transported to NIOF laboratory. 140 individuals of *C. sapidus* were isolated and sexed, then, their carapace width, length and weight were measured using Vernier Caliper (0.05 mm accuracy). Regression equations were derived. Results and Discussion: The results showed that *C. sapidus* ranged from 65 mm to 159 mm in carapace width (CW) and from 52-303 g in weight (Wt). 105 mm CW is considered the main size group observed in its catch, smaller and larger sizes were represented with few individuals. The regression relationship of width length of *C. sapidus* were done. The (b) values were 0.9838, 0.9566 and 0.9267, respectively for males, females and combined sexes. The regression equations for the length- weight relationships were Wt = 0.004 CL3.133, WT = 0.008 CL2.931 and Wt = 0.004 CL3.1234 for males, females and combined sexes, respectively. The exponential values showed a marked deviation from the isometric growth. (r) values of for males, females and combined sexes were 0.9579, 0.9256 and 0.9512 respectively. The (b) values for the carapace width CW and body weight body Wt of males, females and combined sexes were 2.7693, 2.396 and 2.545 respectively, which represents a deviation from isometric growth pattern. The (r) values were 0.9838, 0.9566 and 0.9267 respectively. The analysis of covariance indicates that there is a significant difference between sexes with respect to length-weight relationship. The interrelationship between CW/Length and propodus length/depth for males and with abdomen width /length for females were done which suggested in most cases the positive relationship and the highly significant case. The ratio of females in *C. sapidus* population in Bardawil lagoon was in favor of males. In Turkish waters, the reverse was recorded in Beymelek lagoon *C. sapidus* population as the females were more than males (Sumer et al., 2013). In Brazil, a similar pattern was obtained for Babitonga Bay, with females dominating in most samples, while in the bay of Santos, Sao Paulo state, males dominated in samples. Thus, ratio may be related to the longevity and growth of crabs population, also to different migration pattern in the lagoon system and all these parameters seem to affect their relative occurrence.

Further studies on the population of *C. sapidus* and on the potential dispersal of this species in adjacent areas would be of interest to provide rich information on population structure and dynamics of the blue crab in Bardawil Lagoon.

References

1 - Abdel Razek,F.A. 1987. Crab fishery of the Egyptian waters with notes on the bionomics of *Portunus pelagicus* (L). Acta Adriatica, 28(1-2): 143-154.

2 - Abdel-Razek, F.A., Taha, S.M., Ameran, M.A., 2006. Population biology of the edible crab *Portunus pelagicus* (Linnaeus) from Bardawil Lagoon, northern Sinai, Egypt. Egypt. J. Aquat. Res. 32, 401–418.

3 - Ameran, M.A., 2004. Studies on the Crustacean Fishery in Bardawil Lagoon (Ph.D. thesis). Faculty of Environmental Agricultural Science, Al-Arish, Suez Canal University.

4 - Banoub, M.W. 1963. Survey of the Blue-Crab *Callinectes sapidus* (Rath.), in Lake Edku in 1960. Alexandria Institute of Hydrobiology, Notes and Memoirs 69: 1-20.

5 - GAFRD, 2015. Annual report of Bardawil Lagoon, The general authority for the development of fish resources (in press).

6 - Sumer, C., Teksam, I., Karatas,H., Beyhan, T., and Aydin, C.M., 2013. Growth and Reproduction Biology of the Blue Crab, *Callinectes sapidus*, Rathbun, 1896, in the Beymelek Lagoon (Southwestern Coast of Turkey). 13, 675-84.

BRACHYURAN CRABS ASSOCIATED WITH MARINE FOULING FROM EGYPTIAN MEDITERRANEAN HARBORS

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Abstract
The present study deals with the brachyuran decapods associated with marine fouling in Egyptian Mediterranean harbors. Nine species of 9 genera affiliating to 5 families were recorded. Remarks on the species recorded are provided.

Keywords: Fouling, Decapoda, South-Eastern Mediterranean, Nile Delta

Introduction

Fouling is the growth of marine biota on submerged objects. Its investigation in Egypt dates back to 1960 [1]. Fouling harbors different organisms including brachyuran crabs.

Material and methods

Brachyuran crabs associated with marine fouling in 7 Egyptian Mediterranean harbors (Figure 1) collected between the years 1977 and 2015, were identified.

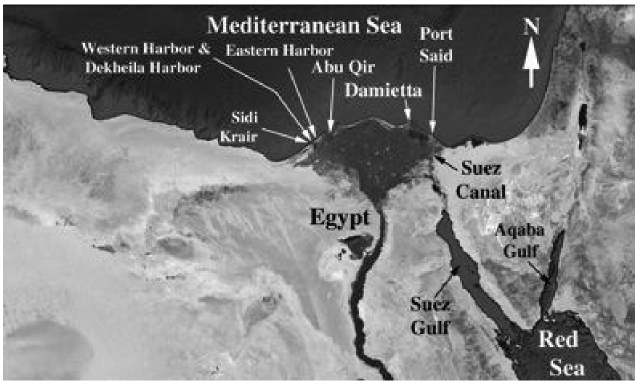

Fig. 1. Sampling localities.

Results and discussion

Through the present work 9 brachyuran crabs affiliating to 9 genera of 5 families were recorded, 5 of them (*i.e.* more than 55% of the total recorded species) are of Indo-Pacific origin (Table 1). These are *Coleusia signata*, *Hyastenus hilgendorfi*, *Charybdis hellerii*, *Pilumnopeus vauquelini*, and *Sphaerozius nitidus*. The other four species (*Liocarcinus depurator*, *Eriphia verrucosa*, *Pachygrapsus marmoratus*, and *Brachynotus sexdentatus*) are Atlanto-mediterranean in origin.

Tab. 1. Distribution of the recorded species in the studied harbors.

Harbor / Species	S.	DK.	W.	E.	A.	D.	P.	O.
C. signata							+	I
H. hilgendorfi							+	I
C. hellerii	+			+				I
L. depurator				+				A
E. verrucosa		+		+				A
P. vauquelini						+	+	I
S. nitidus							+	I
P. marmoratus						+	+	A
B. sexdentatus		+	+	+	+		+	A

S. = Sidi Krair (31º 03'N, 29º 40'E), DK. = Dekheila (31º08'N, 29º47'E), W. = Western (31º 11'N, 29º 52'E), E. = Eastern (31º 12'N, 29º 53'E), A.= Abu Qir (31º 19'N, 30º 04'E), D.= Dameitta (31º 28'N, 31º 45'E), and P.= Port Said (31º 16'N, 32º 19'E). O. = Origin, I= Indo-Pacific, A= Atlanto-Mediterranean.

Coleusia signata inhabits the entire Red Sea on muddy and sandy gravel bottoms from subtidal to 22 m deep. Its first appearance in the Mediterranean dates back to 1953 [2] and in Egypt dates back to 1969 [3]. *Hyastenus hilgendorfi* inhabits Indo-West Pacific region at 0-93 m on coarse and soft bottoms. In Mediterranean it exists since 1960 [4] and in Egyptian Mediterranean since 1969 [3].*Charybdis hellerii* inhabits Indo-West Pacific region and invaded the Western Atlantic [5]. Its depth range is 3-162 m on different types of bottoms [3]. It inhabits the Mediterranean since (1924-25) [5] and in the Egyptian Mediterranean since 1936 [6]. *Pilumnopeus vauquelini* inhabits Red Sea to Arabic Gulf; found in fouling, sandy mud and coarse bottoms at 0-3 m deep. Its first record in the Mediterranean was from Egypt in 1924 [7]. *Sphaerosius nitidus* inhabits Red Sea to japan in fouling and at 50 fathoms deep. Its record in Egypt and Mediterranean dates back to 1969 [3]. The presence of these 5 alien species associated to fouling may define the fouling attached to ship hulls as a mean of introducing these species to the Mediterranean Sea. The number of Indo-Pacific species recorded in the present study equals 1/3 of the total Indo-Pacific species procured in the Egyptian Mediterranean waters. More investigation may reveal more crab species associated to fouling in the Mediterranean.

References

1 - Banoub M.W., 1960. Notes on the fouling of glass plates submerged in the Eastern Harbour. Alexandria, 1958. Alex. Inst. Hydrobiol. Not. and Mem. 64: 1-17.
2 - Holthuis L.B., 1956. Notes on a collection of Crustacea Decapoda known from the Suez Canal. Zool. Meded. Leiden 34: 301-330.
3 - Ramadan Sh. E., 1976. Studies on Bottom Crustacea (Decpoda-Brachyura) in the region between Port Said and Alexandria , M.Sc. Thesis, Fac. of Sci., Alex.Univ., 258 pp.
4 - Lewinsohn C., Holthuis L. B., 1964. New records of decapod Crustacea from the Mediterranean coast of Israel and the eastern Mediterranean. Zoologische Mededelingen, 40: 45-63.
5 - CIESM, 2004. Atlas of Exotic Crustacea.
6 - Balss H., 1936. The fishery grounds near Alexandria, VII- Decapoda, *Note Mem. Fish. Res. Direct*. Egypt 15: 1-67.
7 - Calman W.T., 1927. Report on the Crustacea decapoda (Brachyura). Zoological Results of the Cambridge Expedition to the Suez Canal, 1924. XIII, *Trans. Zool. Soc. Lond*., 22:211-217.

SPATIAL DISTRIBUTION AND MORPHOMETRIC CHARACTERIZATION OF THE INVASIVE SPECIES *CERITHIUM SCABRIDUM* PHILIPPE (1848) IN THE TUNISIAN COASTS

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Abstract
This work is a contribution to the study of the spatial distribution and the morphology of the invasive species *Cerithium scabridum* along the coasts of Tunisia. Among the surveyed stations (18), only four situated in the Gulf of Gabes, revealed the presence of this Cerithe with a relatively large density values. The application of the Factorial Discriminant analysis (FDA) to the metric variables tmesured on specimens sampled from the Gulf of Gabes and the Persian Gulf, divided the stations into two groups significantly different. The isolation of the stations of Jerba seems to be related to environmental conditions favorable to the development of this species. <\/div>

Keywords: Gastropods, Lessepsian migration, Invasive species, Tunisian Plateau

Introduction
The invasive species *Cerithium scabridum* Philippi, 1848 is a prosobranch gastropod subservient to the infralittoral, It is among the first indo-pacific molluscan species recorded in the Suez Canal and then in the Mediterranean Sea. It was recently reported on the Tunisian coasts ([1]). The deficience of researchs on the eco-biology of this Cerithe led us to study its current distribution along the Tunisian coasts and to compare the shell morphology of the introduced specimens with that of individuals from their original environment (Persian Gulf).

Materials and methods
A total of 18 stations were surveyed along the coasts of Tunisia, in spring 2015. At each station containing *C. scabridum*, the density was evaluated using a quadrat of 0.25m² of surface at the rate of 5 replicates at each station and a sample of 30 individuals was collected. In addition, a sample of 30 individuals was brought from the Manifah station (Arabian Gulf). On each shell, metric variables were measured using an electronic caliper (1/100 mm) : Shell length (L), shell width (l), shell thickness (E), last whorl length (LDS), siphonal canal length (Ls), siphonal canal width (ls), aperture length (Lo), aperture width (lo). A factorial discriminant analysis (FDA) has been performed and Wilks test was applied to verify the significance of the difference between the groups obtained by FDA. In addition, the estimated percentages PCS was used to assign individuals into their original samples.

Results and Discussion
The study of the spatial distribution showed that the species was encountered alive only at four stations in the Gulf of Gabes namely: Zarzis a, Zarzis b, Jerba El Borj and Jerba Sidi Jmour. The density values were relatively important varying between 7 and 11 ind / m². The application of Kruskal-Wallis test on the measured variables revealed a highly significant difference between them at the limit of 1% reflecting a clear morphological variability between the studied samples. The results of the FDA performed on the metric variables showed that the two first axes explain 93% of the total variation (Fig. 1).

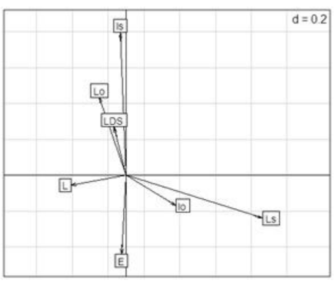

Fig. 1. Contribution of the variables in the formation of the two first discriminant functions

The barycentric representation of the factorial plan FDA (Fig 2) suggested the presence of two main groups: the first is the two stations of Jerba (Jerba El Borj, Jerba Sidi Jmour). The second includes the Zarzis stations and that of Manifah (Arabian Gulf). The Wilks test confirmed the significance of this difference (Wilks lambda = 0.036109, F = 27,143, $p < 0.05$). The calculated percentages of PCS are varying between 95% in Arabian Gulf and 98% in Jerba El Borj reflecting an intra-sample similarity.

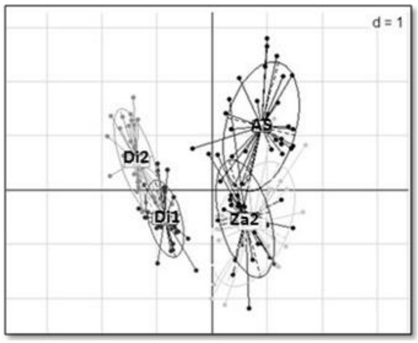

Fig. 2. Factorial Discriminant Analysis (FDA) of studied populations

The absence of *C scabridum* in the Gulf of Tunis despite its signalisation in previous works, seems revealing that the species wasn'i installed in abundance at this level and didn't yet constitute stable populations ([2]). Furthermore, the segregation of Jerba stations may be related to environmental conditions such as the availability of foods and space that appears to be suitable to the prosperity of this invasive species.

References
1 - 1- Enzenross L., Enzenross R. 2001. Untersuchungen uber das Vorkommen mariner Mollusken in tunesischen Gewasser. *Shriften sur malakozoologie*, 17: 45-62.
2 - 2- Antit M., Daoulatli A., Rueda J.L and Salas C. 2013. Temporal variation of the algae associated molluscan assemblage of artificial substrata in the Bay of Tunis (Tunisia). *Medeterranean Marine Science*, 14 (2):390-402.

ABUNDANCE OF INVASIVE ALIEN SPECIES (IAS) CAUGHT BY SMALL-SCALE FISHERIES OF LIPSI ISLAND, GREECE.

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Abstract

Recorded landings from artisanal fishermen of the Lipsi island complex, Greece, were analysed for abundance of IAS ichthyofauna. *Seriola fasciata, Siganus rivulatus, Siganus luridus, Sargocentron rubrum* and *Etrumeus teres* were landed. *Siganidae* sp. comprised 18% of the total catch biomass.The current study confirmed the presence of these IAS at a local scale.

Keywords: Invasive species, Aegean Sea, Fisheries, Alien species

The Aegean Sea, which poses many different anthropogenic influences, provides an opportunity to survey the presence of IAS. Landings from the local, small-scale fisheries gave precise data on IAS presence and abundance, on a local scale. This study was carried out in collaboration with Lipsi Island complex fishermen in order to map IAS distribution and calculate abundance. This is a baseline study to increase the understanding of the local distribution of IAS.

The study took place between April and October 2014 alongside small-scale Lipsi island fishermen. Of fishermen catch, species were identified and the length of each individual was measured and recorded on a daily basis. Gear characteristics, fishing techniques and the substrate type was also recorded. Data analysis was based on 144 landing surveys using long-line, trammel and gill nets. Using the formula $W = aL^b$, length was converted to weight (kg) and biomass per individual (kg) was estimated.

Throughout the sampling period, the majority of the IAS were landed in June and July 2014 whereas the lowest landings were recorded in September and October 2014 (Figure 1). Additionally, shallow waters that are less than 30 m depth had the highest landing rate of IAS.

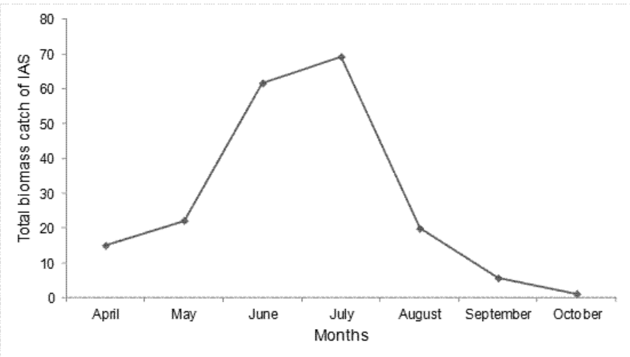

Fig. 1. Figure 1 Total biomass catch of monthly IAS landings in Lipsi island complex, 2014

70 species were identified during the landings, including 5 IAS with a total of 135 individuals: *Siganus luridus* (107), *Siganus rivulatus* (17), *Sargocentron rubrum* (6), *Seriola fasciata* (4) and *Etrumeus teres* (1). *S. luridus* had the second largest biomass caught in the total biomass of species landed in 2014 (Figure 2); this species contributed to 97.6 % of the IAS total biomass. The large presence of Siganidae sp. can be interpreted that the IAS could be dominant over many native biota of Lipsi. These IAS species have previously been recorded in Greek territorial waters, but not as far north as Lipsi island [1, 2].

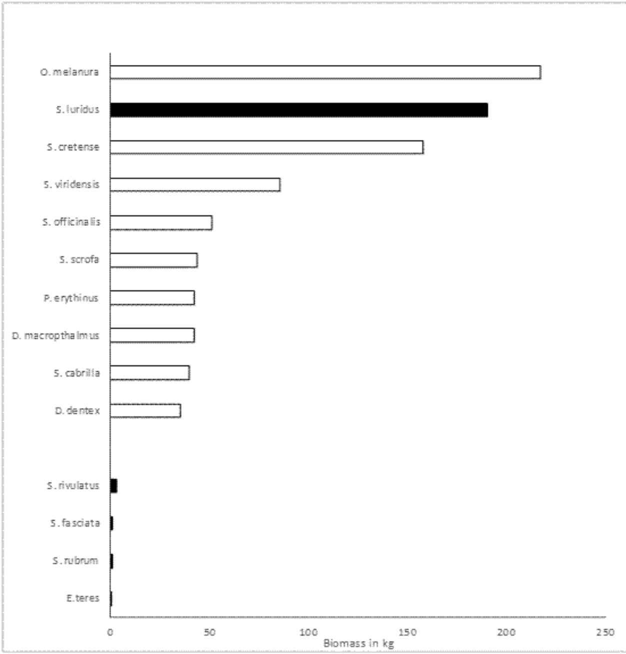

Fig. 2. Figure 2 – Total biomass of 14 caught species landed during the 2014 season – IAS in black, native species in white.

Close co-operation with artisanal fishermen is of great importance, allowing an efficient method to gather data on IAS abundance. However, only information on catchable species would be presented. Siganidae sp. contributed to a high proportion of the biomass caught of IAS whereas only four other IAS were reported, each with a low catch number. It is important to note that most of the IAS were caught in shallow waters; this could be linked to the species habitat preference or higher anthropogenic influences in these areas.

References

1 - ELNAIS. 2016. Elnais – DataBase | ELNAIS BY HCMR. [Online] Available at: http://elnais.hcmr.gr/elnais-database-2/ [Accessed 09 March 2016]

2 - Golani, D., Orsi-Relini, L., Massuti, E., Quingnard, J.P. 2002. CIESM Atlas of Exotic Species in the Mediterranean. Vol.1 Fishes, CIESM Publishers, *Monaco*; 254

NEWCOMER SPECIES FROM MALTESE WATERS: ADDITIONS AND AMENDMENTS

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Abstract
The inventory of newcomers in Maltese waters is updated with the addition of 7 alien and 1 range-expanding species, while one previous entry in the inventory is omitted. Thus, a total of 72 alien and 8 range-expanding species have been recorded by February 2016. Half of these species have established populations in Maltese waters while a further 10% are considered to be invasive. The main modes of introduction for alien species in Maltese waters are 'Shipping' and 'Secondary dispersal' from elsewhere in the Mediterranean. More than half of these newcomer species were recorded since the year 2000.

Keywords: Species introduction, Alien species, Phytobenthos, Sicily Channel, Zoobenthos

Introduction
Timely updates to inventories of non-native species are essential to provide information on the distribution, introduction and dispersal pathways, and on impacts of such species. A total of 66 alien and 7 range-expanding species were confirmed from Maltese waters by December 2014 [1], but there have been a number of new records or changes in the status of previously recorded species since then, which are presented here (updated to February 2016). Definitions of establishment status and origin are as given in Evans *et al*., 2015 [1].

Results and Discussion
New or updated records of newcomer species to be added to the Maltese inventory are listed in Table 1. The 2013 record of *Acanthurus monroviae* [2] was considered questionable [3], but is actually substantiated by a photo (J. Langenack, *pers. comm.*), while a second individual of this species was caught and photographed in November 2015. On the other hand, *Monticellina dorsobranchialis,* recently reported as a non-indigenous species in Maltese waters [4], is not included because it is known to be an Atlanto-Mediterranean species. A specimen of *Kyphosus* sp. was recorded from Malta in January 2016, but its specific identity could not be determined on the basis of photographs and this record was omitted from the inventory. Furthermore, *Stenothoe gallensis* should be removed from the inventory since this record was likely based on a misidentification of the native *S. cattai* [5].

Tab. 1. Additions (filled circles) or updates (empty circles) to the inventory of alien and range-expanding species from Maltese waters. *Vector*: A: aquarium trade, D: dispersal, RE: range expansion, S: shipping, U: unknown; *Status*: C: casual; E: established; *Origin*: A: alien; RE: range expansion.

Species	Date	Vector	Status	Origin	Ref
• *Apionsoma misakianum*	2005	U	E	A	[6]
• *Maritigrella fuscopunctata*	2015	S / D	E	A	[7]
○ *Ondina michaelae*	2009	S	C	A	[8]
○ *Portunus segnis*	1972	U	C	A	[7]
• *Acanthurus coeruleus*	2013	U	C	A	[3]
• *Acanthurus monroviae*	2013	U	C	A	[2]
• *Heniochus intermedius*	2014	U	C	A	[3]
• *Pomacanthus maculosus*	2012	S / A	C	A	*
• *Sargocentron hastatum*	2016	U	C	A?	**
Stegastes variabilis	○2013	U	○C	A	[9]
• *Enchelycore anatina*	2015	RE	C	RE	[10]

* Present authors, unpublished record
** Based on images published on social media

These updates bring the total number of newcomer species recorded from Maltese waters to 80, of which 72 are alien species with the remaining 8 having arrived via natural range expansion. Half of these species have established populations and a further 10% are considered invasive (Fig. 1a). Overall, 'Shipping' and 'Secondary dispersal' from elsewhere in the Mediterranean Sea are the most common introduction pathways for alien species into Maltese waters (Fig. 1b). More than half of the newcomer species were recorded since the year 2000, which is indicative of the accelerated rate of arrivals of new species in the last two decades.

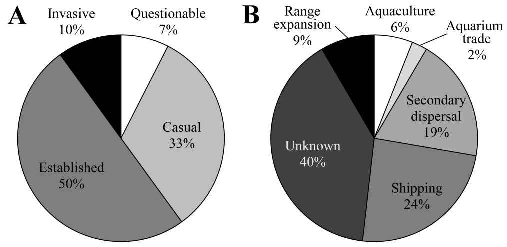

Fig. 1. Newcomer species recorded from Maltese waters by February 2016, grouped according to their (A) establishment success and (B) introduction pathway. All 80 newcomers were included in the analysis of establishment status, while species with a 'Questionable' status were excluded from the analysis of introduction pathways.

References
1 - Evans J., Barbara J. and Schembri P.J., 2015. Updated review of marine alien species and other 'newcomers' recorded from the Maltese Islands (Central Mediterranean). *Medit. Mar. Sci.*, 16(1): 225-244.
2 - Langeneck J., Boyer M., De Cecco P.G., Luciani C., Marcelli M. and Vacchi M., 2015. First record of *Acanthurus chirurgus* (Perciformes: Acanthuridae) from the Mediterranean Sea, with some distributional notes on Mediterranean Acanthuridae. *Medit. Mar. Sci.*,16(2): 427-431.
3 - Evans J., Tonna R. and Schembri P.J., 2015. Portent or accident? Two new records of thermophilic fish from the central Mediterranean. *BioInvasions Rec.*, 4(4): 299-304.
4 - Romeo T., D'Alessandro M., Esposito V., Scotti G., Berto D., *et al*., 2015. Environmental quality assessment of Grand Harbour (Valletta, Maltese Islands): a case study of a busy harbour in the Central Mediterranean Sea. *Environ. Monit. Assess.*, 187: 747.
5 - Krapp-Schickel T., 2013. New or amended data on Mediterranean Amphipoda: genera *Dexamine*, *Ericthonius* and *Stenothoe*. *Zootaxa,* 3613(2): 125-145.
6 - Mifsud C. and Saiz Salinas J.I., 2012. A contribution to the knowledge of the phylum Sipuncula in the Maltese Islands (central Mediterranean). *The Central Mediterranean Naturalist* [Malta], 5(3-4): 20-25.
7 - Crocetta F., Agius D., Balistreri P., Bariche M., Bayhan Y.K., *et al*., 2015. New Mediterranean biodiversity records (October 2015). *Medit. Mar. Sci.*, 16 (3): 682-702.
8 - Cachia C. and Mifsud C., 2015. Considerations about *Leucotina eva* Thiele, 1925 with description of *Ondina michaelae* n. sp. (Heterobranchia: Pyramidellidae). *Triton*, 31: 3-5.
9 - Vella A., Agius Darmanin S. and Vella N., 2015. Morphological and genetic barcoding study confirming the first *Stegastes variabilis* (Castelnau, 1855) report in the Mediterranean Sea. *Medit. Mar. Sci.*, 16(3): 609-612.
10 - Deidun A., Watson D., Castriota L., Mazza G. and Pasolli L., 2015. First record of the fangtooth moray, *Enchelycore anatine* (Actinopterygii: Anguilliformes: Muraenidae), from Maltese waters, Central Mediterranean. *Acta Ichthyol. Piscat.,* 45(3): 315-317.

CIESM Congress Session : Exotic species - fluxes and vectors across seas

Moderator : Henn Ojaveer, Marine Inst., Tartu Univ., Estonia

Moderator's Synthesis

One of the most pressing issues relative to management of new species introductions is uncertainty in our knowledge to assign individual introductions not only to vectors, but even to responsible pathways. Such an uncertainty is also relevant for Mediterranean Sea introductions, and relates to invasions though the Suez Canal (is the invasion vector the canal itself or shipping occurring via the canal).

Although prevention should be in focus in reducing the risk of new introductions in the marine realm, and so the management focus should be invasion vectors, knowing the source of the species is of vital importance. This knowledge may help to better identify the habitat requirements / tolerance limits, suggest the likely invasion vector(s), and design more appropriate mitigation measures. But the deeper we look in the past, the less we know on the origin of non-native species. Therefore, knowing the species origin will play a crucial role for more recent and also future introductions.

The International Convention for the Control and Management of Ships' Ballast Water and Sediments will enter into force in September 2017. Thus, one of the vectors for major species introductions globally will be managed very soon. However, although ship hull fouling has been proven to be an essential invasion vector, no regulation or voluntary guidelines exist for it. This should be considered as an important gap in reducing the risk for new species introductions currently.

DONOR AND RECIPIENT REGIONS FOR EXOTIC SPECIES OF MARINE MACROPHYTES: A CASE OF UNIDIRECTIONAL FLOW, THE MEDITERRANEAN SEA

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Abstract

The Mediterranean Sea is the recipient area for two major flows, at a world scale, of exotic macrophytes: (i) the Lessepsian pathway, based upon the Suez Canal, with the Red Sea as the donor area; (ii) the Japan pathway, based upon the transfer of molluscs. The flows in the opposite direction, stemming from the Mediterranean, are null or negligible, making this sea a kind of sink for species diversity.

Keywords: Phytobenthos, Algae, Mediterranean Sea, Biodiversity

An exotic species (= NIS, Non Indigenous Species), in a recipient area, is a species that has been transported by Man from a distant donor region (i.e. an area non-contiguous to the recipient area). Within exotic species, introduced species are species that can self-reproduce without human assistance (= established species, naturalized species). Within introduced species, invasive species are harmful species, either for other species and ecosystem functioning, the economy and/or human health. Within invasive species, transformer species are species that are autogenic ecosystem engineers and therefore build a new ecosystem, completely distinct from the native one [1-3]. The notion of 'biological invasions' encompasses the full range of these degrees. A biological invasion involves a donor area, a recipient area, a vector (e.g. a ship), a corridor (e.g. the pathway sailed by a ship) and of course a candidate species [3].

The Mediterranean is the area most impacted worldwide by biological invasions. ~1 000 exotic taxa have been recorded [4-7]. The main vectors are fouling and clinging on ship hulls, the species accompanying oyster culture, ballast waters, the aquarium trade and the Suez Canal [4, 7].

The flow of Red Sea species into the Mediterranean Sea, via the man-made Suez Canal ('Lessepsian migration'), is often considered as the major modern biogeographical event, at the Holocene scale [10]. Hundreds of Red Sea species, including 39 species of macrophytes (e.g. the Rhodobionta *Chondria pygmaea*, *Galaxaura rugosa* and *Hypnea anastomosans*, the Magnoliophyta *Halophila stipulacea*, the stramenopile *Stypopodium shimperi*), have entered the Mediterranean through this waterway since the 19th century [7,9]. Because of the recent enlargement of the Suez Canal, this flow is expected to dramatically intensify [10]. The flow is unidirectional. The migration in the opposite direction, i.e. from the Mediterranean to the Red Sea ('anti-Lessepsian migration'), is negligible, because of the mainly unidirectional water flow (Red Sea towards the Mediterranean) [8,9]. No Mediterranean macrophytes have been found to occur in the Red Sea.

Perhaps equivalent, in worldwide magnitude, is the flow of north-western Pacific macrophytes, from Japan, Korea and adjacent areas, towards other regions such as the North American Pacific, Australia, Atlantic European coasts and the Mediterranean Sea. This global bioinvasion event is due to the transfer of oysters (*Crassostrea gigas*, adults and spat) and Manila clams (*Ruditapes philippinarum*) from the north-western Pacific to other areas. The Mediterranean is probably the hardest-hit region worldwide. Between 40 and 50 species of macrophytes have been directly or indirectly (mainly via the North American Pacific coast and the north-eastern Atlantic coasts) introduced into the Mediterranean from the north-western Pacific Ocean. The most invasive species are *Sargassum muticum*, *Undaria pinnatifida* and *Codium fragile*. Their effect on native ecosystems is dramatic. Like the Red Sea-Mediterranean flow, the 'Japan path' is unidirectional: no seaweed species, or just a very few, have taken the opposite path.

The Mediterranean Sea can constitute a kind of 'hub' for Red Sea and 'Japanese' species. For instance, the Red Sea Magnoliophyta *Halophila stipulacea*, once introduced into the Mediterranean, was exported to the Caribbean Sea. The Japanese stramenopile *Undaria pinnatifida*, once introduced into the Mediterranean Thau Lagoon (southern France), has been exported to the north-eastern Atlantic Ocean (Brittany and Galicia).

Overall, the Mediterranean constitutes a sink for exotic marine macrophytes: incomings are massive, whereas outgoings are null or negligible. Could a similar mechanism, at the geological timescale, account for its very high species diversity, making the Mediterranean Sea the main hotspot worldwide for macrophytes species diversity?

References

1 - Boudouresque C.F. and Verlaque M., 2002. Biological pollution in the Mediterranean Sea: invasive versus introduced macrophytes. *Mar. Poll. Bull.*, 44: 32-38.

2 - Boudouresque C.F. and Verlaque M., 2012. An overview of species introduction and invasion processes in marine and coastal lagoon habitats. *Cah. Biol. Mar.*, 53(3): 309-317.

3 - Boudouresque C.F., 1999. Introduced species in the Mediterranean : routes, kinetics and consequences. *Proceedings of the workshop on invasive Caulerpa in the Mediterranean.* Heraklion, Crete, Greece, 18-20 March 1998. UNEP publ., Athens, Greece : 51-72.

4 - Ribera M.A. and Boudouresque C.F., 1995. Introduced marine plants, with special reference to macroalgae: mechanisms and impact. *Progress in Phycological Research*, Round F.E. and Chapman D.J. (eds), Biopress Ltd publ., UK , 11: 187-268.

5 - Galil B.S., 2000. A sea under siege – alien species in the Mediterranean. *Biol. Inv.*, 2: 177-186.

6 - Zenetos A., Gofas S., Verlaque M., Cinar M.E., García Raso J.E., Bianchi C.N., Morri C., Azzurro E., Bilecenoglu M., Froglia C.,Siokou S., Violanti D., Sfriso A., San Martín G., Giangrande A., Katagan T., Ramos-Esplá A., Mastrototaro F., Ocaña O., Zingone A., Gambi M.C. and Streftaris N., 2010. Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. *Mediterr. Mar. Sci.*,11(2): 381-493.

7 - M., Ruitton S., Mineur F. and Boudouresque C.F., 2015. CIESM Atlas of exotic species. 4. Macrophytes. Briand F. (ed.), CIESM Publisher, Monaco: 1-362.

8 - Por F.D., 1978. Lessepsian migrations. The influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Springer publ., Berlin: i-viii + 1-228.

9 - Boudouresque C.F., 1999. The Red Sea - Mediterranean link: unwanted effects of canals. *Invasive species and biodiversity management*, Sandlund O.T., Schei P.J., Viken A. (eds.), Kluwer Academic publ.: 213-228.

10 - Galil B., Boero F., Fraschetti S., Piraino S., Campbell M., Hewitt C., Carlton J., Cook E., Jelmert A., Macpherson E., Marchini A., Occhipinti-Ambrogi A., Mckenzie C., Minchin D., Ojaveer H., Olenin S. and Ruiz G., 2015. The enlargement of the Suez Canal and introduction of non-indigenous species to the Mediterranean Sea. *Limnol. Oceanogr. Bull.*, 24(2): 43–45.

TEMPERATURE TOLERANCE OF TWO AMPHIPOD SPECIES UNDER KIEL FJORD CONDITIONS: BALTIC *VS*. CASPIAN SEA SPECIES

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Abstract

In this study, we tested temperature tolerance of two amphipod species, one originating from the Baltic Sea (*Gammarus oceanicus*) and another from the Ponto-Caspian region (*Pontogammarus maeoticus*) to determine their performance under current and future global warming scenarios. Both amphipod species perform rather similar in temperatures from 6 to 22°C. However, above 24°C, only *P. maeoticus* survived, indicating that in the case of global warming *P. maeoticus* that evolved under higher temperatures of the Caspian Sea might outcompete *G. oceanicus*, which evolved under lower temperatures of the Baltic Sea.

Keywords: NIS, Temperature, Baltic Sea, Caspian Sea

New non-indigenous species are constantly arriving to the Baltic Sea, most likely via ballast water, hull fouling and/or aquaculture [1,2]. A relatively high number of those species originate from the Ponto-Caspian region (*i.e*., Black, Azov and Caspian Seas) [3], with some of them, such as the amphipod *Echinogammarus ischnus*, known to have high impact on local communities and ecosystem functioning [1]. In addition, future global warming may open new environmental and niche opportunities for continuously arriving species [4]. Here, we tested temperature tolerance of two amphipod species, one originating from the Baltic Sea (*Gammarus oceanicus*) and another from the Ponto-Caspian region (*Pontogammarus maeoticus*) to determine their performance under current and future temperature conditions. *P. maeoticus* has been chosen due to its invasion history in freshwater areas of Turkey, but not in the Baltic Sea [1,2,5].

Specimens of *P. maeoticus* and *G. oceanicus* were collected in October 2014 in South Caspian Sea (Iran) and in May 2015 in Kiel Fjord (Germany), respectively. The species were kept at their natural salinity and temperature until the common garden experiment started (*i.e.*, 18°C, 10 ppt and 16°C, 16 ppt, respectively). The experiment was performed in Kiel in November and December 2015, and consisted of a control, a warm (increasing temperature) and a cold (decreasing temperature) treatment. Each treatment was replicated three times with ten individuals of each species per replicate. Two 1-l beakers with mesh on the sides, each containing one species, were submerged in a tank allowing water exchange, but preventing direct contact between species (*i.e*., one replicate). The salinity during the whole experiment was 16 (±0.2) ppt, light/dark cycle was 12:12 hours, and the starting temperature was 16°C. During the experiment, temperature was decreased/increased by 2°C every three days until reaching 6 or 28°C. Animals were fed ad libitum with a mixture of algae flakes. Water was exchanged every three days by replacing half of the volume. Temperature and salinity were monitored every day, while survival was checked every three days during the water exchange.

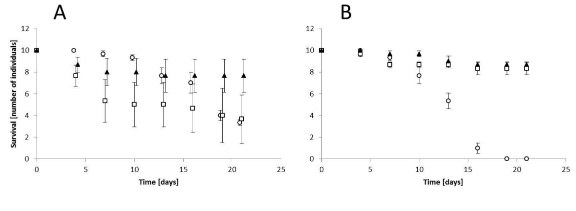

Fig. 1. Survival rates (abundance: mean ± SE, N=3 each) for *Pontogammarus maeoticus* (**A**) and *Gammarus oceanicus* (**B**) at three different temperature treatments (control (white square), warm (white circle) and cold (black triangle)). In (**A**) data points of the same day were slightly shifted to better distinguish the error bars of the different treatments.

At the end of the experiment, survival of *P. maeoticus* was between 0 and 90%, 30 and 40%, and 40 and 100% in the control, warm, and cold treatment, respectively (Fig. 1A). In the warm treatment, survival was rather high until 22°C (90 to 100%; Fig. 1A). In the case of *G. oceanicus*, survival was between 70 and 90%, 0%, and 80 and 100% in the control, warm, and cold treatment, respectively (Fig. 1B). In the warm treatment, all *G. oceanicus* died at 26°C (Fig. 1B).

The present study revealed that both amphipod species perform rather similar in temperatures from 6 to 22°C. Survival rates of *P. maeoticus* varied in the control treatment, which might be due to the salinity change that the species experienced during the experiments. Nevertheless, *P. maeoticus* survived relatively well in the warm treatment, while all *G. oceanicus* died up to 26°C. Our study predicts that in the case of global warming *G. oceanicus*, which evolved under lower temperatures of the Baltic Sea, would not be able to compete with *P. maeoticus* that evolved under higher temperatures of the Caspian Sea. Salinity stress and chemical composition of the Baltic Sea water had less effect on *P. maeoticus* than temperature stress on *G. oceanicus* which indicates that *P. maeoticus* have potential to become a non-indigenous species in Kiel Fjord and probably the Baltic Sea.

References

1 - Leppäkoski E., Gollasch S., Gruszka P., Ojaveer H., Olenin S., and Panov V. 2002. The Baltic - a sea of invaders. *Can. J. Fish. Aquat. Sci.* 59: 1175-1188. (doi: 10.1139/f02-089)
2 - Molnar J.L., Gamboa R.L., Revenga, C. and Spalding M.D. 2008. Assessing the global threat of invasive species to marine biodiversity. *Front. Ecol. Environ.*6: 485-492. (doi: 10.1890/070064)
3 - Casties I., Seebens H. and Briski E. submitted. Importance of geographic origin for invasion success: a case study of the North and Baltic Seas *versus* the Great Lakes-St. Lawrence River region. *Ecol. Evol.*
4 - Hellmann J.J., Byers J.E., Bierwagen B.G. and Dukes J.S. 2008. Five potential consequences of climate change for invasive species. *Conserv. Biol*. 22: 534-543. (doi: 10.1111/j.1523-1739.2008.00951.x)
5 - Ozbek M. 2011. Distribution of the Ponto-Caspian Amphipods in Turkish Fresh Waters: An Overview. *Mediterr. Mar. Sci*. 12: 447-453. (doi: 10.12681/mms.44)

LIVE SEAFOOD IMPORTATION AS A POTENTIAL VECTOR FOR ALIEN INTRODUCTION IN THE TARANTO SEAS (SOUTHERN ITALY, MEDITERRANEAN SEA)

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Abstract

Importation of edible molluscs represents one of the main cause of introduction of alien species throughout the world. Intervalvar water and shells of mollusc imported to the Taranto market were investigated to assess the presence of alien micro- and macroalgae. Up to now, only one alien species was found, and this confirms that the risk of possible future introduction is still lurking.

Keywords: Alien species, Bivalves, Mediterranean Sea, Algae, Ionian Sea

Introduction

The use of exotic seafood in the human diet, mainly bivalve molluscs, is well-established throughout the world nowadays, and has historical basis [1]. Generally, it was started to cover some shortage of the local aquaculture production or even to diversify market supply. However, up to the second half of the last century, there was no idea of the possible damages caused by such an activity [1]. That way, the translocation of these organisms led to the introduction of several alien species, which caused environmental and health harms of different extent [2]. Therefore, localities where seafood importation is massive, are particularly exposed to this hazard. At Taranto, in 2014, about 1,200 tons of molluscs were imported [3]. Here we report the results of a research carried out on molluscs imported to the Taranto market for consumption, to detect possible alien hitchhikers.

Materials and methods

Three specimens of: *Crassostrea gigas* Thunberg, 1793 from France and Spain, respectively, *Venerupis phillippinarum* A. Adams & Reeve, 1850 from the Venice Lagoon, *Mytilus galloprovincialis* (Lamarck, 1819) from Spain and *Modiolus barbatus* Linnaeus, 1758 from Greece, were collected directly from trucks, before arriving to distribution centres. Once in the laboratory, firstly, the intervalvar water was removed from the molluscs, and analysed. Successively, three shells for each batch were put into culture cells, and maintained in seawater for three months with plain air bubbling, in order to assess the presence of epibionts. Periodically, the culture medium was completely and warily changed. At the end of the culture time, each shell was observed under a stereomicroscope to detect all the possible developed epibionts.

Results and Discussion

The analysis of the intervalvar water showed the presence of six different taxa (Tab. 1). Cells of the diatom *Gyrosigma* sp. and the adult of an unidentified copepod were found in *C. gigas* from France. Cells of the potentially toxic dinoflagellate *Prorocentrum* cf. *micans*, cysts of *Alexandrium* sp. and an unidentified ciliate were found in the intervalvar water of *M. barbatus*. Cells of the diatom *Licmophora* sp. and an unidentified ciliate were observed in the intervalvar water of M. galloprovincialis.

Tab. 1. List of micro-and macroalgae found in and on analysed bivalves, respectively. F= France, S=Spain. * alien species

	C. gigas F	*C. gigas* S	*V. philippinarum*	*M. galloprovincialis*	*M. barbatus*
Microalgae					
Alexandrium sp. (cyst)	-	-	-	-	+
Gyrosigma sp.	+	-	-	-	-
Lichmophora sp.	-	-	-	+	-
Prorocentrum cf. *micans* Ehrenberg	-	-	-	-	+
Macroalgae					
**Asparagopsis taxiformis* (Delile) Trevisan de Saint-Léon	-	-	-	-	+
Bryopsis sp.	+	-	-	-	-
Chaetomorpha sp.	+	-	-	-	-
Cladophora sp.	-	+	-	-	-
Dictyota sp.	+	-	-	-	-
Ectocarpus sp.	-	-	+	-	-
Hincksia ovata (Kjellman) P.C.Silva	+	-	-	-	-
Lomentaria clavaeformis Ercegovic	+	-	-	-	-
Polysiphonia subulata (Ducluzeau) Kützing	-	+	-	-	-
Pterothamnion plumula (J. Ellis) Nägeli	+	-	-	-	-
Stylonema cornu-cervi Reinsch	+	-	-	-	-
Ulva sp.	+	+	-	-	-
Total	**8**	**3**	**1**	**1**	**3**

Concerning shell analysis, they appeared uncolonised to the naked eye, but at the end of the culture period, eight thalli of macroalgae were detected developed on *C. gigas* from France, three on *C. gigas* from Spain, one on *V. philippinarum* and one on *M. barbatus.* No epibionts were found on *M. galloprovincialis*. All the thalli were very small, and in most cases sterile, so that their taxonomical identification was performed only to the genus level. In case of fertile thalli, species identification was possible (Tab. 1). From those observations, *C. gigas* confirms to be the mollusc *par excellence* for the settlement of macroalgae on its shells. Indeed, as already observed in previous studies in other Transitional Water Systems in Italy [4], and elsewhere [5], its rough surface holds sediment particles and propagules, favouring the species settlement. Concerning aliens, in our study, only one species, i.e. the tetrasporic phase of *Asparagopsis taxiformis* (Delile) Trevisan de Saint-Léon, was detected on bivalve shells. This phase, previously known as a distinct species, i.e. *Falkenbergia hillebrandii* (Bornet) Falkenberg, was recently reported in the Mar Piccolo of Taranto, but no hypothesis about the vector of introduction was formulated [6]. Since in Taranto, notwithstanding the rules in force, imported molluscs are often improperly stored into the sea up to the sale, and their shells are jettisoned after consumption onto the bottom [3], it is most likely that *A. taxiformis* was introduced through live seafood. Therefore, it is necessary to be always vigilant. Indeed, even though in intervalvar water and on the other mollusc surfaces no alien was detected, the continuous importation of live seafood, the presence of viable microalgal cells in the intervalvar water and of macroalgal propagules on shell surface, and the capacity of the developed thalli to form reproductive structure, are all factors predisposing to the introduction of aliens.

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References

1 - Wolff W.J. and Reise K., 2002. Oyster imports as a vector for the introduction of alien species into northern and western European coastal waters. *In*: Leppäkoski E., Gollasch S., Olenin S. (eds), Invasive aquatic species of Europe. Distribution, impacts and management, Kluwer Academic Publishers, Dordrecht, pp. 193-205.

2 - Mineur F., Le Roux A., Maggs C.A. and Verlaque M., 2014. Positive feedback loop between introductions of non-native marine species and cultivation of oysters in Europe. *Conserv. Biol*., 28: 1667-1676.

3 - Cecere E., Petrocelli A., Belmonte M., Portacci G. and Rubino F., 2015. Activities and vectors responsible for the biological pollution in the Taranto seas (Mediterranean Sea, southern Italy): a review. *Environ. Sci. Pollut. Res.*: DOI 10.1007/s11356-015-5056-8

4 - Manghisi A., Morabito M., Bertuccio C., Le Gall L., Couloux A., Cruaud C. and Genovese G., 2010. Is routine DNA barcoding an efficient tool to reveal introductions of alien macroalgae? A case study of *Agardhiella subulata* (Solieriaceae, Rhodophyta) in Cape Peloro lagoon (Sicily, Italy). *Cryptogamie, Algol.*, 31: 423-433.

5 - Verlaque M., Boudouresque C.F. and Mineur F., 2007. Oyster transfers as a vector for marine species introductions: a realistic approach based on the macrophytes. *CIESM Workshop Monographs*, 32: 39-47.

6 - Bottalico A., Russo C., Pati R., 2015. Sulla presenza del genere *Asparagopsis* Montagne (*Bonnemaisoniales, Rhodophyta*) in Puglia (Italia meridionale). *Informatore Botanico Italiano*, 47: 291-313.

ASSESSING THE POTENTIAL OF SUEZ CANAL SHIPPING TRAFFIC AS AN INVASION PATHWAY FOR NON-INDIGENOUS SPECIES IN CENTRAL MEDITERRANEAN HARBOURS

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Abstract

The shipping traffic visiting seven Central Mediterranean ports within Sicily and Malta over a period of one year (2013) and the ballast water volumes it transported was quantified and classified according to port of origin in order to assess the influence of traffic navigating through the Suez Canal on the marine biota of the same geographical area. Scraping and benthic sediment collection exercises were also conducted within the same ports and a list of non-indigenous species is reported.

Keywords: Alien species, Mediterranean Sea, Suez Canal

Introduction

Shipping is the leading vector for trade in the world and alone is currently responsible for moving round over 80% of the world commodities (UNCTAD/RMT, 2014). Concurrently, the global shipping sector moves around approximately three to five billion tons of ballast water internationally every year (GLOBALLAST, 2015). Although ballast water operation is essential for any type of vessel to carry out safe and efficient cargo operations, such a process also constitutes a serious threat to ecological, economic and human health systems due to the inadvertent introduction of invasive aquatic species within new marine regions. In the Mediterranean Sea, these dynamics and concerns are even more pronounced due to its status as a biodiversity hotspot and its' simultaneous importance as a shipping transit route, crystallized within the recent expansion of the Suez Canal, completed on the 6th of August 2015, which should double vessel traffic within the Canal, with the current average of 49 transits per day expected to increase to 97 passages per day (SCA, 2015).This paper aims to makes a preliminary consideration of the real potential of Suez Canal shipping traffic as an invasion pathway for non-indigenous marine species to a number of Central Mediterranean ports.

Materials & Methods

A total of 5 harbours in Sicily (Catania, Siracusa, Lampedusa, Augusta, Porto Empedocle) and 2 in Malta (La Valletta, Marsaxlokk) in the Central Mediterranean have been investigated in the current study. Maritime traffic data has been gathered from the harbour masters in Sicily and from the Transport Authority ofMalta during 2013 and organized in a database. From the total cohort of vessels within the database, only the data for the vessel category 'Tankers' was extracted since this was recognized as the main vector for the spread of alien species, by virtue of the enormous amount of ballast water that couldpotentially betransported by such vessels. Two extremes (7% and 54% of Gross Registered Tonnage [GRT]) have been adopted by different authors for measuring the minimum and maximum volumes of ballast water that could potentially be discharged within destination ports. For each individual port, the total volume of ballast water coming in, as well as the fraction of ballast hailing directly from ports beyond the Suez Canal, was calculated. Within the framework of the BIODIVALUE project (www.biodivalue.com), four of the Central Mediterranean ports (Valletta, Marsaxlokk, Augusta, Siracusa) under investigation were chosen for sediment and hard bottom (fouling assemblage) pilot sampling. The origin of all identified marine species was classified as Suez, Black Sea, Atlantic and Mediterranean. Fouling assemblages settled on jetties and wharves falling within a 0.5m x 0.5m quadrat were scraped off and collected underwater within a fine-mesh bag. Soft bottom sediments were sampled by means of a van Veen grab (15 litres).

Results

For 2013, the fraction of tankers hailing directly from the Suez Canal (i.e. not making prior stops before reaching the ports under investigation) ranges from 0% for the ports of Catania, Porto Empedocle, Lampedusa and Valletta, to 2% for Augusta and Siracusa and 3% for Marsaxlokk. Applying the 7%-54% of GRT criterion, this traffic was responsible for transporting between 24 and 191 tons of ballast water at the Siracusa port, between 50 and 385 tons at Augusta and between 30 and 218 tons at Marsaxlokk. A total of 13 non-indigenous macrozoobenthic species belonging to the Mollusca and to the Polychaeta were recorded from the four ports at which scraping exercises were conducted. The highest (9) number of such species was recorded at Marsaxlokk, where the only introduction attributed to aquaculture (*Crassostrea gigas*) from the total of 13 non-indigenous species was recorded. No species was recorded from all the four ports, although a number (*Brachidontes pharaonis, Notomastus aberans, Branchiomma bairdi, Pista unibranchia* and *Monticellina dorsobranchialis)* were recorded from three of the same ports. The highest (3109) number of such individuals was recorded from Augusta, although this total was dominated by collections of *B. pharaonis*, which made up for 96% of total non-indigenous individual abundance recorded at this port.

Discussion

The investigated ports, being visited the most by tankers in general and by those hailing directly from the Suez Canal, exhibited the highest rates of colonisation by non-indigenous macrozoobenthic species. The total (including indirect) influence of tankers transiting through the Suez Canal on the Central Mediterranean ports under investigation was probably under-estimated in the current study. This is because tankers hailing from other Mediterranean ports before visiting the ports under investigation (representing the majority of all recorded tankers) probably transited through the Canal at a preceding stage, thus contributing to the discharge of ballast water into the Mediterranean Sea. The current study makes the case for an urgent entry into force of agreements such as the IMO's Ballast Water Management Convention so as to stem the incessant flow of exotic species within busy waterways as the Mediterranean and strengthens the call made by the international biological community for a renewed monitoring effort of the real impact of the enlarged Suez Canal on the marine biota of the Mediterranean.

References

1 - BWMC, 2004. International convention for the control and management of ship's ballast water and sediment. *IMO pubblications*, London.

2 - EQUASIS, 2014. The world Merchant fleet. Equasis statistics. *Equasis publications*. Fearnleys, 2002;

3 - GLOBALLAST, action programme, 2015. Available at: http://globallastlearning.com/login/index.php (accessed 23 August 2015).

4 - SCA, Suez Canal Authority, 2015. available at: http://www.suezcanal.gov.eg/

5 - UNCTAD/RMT, 2014. Review of Maritime Transport 2014. *United Nations pubblications*. New York and Geneva.

THE RELATIVE IMPORTANCE OF AQUACULTURE AND SHIPPING AS VECTORS OF INTRODUCTION OF MARINE ALIEN SPECIES: THE CASE OF OLBIA (SARDINIA)

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Abstract
The macroinvertebrate assemblage in Olbia (Sardinia, Italy) was analysed for occurrence of marine alien species. Two main vectors of introduction operate in this area: vessels and aquaculture. The comparison with alien species assemblages of other three Italian localities connected to Olbia by different pathways (vessels: Genoa, Leghorn; aquaculture: Venice) suggests that shellfish stocking is a major vector operating in Olbia.

Keywords: Alien species, Aquaculture, Tyrrhenian Sea, Zoobenthos

Introduction
The assessment of marine alien species distribution, the areas at high risk of introduction, the main pathways and vectors of introduction are essential elements in designing an effective management and conservation program [1]. We present the results of a study on alien macroinvertebrate assemblages in the harbour of Olbia, a coastal town in North-East Sardinia (Italy) affected by two main pathways of introductions: vessels and aquaculture. Olbia is one of the most important passenger seaports in the Mediterranean Sea (2 million passengers per year), as well as an important trading harbour (4 million tons of traffic volume every year). Ferries and cruises connect Olbia with other Mediterranean harbours on the western coast of Italy (www.olbiagolfoaranci.it/indexen_GB.php?carattere=p, Accessed Feb. 2016). Olbia is also a major site for mussel farming; about 15% of mussels grown in Olbia are imported from the other sites of mussel cultivation in Italy [2]. In this work, we compare the marine alien species assemblages of Olbia with those of other three Italian localities (Fig. 1): Venice (Adriatic Sea), Genoa and Leghorn (Western Mediterranean Sea), in order to assess the relative importance of shipping and aquaculture as pathways of introduction.

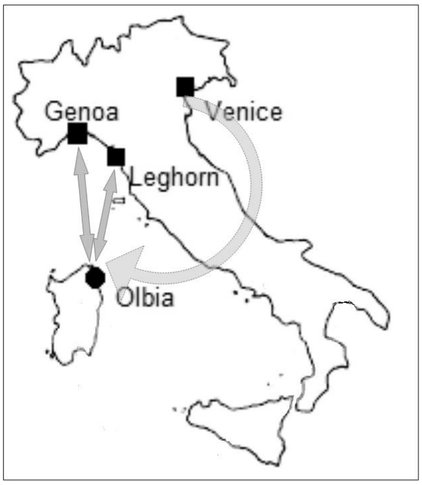

Fig. 1. The harbour of Olbia (Sardinia) is connected with Genoa and Leghorn by ferries and commercial ships (straight arrows). Moreover, Olbia receives stocks of mussels for cultivation from the North Adriatic region (round arrows).

Methods
In summer 2014 we collected 12 samples from 4 distinct areas in the harbour of Olbia; artificial hard substrates (*e.g.* docks, floating pontoons) were scraped and macroinvertebrates removed for further laboratory identification. Data from other localities, to be used for comparisons, were obtained from samples collected with similar methodology from our research team in the years 2012-2013. A similarity analysis was conducted to compare alien species assemblages in the 4 localities, using the software PRIMER 6.1.13.

Results
A total of 24 marine alien species were identified: 13 in Olbia, 19 in Venice, 13 in Genoa and 11 in Leghorn. Olbia displays an alien species pool more similar to Venice (average similarity: 52.3%) and Leghorn (53.0%) than to Genoa (43.9%). Olbia shared with Venice two alien crustaceans not recorded in the other localities: *Ianiropisis serricaudis* Gurjanova, 1936 and *Rhithropanopeus harrisii* (Gould, 1841). On the other hand, the bryozoan *Celleporaria brunnea* (Hincks, 1884) was present in the three Western Mediterranen localities but did not occur in Venice samples.

Discussions and Conclusion
Our results show that the alien species pool of Olbia strongly depends on importation of mussels for restocking: the alien invertebrates of Olbia have a high similarity with those of Venice, and there are species shared by the two localities, such as *I. serricaudis*, that have not been recorded anywhere else so far. Globally, the role of aquaculture in introducing and spreading marine alien species is perceived as declining, compared to shipping and boating. However, we have shown that in the Mediterranean region the transfer and restocking of cultured species, including native mussels, is still contributing to the spread of marine alien species, especially when stocks originate from hotspots of introduction such as Venice [3]. Movement of vessels from and to Olbia can then support the further spread of these aquaculture hitchhikers. The combined effects of these human activities are increasingly homogenizing the Mediterranean marine fouling communities; for this reason, programmes of awareness raising and biosecurity control are urgently needed, in order to reach an effective management plan of marine alien species in the region.

References
1 - McGeoch M.A., Genovesi P., Bellingham P.J., Costello M.J., McGrannachan C. and Sheppard A. (2016). Prioritizing species, pathways, and sites to achieve conservation targets for biological invasion. *Biol. Inv.*, 18 (2): 299-314.
2 - Navone A. and Del Vecchio C., 2008. Nuovo Piano Regolatore Portuale di Olbia e Golfo Aranci – Studio del comparto mitilicoltura nel Golfo di Olbia. (Technical Report SIR_2). Studio Navone, Olbia, pp.55.
3 - Marchini A., Ferrario J., Sfriso A. and Occhipinti-Ambrogi A. (2015). Current status and trends of biological invasions in the Lagoon of Venice, a hotspot of marine NIS introductions in the Mediterranean Sea. *Biol. Inv.*, 17 (10): 2943-2962.

ROLE OF THE BLACK SEA AS A DONOR AREA FOR THE CASPIAN SEA

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Abstract
The Black Sea has become an important international shipping destination during second part of twenty century. High shipping intensity has facilitated species invasions into the Black Sea. Many species have successfully established because of Black Sea disturbances in 1970s. Consequently the Black Sea serves as a hub for species that then spread further to adjacent seas: the Sea of Azov, Marmara, Mediterranean and were brought in different ways in the Caspian Sea. This process facilitated after the Volga-Don Canal construction which connected the Black, Azov and Caspian seas. As a result of invasions of the Black Sea native and non-native species greatly increased in the Caspian Sea they replaced the Caspian species and became predominant in communities and in some cases in entire ecosystem.

Keywords: Alien species, Invasive species, Black Sea, Caspian Sea

Introduction
The Black, Azov, and Caspian seas (Ponto-Caspian) were united as a single basin several times in the past, most recently in the Pliocene. The Black and Azov seas were reconnected again with the Caspian Sea by the Volga–Don Canal in 1952. Owing to accelerating human activities such as shipping, deliberate stocking, unintentional releases many non-native species have arrived and established in the Black Sea. From the Black Sea some of them were introduced in the adjacent seas and with the ship via the Volga –Don Canal the Black Sea native and non-native species arrived and established with the ship fouling and ballast waters in the Caspian Sea.

Results
The Caspian Sea is an inland brackish water basin with the vulnerable ecosystem to invaders because of its long isolation and high species endemism therefore appearance eurybiontic non-native species easily suppressed native species in occupied community and some affected the total ecosystem.
The appearance of non-native species may be divided into three phases in the Caspian Sea (Fig.1). The first deliberate large-scale introductions since 1930s were aimed at enlarging the resources of commercial fishes or their food organisms. However only two finfish (the mullets *Liza saliens* and *L. aurata*) from the Black Sea and two benthic species (the polychaete *Hediste diversicolor* and the bivalve *Abra segmentum*) from the Sea of Azov achieved significance. The second phase started when the Volga--Don Canal opened in 1952. First species were carried from the Black Sea by ships as fouling organisms. Among them zoobenthic animals and macrophytes dominated. The third phase began in the early 1980s when mainly phyto- and zooplanktonic species began to arrive in ballast water after ballast tank constructions on the ships from the Black Sea [1].Among non-native phytoplankton species *Pseudo-nitzschia seriata*, *Pseudo-nitzschia pseudodelicatissima*, *Chaetoceros peruvianus*, *Tropidoneis lepidoptera* became widely distributed. Globally significant coccolithophore alga *Emiliania huxleyi* regular developed now in the Caspian Sea [2,3]. In the Middle Caspian, the cold-water community with non-native *Pseudo-nitzschia seriata, Cerataulina pelagica, Chaetoceros peruvianus* below the thermocline form by the remnants of winter–spring bloom at the end of February-March [2]. Most of these species play now important role in the Caspian ecosystem [3]. Among zooplankton species also the Black Sea species and Black Sea invaders became abundant in the Caspian Sea. The most abundant became the Black Sea Cladocera *Pleopis polyphemoides* widely distributed around the Caspian and comprised more than 50 % Cladocera abundance and the Black Sea non-native Copepoda *Acartia tonsa*, which makes up more than 90% of zooplankton in summer in the most areas of the Caspian, replacing native copepods [1]. Meroplanktonic larvae of non-native *Balanus improvisus* comprised often more than 70%. All these planktonic species although replaced native species became food items for all kilka species [1].
In 1999 the Black Sea invader *Mnemiopsis leidyi* and Black Sea medusa *Aurelia aurita* were recorded [1].
Among benthic species, the mussel *Mytilaster lineatus* was the first accidental invader; it came from the Black Sea with fouling of boats. It replaced Caspian endemic species but became a food resource for roach, bream, zander, sturgeon and stellate sturgeon.Its planktonic larvae are food for planktivorous fish[1].
Two Black Sea prawns, *Palaemon adspersus* and *P. elegans*, were released during mullets introduction, spread all over the Caspian Sea and became a food source for benthic-feeding fishes including sturgeons and seal. In addition they have commercial value [1]. The polychaete *Hediste diversicolor* and the bivalve *Abra segmentum* have become food resources for fish stocks, first of all sturgeons [1].
The crab *Rhithropanopeus harrisi tridentata* arrived in the Caspian Sea together with fouling from the Black Sea where it was introduced from the North America. The crab became a food for sturgeons.
At present among all non-natives *M. leidyi* is the most aggressive invader that affected all levels of the Caspian ecosystem. Its abundance increases in the Middle and Northern Caspian and area of seasonal spreading increase in the Northern Caspian during last years.

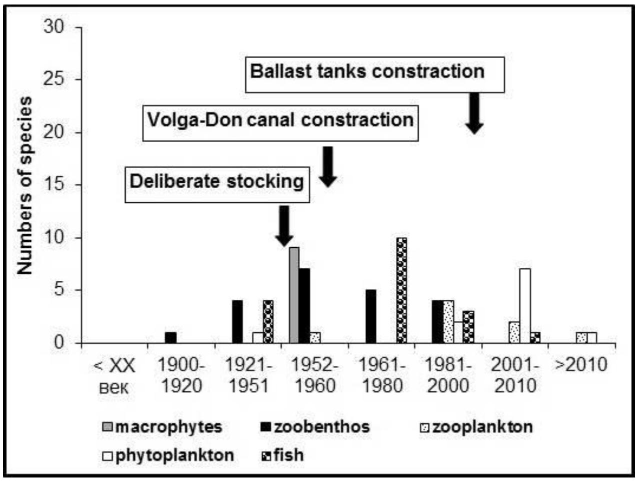

Fig. 1. Chronology of species invasions in the Caspian Sea.

Conclusion
Summarizing this review we may conclude that species invaded from the Black Sea although not numerous in numbers (about 50 species) became predominated in occupied community, replacing native species and therefore recognized as one of the leading treats to biodiversity in the Caspian Sea among them *M.leidyi* imposes enormous economic damage on biodiversity and the Caspian fisheries. Although we may conclude that some of the species became valuable food items for fish when native species almost disappeared after *M.leidyi* invasion.

References
1 - Shiganova T.A. Pautova L.A., Kamakin A.M. 2016. Role invasive species in the Caspian Sea ecosystem. Marine biology (in press).
2 - Pautova L.A., Kravchishina M.D., Vostokov S.V., Zernova V.V.,Silkin V.A.,2015. Pattern of vertical structure of summer phytoplankton of dep regions of the Caspian Sea. Doklady of Academy of sciences.T.462, N 4:479-483.

SUEZ CANAL EXPANSION PROJECT BETWEEN GLOBALIZATION NECESSITY AND ENVIRONMENTAL IMPLICATIONS

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Abstract
Since the inauguration of the Suez Canal Expansion project an agitated sea of newsletters and articles hit the project with assumptions. The main potential impacts alleged was the dramatic increase in the introduced number of alien species. Water hydrodynamic study by RMA-II model indicated that changes in the water volume, current speed and directions may have insignificant impacts on increasing the potential number of migrated species. This mainly was attributed to restriction of expansion works to the middle sector and preserving the canal inlet and outlet without any alterations or deepening. Mitigation measures were identified and evaluated to be implemented. Environmental Monitoring program is currently in place for early warning of potential migrant species, risk assessment and control/eradication of invasive species.

Keywords: Alien species, Suez Canal

Introduction
The Suez Canal is directly linking the Mediterranean Sea to the Red Sea. It is the longest canal without a lock in the world. Opened for shipping in 1869, it abridged the distance between the Eastern and the Western parts of the world. With the increase of globalization in term of international trade, the Suez Canal went through many development stages to increase its size in order to accommodate larger vessels. The Suez Canal expansion project created a new bypass in two areas of the existing canals with total length of 35 km and dredged and expanded the existing pass (at Bitter Lakes) with a total length of 37km (Figure 1). The project aims to increase the navigational capacity and to improve the shipping traffic by eliminating the convoy system and to achieve the non-stop direct crossing for 45 ships in both directions, as well as reducing the crossing and transit time to a maximum of 3 hours instead of 8 to 11 hours. Species migration is a global phenomenon took place all over the word, the drivers behind migration process are often of global nature despite the impacts being observed on local scale. For instance, San Francisco Bay receives a new aquatic species every 14 week (Before 1960, the rate was approximately once every 55 weeks.) This acceleration is likely because of a rise in propagules pressure as a result of increased shipping traffic and aquaculture activities. Humans have also changed aquatic system through eutrophication (the increase of nutrients such as nitrogen and phosphorus), the removal of top predators, and other modifications including Global warming. Rising sea temperature, in response to increased atmospheric carbon dioxide, causes a shift in the geographical distribution of marine species. Increasing temperature in the Mediterranean Sea may result in more favorable conditions for the majority of migrant organisms with Indo pacific origin. This species thrive at relatively high temperature thus will likely favor their reproduction, growth and survival at elevated temperature (1). During 1955 sea temperature rose In the Mediterranean by 1.0 to 1.5 °C in the winter months allowing species such as *Saurida undosquamis, Sargocentron rubrum* and *Upeneus moluccensis* to establish population in the Mediterranean as the higher temperature favored their reproduction compared to the native species. The Mediterranean Sea acidification in a changing climate project, 2014 indicate that changes in the CO_2 concentration of the Mediterranean could indirectly result in vacant niches which increase vulnerability of being colonized by invasive predators.

Results and Discussion
The Mediterranean support an ever growing suit of migrating alien species, not only driven through Suez canal but from various vectors, of them (Atlantic-Mediterranean route; Shipping including fouling organisms and ballast water; Aquaculture and marine curio-trade; as well as global warming phenomena). The migration through the Suez Canal depends on many factors of them, the removal of the salinity barrier of the bitter lake, the elevation of salinity in the eastern Mediterranean as a result of reduction of fresh water inflow from the High dam. As mandatory requested by Environment Law 4 in 1994 amended by Law 9 in 2009 and its Executive Regulations Suez Canal Authority (SCA) submitted a preliminary EIA study of the project on the 29th of July 2014. The Egyptian Environmental Affair Agency (EEAA) studied the submitted document and approved in principle, with an emphasis on the need to prepare a strategic environmental assessment study. In June 2015 the final EIA study was submitted for revision and appraisal. The EIA elaborated the proposed impacts to be on changing the hydrodynamic system of the Suez Canal, increasing of turbidity levels and the movement of tracer materials. The tidal level will change slightly in the central part of Suez Canal with maximum increase of 10 cm while the tidal current will decrease in the central and northern parts at (Deversoir and Ferdan). Moreover the change in discharge flow rate to the Mediterranean is nearly zero. Turbidity was within the permissible level which is less than 60 mg/L except in the area that extends about 1 km north and 1 km south of a spot where dredging occurs. Simulation models of the movement of a tracer from Bitter Lakes to Timsah showed that the new expansion has minor effects on the spread of the tracer material. Feasible mitigation measures were studied and ranked, on top of the list came the salinity barrier (higher or lower than ambient salinity) in combination with other solutions like bubble curtain to deter migration of different planktonic stages. These options raised the need for mesocosm studies to adopt the most suitable solution. Studying the effectiveness of mitigation measures applied on the expansion project will doubtless expand our understanding to apply the proper measure for the entire Suez Canal to control and eliminate the threat of invasive species (2). The study suggested multible vectors mangment approach to manage (ballast water, ship hull fouling and restoration of the natural salinity barrier. The expansion project give us a unique opportunity to study the settlement and succession that took place 150 years ago in Suez Canal. Moreover studies will reveal species traits, time lag in species introduction, settlement and adaptation, as well as the risk assessment of exotic species(3).

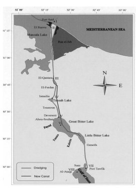

Fig. 1. Suez canal Map showing location of extension project

References
1 - Bellard, J., W. Thuilier, B. Leroy., P. Genoves.,Balkkenes, M. (2013). Will climate change promote future invasion. Global Change Biology, 1 – 9
2 - CBD (2002). Guiding principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species: Annex to CBD Decision V1/23
3 - UNEP/MAP-RAC/SPA (2008). Guide for Risk Analysis assessing the impacts of the Introduction of Non-indigenous species. Ed. RAC/SPA, Tunis. 30 pp

CIESM Congress Session : Aliens biology and adaptations

Moderator : Anders Jelmert, Inst. of Marine Research, Flødevigen, Norway

Moderator's Synthesis

The introductory presentation made a very generic outline of how incomplete knowledge of biological traits and adaptation in NIS lowers our ability to predict the effects of NIS in the recipient ecosystems. The concept adaptation was broken done in three different meanings: A species adaptation to a shifting or a new environment (plasticity and evolution), the ecosystems response to a new (NIS) species, and finally, the human response (how to manage NIS). The introduction also pointed to the fact that issues related to biodiversity (and thus NIS) are partly normative - both for the scientific and the general community.

To stimulate debate after the presentations, and taking into account the session presentation of the concept "tropicalization" of the Mediterranean, one question was put to the audience: "We conventionally regard the effects of a NIS as negative: How are we evaluate NIS in a situation where indigenous species (having key ecosystems functions) no longer can deliver these ecosystem services, whereas a NIS can? "

The question stimulated a fairly lively debate, although some misunderstandings regarding the example of herbivory (macro-algae grazing fishes vs zooplankton) needed to being sorted out. Other issues were commented: the time-span for functional and numerical response (many NIS have been shown to have a rapid growth and impact, but later to become less prominent in effects). This was contrasted to the risk of overlooking NIS that have long lag-phases; both issues call for long-term studies of the presence and effects of NIS.

DO NOT EAT *LAGOCEPHALUS SCELERATUS*: A TRANSNATIONAL ALERT THROUGH THE WESTERN MEDITERRANEAN

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Abstract

A key action in the process of effectively managing the risks posed by an invasive species is to engage and communicate with the public. Here we illustrate the initial stages of a joint alert campaign launched by ISPRA in Italy and by the ICM-CSIC in Spain, aimed to warn about the spread of the toxic silver-cheeked toadfish through the western Mediterranean.

Keywords: Alien species, Fishes, North-Western Mediterranean

Introduction

Public awareness and health surveillance, aiming at preventing the consumption of pufferfishes has assumed increasing relevance in the Mediterranean Sea due to the rapid expansion of the highly toxic *Lagocephalus sceleratus* (Gmelin, 1789), one of the "worst" biological invaders of this basin. Eating this fish may provoke severe intoxications, even lethal, and this renders crucial a rapid dissemination of information. Yet, various initiatives in countries such as Egypt, Turkey, Greece, Cyprus and Tunisia have raised awareness on this issue. In October 2013 the species was firstly found in Italian waters and in July 2014 an individual was recorded in Spain [2].

Materials and Methods

Informative campaigns were launched in Italy and Spain soon after the first occurrences of *L. sceleratus* in these countries, and in 2015 these two separate actions were extended to the national territory and interconnected on the principles of mutual benefit and public biosecurity. The campaigns were mainly based on posters (Fig 1) and divulgated by a variety of different media. Institutional emails and cell phones were dedicated to receive sightings of pufferfishes (from both fishermen and the general public). Both the Spanish and Italian campaigns were promoted by the interactive web platform SEAWATCHERS www.seawatchers.org under the action 'invasive fishes'. The social impact of the alert campaigns was estimated by searching the number of internet pages related to *L. sceleratus* according to the year and country of publication.

Results and discussion

The cumulative number of web pages (Fig 2) shows an abrupt breakpoint in correspondence of the year 2015. In Spain, the number of web pages bearing information on *L. sceleratus* jumped from 73in 2015, to 1220 in 2016. In Italy, 902 pages were available in 2015 and 2070 in 2016. Since November 2013 (beginning of Italian the campaigns), ISPRA registered 5 new records of *L. sceleratus* in Sicily waters and 3 captures of *L. lagocephalus.* In Catalunia - Spain, since August 2014, the Agriculture department of the Catalan Government, together with fishermen associations and the platform SEAWATCHERS registered 22 sightings of pufferfish. Of them, 6 were record of *Sphoeroides pachygaster* and 16 of *L. lagocephalus*. In conclusion, the two campaigns are being useful tools to both inform the general public and to retrieve information related to the occurrence of pufferfish. Because of the risks associated to *L. sceleratus*, it would be advisable to extend this practice to neighboring countries.

Fig. 1. Images of the posters being used for the alert campaigns in Catalonia (left) and Italy (right).

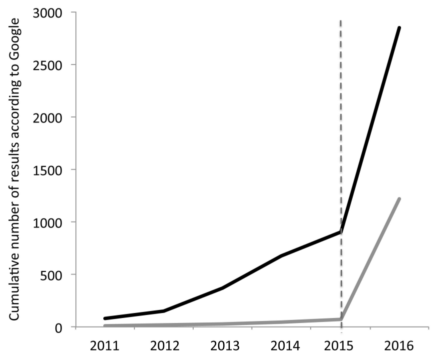

Fig. 2. Cumulative number of results according to the search engine Google and the keyword "*Lagocephalus sceleratus*": Black line = results from Italian web pages; Grey line = results from spanish web pages. The dotted vertical line indicates the beginning of the join awareness campaign in Italy and Spain.

References

1 - Azzurro E, Castriota L, Falautano M, Giardina F, Andaloro F (2014) The silver-cheeked toadfish *Lagocephalus sceleratus* (Gmelin, 1789) reaches Italian waters. Journal of Applied Ichthyology DOI 10.1111/jai.12471

2 - Izquierdo-Munoz A., Izquierdo-Gomez D (2014). First Record of *Lagocephalus sceleratus* (Gmelin, 1789) (Actinopterygii, Tetraodontidae) on the Mediterranean Spanish Coast, pp. 686e687. In: Katsanevakis S. et al. 2014. New Mediterranean. Biodiversity Records (October, 2014).

SEARCHING FOR BIOLOGICAL CHARACTERISTICS OF BENTHIC MEDITERRANEAN EXOTIC SPECIES: PRELIMINARY RESULTS

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Abstract

A large number of metazoan organisms have arrived in the Mediterranean basin during the past decades and most of these species are benthic. The biological characteristics of 489 benthic macro-faunal invasive species were collected from the scientific literature and databases. The analysis of these results indicated that the more species are represented in each family, the more biological characteristics are recorded. Results on the biology of a small proportion of exotic species is shown.

Keywords: Invasive species, Mediterranean Sea, Zoobenthos, NIS, Life cycles

The introduction of alien species in the Mediterranean has been thoroughly investigated and the results of new invasive species are recorded in various databases[1]. The available species-lists include information on the impact of invasive species, the date and vectors of introduction in the Mediterranean, the degree of interaction with native species and the status of establishment success [2]. However, the biological characteristics for most of these species are poorly known. Exceptions to this rule are species used in aquaculture or of other economic importance. The biology of species is a useful information source in order to assess the potential for introduction and spread of invasive alien species[3] and to manage wildlife and habitats, according to European legislation [4]. The biological characteristics of 489 benthic invasive species were collected from 980 scientific literature sources and 25 databases. The information on most characteristics was obtained between 1970 and 2016, and include papers reporting new records of species in the Mediterranean. The traits collected, covered various aspects of biology (morphological, behavioural, reproductive and larval traits) of the benthic invasive species in the Mediterranean. A total of 52 traits where collected, subdivided into 278 sub-categories, called modalities. This group of species belong to six phyla (Annelida, Arthropoda, Echinodermata, Mollusca, Porifera and Sipuncula), the most abundant being Mollusca with 209 species, followed by Annelida-Polychaeta (138 species) and Crustacea (110 species). In total species from 195 families have been registered. Data on the total number of modalities for 25 of these families are shown in Figure 1. Families including more than four invasive species have numerous known biological traits recorded in the scientific literature.

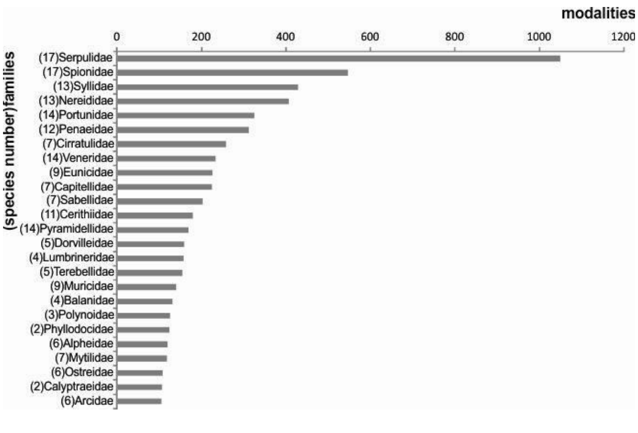

Fig. 1. Number of modalities collected, for 25 families (in parentheses the number of species per family).

Biological characteristics have been collected and stored in a data base. These continuous numerical traits are grouped into different number of range-classes, as shown in figure 2. Published information has been registered for lifespan (36 species), fecundity (80 species), egg size (90 species), age at first maturity (95 species) and maximum body-size (324 species). Body size and age at first maturity showed a maximum in the middle of the modality classes. On the other hand, species tend to have more variable egg sizes, fecundity and lifespan.

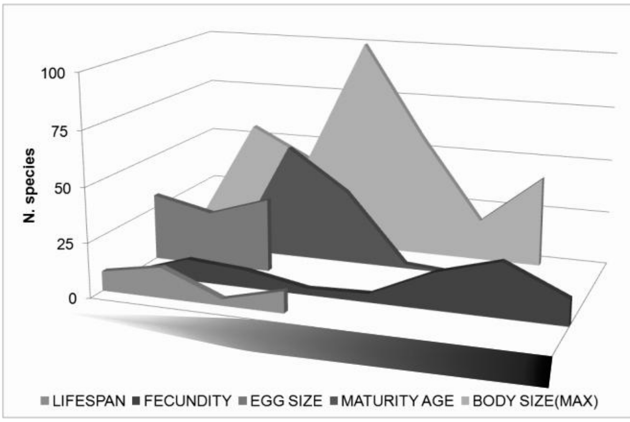

Fig. 2. Number of species per selected trait and range-class. As arrow gradually darkens, the modality values in the range-class increases.

Conclusively, invaders are characterized by mixed biological characteristics according to the published literature. Although aggregating the biological characteristics of so different taxa with a high phenotypic plasticity is risky, it could be a useful approach to detect patterns related to different life strategies of benthic invasive species[5]. At the same time the review of this scattered information is a tool for identifying gaps in the knowledge on the biology of these species which largely determines their dispersal ability.

References

1 - Marchini A., Galil B.S. and Occhipinti-Ambrogi A., 2015. Recommendations on standardizing lists of marine alien species: Lessons from the Mediterranean Sea. *Mar. Pollut. Bull.,* 101: 267–273.
2 - Streftaris N., Zenetos A. and Papathanassiou E., 2005. Globalization in marine ecosystems: the story of non-indigenous marine species across European seas. In: Gibson R., Atkinson R., Gordon J., (eds.). Oceanography and Marine Biology: An Annual Review. CRC Press, pp 419–453.
3 - EU, 2014. Regulation on the prevention and management of the introduction and spread of invasive alien species. PE-CONS 70/14. European Parliament and Council, Brussels.
4 - Genovesi P. and Shine C., 2004. European strategy on invasive alien species: Convention on the Conservation of European Wildlife and Habitats (Bern Convention). Council of Europe Publishing, 68 pp.
5 - Usseglio-Polatera, P., Bournard, M., Richoux, P. and Tachet, H., 2000. Biological and ecological traits of benthic freshwater macroinvertebrates: relationships and definition of groups with similar traits. *Freshwater Biol.*, 43: 175–205

CONTRIBUTION OF LESSEPSIAN INTRUSIONS TO THE ALTERATION OF COASTAL FISH ASSEMBLAGES IN ISKENDERUN BAY (NORTHEASTERN MEDITERRANEAN)

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Abstract
The seasonal bottom trawl surveys those were conducted between 2004 and 2015, revealed that the composition of shallow-soft bottom habitats in Iskenderun Bay significantly changed because of the establishment and progress of lessepsian fishes after 2010. The recent invaders such as *Nemipterus randalli* and *Pomadasys stridens* were found to be responsible on this alteration. A significant parallelism was also observed among the variations of ichthyofaunal composition, temperature and chlorophyll concentration. These arguments were considered as supporting the tropicalization hypothesis in Eastern Mediterranean.

Keywords: Alien species, Iskenderun Bay, Biodiversity, Temperature, Teleostei

Introduction
Due to ongoing introductions of lessepsian species, the structure of coastal fish assemblages reveals apparent inter-annual variations in Levant Basin. Recently, more than 100 Indo-Pacific fish taxa have been recorded in Eastern Mediterranean by the way of this migration [1]. The introduction rate has particularly increased within the last two decades [2]. This circumstance gives a perfect opportunity to evaluate the alterations of ichthyofaunal structure resulting from the invasive species. In this study, the inter-annual changes of the composition of teleost fish assemblages were investigated in a shallow-soft bottom habitat in northwestern coasts of Iskenderun Bay.

Material and Method
A total of 90 bottom trawl operations within 45 expeditions were conducted at 10 and 20m depth contours. The positions of transects were as follows; 35. 87° E, 36. 82°N to 35. 91°E, 36. 86°N and 35. 89°E, 36. 80°N to 35. 93°E, 36. 84° N. The expeditions were performed from 2004 to 2015 with regular seasonal intervals. During the expeditions, commercial bottom trawlers were used with the approximately same fishing effort which was about 700HP engine power and one-hour towing duration. Abundance based CPUE (individual per hour) values and remotely sensed temperature and chlorophyll [3] were used for the statistical analyses. In the first step of analyses, the significant clusters were determined with a Simprof procedure applied to the Bray-Curtis distance matrix. Then, non-metric multi-dimensional scaling (NMDS) combined with indirect gradient analysis was conducted.

Results and Discussion
During the study period we observed a total of 120 teleost fish species. The overall mean of CPUE was 102kg h^{-1} and 7762 individual h^{-1} in biomass and abundance respectively. However, the 73% of total richness was composed of Atlantic-Mediterranean species, 32 Indo-Pacific taxa dramatically dominated the catch. The proportion of lessepsians was determined as 62% of total biomass, and 85% of total abundance. Lessepsian fishes, *Equulites klunzingeri* (17.2%), *Upeneus pori* (16.8%) and *Saurida lessepsianus* (10.8%) constituted the most dominant three species in the study area. Two native fishes, *Pagellus erythrinus* and *Mullus barbatus*, followed them by forming 7.6% and 5.2% of total abundance respectively.
According to Simprof results, the sampling years formed three significant clusters in respect of species composition (Figure 1). Between-group Simper revealed that the first two groups which were 2004-2005 and 2006-2009, were slightly separated from each other with the variations of several native species such as *Arnoglossus laterna* and *Boops boops*. However, the composition of the third group (2010-2015) apparently differed from those of the both, particularly with the contributions of recently recorded lessepsians such as *Nemipterus randalli*, *Pomadasys stridens* and *Apogon smithi*. Mentioned lessepsians were firstly recognized after 2008 in Iskenderun Bay [4]. Apparently, they managed to establish consistent populations and even become the dominant component of the catch (Figure 1). This circumstance eventually resulted with the raise the dominance of lessepsian species in fish assemblages after 2010.

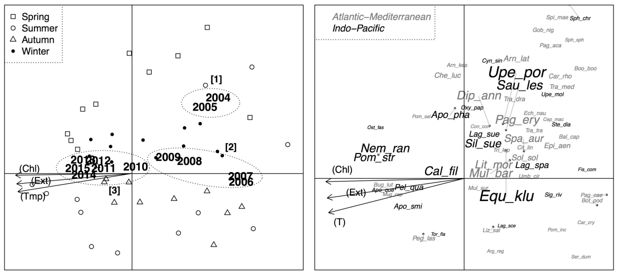

Fig. 1. NMDS ordination by sampling units (left panel) and species (right panel). The numbers in square brackets indicate the significant clusters. (Chl) and (Tmp) indicate the trend components of temperature and chlorophyll. (Ext) shows the approximate positions of annual minimum and maximum chlorophyll and annual minimum temperature. The font size is proportional to the maximum contribution of species to the within group similarity.

The variation of the species composition was significantly parallel with the increment of the annual average temperature and chlorophyll as well as annual minimum and maximum chlorophyll and annual minimum temperature ($p<0.01$). The increasing importance of warm water biota corresponding to the rising temperature and production may be considered as providing further support for the Bianchi and Morri's "tropicalization" concept [5] in Eastern Mediterranean.

Acknowledgements
This study was supported by the Cukurova University, Scientific Research Projects Coordination Unit with the grant number SUF2013-BAP7.

References
1 - Rothman, S.B.S., Stern, N. and Goren, M., 2016. First record of the Indo-Pacific areolate grouper Epinephelus areolatus (Forsskål, 1775) (Perciformes: Epinephelidae) in the Mediterranean Sea. Zootaxa 4067: 479. doi:10.11646/zootaxa.4067.4.7
2 - Lasram, F.B.R., Guilhaumon, F. and Mouillot, D., 2010. Global warming and exotic fi shes in the Mediterranean Sea: introduction dynamic, range expansion and spatial congruence with endemic species, in: Golani, D., Appelbaum-Golani, B. (Eds.), Fish Invasions of the Mediterranean Sea Change and Renewal. pp. 35–56.
3 - Acker, J.G. and Leptoukh, G., 2007. Online Analysis Enhances Use of NASA Earth Science Data. Eos, Trans. Am. Geophys. Union 88: 14. doi:10.1029/2007EO020003
4 - Bilecenoglu, M., Kaya, M., Cihangir, B. and Cicek, E., 2014. An updated checklist of the marine fishes of Turkey. Turkish J. Zool. 38: 901–929. doi:10.3906/zoo-1405-60
5 - Bianchi, C.N. and Morri, C., 2003. Global sea warming and "'tropicalization'" of the Mediterranean Sea: biogeographic and ecological aspects. Biogeographia 24, 319–327.

THE PROXIMATE, AMINO ACID AND FATTY ACID COMPOSITIONS OF *EQUULITES KLUNZINGERI* FROM ISKENDERUN BAY, NORTHEAST MEDITERRANEAN SEA

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Abstract
Equulites klunzingeri which is a lessepsian fish species Mediterranean Sea recognised as discard fish because of its small size. For evaluating nutritional value of *E. klunzingeri*, proximate composition, fatty acid and amino acid composition were investigated in this study.

Keywords: Invasive species, Iskenderun Bay, Lessepsian migration, Nutrients, Mediterranean Sea

Introduction

Equulites klunzingeri (Klunzinger's ponyfish) which was migrated from the Red Sea to the Mediterranean Sea by the Suez Channel is a lessepsian fish species. These fish are called as pony fishes due to their highly protractible mouth, which protract either dorsally, rostrally, or ventrorostrally. The general morphological characters of *E. klunzingeri* are silver coloration, small sized and laterally compressed. *E. klunzingeri*, which is found in large quantities in the Mediterranean Sea, is rejected by Mediterranean countries because of its small size. Because discard fish has a potential as a high quality feed source and a valuable food source for humans as functional ingredients and nutritional supplements, it is important to establish of their components.

Materials ans Methods

E. klunzingeri were captured by academic staff of Fisheries Faculty in Iskenderun Bay. The mean weights and lengths of fish were measured as 5.89±2.56 g and 7.55±1.75cm, respectively. Moisture content and crude ash of the samples were determined in an oven at 103 °C and 550 °C respectively until the weight became constant. Lipid content was analyzed according to procedure of Bligh and Dyer [1] and crude protein was determined by Kjeldahl's method [2]. Amino acid composition was determined by the TUBITAK MAM (Scientific and Technological Research Council of Turkey, Food Institute of Marmara Research Centre). Lipid samples were converted to their constituent fatty acid methyl esters by the method of Ichihara [3]. The fatty acids methyl esters were separated and quantified with a gas chromatograph.

Results and Discussions

The moisture, ash, crude protein and lipid content of *E. klunzingeri* were 74.84±0.45 %, 4.06±0.04 %, 16.45±0.54 % and 3.78±0.06 %, respectively. This proximate composition's data reveals that *E. klunzingeri* caught from the Iskenderun Bay had reasonably high protein and low fat contents. Marine oils are rich sources of polyunsaturated fatty acids (PUFA), especially EPA and DHA. Palmitic and stearic acids are the major constituents of saturated fatty acids (SFAs) in marine lipids. For the monounsaturated fatty acids (MUFA), palmitoleic and oleic acids are the major ones. In the presented study, the obtained data of the main fatty acids from *E. klunzingeri* were also had the same results. The total SFAs, MUFAs and PUFAs of *E. klunzingeri* were determined as 35.31±0.63%, 31.39±1.23% and 18.92±1.07%, respectively. Palmitic acid, stearic acid and myristic acid were found as 23.96±0.42%, 5.81±0.13% and 5.09±0.31%, respectively. Palmitoleic acid and oleic acid were the major MUFA and determined as 13.12±0.77% and 10.32±0.29%, respectively. Among the PUFA, EPA and DHA were also the main fatty acids and they were found as 4.97±0.52% and 10.37±0.54%, respectively. Most researchers have reported that the main amino acids in fish are glutamic acid, aspartic acid, lysine and leucine. In this study, the main amino acids in *E. klunzingeri* were lysine, glutamic acid, leucine, alanine and aspartic acid which constituted in the range of 1131 and 2051 mg/100 g sample. It was determined that the remaining amino acids were in range of 322 and 854 mg/100g sample. The ratio of essential amino acids (E) / nonessential amino acids (NE) was determined as 0.88 for *E. klunzingeri*. For many fish species, the reported range of E/NE ratio was 0.69 to 1.00 [4-5].The results shown that *E. klunzingeri* have well-balanced and high quality protein source in respect to E/NE ratio. It can be concluded that *E. klunzingeri* has valuable nutritional compounds as a result of this study. Therefore, utilisation of this discard fish may have some advantages in terms of environmental pollution and gaining value-added products.

References
1 - Bligh, E.G. and Dyer, W.J., 1959. A rapid method of total lipit extraction and proficiation, *Can. J.Biochem. Physiol.*37: 911-917.
2 - AOAC, 1998. Official methods of analysis of AOAC International. In: *Official methods of analysis*, 16th Eds., Chapter 39 (edited by D.L. Soderberg and P. Cunniff), Gaithersburg, MD.
3 - Ichihara, K., Shibahara, A., Yamamoto, K., and Nakayama, T., 1996. An Improved Method for Rapid Analysis of the Fatty Acids of Glycerolipids. *Lipids,* 31: 535-539.
4 - Özyurt, G. and Polat, A., 2006. Amino acid and fatty acid composition of wild sea bass (*Dicentrarchus labrax*): a seasonal differentiation. *European Food Research and Technology*, 222(3-4): 316-320.
5 - Tokur, B., Çakli, S. and Polat, A., 2006.The Quality Changes of Trout (*Oncorhynchus mykiss* W., 1792) with a Vegetable Topping During Frozen Storage (-18° C)." *Su Ürünleri Dergisi* 23.3.

CIESM Congress Session : Genetic markers of biodiversity

Moderator : Anne Chenuil, IMBE, Aix-Marseille Univ., France

Moderator's Synthesis

Genetic markers of biodiversity are now extremely powerful and affordable. They potentially can contribute to

i) the establishment of community species composition - a new possibility for multicellular organisms, metabarocoding being restricted to unicellular and planktonic cells until now,

ii) phylogenetics reconstructions, and

iii) intra-specific genetic structure description - an important contribution for the management of biodiversity, including connectivity assessment, reproductive mode, effective size estimations, and species delimitations.

The five communications illustrated the diversity of applications of genetic markers to biodiversity although they were mostly dealing with cryptic species: one case of species delimitations/ cryptic species on fish and one on sea urchins, one investigated the demographic history of an invasive alga, and two were on population differentiation in tuna and in jellyfish. Typical traps leading to inconsistencies using genetic tools without appropriate knowledge on population genetics processes were presented in the introduction and illustrated by certain presentations. For instance, the use of allozymes (ancient markers, old fashioned, yet still the best ones to answer many questions!) is often much more sound than the use of mitochondrial sequences. Not any genetic marker can answer every question. Now that technology is deeply revolutionizing this field, using suboptimal methods should be avoided but this will require training of mediterranean marine biologists.

DIFFÉRENCIATION OTOLITHOMÉTRIQUE ET GÉNÉTIQUE DANS LE COMPLEXE *ATHERINA BOYERI* DE MÉDITERRANÉE OCCIDENTALE

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Abstract

L'analyse de la forme des otolithes sagittae et l'étude de la variabilité mitochondriale des populations d'Atherina boyeri de rives Nord et Sud de la Méditerranée occidentale nous a permis d'identifier trois 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.

Keywords: Mediterranean Sea, Coastal waters, Fishes, Genetics, Lagoons

Introduction

Les athérines sont des petits poissons téléostéens vivant dans les zones côtières, les estuaires et les lagunes. *Atherina boyeri* est considéré comme étant un complexe taxonomique, divisé par certains auteurs en divers espèces ou sous-espèces (Trabelsi et al., 2002a; 2002b). Ce travail aborde le statut de cette espèce en utilisant deux outils différents : la forme des otolites et l'ADN mitochondrial.

Matériel et méthodes

Les contours de 752 otolithes sagittae (69 provenant de la lagune Mellah, 51 marins non ponctués, 40 marins ponctués, 66 estuariens provenant de Oued Ziama, 22 de la lagune de Thau, 64 de celle de Mauguio, 64 de celle de Bizerte) ont été numérisés et analysés en utilisant le programme TNPC (5.0). Une analyse factorielle discriminante a été appliquée utilisant les descripteurs de Fourier (Shape v1.3). Une étude génétique utilisant trois marqueurs mitochondriaux (région de contrôle, Cyt b et 16S) a été menée. Neuf échantillons issus de 8 localités différentes ont été recueillies sur les côtes Nord et Sud de la Méditerranée occidentale (côtes et lagunes tunisiennes, françaises, et algériennes). L'ADN total est extrait à partir de la nageoire caudale, en utilisant du Chelex à 10%. L'analyse de maximum de vraisemblance a été réalisée avec PhyML 3.0. La robustesse des nœuds est testée grâce à la réalisation de 1000 bootsraps. Des Analyses bayésienne ont été réalisées à l'aide de MrBayes 3.2

Résultats

Les deux premières fonctions discriminantes de la FDA effectuées utilisant les descripteurs de Fourier représentent 89,40% de la variance. Les individus peuvent être différenciés en cinq groupes basés sur les deux premières fonctions (lambda de Wilks = 0,07, P < 0,001). Les individus ponctuées et non ponctuées du golfe d'Annaba et ceux provenant de Oued Ziama, forment trois groupes bien séparés. Les spécimens des lagunes Mellah et Mauguio forment le quatrième groupe. Le cinquième comprend les individus de l'Étang de Thau et de Bizerte (Fig. 1). Le pourcentage des individus totaux bien classés est de 74,5%. Les résultats de l'analyse moléculaire pour les trois marqueurs d'ADNmt vont dans le même sens et nous permettent de distinguer cinq groupes séparés. Deux d'entre eux correspondait à deux espèces déjà reconnus (*A. presbyter* et *A. hepsetus*), les trois autres clades correspondent au complexe *A. boyeri* (Trabelsi et al., 2002b), avec un clade principal (*A. lagunae*) regroupant les échantillons lagunaires (Bizerte, Mauguio, Mellah) et d'eau douce (oued Ziama et oued Mafragh), ainsi que deux autres clades, l'un regroupant les populations marines non ponctuées (*A. boyeri*), et l'autre les populations marines ponctuées (*A. punctata*). Ces clades sont soutenus par des valeurs élevées de bootstraps et de probabilités a posteriori.

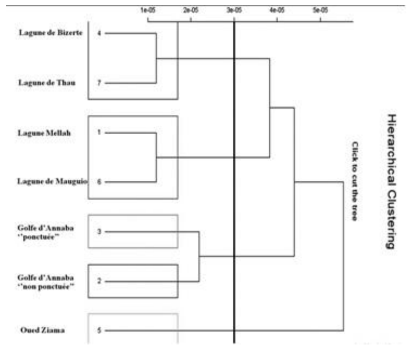

Fig. 1. Classification hiérarchique utilisant les descripteurs de Fourier de la forme des otolithes des différentes populations de *A. boyeri*.

Discussion

Les marqueurs d'ADNmt différents (CR, Cyt b, 16S) corroborent les résultats obtenus à l'aide de la forme des otolithes. Les deux nous ont donné des informations sur combien les formes marines (ponctuées et non-ponctuées) sont différentes. A côté de celà, une variation intra-spécifique de la forme lagunaire de *A. boyeri* selon les deux méthodes est mise en évidence. Nos résultats renforcent le statut d'espèces des trois formes méditerranéennes traditionnellement inclues dans le complexe *A. boyeri*. 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) qui reconnaissent la complexité du taxon *Atherina boyeri* et son organisation en 3 espèces.

References

1 - Klossa-Kilia, E., Prassa, M., Papasotiropoulos, V., Alahiotis, S., et G. Kilias, 2002. - Mitochondrial DNA diversity in Atherina boyeri populations as determined by RFLP analysis of three mtDNA segments. Heredity, 89 (5): 363-370.
2 - Trabelsi, M., Faure, E., Quignard, J.-P., Boussaïd, M., Focant, B.et F. Mâamouri, 2002a. - Atherina punctata and Atherina lagunae (Pisces, Atherinidae), new species in the Mediterranean Sea. 1. Biometric investigations of three atherinid species. Comptes Rendus - Biologies, 325 (9): 967-975.
3 - Trabelsi, M., Gilles, A., Fleury, C., Mâamouri, F., Quignard, J.-P. et E. Faure, 2002 b. - Atherina punctata and Atherina lagunae (Pisces, Atherinidae), new species found in the Mediterranean Sea. 2. Molecular investigations of three Atherinid species. Comptes Rendus - Biologies, 325 (11): 1119-1128.

A NEW GENETIC ANALYSIS OF A LESSEPSIAN SPECIES AS A TOOL TO PREDICT THE INVASIVE FORCE OF A POTENTIAL ECONOMIC RESOURCE

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Abstract

The genetic variability of the lessepsian species Fulvia fragilis was analysed with samples from a Red Sea population and a Tunisian population. Genetic markers showed no genetic loss in the Mediterranean Sea population. This analysis provided a tool to identify the taxonomic position of this little known species. It also underlined a relatively high level of genetic diversity of this newly established population and revealed a likely good adaptability of its potential economic resource.

Keywords: Alien species, Mediterranean Sea, Genetics, Population Dynamics, Bivalves

The phenomenon of colonization of the Mediterranean Sea by fauna from the Indian Ocean was observed soon after the opening of the Canal and has increased with the low input from the Nile fresh water as the result of Aswan dam construction in 1969. The acceleration of this phenomenon is also due to the increased shipping activities that promotes the transport of living organisms via ballast waters, combined with warming impacts that facilitate the settlement and colonization of Lessepsian species [1]. In this context, all alteration of natural communities appears as a particular form of human impacts (shipping, over fishing, aquaculture and artificial water ways) which has affected the eastern basin and now extends to the western basin. Among colonized exotic species, some have potential commercial interest in either fishing or aquaculture. Among these, the bivalve *Fulvia fragilis* (Cardiidae) belongs to a little-known species complex and is widespread around the edge of the Indo-Pacific Ocean. It occurs naturally in the Red Sea and was observed early in the Suez Canal and the Mediterranean Sea. Very quickly, its location has appeared in the form of patches that tend to spread. On the Tunisian coast, it was first observed in the Gulf of Gabes and since 2001, it has crossed the Tunisian-Sicilian channel and develops in the Bizerte lagoon and the Gulf of Tunis (Fig 1).

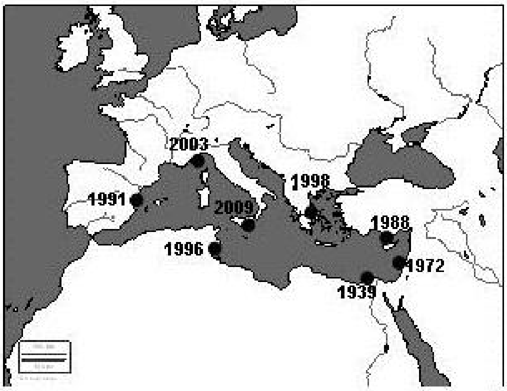

Fig. 1. Geographical distribution of *Fulvia fragilis* in the Mediterranean Sea (Ben Souissi, 2013)

Two populations of *F. fragilis* were sampled, one from the native area (Red Sea) and one from the colonized area (Gulf of Tunis). Molecular techniques were used for the first time on nuclear and mitochondrial genetic markers of this species and allowed us to characterize its genetic signature. They gave data about intraspecific genetic relationship [2]. Moreover, the phylogeographic information provided tools to establish monitoring the colonization of Mediterranean and understand the mechanisms of this process. The genetic analysis clarified the taxonomic position of this lessepsian species. It supplied a first assessment of the genetic diversity of this bivalve in its original area and in a new settled area and led to estimate the impact of colonization of the Mediterranean Sea on its intrapopulationnal genetic diversity (Fig 2).

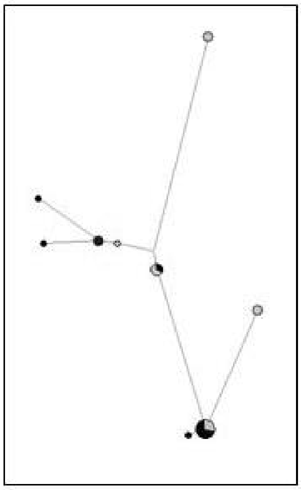

Fig. 2. Genetical relationship between a Mediterranean population (Black circles) and a Red Sea population (Grey circles) of *Fulvia fragilis* based on the ITS-1 sequence. The circle size is proportional to the number of the sequences

The first results suggested that no bottleneck processes reduced the genetic variability of *F. fragilis* populations established in the Tunis Gulf. On the nuclear no-coding region, most of variable sites are Indels ones. The estimation of the genetic diversity of newly established populations is a new tool for evaluating their adaptive capacity and thus their ability to grow facing new environmental characteristics. The level of genetic variability of the new population in the Gulf of Tunis underlined that it seems high enough to explain the success of this implementation. It can also explain that the populations of this invasive species are strong enough to almost eradicate a part of the native fauna [3]. Moreover, in the case of an exploitable invasive species like *F. fragilis*, determining the genetic heritage of the populations in the natural environment is a prognostic tool of its aquaculture potential.

References

1 - Galil, B.S. (2008). Alien species in the Mediterranean Sea- which, when, where, why? Hydrobiologia, 606: 105-116.

2 - Bandelt H-J, Forster P & Röhl A (1999**).** Median-joining networks for inferring intraspecific phylogenies. Mol Biol Evol 16: 37-48.

3 - Ounifi-Ben A., Rifi M., Ghanemi, R., Draief I. Zaouali J. & Ben Souiss J. (2016). Update of alien fauna and new records from Tunisian marine waters Medit. Mar. Sci., 17(1): 124-143

GENETIC CHARACTERISATION OF *THUNNUS THYNNUS* IN THE MEDITERRANEAN: ANALYSIS AT THE MITOCHONDRIAL LEVEL

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Abstract

Currently two differentiated tuna stocks with spawning areas in the Gulf of Mexico and the Mediterranean Sea are recognised although it is proposed that further population sub-structuring may exist. Samples were collected during 2013-14 (n=80)and the Mitochondrial D-loop region was amplified. Pairwiseφ_{ST} analysis demonstrated that there was significant differentiation between this study's samples (Grech, Libya-Eastern Mediteranean) and that of the Gulf of Mexico (Atlantic) (p=0.025). No evidence of differentiation was found between this sample and the historical samples of the Eastern Mediterranean, Libyan samples (p= 0.0678, p= 0.0623 respectively) or the Western Mediterranean (p =0.0549) . The implications are discussed.

Keywords: Mediterranean Sea, Genetics, South-Eastern Mediterranean

Introduction

The Atlantic Bluefin tuna (*Thunnus thynnus*) is an economically important fish found in the Atlantic Ocean and Mediterranean Sea. Currently two differentiated tuna stocks are recognised. However as the Mediterranean Sea consists of two partly enclosed basins (Western and Eastern) differing in oceanography and abiotic parameters it is proposed that further population sub-structuring may exist. The aim of this study was to determine whether sub-structuring of the mitochondrial DNA from *T. thynnus* (representing the Eastern Mediterranean) could be observed.

Material and Methods

25 frozen muscle samples collected in 2013 from Libyan waters, and stored at -20°C were provided by the Malta Aquacultural Research Station, Marsaxlokk. 55 fresh muscle samples were collected from a tuna pen to the South of Malta in 2014. DNA was extracted from samples, then the Mitochondrial D-loop region was amplified using the primer pairs CSBDH/L15998 and PRO5/12SAR3 [1]. Arlequin version 3.5.1.3 [2] was used to calculate the number of haplotypes (nh), haplotype diversity (h) and nucleotide diversity (π) for both sets of data. Tajima's D (D) [3] and Fu's F [4] were used to test whether the studied *T. thynnus* population was stable.

Results and Discussion

The mitochondrial DNA sequences obtained in this study showed high homology to sequences available in the public domain in GenBank (>99.0%). Pairwise φ_{ST}analysis demonstrated that there was significant differentiation between this study's samples (Grech, Libya-Eastern Mediteranean) and that of the Gulf of Mexico (Atlantic) (p=0.025) as presented in [5] (Table 1). In contrast no evidence of differentiation was found between this sample and the historical samples of the Eastern Mediterranean [5] and Libyan samples [6] (p= 0.0678, p= 0.0623 respectively) (Table 1). When the samples in this study were compared to the historical samples of the Western Mediterranean [5] no difference was found between this study (Grech, Libya-Eastern Mediterranean) and that of the Western Mediterranean (p value of 0.0549). The haplotype diversity (h) of the studied samples using the CSBDH/L15998 and PRO5/12SAR3 primer pairs was 0.985 and 0.945 respectively. The nucleotide diversity (π) was also high at 0.0152 and 0.0149 respectively. These values were comparable to those obtained for T. thynnus throughout the Atlantic and Mediterranean regions [1, 5, 7, 8]. These values indicate that the most variation was observed between samples. Tajima's D (D) and Fu's F were both negative at -1.520 and -5.674 (p<0.001) for primer set CSDBH/L15998 and -1.296 (p=0.032) and -3.859 (p<0.001) for primer set PRO5/12SAR3. These indicate an excess of rare nucleotides following a recent population explosion after a population bottleneck and is in accordance with data such as that obtained in [4]. At the mitochondrial level significant large-scale population sub-structuring was reported in this study between the Gulf of Mexico (Atlantic region) and the Eastern Mediterranean region. This is in agreement with the management strategies proposed by ICCAT [9]. No strong evidence was found to support segregation of tuna in the two Mediterranean basins [9]. We recommend extending this study using larger numbers.

Tab. 1. AMOVA pairwise comparison among different *T. thynnus* samples.

	Gulf of Mexico (Carlsson *et al.*, 2007)	West Med (Carlsson *et al.*, 2007)	East Med (Carlsson *et al.*, 2007)	Libya (Vinas *et al.* 2001)
West Med (Carlsson *et al.*, 2007)	0.0129 (*P*=0.0139)	/	/	/
East Med (Carlsson *et al.*, 2007)	0.0134 (*P*=0.1105)	0.0174 (*P*=0.0482)	/	/
Libya (Vinas *et al.*, (2001)	0.0201 (*P*=0.0639)	0.0179 (*P*=0.0667)	0.0132 (*P*=0.0589)	/
Study Samples (Libya)	0.0264 (*P*=0.0254)	0.018 (*P*=0.0549)	0.0128 (*P*=0.0678)	0.0327 (*P*=0.0623)

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References

1 - Alvarado Bremer,,J.R., Baker, N.J. and Mejuto, J. (1995) Mitochondrial DNA control region sequences indicate extensive mixing of swordfish (Xiphias gladius) populations in the Atlantic Ocean. Canadian Journal of Fisheries and Aquatic Sciences, 52 (8) 1720-1732.

2 - Excoffier L. and Lischer, H.E. (2010) Arlequin suite version 3.5: new series of programmes to perform population genetics analyses under Linux and Windows. Molecular Ecology Resources, 10 (3) 564-567.

3 - Tajima, F. (1989) Statistical method for testing the neutral mutation hypothesis by DNA polymorphism. Genetics, 123 (3) 585-595.

4 - Fu, Y.X. (1997) Statistical tests of neutrality of mutations against population growth, hitchhiking and background selection. Genetics, 147 (2) 915-925.

5 - Carlsson, J., McDowell, J.R., Carlsson J.E. and Graves, J.E. (2007) Genetic identity of YOY Bluefin tuna from the Eastern and Western Atlantic spawning areas. Journal of Heredity, 98 (1) 23-28.

6 - Vinas, J., Pla, C., Tawil, N.Y., Hattour, A., Farrugia, A., de la serna J.M (2003) Mitochondrial genetic characterisation of Bluefin tuna from three Mediterranean (Libya, Malta, Tunisia) and one Atlantic locations (Gulf of Cadiz) Collective volume of scientific papers. ICCAT, 55, (3) 1282-1288.

7 - Carlsson, J., McDowell, J.R., Diaz-Jaimes, P., Carlsson, J.E., Boles, S.B., Gold, J.R. and Graves, J.E. (2004) Microsatellite and mitochondrial DNA analyses of Atlantic Bluefin tuna (Thunnus thynnus). Molecular Marine Biology and Biotechnology, 6 (4) 308-214.

8 - Alvarado Bremer, J.R., Vinas, J., Mejuto, J. Bert, E. Pla, C. (2005) Comparative phylogeography of Atlantic bluefin tuna and swordfish: the combined effects of vicariance, secondary contact, introgression, and population expansion on the regional phylogenies of two highly migratory pelagic fishes. Molecular Phylogenetics and Evolution. 36 (1) 169-187.

9 - ICCAT. (2008). Report of the 2008 Atlantic bluefin stock assessment session (scrs/2008/019). Collective Volume of Scientific Papers. ICCAT, 161.

PHYLOGENETIC CHARACTERIZATION OF TWO ECHINOID SPECIES OF THE SOUTHEASTERN MEDITERRANEAN, OFF EGYPT

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Abstract

In this study we investigated the phylogenetics of two sea urchin species, *Arbacia lixula* and *Paracentrotus lividus* collected from the east coast of Alexandria City, Egypt. Pigmentation examination showed four sympatric color morphotypes (black, purple, reddish brown, and olive green). Mitochondrial DNA was extracted from specimens and mitochondrial cytochrome oxidase subunit I and 16S ribosomal RNA were sequenced. The results showed that all black specimens constituted the species *A. lixula*. All other colors belonged to *P. lividus*, with no apparent differentiation between color morphotypes. Moreover, *P. lividus* showed high haplotype diversity and low values of nucleotide diversity, indicating a high degree of polymorphism within this species.

Keywords: Echinodermata, Levantine Basin, Genetics

Materials and Methods. Sampling, DNA extraction & PCR amplification. Twenty individuals were selected from station Sidi Bishr, Alexandria, Egypt (Fig. 1)

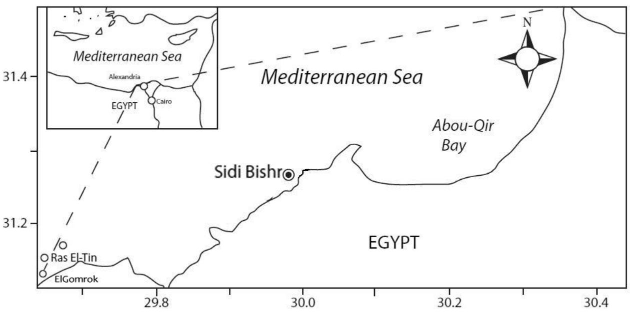

Fig. 1. Sampling site, Sidi Bishr, Alexandria, Egypt.

(16 specimens of *P. lividus* and 4 specimens of *A. lixula*), dissected and their gut and gonads were preserved in absolute ethanol (99.5%). Genomic DNA was extracted from 20 sea urchins from ~0.1 g of gonads using a DNeasy Tissue Kit (Qiagen), following the manufacturer's protocol. Mitochondrial cytochrome oxidase subunit I (COI) was amplified using the forward primer COIe-F 5′-ATA ATG ATA GGA GGR TTT GG-3′ and the reverse primer COIe-R 5'-GCT CGT GTR TCT ACR TCC AT-3′. 16S ribosomal RNA (16S) was amplified using the forward primer 16SA-R 5′-CGC CTG TTT ATC AAA AAC AT-3′ and the reverse primer 16SB-R 5′-GCC GGT CTG AAC TCA GAT CAC GT-3′. PCR reactions were carried out in a 20 µl total volume containing 5–20 ng of template DNA, 0.5 µM of each primer, and 10 µl of HotStarTaq™ Master Mix (Qiagen, Tokyo, Japan), in RNase-free distilled water. The PCR conditions for both markers consisted of an initial denaturing step at 95 °C for 15 min, 35 cycles (94 °C for 1 min, 46 °C for 1 min and 72 °C for 1 min) and a final step at 72 °C for 10 min for both DNA markers. PCR product sizes were checked by gel electrophoresis on 1.5% agarose gel. The amplified products were purified with Exonuclease I and Alkaline Phosphatase Shrimp (Takara) by being incubated at 37 °C for 20 min, followed by deactivation at 83 °C for 30 min. Purified PCR products were sequenced using an ABI Prism automated sequencer at Fasmac Co., Kanagawa, Japan, in both in forward and reverse directions.

Phylogenetic analyses

The sequences for both sea urchin species were edited and aligned using the software Geneious version 8.1. Novel sequences obtained in this study were deposited in GenBank (Accession Numbers KU172482–KU172520). New sequences obtained in this study for *P. lividus* were aligned with previously reported sequences from the eastern Atlantic and western Mediterranean (16S sequences from [1]; COI sequences from[1]), as well as outgroup sequences from *Psammechinus miliaris*. As *P. lividus* sequences were shown to form a well-supported monophyly to the exclusion of the outgroup, we subsequently generated and used unrooted trees in our analyses (without outgroup sequences) to improve their resolution. Sequence data of *A. lixula* were aligned with previous reported sequences in GenBank from the Atlantic Ocean and Mediterranean Sea (16S sequences from Chenuil et al., unpulished; COI sequences from [3]). Maximum likelihood (ML) and Neighbor-Joining (NJ) phylogenetic trees were constructed in MEGA 6 with 1000 bootstraps using a Tamura 3-parameter model as the best-calculated model for both markers without outgroups. There are no data available for these markers in congeners of either species in GenBank. Phylogenetic trees were constructed using Bayesian inference (MrBayes 3.2.2), with 1,000,000 cycles of Markov Chain Monte Carlo (MCMC), 4 heated chains and a burn-in of 100,000. For *P.lividus* (n = 16), the number of haplotypes (H), haplotype diversity (Hd), and nucleated diversity (π) was estimated using DNaSP version 5.1.

Results and Discussion

For the COI and 16S markers, fragments of 602 bp and 515 bp, respectively, were sequenced from specimens of *P. lividus* and *A. lixula*, respectively. Alignments showed clear patterns of differences between each species. A phylogenetic tree constructed with outgroups using the maximum likelihood method showed each species as a monophyly, one clade per species (data not shown). From 16 individuals of *P. lividus* a total of 12 and 9 haplotypes were found in COI and 16S, respectively, indicating a high degree of polymorphism within this species. *P. lividus* showed high values of haplotype diversity (COI; H = 0.9500 and 16S; H = 0.8580) and low values of nucleotide diversity (COI; π = 0.0075 and 16S; π = 0.0049). Genotyping results using 16S and COI sequences showed no relation between genetic differentiation and color morphotypes for *P. lividus*. Sequences of both mtDNA markers of *P. lividus* matched closely or were identical to previously reported sequences. For *A. lixula*, due to limited number of sequences of *A. lixula*, we could not perform meaningful comparisons with previous reports.The current study molecularly confirms the identity of *A. lixula* and *P. lividus* in Egyptian waters, and their close connectivity to previously reported populations in other Mediterranean regions. No significant phylogenetic patterns corresponded to the different observed color morphotypes of *P. lividus*.

References

1 - Calderon, I., Giribet, G., Turon, X., 2008. Two markers and one history: Phylogeography of the edible common sea urchin *Paracentrotus lividus* in the Lusitanian region. Marine Biology, 154, 137-151.

2 - Duran, S., Palacin C., Becerro, M.A., Turon, X., Giribet, G., 2004. Genetic diversity and population structure of the commercially harvested sea urchin *Paracentrotus lividus* (Echinodermata, Echinoidea). Molecular Ecology, 13, 3317-3328.

3 - Wangensteen, O.S., Turon, X., Perez-Portela, R., Palacin, C., 2012. Natural or naturalized? Phylogeography suggests that the abundant sea urchin *Arbacia lixula* is a recent colonizer of the Mediterranean. PLoS ONE, 7, e45067.

POPULATION, ECOLOGY AND GENETIC CHARACTERISTICS OF THE MEDITERRANNEAN BOX JELLYFISH *CARYBDEA MARSUPIALIS* IN THE ISLAND OF MALTA

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Abstract
The main aims of this study were to investigate the environmental parameters associated with blooming events of *Carybdea marsupialis* and to genetically compare the box jellyfish in Malta to other Mediterranean and Atlantic samples. The numbers of adult individuals, as well as abiotic and biotic factors were monitored *in situ* and analysed statistically. Phenological patterns were determined and the abundance of *C. marsupialis* at the Maltese sites was shown to be strongly and positively correlated with sea water temperature. Genetic analysis indicated a high degree of homology between the sequences derived from the analysed Mediterranean specimens, which was not apparent in the genetic material derived from specimens from the Eastern Atlantic (Cadiz).

Keywords: Genetics, Population Dynamics, Mediterranean Sea

Introduction
The jellyfish *Carybdea marsupialis* (class Cubozoa) is an endemic species of the Mediterranean (Bordehore, 2014, Geroun et al, 2015). Previously not considered to be a blooming species in the Central and Western Mediterranean, in recent years unusually high densities of the species have been recorded in South-East Spain [1] Tunisia [3], Malta [2] where they negatively impact the marine ecology and tourism of these affected regions. This study aims to provide data on the factors affecting the abundance of these organisms in Malta.

Methods
C.marsupialis populations were monitored bi-monthly within two Maltese embayments (Birzebbugia and Msida), between July 2014-2015. The sites were selected as these studies had shown that they support year-round populations and are sufficiently distant from each other. Abiotic and biotic factors at each selected site, as well as morphological parameters, diagonal bell width, gastric cirri width, bell height, pedalia width and inter-rhopalia width were recorded. Correlations between abiotic and biotic parameter seasonal values were investigated, using the IBM SPSS Statistics package19. Concurrently, a comparative study of 18S and 28S rDNA from Maltese specimens (n=24), and from reference specimens from the Mediterranean (off Denia) and Atlantic (off Cádiz) coastal waters of Spain was carried out. Five reference samples were studied for each site, with the exception of the sample from Cadiz where one sample was used.

Results and Discussion
The Mann-Whitney U-test was used to reveal strong statistically-significant spatial differences between morphometric measurements with inter-population differences in these values seemingly related to the levels of zooplankton at each site. Overall, population numbers showed a strong seasonality for the duration of the study, with similar phenological patterns exhibited at both sites. The appearance of juvenile stages was recorded at the end of May 2015, with the abundance of adult stages peaking at their highest densities between June-July. The population numbers then declined between February and absence persisted till early-May 2015. PCA and Spearman's Rank Coefficient were used to determine which factors primarily drove the observed seasonal changes in abundance recorded. Abundance was strongly and positively correlated with surface sea water temperature. Negative correlations were recorded between population numbers, nitrate and chlorophyll concentration. Genetic studies of the 18S-28S rDNA regions demonstrated uniformity between the Spanish (Mediterranean population only) and Maltese samples (>98.0% homology). Greater differences were recorded between the genetic sequences of the Mediterranean populations and that of the Atlantic (Cádiz) specimen (~80.0% homology). Less pronounced differences were recorded between the Denia and Birzebbuga samples, whilst all the remaining Maltese samples clustered together, suggesting an element of genetic drift between the Maltese populations. Analysis of the morphometric data confirmed that the Maltese *C. marsupialis* specimens were morphologically similar to the specimens found in Olivia, Baha and Denia (Spain). The negative correlation between jellyfish abundance and phytoplankton and chlorophyll concentration appear at face value to be contradictory. We postulate that Cubomedusae population peaks do track the peaks in phytoplankton (and hence chlorophyll) abundance. However this occurs after a certain lag, with the Cubomedusae abundance responding to the subsequent peak in the abundance of mesoplankton, upon which they prey. The high homology at the 18S-28S rDNA region in the Mediterranean *Carybdea* specimens is compatible with their pelagic nature. Absence of high homology between the sample from Cádiz and the Mediterranean samples may possibly reflect mis-identification or the presence of a different *Carybdea* species. Further genetic studies with larger numbers of *Carybdea marsupialis* are thus recommended. This study highlights the importance of amalgamating both morphometric and genetic tools as a taxonomic tool within the Cubomedusae.

References
1 - Bordehore, C (2014) Studies on the ecology of C marsupialis (Cubozoa) and jellyfish sting management. PhD thesis, University of Alicante (Spain) Department of Ecology.
2 - Deidun A. (2011) A collection of recent ctenophore sightings from the Maltese islands. Journal of the Black Sea/Mediterranean Environment, 17 (1).
3 - Geroun S.K., Acevedo M., Kefi-Daly Y., Deidun A., Fuentes V., Piraino S. & Daly Yahia M. (2015) First records of C. marsupialis proliferation along the Eastern Tunisian coast. Italian Journal of Zoology, 1-6.

CIESM Congress Session : Indicators and tools for biodiversity conservation

Moderator : Patrizio Mariani, DTU Aqua, Charlottenlund, Denmark

Moderator's Synthesis

Biodiversity is expected to affect food-webs and the functioning of marine ecosystems, as well as their provision of goods and services to our societies. Unfortunately the relationship between services, functions and underlying biodiversity remains poorly understood. A pragmatic approach to advance the sustainable management of ecosystems, is used in the EU Marine Strategy Framework Directive (MSFD), which sets 11 qualitative descriptors for “good environmental status”. Descriptor 1 targets that biological diversity is maintained.

Strategies and methodologies applied for the assessment are very diverse (a reviewed in the contribution of Hansjosten) with visual methods on benthic communities being the most used. This calls for standardization of the different approaches and methods and for the development of new general tools that can support biodiversity assessment and conservation. Underwater videography is certainly a powerful census tool that can be used to define both species abundances and distributions and also species-specific interactions (as shown in the paper of Krushel and colleagues). However, those methods are still subject to the spatial variability and habitat range of the different species. Presently there are gaps in terms of tools and indicators used to properly manage the spatial heterogeneity of habitats and species. It has been suggested (in paper of Mariani et al.) that modeling tools of population connectivity can provide the way forward in developing general, objective approaches for ecosystem management targeting biodiversity conservations. A significant advance in this field would be provided by trait-based approaches that can transcend species definition while focusing on the relevant aspects driving connectivity of diverse communities.

Additionally, marine protected areas are recognized as a very effective method for managing marine ecosystems and biodiversity, especially when smart networks of MPAs are set in place (see paper by Topalaglu et al.). To provide reference values for biodiversity maintenance a larger effort should be made to extend the areas that are presently assessed and monitored. To this end, the first study on biodiversity census conducted in Algeria (around the Augueli island and co-authored by Bachetarzi and Rebzani) was able to define a zero-state for a previously largely unknown region of the Mediterranean Sea and was very well received.

Assessments of biological diversity have the ambitious objective of describing the state of an entire ecosystem, often by using only a few selected indicators. This generally needs to take into account the fact that marine biodiversity is sensitive to- and also structured by- additional factors such as salinity, currents, temperature, etc. Models of connectivity combined with genetic analyses, visual census of species and the establishment of MPA networks can provide operation tools for marine spatial planning targeting biodiversity conservation and a sustainable use of marine ecosystems.

BIODIVERSITY MARINE ASSESSMENT OF “AGUELI ISLAND” (WILAYA OF ALGIERS), ALGERIA

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Abstract
The bioecological assessement and knowledge of marine fauna and flora play a key role in the establishment and management of MAPs. It provides essentials informations for making management decisions and measuring their impacts. The present study has for main objective the establishment of (i) a sampling strategy adapted to the study site, (ii) a method of *in situ* observation scuba diving (Underwater Visual Census) to (iii) inventory ichtyological and megabenthic biodiversity in order to lead to (iv) a reference state (called “zero” state).

Keywords: Biodiversity, Phytobenthos, Zoobenthos, Fishes, Algerian Sea

Introduction
MPAs are efficient management tools to protect Mediterranean marine environment. In Algeria, a relative agreement to Costal Planning Plan (PAC) for Algiers costal area has been signed in Algiers between Algerian government and the PNUE in 2001 [1]. The Réghaïa coasts is a representative areas of environment-development problematic; (i) its integration in Algerian metropolitan area in accelerated accretion, (ii) the natural bio-strategic patrimonial importance (RAMSAR) and (iii) the threats that surround (sectorial pressures and intervenants multiplicity) are all factors explaining ecological and socio-economic issues [2].

Materials and methods
The study area is located in the municipalities of Réghaïa and Hraoua, about 30km east of Algiers center (North Africa). It covers an area of approximately 111 ha and covers the spaces between [0 and 20 m] deep near the island Agueli (36°47'39" N - 3°21'7.99" E) (Fig.1). It is the only natural site at the biogeographical zone of Algiers. The sampling was conducted in spring period (March-May, 2015) according to the standardized method of Underwater Visual Census (UVC) and distance-sampling principle [3-5]. For the data representativeness, a sampling random laminate systematic strategy has been suitable.

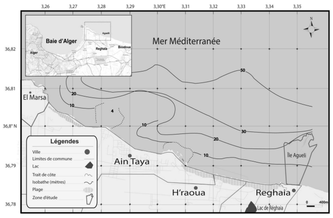

Fig. 1. Map of the study area

Results
The survey results [6] allowed reporting a total of 91 megabenthic species and 42 ichtyologic species divided over 39 sampling stations corresponding to a total surveyed area estimated to 6528 m² (39 transects). The megabenthos qualitatively dominated by Cnidaria (27.78%) and Echinodermata (22.22%) family. The study of ichtyologic population allowed a total abundance of 960 individual essentially dominated by Labridea family, the Sparidae and the Serranidea. Besides the two transects dominated by *Sarpa salpa*, the overall density recorded for 385 individuals was 0.06 ind./m² for a total biomass of 25.35 kg (194g /50m²). The evolution of the megabenthic and fish species richness shows a similar trend dependent on the substrate type (Fig.2).

Discussion
A significant number of ecological, patrimonial, protected statuses, threatened, endemic and invasive species have been observed in the study area. Among them, *Posidonia oceanica* (the extension of its lower limit was observed), *Cystoseira amentacea var. stricta* (endemic species), *Pinna rudis* and *Pollicipes pollicipes* (protected status). Others are classified as invasive species like *Asparagopsis armata*, *A.taxiformis*, *Oculina patagonica* and *Codium fragile* and need to be closely monitored. Bottoms around the Agueli island has a moderately rich fish fauna, compared with results obtained by other authors in the Mediterranean. The demographic stand structure is majority constituted from small individual reflecting overfishing effects (nets, lines and spearfishing), the reproduction success and the importance of the sector as nursery and fry. Moreover, an escape behavior was noted in most of the targeted individuals in the study demonstrating the important spearfishing activity. Among various species observed, *Labrus viridis* is the only one which has an IUCN conservation status of vulnerable (VU).

Conclusion
This study contributed to the enrichment of knowledge and assessment of megabenthic and ichtyological biodiversity around Agueli Island, conducive to the establishment in the near future of a MPA. It’s a reference state (called “zero” state) from which it will be possible to evaluate changes related to dynamics population and the stresses due to global changes as well as the “Island effect” on biodiversity.

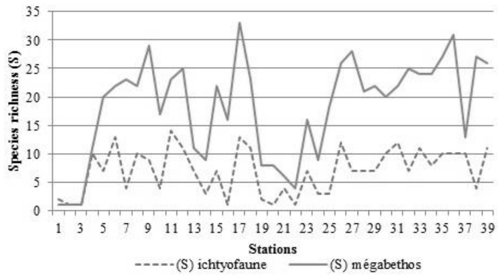

Fig. 2. Evoluation of megabenthic and fish species richeness by sampling station.

References
1 - Meziane, 2005. Programme d’Aménagement Côtier (PAC) "Zone côtière algéroise". Protection des sites sensibles naturels. 138p.
2 - Matev, 2012. Rapport sur la stratégie nationale de gestion intégrée des zones côtières en Algérie et plan côtier de Réghaïa. Rapport de l'atelier de validation de la phase 1. Centre d’Activité Régionale pour le Plan d’Action Prioritaire (PAP/CAR) : 13p.
3 - Harmelin-Vivien M., et Harmelin J. G., 1975. Présentation d’une méthode d’évaluation in situ de la faune ichtyologique. Trav. Sci. Parc nation. Port-Cros. Tome 1 : 6p.
4 - Kulbicki M., Galzin R., Harmelin-Vivien M., Mou Tham G., et Andrefouët S., 1996. Premiers résultats concernant le benthos et les poissons au cours des missions TYPATOLL. Institut de recherche pour le développement. Centre de Nouméa. ISSN 1297-9635., 2000 : 120 p.
5 - Labrosse P., Kulbicki M., Ferraris J., 2001. Comptage visuel de poissons en plongée : conditions d'utilisation et de mise en oeuvre. Secrétariat général de la Communauté du Pacifique (CPS) : 62p.
6 - Bachetarzi R., Benabdi M. et Rebzani-Zahaf C., 2015. Évaluation bioécologique du peuplement ichtyologique et du mégabenthos de l’île Agueli (Wilaya d’Alger). Master Exploitation et Gestion des Ressources Halieutiques. Faculté des Sciences Biologiques/USTHB. 79p.

BENTHIC INDEXES APPLIED TO INTERTIDAL AND INFRALITTORAL ROCKY BOTTOMS IN RELATION TO THE WFD AND MSFD: ASSESSING METRICS

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Abstract

Currently used benthic indexes for the assessment of Good Ecological Status (GEcS) and Good Environmental Status (GenS) according to European legislations (WFD and MSFD) are reviewed. A total of 16 indexes have been found. The most targeted biocenosis are macroalgal communities. A catalogue of indexes with targeted biocenosis and applied metrics is presented.

Keywords: Mediterranean Sea, Biodiversity, Algae, Bio-indicators

An overview of the currently used benthic indexes for the evaluation of the Good Ecological Status (GEcS) of rocky bottoms according to the WFD, and the Good Environmental Status (GEnS) according to the MSFD for European seas, is presented (acronyms used sensu [1]). A bibliographical search was done using online available databases, as well the references from articles. The search included articles published between 2001 and 2016. A total of 16 indexes have been found, which have been develop by different European countries, as well for different water bodies (mainly NE Atlantic and Mediterranean). Intercalibration exercises have been done among countries. Although rocky habitats are exposed to several pressures and impacts, only few evaluations have been done.

The indexes found are (acronyms in alphabetical order): ALEX – Alien Biotic Index; CAI – Coralligenous Assemblages Index; CARLIT-EQR – Cartography of Littoral Rocky Shore Communities; CCO – Cover, Characteristic Species, Opportunistic Species; CFR – Calidad de Fondos Rocosos (Quality of rocky bottoms); COARSE - Coralligenous Assessment by Reefscape Estimation; EEI – Ecological Evaluation Index; ESCA – Ecological Status of Coralligenous Assemblages; HPI – Helgoland Phytobenthic Index; ICS – Index of Community Structure; MarMAT – Marine Macroalgal Assessment Tool; MFCI – Marine Fish Community Index; PAN-EQ-MAT – General Ecological Quality Macroalgal Assessment Tool; QISubMac - Quality Index of Subtidal Macroalgae; RICQI - Rocky Intertidal Community Quality Index; RSL – Reduced Species List.

These indexes target several biocenoses: Macroalgal communities, Coralligenous assemblages, Fish communities and, Intertidal communities. Being Macroalgal communities the most studied with 58.33% of the revised indexes, followed by Intertidal communities with 25%, Coralligenous assemblages with 12.5% and Fish communities with 4.17%. These indexes are usually composed by several metrics, these metrics are combined to result in a number that indicates the status of the water body that is being assessed [2]. A relation of the indexes and their metrics can be found in Table 1.

In this overview we aim to present a catalogue of the different indexes developed for WFD and MSFD, in order to allow other researchers to have a simple but effective comparison of these indexes, mainly for rocky bottom habitats. This review condenses the wide array of benthic indexes that are currently being applied, allowing a comparison of metrics at rocky shores, both intertidal and subtidal, indicating the need of a more reductionist approach to assess Good Ecological Status (GEcS) and Good Environmental Status (GEnS) according to the European legislations.

Tab. 1. Benthic indexes developed for rocky bottoms, intertidal and infralittoral, in relation to targeted biocenosis and applied metrics. Index acronyms see text, WFD – Water Framework Directive, MSFD – Marine Strategy Framework Directive.

Biocenosis	Index	Policy	Regional Sea	Metrics
Coralligenous assemblages	CAI	WFD	NW Mediterranean	Sludge percent cover Percent cover of builders Percent cover of bryozoans
	COARSE	MSFD	NW Mediterranean	Benthic categories percent cover Thickness and consistency of calcareous layer Borer marks Species richness Erect calcified organisms Sensitivity of bryozoans Total cover of species Maximun height Necrosis
	ESCA	WFD & MSFD	NW Mediterranean	Presence/absence and abundance of sensitive taxa/groups Diversity of assemblages Heterogeneity of assemblages
Fish communities	MFCI	MFSD	NE Atlantic	Diversity and composition Abundance Nursery function Trophic integrity
Intertidal communities	CCO	WFD	Atlantic - French Channel	Global cover of macroalgal communities Number of characteristic species per topographic/level community Cover of opportunistic species
	ICS	WFD & MSFD	Atlantic - French Channel	Stratification sub-index Organization sub-index Taxonomic sub-index
	MarMAT-EQR	WFD	NE Atlantic	Species richness Proportion of Chlorophyta Number of Rhodophyta Number of opportunists/ESG1 Proportion of opportunists Shore description Coverage of opportunists
	PAN-EQ-MAT	WFD	NE Atlantic	Species richness Total abundance/cover Opportunistic species abundance/cover
	RICQI	WFD	NE Atlantic	Indicator species Morphologically complex algae Species richness Faunal cover
Macroalgal assemblages	ALEX	MFSD	NW Mediterranean	Abundance of native species Abundance of alien species Abundance of established alien species Abundance of invasive alien species
	CARLIT-EQR	WFD	NW Mediterranean	Presence and abundance of communities
	CFR	WFD	NE Atlantic	Coverage of characteristic macroalgae Fraction of opportunistic species Richness of characteristic magroalgae
	EEI	WFD	E Mediterranean	Abundance of ESG I Abundance of ESG II
	HPI	WFD	North Sea	Species richness Green algae Fucetum Depth limit
	QISubMac	WFD	Atlantic - French channel	Presence/absence of sensitive perennial macroalgae Maximum depth extension Mean density of structuring species Number of characteristic species Mean density of opportunistic species Total number of identified taxa Mean *Laminaria hyperborea* stipe length Mean quantity of epibionts on *Laminaria hyperborea* stipes
	RSL	WFD	NE Atlantic	Species richness Proportion of Chlorophyta Proportion of Rhodophyta Proportion of opportunist species ESG ratio Physical type of shore

References

1 - Borja, A., Elliott, M., Andersen, J. H., Cardoso, A. C., Carstensen, J., Ferreira, J. G., Heiskanen, A-S., Marques, J.C., Neto, J.M., Teixeira, H. Uusitalo, L. Uyarra, M.C, Zampoukas, N. 2013. Good Environmental Status of marine ecosystems: what is it and how do we know when we have attained it? *Marine Pollution Bulletin*, 76(1-2): 16-27

2 - Green, R. and Chapman, P. M. 2011. The problem with indices. *Marine Pollution Bulletin*, 62(7): 1377-1380

INTERTIDAL AND SUBTIDAL ROCKY SHORE SAMPLING METHODS: A REVIEW. ADDRESSING THE NEEDS OF WFD AND MSFD

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Abstract
With European legislations compelling Member States to evaluate their seas, the need of comparable data and methodologies grows. In the intertidal and the subtidal rocky shores, benthic communities (flora and fauna) and macroalgal communities are the most assessed. Strategies and methodologies applied are diverse. Visual censuses are the most used strategy, while quadrats are the most applied methodology. A review of different methods is presented.

Keywords: Mediterranean Sea, Algae, Biodiversity, Bio-indicators

Introduction
As European and international legislations are developed and applied, the necessity of comparable data grows. The European legislations (WFD and MSFD) compel Member States to determine, either, the Good Ecological Status [1], or the Good Environmental Status [2]. Rocky shores gather habitats of great importance, like macroalgal communities, which are among the principal habitats in European seas [3]. The aim of this study is to review sampling strategies and methods used across European countries, for the assessment of intertidal and subtidal rocky shores, in order to provide an overview of sampling methodologies used, and to evaluate their possible gaps.

Material and Methods
A bibliographical search was done using online available databases, key words and applying Boolean modifiers like quotation marks or parenthesis. Scientific peer reviewed articles published from 1999 to 2015 were selected. The search was focused on European countries.A data matrix was created including all relevant information concerning the sampling strategies, methodologies and method size, as well complementary information about geographic location, biocenosis targeted, or depth range, among others.

Results and Discussion
A total of 47 research articles were selected, all related to either intertidal or subtidal rocky shores from European seas. Biocenosis target by research articles are: Benthic communities (algae and fauna), assessed in 48.94% of the revised literature, Macroalgal communities (21.28%), Coralligenous assemblages (14.89%), Intertidal communities (10.64%) and Fish communities (4.26%) (Fig. 1). The demanding of the European legislations is reflected as well the use of macroalgae as water quality indicators.The most applied sampling strategy is visual censuses in 63.93% of the revised articles, followed by Photographic/video surveys with 21.31% (Fig. 2). Several methods are applied, being the most used: quadrats, applied in 45.9% of the revised articles, transects in 13.11%, and areas (of variable surface) in 11.48%. Most methodologies are non-destructive, which allows applying them in marine protected areas (MPA) and in protected communities. Sampling method size greatly differs among studies.

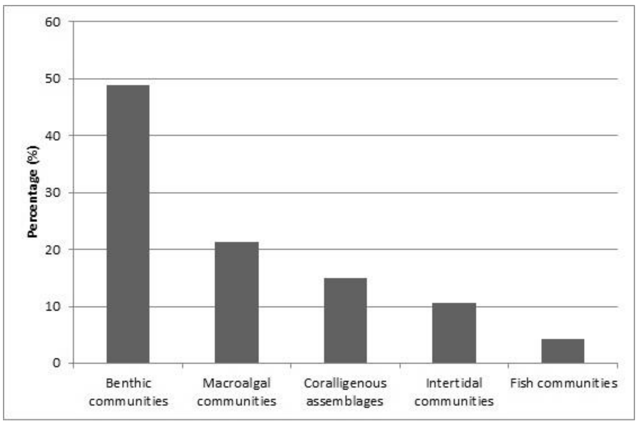

Fig. 1. Percentage of biocenosis targeted to address WFD and MSFD rocky shores extracted from revised literature (n=47 published articles), from 1999 to 2015.

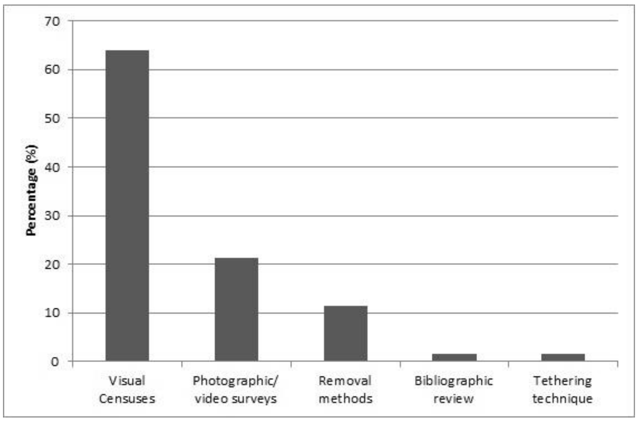

Fig. 2. Percentage of sampling strategy targeted to address WFD and MSFD rocky shores extracted from revised literature (n=47 published articles), from 1999 to 2015.

Data are gathered usually as cover percentage, number of individuals or presence/absence data. Abundance, species richness or diversity are common data calculations, among others. Taxonomic classification for the determination of organisms is done to the lowest level possible, although the use of structural or functional groups is also present in the assessments. Regarding experimental designs, time and space factors are considered, and included to evaluate variability due to this to factors.
These preliminary results highlight the vast array of sampling methods applied in rocky bottoms, indicating the need for standardization of sampling techniques to gather appropriate data for addressing environmental status at European coastal areas.

References
1 - E.C., 2000. Directive 200/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Off.J.E.C.*(22/12/2000)
2 - E.C., 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). *Off.J.E.C.* (25/06/2008)
3 - Mineur, F., Arenas, F., Assis, J., Davies, A. J., Engelen, A. H., Fernandes, F., Malta, E-J., Thibaut, T., Van Nguyen, T., Vaz-Pinto, F., Vranken, S., Serrão, E.A., De Clerck, O. 2014. European seaweeds under pressure: Consequences for communities and ecosystem functioning. *Journal of Sea Research*, 98, 91–108

THE EFFECTS OF INTERFERENCE INTERACTIONS ON FISH COMMUNITIES AS ASSESSED BY BAITED REMOTE UNDERWATER VIDEOGRAPHY (BRUV)

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Abstract

Interference competition can exclude subordinate species from habitats and alter community structure. An example is the predatory release of mesopredators resulting in changes in their prey and competitor community. Baited, remote, underwater videography is a powerful census tool that can be biased if dominance excludes species from view. At interspecific encounters during BRUV deployments in the Adriatic Sea, Croatia, no such general bias occurred. BRUVS detected few negative co-occurrences for species pairs and they rarely interfered at opportunities near the bait. Most species pairs positively co-occurred and were unique for each habitat type, which indicates that habitat heterogeneity plays an important role in driving fish biodiversity.
This research was supported by the Croatian Science Foundation under the project COREBIO (3107).

Keywords: Fish behaviour, Biodiversity, Competition, Monitoring, Mediterranean Sea

Every species has a fundamental niche which then is reduced to its realized niche by mechanisms such as predation, source-sink dynamics, and competition. One possible outcome of competition is the exclusion of a species from a patch of resources by another species, e.g. by a combination of intense interference competition and superior resource exploitation [1]. Interspecific interference competition may bias the community structure inferred from fish censuses because of behaviorally induced negative co-occurrences at sampling stations [2]. Such mechanisms can be best detected when the census method allows for observations of individuals' behaviour in combination with unbiased measures of community descriptors. Non-consumptive methods that provide direct observations of fish within their occupied habitats, such as diver visual census and remote video-based methods, are increasingly popular [3]. They are recognized capable of providing high statistical power because they allow collection of large sample numbers with little time, cost, and effort. While biases relating to type of bait and the resulting bait plume within the BRUV method are well studied, little is known about the effects of competitive interference between fish at the bait station. Our research was motivated by three major questions: 1. Are interspecific interference interactions and negative co-occurrences commonly detected at BRUV stations? 2. Can negative co-occurrences of species pairs be explained by the interspecific interference behaviours observed for such pairs? 3. Do interspecific interferences at BRUV stations create a method bias that over-counts aggressive/dominant species and under-counts submissive/subordinate species?

Two independent datasets were generated from two collections of BRUV video footages generated in 2012/13 and 2014/15 at 3/25 and 9/12 locations/deployments. In the first we purposefully searched for pairs of fish in interference interactions (121 found) and from the same videos we collected community descriptors, including diversity, richness, and relative abundance at the BRUV. In the second study we chose random individuals, followed their path through the camera view-field, noted and observed all encounters (840 found), and calculated the probabilities of encounters with interspecific interferences (167 found). A total of 32 fish species were observed.

Of the encountering fish pairs observed, 79 % lacked any interaction, the two individuals in each pair showed consistent neutral behavior and there was no indication of dominance or subordination. Of the species-pairs observed in interference interactions, the only significantly aggressive/dominant species were *Serranus scriba*, *S. hepatus* and *Coris julis*, all three are mesopredators. The only significantly submissive/subordinate species were *Symphodus tinca*, *Spicara smaris*, and *Symphodus cinereus*, all of which were commonly observed in the BRUV's field of view. We calculated Pearson product-moment correlation coefficients, testing the hypothesis of no relationship using t-distribution. The only significant negative co-occurrence pairs found were *Diplodus annularis*/*Serranus hepatus* (-0.51, p = 0.006), *D. annularis*/*Coris julis* (-0.62, p = 0,04), *D. annularis*/*Symphodus cinereus* (-0.75, p = 0.02), and *Symphodus melanocercus*/*Coris julis* (-0.75, p = 0.03). None of these pairs had a high probability of engaging in interference interactions. An analysis of species-specific arrival times at the BRUV revealed that *Diplodus annularis* appears consistently and significantly later at the BRUVs than the three species with which it has significant negative co-occurrences. On the basis of our study it can't be determined if this temporal negative co-occurrence is due to avoidance learned from past interferences or caused by other unknown behavioral traits. *D. annularis* has been found to be an aggressive species when provoked but almost all interferences observed in our two studies were intraspecific. We found many significantly positive co-occurrences in all habitat types. Almost all were unique to a particular habitat type, indicating habitat-consistent assemblages. The only potential for bias in our BRUV–based censuses caused by species interactions may be related to the high abundances of a few schooling species, such as *Boops boops*, *Spicara maena*, and *S. smaris*. These typically arrive in large and active groups, display primarily intraspecific interferences, and tend to stay near and circle around the bait throughout the deployment, which physically crowds access to the bait by other species. This situation, however, does not result in negative co-occurrences. Rather, other species remain active in the field of view of the BRUV and can be positively correlated with these gregarious species. One other similar case of bait occupation is the presence of *Muraena helena*, a large sneak-and-attack predator. Once settled at the bait it will frequently feed off the bait through the remainder of the deployment, however no aggressive approaches of other species and no avoidance by other species have been observed, in fact other species benefit from the clouds of smaller bits of bait generated by *M. helena*.

Overall we conclude that interference is not common at BRUV even when the density of fish around the bait is high, there is little indication for bias in favour of aggressive and against submissive species in fish censuses by BRUV, and negative co-occurrences are rare and not matched by frequent interspecific aggression. However, the inclusion of observations from deployments with large schools of gregarious fish and large predators which physically limit access to the bait should be considered with care. We also conclude that BRUV is capable of censusing a substantial portion of the fish community and of recognizing habitat specific assemblages that are consistent across samples within and among locations 10s-100s km apart.

References

1 - Reitz SR, Trumble JT. 2002. Competitive displacement among insects and arachnids. Annual Review of Entomology 47: 435–465.
2 - Stoner, A.W 2004. Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. Review paper, Journal of Fish Biology 65, 1445–1471.
3 - Harvey E.S., McLean D. L., Frusher S. , Haywood M. D. D. , Newman S. J., Williams A. 2012. The use of BRUVs as a tool for assessing marine fisheries and ecosystems: a review of the hurdles and potential. University of Western Australia (publisher).

A MIGRATION GAME MODEL FOR HABITAT CONNECTIVITY OF HIGHLY MIGRATORY SPECIES

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Abstract

A migration game model is suggested to resolve adaptive migration in direction of increasing fitness over a complex global network of distant habitats. Many factors contribute to the migration process of highly migratory species and of primary importance are individual and collective dynamics regulating intra-specific competition and habitat selection processes. When applied to the Atlantic bluefin tuna the model predicts patterns of migration resembling those commonly observed for this species and predicts new migratory routes under future climate change scenarios. The resulting dispersal and migration dynamics can affect connectivity between distant habitats having implications for future fishery management and conservation of the species.

Keywords: Tuna, Habitat, Migration, Mediterranean Sea, North Atlantic

Movement of organisms is a widespread phenomenon in nature and it happens at all scales from bacteria moving in chemical gradients, to plankton searching for food and mates, to fish and birds travelling thousands of kilometers between distant habitats. The behavioral traits regulating movement and the ability of marine organisms to perform long distant migrations are largely unknown but when moving in large groups, are likely dependent on a balance between individual preferences and collective decisions processes. Feeding and spawning migrations between widely separated but geographically stable locations raise several questions on the ability of species moving in groups or in isolation to store information on often-complex routes as well as on the level of adaptation of the individuals to environmental changes and anthropogenic pressures.

It has been hypothesized that collective memory, transmission of social information and decision-making processes might all play an important role in migratory behavior for a large range of fish species and can regulate connectivity between distant habitats [1, 2]. Moreover, fitness based arguments are commonly used to describe the process of habitat selection in migrating populations. When moving between different habitats, individuals should prefer those sites that provide them with the highest payoff, i.e., where their fitness is maximized [3]. Nevertheless, both fitness and habitat selection typically depend on interactions among individuals, which usually have the form of a density dependent relation linking habitat quality and species distribution. Under negative density dependence, if dispersal is cost free and individuals are omniscient and free to settle at any habitat, the evolutionarily stable strategy corresponds to the ideal free distribution (IFD) [4]. At the IFD, payoffs in all occupied habitats are the same and larger or equal than those in the unoccupied habitats. Thus, no individual can improve its fitness by choosing a different habitat. Difference in competitive ability of the individuals, as well as constrains in habitat connectivity imposed by geographical (e.g., topography) or temporal (e.g., seasons) patterns can however prevent the applications of IFD theory to species performing long distance migrations.

A migration game approach has been suggested for those species migrating in a complex network of connected habitats subject to seasonal changes [5]. The approach describes population-migration dynamics in age-structured populations and in temporally varying environments and is able to predict species distribution and migratory routes for a large range of organisms.

When used to describe the seasonal migration of the Atlantic bluefin tuna, results show how changes in the resource level, population demography and cost of migration, can alter population distribution across large distances [5]. The model can also simulate future scenarios of migrations (Figure 1). Using values of habitats payoffs derived from climate models simulating tuna habitat index [6] the migration game predicts that only some subsets of the available routes on the network are effectively selected as migratory pathways, while many other routes are not utilized (Figure 1a). Moreover, the model predicts the emergence of new migration routes in the future, in particular towards Greenland and the recover of a lost historical migration route towards the northern North Sea (Figure 1b).

Bluefin tuna is a highly migratory species, and migrates across ocean zoning boundaries of several jurisdictions, and also across stock management boundaries, migration models that quantify rates and timing of exchanges among areas could potentially have practical application in fishery management and conservation.

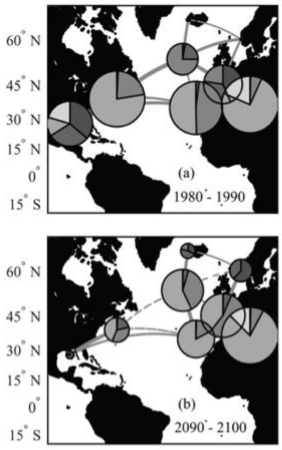

Fig. 1. Predicted distribution of bluefin tuna biomasses and migration routes between North Atlantic habitats in the period (a) 1980 – 1990 and (b) 2090 – 2100. Different age classes have different colors: from young of the year (light gray) to mature large individuals (dark gray). Connection lines indicate migration routes; dashed line are available route not used for migration.

References

1 - De Luca G, Mariani P, MacKenzie BR, Marsili M. 2014. Fishing out collective memory of migratory schools. J. R. Soc. Interface 11(95): 1742-5662.

2 - Petitgas P, Secor DH, McQuinn I, Huse G, Lo N. 2010 Stock collapses and their recovery: mechanisms that establish and maintain life-cycle closure in space and time. ICES J. Mar. Sci. 67, 1841–1848.

3 - Rosenzweig ML 1981 A theory of habitat selection. Ecology 62 (2): 327–335.

4 - Fretwell SD, Lucas HL 1969, On territorial behavior and other factors influencing habitat distribution in birds. Acta Biotheor 19 (1):16–32.

5 - Mariani P, Krivan V, MacKenzie BR, Mullon C. 2015. Migration game in habitat network: the case of tuna. *Theor. Ecol*. DOI: 10.1007/s12080-015-029.

6 - Lehodey, P, Senina, I, Sibert, J, Bopp, L, et al., 2010. Preliminary forecasts of Pacific bigeye tuna population trends under the A2 IPCC scenario. Prog. in Ocean., 86(1), pp.302-315.

EUNIS HABITAT CLASSIFICATION OF A POTENTIAL MPA, SILE -TURKEY (WESTERN BLACK SEA)

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Abstract
Sile region was the Pilot Project (PP) area of the EU-FP7 project, CoCoNet and proposed as one of the potential MPAs along the Turkish Black Sea coast. This study aimed to describe the habitat types according to EUNIS. Three coastal and 12 marine habitats were determined along the coasts and littoral zone of Sile PP area.

Keywords: Biodiversity, Infralittoral, Supralittoral, Black Sea

Introduction
The Black Sea has been through dramatic ecosystem changes during the last five decades and still faces several problems mostly originated by anthropogenic activities [1]. Marine Protected Areas are recognized as one of the most effective methods for the recovery of marine ecosystems. Numerous MPAs and reserves have been designed by Black Sea coastal states, such as Zernov's *Phyllophora* Field Botanical Reserve in Ukraine or Danube Delta Biosphere Reserve in Romania [2]. Turkey has not officially designed MPAs along its Black Sea coastline. Ozturk at al. [1] proposed five MPAs, including Sile region, along Turkish Black Sea coasts based on criteria specified by the Convention of Biological Diversity. Sile region is also known to host cetacean populations [3]. Sile region is a Pilot Project (PP) area of the EU-FP7 project, CoCoNet (GA No: 287844). The aim of this study was to describe the habitat types present along Sile coastline which is a potential MPA in the Turkish Black Sea coasts, according to Habitat Classification guidelines developed by EUNIS.

Material and Method
The coastline was observed from a boat while the underwater landscape was investigated by SCUBA diving. A coastline of 10 nm was studied in total (Fig.1). Species of typical communities in the area were sampled and preserved in %4 formalin solution. The identifications of the samples have been done in the I.U. Fisheries Faculty Marine Biology Laboratories.

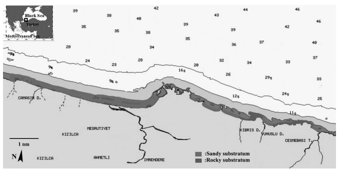

Fig. 1. Location of the Sile Pilot Project Area

Results and Discussion
Three main coastal habitat types and 12 marine habitats were determined along the coasts and littoral zone of Sile PP area. The Western part of the coastline was mostly characterized by sandy beaches with some subtidal rocks. The central and western parts constituted mainly by rocky substratum with few small sandy beaches. The sublittoral zone has a very slowly descending structure and depths over 20 m are attained almost 2 - 3 km away from the coastline.

Coastal Habitats: B1.24 : "Sandy beach ridges with no or low vegetation": The section between the central and western edge of the PP area consists of fine sands mixed with fragmented shells and gravels (Fig.2a). B3.26 : "Mediterraneo-Pontic sea-cliffs and rocky shores": Sea-cliffs with ledges and caves, rocky shores and isolated rocks are found particularly along the eastern coast of Sile PP area. B3.11 : "Lichens or small green algae on supralittoral and littoral fringe rock": Lichen communities form zones or bands in the splash zone on some rocky shores along the western coast of Sile PP area.

Marine Habitats: A1.163 "Pontic ephemeral patchwork of green and red algae with Mytilaster and Mytilus": These habitats are common in the central and western parts of the Sile PP area. A1.166 "Pontic mediolittoral barren rock scoured by sand": Rocks and boulder piles are present on the midlittoral rocky shores and as part of the rocky cliffs. These rocky forms are typically observed in the eastern part and also sparsely in the central area (Fig. 2c). A2.22 "Barren or amphipod-dominated mobile sand shores": The sand is duned or rippled as a result of wave action at some points along the western part. A1.44C "Pontic mediolittoral caves with *Hildebrandia, Phymatolithon, Lithophyllum*, bryozoans, *Pachygrapsus, Eriphia*": Large to medium size rocks appear out of the sea level and are covered by waves depending on the sea condition. This kind of habitats is observed especially in the eastern part of the area (Fig. 2g). A2.613 "Pontic *Zostera marina* and *Zostera noltii* meadows":*Zostera* meadows were observed at the entrance of the Sile harbor in the central area. A3.23N "Pontic ephemeral mosaic of green and red seaweeds on moderately exposed or sheltered infralittoral rock (*Enteromorpha, Ulva, Ceramium, Cladophora, Gelidium, Callithamnion, Corallina*)": The infralittoral rocks covered by photophilic algae constitute a very common habitat type in the central and eastern part of the area (Fig. 2f). A3.23M "Pontic association with *Cystoseira barbata* and *Ulva rigida*": This habitat is common along central and eastern parts. A3.241 "Pontic *Mytilus galloprovincialis* beds on infralittoral rock": *M. galloprovincialis* is one of the most common organisms in the Black Sea coast of Turkey (Fig. 2d). A3.742 "Pontic caves dominated by sponges *Dysidea sp.* and *Haliclona sp.* with crustose corallines, *Actinia equina*, and *Hemimysis sp.*": A number of submerged caves characterized with this habitat are present in the eastern and central areas of the Sile PP area (Fig. 2e). A3.743 "Pontic cave entrances with *Palaemon elegans, Actinia equina, Pachygrapsus marmoratus* and *Eriphia verrucosa* and little sponges": This is a very typical habitat along the central and eastern parts of the Sile PP area. A5.247 "Pontic thalassinid-dominated muddy sands with *Upogebia pusilla*": This habitat is present from the beginning of sandy infralittoral zone to 30 m depth. A crustacean *Paguridea* (sp), an important bioturbator organism, and *Chamelea gallina* were also observed in the area (Fig. 2b). A5.2374 "Pontic shallow clean fine sands with *Chamelea gallina, Lentidium mediterraneum* and *Divaricella divaricata*": This habitat has been commercially exploited in the region between 1985 and 2000.

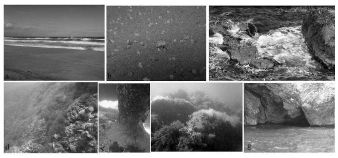

Fig. 2. EUNIS Habitat types defined along Sile Pilot Project Area

References
1 - Öztürk B., Topaloglu B., Kideys A.E., Bat L., Keskin Ç., Sezgin M., Öztürk A.A., Yalciner A.C. 2013. A proposal for new marine protected areas along the Turkish Black Sea coast. J. Black Sea/Mediterr. Environ. 19 (3): 365?379
2 - Begun T., Muresan M., Zaharia T., Dencheva K., Sezgin M., Bat L., Velikova V. 2012. Conservation and Protection of the Black Sea Biodiversity. EC DG Env. MISIS Project Deliverables. www.misisproject.eu
3 - Öztürk B., 1988. Black Sea Biological Diversity. Environmental Series Vol. 9. UN Publications, New York. 144pp.

CIESM Congress Session : Soft-bottom ecology

Moderator : Tom Moens, Biology Dept., Ghent Univ., Belgium

Moderator's Synthesis

The moderator focused his introduction on key ecosystem services (ES), such as the mineralization of organic matter, which link to other marine ES such as food production and carbon sequestration. Ecosystem services provide one way of assessing the 'value' of marine ecosystems and to 'brand' ecological research. They are affected by community composition as well as by species diversity, although the relation between them is rarely straightforward and heavily depends on the system studied. An improved mechanistic understanding of that relationship is much needed. But while a majority of studies to this end focus on single processes or functions, ES are inherently multifunctional.

Hitherto, most pertinent research has either focused on monitoring particular ES with a limited understanding of the supporting processes and functions, or – vice versa – on a detailed understanding of specific processes and functions, with a limited understanding of how this should translate in rates of ES. Similarly, while most research has focused on the effects of single stressors in isolation, organisms live in multistressor environments, and the response to a single stressor may deviate profoundly from the response of the same organism to that same stressor but in combination with other stressors. Both of these key issues highlight the necessity (a) to bridge the gap between laboratory-scale, single-impact or single-function studies and the real-life complexity of ecosystem responses to a multistressor environment, and (b) to maximize our mechanistic understanding of community functioning and its responses to stress.

In the discussion that followed the different pitch presentations, several participants emphasized that the gap between measuring ES and investigating the underlying factors is even larger for the system(s) they study, because baseline information on community composition, biodiversity and taxonomy are often lacking. There is clearly an urgent need for baseline research and baseline information in several areas, to describe the multitude of soft-bottom invertebrates which are new to science and to investigate little described systems. Unfortunately funding for baseline biodiversity research, such as taxonomy and description of community composition patterns, is extremely limited.

Another issue that emerged from the discussion is the question whether and when biodiversity conservation needs to be a prime management goal. The trigger for this discussion was the correct observation that one should not over-generalize the positive relationships between biodiversity and ES. In fact, particularly at local scales, certain ES may score better in lower-diversity communities. As such, scientists should take a diversified stand towards ecosystem management and not automatically enter it from a single perspective, be it that of biodiversity per se of that of particular ES. On a larger geographical scale, this may require locally diversified management strategies.

EXPLORING INSHORE/OFFSHORE PATTERNS OF VARIABILITY IN SOFT-SEDIMENT MACROFAUNAL ASSEMBLAGES IN THE OLIGOTROPHIC RED SEA

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Abstract
Information available for soft-sediments in the oligotrophic Red Sea is almost inexistent. To contribute to a better knowledge of the inshore/offshore patterns of macrobenthic diversity, biological and environmental samples were taken twice in the winter of 2014. Stations were established at increasing depths (~22° N) in two areas: i) inshore (lagoon; three stations); and ii) offshore (nearby coastal area; nine stations). Macroinvertebrate abundance and number of taxa decreased with depth, which was found to be one of the main drivers structuring the distribution patterns of benthic assemblages. Compared to other regions, assemblages were characterized by high biodiversity and low abundances, hence high equitability, which may result from the oligotrophic conditions and low levels of anthropogenic disturbance in the study area.

Keywords: Biodiversity, Sediments, Red Sea

The Red Sea is a semi-enclosed sea connected to the Mediterranean Sea through the Suez Canal. Like the Mediterranean, it is an oligotrophic environment but experiencing higher salinity (37-42) and temperature (21-32°C) (1). Despite these extreme conditions, high levels of biological diversity have been reported. This study provides new insight into the patterns of spatial variation in macrobenthic assemblages across an inshore/offshore gradient in the Red Sea. This study comprises two main areas: an inshore area (a coastal lagoon), and the nearby coastal area. Three stations were established in the lagoon, two in seagrass meadows (mainly *Enhalus acoroides*) and one in the channel (10m depth) that connects the lagoon to the coastal area. Nine stations were established towards the offshore from 25 to 90m. We identified 1161 organisms (133 taxa, 110 families and 10 phyla).

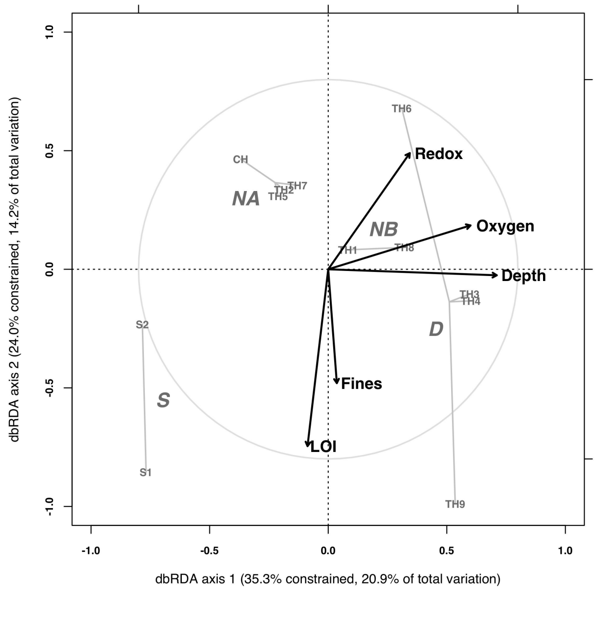

Fig. 1. Distance-based redundancy analysis (dbRDA) ordination plot based on a set of environmental variables and macroinvertebrate data the Red Sea (Thuwal, Saudi Arabia).

The distance-based redundancy analysis (dbRDA, Fig. 1) results showed that environmental gradients explained a significant part of the biological variability (59.3%). Depth was the main environmental driver, separating the stations into five assemblages: seagrass meadows (S), associated to high percentage of fines and organic matter content (LOI), two groups in the nearshore (NA and NB) and offshore deeper stations (D). Higher abundance and number of taxa were recorded in seagrass meadows and group NA, decreasing towards the deepest stations (D) (Fig. 2). It is worth noting that, as depth can be related to changes in the environment that may be reflected in the physical stress by the wind and waves (2 and references therein), one cannot assume it is the sole "causative" effect of the animal distributions.

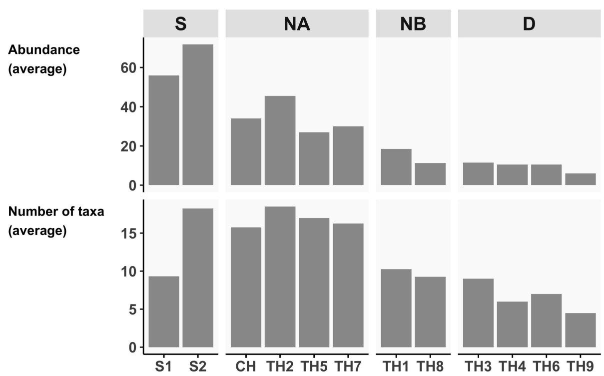

Fig. 2. Distribution patterns of abundance and number of taxa in the study area.

Several taxa, namely Lumbrineridae, Eunicidae, Cirratulidae, Capitellidae and Callianassidae are present at all sampled depths. Sipunculida were present in most stations but were more abundant in the seagrass meadows.

Some taxa were mainly associated with the nearshore areas, namely the polychaete families Amphinomidae, Magelonidae, the crustaceans Macrophthalmidae, and *Ampelisca* spp., as well as the sea urchins *Metalia persica* and *Paraster gibberulus*. The molluscs *Barbatia foliata*, Veneridae sp., and *Ancilla* sp. were associated to the seagrass meadows, which may be related to the trapping effect of the plants. In opposition to most studies from temperate regions, abundances were comparably low. Being one of the few studies undertaken in this sub-tropical sea, the present study makes a relevant contribution to the ecological and environmental drivers of the soft-sediment assemblages and provides baseline data that can be used in future monitoring. At the regional level, these baseline data will help assessing the ecological impacts resulting from the expansion of nearby urban areas that are expected to occur in the near future.

References
1 - Sofianos, S.S. and Johns, W.E., 2002. An oceanic general circulation model (OGCM) investigation of the Red Sea circulation, 1. Exchange between the Red Sea and the Indian Ocean. J Geophys Res-Oceans, 107, 3196.
2 - Carvalho, S., Cunha, M.R., Pereira, F., Pousão-Ferreira, P., Santos, M.N. and Gaspar, M.B., 2012. The effect of depth and sediment type on the spatial distribution of shallow soft-bottom amphipods along the southern Portuguese coast. Helgoland Mar. Res., 66: 489-501.

COMPARISON OF ECOLOGICAL QUALITY STATUS EVALUATED BY SOFT-BOTTOM MACROFAUNA AND BY FORAMINIFERA ALONG A SEWAGE OUTFALL TRANSECT IN CALVI BAY, CORSICA

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Abstract
In Calvi Bay (Corsica, France), comparison of ecological quality statuses obtained by foraminifera and soft-bottom macrofauna studies is done along an outfall transect during two seasons. Depending of the macrofauna index calculated, results are comparable with the foraminifera's index or more precise. More samples are needed to confirm those preliminary results.

Keywords: Ligurian Sea, Zoobenthos, Foraminifera, Sewage pollution, Monitoring

Introduction
The water quality statuses are defined according to different physico-chemical and biological indicators among which soft-bottom fauna. Several biotic indices based on soft-bottom macrofauna are traditionally used [e.g. 1, 2]. More recently, a foraminiferal index has been developed for the Mediterranean Sea [3]. Thanks to the STARE-CAPMED research program [4], we were able 1) to compare Ecological Quality Status (EQS) based on macrofauna and foraminiferal biotic indices and 2) to validate a new macrofauna index adapted to Corsica habitats [5]. This study is located in Calvi Bay (NW Corsica) with samples done twice a year, in May and in September. This is a presentation of the first year results 2013.

Material and methods
Four stations were sampled (35-40 m water depth): three along a sewage outfall transect (Source, Middle, Far) and one out of human influences (Ref). In each station, triplicate cores were sampled for foraminifera and triplicate grabs were sampled for macrobenthos. Supplementary cores were sampled for sediment analysis. In the lab, the first cm of each core was sampled and stored in Rose Bengal/Ethanol solution for foraminiferal analyses. Sediment was sieved and organisms were sorted, identified and analyzed from the 150-500 µm size fraction, the index proposed by [3] was calculated. For soft-bottom macrofauna, sediment was sieved (1 mm mesh size) and preserved in 5-10% formaldehyde solution. Organisms were sorted and identified until the lowest level with WORMS as reference list. AMBI and M-AMBI were calculated as well as the J'MAMBI proposed by [5]. TOC (%), OM (%) and grain size analysis were performed by an accredited lab.

Results and discussion
The sediment characteristics allowed identification of different habitat weakly to moderately enriched in OM and TOC (Table 1).
In all foraminiferal samples, tolerant species are almost absent whereas pollution-sensitive species dominate the assemblages. The EQS evaluated by the Foram Index are high for all stations before and after summer (Table 1).

Tab. 1. Main characteristics of the sediment and Ecological status for Foraminifera and Macrofauna along the outfall sewage transect in May and September 2013 in Calvi Bay (STARE-CAPMED research program). CS: Coarse Sand, FS; Fine Sand, +35: depth more than 35 m; EQS: Ecological Quality Status

		May 2013				September 2013			
		Source	Middle	Far	Ref	Source	Middle	Far	Ref
Sediment	Median (µm)	1203.6	525.4	123.1	685.1	1023.5	179.9	117.8	773.8
	TOC (%)	0.33	0.27	0.21	0.661	0.524	0.523	0.442	0.524
	OM (%)	1.46	2.02	1.09	2.22	2.35	2.14	1.83	3.49
	Fraction < 63 µm	5.46	5.81	12.64	11.78	10.22	10.69	17.27	7.67
	Habitat	CS+35	CS+35	FS +35	CS+35	CS+35	FS +35	FS +35	CS+35
Foraminifera	Foram Index	2.16	0.50	1.13	0.99	1.87	1.28	2.08	0.48
	Foram Index EQS	High	High	High	High	High	High	High	High
Macrofauna	AMBI	1.38	1.39	1.40	1.42	0.56	1.55	1.51	1.54
	AMBI EQS	Good	Good	Good	Good	High	Good	Good	Good
	M-AMBI	1.01	0.95	0.98	0.88	0.87	0.87	0.85	0.88
	M-AMBI EQS	High	High	High	High	High	High	High	High
	J'	0.84	0.88	0.83	0.82	0.53	0.90	0.87	0.83
	J'MAMBI	0.85	0.83	0.81	0.73	0.46	0.79	0.74	0.72
	J'MAMBI EQS	High	High	High	Good	Moderate	Good	Good	Good

The soft-bottom macrobenthos assemblages are dominated by pollution-sensitive to tolerant invertebrates. The AMBI or M'AMBI EQS are good or high for all the stations. The M-AMBI gives the same evaluation as the foraminiferal index whereas AMBI give slightly lower quality statuses. The J'MAMBI EQS are slightly higher in May than in September (Table 1). Results are good or high except for Source Sept 13 where the status is moderate. In this time the high abundance of the sipucilian Aspidosiphon mullerei could be responsible of this unbalanced assemblage. Therefore, the J'MAMBI seems to be more sensitive than the other indices in this study area and could highlight small perturbation of the ecosystem.
The preliminary foraminiferal analyses of 2014 samples show a degradation of the ecosystem especially after the touristic period. Further analyses and comparisons of the different indices will confirm those preliminary results.

Acknowledgment
This study was funded by Agence de l'eau RMC and Collectivité Territoriale Corse.

References
1 - Borja Á., Franco J. and Pérez V. (2000). A Marine Biotic Index to Establish the Ecological Quality of Soft-Bottom Benthos Within European Estuarine and Coastal Environments. Marine Pollution Bulletin 40(12): 1100-1114.
2 - Muxika I., Borja Á. and Bald J. (2007). Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive. Marine Pollution Bulletin 55(1-6): 16-29.
3 - Barras C., Jorissen F. J., Labrune C., Andral B. and Boissery P. (2014). Live benthic foraminiferal faunas from the French Mediterranean Coast: Towards a new biotic index of environmental quality. Ecological Indicators 36: 719-743.
4 - Michel L., Abadie A., Binard M., Biondo R., Borges A., Collignon A., Champenois W., Chéry A., Donnay A., Gobert S., Goffart A., Hecq J.-H., Pelaprat C., Pere A., Plaza S., Thomé J.-P., Volpon A. and Lejeune P. (2013). STARE-CAPMED (STAtion of Reference on Change of local and global Anthropogenic Pressures on Mediterranean Ecosystems Drifts): Rapport d'activité - Année 2012. STARESO SAS.
5 - Donnay A., Pelaprat C., Lejeune P. and Gobert S. (in prep). J'MAMBI, an adapted index to define the Ecological quality status of the marine environment based on soft-bottom macorbenthos in Corsica.

THE POPULATION DYNAMICS AND FISHING STATUS OF *NEPHROPS NORVEGICUS* (L.) IN THE NORTHERN AEGEAN SEA

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Abstract
This research was conducted in Northern Aegean Sea at especially around Gökçeada island between 2010-2014. Norway lobster samples were collected by various commercial bottom trawler. A total of 232 Norway lobster were sampled. The mean carapace length 16,2 mm in females, 19,2 mm in males were determined. The CPUE was calculated 2,3 (kg/h).

Keywords: Crustacea, Aegean Sea, Fisheries, Saros Bay

Introduction
Nephrops norvegicus is a widespread species that is found in commercial quantities throughout its range ranging from Iceland, the Faroes and Norway in the north of its range, to the Atlantic coast of Morocco in the south including the west and central region of the Mediterranean, but is absent from the eastern Mediterranean, the Baltic Sea, the Bosphorus and the Black Sea [1]. *Nephrops norvegicus* has been assessed as Least Concern [2]. It is commercially harvested as a food source. The greatest threat to this species is the commercial scale harvest for human food across. It is a sedentary lobster which inhabits burrows constructed in muddy subtrates throughout the continental shelf of the north-eastern Atlantic and Mediterranean

Material and Methods
This research was conducted in Northern Aegean Sea at especially around Gökçeada island between 2010-2014 (Fig 1). Norway lobster samples were collected by various commercial bottom trawler. A total of 78 hauls were carried out between 130 and 480 m depth. Carapace lengths were measured to the nearest 0.01 mm with a caliper. Total weight was measured to the nearest 0.01 g. The biomass values and frequency of Nephrophs individuals were calculated and compared to others studies from Northern Aegean Sea.

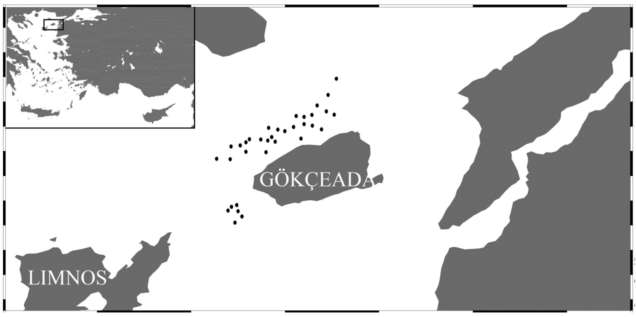

Fig. 1. Sampling stations of Norway lobster in the Northern Aegean Sea.

Results and Discussion
Due to its ecological demands for particular sediments, it has a very patchy distribution and is divided into over 30 populations [3]. *N. norvegicus* is considered commercial important species for Turkey. Rose shrimp (*Parapenaeus longirostris*)and Norway lobster (*Nephrops norvegicus*) are the two main target crustaceans for the demersal trawl fleet in the international waters of the Aegean Sea [4]. Highest biomass of *N. norvegicus* in Saros Bay (the northeastern Aegean Sea) was recorded as 433.22 (kg/m^2) for Spring time [5]. Table 1 shows that the biomass of *N. norvegicus* in this study between 2010-2014 years and other two studies. Add to that it gives carapace length. In this study, a total of 232 Norway lobster were sampled. The mean carapace length 16,2 mm in females, 19,2 mm in males were determined. The CPUE was calculated 2,3 (kg/h) (Table 1) It clear that biomass and mean carapace length decreased year by year. The reason for this might be overfished and commercial trawl codends size (44 mm diamond) in Northern Aegean sea. Compilation of field data usually by scientists from fishermen can offer valuable insight into the bias resulting from data collection procedures. Fishermen's associations is uncertain. So fisheries studies must based on data supplied directly the field.

Tab. 1. The CPUE (kg/h) and female-male carapace length of Nephrops norvegicus.

	Northern Aegean Sea (1996) (Oray et al 2000)	Saros Bay (2005-2008) (İşmen et al 2013)	Gökçeada Island Present Study (2010 - 2014)
CPUE (kg/h)	No data	10,58	2,3
Mean carapace length	30,2 - 30,7	38 - 42	16,2 - 19,2
Maximum carapace length m (F -M)	54,3-58,9	59 - 72	22,1 - 23,1
Minumum carapace length mm (F -M)	12,1 - 12,8	21 - 23	10,4 - 11,2

References
1 - Holthuis L. B. 1991. "*Nephrops norvegicus*". *FAO Species Catalogue, Volume 13. Marine Lobsters of the World*. FAO Fisheries Synopsis No. 125. Food and Agriculture Organization. ISBN 92-5-103027-8.
2 - Bell, C. 2015. *Nephrops norvegicus*. The IUCN Red List of Threatened Species 2015
3 - Bell M. C., Ian Tuck (2006). "*Nephrops* Species". In Bruce F. Phillips. *Lobsters: Biology, Management, Aquaculture and Fisheries*. Wiley-Blackwell. pp. 412–461. ISBN 978-1-4051-2657-1.
4 - Tokaç, A., Özbilgin, H., Kaykaç, H. 2009. Alternative codend designs to improve size selectivity for Norway Lobster (*Nephrops Norvegicus*) and rose shrimp (Parapeneaus longirostris) in the Aegean Sea. Crustaceana 82 (6): 689-702.
5 - Ismen, A., Inceoglu, H., Arslan, M., Yigin, C. C. 2013 Distribution And Population Structure Of Norway Lobster (*Nephrops Norvegicus* Linnaeus, 1758) In Saros Bay (North Aegean Sea, Turkey). *Rapp. Comm. int. Mer Médit., 40, 2013*
6 - Oray I, Deval M. C., Karakulak S., Ates C., Gönül M., Kahraman A., Aliçli T. Z. 2000. Growth of the Norway lobster in the Norther Aegean Sea. Journal of Fisheries and Aquatic Sciences. 17:3-4 Pg 85-93 (in Turkish)

FIRST INVESTIGATION ON THE REPRODUCTIVE TRAITS OF *TRACHINUS RADIATUS* CUVIER, 1829

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Abstract
Reproductive traits of the exploited stock of *Trachinus radiatus* were studied for the first time in the Gulf of Tunis; results are also new for all its area of distribution. The global sex-ratio was biased towards females. No significant difference between mean size of males and females was found. The sexual activity period was between May and September. Best condition was in spring and summer and worst was in autumn and winter. Length at first maturity was estimated as LT_{50} = 21.9 cm.

Keywords: Gulf of Tunis, Fishes, Reproduction

Introduction
Trachinus radiatus is a by-catch species in the Gulf of Tunis. In recent years, the decline of fish resources and the high demand of fishery products increased interest in a greater variety of other stocks as the starry weever one. The only available work focusing on this species, on a local and global scale, was done by the present authors, and gives data on its morphometric characteristics and population structure in the Gulf of Tunis [1]; this have prompted a first investigation on some of the reproductive traits of *T. radiatus* in the same area. Sex-ratio, gonadosomatic index (GSI), hepatosomatic index (HSI), sexual activity period, condition factor (K_C) and length at first maturity (LT_{50}) were then studied.

Material and methods
A total of 214 specimens of *T. radiatus* were collected monthly between February 2014 and January 2016; they were caught by trawlers in the Gulf of Tunis. For each individual, sex identification was based on the macroscopic observation of the gonads and was further used to evaluate the sex-ratio. Sexual activity and spawning periods were delimited using monthly variations of the gonadosomatic index ($GSI=100GW.EW^{-1}$, where GW= gonad weight and EW= eviscerated weight) and the hepatosomatic index ($HSI=100LW.EW^{-1}$, where LW= liver weight and EW= eviscerated weight). Changes in body condition were expressed using Clark's condition factor [2]: $KC=100000EW.TL^{-3}$ where EW= eviscerated weight (g) and TL= total length (mm). Length at first maturity (LT_{50}) was estimated using the formula [3]: $P=1/(1+e^{-b(TL-LT_{50})})$, where P= proportion of mature individuals, b= the slope, TL= total length and LT_{50}= length at which 50% of the individuals of the population are mature.

Results and discussion
Global sex-ratio of male to female fish was 1:1.42, it was biased toward females with a significant difference between the two sexes ($Chi^2>3.84$, $p<0.05$). Total length varied between 11 and 50.7 cm for the total sample, between 17.8 and 43.4 cm for males and between 16.5 and 50.7 cm for females. However, mean total lengths of males (31.1±0.687) and females (31.6±0.611) were not significantly different (Mann-Whitney, $p>0.05$). Mean GSI increased between May and September, with a peak in June (Males, 0.979 ± 0.132; Females, 4.685 ± 0.808); mean GSI slight decrease in July and August is rather related to the more reduced size range of specimens collected during that period; this was clearly demonstrated when studying the monthly mean size variations. Mean GSI values for males (0.472 ± 0.042) and females (1.956 ± 0.239) were significantly different (Mann-Whitney, $p<0.05$) with a greater investment of the females in the reproductive effort. The monthly mean values of the hepatosomatic index varied in the same way as the gonadosomatic ones; their highest values were observed between June (GSI, males: 0.979 ± 0.132, females: 4.685 ± 0.808; HSI, males: 1.248 ± 0.224, females: 1.828 ± 0.171) and September (GSI, males: 0.653 ± 0.069, females: 3.485 ± 0.515; HSI, males: 1.286 ± 0.155, females: 2.084 ± 0.192), then they decreased both from October. These HSI variations are classically linked in fishes to the use of the hepatic lipid reserves for the needs of reproduction. The total sample condition was the best between June and September (KC, June: 1.029 ± 0.011, September: 1.048 ± 0.015) which is probably related to the increase of temperature and to the better availability of food in the Gulf of Tunis during that period. However, condition has recorded its lowest values in winter, between December and February (K_C, December: 0.955 ± 0.025, February: 0.947 ± 0.031). Regarding the evaluated length at first sexual maturity (LT_{50}), it was 21.9 cm for *T. radiatus* in the Gulf of Tunis.

References
1 - Hamed O. and Chakroun N., 2016. Caractérisation des Trachinidae du golfe de Tunis. Caractéristiques morphométriques, structure démographique et croissance. Editions universitaires européennes, 120p.
2 - Clark F.N., 1928. The weight-length relationship of the California sardine (*Sardina coerulea*) at San Pedro. *Fish bulletin*, 12: 1-59.
3 - Saila S.B., Recksiek C.W. and Prager M.H., 1988. Basic fishery science programs: a compendium of microcomputer programs and manual of operation. *Developments in aquaculture and fisheries science*, 18: 1-230.

CAN FOSSIL SHELLS BE USED AS HOUSING?

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Abstract
The use of fossil gastropods belonging to the Buccinidae as housing by the large-sized hermit crab *Dardanus arrosor* is reported for the first time in the Mediterranean.

Keywords: Crustacea, Gastropods, Sicily Channel, Mediterranean Sea

Recently Massi et al. [1], investigating a thanatocoenosis with the fossil gastropods *Neptunea contraria* (Linnaeus, 1771) and *Buccinum undatum* Linnaeus, 1758 in the Strait of Sicily, found that the benthic community associated to the thanatocoenosis had a higher biodiversity compared to those of similar areas where the two fossil gastropods were not present. This contribution addresses the question of whether fossil shells within these thanatocoenoses can be used by living organisms for housing. The role of host structures as a major "protective" resource and a limiting factor for hermit crab natural populations has been extensively investigated. In general, more than 60% of useable shells are inhabited by hermit crabs, that show a marked preference for gastropod shells. Shell attributes such as weight, shape and, more importantly, size and volume, are accurately "selected" by hermit crabs and are known to affect their growth and reproduction [2]. Few examples of the use of fossil shells by hermit crabs are reported in the scientific literature. In Bermuda, the terrestrial hermit crab *Coenobita clypeatus* (Fabricius, 1787) uses fossil shells of *Cittarium pica* (Linnaeus, 1758) as housing [3] and the large semi-terrestrial hermit crab *Coenobita rugosus* H. Milne Edwards, 1837 utilizes fossil shells deriving from marine erosion of the limestone coast of Madagascar when no other suitable casing is available [4]. Here we examine samples of marine hermit crabs inhabiting fossil gastropods collected on soft bottoms. They were derived from the "MEDITS 2015" scientific trawl survey as well as sampling of commercial catches "CAMPBIOL 2015", within the European Data Collection Framework. Shells and crabs were measured and weighed according to [2]. We found five hermit crabs *Dardanus arrosor* (Herbst, 1796) living in the fossil shells of *Buccinum humphreysianum* Bennett, 1824 (sample n. 1), *Buccinum undatum* Linnaeus, 1758 (samples n. 2, 3 and 4) and *Neptunea contraria* (Linnaeus, 1771) (sample n. 5) (Table1).

Tab. 1. Measures of fossil gastropods and Dardanus arrosor (length in mm, volume in cm3 and weight in g): shell length (SL), shell width (SW), shell aperture height (AH), shell aperture width (AW), shell internal volume (SiV) and shell weight (SWe); crab cephalothorax length (CFL), crab cephalothorax width (CFW), cheliped length (ChL), cheliped width (ChW) and crab weight (CW). Approximate geographical position and mean depth (in m) of the hauls are given.

	Shell parameters						Dardanus arrosor					Geographic position		
Shell species	SL	SW	AH	AW	SiV	SWe	CFL	CFW	ChL	ChW	CW	LAT.	LONG.	DEPTH
1.B. humphreysianum	63	37	35	16	16	8	30	15	29	17	20	373237	122340	157
2.B. undatum	57	32	28	15	10	6	17	7	12	8	3	374240	121131	210
3.B. undatum	69	38	36	17	12	15	25	11	22	10	10	374050	122215	120
4.B. undatum	63	35	32	16	14	10	20	8	16	9	8	373848	120821	107
5.N. contraria	90	45	53	22	25	36	30	13	25	14	21	not av.	not av.	not av.

Our samples pertain to the north-western shelf to slope sectors of the Adventure Bank (Strait of Sicily), where late Pleistocene biocalcarenites with reworked cold faunal assemblages form small infralittoral prograding wedges. In the Mediterranean, *D. arrosor* may reach sizes of 6-10 cm; it lives between 5 m and 669 m depth and inhabits available gastropod shells, often associated with the anemone *Calliactis parasitica* [5]. On the trawlable bottoms of the Strait of Sicily we observed that the species is rather ubiquitous with the larger individuals selecting shells belonging to the Buccinidae, Ranellidae, Tonnidae, Cassidae, Muricidae and Naticidae families. To the best of our knowledge, these results provide the first reporting of a marine hermit crab utilizing fossil shells as housing and the fact they belong to the Buccinidae family is worthy of note. Although the examined specimens are few and do not allow to obtain significant relationship, the size of D. arrosor appears to be linearly related to the internal volume (SiV) and width (SW) of the fossil shells.

References
1 - Massi D., Titone A., Mancuso M., Garofalo G., Gancitano V., Badalucco C., Gristina M. and Fiorentino F., 2015. *Neptunea contraria* (Linnaeus, 1771) and *Buccinum undatum* Linnaeus, 1758 (Gastropoda, Buccinidae) thanatocoenosis in the Strait of Sicily. *Biol. Mar. Mediterr.*, 22: 99-100.
2 - Caruso T. and Chemello R., 2009. The size and shape of shells used by hermit crabs: A multivariate analysis of Clibanarisu erythropus. *Acta Oecologica*, 35: 349-354.
3 - Walker S.E., 1994. Biological Remanie: Gastropod Fossils Used by the Living Terrestrial Hermit Crab, Coenobita clypeatus, on Bermuda. *Palaios*, 9 (4): 403-412.
4 - Barnes D.K.A., 2001. Resource availability: Ancient homes for hard-up hermit crabs. *Nature*, 412: 785-786.
5 - Pipitone C. and Tumbiolo M.L., 1993. Decapod and stomatopod crustaceans from the trawlable bottoms of the Sicilian Channel (Central Mediterranean Sea). *Crustaceana*, 65 (3): 358-364.

BENTHIC FORAMINIFERAL FAUNAS ALONG THE FRENCH MEDITERRANEAN COASTS: A NEW BIOTIC INDEX IN THE EU WATER FRAMEWORK DIRECTIVE

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Abstract
Along the French Mediterranean coast, we monitored ecological quality based on living benthic foraminifera. We reassessed the Foraminiferal Index (FI) including smaller stress-tolerant species, and investigated the interest of dead assemblages to evaluate the historical evolution of the studied ecosystems.

Keywords: North-Western Mediterranean, Foraminifera, Bio-indicators, Monitoring, Zoobenthos

Introduction
Benthic foraminifera are excellent biomonitoring tools. They are short living and react rapidly to environmental changes. They occur in high numbers and are preserved in the sediment record, allowing the reconstruction of the historical evolution of the investigated area. We studied recent benthic foraminiferal faunas on the French Mediterranean coast, in order to improve a new ecological biomonitoring index, FI (Foraminiferal Index) [1]. In the context of the European Union Water Framework Directive, our aims were (i) to monitor the ecological quality along the French Mediterranean coast; (ii) to improve the FI; (iii) to use the dead foraminiferal faunas for the reconstruction of past ecological conditions.

Material & Methods
In April 2012, 36 stations were sampled along the French Mediterranean coast (Figure 1). This study follows a previous survey from 2009 in the same area [1]. Sampling and samples were processed respecting recommendations of the FOBIMO (FOraminiferal BIo-MOnitoring initiative) group [2]. Three replicates were taken from different Reineck box-core launches at each station. Our study focusses on the topmost first centimetre of the sediment (sub-cores of 7.1 cm in diameter). Samples were preserved in ethanol and stained with 2 g/l Rose Bengal. Living foraminifera from the 125-150 and 150-500 µm fractions were wet-picked and determined at a species level using earlier Mediterranean studies. To characterise foraminiferal faunas, we calculated several diversity indices, defined indicative species groups based on literature (sensitive, stress-tolerant and epiphytic species), and calculated FI. This index is based on the relative proportions of stress-tolerant species and includes a correction for the sediment grain size. Finally, the succession of dead foraminiferal assemblages was studied at three sites, in ^{210}Pb dated sediment cores.

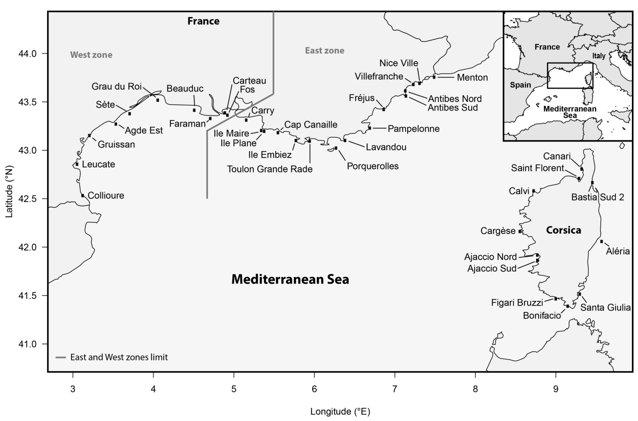

Fig. 1. Sampled stations during the survey in 2012. Two zones are shown, Gulf of Lion (West) and PACA (Provence-Alpes-Côte d'Azur) + Corsica (East).

Results and Discussion
Two strongly contrasting zones have been studied: the Gulf of Lion (West) and the PACA (Provence-Alpes-Côte d'Azur) area (East) (Figure 1). Corsica is associated to the eastern area. Stations from the Gulf of Lion have an average depth of 17 m and are characterized by sandy sediment. Stations from the PACA area are on average 37 m deep and mainly constituted of clayey to silty sediment. These different sedimentary environments resulted in very different foraminiferal assemblages, largely complicating the attribution of ecological quality classes. Since the coarser sediments in the east naturally host much lower percentages of stress-tolerant taxa, the correction on the basis of grain size characteristics is an essential part of our bio-indication method.

At some stations we observed high variability of the foraminiferal fauna between replicates. This can be due to small scale spatial variability, but also partly due to sampling bias (partial loss of the sediment surface layer containing rich foraminiferal faunas). Our data underline the need to sample at least three independent replicates per station. In total we observed 261 species. The study of the 125-150 µm (not studied in 2009) yielded 8 ±4 new species per station. This fraction is not only characterised by juveniles, but also by small-sized species which are often known for their opportunistic tendency. Therefore, the study of the 125-150 µm produces important additional information.

In 2009, the FI (FI_{2009}) was defined on the base of the 150-500 µm fraction. The FI_{2009} shows a good constancy in the replicates, except at three stations. In general, there are few differences in FI_{2009} values between the same stations in 2009 and 2012. Only stations Carry, Carteau, Cap Canaille, Leucate and Toulon have a lower ecological quality status in 2012. In order to also take into account the 125-150 µm fraction (including additional stress-tolerant species), the reference conditions for FI calculation was reassessed using only the data from the 2012 survey (FI_{2012}). For most stations, the FI_{2012} values were slightly higher than the FI_{2009} values. However, in most cases, the ecological quality status remained unchanged.

The three studied sediment cores go back in time for 20 to 65 years. Direct comparison between dead and living faunas is difficult because of important bias due to taphonomic processes. Nonetheless, this study has the merit to place the one-time observations of the composition of the living foraminiferal faunas and the ecological quality index in a historical perspective.

References
1 - Barras C., Jorissen F., Labrune C., Andral B., Boissery P., 2014. Live benthic foraminiferal faunas from the French Mediterranean Coast: Towards a new biotic index of environmental quality. Ecological Indicators. 36: 719– 743.
2 - Schönfeld, J. Alve E., Geslin E., Jorissen F., Korsun S., Spezzaferri S. and Members of the FOBIMO group, 2012. The FOBIMO (FOraminiferal BIo-MOnitoring) initiative - Towards a standardised protocol for soft-bottom benthic foraminiferal monitoring studies. Marine Micropaleontology, 94-95: 1-13.

EVIDENCE ON ECOLOGY OF SMALL HERMIT CRAB (*DIOGENES PUGILATOR* (ROUX,1829)) IN A SOFT-BOTTOM NEARSHORE ECOSYSTEM (SOUTHERN BLACK SEA)

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Abstract
The distribution and abundance of small hermit crab inhabiting Samsun Shelf Area was investigated in terms of sediment type, depth and season. Samples were collected in an experimental survey investigating the impact of trawling on benthic habitat. All three factors are determined to be effective on distribution pattern and abundance values. Small hermit crab prefers the sandy bottoms and reaches high abundance values in summer months especially in 0-20m depth range.

Keywords: Coastal waters, Crustacea, Black Sea

Introduction
The small hermit crab (*Diogenes pugilator (*Roux,1829)) was studied in many different marine areas in terms of different aspects[1-4]. In this study, it is aimed to reveal the abundance and distribution of the hermit crab depending on variation of season, sediment type and depth in a nearshore ecosystem in middle-south Black Sea.

Material and Method
The samples were collected along the inshore ecosystem discharged by two big rivers; Kizilirmak and Yesilirmak. This shelf area is also a major fishing ground along the southern Black Sea coasts. Particle size was analyzed from the sediment samples from six stations and the type of the substrate was defined according to Blot and Pye [5]. Biological samples were collected by both a beam trawl and a grab between depths of 0-40 m and seasonally for a whole year. The abundance values of the hermit crab firstly normalized with log(x+1) transformation. Four depth intervals with a range of 10 m, 4 seasons and 5 types of sediment (sand, sandy mud, muddy sand, mud and gravel) are assumed to be the factors controlling the distribution of the hermit crab along this shelf area. The ordination of the abundance values and the factors responsible from the variance was determined by the method of Principal Component Analysis (PCA, PAST 3.10).

Results and Discussion
The small hermit crab existed both in infauna and epifauna (Fig 1).

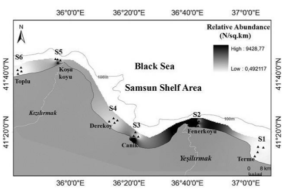

Fig. 1. Distribution and abundance of small hermit crab along stations (S1-S6) in Samsun Shelf Area.

The mean weight of individuals was 0.44 g (±0.03). It is observed that hermit crab mostly occupied the empty shells of small gastropods; *Nassarius reticulatus, Cyclope neritea* and small *Rapana venosa*. It is reported that hermit crab lives around the salinity level of 33.80-39.05 PSU [6]. However, it achieves high abundancies in this nearshore ecosystem of 17-18 PSU and even lower at time of high river discharges. PCA results revealed that depth has a determinative effect on distribution of hermit crab (PC1, 77.7% and PC2, 14.8% of total variance) (Fig 2a). It was more abundant in depths of 0-10m and 10-20m, but quite rare in depths over 30m. Winter did the greatest contribution to the variation in PC1 (46.5%) and the fall to PC2 (40.7%) making season a significant factor controlling the distribution of hermit crab (Fig 2b). Spring and summer were the seasons that hermit crab reaches the highest abundancies especially along the stations between two estuaries and inside the bay . Sandy substratum was responsible of variance in PC1 (63.7%) and muddy sand and sandy mud in PC2 (19.7%) showing that the hermit crab is inhabiting mostly in sandy bottoms (Fig 2c). The small hermit crab being a short lived and a scavenger organism may be accepted as a typical representative of epifaunal communities exposed to high trawling disturbance as well as in this nearshore ecosystem.

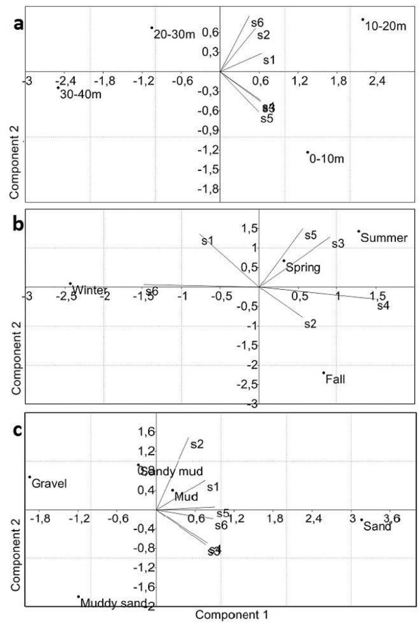

Fig. 2. PCA ordination of abundance data for a) depth, b) season, c) sediment type.

Acknowledgement: This study is funded by the EU- FP7 project BENTHIS (312088).

References

1 - Mutlu, E. and Ergev, M. B.,2010. Temporal variability of density and diverse shell occupancy of *Diogenes pugilator* on a sandy bottom of the Levantine Sea and their biometrical relationships. Cah. Biol. Mar. 51: 55-67.
2 - Manjón-Cabeza M.E.and García-Raso J.E., 1998. Population structure and growth of the hermit crab *Diogenes pugilator* (Decapoda: Anomura: Diogenidae) from the Northeastern Atlantic. J. Crust. Biol., 18: 753-762.
3 - Tirelli, T., Dappiano, M., Maiorana, G. and Pessani, D., 2000. Intraspecific relationships of the hermit crab *Diogenes pugilator*: predation and competition. Hydrobiologia, 439: 43-48.
4 - Türkay, M., 2014. On the occurrence of *Diogenes pugilator* in the German Bight (Crustacea: Decapoda Diogenidae). Helgoland Mar Res, 68 (2), 281-287.
5 - Blott S. J., Pye K., 2012. Particle size scales and classification of sediment types based on particle size distributions: Review and recommended procedures, Sedimentology, 59: 2071–2096.
6 - Http://eol.org/pages/2949954/data#data_point_6153208

CIESM Congress Session : Deep sea ecology

Moderator : Carlos Jimenez, Environmental Research Center, Nicosia, Cyprus

Moderator's Synthesis

Discussion gravitated around invasive/destructive sampling and survey methods and the potential alternatives. Long-lived species in the deep-sea are the ones telling us not to use destructive methods. MEDITS Survey was intensively discussed although it is viewed as invasive and destructive. One strong supporting argument heard is that MEDITS cannot be replaced for the purposes of stock assessment. In addition, it takes place once a year while there are hundreds of commercial trawlers operating everywhere. The concept is wrong but it seems there is no easy way out of it.

A major open question is how we can achieve the same sampling success as MEDITS without being destructive. Alternatives suggested include opportunistic sampling by means of collaboration with military, industry and research institutions that already have ship-time (this seems terribly difficult due to cost-effective constraints). Another major concern is how to produce data on the pelagic system. One final concern concerns data generation which is faster than our capacity to process it.

BIOTOPE CHARACTERISATION AND COMPILED GEOGRAPHICAL DISTRIBUTION OF THE DEEP-WATER OYSTER *NEOPYCNODONTE ZIBROWII* IN THE ATLANTIC OCEAN AND MEDITERRANEAN SEA

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Abstract
We collected and compared 261 geographical *Neopycnodonte zibrowii* records, retrieved from cruises, non-shipbased submersible expeditions and terrestrial field trips, carried out between June 1882 and January 2016. Hosted in a database, records further contain valuable site-specific metadata, including standardised describers for the variety of observed deep-sea oyster biotopes.

Keywords: Bathyal, Biodiversity, Bivalves, Canyons, Mediterranean Sea

It may seem surprising that probably one of the largest and most long-lived deep-water bivalves, the gryphaeid *Neopycnodonte zibrowii* Gofas, Salas & Taviani in Wisshak et al. (2009) [1], experienced a taxonomic description as late as in the early 21st century. Previously *N. zibrowii* oyster findings were informally treated as 'large oyster', *Ostrea* sp. or they were admixed with the cosmopolitan gryphaeid *Neopycnodonte cochlear* (Poli, 1795). Thus, a taxonomic re-evaluation of some *N. cochlear* and *Ostrea* sp. samples from unusual depths and/or sizes led to additional records for *N. zibrowii*. A large number of dead *N. zibrowii* records were accidental findings deriving from dredging and contributing to the fact that just some records of the data compilation have previously been published in the literature. The ever increasing number of *in situ* recordings and direct sampling of *N. zibrowii* in its specific biotopes over the last 2-3 decades is related to the systematic reconnaissance of cold-water coral habitats as biodiversity hotspots and their environmental controls along the continental margins of Europe and Africa, and jointly with the increase in applying advanced marine technologies, such as manned submersibles and remotely-operated vehicles (ROVs). This study is based on geographical *N. zibrowii* records retrieved from cruises, non-shipbased submersible expeditions and terrestrial field trips, carried out between June 1882 and January 2016.

The revealed geographical distribution of live *N. zibrowii* occurrences spans latitudinally from 48° N (Whittard Canyon, Celtic Sea) to 9° S (Anna Ridge off Angola, South Atlantic Ocean), and longitudinally from 28° W (Faial Channel, Azores, North Atlantic Ocean) to 13° E (Urania Bank, Sicilian Channel, central Mediterranean Sea). Late Pleistocene submerged occurrences further extent this distribution to 26° E (southeast off Crete, eastern Mediterranean Sea). Bathymetrically, live *N. zibrowii* are found between 234 m (off Mauritania, North Atlantic Ocean) and 983.5 m water depth (Emile Baudot Escarpment, western Mediterranean Sea), usually between 500 and 700 m.

Within suitable physical limits and nutritional settings, *N. zibrowii* grows on hard substrates and shows the highest colonisation densities in sediment-protected and current-exposed zones, such as rocky overhangs and (sub-) vertical rock exposures on seamounts, escarpments and in canyons. Nowadays, also anthropogenic items, like shipwrecks, serve as substrate. The lifespan of the thick-shelled *N. zibrowii* can exceed 500 years, thus belonging to the longest-living non-colonial animals; the largest valves with up to 30 cm length were reported from the Azores. Live *N. zibrowii* and their *post-mortem* remains serve as substrate for their own larvae, generating over several generations a built-up, formed as chaotic clusters or stacks. Also, they provide a suitable ecospace for a diverse associated community of attached/excavating sclerobionts, mobile organisms and for demersal benthopelagic fishes, and therefore configure a well-defined deep-sea habitat. *Neopycnodonte zibrowii* often co-occurs with scleractinians, such as *Lophelia pertusa*, *Madrepora oculata* and *Desmophyllum dianthus*. Based on video and image material from ROV and submersible dives, we characterise the *N. zibrowii* biotopes, following the "Coastal and Marine Ecological Classification Standard".

Fossil *N. zibrowii* can be preserved *in situ* (double valved) and contribute to a lithified oyster-*Desmophyllum* framestone, as reported off Crete, but more commonly, the non-cemented right valve falls off and is accumulated at or near the base of the steeply inclined substrate. The oldest geological record dates back to the Early to Mid-Pleistocene and is based upon shells putatively attributable to *N. zibrowii* occurring on outcrops at Capo Milazzo (Sicily, Italy) and St. Paul's Bay Limestone (Rhodes, Greece).
The present database contains 261 entries and provides valuable site-specific metadata, including standardised describers for the variety of observed deep-sea oyster biotopes.

References
1 - Wisshak, M., López Correa, M., Gofas, S., Salas, C., Taviani, M., Jakobsen, J., and Freiwald, A.: Shell architecture, element composition, and stable isotope signature of the giant deep-sea oyster *Neopycnodonte zibrowii* sp. n. From the NE Atlantic, Deep-Sea Research I, 66, 374-407, 2009.

RECENT EVIDENCE THAT THE DEEP SEA AROUND MALTA IS A BIODIVERSITY HOTSPOT

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Abstract
Recent ROV surveys of deep-sea areas around the Maltese Islands resulted in the discovery of highly diverse habitats, including extensive rocky areas dominated by living cold water corals and gorgonians at depths of 300–1000 m, a sub-fossil lithistid sponge reef at a depth of *ca*. 300 m, deep-water caves located at 270–450 m, and vast expanses of soft-bottom habitats, each of which had a rich variety of associated fauna. Most of these habitats are of high conservation interest, highlighting the need for the establishment of offshore marine protected areas in order to protect these very diverse, but highly vulnerable, deep-sea habitats.

Keywords: Biodiversity, Deep sea ecology, Zoobenthos, Malta Trough, Sicily Channel

Introduction
The diversity of the Mediterranean deep sea is poorly known, but has received increased research attention in recent years [1]. This is particularly true for hard substratum communities, which could not be studied in detail until the advent of Remotely Operated Vehicle (ROV) exploration that has led to the discovery of highly diverse assemblages such as cold water coral (CWC) reefs [2]. One of the five CWC provinces known from the Mediterranean is located in Maltese waters (the 'South Malta CWC province') [2], but apart from this area, observations of the deep-sea surrounding the Maltese Islands are scant and mainly based on areas with muddy bottoms studied through trawl surveys.

Material and Methods
During June-July 2015, Maltese deep-sea areas were surveyed by the R/V 'Oceana Ranger' using a Saab Seaeye Falcon DR ROV as part of the project 'LIFE BaHAR for N2K' ("Benthic Habitat Research for Marine Natura 2000 Site Designation", http://lifebahar.org.mt/). The surveys were carried out within the 25 nautical mile Fisheries Management Zone (Figure 1) around the Maltese Islands and focused on previously unstudied regions such as the Malta Graben.

Results and Discussion
The ROV surveys resulted in the following new findings regarding deep-sea habitats in Maltese waters:
♦ New areas with extensive and diverse CWC assemblages at depths of 300–1000 m extending some 20 km along the Malta Graben, including black coral (*Leiopathes glaberrima*) forests at 300–400 m and predominantly white corals (*Madrepora oculata* and *Lophelia pertusa*) in waters deeper than 500 m, with some areas dominated by the gorgonian *Callogorgia verticillata*, together with other less abundant habitat-forming species such as *Acanthogorgia hirsuta*, *Villogorgia bebrycoides*, *Paramuricea macrospina*, *Dendrobrachia bonsai*, and *Muriceides lepida* and a high diversity of associated fauna (especially sponges, echinoderms, molluscs and crustaceans).
♦ A dead (possibly fossil) lithistid sponge reef located north of Gozo at a depth of *ca.* 300 m, and extending over a 7 km wide area, serving as a substratum for several species including *Bebryce mollis, C. verticillata, V. bebrycoides, Stenocyathus vermiformis,* bryozoans, sponges, ophiuroids and hydroids.
♦ Deep-water caves located west of Gozo at depths of 270–450 m.
♦ Extensive soft-bottom areas with epibenthic species such as *Funiculina quadrangularis*, *Isidella elongata*, *Pennatula* spp., and in some areas *Kophobelemnon stelliferum* and *Thenea muricata*, as well as motile echinoderms and crustaceans (including *Nephrops norvegicus*).
♦ An overall high species diversity, with some 75 fishes, 55 cnidarians, 35 crustaceans, 32 molluscs, 21 echinoderms and 15 sponges identified so far from a preliminary analysis of the ROV video footage, as well as tunicates, bryozoans, brachiopods and annelids.

These findings indicate that the deep-sea around Malta represents an important biodiversity hotspot with a variety of different assemblages dominated by suspension feeders (mainly cnidarians and sponges) as habitat-forming taxa. The Malta Graben, in particular, seems to serve as a conduit transporting organic matter and nutrients to deep water, thus making conditions favourable for such suspension feeders, which in turn are accompanied by a high diversity of associated fauna. Reefs such as those formed by CWC and lithisthid sponges are included in Annex I of the EU 'Habitats Directive' (Natural habitat types of Community interest whose conservation requires the designation of special areas of conservation) [3], while bathyal muds with facies of *F. quadrangularis* and *I. elongata* and deep-sea caves are also considered to be of conservation interest [4]. The present results highlight the need for the relevant authorities to consider establishment of offshore marine protected areas in order to protect these very diverse, but highly vulnerable, deep-sea habitats.

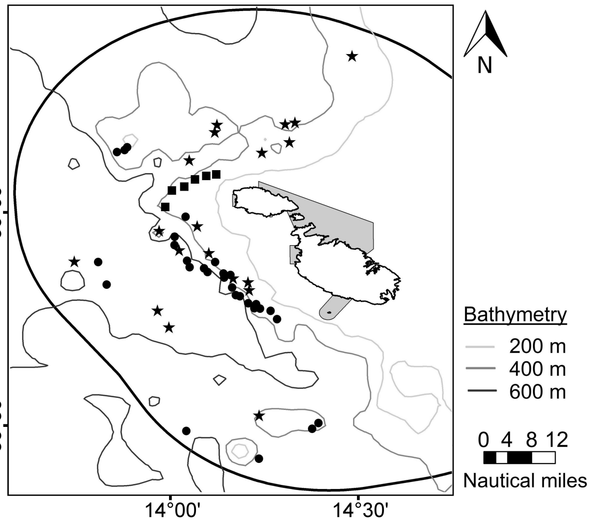

Fig. 1. Map of the Maltese Islands showing the sites with living cold water corals (circles), dead lithistid reef (squares) and muddy bottom (stars) identified through the present survey. The partial extent of the 25 nautical mile Fisheries Management Zone (oval around the Maltese Islands), and the location of current Marine Protected Areas in Maltese waters (grey shading) are also shown.

Acknowledgements: The LIFE BaHAR for N2K (LIFE12 NAT/MT/000845) Project is 50% co-financed by the EU LIFE+ Funding Programme. We thank the Malta Environment and Planning Authority - Environment Protection Directorate and the Ministry for Transport and Infrastructure - Continental Shelf Department for granting the permits to undertake this work.

References
1 - Coll M., Piroddi C., Steenbeek J., Kaschner K., Ben Rais Lasram F., et al., 2010. The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. *PLoS ONE* 5(8): e11842
2 - Taviani M., Angeletti L., Canese S., Rannas R., Cardone F., et al., in press. The "Sardinian cold-water coral province" in the context of the Mediterranean coral ecosystems. *Deep Sea Research II*; DOI: 10.1016/j.dsr2.2015.12.008
3 - Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, OJ L 206, 22.7.1992
4 - UNEP-MAP-RAC/SPA, 2006. Reference list of marine habitat types for the selection of sites to be included in the national inventories of natural sites of conservation interest. UNEP-MAP-RAC/SPA; 5pp

INERTIAL BIOLUMINESCENCE RHYTHMS AT THE CENTRAL MEDITERRANEAN KM3NET DEEP-SEA NEUTRINO TELESCOPE

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Abstract

Here, we used data from the prototype tower detector installed 80 km off-shore Capo Passero in the abyssal Central Mediterranean KM3NeT neutrino telescope (3500 m depth), to portray bioluminescence rhythms at different depths of the structure. The tower raises 420 meters above the bottom and contains 8 floors (3349-3069 m). We focused on 10-min bioluminescence readings for June 2013, as detected by Photo Multiplier Tubes. A significant periodicity in bioluminescent intensity, equivalent to ca. 20.27h, was detected. A time-lag in phase timing appears from shallower to the deeper floors, with progressive dampening of bioluminescence fluctuations. The presence of structured peaks in overall bioluminescence suggests that drifted organisms travel in discontinuous swarms and bursts are provoked by currents bringing animals against the tower.

Keywords: Abyssal, Deep sea ecology, Vertical migration, Ionian Sea

Introduction

Presently, the ecological relevance of bioluminescence emitted by deep pelagic fauna and its temporal pattern due to the interaction of animals with cyclic water flow changes are poorly known. In the Mediterranean Sea tidal forces are almost negligible and may be replaced by sea winds producing inertial currents. We used data from the prototype tower detector installed in Capo Passero site (80 km off-shore) in the abyssal Central Mediterranean KM3NeT deep-sea neutrino telescope, deployed at 3500 m depth (KM3NeT; www.km3net.org), to portray bioluminescence rhythms at different depths of the structure. Therefore, detected temporal variations in bioluminescent intensity were used here for the first time as a proxy of deep vertical displacements of abyssopelagic fauna.

Materials and Methods

The Cherenkov neutrino telescopes are deep-sea research infrastructures, belonging to the KM3Ne network in the Mediterranean Sea. Their primary goal is the detection of high energy neutrinos of astrophysical origin into dark marine backgrounds. Each tower raises 750 mab and contains 8 floors separated by 40 m (from 3349 to 3069 m of depth). We focused on 10-min bioluminescence readings for the month of June 2013, as detected separately by Photo Multiplier Tubes. We also recorded by 10 min tower movements as a proxy for currents.

Results

We obtained a total of 32,970 bioluminescence readings by 10 min at the 8 telescope floors. We detected a significant fluctuation periodicity in bioluminescent intensity, corresponding to inertial currents at the latitude of the telescope site (i.e. periods between equivalent to 20.27±0.12 h at all 8 floors). Waveform analysis outputs (Fig. 1), based on mean periodogram results (i.e. time series subdivided into sub datasets of 20.5 h length. equivalent to 1230 min), clearly indicate the presence of mean pattern of fluctuations in bioluminescence at each telescope floor. A progressive dampening of mean bioluminescence fluctuations occurs from shallower to the deeper floors, with the exception of floor no. 5. A time lag in phase timing seems to appear as function of depth.

Discussion

The inertial-related periodicity here found points out a strict relationship between currents and the phenomenon of bioluminescence, based on mechanical stimulation. Results suggested that organisms drifted by currents hit the deployed telescope infrastructures, resulting emission peaking at collision (Tamburini et al., 2013). Further, the presence of temporally structured peaks and troughs in average overall bioluminescence suggests that drifted organisms travel in discontinuous swarms and bursts are provoked by currents bringing animals against the tower structure. A question still to be solved is related to the identification of which organisms are responsible for the reported bioluminescence temporal patterns.

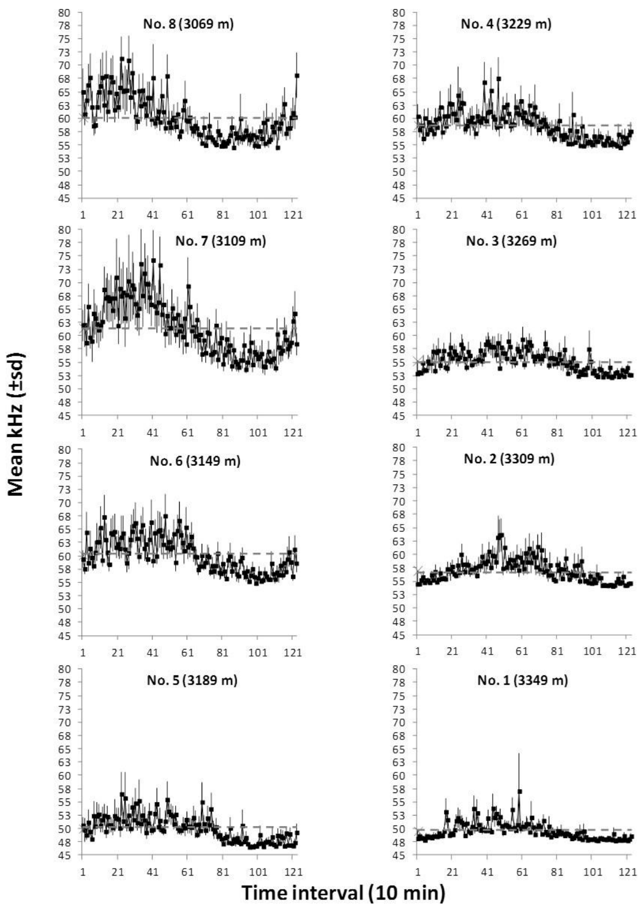

Fig. 1. Waveform analysis outputs indicating the occurrence of bioluminescence phase and amplitude. Horizontal dashed lines define peaks temporal amplitudes.

References

1 - Tamburini C., Canals M., Durrieu de Madron X., Houpert L., Lefèvre D., Martini S., et al. 2013. Deep-sea bioluminescence blooms after dense water formation at the ocean surface. *PLoS ONE*, 8(7): e67523.

TIME-SERIES ANALYSIS OF ABUNDANCE INDICES OF DEEP SEA RESOURCES IN THE STRAIT OF SICILY

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Abstract

Time-series of abundance indices of deep sea demersal resources (501-800m) derived by the MEDITS trawl survey in the Strait of Sicily (GSA 16) were analyzed by aggregated taxa (bony fish, cartilaginous fish, cephalopods and crustaceans) and species using a polynomial approach. The results showed a significant increasing trend of the cartilaginous fish and cephalopods, in terms of biomass (kg/km^2) and density (n/Km^2) indices, whereas temporal pattern in bony fish and crustaceans resulted not significant. *Helicolenus dactylopterus*, *Hoplostetus mediterraneus*, *Galeus melastomus*, *Nephrops norvegicus* and *Aristaeomorpha foliacea* showed significant trends in both number and weight, whereas *Aristeus antennatus*, *Etmopterus spinax* and *Chimera monstrosa* only in biomass.

Keywords: Time series, Biomass, Fisheries, Sicily Channel, Mediterranean Sea

The time series of the catch rates collected through experimental surveys are one of the most powerful tools to assess the dynamics of exploited resources and understand changes in marine communities [1]. In this study we used biomass and density data collected during the bottom trawl survey MEDITS in the South of Sicily (GSA 16) to evaluate the temporal trends in abundance of bony fish, cartilaginous fish, cephalopods and crustaceans as well as some of the main species distributed on the middle slope (501-800 m). The biomass (BI, kg/km-^{2}) and density (DI n/Km-^{2}) indices of these taxa for the period 1994-2013 were modeled to assess the temporal trend and perform a short time predictions (2 years) using a polynomial model through the Ordinary Least Squares method (OLS). All the analyses were performed in R [3]. In 2014 the MEDITS was not carried out in the depth strata (501-800 m) due to administrative issues. Trend in BI and DI of bony fish was dome shaped, (R^2= 0.21 and 0.17 for BI and DI respectively) with a decreasing pattern since 2009 (Fig. 1). Differently, cartilaginous fish displayed an increasing trend for both indices with a six-degree polynomial trend (R^2= 0.89; 0.83). Cephalopods showed a significant linear increasing trend for both DI and BI (R^2=0.64; R^2=0.34) but the trend of both abundance indices for the crustaceans was not significant (R^2= 0.09; 0.12) (Fig. 1). The temporal patterns was significant trends for both DI and BI in almost all species with the exceptions of *Lepidorhombus boscii* (R^2= 0.15; 0.25) whereas *A. antennatus*, *E. spinax* and *C. monstrosa* showed significant trend only in biomass (R^2= 0.52; 0.33; 0.79) (Fig. 1). Considering the two years forecast an increase both indices BI and DI was predicted in *H. dactylopterus*, while predicted values of DI were increasing in *H. mediterraneus, G. melastomus, C. monstrosa, N. norvegicus* and *A. foliacea*. (Fig. 1). Our results depict a feeble recovery of the demersal community of the middle slope in the South of Sicily which is consistent with the decreased fishing capacity observed in the area during the last 10 years [4].

Acknowledgments - This work was carried out within the Data Collection Regulation and Framework - module trawl surveys MEDITS funded by European Union and the Italian Ministry of Agricultural, Food and Forestry Policies.

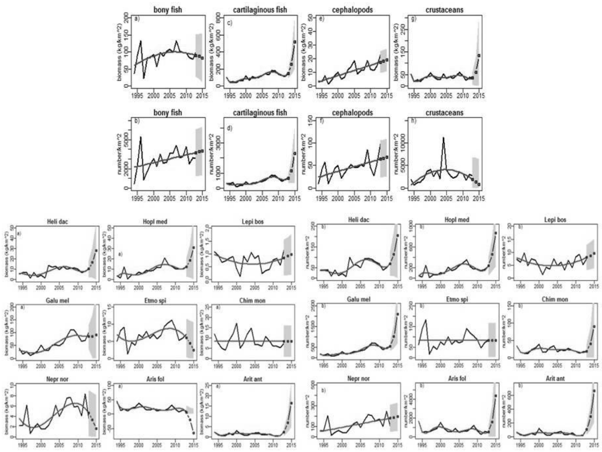

Fig. 1. Biomass and density time series trends and forecasts of aggregated taxa (bony fish, cartilaginous fish, cephalopods and crustaceans) and species in the Strait of Sicily.

References

1 - Link J., Burnett J., Kostovick P., Galbraith J., 2008. Value-added sampling for fishery independent surveys: Don't stop after you're done counting and measuring. Fisheries Research 93: 229–233.

2 - Bertrand J.A., Gil de Sola L., Papaconstantinou C., Relini G., Souplet A., 2002.The general specifications of the Medits survey. Sci. Mar., 66 (Suppl. 2): 9-17.

3 - R CORE TEAM, 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

4 - Gancitano V., Enea M., Colloca F., Gancitano S., Ingrande G., Massi D., Rizzo P., Titone A., Fiorentino F.,2015. Temporal dynamics of demersal resources in the south of Sicily (GSA 16) during the last twenty years. Biol. Mar. Mediterr., 22 (1): 166-167

LIVING IN CLOSE QUARTERS: EPIBIONTS ON *DENDROPHYLLIA RAMEA* DEEP-WATER CORALS (CYPRUS AND MENORCA CHANNEL)

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Abstract

In sharp contrast to shallow and/or tropical coral habitats, the role of deep-water corals (DWC) as habitat providers is not well known and even less understood. For this purpose, epibionts on the deep-water coral *Dendrophyllia ramea* were studied from samples collected in Cyprus and compared to those from Menorca Channel. A total of 63 species were found; bryozoans (ca. 60%) and serpulid polychaetes (ca. 10%) dominated the assemblage of species. Cyprus (48 species in total) and Menorca (22) corals shared few epizoic species (7). Several of these species were previously thought absent from the Levantine basin. These results are important contributions to the knowledge on the deep-water epibiotic biodiversity of the Levantine Basin and the Mediterranean Sea in general.

Keywords: Biodiversity, Deep sea corals, Bryozoa, Deep sea ecology, Levantine Basin

Introduction

Coral communities are habitats known to host rich assemblages of associated organisms sometimes in complex relations with the host. The structural complexity offered by deep-water coral (DWC) habitats allows for the development of diverse associated communities that usually result in considerably higher biodiversity than the surrounding environment [1]. Inherent difficulties to study DWC communities limit the expansion of our knowledge on their associations and composition. In consequence, every coral sample brought up from the deep is a priceless source of information. The epifauna associated to the DWC coral *Dendrophyllia ramea* is described here for the first time for specimens from Cyprus and compared to *D. ramea* from the Western Mediterranean.

Methods

Colonies (n=8) and branches of colonies (n=5) of *D. ramea* were collected by longline fishermen and ROV surveys in Cyprus (150 to 200m depth). Samples (dry or frozen), including other material (e.g. monofilament lines) attached to the corals, were inspected using a stereomicroscope and selected epibionts were prepared for scanning electron microscope (SEM). Relative position, abundance (% cover) and diversity of major taxa on *D. ramea* colonies from Cyprus was compared to those of one conspecific colony from Menorca Channel (ca. 240m).

Results

Sixty-three taxa in total were found; the majority (ca. 57%, n=36) were bryozoans followed by serpulid polychaetes (ca. 11%). Other groups (pooled together 32%), such as corals, sponges, brachiopods, foraminifera, and calcareous algae were less represented. More than 60% (n=41) of the species were found only in Cyprus; few (11%, n=7) co-occur in both areas. Sponges were entirely absent from the samples from Cyprus. In contrast, the scleractinian coral *Stenocyathus vermiformis* was found only on *D. ramea* from Cyprus (three colonies). In general, upright branches with live polyps and exposed sides had significantly fewer epibionts (<5% cover) compared with dead portions of the same colony. Epibionts' cover was higher (>40%) on those sides as well as in the basal sections (Fig. 1A) and the monofilament fishing lines (Fig. 1B).

Discussion and Conclusions

All species in the examined material are known as habitual epibionts of a variety of coral species. This is the first contribution for the deep-water biodiversity of epibionts in the Levantine Basin. Many of the species (ca. 45%) were not reported for Cyprus, nor for any other DWC in the Levantine area, even though their depth range of distribution range extends to shallow habitats (<50m). Although all epibionts found are indicative of some environmental conditions, bryozoans and sponges strongly respond to environmental factors such as oligotrophy and sedimentation. These results suggest that generalizations regarding DWC habitats and their associated communities in the Mediterranean are not to be taken lightly. The deep-water habitats of the Levantine Sea are under heavy pressure by human activities that may alter the benthic landscape, posing a challenge to produce immediate information on poorly known ecosystems and on even less understood relationships between species and their ability to adapt to these changes.

Acknowledgements

Collection of corals in Cyprus by CYCLAMEN project (Total Foundation; BIO_2014_091_Juin_CS-8) and Department of Fisheries and Marine Research; in Menorca Chanel by INDEMARES project (LIFE07/NAT/E/000732).

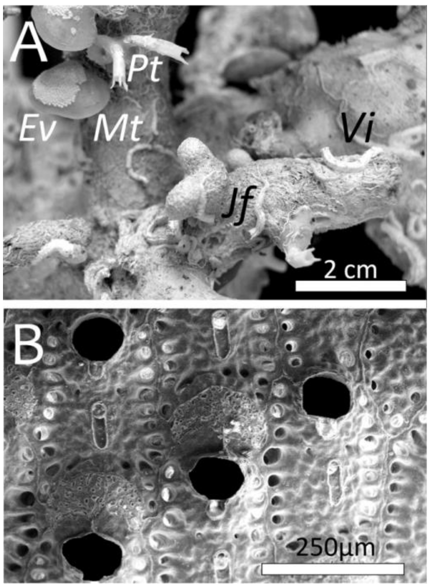

Fig. 1. (A) Epizoans: *Escharina vulgaris* (Ev), *Megerlia truncata* (Mt), *Placostegus tridentatus* (Pt), *Vermiliopsis infundibulum* (Vi), *Janita fimbriata* (Jf). (B) Bryozoan *Smittoidea marmorea* with ovicells and avicularia.

References

1 - Buhl-Mortensen L., Vanreusel A., Gooday A.J., Levin L.A., Priede I.G., Buhl-Mortensen P., Gheerardyn H., King N.J. Raes M., 2010. Biological structures as a source of habitat heterogeneity and biodiversity on deep ocean margins. Mar. Ecol. 31:21-50.

NEW DEPTH RECORD OF THE PRECIOUS RED CORAL *CORALLIUM RUBRUM* FOR THE MEDITERRANEAN

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Abstract

Live colonies of the precious red coral *Corallium rubrum* have previously been recorded at depths of 600-800 m in the Sicily Channel, but deep-water populations of this species remain poorly known. During a recent research expedition within the 25 nautical mile Fisheries Management Zone around the Maltese Islands, numerous colonies growing deeper than 800 m, down to depths of 1016 m were observed. These colonies were part of a diverse community of habitat-forming species of scleractinians, gorgonians and antipatharians.

Keywords: Deep sea corals, Malta Channel, Mediterranean Sea, Deep waters

Introduction

The precious red coral *Corallium rubrum* inhabits a variety of sublittoral hard substratum habitats in the Mediterranean Sea and the Eastern Atlantic Ocean, with live colonies generally reported from depths ranging between 15 m and 300 m [1, 2, 3, 4, 5]. In 2006 and 2007, deep-water colonies of red coral were for the first time observed at depths down to 800 m, living in association with the deep-water stony corals *Madrepora oculata* and *Lophelia pertusa* [6, 7, 8]. Deep-water red coral populations however remain poorly known. Indeed, the remoteness and inaccessibility of the reported bathyal habitats (overhangs, steep escarpments) serves to protect this species from exploitation for the jewellery trade, which shallower water colonies have been subjected to since antiquity [7, 8].

Method

Red coral colonies were visually recorded and documented during a Remotely Operated Vehicle (ROV: Saab Seaeye Falcon DR) survey by the R/V 'Oceana Ranger' as part of the project LIFE BaHAR for N2K ('Benthic Habitat Research for Marine Natura 2000 Site Designation'; http://lifebahar.org.mt/). The survey was carried out in June-July 2015 within the 25 nautical mile Fisheries Management Zone (Figure 1) around the Maltese Islands.

Results & Discussion

Living colonies of *Corallium rubrum* were observed at depths ranging from 338 m to a maximum of 1016 m, and in 10 out of a total of 15 ROV dives that surveyed hard bottoms, rocky outcrops, or dead coral frameworks located in waters deeper than 800 m off the south to southwest coasts of the islands (Figure 1). These records represent a further significant extension of the known bathymetric range of red coral populations.

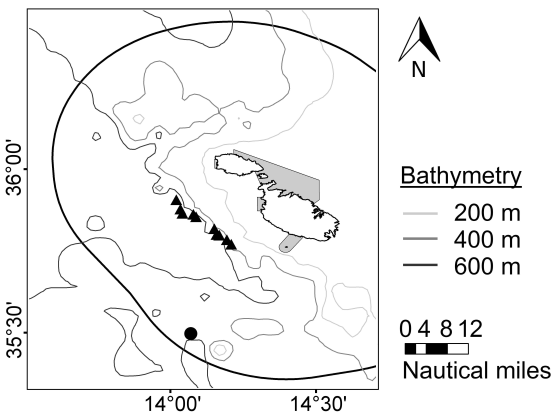

Fig. 1. Map of the Maltese Islands showing the location of sites where live *Corallium rubrum* colonies were located at depths of 800–1016 m (triangles). Previous records of deep-water red coral (circle), the partial extent of the 25 nautical mile Fisheries Management Zone (oval line around the Maltese Islands), and the location of current Marine Protected Areas in Maltese waters (grey shading) are also shown.

Red coral colonies recorded at depths of 800–1016 m were found to be part of a cnidarian-dominated megabenthic community on deep-water hard substrata characterised by a mixture of habitat-forming scleractinians, gorgonians and antipatharians. The most common species associated with the red coral colonies were (in order of abundance): *Callogorgia verticillata*, *Madrepora oculata, Placogorgia massiliensis, Muriceides lepida, Isozoanthus primnoidus, Pachastrella monilifera, Lophelia pertusa, Acanthogorgia hirsuta, Desmophyllum dianthus* and *Leiopathes glaberrima*. Habitats where red coral colonies were found included rocky outcrops and slopes, vertical escarpments, overhangs, and in several instances, dead coral frameworks.

The designation of offshore Marine Protected Areas should be considered by the relevant authorities in order to protect these so far unique, deep-sea red coral habitats.

Acknowledgements

The LIFE BaHAR for N2K (LIFE12 NAT/MT/000845) Project is 50% co-financed by the EU LIFE+ Funding Programme and implemented by the Malta Environment and Planning Authority (MEPA), the University of Malta, Fundacion Oceana, the Ministry for Sustainable Development, the Environment and Climate Change (MSDEC), and the Department for Fisheries and Aquaculture within MSDEC. We thank the Malta Environment and Planning Authority - Environment Protection Directorate and the Ministry for Transport and Infrastructure - Continental Shelf Department for granting the permits to undertake this work.

References

1 - Weinberg S., 1978. Mediterranean octocorallian communities and the abiotic environment. *Mar. Biol.*, 49: 41–57.
2 - Zibrowius H., Montero M. and Grashoff M., 1984. La répartition du *Corallium rubrum* dans l'Atlantique. *Thetys*, 11: 163–170.
3 - Chintiroglou H., Dounas C. and Koukouras A., 1989. The presence of *Corallium rubrum* (Linnaeus, 1758) in the Eastern Mediterranean Sea. *Mitt. Zool. Mus. Berlin*, 65: 145–149.
4 - Abbiati M., Santangelo G. and Novelli S., 1993. Genetic variation within and between two Tyrrhenian populations of the Mediterranean alcyonarian *Corallium rubrum*. *Mar. Ecol. Prog. Ser.*, 95: 245–250.
5 - Rossi S., Tsounis G., Orejas C., Padron T., Gili J. M., Bramanti L., Teixido N. and Gutt J., 2008. Survey of deep-dwelling red coral (*Corallium rubrum*) populations at Cap Creus (NW Mediterranean). *Mar. Biol.*, 154: 533–545.
6 - Freiwald A., Beuck L., Ruggeberg A., Taviani M., Hebbeln D. and R/V Meteor M70-1 Participants, 2009. The white coral community in the Central Mediterranean Sea revealed by ROV surveys. *Oceanogr.*, 22: 58–74.
7 - Costantini, F., Taviani, M., Remia, A., Pintus, E., Schembri, P. J. and Abbiati, M., 2010. Deep-water *Corallium rubrum* (L., 1758) from the Mediterranean Sea: preliminary genetic characterisation. *Mar. Ecol.*, 31(2): 261-269.
8 - Taviani, M., Freiwald, A., Beuck, L., Angeletti, L. and Remia, A., 2010. The deepest known occurrence of the precious red coral *Corallium rubrum* in the Mediterranean Sea. In *Proceedings of the International Workshop on Red Coral Science, Management, Trade: Lessons from the Mediterranean*, pp: 87-93.

DEEP-WATER CEPHALOPODS FROM GFCM GEOGRAPHICAL SUB-AREA 15 (CENTRAL MEDITERRANEAN).

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Abstract
The cephalopod fauna of the circalittoral waters around the Maltese Islands has not been systematically studied to date. A list of the species collected during MEDITS surveys, made in General Fisheries Commission for the Mediterranean's Geographical Sub-area 15 between 2005 and 2012, is presented. Of the 27 cephalopod species recorded, 10 are new records for Maltese waters, bringing the total number of cephalopods recorded from the area to 37, representing about 56% of the cephalopod species known from the Mediterranean.

Keywords: Sicily Channel, Cephalopods, Biodiversity, Biogeography, Trawl surveys

Introduction
Cephalopods are important both for fisheries as well as ecologically. In fisheries, they are targeted for human consumption, as food for ranged tuna and as bait; they are also caught as by-catch. Cephalopods are known to be preyed upon by many marine species, including commercially important ones [1]. An inventory of cephalopod species recorded from the Maltese Islands exists [2, 3], however, this is not exhaustive as it is based on non-systematic sampling. For example, species which are frequently recorded during MEDITS trawl surveys, which have been carried out in Maltese waters since 2002, are not included, or else are reported as single records. Here we present a list of the species collected during MEDITS surveys [4] made in the General Fisheries Commission for the Mediterranean's Geographical Sub-area 15 [GSA 15] between 2005 and 2012.

Methods
All cephalopods from 358 hauls made in 82 sampling stations (Fig. 1) within the GFCM's GSA 15 at depths between 45 m and 810 m were identified to species level, based on morphology.

Results and Discussion
The species recorded in the MEDITS trawls are listed below. Also included are species reported from the Maltese Islands but not recorded during the present study (in square brackets) such as to provide an updated inventory of the cephalopod species of Maltese waters.

Argonautidae: [*Argonauta argo*]; **Octopodidae:** *Bathypolypus sponsalis*, [*Callistoctopus macropus*], *Eledone cirrhosa*, *E. moschata*, *Macrotritopus defilippi*, *Octopus salutii*, *O. vulgaris*, *Pteroctopus tetracirrhus*, *Scaeurgus unicirrhus*; **Ocythoidae:** [*Ocythoe tuberculata*]; **Tremoctopodidae:** [*Tremoctopus violaceus*]; **Sepiidae:** *Sepia elegans*, *S. officinalis*, *S. orbignyana*; **Sepiolidae:** *Neorossia caroli*, *Rossia macrosoma*, *Sepietta neglecta*, *S. obscura*, *S. oweniana*, [*Sepiola atlantica*], [*S. aurantiaca*], [*S. intermedia*], [*S. ligulata*], *S. robusta*, [*S. rondeletii*]; **Enoploteuthidae:** *Abralia veranyi*; **Histioteuthidae:** *Histioteuthis bonnellii*, *H. reversa*; **Loliginidae:** *Alloteuthis* sp., *Loligo forbesii*, *L. vulgari*; **Ommastrephidae:** *Illex coindetii*, *Todarodes sagittatus*, *Todaropsis eblanae*; **Pyroteuthidae:** *Pyroteuthis margaritifera*; **Thysanoteuthidae:** [*Thysanoteuthis rhombus*].

Of the 27 cephalopod species recorded in the present study, eight are completely new records from Maltese and surrounding waters: *Abralia veranyi*, *Loligo forbesii*, *Bathypolypus sponsalis*, *Pteroctopus tetracirrhus*, *Neorossia caroli*, *Pyroteuthis margaritifera*, *Sepietta neglecta* and *S. obscura*; two others, *Histioteuthis bonnellii* and *H. reversa*, had been recorded previously [5] but not published. It is not possible to distinguish between *Alloteuthis media* and *A. subulata* on morphological features alone [6], so the species present in the MEDITS samples is for the present listed as *Alloteuthis* sp. in the list above.

Together with an additional 10 previously recorded species that were not found during the present study, the number of cephalopods known from Maltese waters is now 37 (excluding *Spirula spirula* only known from a single beached shell collected in 1979 [4]), representing 56% of the Mediterranean cephalopods [6]. The species previously recorded in Maltese waters but not observed during the present study are pelagic species, or distributed in shallow waters and thus not sampled during MEDITS surveys, or are very rare.

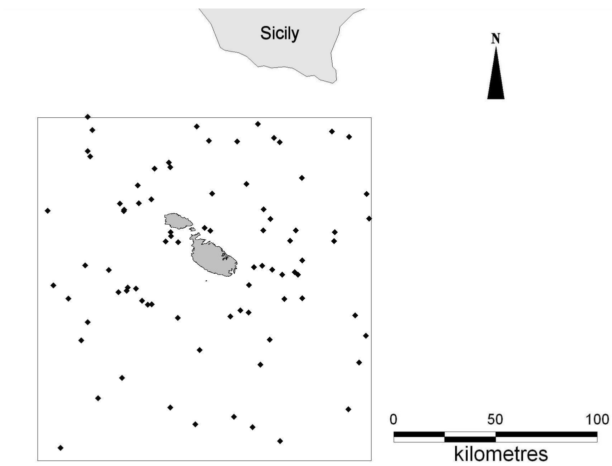

Fig. 1.
Map of the GFCM's GSA 15 (rectangle) showing the 82 sampling stations (dots) where trawls were made.

Acknowledgements
We thank the Department of Fisheries and Aquaculture (Ministry for Sustainable Development, the Environment and Climate Change) for providing MEDITS data and the University of Malta for financial support.

References
1 - Quetglas A., Valls M., Ordines F., de Mesa A., Olivar M.P., Keller S. and Massutí E., 2013. Structure and dynamics of cephalopod assemblages in the water column on shelf-break and slope grounds of the western Mediterranean. *J. Mar. Systems*, 138: 150-159.
2 - Mifsud C. and Cachia C., 2011. New additions and corrections, with annotations, to the check-list of the marine Mollusca of the Maltese Islands. *Triton*, 23: 10-18.
3 - Cachia C., Mifsud C. and Sammut P.M., 2004. The marine Mollusca of the Maltese Islands. Part four. The classes: Caudofoveata, Solenogastres, Bivalvia, Scaphopoda & Cephalopoda. Backhuys Publishers, Leiden, The Netherlands, 270pp.
4 - Fiorentini L., Dremière P.Y., Leonori I., Sala A. and Palumbo V., 1999. Efficiency of the bottom trawl used for the Mediterranean international trawl survey (MEDITS). *Aquat. Living Resour*., 12(3): 187–205.
5 - Zammit P.P., 2011. Aspects of the biology of the jewel squid *Histioteuthis* in Maltese waters. Unpublished MSc dissertation, Faculty of Science, University of Malta, viii + 126pp.
6 - Bello G., 2008. Cephalopoda. *Biol. Mar. Medit.*, 15 (Suppl.): 318–322.

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COMMUNITY COMPOSITION OF MACROINVERTEBRATES IN THE MEDITERRANEAN SEA

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Abstract
Artificial sampling units (ASUs) allow for standardized sampling in the marine environment. We deployed ASUs at three sites in the Bay of Marseille for 14 months to measure the diversity and community composition of macroinvertebrates within and among sites. Invertebrates were identified morphologically to the class level. At this resolution, variability within sites was high enough to obscure differences among sites in both taxonomic diversity and community composition. Future work will use metabarcoding techniques to study diversity at the species level, both in the Bay of Marseille and other sites in the Mediterranean and more regional European seas.

Keywords: Biodiversity, Mediterranean Sea, Monitoring

The subtidal environment is an area that is particularly difficult to access for ecological studies. The use of Artificial Sampling Units (ASUs) allows for standardization of the sampling of marine communities. To study community composition and diversity in the Mediterranean Sea, we deployed ASUs in the Bay of Marseille in coralligenous reef habitats. These reefs are important centers of biodiversity in the Mediterranean, but are usually located at greater than 5 m depth and are therefore difficult to sample [1]. Three replicate ASUs were deployed at each of 3 sites. The ASUs were made of four nylon pot scrubbers that were cable-tied together and fixed to the substrate [2]. They were left on the reefs for 14 months. After the ASUs were retrieved by divers, we removed all mobile macroinvertebrates and identified them morphologically to the class level. We then calculated Simpson's diversity index for each replicate, and compared taxonomic diversity among sites using an analysis of variance with Simpson's index as a response variable. We used an analysis of similarity (ANOSIM) and a nonmetric multidimensional scaling (NMDS) analysis to compare community composition across sites. At this level of taxonomic identification, Simpson's index was not different among sites ($F_{2,6} = 2.271$, $p = 0.184$; Figure 1).

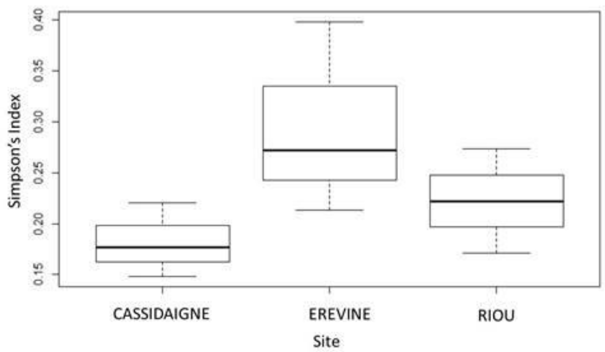

Fig. 1. Boxplots of Simpson's Index of diversity, calculated from three replicate ASUs at each of three sites. There were no significant differences among the sites.

Likewise, the ANOSIM revealed no differences in community composition among sites ($R = 0.1276$, $p = 0.266$). Figure 2 shows the NMDS plot of the data.

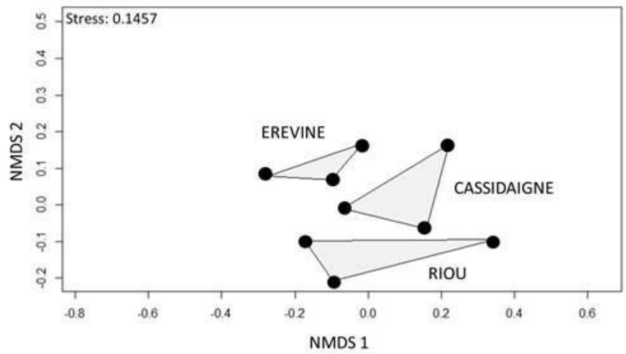

Fig. 2. Nonmetric multidimensional scaling plot of the community composition at three sites. An analysis of similarity showed no differences among the sites.

Although replicates within sites are generally clustered on the plot, the differences among sites are not significant. Future work is underway to use molecular metabarcoding techniques [3,4] to investigate community composition at the species level. We expect that there will be stronger differences among sites when data are collected at the species level. Given the large number of cryptic species found in marine environments [5], we may also uncover previously unknown cryptic diversity by using molecular methods rather than morphological ones. We will also expand this study to other sites in the Mediterranean and across different regional seas of Europe, to study diversity and composition on a larger spatial scale.

References
1 - Ballesteros, E., 2006. Mediterranean coralligenous assemblages: a synthesis of present knowledge. *Oceanography and Marine Biology: An Annual Review*, 44: 123-195.
2 - Hale, R., Calosi, P., McNeill, L., Mieszkowska, N., Widdicombe, S., 2011. Predicted levels of future ocean acidification and temperature rise could alter community structure and biodiversity in marine benthic communities. *Oikos*, 120: 661-674.
3 - Leray, M., Knowlton, N., 2015. DNA barcoding and metabarcoding of standardized samples reveal patterns of marine benthic diversity. *PNAS*,112: 2076-2081.
4 - Taberlet, P., Coissac, E., Pompanon, F., Brochmann, C., Willerslev, E., 2012. Towards next-generation biodiversity assessment using DNA metabarcoding. *Mol. Ecol.*, 21: 2045-2050.
5 - Knowlton, N., 1993. Sibling species in the sea. *Ann. Rev. Ecol. Sys.*, 24: 189-216.

MERCURY IN WATER AND ORGANISMS FROM SOME SELECTED ANCHIALINE CAVES, EASTERN ADRIATIC COAST (CROATIA)

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Abstract
This preliminary study examines mercury levels in the water columns and tissues of organisms from four anchialine caves (Bjejajka, Mandalina, Capljina and Bicina) on the eastern coast of the Adriatic Sea.

Keywords: Mercury, Nutrients, Central Adriatic Sea, Anoxia

Introduction
The anchialine environment, redefined as "tidally-influenced subterranean estuary located within crevicular and cavernous karst and volcanic terrains that extends inland to the limit of seawater penetration" [1], is characterized by sharp physical and chemical stratification and merges with a marine system at the coast and a groundwater system inland. The anchialine ecosystem supports a relatively diverse biotic assemblage of stygobiotic species of marine origin, dominated by members of Crustacea, both numerically and by species richness. Anchialine caves are a common phenomenon in the Croatian karst. Due to systematic work of a group of Croatian speleologists and scientists more than 100 anchialine caves have been registered along the coast and on the islands. Anchialine systems are particularly susceptible to elevated heavy metal concentrations due to water stratification, restricted water exchange and long residence times of waters in the caves, as well as due to isolation of endemic populations. However, in waters from some anchialine caves naturally elevated metal concentrations were found [2-4]. Of greatest concern were the substantially elevated mercury concentrations found in water from Bjejajka cave, in comparison with nearby sea water. In order to determine the impact of elevated mercury concentration on anchialine ecosystems, we examined four anchialine cave environments located on the Croatian coast: Bjejajka, Mandalina, Bicina and Capljina, where different mercury concentrations were expected. In addition to mercury concentrations, the main physico-chemical parameters and nutrients concentrations were determined.

Study area & methodology
The anchialine caves presented here are located near the central and southern part of the Croatian coast (Fig. 1).

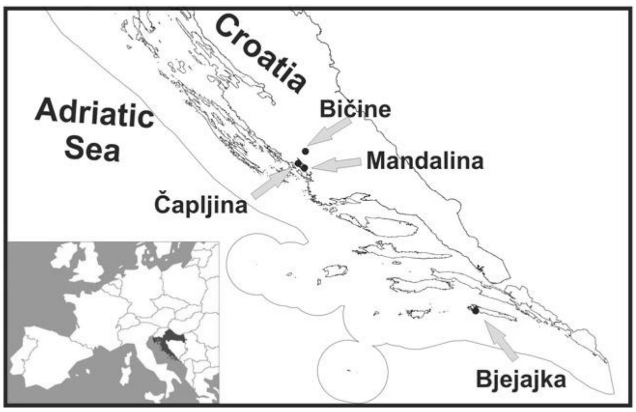

Fig. 1. Locations of researched anchialine cave

Cave waters were sampled at the surface, above and below the halocline and at the bottom by a scuba diver. Specimens were caught at same locations by traps and by hand. Mercury concentrations were determined by CV-AAS (Mercury Monitor 3200, Thermo Separation Products, USA). The concentrations of nitrogen species, phosphate and silica were measured by Perkin–Elmer Lambda 25 UV–Vis spectrometer.

Results
Total mercury concentrations (THg) were the highest in Bjejajka cave waters. The highest concentration was found below the halocline (110 ng L^{-1}), and was considerable lower to that previously reported (920 ng L^{-1}) [4]. Meanwhile, in Capljina and Mandalina caves the highest THg levels were found at the bottom (55.0 and 50.0 ng L^{-1} respectively), while in Bicina cave THg concentrations were the lowest (<3 ng L^{-1}). In the specimen tissues, THg levels ranged between 156 and 450 ng g^{-1} in Bjejajka cave, between 109 and 538 ng g^{-1} in Mandalina cave and between 49.0 and 74.5 ng g^{-1} in Capljina cave, while in Bicina cave the concentration in the tissue remained uniform (≈ 210 ng g^{-1}).

Conclusion
As a result of the endemic nature of the populations and different trophic structure of the four anchialine caves, it is still too early to determine the influence of higher mercury concentrations on the cave communities. Nevertheless, this preliminary set of data serves as a baseline for future researchers and multidisciplinary collaboration since these caves with current elevated mercury levels served as a valuable source of potable water during human history in that area.

References
1 - Bishop, E. R., Humphreys, F. W., Cukrov, N., Žic, V., Boxshall, A. G., Cukrov, M., Iliffe, M. T., Kršinic, F., Moore, S. W., Pohlman, W. J. and Sket, B. 2015. 'Anchialine' redefined as a subterranean estuary in a crevicular or cavernous geological setting. Journal of crustacean biology. 35, 4; 511-514.
2 - Cuculic, V., Cukrov, N., Kwokal, Ž. and Mlakar, M., 2011. Distribution of trace metals in anchialine caves of Adriatic Sea, Croatia. Estuarine Coastal Shelf Sci., 95, 253-263.
3 - Cuculic, V., Cukrov, N., Omanovic, D. and Jalžic, B. 2012. Preliminary study of trace metals distribution in the water column of Urinjska Špilja anchialine cave (Croatian Adriatic coast). Natura Croatica. 21, 28-31.
4 - Kwokal, Ž., Cukrov, N. and Cuculic, V. 2014. Natural causes of changes in marine environment: mercury speciation and distribution in anchialine caves. Estuarine Coastal Shelf Sci., 151, 10-20.

COMMUNITY ECOLOGY OF THE CORALLIGENOUS ASSEMBLAGES USING A METABARCODING APPROACH

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Abstract
Coralligenous habitats are bioconstructed, emblematic habitats of the Mediterranean Sea which presents a remarkably complex 3D structure resulting of the permanent dynamics between bioerosion and bioconstructions. This highly complex framework represents an habitat for around 1600 species and is so considered as one of the most important biodiversity hotspot of the Mediterranean Sea. Assessment of species diversity for this very complex habitat is very challenging, here we use a metabarcoding approach to estimate the species richness of 19 different sites of coralligenous habitats in the Bay of Marseille.

Keywords: Mediterranean Sea, Biodiversity, Conservation, Genetics

Coralligenous habitats are bioconstructed, emblematic habitats of the Mediterranean Sea which presents a remarkably complex 3D structure resulting of the permanent dynamics between bioerosion and bioconstruction. The main builders of these habitats are corallines red algae but other marine invertebrates such as bryozoans directly contribute to the frameworks of the habitats as they build their own calcareous skeletons. This highly complex framework represents a habitat for around 1600 species [1] and is so considered as one of the most important biodiversity hotspot of the Mediterranean Sea. It provides many ecosystems services such as : (i) Entertainment, coralligenous habitats are the favorite spot of divers in the Mediterranean Sea, (ii) food production, several species of high commercial values live or feed on these habitats, (iii) jewelry, as it is the habitat were the red coral is harvested, (iv) potential carbon sink as many of the organisms constituting the habitat are calcareous biocontructors. These habitats are threatened by human activities and the global change resulting of them. First mechanical degradation due to anchoring, divers' fins or nets of fisheries are responsible for a direct destructing of the habitats. Many organisms of these habitats are affected by global warming especially gorgonians which encouter mass mortality events correlated with positive thermal anomalies of the seawater. Combination of acidification and warming has been shown to have a deleterious impact on calcareous organisms of the habitats such calcareous red alga or bryozoans [2]. The increasing amount of organic matter due to human activities, invasive species and overfishing are also impacting the composition of the coralligenous communities. Moreover, as coralligenous habitats are found quite deep in the sea they are poorly studied and our lack of knowledge is probably the major constraint to the settup of efficient protection strategies.

Until now the assessment of species richness and monitoring of coralligenous habitats has been mainly conducted using conventional approaches especially direct assessment by scuba diving or based on photographs. These methods can be inefficient in detecting particular taxonomic groups or very small organisms in particular in the very complex framework of coralligenous habitats. Moreover they rely on a very good taxonomic expertise which made them difficult to apply in a monitoring purpose [3]. Metabarcoding is a fast, powerful, potentially cost effective molecular approach to study species diversity [4], and has not yet been used to study ecological communities of the coralligenous habitats.

Fig. 1. Collection of the samples by scuba diving

240 samples from 19 sites of the bay of Marseilles were collected by scuba diving (Figure 1) using a suction sampler and a hammer to extract a 10 square centimeters area of coralligenous habitats. The samples were weighted, examined and a quick counting of the different easily recognizable taxa (Figure 2) was done before crushing them with a blender.

Fig. 2. Examination of the samples in the laboratory

DNA extractions, PCR amplification of a 313 bp fragment of the COI and of the 28S gene were conducted. The first testing sequencing run on Illumina Miseq will allow us to test robustness of our molecular biology protocols by comparing the obtained results with the rapid identification method. Comparison of the results obtained on the 19 different sites and on the different ecological profiles results will allow us to establish connectivity pattern and environmental variables effects on the species diversity. Finally, we will be able to propose new monitoring strategies and indicators to monitor the coralligenous habitats.

References
1 - Ballesteros E., 2006. Mediterranean Coralligenous Assemblages: A Synthesis Of Present Knowledge. Oceanography and Marine Biology: An Annual Review, Volume 44, pp. 123-195.
2 - Rodolfo-Metalpa, R., Lombardi, C., Cocito, S., Hall-Spencer, J. M. and Gambi, M. C. (2010), Effects of ocean acidification and high temperatures on the bryozoan *Myriapora truncata* at natural CO_2 vents. Marine Ecology, 31: 447–456. doi: 10.1111/j.1439-0485.2009.00354.x
3 - Wheeler QD, Raven PH, Wilson EO (2004) Taxonomy: impediment or expedient? Science, 303, 285.
4 - Dejean T, Valentini A, Miquel C et al. (2012) Improved detection of an alien invasive species through environmental DNA barcoding: the example of the American bullfrog Lithobates catesbeianus. Journal of Applied Ecology, 49, 953–959.

BRYOZOANS AND SERPULOIDEANS IN SUBMARINE CAVES OF THE EASTERN MEDITERRANEAN

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Abstract
Bryozoan and serpuloidean communities have been examined for the first time from two submarine caves of the Aegean Sea. Preliminary results point to a high diversity for bryozoans, represented by 72 species, and a relatively low diversity for serpuloideans, which were present with 18 species. Bryozoan assemblages in the two caves shared only half species and showed different patterns of species distribution and growth adaptations, in agreement with general information for submarine cave habitats. Serpuloidean species richness weakly increased inwards accompanied by replacement of some species.

Keywords: Polychaeta, Aegean Sea, Bryozoa, Biodiversity

Bryozoans and serpuloideans from submarine caves of the Eastern Mediterranean Sea are still unknown and this paper is a first contribution to their knowledge. Two submarine caves, i.e. Fara (11-18m) and Agios Vasilios (24-40m), located in Lesvos Island (Aegean Sea), have been examined for their bryozoans and serpuloideans. The former is a 32m long tunnel ending to a dark chamber connected through a fissure with a second cave. The latter is wider in its proximal part and narrows at about 15-20m from the entrance before its blind end [1]. A total of 30 square surfaces of 400cm^2 (20x20cm) were scraped from the walls and ceilings, at progressive distance levels from the entrance, representing different assemblages and facies in the distinct light zones of the two caves [2], [3]. Bryozoans had considerable coverage. A total of 72 living species were identified with cheilostomes (57 spp.), largely prevailing over cyclostomes (14 spp.) and ctenostomes, represented by only one species. More than half of them (37 spp.) were found in both caves;32 other species were exclusively found in Agios Vasilios cave, which, exhibited the highest species richness (69 spp.). On the other hand, only 5 species were found exclusively in Fara cave, which hosted a total of 42 species. Diversity increased from the entrance to the inner zones of Fara cave, whereas the total number of species was quite stable along Agios Vasilios cave, notwithstanding changes in assemblage composition. Noteworthy, several species presented few specimens and in a small number of samples whereas only 20 species made up the bulk of the bryozoan assemblages, representing typical dwellers of cryptic habitats. Both flexible and rigid erect colonies were occasionally present whereas encrusting morphotypes largely prevailed with uni-to multilaminar and celleporiform hemispherical colonies. Spot-like species and runners were also observed. Serpuloideans presented low coverage and were represented by a total of 18 species (13 serpulids and 5 spirorbids). Most of them were present in both caves, but 4 species were exclusively found in Agios Vasilios cave. *Semivermilia crenata* was the commonest species. A weak increase in diversity was observed from the cave entrances inwards, coupled with a marked change in taxonomic composition. Nodular, fungiform and crest-like bioconstructions (up to 3-4cm in height and diameter) were observed, formed by the bryozoans *Hippaliosina depressa, Rhynchozoon neapolitanum* and *Parasmittina rouvillei*. Smaller nodular structures were often produced by *Onychocella marioni, Hippomenella mucronelliformis, Hippopodina ambita, Therenia rosei* and *Anarthropora monodon*. Tube aggregates of large-sized *Protula* specimens occurred, forming coiled donuts (up to 6cm in diameter) and plaits (ca. 8cm high and 4cm in diameter), hanging from the ceilings in Agios Vasilios and Fara cave, respectively. Although the observed patterns of bryozoan and serpuloidean species distribution and growth adaptations were in agreement with those recorded in other submarine caves[4 with references], the vast majority of the recorded taxa are new records for the cave fauna of the eastern Mediterranean Sea. Further studies are expected to increase our knowledge on the regional diversity of these understudied sessile groups in the marine cave habitat.

References

1 - Gerovasileiou V., Voultsiadou E. 2015.,Sponge diversity gradients in marine caves of the eastern Mediterranean. *JMBA UK*, 1-10.
2 - Gerovasileiou V., Vafidis D., Koutsoubas D., Voultsiadou E., 2013. Spatial heterogeneity of sessile benthos in a sub-merged cave of the eastern Mediterranean. *Rapp. Comm. Int. Médit.*, 40: 880.
3 - Gerovasileiou V., Koutsoubas D., Voultsiadou E., 2014. Spatial heterogeneity of benthic communities in a marine cave off Lesvos Island (Aegean Sea). *In:* Langar H., Bouafif C., Ouerghi A. (eds), Proceedings of the 1st Mediterranean Symposium on the conservation of dark habitats, RAC/SPA publ., Tunis, pp. 69-70.
4 - Rosso A., Sanfilippo R., Taddei Ruggiero E., Di Martino E. 2013. Serpuloidean, bryozoan and brachiopod faunas from submarine caves in Sicily. *Bollettino Società Paleontologica Italiana*, 52(3): 167-176.

PRELIMINARY DATA ON INVERTEBRATES ASSOCIATED TO *CYSTOSEIRA* COMMUNITIES FROM THE MEDITERRANEAN SEA

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Abstract
The present paper aims to provide first information about invertebrates (bryozoans, serpulids, spirorbids, ostracods and foraminifers) associated to selected *Cystoseira* communities, from the Ciclopi Islands Marine Protected Area, also contributing knowledge on distribution patterns.

Keywords: Bryozoa, Polychaeta, Foraminifera, Algae, Ionian Sea

Knowledge on epibiont communities on *Cystoseira* are scarce (Campisi et al., 1973). First information on bryozoans, serpuloideans, ostracods and foraminifers from shallow-water communities sampled in the frame of the CIMPA-BioChange Project (Biodiversity and spatio-temporal variations of *Cystoseira* communities of the Biocoenosis of the Infralittoral Algae from the Ciclopi Islands Marine Protected Area, Ionian Sea) is presented. Samples were collected in June 2015, in two sites (three stations each), few km N of Catania: Punta Aguzza (Acicastello), within the Ciclopi Islands MPA, S. Maria La Scala and S. Tecla (Acireale), outside the CIMPA. Communities in the *Cystoseira brachycarpa, C. sauvageauana* and *C. spinosa*, were sampled at 5, 9, and 25 m depth, respectively. Bryozoans are present with more than 50 species, consisting mostly of cheilostomes (41 species) and subordinate cyclostomes and ctenostomes. However, several cyclostome species (particularly *Crisia* spp. and *Patinella radiata*) are dominant, with a high number of colonies. Cheilostomes, instead, are represented by single or few colonies, except for *Aetea* spp., *Copidozoum tenuirostre* and some celleporiids.Among serpuloideans, 20 species (14 serpulids and 6 spirorbids) have been detected. Spirorbids are greatly dominant in terms of specimens, mainly belonging to *Pileolaria* spp., *Janua* spp. and *Spirorbis cuneatus.* Serpulids are mostly represented by *Josephella marenzelleri* and *Pomatoceros triqueter,* followed by *Vermiliopsis straticeps* and *Serpula vermicularis.* Ostracods include some 25 species, that are all known from shallow-water vegetate bottoms. Species belonging to the genera *Xestoleberis* (especially *X. dispar*) and *Paradoxostoma* largely prevail.Foraminifers are represented by more than 30 species. Miliolids dominate (mostly with some *Quinqueloculina* species) followed by *Elphidium* representatives. Nearly all species were found on the algal thalli. Overall, invertebrate communities show low cover values. A general trend of increasing species diversity can be traced from the shallowest to the deepest communities. The number of specimens/colonies for each of the taxonomic group analysed appears to be related to the availability of suitable microhabitats and substrata created by the hosting algal species. Differences are also evident between the two sites, with samples collected within the CIMPA, characterised by a lower species diversity and specimen/colony abundance, in relation to those collected outside the MPA. Patterns of distribution were also evident for encrusting bryozoans, with some species restricted to, or preferentially colonising the basal or the top parts of the algal thalli. Adult serpuloidean specimens were mostly localised on the axial thicker algal portions that provide a relatively firm substratum. Bryozoan colonies are invariably small but fertile, thus pointing to dominant r-strategy, as a special adaptation to the ephemeral substratum offered by the algae.

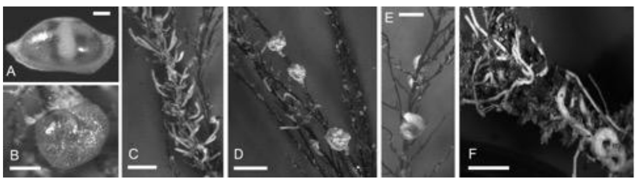

Fig. 1. A. The ostracod *Bairdia longevaginata.* Scale bar: 200 mm. SampleSM.1.S9. B. The foraminifer *Cibicides advenum*. Scale bar: 200 mm. Sample CPA.1.Z26. C. The bryozoan *Aetea anguina* on *Halopteris scoparia*. Scale bar: 1 mm. SampleST.1.Z9. D. The bryozoan *Patinella radiata* on *H. scoparia*. Scale bar: 2 mm. Sample ST.1.Z9. E. The spirorbid *Pileolaria pseudomilitaris* on *H. scoparia*. Scale bar: 1mm. Sample CPA.1.Z26. F. The serpulids *Josephella marenzelleri* (left) and *Serpula concharum* (right). Scale bar: 5 mm. Sample SM.1.Z25.

References
1 - Campisi M.R., Di Geronimo I., Furnari G., Scammacca B. (1973) - Premiéres observations sur les Algus, les Bryozoaires et les Mollusques d'un peuplement de Cystoseira dubia Valiante à l'île Lachea (Sicile orientale) . Rapp. CIESMM, 22: 51-52.

CIESM Congress Session : Marine artificial habitats
Moderator : Salud Deudero, IEO, Palma, Spain

Moderator's Synthesis

There is a worldwide increase in adding new artificial structure and substrates linked to a wide array of human activities ranging from aquaculture, energy derived structures (gas and oil platforms, offshore wind parks), coastal urbanization and recreational activities, maritime activities (harbors, marine litter…)

The session contributions covered mostly the artificial approach of increasing biomass of fishes gathered by attraction towards new substrates. The concept of mimicking the natural substrates, either in size and materials was presented as promising management units that can minimize impacts of artificial habitats related with diving activities and eco-tourism in Crete (contribution from Doumas et al.).

Evaluating spatial and temporal aggregations of fishes around gas platforms is more effectively performed by a combination of methodologies: underwater visual census, camera records and hydroacustics (contribution from Gaetani et al). In the same regard, fish community structure reveals changes in fish abundance and size around the largest artificial reefs of the Mediterranean (contribution from Özgül & Lök). Similarly, analysing the home range and movement patterns of resident species (*Scorpaena scrofa* and *S. porcus*) can be achieved with fine-scale radiotracking (contribution from Özgül & Lök).

Future concerns deal with jumping from the traditional ‘fisheries approach’ (i.e. artificial reefs, fish aggregation devices FADS…) towards innovative approaches such as the design of eco-structures, biofoulings, regulations of dumping at sea, materials for foundations and artificial structures, marine litter as a new substrate, along with the consideration of accumulative effects.

Several questions arose in the debate, especially with regard to selection criteria for habitat deployment, habitat restoration with artificial reefs, links with conservation and along with recruitment processes linked to marine corridors, stepping stones and marine litter.

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RECREATIONAL DIVING OASIS WITH ARTIFICIAL HABITATS

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Abstract
A new type of artificial habitat for recreational diving that fully retains or even exceeds the functionality of natural reefs has been developed by the Hellenic Centre for Marine Research (HCMR). The deployment of these innovative artificial structures made of concrete provides enhanced availability and diversity of microhabitats and structural refugia for reef-dwelling benthic and benthopelagic organisms while at the same time simulating the form and the aesthetics of natural reefs. By using this new technology, a network of artificial underwater "oases" suitable for recreational diving can be installed on designated small parts of the seabed, at relatively shallow depths, in the proximity of the main urban and touristic centres and in coastal areas that do not show any specific ecological, archaeological or fishing interest.

Keywords: Artificial reefs, Marine parks, Cretan Sea

The growth of marine ecotourism has resulted in ever-increasing environmental pressure and a concomitant decrease in biodiversity mainly revealed in destinations with a particular diving interest [1]. These effects are mostly due to the presence of the divers themselves. The documentation made after the taking of direct observations has shown that in almost every recreational diving activity, many incidents of unintentional or deliberate contact with marine organisms have occurred, resulting in the injury or killing of many of them [2]. The degradation of many underwater diving destinations because of massive tourism necessitates the adoption of management measures aiming at decongesting visits, such as the reduction of divers and the diverting of a proportion of visitors away from sensitive natural areas of high ecological and aesthetic value [3, 4]. One solution is the creation of artificial underwater ecotourism attractions using specially constructed artificial habitats (reefs) in an attempt to simulate the functional and morphological characteristics of the sublittoral rocky substrata, known as natural reefs. Given the documented lack of artificial reefs capable of satisfying modern recreational diving requirements [3], the main objective of the research carried out by HCMR was to overcome the drawbacks and deficiencies of the designs that exist up to now, with the development, construction and deployment of a new type of artificial reef dedicated to recreational diving. The innovative type of HCMR artificial habitat mimics the form and aesthetics of natural reefs while fully retaining or even exceeding their functionality. These artificial habitats provide an enhanced availability and heterogeneity of many microhabitats and structural refugia suitable for the attraction and final settlement of various benthic and benthopelagic organisms. Twelve experimental reef units were deployed in May 2015 at 20 m depth on a silty-sand bottom covered by scarce patches of *Caulerpa prolifera* at the Underwater Biotechnological Park of Crete (UBPCrete), a marine protected area located on the north coast of Crete. Made of concrete, they had the general form of an upright elongate monolith ranging in size between 2 m width at the base and 2.0 to 2.3 m height. They are characterized by an extensive structural complexity as they provide extensive vertically or almost vertically delimited surface at the exterior; in this way they comprise a plurality of irregular corrugations in the form of successive recesses and overhangs emulating the micro-texture of underwater rock. Irregularly-sized blind holes of varying diameter and depth were created at selected locations of the exterior surface. Furthermore, inwardly-oriented through or blind crevices of varying sizes and thickness have been formed that perpendicularly, obliquely or transversely pass through large parts of the main structure. Special wider chambers that communicate with the external environment through these crevices are constructed in the interior of the units. All these configurations have provided microhabitats and refugia to a wide size range of reef-dwelling fish (e.g. goldblotch and dusky groupers, white and common two-banded seabreams, etc.). These organisms found permanent shelter within the structures of the experimental HCMR artificial habitats only a few weeks after their deployment in the UBPCrete. According to preliminary results from a visual fish census survey the external surface of all experimental reef units were occupied by dense populations of damselfishes (*Chromis chromis*) even from the first week of reef deployment. Within three weeks the external holes of the reefs were inhabited by eleven individuals of goldblotch groupers (*Epinephelus costae*) of various sizes while in less than two months six individuals of dusky groupers (*Epinephelus marginatus*) were encountered. Furthermore, many individuals of Sparidae (*Diplodus sargus sargus* and *Diplodus vulgaris*) were also recorded in the crevices and the inner canals and chambers of the reef units. It should be noted that throughout the period of visual observations no macroalgae or other fouling organisms were visible to the naked eye on the external surface of the experimental reefs, most probably due to the extreme summer oligotrophic conditions which prevailed locally. Furthermore, the north coasts of Crete are characterized by a scarcity of sublittoral natural reefs suitable for crevice-dependent fish which are rare in the study area. This innovative technology mimics the natural rocky reef habitat to such a degree that it can substitute or even avert to some extent the modern trend of establishing recreational diving parks in remote and environmentally sensitive natural reef areas of outstanding ecological and conservation importance. By using this new technology, a large number of artificial underwater oases suitable for recreational diving could be installed on small areas of the seabed (e.g. 20,000-30,000 m²), at relatively shallow depths (from 15 to 30 metres), near main urban and touristic centres and in coastal areas of no specific ecological, archaeological or fishing interest. The development of a network of such recreational diving oases may offer many advantages. Their installation even in environmentally degraded coastal areas is expected to contribute to the protection and upgrading of the local environment. Recent research has shown a significant and in many cases irreversible environmental degradation in numerous natural diving destinations characterized by mass ecotourism. Also, their installation near large tourist and urban centres may offer easy access and efficient control of diving activities, while it may provide protection and upgrading of the neighbouring marine ecosystem supporting biodiversity and increasing local fish stocks. As management tools, they could ensure acceptance and coexistence with other end-users of the coastal zone. Finally they may offer opportunities for marine education and training activities, exercise and entertainment.

References

1 - Hasler H., Ott J.A., 2008. Diving down the reefs? Intensive diving tourism threatens the reefs of the northern Red Sea. Marine Pollution Bulletin, 56 (10), 1788–1794.
2 - Di Franco A., Millazo M., Pasquale B., Tomasello A., Chemello R., 2009. SCUBA diver behaviour and its effects on the biota of a Mediterranean marine protected area. Environmental Conservation, 36, 32-40.
3 - Stolk P., Markwell K., Jenkins J., 2007. Artificial reefs as recreational scuba diving resources: A critical review of research. Journal of Sustainable Tourism, 15 (4): 331-350.
4 - Van Treeck P., Schuhmacher H., 1998. Mass diving tourism – A new dimension calls for new management approaches. Marine Pollution Bulletin 37 (8–12), 499–504.

SPATIAL DISTRIBUTION OF FISH ASSEMBLAGES AROUND A GAS PLATFORM

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Abstract
The spatial distribution and abundance of fish assemblages surrounding an offshore gas platform was investigated through underwater camera records, hydro-acoustic (Multibeam echousounder, MBES) and fishing surveys. Matching different methodologies, it was possible to deduce the species detected through the acoustic surveys.

Keywords: Fish behaviour, North Adriatic Sea, Acoustics

Introduction - Research on abundance and composition of fish assemblages surrounding offshore platforms is essential to evaluate the impacts of these structures in terms of potential increase in biomass and to understand the relationships between natural and artificial habitats [1]. In this study, the spatial distribution of fish assemblage was investigated around a three legs gas extraction platform placed at 80 m depth in the central Adriatic sea. Surveys were carried out since the end of its installation: hydro-acoustic investigations, fishing captures and underwater video camera.

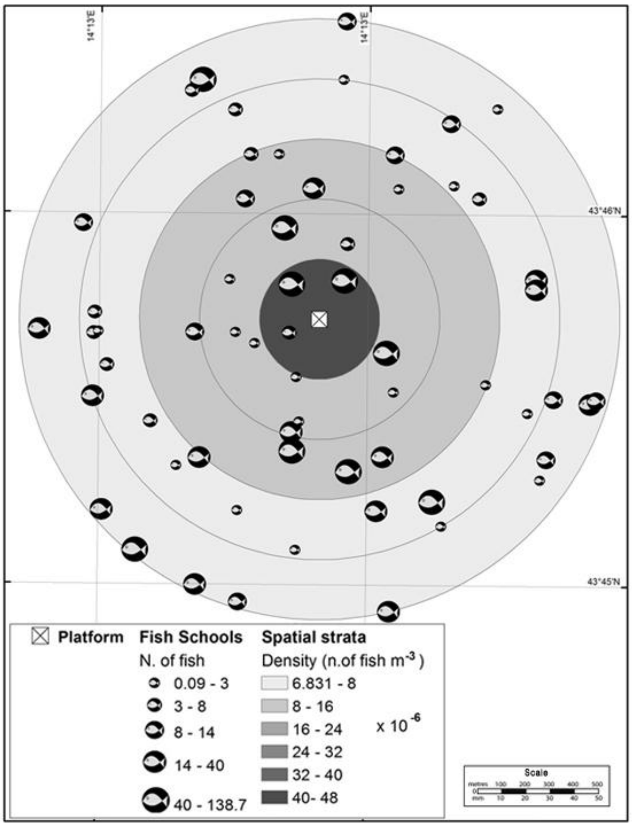

Fig. 1. Spatial distribution and density of shoals for one year after installation

Methods - MBES surveys were carried out using a high-resolution 300-kHz EM3002D (Kongsberg Simrad), a dual head system which offers the potential of detecting fine-scale distribution of fish aggregation, combining its ability to detect at the same time the seafloor and the water column. The water column was investigated monthly for one year after the installation, at the same time of day, at a speed of 5 knots, in condition of calm sea or little moved. A squared area of 1.5 x 15 Km, focused on the platform was investigated with a total coverage. Fishing surveys were performed monthly, for one year, using a bottom trammel net. The nets were lowered at sunset and recovered at dawn within a 50 m radius from the platform and at two reference sites located at the same depth (80 m depth) but 1.800 m away from the structure. The underwater camera videos were monthly recorded just close to the platform to detect fish at different depths along the water column. Acoustic raw data were processed using a 3D school detection algorithm to extract target models and related metric and acoustic features. As EM3002D system is not calibrated for the identification of particular fish species, it was considered a frequency based target strength (-30/-54 dB) [2] and a dimensional range (80 cm in XYZ) according to the size of experimental catches. Processing MBES bathymetric and water column data, 3D virtual scenes of the artificial habitat were created, receiving an intuitive-looking depiction of its state and allowing overtime to evaluate its change in terms of dimensional characteristics and depth fish schools' disposition. GIS analysis were carried out to spatially investigate the influence of the platform on the fish assemblages using concentric spatial with increasing offset: 150m, 300m (the radius of influence of the platform in a natural habitat [3]), 450m, 600m and 750m (study area extent). Densities (fish m-3) were computed spatial joining circular strata with intersecting fish schools, summing relative fish abundances and standardizing by strata volumes (Fig.1).

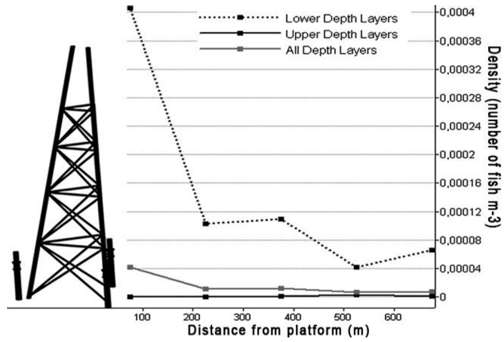

Fig. 2. Mean horizontal fish density for different depth layers

Results - Fish distribution varied significantly with depth layers: the 73% of fish schools were detected in the first 10 m from the bottom and usually aggregate around the platform. Basing on video and fishing surveys, these schools could be attributed to necto-benthic or pelagic species partially attracted by artificial and/or natural substrates (*i.e., Pagellus bogaraveo, Trisopterus minutus capelanus, Boops boops and Trachurus trachurus*). Along the water column, density decreased with distance from structure from 7x10-6 to 42x10-6 fish m-3 (Fig. 2). This decreasing was more underlined (from 42x10-6 to 406 x10-6 fish m-3) for the deepest schools, while the shoals occurring in the upper depth layers were scattered in the overall area with a density from 0.001 x10-6 to 2,86 x10-6 fish m-3. These superficial schools are likely made of not attracted pelagic species such as *Engraulis encrasicolus and Sardina Pilchardus*.

References
1 - Fabi G. and Sala A., 2002. Assessment of biomass and diel activity of fish at an artificial reef (Adriatic sea) using stationary hydroacoustic technique. *ICES J. Mar. Sci.*, 59: 411-420.
2 - Mccartney B.S. and Stubbs A.R., 1971. Measurements of the acoustic target strengths of fish in dorsal aspect, including swimbladder resonance. *J. Sound Vib.* 15(3): 397-420.
3 - Scarcella G., Grati F. and Fabi G., 2011. Temporal and spatial variation of the fish assemblage around a gas platform in the Northern Adriatic Sea, Italy. *Turk. J. Fish. Aquat. Sci.*, 11: 433–444.

MOVEMENT PATTERNS OF BLACK AND RED SCORPION FISH ON ARTIFICIAL REEFS IN THE AEGEAN SEA, TURKEY

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Abstract
This paper presents the results of an application of a new ultrasonic telemetry method for black scorpionfish (*Scorpaena porcus*) and red scorpionfish (*Scorpaena scrofa*) inhabiting an artificial reefs in the northern Aegean Sea, Turkey. The objective of the study was the use of Vemco Positioning System (VPS) methods to determine the residency and fine-scale movements of both species around artificial reefs. The results provided proof for a variety of aspects of the behavioural biology of both species, including strong site-fidelity and low levels of mobility around artificial reefs The results can be offer useful approach to decision makers in the field of sustainable fisheries in artificial reef sites.

Keywords: Artificial reefs, Fish behaviour, Acoustics, Aegean Sea, Fisheries

Artificial reefs have been widely implemented as tools for biodiversity conservation and fisheries management, amongst other goals. *S. porcus* and *S. scrofa* are associated with artificial habitats in the Mediterranean Sea [1, 2]. However, fine-scale movements and use of artificial reefs by both species is unclear. This paper, aims to report the residency and movements of these species around artificial reefs, using the VPS. The study was carried out between August 2013 and August 2014 in the Gulf of Edremit in the Northern Aegean Sea. The artificial reefs area was created by The Republic of Turkey Ministry of Food, Agriculture and Livestock between 2009 and 2012 which consist on ~7000 concrete blocks and approximately 3.7 km^2, it runs parallel to the coastline and has depths ranging between 12 and 32 m (Fig.1).

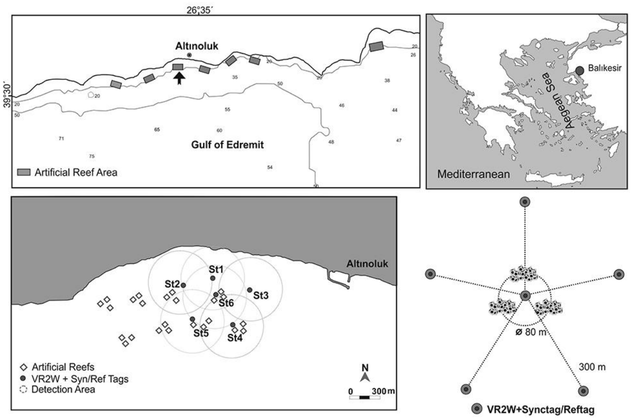

Fig. 1. Artificial Reef Area and VPS Design for Artificial Reefs

Movements of tagged fish within the artificial reef site were tracked using the VPS, which consists of receiver, synchronization tags and data processing [3]. In this study, six receivers (Vemco VR2W) were placed around the artificial reefs using a pentagonal design. Fourteen *S. porcus* (X = 23.3 cm TL) and seven *S. scrofa* (X = 32.1 cm TL) were caught with trammel nets and were surgically implanted with Vemco V8 and V9 tags. After surgery fish were released in artificial reefs with divers. To quantify the degree of site fidelity of tagged fish in the study area a residency index (RI) was calculated. In the present study, a total of 936867 detections were downloaded from the array of receivers and a total of 85442 positions were determined by the VPS system. The VPS system calculated the highest number of positions (45859) for fish coded T01 while no positions were calculated for T07 and T18. The tagged fish, the rates of detection and calculated positions are summarized in Table.1.

The tagged *S. porcus* and *S. scrofa* were found to have stayed in the artificial reef area for average 22.8 ± 4.4 days and 61.3 ± 10.1 days respectively. Average residency index (RI) values, defined in relation to the position of the acoustic array were 0.88 ± 0.10 for *S. porcus*, and 0.95 ± 0.00 for *S. scrofa*. These values show that both species have high interactions with artificial reefs. Fish size was not significantly correlated with residence index. However, there were significant correlations between fish size and total period of detection ($p<0.05$).

Tab. 1. Characteristics of tagged *S. porcus* and *S. scrofa* (TL: Total length; TP: period between the release date and the last detection; DD: total number of days detected; RI: residence index).

Fish ID	Species	TL (mm)	Weight (g)	Tag	Detections	Positions	TP (d)	DD (d)	RI
T01	S.scrofa	445	1347.6	V9-2H	262559	45859	102	99	0.97
T02	S.porcus	271	359.4	V9-2H	158398	21098	48	48	1.00
T03	S.scrofa	364	852.2	V9-2H	35954	5788	48	48	1.00
T04	S.porcus	211	162.8	V8-4H	16071	408	34	34	1.00
T05	S.porcus	195	121.4	V8-4H	7197	145	25	25	1.00
T06	S.porcus	182	109.4	V8-4H	32117	1874	24	24	1.00
T07	S.porcus	196	123.5	V8-4H	101	0	1	1	1.00
T08	S.porcus	238	275.3	V8-4L	2421	16	7	6	0.86
T09	S.porcus	206	170.5	V8-4L	1256	16	15	6	0.40
T10	S.scrofa	275	341.3	V9-2H	10158	65	57	57	1.00
T11	S.scrofa	275	224.3	V9-2H	94146	776	91	91	1.00
T12	S.porcus	277	395.0	V9-2H	12626	527	23	23	1.00
T13	S.porcus	253	288.0	V9-2H	171737	3021	59	59	1.00
T14	S.porcus	240	287.3	V9-2H	47921	3278	15	15	1.00
T15	S.porcus	245	238.5	V8-4H	309	2	25	8	0.32
T16	S.porcus	223	181.9	V8-4L	7890	13	30	28	0.93
T17	S.porcus	269	370.0	V8-4L	5099	43	12	10	0.83
T18	S.scrofa	259	271.2	V8-4L	4225	0	23	22	0.96
T19	S.scrofa	376	1008.1	V9-2H	32559	1892	54	38	0.70
T20	S.scrofa	252	236.1	V9-2H	33751	590	54	54	1.00
T21	S.porcus	259	305.1	V9-2H	372	31	1	1	1.00

Acoustic telemetry can be an extremely useful tool to understand the behavior and movement models of the fish type in artificial reefs. This study has contributed new information on black and red scorpion fish movements at artificial reefs and is the first to focus on movements and habitat use of these species using VPS. Acoustical data indicate that artificial reefs and nearby areas provided suitable habitat for *S. porcus* and *S. scrofa* for ecologic reasons [4]. Both species fish showed that clear homing behavior and strong site fidelity. In future studies, should be increased the number of tagged fish and monitoring time to understand fish behaviors in artificial reef area. This will provide us with better understanding of the relationship between fish and artificial reefs and fish and fishermen.

Acknowledgements: This study is funded by TÜBITAK (TOVAG-1120383). We thanks to our colleagues, students and fishermen in Altinoluk for their help during to sea trials.

References

1 - Moreno, I. 2002. Effects of substrate on the artificial reef fish assemblage in Santa Eulalia Bay (Ibiza, Western Mediterranean). *ICES J. Mar. Sci*, 59: 144-149.
2 - Fabi, G., Gtati, F., Puletti, M., Scarcella, G. 2004. Effects on fish community induced by installation of two gas platforms in the Adriatic Sea. *Mar. Ecol. Progr. Ser*, 273:187-197.
3 - Espinoza, M., Farrugia, T.J., Webber, D.M., Smith, F., Lowe, C.G., 2011. Testing a new acoustic telemetry technique to quantify long-term, fine-scale movements of aquatic animals. *Fish. Res*, 108: 364–371.
4 - Bohnsack, J. A. 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioral preference? *Bull. Mar. Sci*., 44:631–645.

FISH COMMUNITY STRUCTURE ON ARTIFICIAL REEFS IN THE NORTHERN AEGEAN SEA, TURKEY

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Abstract

The aim of study is to determine fish community structure around the artificial reefs deployed on Gulf of Edremit in the Northern Aegean Sea, from June 2013 to July 2015. Underwater visual census technique was used to determine fish species, number of individual and size estimation. A total of 46 species from 21 families were recorded; among the most abundant species were: *Diplodus vulgaris* (98,7 kg), *Chromis chromis* (2,9kg), and *Sciaena umbra* (145,2 kg).

Keywords: Artificial reefs, Biodiversity, Fisheries, Edremit Bay, Aegean Sea

An artificial reef is a submerged structure deliberately placed on the seabed to mimic some functions of a natural reef, such as protecting, regenerating, concentrating and/or enhancing populations of living marine resources [1]. Artificial reefs have been deployed along the coast of Aegean Sea, Turkey since 1990 to enhance artisanal fisheries, protect marine biodiversity and also diving tourism. This study focused on the description of composition, abundance and seasonality of fishes associated with artificial reefs in the Gulf of Edremit in the northern Aegean Sea. Artificial reef area was created in 2009 by The Ministry of Food, Agriculture and Livestock, and consists of 215 sites each of 30 concrete blocks in seven different fields, with the aim to promote small-scale fisheries and protect marine biodiversity (Fig. 1).

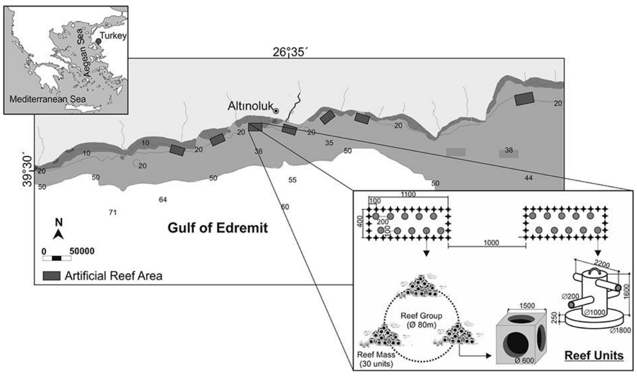

Fig. 1. Study site and Design of Artificial Reefs Area

Fish communities were sampled by scuba divers. The same divers undertook censuses of all fish at the same time of day, identified the species and estimated individual sizes using visual census methods. The three artificial reef sets were visited monthly during all the observations. Differences between seasons, species composition and abundance were determined by the Mann-Whitney U test. Species' diversities for the seasons were calculated by the Shannon–Wiener index (H′).

During the study period a total 5578 fish comprising of 21 family and 46 species were recorded. By far the most abundant observed families were Sparidae, Labridae and Serranidae. Thirty five species were classified as of commercial value and carnivores were clearly dominant (Table 1). Diversity index (H´) values changed between 2.54 and 3.56 according to seasons. While the highest value H´ was in the summer, the lowest value was in the autumn. Bray-Curtis similarity analysis observed the highest similarity (86.3%) between spring and winter.

Recorded number of species in this study was higher than other artificial reefs in the Mediterranean; 44 species in Italy [2] 21 species in Spain [3], 40 species in France [4]. Although some species and families are similar to those by the above, most of them were found to be different, the reason for which is that there are variable oceanographic characteristics between the seas [4]. Those results will be of importance to the success of artificial reef projects, especially as regards their use as a tool for fisheries management.

Acknowledgements:This study was funded by Turkish Scientific and Technological Research Council (TÜBITAK Project No: 1120383).

Tab. 1. List of species and total number recorded on the artificial reef (*Economic value, C: Carnivore, O: Omnivore, H: Herbivore).

Family	Species	Trophic Tendency	Abundance	Biomass (g)	Length (cm)
Scombridae	*Scomber japonicus**	C	100	260.0	5.0
Clupeidae	*Sardina pilchardus**	C	100	157.0	5.0-8.0
Carangidae	*Trachurus trachurus**	C	1	8.7	12.0
Sparidae	*Dendex dentex**	C	38	14411.4	15.0-45.0
	*Oblada melanura**	C	133	23931.5	10.0-30.0
	*Boobs boops**	O	173	4054.9	5.0-20.0
	*Diplodus puntazzo**	O	119	1967.1	10.0-30.0
	*Diplodus sargus**	C	261	59375.2	8.0-40.0
	Diplodus annularis	C	287	11957.5	5.0-20.0
	*Diplodus vulgaris**	C	1626	98649.7	5.0-40.0
	*Spondyliosoma cantharus**	C	341	20509.5	10.0-25.0
	*Pagellus erythrinus**	C	16	1150.4	10.0-40.0
	*Sparus aurata**	C	68	14625.4	15.0-45.0
	*Pagrus pagrus**	C	2	67.3	10.0-14.0
	*Sarpa salpa**	H	10	3252.0	30.0-35.0
Centracanthidae	*Spicara maena**	O	355	27611.9	10.0-30.0
Scorpaenidae	*Scorpaena scrofa**	C	24	2208.5	5.0-30.0
	*Scorpaena porcus**	C	32	2624.7	5.0-30.0
	*Scorpaena notata**	C	22	1054.0	5.0-15.0
Triglidae	*Trigla lucerna* *	C	1	127.2	25.0
Mugillidae	*Liza aurata**	O	10	3652.3	20.0-25.0
Balistidae	*Balistes capriscus**	C	8	1442.3	20.0-30.0
Pomacentridae	*Chromis chromis*	C	845	2844.2	5.0-10.0
Gadidae	*Physic physic**	C	10	2228.7	10.0-45.0
	*Merluccius merluccius**	O	54	4292.1	20.0-25.0
Sciaenidae	*Sciaena umbra**	O	316	145184.5	20.0-40.0
Labridae	*Labrus merula*	O	6	407.7	13.0-20.0
	Symphodus mediterraneus	O	3	542.6	15.0
	Symphodus tinca	C	9	851.9	15.0-30.0
	Labrus viridis	O	6	788.1	10.0-15.0
	Coris julis	O	1	52.3	17.0
Blennidae	*Blennius ocellaris*	O	1	16.6	10.0
	Parablennius rouxi	O	4	19.1	4.0-5.0
Zeidae	*Zeus faber**	C	1	3.2	5.0
Mullidae	*Mullus barbatus**	O	7	395.3	8.0-20.0
	*Mullus surmuletus**	O	8	1492.4	10.0-35.0
Serranidae	*Serranus cabrilla**	C	38	2416.6	10.0-30.0
	*Serranus scriba**	C	29	4192.3	5.0-40.0
	Serranus hepatus	C	12	269.8	4.0-12.0
	*Epinephelus costae**	C	1	18.8	7.0
Blenniidae	*Parablennius rouxi*	O	20	68.0	5.0-8.0
Congridae	*Conger conger*	C	5	2519.9	50.0-100.0
Rajidae	*Myliobatis aquila**	C	1	1300.0	40.0
Crustacea	*Palinurus vulgaris**	C	1	15.0	6.0
	*Homarus gammarus**	C	2	2800.0	40.0-45.0
Cephalopoda	*Octopus vulgaris**	C	4	7650.0	
	Total		**5578**	**541902.4**	

References

1 - Seaman, W., 2000. Artificial Reef Evaluation with Application to Natural Marine Habitats. CRC Press, Boca Raton, USA.
2 - Relini, G., Relini, M., Torchia, G., Palandri, G., 2002. Ten years of censuses of fish fauna on the Loano artificial reef. *ICES J Mar Sci*, 59, 132–137.
3 - Bayle-Sempere, J. T., Ramos-Espla ´, A. A., and Charton, G. 1994. Intra-annual variability of an artificial reef fish assem- blage in the marine reserve of Tabarca (Alicante, Spain, SW Mediterranean). *Bull. Mar. Sci.*, 55: 824–835.
4 - Charbonnel, E., Serre, C., Ruitton, S., Harmelin, J.G. and Jensen, A. 2002. Effects of increased habitat complexity on fish assemblages associated with large artificial units (French Mediterranean coast). *ICES J Mar Sci*, 59: 208-213.

CIESM Congress Session : Zooplankton I

Moderator : Maria-Luz Fernández de Puelles, IEO, Palma, Spain

Moderator's Synthesis

Zooplankton in general and its main role in transferring organic matter throughout the marine food web were presented in this session. The importance of zooplankton time series, stressing the diversity key role, was also highlighted, as signal of the impact of climate change. The high decrease of taxonomists in past decades should encourage young generations and policy institutions for further research, as complementary to zoo-images, automatic and acoustic technics but never in substitution of them. Finally the role of the Mediterranean Sea in the relation of the global climate system, particularly of the Atlantic Ocean, was indicated.

In addition were presented:

- the case of the zooplankton time series in the Baleares area during 13 years as signal of climate change and several studies in relation to different topics on zooplankton at different Mediterranean areas; - pollution in main zooplankton groups of the Black Sea and their metal concentration ranges. - the interest of studies on the microzooplankton community and its distribution in the Adriatic, Black Sea and Egyptian waters. - Seasonal distribution species (copepods, appendicularians, etc.) in the Black Sea, among other areas, were defined. - Several alien species in the Black Sea and neighbouring areas in relation to autochthonous species were also shown. Moreover, the importance of new zooplankton species coming into the Mediterranean through the Suez Canal was noted, particularly in Egyptian waters. - Finally, acoustic krill identification was presented in the Spanish Mediterranean Sea.

INVESTIGATION ON METAL CONCENTRATIONS AND ABUNDANCE OF THE SOUTH EASTERN BLACK SEA PLANKTON

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Abstract

Seasonal changes of some metal concentrations and planktonic groups abundance in plankton were investigated in Sürmene shore (Trabzon) of the South Eastern Black Sea from July 2010 to may 2011.Results showed that average metal concentrations in plankton decreased in the order; 270.42 (Zn), 45.08 (Ni), 24.49 (Cu), 14.61(Pb), 11.32 (Mn), 9.49 (As), 3.88 (Cr), 2.32 (Cd), 0.84 (Co), 0.62 (Mo) mg/kg dry weight respectively. Most kind of plankton groups as Dinopyhlagellate, Copepod, Cladocera and Bivalve were observed in July.

Keywords: Metals, Black Sea, Plankton

Introduction Heavy metals have interested considerable attention because of their environmental persistence, tend to be concentrated in aquatic organisms and negative effect on organisms in the aquatic environment [1], [2]. Metals coming from planktonic organism accumulate rapidly along the food chain. Because plankton are the main diet for many aquatic organism. So the metal concentration in planktonic organisms are very important. The objective of this study was to determine the metal concentrations and abundance of plankton groups in the nearshore and off-shore of Sürmene in Trabzon of the South Eastern Black Sea.

Material and Methods Plankton samples were collected seasonally from 50 cm upper layer of Black Sea horizontally with 200 µm mesh size Hensen type plankton net from nearshore (0.5 miles and 50 meters depth) and off-shore (10 miles and 750 meters depth) stations**.** Samples dried with freeze dryer after filtered. A temperature-controlled microwave heating device was used for digestion of the dried plankton. About 0.5 g homogenized samples were taken and placed into digestion flasks. Ultrapure concentration HNO_3 and H_2O_2 (7:1 v/v) was added on the samples and heated to 200^{o}C until dissolution. Sample preparation was carried out according to the procedure [3], [4]. After dissolution, samples diluted with ultra-pure water. Cobalt (Co), Chromium (Cr), Copper (Cu), Nickel (Ni), Cadmium (Cd), Arsenic (As), Lead (Pb), manganese (Mn), Molybdenum (Mo) and Zinc (Zn) were determined by ICP-MS (inductively coupled plasma mass spectrometry) [5].The Collosion Reaction Interface (CRI) was used during the determination of As. All data were given mg/kg dry weight (dw).

Results and Discussion Dinoflagellate (*Noctiluca scintilans*) and Copepod were the dominant groups in all seasons. However, Dinoflagellate, Copepod, Cladocera and bivalves were the most abundant plankton groups in July 2010. Copepods and dinophylagellates were determined as the most abundant species in the all seasons. Cobalt (Co), Chromium (Cr), Copper (Cu), Nickel (Ni) and Molybdenum (Mo) were increased, depending on the season except for autumn. Dinophylagellate abundance showed a smilar seasonal trend with Co, Cr, Cu, Ni and Mo.

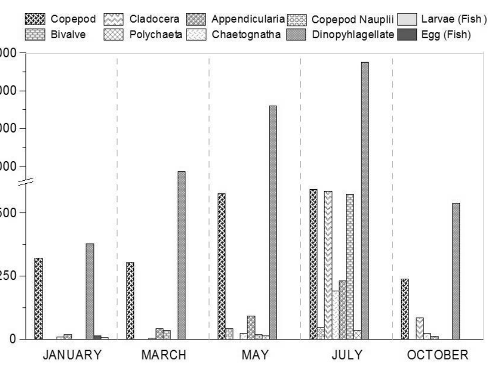

Fig. 1. Seasonal groups abundance(ind m^{-3}) in plankton samples

Manganese (Mn) concentrations were changed depending on season. While the highest Mn concentrations were measured during winter, the lowest measured in summer. The high Mn concentration may be associated with abundance of fish eggs and larvae especially during the winter. Abundance bivalve, cladocera and chaetognatha were increased during the summer. Relatively higher lead (Pb) and cadmium (Cd) concentration may be associated with this stuation.

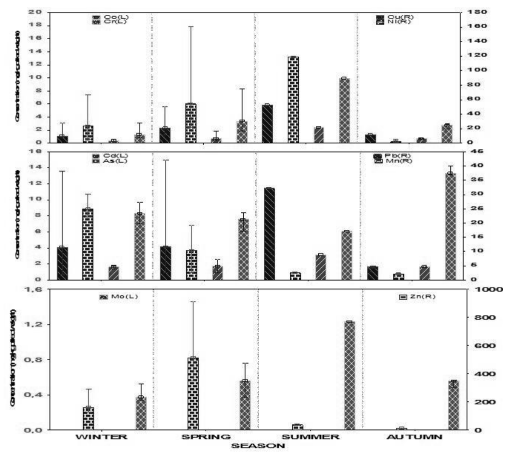

Fig. 2. Seasonal metal concentration (Co, Cr, Cu, Ni, Cd, As, Pb, Mn, Mo and Zn) in plankton samples

Conclusion

Metal concentrations of plankton are influenced by seasons and plankton abundance.

References

1 - Atici A., Ahiska S., Altindag A. and Aydin D., 2008. Ecological effects of some heavy metals (Cd, Pb, Hg, Cr) pollution of phytoplanktonic algae and zooplanktonic organisms in Sariyar Dam Reservoir in Turkey, African Journal of Biotechnology, pp 1972- 1977.

2 - Altindag A., Yigit S., 2005. Assessment of heavy metal concentrations in the food web of lake Beysehir, Turkey, Chemosphere, PP 552- 556.

3 - Milestone., 2011. Aplication note HPR-FO-17. Available at: http://www.milestonesci.com/index.php/product-menu/digestion/ethos-ez/digestion-resources/ digestion-apps/ finish/158/931.html. (accessed 17 March 2011).

4 - Richard O ., 2002. Analytical methods for heavy metals in the environment. Heavy Metals in the Environment. CRC Press.

5 - Alkan N., Alkan A., Gedik K. And Gedik K., 2013. Assessment of metal concentrations in commercially important fish species in Black Sea, Toxicology and Industrial Health, pp 1-10.

SMALL OITHONID COPEPODS IN THE NORTHEASTERN MARMARA SEA

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Abstract
Abundance, population structure and salinity tolerance as an index of adaptive capacity were studied in cyclopoid copepods *Oithona nana* and *Oithona davisae* in the Golden Horn Estuary and adjacent Marmara Sea during October 2015. For comparison the data on *O. davisae* from Sevastopol Bay (Black Sea) and *Oithona similis* (common for all studied regions) were presented. Our field and laboratory data suggested high adaptive potential in *O. davisae* recently penetrated from the Black Sea into the Marmara Sea.

Keywords: Copepoda, Marmara Sea, Salinity

Introduction
Warm-water *Oithona nana* and cold-water *Oithona similis* were the only mass small oithonids in the Marmara Sea and Bosphorus area before the appearance of alien estuarine *Oithona davisae* in this region in 2014 [1, 2]. All these oithonids of the Black Sea origin inhabited upper layers of the Marmara Sea with low salinity of about 18 psu. To understand the invasion success of *O. davisae*, we conducted comparative population studies of *O. nana* and *O. davisae* in the Marmara Sea and Golden Horn Estuary and *O. davisae* in the Black Sea (Sevastopol Bay) during the same period (November 2015). In order to evaluate the environmental adaptability of *O. davisae*, we compare their salinity tolerance with that of *O. nana* and *O. similis*.

Material and methods
Horizontal hauls (30 m) at the depth of 1 m with a Nansen net (100 µm mesh size, 0.5 m diameter) were performed for calculating the abundance of copepodites and adults of the studied species. To determine the number of nauplii and early copepodite stages, synchronously to net tows the integrated sea water samples were collected by plastic sampler of 10 L along the net track from the same depth. In the laboratory experiments females of studied species collected at 18 psu were subjected at 20 C to a gradual salinity decrease or increase at a rate of 2-3 psu per h during 6 - 10 h. Salinity tolerance ranges of the copepods were estimated taking into account the lethal salinity values affecting 50 % of the initial number (LS_{50}) of individuals in 24 h after salinity changes.

Results and Discussion
The data obtained showed that age structure of *O. davisae* populations, as in the Golden Horn Estuary, as in the Marmara Sea, was similar to that in Sevastopol Bay in the same period. Total density of *O. davisae* populations in the Marmara Sea, Golden Horn Estuary and Sevastopol Bay amounted to 151000, 95000 and 342000 ind m^{-3}, respectively (Fig. 1A). In all studied areas we did not observe significant differences in population age structure which indicated close reproduction modes. Therefore, at present time the parameters of *O. davisae* population in the Marmara Sea are close to those in Sevastopol Bay where this species appeared 14 years ago. Moreover, dominating of *O. davisae* over *O. nana* in the Marmara Sea and especially in the Golden Horn Estuary can be evidence of the process of competitive exclusion of *O. nana* from the zooplankton community. The salinity tolerance range after one day following gradual salinity change with the rate of 2-3 psu per h in alien *O. davisae* (5 – 45 psu) was much wider than those in indigenous *O. similis* (10 – 30 psu) and especially in *O. nana* (15 – 28 psu) (Fig. 1B). This indicates higher adaptive capacity of Asian estuarine *O. davisae* [3] in comparison with marine small oithonids of the Marmara and Black Sea areas.

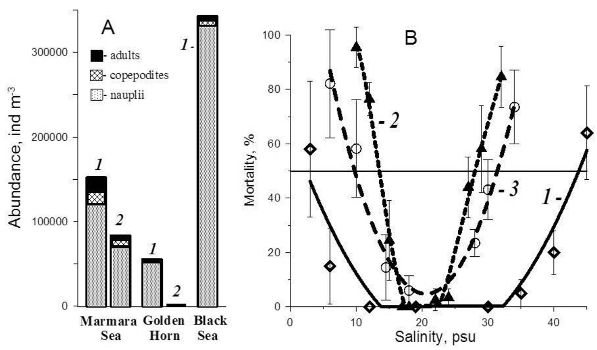

Fig. 1. Abundance and population structure (A) of *Oithona davisae* (1) and *Oithona nana* (2) in October 2015 in the Marmara Sea, Golden Horn Estuary and Black Sea, and salinity tolerance ranges (B) of *Oithona davisae*, *Oithona nana* and *Oithona similis* (3).

Acknowledgements
The present study was partly supported by the Scientific and Technological Research Council of Turkey (114Y424) and the Research Fund of the Istanbul University (IRP-49165).

References
1 - Dogan G. and Isinibilir M. First report of a new invasive species *Oithona davisae* Ferrari and Orsi, 1984 (Copepoda: Cyclopoida) in the Marmara Sea. Turkish Journal of Fisheries and Aquatic Science, in press.
2 - Isinibilir M., Svetlichny L., Hubareva E., Yilmaz I.N., Ustun F., Belmonte G., Toklu-Alicli B. 2011. Adaptability and vulnerability of zooplankton species in the adjacent regions of the Black and Marmara Seas. Journal of Marine Systems, 84:18–27.
3 - Ferrari F. And Orsi J. 1984. *Oithona davisae*, new species, and *Limnoithona sinensis* (Burkckhard, 1912) (Copepoda: Oithonidae) from the Sacramento-San Joaquin Estuary, California. Journal of Crustacean Biology 4 (1): 106–126.

MICROZOOPLANKTON IN THE SOUTH ADRIATIC SEA

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Abstract

An oceanographic cruise has been carried out in the South Adriatic (May 2013) in the frame of the FP7 project CoCoNET for the study of connectivity among coastal MPAs. To assess the existence of pelagic propagules, an investigation of plankton composition was performed. Here the results relative to the micro-zooplankton fraction are presented. A total of 142 taxa were recognized from a total of 156 samples collected. The statistical elaboration of data allowed us to establish, for the surface samples, that the assemblages identified at least four main geographic areas. In the north, surface microzooplankton showed a similar composition between Montenegro and Apulia. In the south (Otranto channel), notwithstanding the smaller distance of the two coasts, the opposite sides remained well distinct.

Keywords: Biogeography, Mediterranean Sea, Mapping, Zooplankton

Introduction. The South Adriatic Sea is affected by two coastal currents of surface waters with different abiotic features. The southerly directed waters, along the Italian coast, show lower salinity and higher nutrient concentration [1], while the northerly ones, moving along the Balkan coast, are saltier and warmer [2]. The plankton generally show a community structure influenced by primary production which, in the Adriatic sea, typically describes East–West and South–North gradients [3]. The scant knowledge of the microplankton community, in general, encouraged to consider it in a recent study carried out for the individuation of biological possible connectivity among the two opposite coasts of the south Adriatic basin (FP7 project CoCoNET).

Material and Methods. An oceanographic cruise has been carried out in the South Adriatic sea and Otranto Channel in May 2013, to study the geographic distribution of plankton. Micro-zooplankton has been collected with Niskin bottles (each sample, 5 liters) arranged around a rosette device, at bottom and surface of 39 stations. The surface collection has been carried out between 0.5 and 1.5 m below the sea level; the bottom collection has been carried out at 3-5 m from the sea floor, in a depth range of 27 - 1170 m below the sea level. Each 5 L sample was filtered throughout a sieve of 10 µm of mesh size. At each position (bottom and surface), samples have been collected as two replicates (two different Niskin bottles) for a total of 156 samples which have been analyzed under a compound microscope. The Niskin rosette was equipped also with probes to register the main environmental parameters (Salinity, Temperature, dissolved Oxygen). A cluster analyses was carried out on abundance data of two matrices (one per each position) of 78 samples x 142 taxa to obtain a picture of the geography of the basin, based on the distribution of micro-zooplankton. A multinet BIONESS equipped, used to collect meso-zooplankton at different depths, allowed to obtain measurements of Chl *a* concentrations along the water column.

Results and Discussion. The abiotic parameters measured showed roughly constant values in the area, with exception of surface low values of temperature along the Albanian coast, with homothermy in the water column of Grama (deep > 200 m). A total of 142 taxa have been recognized in the micro-zooplankton. The whole assemblage was numerically dominated by Dinophyta, but Ciliofora showed the highest taxa richness (52 taxa). The surface stations of the geographic area clustered in four main groups (Fig.1). The bottom samples gave less understandable clusters probably because they were not homogeneous regarding to the collection depths (from 27 down to 1170 m below the sea level, according the stations). The finding of maximum Chl*a* concentration between 30 and 100 m below the sea level (according to the station) allowed us to hypothesize that a relevant part of the micro-plankton community (for example, Dinophyta, and associated organisms) could be not revealed. In fact, the maximum number of taxa found at bottom position of stations S03 and Gijri Vlore (near Tremiti islands, and in front of Vlore city, at depths < 40 m) is probably due to a collection occurred just in a layer more productive than the other analyzed (surface, and bottoms > 100 m in all the stations). The distribution of microzooplankton in surface waters of South Adriatic sea, demonstrated that marine connecting routes are not obvious. The widest part of the basin (in the North) appears as a connecting route among the two opposite coasts. The narrower part of the basin (in the South), on the contrary, is a point where the opposite coasts, although close, appear as well separated in terms of community composition (Fig. 2).

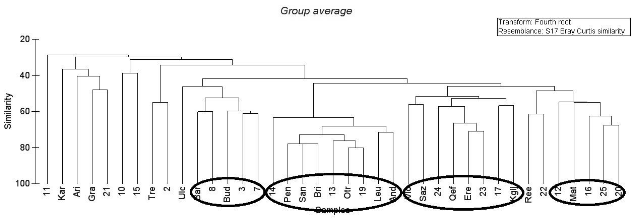

Fig. 1. Non parametric multidimensional scaling representation of microzooplankton surface samples collected in May 2013 (39 stations) with superimposed cluster at 55 % of similarity.

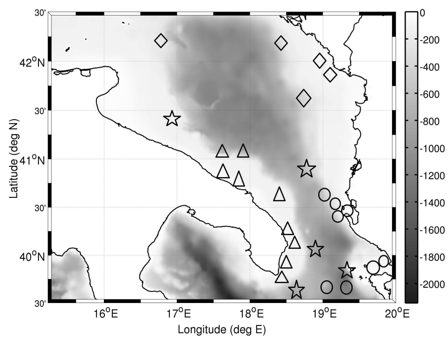

Fig. 2. Map of the clusters of stations in the south Adriatic, based on data from the surface microzooplankton. To be compared with the Fig. 1. Cluster of triangles indicates stations 13, 14, Pen, Br, 19, San, Otr, And, Leu. Cluster of circles indicates stations 17, Saz, Kgjj, Vlo, Qef, Ere, 23,24. Cluster of squares indicates stations Bar, Bud, 3, 7, 8. Cluster of stars indicates stations 12, 16, 20, 25, Mat.

References

1 - Fonda-Umani, S., 1992. Successioni fitoplanctoniche, micro e mesozoplanctoniche nell'Alto Adriatico. In: Marchetti, R., Cotta Ramusino, M. (Eds.), Atti V Congresso SITE, pp. 221–246.

2 - Zore-Armanda, M., 1968. The system of currents in the Adriatic Sea. Stud. Rev. Gen. Fish. Counc. Medit. 34, 1–48.

3 - Giordani, P., Helder, W., Koning, E., Miserocchi, S., Danovaro, R., Malaguti, A., 2002. Gradients of benthic–pelagic coupling and carbon budgets in the Adriatic and Northern Ionian Sea. J. Mar. Syst. 33–34, 365–387.

DISTRIBUTION OF *OIKOPLEURA (VEXILLARIA) DIOICA* FOL, 1872 (CLASS: APPENDICULARIA) IN THE SOUTHERN BLACK SEA IN 2006-2007

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Abstract
Distribution and abundance of *Oikopleura* (*Vexillaria*) *dioica* in the southern Black Sea (theTurkish EEZ) were studied in June, October 2006 and May 2007. The abundance of *O. dioica* was observed between 0.14-66.06 ind.m^{-3} in June 2006; 2.56-344.11 ind.m^{-3} in October 2006 and 0.85-187.18 ind.m^{-3} in May 2007. During sampling periods, four size classes (<0.5, 0.5-1, 1-2 and 2-3 mm) of *O. dioica* were determined and the contributions of 0.5-1 and 1-2 mm size classes were >35%.

Keywords: Zooplankton , Black Sea

Introduction
Oikopleura (*Vexillaria*) *dioica* Fol, 1872 is the only representative of Appendicularia living in Black Sea. As they are feeding by filtration, they are very important in the nutrition food web of Black Sea [1]. They trap small food particles such as nano-pico phytoplankton, bacteria and even dissolved organic matter by their mucus structure named "the house". The house is ready for renewal when the old one is disposed of and the disposal occurs every 4-6 hours (chaetognat, copepod, ctenophore, juvenile and adult fish, juvenile and adult fish) and provide contribution to vertical movement of organic matter from sea surface to sea bottom [2]. The aim of this study was to investigate distribution and abundance of *O. dioica* in southern Black Sea.

Material and method
The study was performed on 10-25 June 2006, 7-25 October 2006 and 8-27 May 2007 in the southern Black Sea (the Turkish EEZ). Samples were collected with Nansen plankton net (0.7 m mouth opening and 112μm mesh size) from the bottom to surface in coastal stations and from the depth of the beginning of anoxic zone to the surface in the offshore stations. The depth of the beginning of H_2S layer (sigma theta, σ_θ= 16.2) was determined by Tugrul et al. [3]. Samples were preserved in 4% buffered formaldehyde until microscopic analysis. For the microscopic identification and counts, sub-samples were taken two times from a known volume of a container with 2.5 ml Stempel pipette. The results were then averaged and extrapolated to the whole sample. Sea water temperature was recorded by using a Seabird CTD sensor.

Results and Discussion
Sea surface temperature was changed between 17.49°C and 24.65°C in June, 17.39°C and 22.07°C in October, and 10.22°C and 19.69°C in May. Abundance values of *O. dioica* were higher in October varying between 2.56-344.11 ind.m^{-3} as observed in the previous studies (Ünal [4], Üstün [5], Yildiz and Feyzioglu [6]). In May 2007 their abundance ranged between 0.85-187.18 ind.m^{-3} and lowest abundance were observed in June between 0.14-66.06 ind.m^{-3}. The distribution of *O. dioica* abundance value was high on the eastern Black Sea (Trabzon shores) in June, central Black Sea (Sinop Türkeli shore) in October and western and central Black Sea (Sinop Turkeli shore) in May in (fig. 1). The total average abundance value of *O. dioica* was calculated to be 9.1±16.12 ind.m^{-3} in June 2006, 60.6±70.36 ind.m^{-3} in October2006 and 29.37±42.39 ind.m^{-3} in May 2007. During sampling period, we determined four size class (<0.5, 0.5-1, 1-2 and 2-3 mm) of *O. dioica*. Quantity of individuals with size class of 0.5-1 mm and 1-2 mm were determined to be more. The maximum contribution of the 0.5-1 mm size class was 59.46% in October. The highest contribution of 1-2 mm size group was observed in June (58.21%).

Acknowledgment
The present work was funded by a Project "TUBITAK CAYDAG-104Y289".

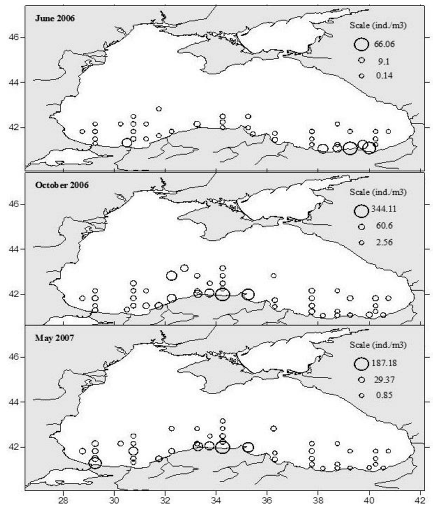

Fig. 1. Distribution of *O. dioica* abundance values (ind.m^{-3}) in stations in June 2006, October 2006 and May 2007

References
1 - Shiganova, T., 2005. Changes in appendicularian *Oikopleura dioica* abundance caused by invasion of alien ctenophores in Black Sea. *J. Mar.Bio. Ass. U.K.*, 85: 477-494.
2 - Sato, R., Tanaka, Y. and Ishimaru, T., 2001. House production by *O. dioica* (Tunicata, Appendicularia) under laboratory conditions. *J Plankton Res.*, 23: 415-423.
3 - Tugrul, S., Basturk, O., Saydam, C., Yilmaz, A. 1992. Changes in the hydrochemistry of the Black Sea inferred from water density profiles. *Nature*, 359: 137-139.
4 - Ünal, E., 2002. Seasonality of zooplankton in the Southern Black Sea in 1999 and Genetics of Calanus euxinus (Copepoda). M.S. Thesis, IMS-Middle East Technical University, Ankara, Turkey, 214pp.
5 - Üstün, F., 2005. The composition and seasonal distribution of zooplankton in the region of Sinop Cape of the Black Sea, Turkey. M.S. Thesis, OMÜ-Ondokuz Mayis University, Samsun, Turkey, 149 pp.
6 - Yildiz, I. and Feyzioglu, A.M., 2014. Biological diversity and seasonal variation of mesozooplankton in the southeastern Black Sea coastal ecosystem. *Turk J Zool*, 38: 179-190.

ACOUSTIC IDENTIFICATION OF *NYCTIPHANES COUCHII* AND *NEMATOSCELIS MEGALOPS* IN THE SPANISH MEDITERRANEAN SEA

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Abstract

During the 2015 routine acoustic survey for stock assessment carried out in the Spanish Mediterranean continental shelf, krill swarms were localized in two different places using an EK60 scientific echosounder, operating at multiple frequencies. Biological identification was performed by mean of a plankton net (bongo 90) equipped with two different mesh sizes (500 to 2000 microns). Although krill frequency response was similar in both localizations, samples analysis revealed the presence of two different species: *Nyctiphanes couchii* (Bell, 1853) and *Nematoscelis megalops* (Sars, 1883).

Keywords: Acoustics, Crustacea, Continental shelf, North-Western Mediterranean

Introduction

Krill species are key organism in marine foods webs [1]. An understanding of the spatial and temporal variability in krill distribution is essential for implemented fisheries management based on ecosystem approach [2]. Acoustic surveys techniques developed rapidly during the 1980s, and since the early 1990s acoustic surveys have become the main method for study the krill distribution and abundance. Groundtruthing is an important component of acoustic surveys because the unbiased species identification is needed [3]. Krill frequency response has been properly studied, krill resonance occurs at high frequencies, around 120 or 200 kHz [4], but different krill species present different frequency response that can be used for species discrimination [5].

Material and methods

The study was carried out in summer 2015, during the annual acoustic survey for small pelagic stocks assessment (MEDIAS). The survey covers the Spanish Mediterranean continental shelf, from 30 to 200 meters depth (Figure 1). Acoustic data were acquired using an EK60 calibrated echosounder (Simrad®) operating at five frequencies, 18, 38, 70, 120 and 200 kHz. Biological samples were collected by means of a plankton net bongo 90 equipped with two different mesh size (500 and 2000 microns). In order to sample exactly the echotraces detected, the sample device was provided with a depth sensor (ITI, Simrad) which allowed monitoring the net track in real time. Krill swarms echotraces were delimited, geographically localized and their frequency response pattern determined using Echoview software (Miriax Lt.).

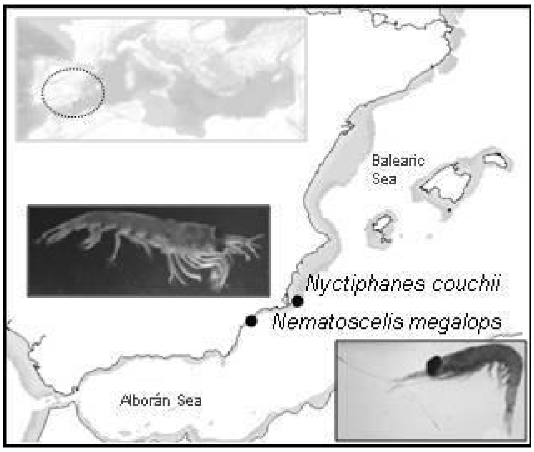

Fig. 1. Study area (continental shelf marked in grey). Identification hauls (black dots).

Results and discussion

Nyctiphanes couchii swarms were localized at 50 meters depth, on the continental shelf (144 m bottom depth). *Nematoscelis megalops* swarms were localized at 86 meters depth, on the continental shelf break (256 m bottom depth) (Figure 1). Differences in the mean volume backscattering strength (MVBS) were exhibited between species (Figure 2), although further research is needed to separate accurately this two species based on their frequency response in the study area.

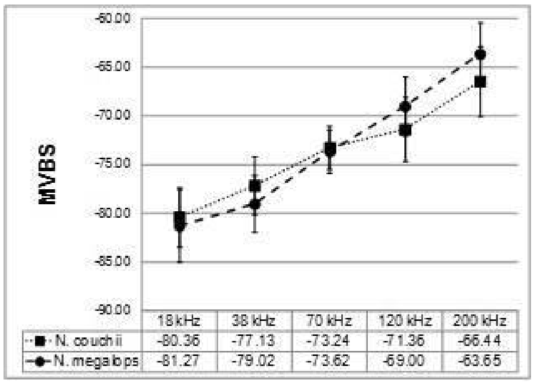

Fig. 2. Mean volume backscattering strength (MVBS) at different frequencies for the two species analyzed.

References

1 - Everson I. 2000. Ecosystem Dynamics Involving Krill. *In*: Everson I. (ed.), Krill biology, ecology and fisheries. Blackwell Science, London p 228–261.
2 - FAO, 2008. Fisheries Management 2. The Ecosystem Approach to Fisheries. 2.1 Best Practices in Ecosystem Modelling for Informing an Ecosystem Approach to Fisheries. FAO Fisheries Technical Guidelines for Responsible Fisheries, Add. 1: 78p.
3 - Simmonds E.J. and MacLennan D.N. 2005. Fisheries acoustics. (2nd ed.), Oxford: Blackwell Science Ltd.
4 - Fernandes P. G., Korneliussen R.J., Lebourges-Dhaussy A., Massé J., Iglesias M., Diner N., Ona E. 2006. The SIMFAMI project: Species identification methods from acoustic multifrequency information. Final report of the EC. Q5RS-2001-02054.
5 - McQuinn I. H., Dion M. and St. Pierre J.F. 2013. The acoustic multifrequency classification of two sympatric euphausiid species (*Meganyctiphanes norvegica* and *Thysanoessa raschii*) with empirical and SDWBA model validation. ICES J. Mar Sci, 70: 636–649.

PLANKTONIC PROTOZOAN ASSEMBLAGES INHABITING THE EGYPTIAN MEDITERRANEAN WATERS

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Abstract

Abundance and species composition of planktonic protozoan assemblages were investigated in the western part of the Egyptian Mediterranean waters during 2008-2010. Planktonic protozoans constituted about 5.4% of the total zooplankton count. 123 protozoan species were identified during the present study, out of them 91 tintinnid species, 17 radiolarians and 15 Foraminifera. Planktonic protozoans were more abundant during winter. Fifty seven protozoan species recorded in the Egyptian Mediterranean waters for the first time.

Keywords: Zooplankton , South-Eastern Mediterranean, Alien species

Planktonic protozoans play a major role in carrying organic matter and energy between the microbial and the metazoan communities and constitute an important link in marine planktonic food webs. Few comprehensive studies have been made on planktonic protozoan assemblages in the Egyptian Mediterranean waters despite their ecological importance in the marine food webs as the major consumers of phytoplankton. Previous works on zooplankton in the area were mostly devoted to the study of copepods, the major zooplankton component. Planktonic protozoan assemblages are considered of secondary importance in terms of numerical abundance and hence were not treated in details. Information on planktonic protozoans is restricted to the coastal waters This research reveals data on the distribution, abundance and community composition of planktonic protozoan assemblages inhabiting the western part of the Egyptian Mediterranean Coast. The geographical distributions of the recorded species and their ecological affinities are also included to follow up the origin of the new record species in the study area. The study area lies between longitudes 25°30'E and 28°30'E and extends northward to latitude 32°30'N. Quantitative and qualitative studies on the planktonic protozoan assemblages in the study area were perform ed during four seasons namely; spring (April, 2008), summer (August, 2008) and winter (February, 2009 and 2010) using the Egyptian R/V Salsabeel. The samples were collected by vertical hauls (from bottom to the surface) using standard plankton net of 55µm mesh size. Samples were collected from six longitudinal sections perpendicular to the coast. Each section comprised 3 stations covering the coastal zone (depth ≤50m), the shelf zone (50-100m) and offshore zone (depth ≥ 200m). A total of 123 protozoan species belong to 53 genera, 29 Families and 5 orders were identified. Tintinnida was the highest abundant (67.1% of the total protozoan counts, average 30.4 ind.m^{-3}) and diversified (91 species) protozoan group (Fig. 1). Tintinnidae, Undellidae and Dictyocystidae were the highest abundant tintinnid families in the study area (constituted about 25.4%, 21.4% and 13.6% of the total tintinnid counts respectively). *Undella hyalina*, *Rhabdonella spiralis* and *Eutintinnus fraknoi* were the most common tintinnid species. Foraminifera ranked as the second abundant protozoan group forming 26% (average 11.8 ind.m^{-3}) of the total protozoan counts. They represented by 15 species belong to 11 genera and 10 families dominated by family Globigerinidae (54.85% of the total Foraminifera counts). *Globigerina bulloides* was the highest abundant Foraminifera species (52.6% of the total Foraminifera counts).*Globorotalia truncatyloides* and *Globigerinoides conglobatus* were rather frequent. Radiolarians constituted about 6.9% (average 3.1 ind.m^{-3}) of the total protozoan counts. Seventeen radiolarian species belong to 14 genera and 8 families were recorded. *Spongotrochus brevispinus* was the most common radiolarian species (44.6% of the total radiolarian counts). The magnitude of the Protozoa community composition gave raise a total of 123 species. Among them, 91 tintinnied species dominated by *Undella hyaline*, *Rhabdonella spiralis* and *Eutintinnus fraknoi*, 15 species of Foraminifera dominated by *Globigrina bulloides*, *Globigrina truncatyloides* and *Globorotaliaconglobata* and 17 radiolarians dominated by *Spongotrochus brevispinu*s. Dowidar and El-Maghraby (1970) recorded 99 tintinnids species, 15 radiolarians and only one Foraminifera species (*Globigrina bulloides*) at Alexandria shores. Abdel-Aziz and Aboul-Ezz (2003) were recorded 37 tintinnids species and 18 radiolarians along the Egyptian Mediterranean Coast. Zakaria (2006) recorded 53 protozoan species in the Alexandria waters. Fifty seven new recorded species of planktonic protozoan were found in the Egyptian Mediterranean waters. Of them 10 species recorded in the Mediterranean Sea for the first time. Among the new recorded species about 39 tintinnid species, 6 Foraminifera, 12 radiolarians. The percentage of origin of the recorded species revealed that, 60.7% of them were previously recorded in the Atlantic Ocean, 46.2% in Indian Ocean, 75.2% in Pacific Ocean and 44.4% were recorded in the Red Sea.

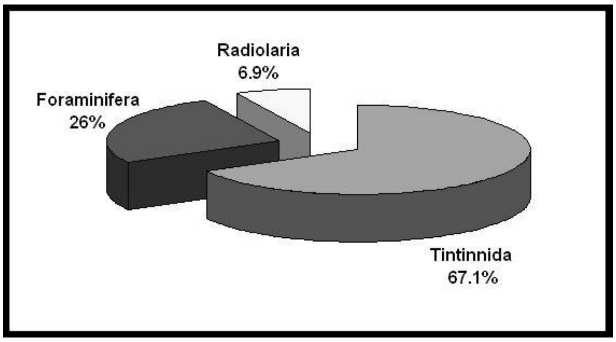

Fig. 1. The percentage frequencies (%) of the protozoan groups recorded in the Egyptian Mediterranean waters.

References

1 - Abdel-Aziz N. E., Aboul-Ezz S. M. (2003) Zooplankton community of the Egyptian Mediterranean coast. Egy. J. Aquat. Biol. & Fish., 7(4): 91-10.
2 - Dowidar N. M., El-Maghraby A. M. (1970) The neritic zooplankton of the southeastern Mediterranean at Alexandria. II. Consideration of the total zooplankton species community. Bull. Nat. Inst. Oceano. and Fish., Egy., 1: 275-303.
3 - Zakaria H. Y. (2006) The zooplankton community in the Egyptian Mediterranean waters: A Review. Acta Adriat., 47(2): 195-206.

CIESM Congress Session : Zooplankton II , including gelatinous plankton

Moderator : Alessandra Conversi, CNR-ISMAR, Lerici, Italy

Moderator's Synthesis

About 30 people attended the session. The debate ensuing the presentations was very lively and addressed several topics.
Increase of gelatinous plankton: the question of whether such increase is perceived or real, and, if so, whether it is due to global warming or overfishing, was not directly answered. However, several examples proposed by the audience and speakers indicated the importance of this subject. For example, the jellyfish invasions and the new sighting of the *Discomedusa lobata* in the Marmara Sea; the huge 2006-08 jellyfish blooms which affected the Mediterranean ecosystem; the current blooms of *Mnemiospis leidyi* in all coastal areas in the Adriatic; the relatively recent first sighting of *Mnemiospis leidyi* in the Ligurian Sea and its now regular occurrence there,
Overall the audience indicated that gelatinous zooplankton is considered a priority study area, as well as investigating the factors of the blooms, such as global warming and ballast waters discharge. With regard to *Mnemiospis leidyi*, the question of whether its relatively new presence in some area may yield the possibility of an ecological regime shift in the future was not resolved, however it was shared that this species should be closely monitored..
Taxonomy : Another topic of discussion concerned taxonomic vs automatic (optical, acoustical) recognition of species. While these different approaches should be complementary, the actual funding might be antagonistic. The fundamental importance of taxonomy was once more repeated, as well as the current continual loss of taxonomical expertise. It was suggested to set an inventory of expertise in the Mediterranean/ Black Sea region..
Ecosystem resilience and tipping points: A final topic considered of importance for research is the link between temperature increase and northward migration of marine species, as followed by the CIESM Tropical Signals program with ensuing decreased ecosystem resilience and increased risk of approaching tipping points.

BLOOMING OF THE NOMAD JELLY FISH *RHOPILEMA NOMADICA* ALONG THE EGYPTIAN MEDITERRANEAN COASTS

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Abstract
A massive number of *Rhopilema nomadica* was recorded along the coasts of Port Said, Damietta and Alexandria along the Mediterranean coast in summer 2015. The ever occurring blooming event was only recorded along the Mediterranean Sea while no blooms was recorded along Ismailia, Suez and El-Sukhna along the Suez Canal and Gulf of Suez. The species was studied in order to evaluate impacts on fisheries and tourism activity in the area. Number of nomadic jellyfish was recorded for two weeks on the beach and the nets of fishermen. Regular shoreline surveys were carried out using a standard line-transect method. Jellyfish were identified to species and tallied to give an indication of relative abundance.

Keywords: Invasive species, Mediterranean Sea

Introduction
Rhopilema nomadica is a neritic epipelagic, swarming, planktotrophic jellyfish. It is native to the east coast of Africa and the Red Sea. It was introduced into the Mediterranean in the late 1970s. Although it is assumed to have arrived via the Suez Canal, *R.nomadica* is rare in the red Sea and is not known from elsewhere (Mills 2001). The blooming incidence may be attributed to global warming, pollution loads, eutrophication and overfishing together with increasing water temperature. Despite the scarcity of hard substrate along the Egyptian coast of the Mediterranean which was believed to essential for blooming of the nomadic jelly fish (Purcell, 2012) multiple blooming events were recorded along the Egyptian coast resulting in negative impacts on fisheries, socio-economic and health risks. In a changing world of biodiversity Jellyfishes are able to increase in abundance rapidly and adapt to new conditions following ecosystem regime shifts and can spread into any vacant niches. With very few exceptions, jellyfish are carnivores, and use their cnidocysts to kill their prey that, according to the species, can be either other jellyfish, or crustaceans, or fish eggs and larvae, or anything reaching a viable size for the predator.

Results and Discussions
Around 1000 to 5000 m^3 of water were sampled depending on the abundance of jellyfish in each monitoring station of the selected coastal location (Figure, 1) along three coastal cities of the Mediterranean coast of Egypt. A total of 514 specimens were collected, measured and dissected for the reproductive and feeding biology. Large number of juvenile fishes of different species were removed from the gut of the jellyfish (Figure, 2). Juvenile fishes from the gut were measured and identified to species level. The size ranged from 10 cm to 64cm. guts of the jellies were dissected. A total of 65 fish specimens representing 10 species were identified *Sardinella aurita* and *Terapn jurba* were the most abundant fish species.

Fig. 1. Jelly fish in fishing nets

Fig. 2. Fish eaten by the nomadic jellyfish

References
1 - Boero, F. 2013. Review of jellyfish blooms in the Mediterranean and Black Sea. Studies and Reviews, General Fisheries Commission for the Mediterranean. No. 92, FAO, Rome, Italy. 53 pp.
2 - Boero, F., Bouillon, J., Gravili, C., Miglietta, M. P., Parsons, T., and Piraino, S. 2008. Gelatinous plankton: irregularities rule the world (sometimes). Marine Ecology Progress Series, 356: 299–310.
3 - Galil BS, Spanier E, Ferguson W .1990. The Scyphomedusae of the Israeli Mediterranean coast, including two lessepsian migrants to the Mediterranean. Zoologische Mededlingen 64(7):95-105
4 - Mills, C.E. 2001. Jellyfish blooms: are populations increasing globally in response to changing ocean conditions. *Hydrobiologia*, 451: 55-68.
5 - Purcell, J. E. 2012. Jellyfish and ctenophore blooms coincide with human proliferations and environmental perturbations. Annual Review of Marine Science, 4: 209–235.

ENERGETIC COST OF EGG-CARRYING STRATEGY IN CALANOID COPEPOD *PSEUDOCALANUS ELONGATUS*

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Abstract

Respiration rates were measured in active and anesthetized females of *Pseudocalanus elongatus* with or without ovisacs in order to estimate the energy cost of egg-carrying strategy. Mass density of the body and eggs and sinking and swimming speed of female in different reproductive stages were measured to understand the effect of brood on body position maintaining in the water and predator avoidance of females.

Keywords: Copepoda, Black Sea, Zooplankton

Introduction

Widespread calanoid copepod *Pseudocalanus elongatus* spawn their eggs into ovisacs remaining attached to the female until the emergence of nauplii. The main advantage of such egg-carrying strategy is the decrease in egg mortality [1]. Therefore, egg sac attached to the body may increase energy losses for locomotion [2] and vulnerability of females to predation. Our aim was to evaluate extra energy expenditure due to egg carrying and study the effect of ovisacs on mean mass density, sinking speed and active swimming of females.

Material and methods

Respiration rate of *Pseudocalanus elongatus* was determined by a sealed chamber method using luminescent dissolved oxygen sensor HACH LDO 101. The cost of egg sac transport (R_{et}) in unfed individuals was calculated as: $R_{et} = R_{aOF} - R_{aNOF} - R_{egg}$; where R_{aOF} and R_{aNOF} are the respiration rates of active ovigerous and non-ovigerous females, respectively, and R_{egg} is the respiration rate of eggs in the ovisac which can be expressed as a difference between respiration rates of anesthetized ovigerous R_{anOF} and non-ovigerous R_{anNOF} females: $R_{egg} = R_{anOF} - R_{anNOF}$ [2]. Mass density and sinking speed of females and their eggs were determined according to Svetlichny and Hubareva (2014). Copepod swimming speed was measured using videoshooting by the Nikon 1 V1 camera at a rate of 1200 frames s^{-1}.

Results and Discussion

Respiration rate in females carrying ovisacs (9.8 ± 2.5 eggs per sac) was 1.27 times higher than that in females without ovisacs (0.0792 ± 0.013 µg O_2 ind^{-1} h^{-1}) due to extra energy expenditure on oxygen consumption of eggs and transport of egg sac (10 and 17 % of energy demands of females, respectively) (Fig.1). Mass densities of the body and eggs were similar (1.051 and 1.056 g cm^{-3}, respectively), sinking speed was 10 % higher in ovigerous females while speeds of routing and escape swimming were 40 and 9 % lower, respectively. Taking into account that clutch size in *P. elongatus* in high-productivity seas on average amounts to 20 and may reach 40 [4], one can suggest significantly higher energy expenditure and higher vulnerability to predation in those females in comparison with the individuals studied in our experiments.

Acknowledgements

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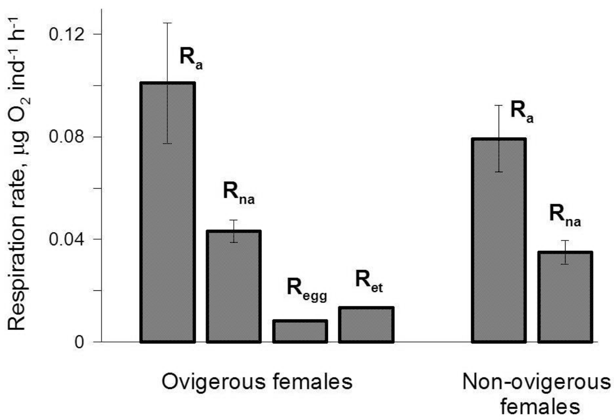

Fig. 1. Respiration rates of ovigerous and non-ovigerous active (R_a) and anesthetized (R_{an}) females, respiration rate of eggs (R_{egg}) and energy cost of egg sac transport (R_{et}).

References

1 - Liang D. and Uye S. 1997. Population dynamics and production of the planktonic copepods in a eutrophic inlet of the Inland Sea of Japan. IV. *Pseudodiaptomus marinus*, the egg-carrying calanoid. Mar. Biol., 128: 415-421
2 - Svetlichny L., Khanaychenko A., Hubareva E., Aganesova L. 2012. Partitioning of respiratory energy and environmental tolerance in *Calanipeda aquaedulcis* and *Arctodiaptomus salinus*. Estuar. Coast. Shelf Sci., 114: 199-207.
3 - Svetlichny L. and Hubareva E. 2014. Salinity tolerance of alien copepods *Acartia tonsa* and *Oithona davisae* in the Black Sea. J. Exp. Mar. Biol. Ecol., 461: 201-208.
4 - Drif K., Hirst A.G., Hay S. 2010. Seasonal abundance and egg production rates of *Oithona similis* and *Pseudocalanus elongatus* in the northern North Sea: a first comparison of egg-ratio and incubation methods. Mar. Ecol. Prog. Ser., 415: 159–175.

OLINDIAS PHOSPHORICA (DELLE CHIAJE, 1841) PRESENCE IN THE VALENCIAN COMMUNITY (EAST AND SOUTH-EAST SPAIN)

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Abstract

A monitoring program on presence of jellyfish takes place in the Valencian Community since 2009. This program has evidenced the seasonality and relative abundance of jellyfish in beaches as well as the incidence of stings on bathers. The presence/abundance of most jellyfish depends on winds, ocean currents and seasons, and it is common throughout the coast. This is the case of *P. noctiluca, R. pulmo* and *C. tuberculata*. *Olindias phosphorica* does not have the same behaviour. This species is distributed particularly in hot spots which are permanent living place. The presence in these enclaves is related with sheltered waters and artificial substrates such as breakwaters. Where *O. phosphorica* has a resident character, it is the major species and the stings registered are 5 times higher than the average calculated for the whole region.

Keywords: Mediterranean Sea, Cnidaria, Plankton

The presence/absence of jellyfish has been monitored in the Valencian coast since 2009, through a network of volunteer observers and rescue services of beaches. Since then it has found the usual presence of species such as *Pelagia noctiluca*, *Rhizostoma pulmo* and *Cotylorhiza tuberculata [*1]. The abundance depends mainly on the wind regime and presence is common along the entire coast [2] [3]. Nevertheless *Olindias phosphorica* presents a distribution pattern focused in particular locations such as Santa Pola, where this species is resident since at least 2009 (Figure 1). In these beaches *O. phosphorica* represents the most abundant species during the summer, with a percentage from 66 up to 75% of all jellyfish identifications between 2010 and 2015. The high abundance of *O. phosphorica* is responsible for the high number of stings registered in this location if compared to other Valencian municipalities. The figure 1 shows a comparison between the number of stings from jellyfish recorded by the rescue services on the beaches of Valencian Community during the month of August (month of highest number of stings) and those obtained in Santa Pola.

	2013	2014	2015
Valencian Community	7,22	5,73	4,27
Santa Pola	35,29	23,3	20,63

Fig. 1. Number of stings per km of beach and day during August in Valencian Community and municipality of Santa Pola.

The resident character of this species in certain locations as Santa Pola suggests that *O. phosphorica* completes their cycle polyp-jellyfish on the local waters. Thus the behaviour is different than other species of jellyfish that come from remote areas and are carried by winds and ocean currents. We drew on preliminary similarities among the factors influencing the phenomenon observed: (i) The character of sheltered waters protected from the effects of East and Northeast wind; (ii) Low water renewal rates because of breakwaters built to regenerate the beaches; (iii) Artificial substrates in the breakwaters and the *Caulerpa prolifera* meadows probably promote the polyp stage in local waters.

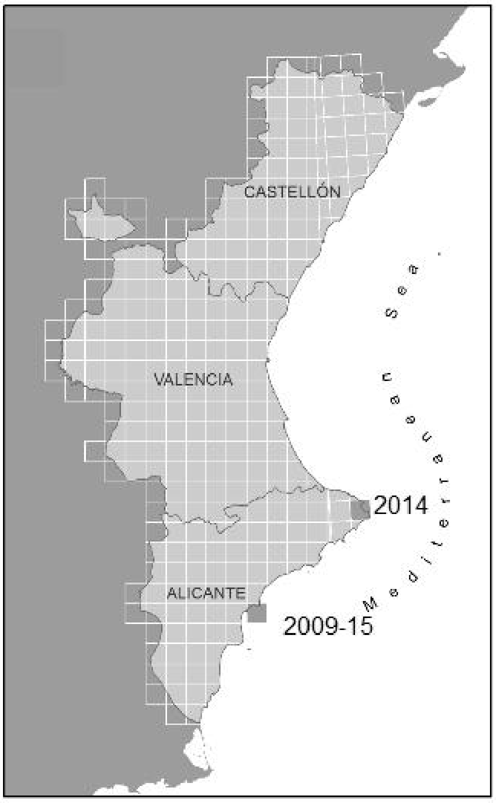

Fig. 2. Presence/absence of *O. phosphorica* in the Valencian Community.

References

1 - Guillén, J.E., Gras, D., Martínez, J. and Triviño, A., 2013. Monitoring the abundance of jellyfish off the coast of Valencia (Spain) during the summer period (2009-2012). *Rapp. Comm. int. Mer Médit.,* 40: 537.

2 - Guillén, J.E., Gras, D., Triviño, A., Martínez, J., Jiménez, S., Soler, G. and Organ, S. (in press). Tracing jellyfish in the Valencian Community (East and South-East Spain) (2010 – 2014). In Mariottini, G.L. (eds.) Jellyfish: Ecology, Distribution. Pattern and Human Interactions. Nova Publishers. New York.

3 - Boero, F., 2013. Review of jellyfish blooms in the Mediterranean and Black Sea. *Studies and Reviews. General Fisheries Commission for the Mediterranean,* 92: 53 pp.

THE SUCCESSION OF MESOZOOPLANKTON GROUPS IN INSHORE AND OFFSHORE WATERS OF THE ISKENDERUN BAY (NORTHEASTERN MEDITERRANEAN SEA)

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Abstract

The purpose of the present study was to characterize annual cycling of the zooplankton groups and to describe their monthly succession in the Iskenderun Bay. Zooplankton samples were collected monthly using a WP-2 net (200μm) at inshore and offshore stations during March 2010- February 2011. A total of 27 mesozooplankton groups were observed. Copepoda mostly dominated the mesozooplankton population, however the highest abundance peaks were driven by Cladocera during summer months and by Doliolida in early autumn at offshore. Environmental factors lead to succession of zooplankton groups in the area.

Keywords: Zooplankton , Iskenderun Bay, Copepoda

Introduction

Iskenderun Bay (avarage depth 70 m) located at the Northeastern corner in the eastern Mediterranean and has a dynamic structure being affected by the local winds, freshwater inputs and current systems prevailing in the eastern Mediterranean. In contrast to ultraoligotrophic trophic structure of Levantine Basin, primary production was 2-4 times higher (Yilmaz et al. 1992) in the bay. Additionally, Iskenderun Bay is regarded intensely industrialized with petroleum pipelines, iron-steel and fertilizer industries and this industrialization is increasing day by day. The aim of this study was to investigate annual succession of most important mesozooplankton groups in the study area and response to main environmental variables.

Materyal and Methods

Sampling was performed using WP-2 net (200 µm) at monthly interval at two stations located inshore and offhore region of the Iskenderun Bay. After collection, zooplankton samples were immediately fixed in 4% buffered formalin- seawater solution. The aliquots were obtained with a Folsom splitter, depending on the density of the organisms. The subsamples were identified and counted using a Bogorov counting chamber. Additionally environmental variable (temperature, salinity, chlorophll-a, pikoplankton, phytoplankton and microzooplankton densities) measured at the same time was obtained from Polat (2011). Spearman correlation was applied to test effect of environmental factors on zooplankton groups.

Results

A total of 27 mesozooplankton groups were found in the present study area and all groups were observed in offshore stations, whereas only twenty groups were present in inshore station. Annual mean mesozooplankton abundance was lower at offhore station (1715± 1346 ind. m^{-3}) than inshore station (2556±3426 ind. m^{-3}). Mesozooplankton abundance fluctuated from 522 to 12931 ind. m^{-3} inshore station, while from 521 to 5443 ind. m^{-3} at offshore station. Two zooplankton peaks were observed in the sampling area. Cladocera dominated peaks was clearly observed during June and July in inshore and offshore stations, respectively. Other peak was slightly occured during October and September at inshore and offshore stations, respectively . Copepoda consisted the bulk of the zooplankton population in the most of the year. However, there is clear changes in the dominancy of zooplankton groups at different period. In coastal station, Copepoda dominancy replaced by Salpidae in February and March, Gastropoda in May and Cladocera in June and July (Figure 2). Similarly, Copepoda was mainly dominant in the offshore station. However, Cladocera dominated the zooplankton during May and July, while Doliolida was most abundant group in September (Figure 2). Other important mesozooplankton groups besides dominant groups were Appendicularia, Bivalvia Cirripedia, in inshore station, while Salpa, Appendicularia Chaetognatha, Bivalvia in offshore station. Temperature was most important abiotic factor and well correlated with most of the common zooplankton groups. Especially picoplankton density and temperature is closely related to the Cladoceran peaks. Moreover, Appendicularia was well correlated with Chl-a and, Gastropoda, Cirripedia and Doliolida with phytoplankton density. Zooplankton group composition and abundance changes showed similar trend with previous studies conducted in Iskenderun Bay (Terbiyik Kurt and Polat, 2013; 2014; 2015) As a conclusion, variations in monthly succession and hence, mainly temperature and food sources play a key role in the structure of zooplankton communities.

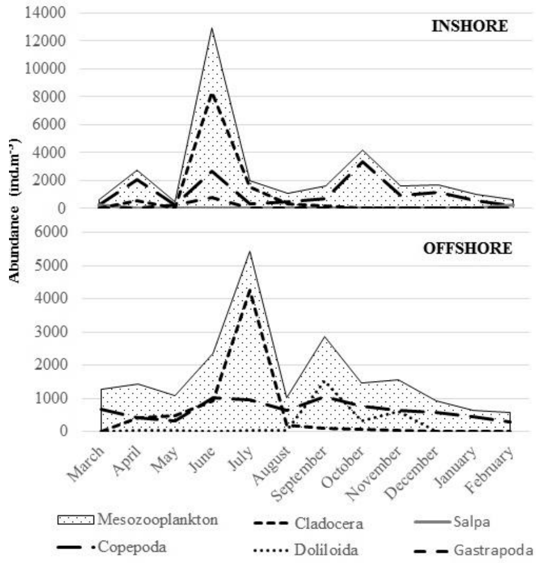

Fig. 1. Monthly changes in the dominant mesozooplankton groups.

References

1 - Polat. S., Terbiyik, T. and Mavruk, S., 2011. the Study of the Temporal Changes in Phytoplankton and Zooplankton Communities in Iskenderun Bay, C.U.BAP Project report. 19 p.

2 - Terbiyik Kurt, T. and Polat, S., 2013. Seasonal Distribution of Coastal Mesozooplankton Community in Relation to the Environmental Factors in Iskenderun Bay (Northeast Levantine, Mediterranean Sea), Journal of the Marine Biological Association of the United Kingdom, 93(5):1163-1174.

3 - Terbiyik Kurt, T. and Polat, S., 2014. Characterization of the seasonal and interannual changes in abundance of marine cladoceran species in Turkish coast of the Northeastern Levantine Basin Crustaceana, 87(7):769-783.

4 - Terbiyik Kurt, T. and Polat, S., 2015. Zooplankton abundance, biomass and size structure in the coastal waters of northeastern Mediterranean Sea, Turkish Journal of Zoology, 39: 378-387.

5 - Yilmaz, A., Basturk, O., Saydam, C., Ediger, D., Yilmaz, K. and Hatipoglu, E., 1992. Eutrophication in Iskenderun Bay, northeastern Mediterranean. Science of Total Environment (Special Issue). In *Marine Coastal Eutrophication*, edited by Vollenweider, R.A. Marchetti, R. and Viviani, R. Amsterdam: Elsevier.

CIESM Congress Session : Vertebrates under threat

Moderator : Juan Antonio Camiñas, IEO, Malaga, Spain

Moderator's Synthesis

The moderator introduced different approaches and definitions of the concept of "*threatened species*" that exist in the framework of regional or international organisations such as the Barcelona Convention, IUCN or GFCM, and presented some facts related to the number of species of reptiles, mammals, birds and fishes under threat in the Mediterranean Sea, as well as existing mitigation measures implemented by different RFMOs. Following the presentation of five communications focused on different species groups (tuna, groupers, marine turtles and mammals), a general discussion followed where participants presented their views and recommendations, notably:

- The need to focus the attention of the public and the managers not only on the charismatic species (mammals, birds, turtles or sharks) but also on those species of vertebrates currently discarded by different fisheries and those included as data-deficient and not evaluated.
- A general concern related to the effect of plastics in the life cycle of marine vertebrates, from fish larvae to big mammals, and the need for better research collaboration and coordination.
- The biodiversity of coastal vertebrates populations, except in MPA, is decreasing in most Mediterranean areas such as the Tunisian coast. A better protection of ecological corridors and straits.

The main conclusions after the discussion were:
Threats affecting vertebrates in the Mediterranean Sea are everywhere, but human activities, including coastal pollution, transport, coastal degradation, etc., do not have not the same intensity and effects on the populations at local, sub-regional or Mediterranean level. Thus the cross-basin spatial distribution of threatened species must be better studied. Actions to mitigate the degradation and loss of biodiversity in coastal areas are required at the local level, for example increasing the number of MPAs in south and eastern Mediterranean waters, but also at higher level, for instance via a better protection of ecological corridors and straits that would improve the status of some isolated populations by facilitating gene exchange. Migratory species (marine mammals, turtles, pelagic sharks, tuna or swordfish) are distributed along different Mediterranean basins during their life cycle. The characterisation of their movements across straits and corridors, their mapping between areas of concentration (for reproduction, feeding, mating, etc.) during annual migrations, are scientific issues of paramount importance for their conservation.

BIOMETRY ANALYSIS OF JUVENILE ATLANTIC BLUEFIN TUNA (THUNNUS THYNNUS L., 1758) IN THE EASTERN MEDITERRANEAN SEA

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Abstract

This paper presents some biological features of juvenile specimens of Atlantic bluefin tuna, *T. thynnus* Linnaeus, 1758, in the eastern Mediterranean Sea. A total of 369 specimens were analysed. Juvenile individuals ranged from 12.2 to 46.5 cm. In order to analyse biometry, 11 morphometric characters were analysed. Length-weight relationships of juveniles was $W = 0.0087xFL^{3.246}$.

Keywords: Fishes, Pelagic, Biometrics, North-Eastern Mediterranean

Atlantic bluefin tuna is highly migratory and pelagic species. This species is distributed in the Atlantic Ocean including the Mediterranean and Black Sea [1]. *T. thynnus* is important species for the Turkish fishery. Juvenile *T. thynnus* was collected from commercial hand line fisheries of Turkish waters (Eastern Mediterranean Sea) between July and October, 2011-2013. This area is considered an important spawning and feeding ground for tuna species [2] and this species was captured during the feeding phase. According to the growth parameters for bluefin tuna stock of eastern Atlantic and Mediterranean [3], the age of specimens correspond to 0 to 1 years old and they were fully immature [4]. Juvenile *T. thynnus* (smaller than the minimum landing size, i.e. 115 cm FL) were collected under the provision of the ICCAT Atlantic Wide Research Program for Bluefin Tuna (GBYP).

A total of 11 morphometric parameters were used for analyses. Measurements were obtained from inter-landmark distances (as a straight line in cm) following anatomical landmarks [5]. Inter-landmark refer to: fork length (FL), head length (LH), first predorsal length (LD1), length of pectoral fin (LP), preanal length (LA), second dorsal fin height (HD2), caudal fin width (CC'), maximum body height (H), snout length (SL), eye diameter (ED), and postorbital length (PO). All measurements were taken a caliper to nearest 0.05 millimeter and a digital balance to the nearest 0.01 g. Length-length and length-weight relationships were determined by the least squares method to fit a simple linear regression model.

A total of 369 specimens were collected during the study period. The fork length ranged 12.2 to 46.5 cm with a mean of 24.95±3.61 cm. Total weight varied from 0.025 to 2.300 kg. The mean values and standard deviations (SD) of total weight were 0.324±0.21 kg.

The morphology of the sampled fish is described as relative body proportions of the LH, LD_1, LA, LP, HD_2, CC and H related to the FL, and SL, ED and PO related to the HL (Table 1). The coefficients of variation (CV) indicated the highest variability in the CC/FL ratio (CV=13.11%) while the lowest variability was noted in the LH/FL ratio (CV=2.55%).

Tab. 1. Morphometric characteristics of *T. thynnus* caught in the eastern Mediterranean Sea.

Parameter	N	Min.	Max.	Mean±SD	CV (%)
FL	369	122.00	465.00	249.50±36.07	6.50
%FL					
LH	369	24.22	29.74	28.23±0.72	2.55
LD_1	369	28.30	36.22	31.99±0.93	2.91
LA	363	46.62	71.99	61.29±2.40	3.92
LP	369	10.84	18.83	15.39±1.06	6.89
HD_2	369	5.58	10.05	7.51±0.62	8.26
CC	358	13.80	30.81	23.04±3.02	13.11
H	369	11.21	29.43	23.99±1.68	7.00
%LH					
SL	369	21.16	35.59	27.67±1.64	5.93
ED	369	15.97	29.27	20.02±1.45	7.24
PO	369	42.69	61.78	52.33±1.89	3.61

Overall data of relative morphometric relationships of measured body proportions for *T. thynnus* are presented in Table 2. Morphometric characters were strongly positively correlated except for LD_1/FL and LA/FL ($p<0.05$). The best fit for length-length relationships was recorded between pectoral fin length (LP) and fork length (FL) (r=0.699). The lowest value of correlation coefficient was found between the head length (HL) and the fork length (FL) (r=0.116). The length-weight relationship is described $W = 0{,}0087xFL^{3{,}246}$ (r=0.988).

Genovese [6] found significant differences in morphometric characteristics among *T. thynnus* caught from the Tyrrhenian Sea and off the coast of Tunis, mainly related to FL, LH, LD1, and LP. According to Ticina et al. [5], for western Mediterranean *T. thynnus* samples, the LH, LA, LD1, LP and ED were relatively greater than in the eastern Atlantic specimens. Comparing the biometric characteristics of *T. thynnus* caught in the eastern Mediterranean Sea with the fish caught in the Adriatic Sea, the LH, LA, LD1, and PO were similar to each other (close together), but LP, HD2, CC, H, and SL were shorter than in Adriatic Sea specimens. However, the ED was relatively greater than in Adriatic Sea specimens. The differences of the biometric characteristics of *T. thynnus* caught in the different areas could be originated by the regional differences, the case of different stock or variation of the sample sizes.

Tab. 2. Linear regression analyses describing changes in body proportions of *T. thynnus* related to increment of fork length (FL) and head length (HL).

X variable	Y variable	r	intercept	slope	$95\%CI_{slope}$	*F*
ln FL	ln ($LH/FLx10^2$)	0.116	24.992	0.022	0.012 to 0.032	5.002*
ln FL	ln ($LD_1/FLx10^2$)	0.007	32.238	-0.001	-0.012 to -0.01	0.017
ln FL	ln ($LA/FLx10^2$)	0.067	55.079	0.019	0.004 to 0.034	1.640
ln FL	ln ($LP/FLx10^2$)	0.699	2.139	0.358	0.339 to 0.377	351.147*
ln FL	ln ($HD_2/FLx10^2$)	0.310	2.669	0.187	0.157to 0.217	39.030*
ln FL	ln ($CC/FLx10^2$)	0.176	8.593	0.177	0.124 to 0.230	11.346*
ln FL	ln ($H/FLx10^2$)	0.221	12.165	0.123	0.095 to 0.151	18.842*
ln LH	ln ($SL/LHx10^2$)	0.262	17.329	0.110	0.089 to 0.131	27.101*
ln LH	ln ($EE/LHx10^2$)	0.522	60.316	-0.260	-0,282 to -0,238	137.235*
ln LH	ln ($PO/LHx10^2$)	0.264	39.237	0.068	0.055 to 0.081	27.468*

References

1 - Collette, B.B., 1986. Scombridae (including Thunnidae, Scomberomoridae, Gasterochismatidae and Sardidae). p. 981-997. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean, Volume 2. Unesco, Paris.

2 - Karakulak, S., Oray, I., Corriero, A., Deflorio, M., Santamaria, N., Desantis, S., De Metrio, G. 2004. Evidence of a spawning area for the bluefin tuna (*Thunnus thynnus* L.) in the eastern Mediterranean. *J. Appl. Ichthyol.* 20, 318–320.

3 - Cort, J. L., Deguara, S., Galaz, T., Mèlich, B., Artetxe, I., Arregi, I., Neilson, J., Andrushchenko, I., Hanke, A., Dos Santos, M. N., Estruch, V., Lutcavage, M., Knapp, J., Compeán-Jiménez, G., Solana-Sansores, R., Belmonte, A., Martínez, D., Piccinetti, C., Kimoto, A., Addis, P., Velasco, M., De la Serna, J. M., Godoy, D., Ceyhan, T., Oray, I. K., Karakulak, S., Nøttestad, L., López, A., Ribalta, O., Abid, N., Idrissi, M., 2013. Determination of Lmax for Atlantic Bluefin Tuna, *Thunnus thynnus* (L.), from Meta-Analysis of Published and Available Biometric Data. *Rev. Fish. Sci*. 21 (2), 181-212.

4 - Corriero, A., Karakulak, S., Santamarina, N., Deflorio, M., Spedicato, D., Addis, P., Desantis, S., Cirillo, F., Fenech-Farrugia, A., Vasallo-Aguis, R., De La Serna, J. M., Oray, I. K., Cau, A., Megalofonou, P., De Metrio, G., 2005. Size and age at sexual maturity of female bluefin tuna (*Thunnus thynnus* L. 1758) from Mediterranean Sea. *J. Appl. Ichthyol.* 21, 483–486.

5 - Ticina, V., Grubišic, L., Šegvic Bubic, T., Katavic, I., 2011. Biometric characteristics of small Atlantic bluefin tuna (*Thunnus thynnus*, Linnaeus, 1758) of Mediterranean Sea origin. *J. Appl. Ichthyol.* 27, 971-976.

6 - Genovese, S., 1958. Dati biometrici sul tonno (*Thunnus thynnus* L.) Tirenico. *Rapp. Comm. Int. Mer. Mèdit*. 14, 327-328.

PRELIMINARY GLOBAL PHYLOGEOGRAPHY OF THE ENDANGERED DUSKY GROUPER, *EPINEPHELUS MARGINATUS*, AS REVEALED BY MITOCHONDRIAL DNA

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Abstract
The purpose of this study is to describe global phylogeography of *Epinephelus marginatus* using a mitochondrial DNA marker. *E. marginatus* is an economically important amphi-Atlantic marine fish found throughout the Mediterranean Sea that is facing extinction in the wild. The evaluation of genetic and biogeographic connectivity is a fundamental component of a species' conservation status. Genetic analyses revealed five discrete populations of *E. marginatus* throughout their global geographic range, where the northern Atlantic population represents a distinctly separate phylogenetic species. Estimated divergence time between the most ancestral population found in the northern Atlantic Ocean and the *nouveau*-Mediterranean Sea is on the order of two million years.

Keywords: Biogeography, Mediterranean Sea

Introduction

Known as the "King of the Mediterranean," the dusky grouper, *Epinephelus marginatus* is an iconic marine fish prized by recreational and commercial fishermen for its quality of flesh and steep market price. Present day they can be found within reefs and along rocky coastal shores up to 50 m depth throughout the Mediterranean Sea, along the east and south coasts of Africa as well as Brazil (Fig 1; [1]). Due to overexploitation and habitat degradation throughout their global range, this long-lived sedentary protogynous hermaphrodite, is considered at high risk of extinction in the wild [2]. Irrespective of their large and discontinuous distribution, *E. marginatus* is classified as a monotypic species. Despite amphi-Atlantic morphological cohesiveness, fundamental ecological and evolutionary processes generating biogeographical patterns leading to reproductive isolation calls into question systematic unification. A previous study by Gilles et al. [3] suggests that morphological and genetic evolution may be uncoupled in *E. marginatus* resulting in morphological similarities between regions regardless of extensive genetic divergence. The aim of this research is to determine systematic unification and describe global phylogeography of *E. marginatus*.

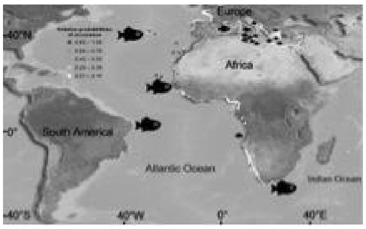

Fig. 1. Collection site map of 377 *Epinephelus marginatus*' from 17 locations (fish symbol) in the Atlantic Ocean and Mediterranean Sea.

Materials and Methods

Samples from 377 *E. marginatus* individuals were collected from 17 localities and three continents from the Mediterranean Sea (Spain, Tunisia, N. Sicily and Linosa (IT), Malta and Hurd Bank [located E 12 NM from Malta], three locations along the Libyan north African shoreline to Egypt, Crete (GR) and N. Aegean Sea), east Atlantic (Angola, Senegal, South Africa), north-Atlantic (Azores, PT) and west Atlantic Ocean (Brazil). All *E. marginatus*' were wild caught with the exception of samples from Crete, GR, which were F1 generation individuals donated from the Crete Aquarium. To assess global systematic unity of E. marginatus' an integrative approach to molecular population genetics based on comparative phylogeography and coalescent based methodologies were conducted on a subset of 202 individuals using a 398 base pair catenated alignment of high density intraspecific variation from the mitochondrial control region (Fig 2). To avoid *a priori* assumptions of delimited populations, individual *E. marginatus*' were assigned to spatially explicit genetic groups for comparative analysis downstream using GENELAND ver. 4.0.5 [4].

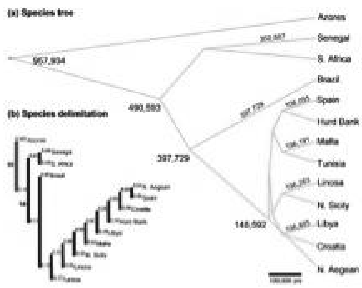

Fig. 2. (a) Consensus species tree with population divergence times and (b) species delimitation using the Poisson Tree Process.

Results

Eighty-eight distinct haplotypes containing 108 variable sites (plus three indels), of which 68 were parsimony informative, were represented between five spatially explicit global populations in the Azores, Brazil, Senegal, South Africa and the Mediterranean Sea with a collective modern effective population size estimate (*Nef*) of around 4.4 million. The Azorean population was identified as the origin of species and currently represents a distinctly separate phylogenetic clade. The age of the *nouveau*-Mediterranean population is estimated to be around 150,000 Ma with a separation time from the origin of species on the order of two million years.

Acknowledgements: Many thanks to those that helped with sample collection: Dr Teresa Maggio (Palermo, Italy), Dr Sabina De Innocentiis (Rome, Italy), Dr Sandra Mollol-Martínez (Palma de Mallorca, Spain), Celia Schunter (Barcelona, Spain), Dr Daw Haddoud, R.A. Ban, A. Ariana, W.B. Gema (Tripoli, Libya), Dr Sanja Matic-Skoko and Dr Branko Glamuzina (Split, Croatia), Dr Grigorios Krey (Kavala, Greece), Dr Aspasia Sterioti (Crete, Greece), Dr Sergio Stefanni (Azores, Portugal), Dr Rodrigo Torres (Recife, Brazil), Dr Philip Heemstra and Dr Warren Potts (Grahamstown, South Africa) and all those at the South African Institute of Aquatic Biodiversity (SAIAB) who donated samples for this project.

References

1 - Heemstra P, Randall J. Groupers of the world (family Serranidae, subfamily Epinephelinae). FAO Fish Synop 1993; 125(16):1-382.
2 - Cornish A, Harmelin-Vivien M. *Epinephelus marginatus*. In: IUCN Red List of Threatened Species [online]. Available from: http://www.iucnredlist.org [Accessed 31 January 2016].
3 - Gilles A, Miquelis A, Quignard J, Faure É. Molecular phylogeography of western Mediterranean dusky grouper *Epinephelus marginatus*. CR Acad Sci III, Sci Vie 2000; 323(2):195-205.
4 - Guillot G, Mortier F, Estoup A. GENELAND: A program for landscape genetics. Mol. Ecol. Notes 2005; 5:712-715.

GOING PUBLIC: ONLINE MAP OF SEA TURTLE RESCUE POINTS IN THE MEDITERRANEAN

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Abstract
The Map of Sea Turtle Rescue Points in the Mediterranean is a joint initiative of the authors aiming to bridge information, communication, and collaboration gaps in sea turtle conservation. Open access to contact details of all known rescue facilities will be provided to the public and professionals alike. Using solely freeware and capitalizing on a published study that offers the necessary contextual framework, we are developing an inexpensive online tool to increase awareness and visibility of facilities and to assist in management, research, and decision-making on a Mediterranean scale. The timeline for finalization of the alpha version of this work-in-progress is summer 2016.

Keywords: Turtles, Mapping, Conservation, Mediterranean Sea

The Map of Sea Turtle Rescue Points in the Mediterranean is a joint initiative of MEDASSET (lead partner), RAC/SPA, and the authors of [1], based on their Mediterranean-wide compilation of sea turtle rescue facilities. A key issue in conservation biology is recognizing and bridging the gap between scientific results and specific action [1], often under monetary limitations. Our current work-in-progress aims to answer the call [1, 2, 3] for a common online database to compile rescue facility-relevant data, facilitate communication and networking among professionals, and increase public awareness and involvement (Fig. 1). Since publication of the paper, feedback has been received on new facilities and will be incorporated in the online map. The database and map will use the contextual framework proposed by the paper.

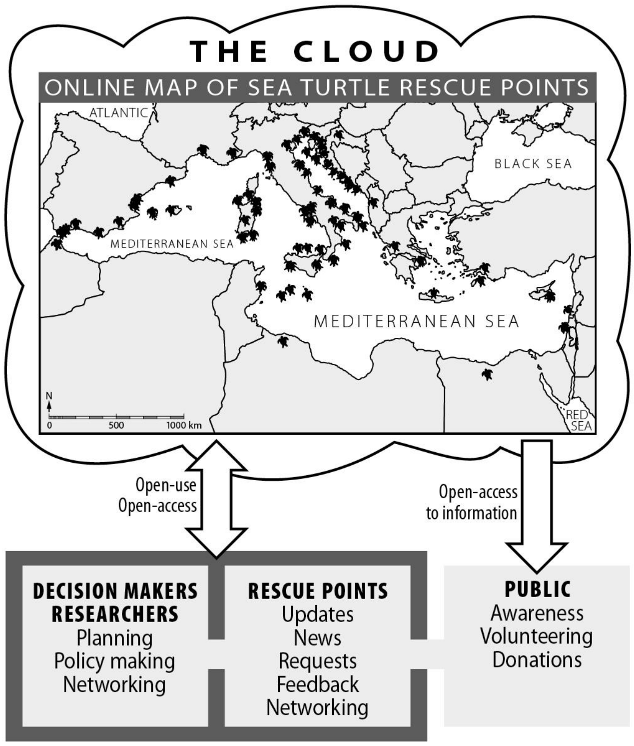

Fig. 1. Outline of the Online Map project to facilitate access to information, thereby increasing public awareness and assisting in management, research, and decision-making on a Mediterranean scale.

Constraints and objectives were to develop a readily accessible information and communication platform with the least cost-intensive (but functional) technical tools, allowing for a minimum start budget, low-profile software skills for maintenance, and therefore increased longevity. Two online maps will be set up in the cloud for a) the public and b) decision makers, planners, and researchers. The principle of both is open access to basic information about all rescue facilities in the Mediterranean, assembled in one spot, presented in "living" maps instead of static texts and tables. The map aiming to provide public information and intended for "awareness" and a broad target group, will be made available on Google Maps by MEDASSET. The one intended for planning and decision making will be made available in MedGIS – Mediterranean Geographical Information System on biodiversity – managed by RAC/SPA. The new layer is expected to be used in RAC/SPA and UNEP/MAP planning and decision making processes, such as the Ecosystem Approach Integrated Monitoring and Assessment Programme (EcAp). Both maps will be based on data collated in a unique spreadsheet in a shared online environment, allowing for direct update of contact details by users with basic spreadsheet skills. Any internet user can embed Google Maps into their website thus multiplying the initiative's aims and impact. The setup ensures that maintenance will also be simple and inexpensive: MEDASSET will engage its interns and volunteers for a scheduled once-a-year spreadsheet update and map maintenance. MEDASSET will use web analytics to tangibly assess the public map's impact and ensure continual improvement. Facilities will be contacted to provide updated details within a set deadline. The map will state when the respective information was last updated. MEDASSET or RAC/SPA, depending on the contact, will make the effort to ensure contact details are up to date or confirm cessation of activities of the respective contact. RAC/SPA Focal Points government authority representatives will be contacted for validation of information as necessary. Facilities will be able to update information or deliver news, feedback, and requests directly online on an unscheduled basis. A notification setting will be created to inform facilities about changes made. The timeline for finalization of the alpha version in English is June 2016. Once implemented, next objectives will be expanding the contact list, maintaining the maps online, reviewing the working process on a biannual basis, and developing a multi-lingual beta version. The project is self-financed by the partners using available human resources and freeware.

References
1 - Ullmann J. and Stachowitsch M., 2015. A critical review of the Mediterranean sea turtle rescue network: a web looking for a weaver. *Nature Conservation*, 10: 45-69.
2 - Panagopoulou A. and Rees A.F., 2009. Networking among Rescue Centres in the Mediterranean. *In*: Demetropoulos P. and Turkozan O. (Eds) Proceedings of the Second Mediterranean Conference on Marine Turtles, Kemer, Antalya (Turkey), May 2005. Barcelona Convention, Bern Convention, Bonn Convention (CMS), pp 144–147.
3 - Kasparek M., 2003. Proposals for Setting-Up a Clearing-House Mechanism to Monitor Marine Turtle Populations in the Mediterranean. *In*: Margaritoulis D. and Demetropoulos A. (Eds) Proceedings of the First Mediterranean Conference on Marine Turtles, Rome (Italy), October 2001. Barcelona Convention, Bern Convention, Bonn Convention (CMS), Nicosia, Cyprus, pp 151–155.

RESOLVING BOTTLENOSE DOLPHIN-FISHERIES ASSOCIATION PROBLEMS IN MALTESE WATERS, CENTRAL MEDITERRANEAN

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Abstract
Research on bottlenose dolphin, *Tursiops truncatus*, distribution and ecology since 1997 has allowed the comparison of distribution of this species throughout the year in relation to anthropogenic activities including fishing and aquaculture. Bottlenose dolphins have been observed to increasingly forage close to the large tuna-penning zones, South East of Malta. As this area is also a traditional artisanal fishing zone, impacts on the fishing catches due to depredation and net damages by dolphins has caused hostile reactions by some fishermen. The use of pingers has been tested during a pilot research project to keep dolphins away from fishing gear in order to avoid entanglement and avert the increasing negative reactions by frustrated fishermen. Preliminary results indicate pingers may prove helpful to both dolphins and fishermen

Keywords: Cetacea, Fisheries, Conservation, South-Central Mediterranean

Introduction
The Bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821), is one of the most frequently observed cetaceans in the Mediterranean [1]. In Maltese waters this species has been subject of dedicated research since 1997 [2,3,4,5]. Conflicts between fishermen and these dolphins have been increasing as fisheries resources are decreasing and anthropogenic activities are increasing in coastal waters [3,4]. The latter include aquaculture and tuna penning activities. In order to mitigate against dolphin entanglement in increasing congestion of fishing gear and avert detrimental conflicts with frustrated fishermen, a pilot project using Banana Pingers was run to assess the efficacy of these instruments in helping dolphins stay away from trouble.

Materials and Methods
The Banana Pinger used for this pilot study meets the criteria set by the European Union Council Regulation 812/2004 for pingers that can be used at 200m spacing on nets. It produces pings with randomised intervals between pings of 4 to 12 seconds. Each ping last 0.3 seconds and contains a series of frequencies in a random order, with each lasting 20ms or more. The frequencies range from 50 to 120kHz. [6].

Thirty banana pingers were distributed among 3 coastal artisanal trammel net fishermen, which had been monitored for 3 months prior to the use of pingers to assess the extent of the problems with dolphins and the risks to dolphins when depredating from fishing nets. Controls included monitoring both the fishermen using pingers and another 3 fishermen not using the pingers and fishing away from the fishermen with pingers but in similar coastal areas where bottlenose are known to range. For every fishing event, data on fishing position, time, marine species caught, presence or absence of dolphins during fishing and collection of nets, evidence of depredation or damage of nets was recorded and compared.

Results
Field research around the Maltese islands reveal an increasing tendency for specific groups of bottlenose spending more time in tuna-pening zones also utilised by artisanal fishermen in coastal waters. The preliminary results on associations of bottlenose dolphins and trammel fishermen activities have been found to be high with more than 60 to 80% of trammel fishing found to be undertaken in the presence of bottlenose dolphins. After a trial research period using banana pingers staring in 2015, results indicate that trammel net damage and catch depredation by dolphins were both dramatically reduced to 2% and 6% respectively when compared with the original records of damage and depredation before starting the pilot project and in comparison to the controls involving fishing effort running contemporaneously without the use of these pingers. A second phase of this research project is assessing the extent to which seasonality, potential habituation by the dolphins and presence of other anthropogenic activities in the area may influence the sustained efficacy of these instruments.

These research aspects are important especially since occasional feeding of wild dolphins by the tuna-penning operators found in one of the main fishing zones may exacerbate the conflicts between dolphins and fishermen due to their increased presence and the increased possibilities for pinger habituation by these dolphins due to the reward of foraging in this tuna-penning and fishing zone.

Acknowledgments
Thanks are due to to the artisanal fishermen who are taking part in this project and The Biological Conservation Research Foundation, BICREF non-profit ngo, for making available the banana pingers for research by funding this pilot project.

References
1 - Notarbartolo di Sciara, G. & Demma, M. (2004) Guida dei mammiferi marini del Mediterraneo. Franco Muzzio, Editore, Padova. 264 pp.
2 - Vella, A. (1999) Conservation research of Bottlenose dolphins, Tursiops truncatus around the Maltese Islands (Central and Southern Mediterranean region). Proceedings of the European Research on Cetacean – No. 13 (Eds.) Evans, Cruz and Raga.
3 - Vella, A. (2006) Human Impacts on coastal Cetaceans around the Maltese Islands. ECS 20th Annual Conference in Gdynia, Poland. Proceedings of the European Research on Cetacean – No. 20. (Eds.) P.G.H. Evans and I. Kuklik.
4 - Vella, A. (2014) Long-term research: essential for understanding how cetaceans are indicators of a changing environment in the Central-Southern Mediterranean Sea Proceedings of the European Research on Cetacean – No. 27. 259pp. Available at: http://www.europeancetaceansociety.eu/sites/default/files/abstract_book.pdf
5 - Vella, A. (2015) Aerial surveys to study cetaceans: implications for integrated conservation management and sustainable maritime development. Proceedings of the European Research on Cetacean – No. 28. (Eds.) Vella A., Vella N., & Mifsud C. 254pp. Available at: http://www.europeancetaceansociety.eu/sites/default/files/gallery/ECS2015_3_ProgrammeAndAbstracts.pdf
6 - Crosby, A., Tregenza, N., & Williams, R. (2013) The Banana Pinger Trial: Investigation into the Fishtek Banana Pinger to reduce cetacean bycatch in an inshore set net fishery. Report, The Wildlife Trusts Cornwall. 27pp.

THE FIRST GENETIC ANALYSES OF THE LEATHERBACK TURTLE, *DERMOCHELYS CORIACEA* FROM A STRANDING IN CENTRAL MEDITERRANEAN.

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Abstract

On the 16th of July 2015, a dead Leatherback turtle, *Dermochelys coriacea*, stranded in Cirkewwa, Malta and was collected by the Armed Forces of Malta. This is the first stranded record of this species for the Maltese islands. As part of ongoing conservation field research on marine turtles around the Maltese islands, the presence of this species in the central Mediterranean has been monitored too for the past 20 years and has been recorded only three times. The specimen found dead and stranded was tissue sampled for genetic analyses at three mtDNA loci and three nuclear DNA loci. This allowed for a first time genetic study to compare the characters of this species in the Mediterranean with any other genetic sequence data already available for this species from other regions.

Keywords: Turtles, Conservation, Genetics, South-Central Mediterranean

The Leatherback turtle, *Dermochelys coriacea* (Vandelli, 1761), is the most widely distributed sea turtle species in the world, with its population being subdivided into 7 regional management units (RMUs). In 2009, this species has been evaluated as Vulnerable by IUCN, with some of its RMUs being rated at a higher risk of extinction [1]. Mediterranean records for this species are limited to rare sporadic observations of isolated individuals and with no records of nesting sites in the region. Any specimens of this species in the area are reported as migrants from the Atlantic Sea [2,3].

As part of ongoing conservation field research on marine turtles around the Maltese islands, the presence of this species in the central Mediterranean has been monitored as well for the past 20 years and has been recorded few times. On the 16th of July 2015, a dead specimen of *D. coriacea* weighing approximately 200kg and with a carapace of about 2m long from head to tail was collected by the Armed Forces of Malta. From a muscle tissue sample, it was possible to extract genomic DNA which was analysed for the mtDNA control region (CR); 12S rRNA gene (12S); cytochrome c oxidase I gene (COI); brain-derived neurotrophic factor gene (BDNF); oocyte maturation factor Mos (Cmos); and RNA fingerprint protein 35 gene intron 1 (R35), using their respective amplification protocol [4-6]. Each PCR product was sequenced using both forward and reverse primers, where a total of 4452bp were sequenced and deposited in GenBank accession numbers KU883271-6 respectively. The sequences were compared to genetic data available in genetic sequence databases.

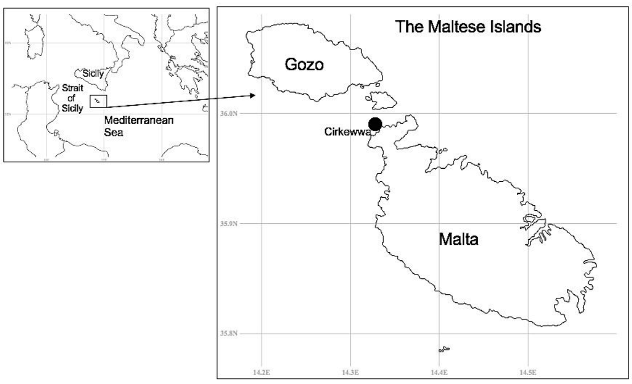

Fig. 1. Map showing location from where the Leatherback turtle, *Dermochelys coriacea*, was collected.

Specific genetic data for this species on most of the studied loci is very limited, and all the sequences obtained during this study matched the few reported sequences at 100% identity. The R35 gene obtained in this study had a 1bp difference (99.9% identity match) a homologous sequence obtained from an Atlantic specimen but completely matched a sequence from a Pacific specimen. However here it has to be noted that genetic data for only two specimens of *D. coriacea* is currently available for this gene and thus the genetic variation of each RMU at this gene is unknown.

The CR also matched other sequences obtained during other studies. The CR haplotype placed the locally collected specimen within the commonest haplotype found in the Atlantic Sea [7,8], further supporting the hypothesis that Mediterranean Leatherback turtles are of Atlantic origin.

Acknowledgments:
Thanks are due to: The Armed Forces of Malta for providing assistance with data and stranded turtle collections; The Malta Environment and Planning Authority for providing the tissue sample on which these analyses were possible under MEPA turtle handing and sampling permit number NP 20/15; The University of Malta, Conservation Biology and Genetics laboratory research facilities.

References

1 - Wallace BP., Tiwari M. and Girondot M., 2013. *Dermochelys coriacea*. The IUCN Red List of Threatened Species 2013: (http://www.iucnredlist.org/). Accessed 4th February 2016.
2 - Casale, P. and Margaritoulis D., (Eds.) 2010. Sea turtles in the Mediterranean: Distribution, threats and conservation priorities. 2010. Gland, Switzerland: IUCN. 294 pp.
3 - Casale P., Nicolosi P., Freggi D., Turchetto M. and Argano R., 2003. Leatherback turtles (*Dermochelys coriacea*) in Italy and in the Mediterranean Basin. Herpetological Journal 13:135-139.
4 - Abreu-Grobois FA., Horrocks J., Formia A., Browne D. and Beggs J., 2006. New mtDNA D-loop primers which work for a variety of marine turtle species may increase the resolution capacity of mixed stock analysis. p. 179. In: Proceedings of the 26th Annual Symposium on Sea Turtle Biology and Conservation, Crete, 3rd-8th April 2006. Inter- national Sea Turtle Society, Athens, Greece.
5 - Naro-Maciel E., Reid B., Fitzsimmons NN., Le M., DeSalle R. and Amato G., 2009. DNA barcodes for globally threatened marine turtles: a registry approach to documenting biodiversity. Molecular Ecology Resources, 10:252-263.
6 - Naro-Maciel E., Le M., FitzSimmons NN., and Amato G., 2008. Evolutionary relationships of marine turtles: a molecular phylogeny based on nuclear and mitochondrial genes. Molecular Phylogenetics and Evolution, 49: 659-662.
7 - Molfetti E, Vilaca ST., Georges JY., Plot V., Delcroix E., Le Scao R., Lavergne A., Barrioz S., dos Santos FR. and de Thoisy B., 2013. Recent Demographic History and Present Fine-Scale Structure in the Northwest Atlantic Leatherback (*Dermochelys coriacea*) Turtle Population. Plos One, 8: e58061.
8 - Dutton PH., Roden SE., Stewart KR., LaCasella E., Tiwari M., Formia A., Thome´ JC., Livingstone SR., Eckert S., Chacon-Chaverri D., Rivalan P. and Allman P. 2013. Population stock structure of leatherback turtles (*Dermochelys coriacea*) in the Atlantic revealed using mtDNA and microsatellite markers. Conservation Genetics 14:625-636.

CIESM Congress Session : Endangered invertebrates
Moderator : Sabiha Tlig-Zouari, Tunis El Manar Univ., Tunisia

Moderator's Synthesis

The Mediterranean Sea is a region of high biodiversity that ranks among the best known in the world. Over the last decades, this complex region has frequently suffered deleterious changes and threats causing serious erosion of marine biodiversity. The quality of information for invertebrate threatened species in the Mediterranean Sea is far lower than for vertebrates and the real degree of extinction risk is underestimated.

Five communications were presented and followed by an intense discussion. The speakers illustrated several aspects of the ecobiology of endangered marine invertebrates (*Pinna rudis*, *Pinna nobilis*, *Lithophaga lithophaga*, *Virgularia mirabilis* and *Funiculina quadrangularis*) for several coastal and protected marine areas of the Mediterranean Sea. A decline of the endangered species population and variability in density spatial distribution, in spite of species protection, explained by human stressors (anchoring) and environmental variables played a secondary role. Knowledge of Biology aspects such as growth, biometric, size frequency structure, condition index is important to develop conservation strategy of threatened species. Furthermore, protected marine areas should be implemented to reduce pressures on invertebrate populations and safeguard critical benthic communities habitats.

The debate made clear that deep investigations on the ecology and biology of invertebrates species are still needed for a large number of sites in the Mediterranean Sea basin to properly assess the current status of these species. The present situation indicates that Mediterranean coastal areas are inadequately protected, planned and managed and in need of urgent conservation efforts to protect marine habitats and threatened species. Data collection could be sustained through participatory projects involving local populations.

MARINE PROTECTED AREAS EFFECTIVELY MAINTAIN ENDEMIC *PINNA NOBILIS* POPULATIONS

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Abstract
Coastal habitat degradation compromise sessile marine species. Populations of the endemic species, fan shell bivalve *Pinna nobilis* are declining in spite of species protection. Models analyzed environmental versus human-derived stressors as explanatory variables depicting populations at mesoscale level. Human stressors explained most variability in density spatial distribution significantly disturbing benthic communities, while habitat protection affected *P. nobilis* structure and physical aggression by anchoring highly impact on densities. Environmental variables played a secondary role, indicating that global change processes are not so relevant in coastal benthic communities as human-derived impacts.

Keywords: Mediterranean Sea, Conservation, Endemism, Stressors, Marine reserves

Coastal degradation, habitat fragmentation and habitat losses are undermining marine biodiversity and especially sessile marine species. The largest bivalve in the Mediterranean basin – the fan shell *Pinna nobilis* - is an endemic, vulnerable species and in spite of species legal protection, populations are declining. Climate change, invasive species, contaminants, food web alterations, habitat loss and anchoring and have been claimed to the main treats affecting *Pinna nobilis* populations [1].

In this study we analysed the contribution of several explanatory variables that depict *Pinna nobilis* populations at mesoscale level. We have applied multivariate models (DistLM distance-based linear model routine marginal test) to assess the relationships between environmental variables (mean depth, Hs mean, Hs maximum, mean Tp and mean direction) and human-derived stressors (anchoring, protection status, sewage effluents, fishing activity and diving) in the Balearic Islands, W Med. Human stressors that disturb the benthic communities mainly determine the density spatial distribution of fan shell (Table 1). Habitat protection affected *P. nobilis* structure and physical aggression by anchoring reveals a high impact on its densities. Environmental variables contributed less to the variability in densities, but did influence the size structure. Human derived impacts in the coastal zones must be properly addressed to guarantee protection of coastal benthic communities. Altogether, indicating that global change processes are not as relevant as human-derived impacts.

Tab. 1. DistLM (distance-based linear model routine) marginal test for relationships among environmental (mean depth, Hs mean, Hs maximum, mean Tp and mean direction) and human variables (anchoring, protection status, sewage effluents, fishing activity and diving) for: *P. nobilis* densities, sizes and *P. nobilis* densities, major variables.

	***Pinna nobilis* density**			***Pinna nobilis* size**		
Explanatory variable	**% var.**	**Pseudo-*F***	***p***	**% var.**	**Pseudo-*F***	***p***
Mean depth	<0.01	0.0079	0.9658	**7.1**	130.6	**0.01**
Hs mean	0.81	43.023	**0.0204**	0.18	3.12	0.072
Hs maximum	0.16	0.8431	0.3182	<0.01	1.063	0.304
Mean Tp	0.18	0.9655	0.2789	1.62	28.117	**0.001**
Mean direction	2.55	13.579	**0.0001**	**4.007**	71.3	**0.001**
Anchoring	**19.93**	106.16	**0.0001**	**3.918**	69.656	**0.001**
Protection status	**11.72**	62.412	**0.0001**	**3.296**	58.214	**0.001**
Sewage effluents	<0.01	0.1216	0.7044	0.922	15.904	**0.001**
Fishing activity	4.38	23.343	**0.0001**	**3.877**	68.897	**0.001**
Diving	6.05	32.255	**0.0001**	1.33	22.985	**0.001**
***Pinna nobilis* density Major Variable**	**% var.**	**Pseudo-*F***	***p***			
Environmental	6.602	92.603	**0.001**			
Human	**21.575**	36.039	**0.001**			

This large-scale study performed with a high spatial resolution demonstrates that the spatial distribution of *Pinna nobilis* is distressed by human stressors more than environmental variables. Anchoring is the main factor affecting density of the fan mussel in the studied sites as already stated in previous studies [2, 3]. Legal protection of habitats is crucial in maintaining population structure of large, long-lived and sessile benthic organisms such as the fan mussels. This study shows that protection is widely affecting densities of *P. nobilis* at the studied geographical extent. Contrasted densities are two-fold in the MPA (Cabrera) where no-take reserves have been effectively set for more than 20 years [4]. Those results indicate that MPAs guarantee conservation demonstrating that a combination of protection size and age of the MPAs [5] seems to set the optimal conditions for growth and development of the species.

References
1 - Basso L, Vázquez-Luis M, García-March JR, Deudero S, Alvarez E, Vicente N, Duarte CM, Hendriks I. The pen shell, *Pinna nobilis*: A review of population status and recommended research priorities in the Mediterranean Sea. Advances in Marine Biology, 71: 109-160.
2 - Hendriks, I.E., Tenan, S., Tavecchia, G., Marbà, N., Jordà, G., Deudero, S., Álvarez, E., Duarte, C.M., 2013. Boat anchoring impacts coastal populations of the pen shell, the largest bivalve in the Mediterranean. Biol. Conserv. 160, 105–113.
3 - Vázquez-Luis, M., Borg, J.A., Morell, C., Banach-Esteve, G., Deudero, S., 2015. Influence of boat anchoring on *Pinna nobilis*: a field experiment using mimic units. Mar. Freshw. Res.
4 - Deudero S, Vázquez-Luis M, Alvarez E, 2015. Human stressors are driving coastal benthic long-lived sessile fan mussel *Pinna nobilis* population structure more than environmental stressors. Plos One 10(7):1-14.
5 - Claudet J, Osenberg CW, Benedetti-Cecchi L, Domenici P, García-Charton J-A, Pérez-Ruzafa Á, Planes S. Marine reserves: Size and age do matter. Ecology Letters. 2008; 11(5): 481–489.

SEASONAL VARIATIONS OF BIOMETRIC RELATIONSHIPS OF DATE MUSSEL *LITHOPHAGA LITHOPHAGA* (LINNAEUS, 1758), FROM ALEXANDRIA COAST, EGYPT.

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Abstract

Lithophaga lithophaga (Linnaeus, 1758) is an important mussel species. In Egypt, they are exploited commercially throughout the year for local as well as external market due to heavy demand. 571 individuals were collected in the size range 15.54-97.92 mm. The morphometric relationships between length-width and length-weight from Oct. 2012 to Sep. 2013 were estimated. The length frequency distributions of all samples were represented.This study was undertaken to assess seasonal variations in the quality of the meat mussel by estimating the condition index. This index also reflect the chemical composition and physiological states during gonad development and reproductive phases of the mussel.

Keywords: Bivalves, Levantine Basin, Biometrics

Introduction

The date mussel (*Lithophaga lithophaga* Linnaeus, 1758) (Bivalvia: Mytilidae) is an endolithic bivalve which bores calcareous substrata by glandular secretion. (Morten & Scott, 1980). It is widespread in the infra littoral region, usually at shallow depth, of the Mediterranean of the Red Sea (Fischer et al; 1987). Previous study in the same area of study focused mainly of the effect of pollution and bioaccumulation of the population of *L. lithophaga*. The present study gives the first insights on the biometrics of *L. lithophaga* in the studied area.

Material and methods

Samples of *Lithophaga lithophaga* were collected from Sidi Bishr, Miami, El Asafra, and El Montaza sites (Fig. 1) at (5-7 m) depth.

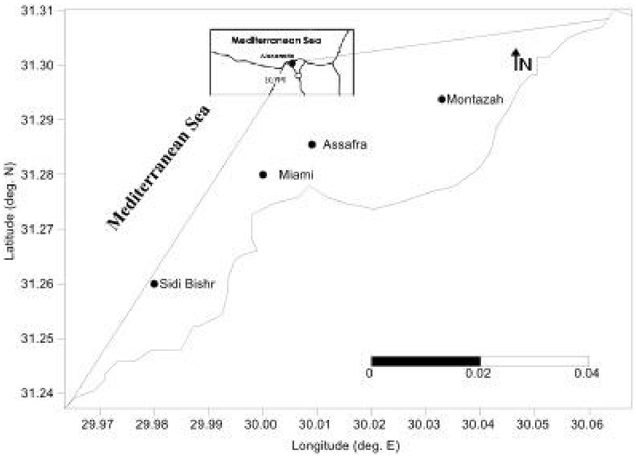

Fig. 1. Map showing sampling location of Alexandria coast

Live mussel samples were transferred to the laboratory. The samples were sexed and measurements of the shell length (maximum antero-posterio distance) were recorded accurately to 0.01 mm using a Vernier Caliper. Total weight of the mussel was determined to the nearest 0.01 g using an electronic balance. Length-weight relationships were fitting using power function $y=bx^{a.}$ Condition index was calculated according to Devenport and Chen (1987).

Results and discussion

1. Length-weight relationships

All relations indicate highly positive allometry, significant at 1% level. All the biometric variables are in Table 1.

Tab. 1. Seasonal variations of combined sex of *L. lithophaga* of the collected samples.

	Season	N	a	b	r	r^2	All
♂	Autumn	78	0.0002	2.7107	0.9781	0.9569	+
	Winter	101	0.002	2.031	0.8456	0.715	+
	Spring	99	0.0002	2.6798	0.9714	0.9436	+
	Summer	90	0.0002	2.6636	0.9193	0.8452	+
♀	Autumn	40	0.0004	2.5321	0.9781	0.9597	+
	Winter	61	0.002	2.067	0.8792	0.773	+
	Spring	41	0.0001	2.8278	0.9704	0.9417	+
	Summer	60	0.0001	2.8369	0.9665	0.9342	+

N number of individuals. a: constant; b: slope (general allometric factor); r: correlation coefficient; R^2: coefficient of determination; All: allometry;

;

2. Size frequency structure

The shell length of the studied samples ranged from 15 mm to 85 mm with high frequency abundance of shell length from 45 mm to 55 mm of combined sexes. Similarly, in Croatia, Pehrada et al., (2015) recorded in his study that the population of *L. lithophaga* shell length ranged from 30.6 to 93.6 mm.

3. Condition Index.

The monthly distribution of the condition index (CI) shows that there is one peak in October and a second peak during June. Also, a gradual decrease of CI from November to March was observed. This may indicate a significant loss in tissue weight or reserves due to release of gonadal content (Sahin et al., 2006)

This present study is important in planning studies assessing the resilience capability of natural populations of *L. lithophaga* after using illegal destructive harvesting methods.

References

1 - Davenport, J. and Chen, X., 1987. A comparison of methods for the assessement of condition in the mussel (*Mytilus edulis* L.). J. Moll. Stud., 53, 293-297.

2 - Peharda, M., Puljas, S., Chauvaud, L., Schone, B.R., Ezgeta-Balie, D., Thebault, J., 2015. Growth and longevity of *Lithophaga lithophaga* : what can we learn from shell structure and stable isotope composition?. Mar. Biol., 162, 1531-1540.

3 - Sahin C., Düzgünes E. and I. Okumus,2006. Seasonal variations in condition index and gonadal development of the introduced blood cockle *Anadara inaequivalvis* (Bruguiere, 1789) in the southeastern Black Sea coast. Turkish J. Aquat. Sci., 6, 155-163.

DISTRIBUTION OF THE SEA PENS *VIRGULARIA MIRABILIS* AND *FUNICULINA QUADRANGULARIS* (CNIDARIA ANTHOZOA) IN THE NORTHERN AND CENTRAL ADRIATIC SEA

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Abstract

Occurrence and distribution of the sea pens *Virgularia mirabilis* and *Funiculina quadrangularis* in the northern and central Adriatic Sea were determined from data collected during five trawl surveys from 2011 to 2015 carried out through *rapido* trawl. Species density data (number of individuals per km^{-2}) were processed to describe their spatial distribution.

Keywords: Cnidaria, Conservation, North Adriatic Sea

Introduction

Virgularia mirabilis (Müller, 1776) and *Funiculina quadrangularis* (Pallas, 1766) are two sea pens species that, with *Pennatula phosphorea* Linnaeus, 1758, characterize the "Sea pen and burrowing megafauna communities" habitat. This biotope complex was classified by OSPAR as a 'Threatened and/or Declining Habitat' [1]. Recently, these species were also included in the IUCN red list of Italian corals [2]: *V. mirabilis* as vulnerable species while *F. quadrangularis* as critically endangered species. For these reasons, a better knowledge of the distribution of these sea pens is of key conservation importance.

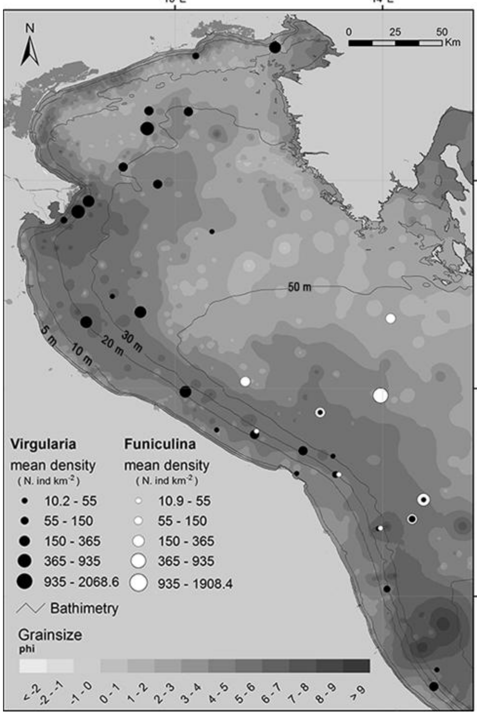

Fig. 1. Mean density (N. ind km^{-2}) of *Virgularia mirabilis* (black dots) and *Funiculina quadrangularis* (white dots) in the Adriatic Sea estimated over the five survey years.

Material and Methods

Specimens of *V. mirabilis* and *F. quadrangularis* were collected in the northern and central Adriatic Sea during SoleMon trawl surveys carried out in fall from 2011 to 2015, using *rapido* trawls [3]. Specimens were identified and counted. Data were standardized to km^2 and used to draw the distribution map.

Results

V. mirabilis density ranged from a minimum of 27.4 (2012) to a maximum of 6500.3 (2015) ind km^{-2}, while *F. quadrangularis* density ranged from 54.7 (2014) to 7771.6 (2014) ind km^{-2}. Both species occurred on muddy or muddy-sand sediments: *V. mirabilis* was confined to shallow waters along the Italian coast (<50 m depth), while *F. quadrangularis* mainly occurred in deeper waters in the central Adriatic Sea (>40 m depth) (Fig. 1).

Discussion and Conclusions

The spatial distribution of *V. mirabilis* and *F. quadrangularis* in the northern and central Adriatic Sea revealed that both species mainly inhabit sediments with high mud content, although they have been also recorded in sandy bottoms. In particular, the occurrence of *V. mirabilis* in shallow waters may be related to the inflow of the Po River plume, which mainly affects the Italian coast and partially off the Venice Lagoon, where it spreads over the region developing cyclonic and anticyclonic subregional gyres [5]. On the contrary, *F. quadrangularis* distribution is almost limited to deeper waters characterized by low hydrodynamism. These findings agree with what already reported by Greathaed *et al*. [4], who found that sea pen distribution is strongly related to mud contents, but also to other environmental variables, such as depth, current speed, salinity and nutrient concentration. Further studies are needed to establish the correlation between the distribution of these threatened sea pens in respect to their adaptability to different environmental conditions. Considering that *rapido* trawls have a low catchability for these anthozoans [4], data collected by means of other sampling methods (e.g., diving or video surveys) would be needed to get more accurate estimations of abundance of the two species and to find the better solution for sea pens conservation strategy.

References

1 - OSPAR, 2010. Background document for seapen and burrowing megafauna communities. Biological Diversity and Ecosystems Series, 2010/48. OSPAR Commission. http://www.ospar.org/documents/dbase/publications/p00481/p00481_seapen%20and%20burrowing%20megafauna.pdf (March 2014).

2 - Salvati E., Bo M., Rondinini C., Battistoni, A. and Teofili, C., 2014. Lista Rossa IUCN dei coralli Italiani. Comitato italiano IUCN e Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Roma.

3 - Grati F., Scarcella G., Polidori P., Domenichetti F., Bolognini L., Gramolini R., Vasapollo C., Giovanardi O., Raicevich S., Celic I., Vrgoc N., Isajlovic I., Jenic A., Marceta B. and Fabi G., 2013. Multi-annual investigation of the spatial distributions of juvenile and adult sole (*Solea solea*, L.) in the Adriatic Sea (Northern Mediterranean). *J. Sea Res*., 84: 122-132.

4 - Greathead C., González-Irusta J.M., Clarke J., Boulcott P., Blackadder L., Weetman A. and Wright P.J., 2015. Environmental requirements for three sea pen species: relevance to distribution and conservation. *ICES J. Mar. Sci*., 72 (2): 576-586.

5 - Giani M., Djakovac T., Degobbis D., Cozzi S., Solidoro C. and Fonda Umani S., 2012. Recent changes in the marine ecosystems of the northern Adriatic Sea. *Estuar. Coast. Shelf. S.*, 115: 1-13.

AGE AND GROWTH OF THE THREATENED PEN SHELL *PINNA RUDIS*, LINNAEUS, 1758 IN A MPA

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Abstract
Age and growth *of Pinna rudis* were studied in Cabrera National Park MPA. To determine age and growth, the shells were processed to study the growth records across the posterior adductor muscle scar. The absolute growth of studied population was asymptotic, with a maximum longevity and length of 28-31 years and 45 cm respectively. This is the first study on age and growth determination of this protected species.

Keywords: Bivalves, Growth, Mediterranean Sea

Introduction
The bivalve *Pinna rudis,* Linnaeus 1758is a protected species, but its biology and ecology are largely unknown. Sclerochronology has proven to be a very useful technique to assess individual age and population growth rates. The Von Bertalanffy growth model (VBGM) is commonly applied in mollusc research because it fairly represents size at age. The aims of the present study were to estimate for the first time age and growth parameters of this species. For this aim empty shells of a population inhabiting the MPA were collected and their growth records analyzed.

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 19 empty shells of dead individuals were collected by scuba diving during July 2011 and July 2012. To determine age and growth, the shells were processed to study the growth records across the posterior adductor muscle scar using the methodology proposed by [1]. A Von Bertalanffy growth model (VBGM) was fitted to the size-age data obtained from the shells using a non-linear mixed-effects model (NLME), considering L_{max} random and t_0 and k fixed (this method requires knowledge of the age of the bivalves at each measurement).

Results and Discussion
In the MPA, the studied *P. rudis* exhibited an asymptotic growth, and reached a maximum longevity of 28-31 years and a maximum shell length of 45 cm (Table 1).The growth equation for studied population was C1 (Table 1). The resulting parameters suggested that first nacreous layers of *P. rudis* are too thin to be observable under binocular lens (Figure 1), and therefore, a second equation C2 was calculated (adding 3 missing years) fitting better with in situ observations (Table 1).

Tab. 1. Growth parameters for *P. rudis*. *k*: speed at which the maximum asymptotic size of the population is reached, L_{max}: maximum length of the population, n: number of individuals within the population, t_0: age at length 0.

Equation	Populations	k	t_0	L_{max}	n
C1: $L_{(t)} = 45.27 \cdot (1- e^{-0.14\,(t+3.80)})$	Cabrera MPA	0.14	-3.80	45.27	14
C2: $L_{(t)} = 45.27 \cdot (1- e^{-0.14\,(t+0.80)})$	Cabrera MPA +3	0.14	-0.80	45.27	14

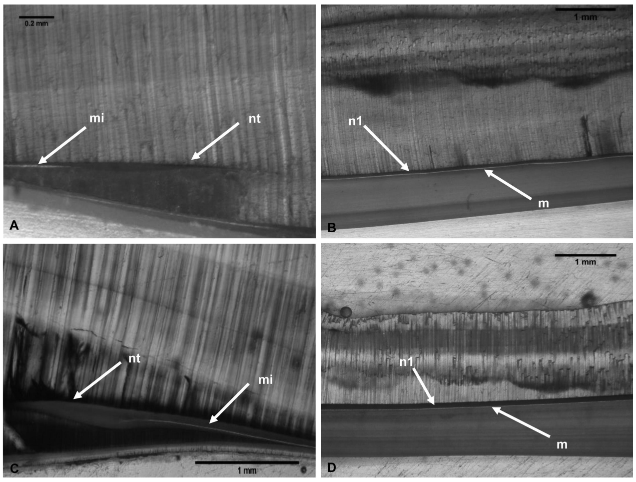

Fig. 1. A), B): Inner record of *Pinna rudis* shells; C), D): inner record of the congeneric *Pinna nobilis*. Abreviations: nt, nacre tongue; m, miostracum layer; mi, miostracum intrusion; n1, nacreous layer 1.

References
1 - García-March J.R. Márquez-Aliaga A. Wang Y.G. Surge D. Kersting D.K., 2011. Study of *Pinna nobilis* growth from inner record: How biased are posterior adductor muscle scars estimates? Journal of Experimental Marine Biology and Ecology, 407:337-344.

SPATIAL DISTRIBUTION AND POPULATION STRUCTURE, OF THE THREATENED PEN SHELL *PINNA RUDIS*, LINNAEUS, 1758 IN A W MEDITERRANEAN MARINE PROTECTED AREA

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Abstract
Spatial distribution, sizes and densities of *Pinna rudis* have been studied in the Cabrera National Park. Densities varied spatially within the park (from low 0-0.16 to high 6.89 ind./100 m^2) corresponding to a wide range of sizes. Most pen shells were patchily distributed and mainly concentrated in caves. High densities were observed in two hotspots, and represented the highest densities recorded worldwide, possibly linked to retention processes through high larval accumulation. The population size structure showed a unimodal distribution with individuals ranging from 6.2 to 25.0 cm shell width, with an average shell width of 16.0 ± 3.4 cm. Given the scarce data on this species, the present study provides valuable information for the spatial management and conservation of this threatened species.

Keywords: Density, Bivalves, Mediterranean Sea

Introduction
The bivalve *Pinna rudis*, Linnaeus 1758is patchily and widely distributed in Mediterranean Sea and Atlantic Ocean. This species is included in Annex II of Bern Convention (as strictly protected species) and Barcelona Convention (as marine species endangered or threatened). Population of *P. rudis* is threatened by 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. The main objective was to assess the density of *P. rudis* individuals, distribution and size structure of the population in a MPA.

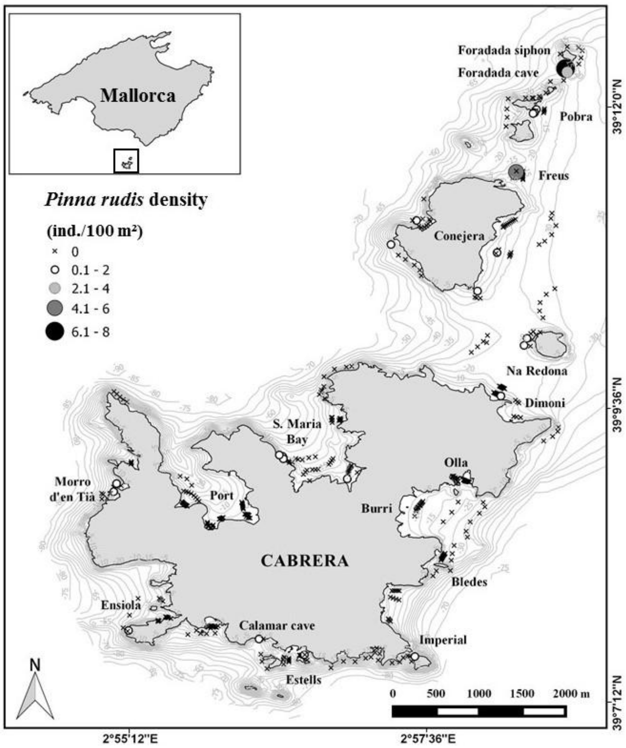

Fig. 1. Distribution and density of *Pinna rudis* individuals in Cabrera MPA.

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 418 strip transects were conducted by scuba diving in order to survey *P. rudis* density in all habitats at depths ranging from 4 to 40 meters depth. The field survey was carried out at the end of July 2011,2012 and 2013. Data gathered were expressed in individuals per 100 m^2 and differences in density distribution among habitats were assessed applying a permutational test (based in a similarity matrix and Euclidian distance on untransformed data) of one-factor design, with habitat as fixed factor with 5 levels (caves, coastal detritic, rock, sand and seagrass).

Results and Discussion
A total of 88 living individuals and 25 dead individuals of *P. rudis* were recorded along 152,146.35 m^2 in a depth range from 4.7 to 34 m. In general, low densities of *P. rudis* were found in the MPA (mean density of 0.01–1.69 ind./100 m^2, Fig. 1).
Habitat type mainly determined its distribution being more abundant in caves with peaks of 6.89 ind./100 m^2 (P= 0.001, Fig. 2a). The population size structure showed a unimodal distribution with individuals ranging from 6.2 to 25 cm shell width, with an average shell width of 15.99 ± 3.39 cm (Fig. 2b). The MPA hosts a well-established population with individuals of all size ranges and the present study found the highest density recorded worldwide. Therefore, monitoring and further studies are highly recommended.

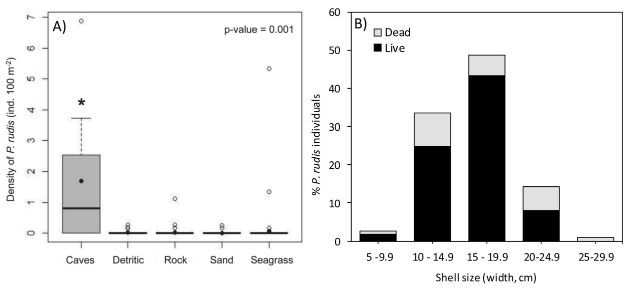

Fig. 2. A): Boxplot of values of *P. rudis* density (ind./100 m^2) in the studied habitats; and B): shell size structure (N=88 living individuals and 25 dead individuals).

References
1 - Nebot E. Vázquez-Luis M. García-March J.R. Deudero S., 2016. Population Structure and Growth of the Threatened Pen Shell, *Pinna rudis* (Linnaeus, 1758) in a Western Mediterranean Marine Protected Area. Mediterranean Marine Science, *in press*

COMITÉ 6

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Ecosystèmes côtiers

Président : Yves Henocque
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CIESM Congress Session : Valuation of marine ecosystems / green tourism

Moderator : Yves Henocque, Ifremer, France

Moderator's Synthesis

The varied ecosystem service assessments, though accounting for only a few of them, were mainly focused towards the development of tourism and ecotourism on one hand, and the current or potential (acidification) loss of natural capital. Ecotourism development, in positive interaction with fisheries, appears to be particularly promising for both natural and social capitals as it was demonstrated in the case of small Mediterranean islands and the most emblematic coralligenous habitat (First prize winner as a poster). A simple index of local vulnerability has been developed and discussed in regard to beach tourism and possible impacts of climate change.

THE POTENTIAL OF COASTAL ECOTOURISM IN CENTRAL MEDITERRANEAN ISLANDS: A CASE STUDY FROM THE AEGADIAN ARCHIPELAGO

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Abstract
The study aims at identifying the challenges hindering the success of coastal ecotourism within a central Mediterranean archipelago - the Aegadian one, off the western coast of Sicily - and at identifying good practices in an attempt to propose a tourism model that addresses the environmental and socio-economic challenges of this archipelago. 4 study visits and 40 interviews with various coastal tourism stakeholders were carried out between October 2012 and October 2015. Whereas numerous challenges to coastal ecotourism have been identified, a number of success stories have been recorded, which confirm that should adequate policies be implemented and necessary actions taken, coastal ecotourism can serve as an alternative to the characteristic seasonal and mass tourism pattern currently dominating this archipelago.

Keywords: Coastal management, Islands, Marine parks, Mediterranean Sea

Introduction
Coastal ecotourism is a form of responsible travel to coastal and/or marine settings for environmental conservation, improvement of natural resources and to support the well-being on the local communities. It encompasses a myriad of activities including nature photography, visiting cultural and heritage sites, cycling, snorkelling, scuba diving, kayaking, canoeing and bird watching (Sakellariadou, 2014). Other activities include rock pooling, walking on coastal footpaths and observing marine mega-fauna such as dolphins and seals (Garrod and Wilson, 2003).

Methodology
The Aegadian archipelago is located to the west of the city of Trapani at the western-most point of Sicily (see Figure 1). It includes 3 inhabited islands Favignana, Levanzo and Marettimo, and is characterised by the largest Marine Protected Area (MPA) in Italy and the second largest MPA in the Mediterranean (Himes, 2007). 4 study visits were carried out on the 3 islands between October 2012 and October 2015 and relevant observations were made on any coastal ecotourism-related activity taking place within the archipelago. During the same period 40 informal and in-depth interviews were held with all stakeholders including local people, non-governmental organisations (NGOs), politicians and governmental agencies, operators, academics and tourists. Content analysis was then carried out to identify the challenges faced by and success stories from the coastal ecotourism sector in the archipelago.

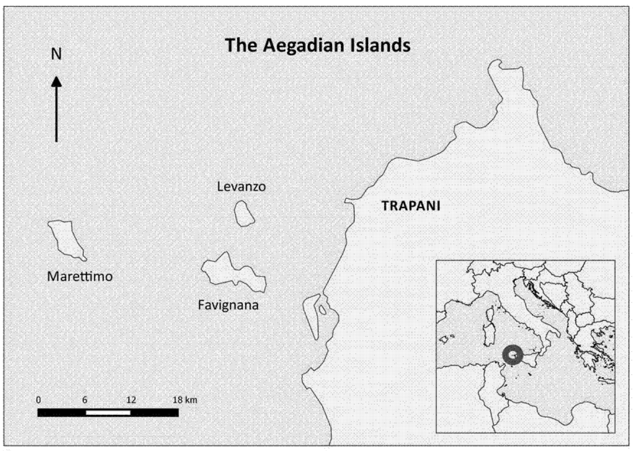

Fig. 1. Location of the Aegadian Islands off the western coast of Sicily.

Results and discussion
Challenges to coastal ecotourism include island connectivity issues due to bad weather and regular disputes between regional government and service providers, lack of ecotourism services all year round due to insufficient numbers of tourists and the seasonal working lifestyle preferred by service providers, green washing due to lack of true ecotourism understanding, emphasis on provision of mass tourism services, lack of awareness among locals and operators of the full ecotouristic potential of the islands during the off-peak seasons, failure by locals and fishermen to see the MPA as an exploitable resource that could sustain their income through ancillary tourism activities possibly due to bureaucracy at license-application stage, lack of mentoring and financing for new coastal ecotourism ventures and lack of interest by politicians in coastal ecotourism. Lack of holistic planning, disproportionate attention dedicated to the largest island within the archipelago (Favignana), coupled with lack of collegiality within the archipelago and stiff competition between operators on the same islands hinder the development of an ecotourism package for ecotourists. Lack of promotion and marketing of the Aegadian Islands as a coastal ecotourism destination and lack of (multi-lingual) interpretation/signage along with the language barrier were considered to limit the destination to domestic tourism. Last but not least, illegal dumping, lack of cleanliness in certain coastal areas as well as the discharge of raw untreated sewage in nearby shores are considered to be other main challenges.

Success stories included 2 projects which saw the involvement of the municipality of the Aegadian Islands and the management body of the MPA. The first project was spearheaded by the agency ENEA and included the introduction of an ecolabel, restoration of *Posidonia oceanica* meadows and the publication of two guide books for underwater excursions leading to a 7% increase in tourism on the islands. The second project was managed by the consortium Vivilitalia and included a broad stakeholder analysis to assess current nature-based tourism practices and propose new strategies. Within this context four cycling itineraries have been developed along the coast of Favignana. The NGO 'Quelli della Farfalla – C.P.A.C Marrobbio' based in Favignana has been involved in cleaning and maintaining the coastal area between Cala Rossa and Bue Marino and proposed the prohibition of vehicular access in the zone and the introduction of bike stations. New ecotourism services have stemmed throughout the archipelago and include guided coastal walks followed by tasting of local products, snorkelling excursions combined with coastal cycling tours, selling of souvenirs produced from flotsam and donkey rides through pathways along the coast which are constantly maintained by the local forest rangers. The day-to-day of the archipelago's MPA is partially self-supported through administrative fees for licenses required by service providers to conduct an activity within the precincts of the MPA. This income is being used within the domains of conservation, monitoring and for the general upkeep of the archipelago's MPA.

References
1 - Garrod B. and Wilson J.C., 2003. Marine ecotourism: issues and experiences. Sydney, Australia: *Channel View Publications*, 1-16pp
2 - Himes A.H., 2007. Fishermen's opinions of MPA performance in the Egadi Islands marine reserve. *MAST*, 5(2): 55-76.
3 - Sakellariadou F., 2014. The concept of marine ecotourism: a case study in a Mediterranean island. *International Journal of Climate Change: Impacts and Responses* 6(1): 33-39.

THE IMPORTANCE OF CORALLIGENOUS HABITAT TO THE LOCAL ECONOMY OF ISOLE TREMITI MPA (ADRIATIC SEA): THE CASE OF RECREATIONAL DIVING

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[3] Intependent Researcher and Consultant, Greece

Abstract
Coralligenous represents a key habitat of the Mediterranean continental shelf in terms of biodiversity and aesthetic value. An annual economic benefit of €0.88 M (2014 €) generated by SCUBA diving on coralligenous habitat in the Isole Tremiti MPA (South Italy) was estimated through a survey questionnaire administered to diving centres. Notwithstanding the results represent only one among many other ecosystem services generated by coralligenous, they highlight the importance of cultural ecosystem service related benefits in the marine ecosystems and of coralligenous in particular.

Keywords: Coastal systems, Ecosystem services, Economic valuation, Marine parks, Mediterranean Sea

The assessment of Ecosystem Services (ES) provides a useful analytical and communication tool to support spatial planning and management of marine systems by connecting ecosystem processes to human welfare [1]. Among Cultural Ecosystem Services (CES [2], recreation and aesthetic benefits have long been recognized as important features in land use planning and management, as it should also be in the marine environment. In the present study we assessed part of the economic value generated by coralligenous outcrops, one of the most important Mediterranean habitats in terms of structural complexity and species richness [3], considering the diving industry in the Isole Tremiti Marine Protected Area (MPA; South Adriatic Sea, Italy). A survey questionnaire was distributed to the Diving Centres (DCs) working within the MPA to: a) produce a systematic mapping of the most visited diving sites and understand their spatial distribution within the MPA and their main habitat; b) assess which are the habitats that divers prefer to visit and explore the role of coralligenous in the diving frequentation; c) estimate the economic importance of coralligenous in the recreational SCUBA diving industry considering the gross revenue generated by the number of dives carried out, the number of diving licences released, the gears rented and the number of tanks rented/refilled by each DC during 2014. According to the respondent DCs (4 of the 5 DCs working within the MPA), 34 main diving sites were identified, all featured by the presence of coralligenous. Eight of them were also featured by marine caves. Coralligenous resulted the favourite habitat for divers, along with marine caves, stressing the valuable aesthetic significance of coralligenous as a seascape (CES). The cost of a single recreational SCUBA dive in 2014 ranged from €35 to €40, with a mean cost of €37.00±2.45. Considering the number of dives, the number of divers and the number of days of each season in 2014 (table 1), it was estimated that 4,175 individual dives/year (considering each single diver in the water as one dive) were carried out in the MPA by each of the respondent DCs. An indication of the economic flow yielded from SCUBA dives on coralligenous in Isole Tremiti MPA, based on the mean cost of a single dive, was estimated to be on average €154,468/year per DC. Considering all the active DCs censed (N=5), a total of €772,340 of gross revenue from SCUBA dives was estimated. In addition, an annual economic gross revenue of €20,809 per DC was assessed considering the diving licences (table 2). As DCs do not offer tanks rental/refills and gear rental services to divers not diving with them, no additional revenue was considered from these activities.

Tab. 1. Mean number and standard deviation (SD) of the number of dives per day and divers per dive in 2014, according to the respondent DCs, and their estimated gross revenue.

Season	Dives per day		Divers per dive		N days	Individual dives per season	Gross revenue (€)
	Mean	SD	Mean	SD			
Spring	0.70	0.16	7.25	2.06	93	472	17463
Summer	3.75	0.50	10.00	2.16	93	3488	129038
Autumn	0.33	0.13	7.25	2.99	90	215	7967
Winter	0.00	0.00	0.00	0.00	89	0	0
Total						**4175**	**154468**

Tab. 2. Mean number and standard deviation (SD) of diving licences issued during 2014 and their costs, according to the respondent DCs. OWD: Open Water Diver, AD: Advanced Diver, DM: Dive Master, TD: Tech Dive.

Diving licence	Licences issued		Cost (€)		Gross revenue (€)
	Mean	SD	Mean	SD	
OWD	27.50	9.88	387.5	47.87	10656
AD	19.00	5.48	347.5	41.13	6603
DM	3.67	1.53	600	173.21	2200
TD	5.0	4.24	270	14.14	1350
Total					**20809**

Summing up the average gross revenue per DC for each of the activities considered, an annual gross revenue of €0.88 million was estimated (€876,385; average annual gross revenue per DC of €175,277). This gross revenue can be considered entirely related to coralligenous habitat since all the main diving sites in the MPA resulted characterized by this habitat. Despite the limitations, the present study represents an exploration of the economic role of recreational SCUBA diving to approximate part of the CES benefits provided by coralligenous, considering that recreational practices are closely related to benefits such as identities, spiritual and aesthetic experiences [2]. The estimated gross annual revenue is indicative of a portion of the economic role that a single MPA can obtain from the diving frequentation on coralligenous. This must be intended as a minimum estimate of its CES since other important sources of income (e.g., boat rental, meals, travel and accommodation) were not included in the analysis. Moreover, the total economic value of coralligenous outcrops could strongly increase also taking into account the other ES provided by this habitat, presented as the direct and indirect benefits that contribute to human welfare (e.g. habitat for species of commercial interest, hot-spot of biodiversity, coastal erosion, climate regulation) [3]. However, the present study provides an insight to the potential economic value of coralligenous considering the market impact of diving to capture the magnitude of the importance that recreational diving and tourism related to the coralligenous habitat have in the local economy of an MPA. These results are critical to address the challenges of including economic assessments to complement management measures in the refinement of better informed environmental policies.

References
1 - Böhnke-Henrichs A., Baulcomb C., Koss R., Hussain S.S., 2013. Typology and indicators of ecosystem services for marine spatial planning and management. *Journal of Environmental Management*, pp. 135-145.
2 - Jobstvogt N., Watson V., Kenter J.O., 2014. Looking below the surface: The cultural ecosystem service values of UK marine protected areas (MPAs). *Ecosystem Services*, 10: 97-110. doi:10.1016/j.ecoser.2014.09.006.
3 - Ballesteros E., 2006. Mediterranean coralligenous assemblages: a synthesis of present knowledge. *Oceanogr. Mar. Biol. Annu. Rev.*, 44: 123-195.

EVALUATION DU SERVICE ÉCOSYSTÉMIQUE FOURNI PAR LES HERBIERS DE POSIDONIES DANS LE GOLFE DE GABÈS

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Abstract
L'évaluation du service écosystémique fourni au secteur de la pêche côtière par les herbiers de Posidonies de la partie centrale du Golfe de Gabès se base sur le fait que leur bon état de santé impacte directement la diversité et le volume des prises de la majorité des espèces benthiques. En tenant compte du prix des produits de ce type de pêche et de la surface actuelle des herbiers, la valeur d'un hectare de ces derniers est estimée entre 280 et 340 €. Or, depuis 25 ans, le volume des prises côtières dans la partie centrale du golfe a baissé d'environ 50%, parallèlement à la diminution drastique de la superficie des herbiers. Ainsi, il est possible d'estimer les pertes de valeur directe d'usage liée à cette diminution des herbiers du Golfe de Gabès autrefois les plus étendus du bassin méditerranéen.

Keywords: Gulf of Gabes, Posidonia, Ecosystem services, Fisheries

Depuis plus de 20 ans, la production de pêche, tout secteurs confondus (pêche artisanale/côtière et pêche industrielle), du Golfe de Gabès représente plus de 65% de la production nationale tunisienne. Cependant elle apparaît en constante diminution [1]. Dans cette situation de fléchissement, le secteur de la pêche côtière devient inquiétante. Sa production a varié de ≈29 000 t pendant l'intervalle 1982-1991 à moins de 14 000 t en 2009 [2] soit une diminution de plus de 50% en près de 30 ans. Cette situation se manifeste surtout dans la partie centrale du golfe (Gabès) et dans une moindre mesure plus au nord (Sfax) et plus au sud (Médenine) [1]. La production totale à Gabès (Gabès-Médina, Zarrat et Ghannouch) est ainsi passée de 14 000 t en 1990 [3] à 9000 t en 2001 et 7000 t en 2013 [1] représentant une diminution de 50%. La pêche côtière, essentiellement constituée d'espèces benthiques (poisons, crustacés et céphalopodes) directement dépendantes de la présence d'herbiers à posidonie (Fig.1, [4]), a également diminuée de 50% pendant cette même période passant de 3000 t en 1990 [3] à 1500 t en 2013 [1].

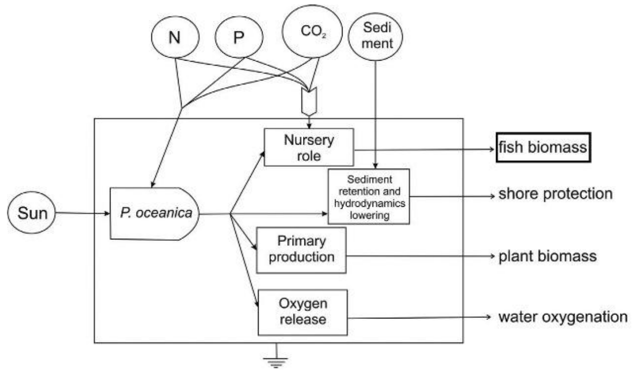

Fig. 1. Schéma des services écosystémiques de *P. oceanica* [4].

Parallèlement à cette décroissance du volume des prises benthiques, l'emprise spatiale des herbiers à posidonie à également diminuée drastiquement. Actuellement, ils ne forment plus qu'une étroite bande côtière discontinue, ne dépassant pas la profondeur de 10 m entre le Nord de l'île de Djerba et La Skhira et sont absents sur plus de 30 km entre Tebelbou et Metouia [5]. Une estimation indique que ces herbiers ne représentent, sur cette portion centrale, qu'environ 130 km^2 (± 13 km). Ainsi, en tenant compte simultanément du prix moyen des produits de la pêche côtière en 2013 évalué à 2700 €/t [1] et de la surface d'emprise actuelle des herbiers, la valeur estimée d'un hectare d'herbiers à Posidonie est comprise entre 280 et 340 €/hectare/an.

Ainsi, il est désormais possible d'évaluer les pertes de valeur directe d'usage pour la pêche côtière occasionnée par cette diminution drastique - estimée à 95% de la surface initiale [5] - de la surface des herbiers à Posidonies sur l'ensemble de la partie centrale du Golfe de Gabès, comprise entre 69 et 84 millions d'euros (valeur 2013).

References
1 - Anonyme, 2013. Annuaire statistique de la direction générale de la pêche.
2 - M'Rabet, R., Jarbaoui, O., Camiñas, J. A., Bernardon, M., 2011. La pêche artisanale à Ghannouch (Tunisie) Passé, présent, avenir. FAO, Malaga, 50 pp.
3 - Ministère du transport et de l'équipement, 2011. Atlas du Gouvernorat de Gabes, Direction Générale de l'Aménagement du Territoire, 124 pp.
4 - Vassallo, P., Paoli, C., Rovere, A., Montefalcone, M., Morri, C. and Bianchi, C.N., 2013.The value of the seagrass *Posidonia oceanica*: a natural capital assessment.*Mar. Pollut. Bull.*, 75: 157–167.
5 - Hattour A. et Ben Mustapha K., 2013. Le couvert végétal marin du Golfe de Gabès. Publication de l'Inst. Nat. Sci. Tech. Mer, 151 pp.

BEACH TOURISM AND CLIMATE CHANGE. A SIMPLE INDEX TO ASSESS VULNERABILITY AT LOCAL LEVEL

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Abstract
Beach tourism is the cornerstone of the Spanish tourism industry. Mass tourism has been developed from the 50s through an economic model based on climate and the exploitation of the beaches. The National Climate Change Adaptation Plan (NAP) expects that changes in sea-level will promote erosion and coastal retreat. It is very likely that these physical changes will affect to the tourist destinations attractiveness. This paper analyses the vulnerability of the beach tourism at local level by means a simple index constructed using datasets referred to lodging and beach coverage. It has been tested in the province of Alicante and the results indicate minimum changes in the beaches coverage of 1.03% in 2020 and maximum of 4.26% in 2040.

Keywords: Beach, Global change, Erosion, Mediterranean Sea

The beach as a tourist attraction is a key factor for tourism destinations competitiveness. The beach ecosystem services have included recreational functions which provide benefits and well-being to local communities. Coastal erosion is decreasing the attractiveness of coastal areas leading to natural and economic impacts. The effects of climate change are predicted to have dramatic consequences, particularly when coastlines are retreating inland in response to rising sea levels [1]. The most likely scenario is the loss of considerable coastal areas and the reduction of the beach coverage [2]. Nevertheless the tourism literature has been overlooked the climate change, probably explained by the complexity of expected tourism demand reactions [3]. There has been little examination of the impact of climate on the success of tourism destinations [4] and the importance of physical changes in the beach ecosystem services [5] [6]. The competitiveness models of tourism destinations usually consider natural resources but a large scale and transfer environment-attractiveness relationship it is difficult from national to local level.

This paper analyses the vulnerability of the beach tourism at local level towards climate change by means an index approach. Their construction is simple and affordable, and the results of the index calculations are understandable. The datasets used are referred to the physical conditions of the beach and lodging in the coastal municipalities. The beach coverage and the changes projected are available through the project C3E included in the NAP. This project subdivides the coastline into squares (units) and provides information about length/area of the beaches and the response of the shoreline to sea-level rise. The time frame chosen is four-fold and thus represents the current scenario and a hypothetical situation projected in 2020, 2030 and 2040. The lodging data is published by the regional statistics services every year (considering 2014 database in any scenario). The index has set as follows: $I_t=(A-R_tL)/B$ where A is the beach coverage at a particular scenario (m); L is the beach length (m); R is the coastal retreat estimated at a particular scenario (m); and B is the bed places in coastal municipalities.

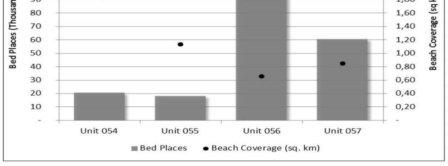

Fig. 1. Beach coverage and bed places distributed in squares (units).

The index has been tested in the province of Alicante, one of main beach tourism destinations in Spain. The length of the beaches is 78 km and supposes 33% of province shoreline. The capacity of the tourist accommodation sector in coastal municipalities is estimated in 191,784 bed places. The province is subdivided in four squares (units 54 to 57). The units 56-57 have 37.5% of total length beaches, 33.6% of total beaches coverage and 80% of total bed places. Both units incorporate important tourist destinations as Benidorm, Calpe, Jávea or Dénia. The index estimates 7.01 and 13.86 m^2/bed for unit 56 and 57 in the current scenario respectively. The result for unit 54 is 89.3 m^2/bed and 62.5 for unit 55. We appreciate that situation between 54-55 and 56-57 units is unevenly balanced. Nevertheless the coastal retreat is worse in first than last units. The percent of beach coverage affected would have from 1.03 up to 1.19%. In 2030 would have from 2.35 up to 2.71%. More than 3 point increase is estimate in 2040 going from 3.72 to 4.26%. The variation of area per bed place would have from 0.29 up to 3.32 m^2 in absolute terms if we compare current and 2040 scenarios. While the 56-57 units decrease 0.29 and 0.60 m^2, 54-55 units do 3.32 and 2.46 m^2 respectively. These consequences on beach coverage should be on the agenda of tourism industry and the integrated coastal management.

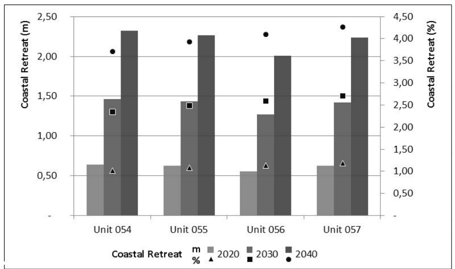

Fig. 2. Coastal retreat estimated by squares (units).

References
1 - Schlacher T.A., Schoeman D.S., Dugan J., Lastra M., Jones A., Scapini F. and McLachlan A., 2008. Sandy beach ecosystems: key features, sampling issues, management challenges and climate change impacts. *Marine Ecology*, 19: 70-91.
2 - Losada, I., Izaguirre, C. and Diaz, P., 2014. *Cambio climático en la costa española*. Oficina Española de Cambio Climático, Ministerio de Agricultura, Alimentación y Medio Ambiente. 133 pp.
3 - Roselló-Nadal, J., 2014. How to evaluate the effects of climate change on tourism. *Tourism Management*, 42: 334-340.
4 - Day, J., Chin, N., Sydnor, S. and Cherkauer, K., 2013. Weather, climate, and tourism performance: A quantitative analysis. *Tourism Management Perspectives*, 5: 51–56.
5 - Sardá, R., 2013. Ecosystem services in the Mediterranean Sea: the need for a economic and business oriented approach. *In*: Hughes, T. (ed.) Mediterranean Sea: Ecosystems, Economic Importance and Environmental Threats, Nova Publishers, pp.1-33.
6 - Perch-Nielsen, S.L, 2011. The vulnerability of beach tourism to climate change – an index approach. *Climatic Change*, 100: 579-606.

ASSESSMENT OF ACIDIFICATION IMPACTS IN THE MEDITERRANEAN SEA: FROM META-ANALYSIS TO ECOSYSTEM SERVICES VALUATION

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Abstract

We have performed a meta-analysis that examines the biological responses of the Mediterranean organisms to acidification. The obtained results depict possible future impacts on two important habitats: the coralligenous concretions and the seagrass meadows. We used a conceptual model to evaluate the potential impacts of future climate scenarios on ecosystem services and benefits that the two habitats provide. In particular, we have evaluated the direct-use value through a market value for the fishing revenues.

Keywords: Mediterranean Sea, Ecosystem services, Economic valuation

Seawater acidification, together with global warming, is expected to cause significant changes in marine environment over the coming century. In this scenario, the Mediterranean Sea is predicted to be one of the most impacted ecosystems by global change drivers [1]. The effects of acidification on organisms' physiology has been studied during the last two decades but still remains a challenged concept due to the contradictory results of field assessments [2]. Therefore, in order to synthesise the current knowledge, we performed a meta-analysis on 67 published studies carried out in the Mediterranean Sea, both in controlled manipulative experiments and *in situ* experiments close to vents area. For each experiment, the effect of acidification was calculated as the log-transformed response ratio (LnRR) of experimental versus control conditions [3]. The quantitative synthesis obtained by the meta-analysis highlights: 1) an increment of the fleshy algae cover (+122%) which could lead to a competitive advantage over calcifying macroalgae (-79%); b) a reduction of the calcification for both algae (-67%) and corals (-5%); c) seagrass shoots enrichment (+13%) under low pH (7.8) and d) a general increase in the photosynthetic activity (+49%) of macrophytes.

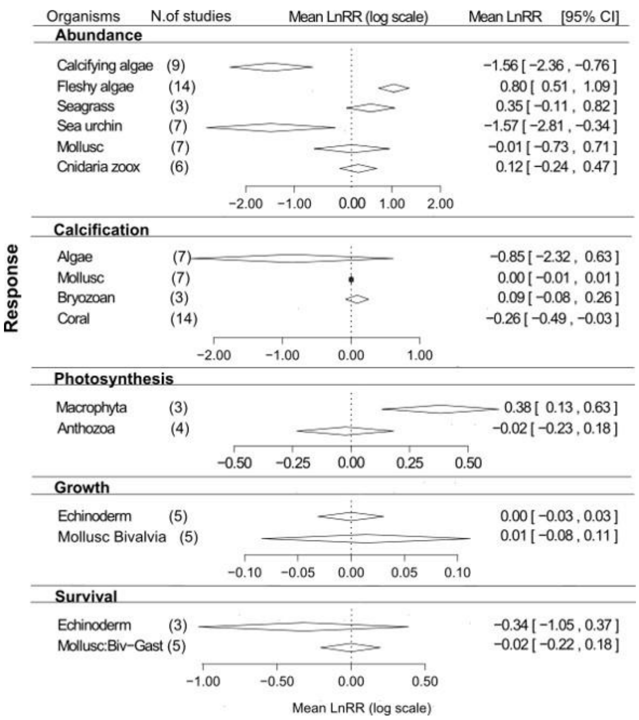

Fig. 1. The mean log response ratio and 95% CI of Mediterranean acidification on physiological responses.

The analysis highlights the existence of direct effects, but suggests the instauration of indirect effects that could trigger a habitat modification. The loss of sea urchins (-80%) combined with the advantages that fleshy algae may have from the acidification, may trigger a transition towards fleshy algae dominated environments. We used the results of the analysis to build a conceptual models of two of the most important and vulnerable habitats of the Mediterranean Sea (coralligenous and seagrass habitats). The models aimed at identifying ecosystem functions, services (ES) and benefits at current and future conditions. Using a preference based approach [4], we estimated the current economic value of coralligenous and seagrass habitats in Italy, and then we assessed future changes through projections of possible acidification scenarios. The direct use value has been evaluated [4] through a market analysis of the fishery provision services. We performed a preliminary assessment of the demersal fisheries production in Italy [5] for coralligenous and seagrass habitats [6] and then we projected their future expected value, considering the habitat alteration due to acidification. The preliminary results have shown a higher economic value of the fisheries revenues from the coralligenous and seagrass habitat. We have quantified the effect of climate change in different scenarios based on change in coverage of the coralligenous and the seagrass meadows and their evolution toward, respectively, hard rock and sand habitats. Our worst-case scenario estimates a loss of demersal resource up to 73% of the current biomass and a maximum economic loss around 100 million of euro per year. Further economic assessments will be performed in order to evaluate the total economic value of the coralligenous and seagrass habitats.

References

1 - IPCC, 2007. The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) Cambridge University Press: Cambridge, UK, and New York, USA.
2 - Gattuso, J.-P., Mach, K.J., Morgan, G., 2013. Ocean acidification and its impacts: an expert survey. Clim. Change 117, 725–738.
3 - Hedges, L. V., Gurevitch, J., Curtis, P.S., 1999. The meta-analysis of response ratios in experimental ecology. Ecology 80, 1150–1156.
4 - TEEB, 2010. The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington
5 - FAO, 2014. Fishery and Aquaculture Statistics. A-1 (e): Capture production by principal species in 2012. FAO Yearbook. 25–27.
6 - Mangos A., Bassino J-P., Sauzade D., 2010. The economic value of sustainable benefits rendered by the Mediterranean marine ecosystems. Plan Bleu, Valbonne. (Blue Plan Papers 8)

CIESM Congress Session : Fishery and aquaculture issues

Moderator : Anna Rindorf, DTU Aqua, Charlotttenlund, Denmark

Moderator's Synthesis

This session focused on knowledge of the impact of fisheries and aquaculture on the ecosystem and the impact of external drivers on fisheries. Fisheries and aquaculture provide food and livelihood for many people in the Mediterranean and the continued or increased benefit delivered by these activities relies on sustainable and adaptive management of the resources, to deliver an ecosystem where numerous activities coexist and continue to do so. Over time, yields in capture fisheries have declined somewhat as important stocks such as hake were overexploited whereas aquaculture continues to increase. At the same time, the Mediterranean ecosystems faces changes in climatic conditions, invasive species, few alternatives for fishers to continued fishing and new developments in marine policies, including the upcoming obligation to eliminate discards of major commercial species. The presentations gathered knowledge on the effects of aquaculture on fish biology, nutrient load and biodiversity, on the effects of fishing on biodiversity, the effects of climate on fisheries yield, the effect of technical regulations on fisheries yield, the availability of data and the use of modelling in estimating fisheries indicators.

The success of future management of fisheries and aquaculture relies on the provision of reliable scientific knowledge on the possible effects of these activities on the marine ecosystem and on the ability of scientists to make the value of management clear to both managers and stakeholders. This is particularly true in the Mediterranean where local involvement in fisheries and aquaculture is often large. Reliable scientific knowledge requires information and data on the ecosystem as well as knowledge of processes and dynamics. Both issues need further attention as time series are often short and spatially and taxonomically restricted and methods used in other systems are therefore not directly applicable. In addition to this, science needs to be communicated to managers, policy makers and stakeholders in a way which acknowledges the ties placed by existing legislation and policies. Scientific advice needs to use collaboration with stakeholders to suggest appropriate management measures instead of the traditionally used top-down process which is unlikely to be successful when applied to local fisheries.

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EFFECTS OF A BLUEFIN TUNA FARM ON WATER QUALITY IN THE EASTERN AEGEAN SEA, TURKEY

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Abstract
Fattening of Bluefin tuna at net cages has been expanding in the Mediterranean but there are few studies dealing with environmental impacts of this new sector. To detect possible negative effects, four samplings were carried out between July 2011 and May 2012. Some physico-chemical variables and chlorophyll a values were investigated. Although some increases in nutrients were observed at farm station, these were not significant due to high water depth, good farm management and periodic farming in the area.

Keywords: Aquaculture, Aegean Sea, Nutrients, Chlorophyll-A

Introduction
The Tuna farming is based on capture from the wild and fattening at cages for 4 to 8 months. Tuna fattening is an intensive aquaculture and bait fish used for food demand. Hence, high organic loads may be observed around the cages [1]. Unconsumed bait fish and feces are the main concern. The aim of the study is assessment of the effects of tuna fattening on the water quality in the SE Aegean Sea.

Materials and methods
The study was accomplished in the Gerence Bay, Eastern Aegean Sea. Four stations were chosen for sampling. Farm station (FS) was in the center of the cage system, while control stations were located 200 (C200) and 1000 m (C1000) Northwest, 300 m (C-300) Northeast of the cages (Fig.1). Depths at the sampling stations are between 48 and 58 m. Samplings were done in July 2011, October 2011, March 2012 and May 2012. Surface and bottom water samples were collected by Nansen bottle.

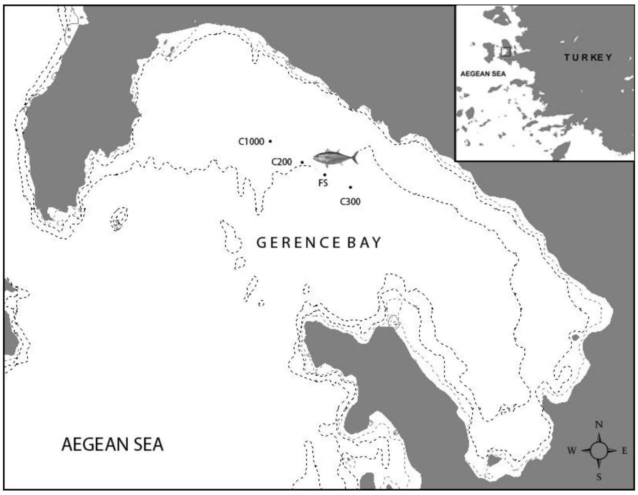

Fig. 1. Map showing the studied area and stations.

Temperature, salinity (SCT meter) and dissolved oxygen (DO) measurements (Oxygen meter) were carried out on site, pH was measured by pH meter, chlorophyll a and nutrients (nitrate–nitrogen, ammonium–nitrogen, and phosphate–phosphorus) were determined spectrophotometrically at the laboratory [2].

Results and discussion
Range of some physico-chemical parameters of the four stations are presented in table 1. Temperature, pH and salinity values varied in relation to seasonal changes.

Tab. 1. Range of physico-chemical variables at the sampling stations.

Parameters	C -300	FS	C 200	C 1000
Temperature (oC)	15.0-22.2	15.1-22.7	15.1-22.6	14.7-22.7
pH	7.9-8.2	7.9-8.2	7.8-8.30	7.8-8.30
DO (mg/L)	6.40-8.23	6.56-8.01	6.50-8.17	6.48-8.30
Salinity (‰)	35.1-37.8	35.0-36.9	35.2-37.1	35.5-37.2
Nitrate+nitrite (µM)	0.01-0.61	0.02-0.51	0.01-1.04	0.04-0.44
Ammonium (µM)	0.12-0.97	0.51-1.39	0.21-1.69	0.21-2.78
Phosphate (µM)	0.61-4.59	0.31-6.12	0.31-3.06	0.31-3.67
Chl-a (µM)	0.63-4.27	0.63-4.64	2.85-4.60	3.80-4.27

DO values varied with weathering and no significant differences were detected between the farm and control stations. DO never dropped below the healthy fish farm value of 5.6 mg/L [3]. Nitrite+nitrate values showed no detectable differences between the stations. However, highest mean values for ammonium and phosphate were observed at FS. Highest phosphate concentrations were also measured at farm station in July 2011. Nevertheless, these differences were not found statistically significant. Similar results were also reported at the same farm [4] and at the other tuna farm [5]. Mean chlorophyll a concentrations were calculated as 1.76±0.72 µg/L at farm station and this value is way lower than the standard values of 10 µg/L recommended for the Northern European waters [6]. In addition, no significant differences were found between the stations for chl a.

Although some increases in nutrients were observed at farm station compared to the controls, these increases were not significant due to high water depth, sound farm management and periodic farming activity in the area.

References
1 - Vezzulli, L., Moreno, M., Marin, V., Pezzati, E., Bartoli, M., & Fabiano, M. (2008). Organic waste impact of capture-based Atlantic bluefin tuna aquaculture at an exposed site in the Mediterranean Sea. Estuarine, Coastal and Shelf Science, 78, 369–384.
2 - Strickland, J. D. H., & Parsons, T. R. (1972). A practical handbook of seawater analysis. Ottowa: Fisheries Research Board of Canada.
3 - Abo, K., & Yokoyama, H. (2007). Assimilative capacity of fish farm environments as determined by the benthic oxygen uptake rate: Studies using a numerical model. Bulletin of Fisheries Research Agency, 19, 79–87.
4 - M. Aksu, A. Kaymakçi Basaran, and Ö. Egemen, 2010, Long-Term Monitoring of the Impact of a Capture-Based Bluefin Tuna Aquaculture on Water Column Nutrient Levels in the Eastern Aegean Sea, Turkey. Environmental Monitoring and Assessment, 171:681–688.
5 - Matijevic, S., Kuspilic, G., & Baric, A. (2006). Impact of a fish farm on physical and chemical properties of sediment and water column in the middle Adriatic Sea. Fresenius Environmental Bulletin, 15, 1058–1063.
6 - Pitta, P., Karakassis, I., Tsapakis, M., & Zivanovic, S. (1999). Natural vs. mariculture induced variability in nutrients and lankton in the eastern Mediterranean. Hydrobiologia, 391, 181–194.

EFFECT OF A SMALL-SCALE FISHING CLOSURE AREA ON THE DEMERSAL COMMUNITY IN THE NW MEDITERRANEAN SEA

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Abstract

The study was conducted in the NW Mediterranean where Rosas' fishermen association has closed during two years one of their fishing grounds. We compared the community structure between the closed fishing ground, and an adjacent area where fishing was permitted in order to explore the effects of the closed area on the community assemblage. Preliminary results indicate that density of most representative taxonomic groups is significantly higher into the closed zone than in the surrounding fishing area. Additionally, the multidimensional scaling analysis showed two well-defined assemblages corresponding to the fishing allowed and the closed zone. The results suggest that fishing closure is an appropriate measure to habitat protection.

Keywords: Density, North-Western Mediterranean, Restoration, Continental shelf

Closed areas have become important elements of fishery management programs for their capacity to protect marine resources and ecosystems [1]. Numerous studies on rocky littoral areas have documented benefits from protection measures, particularly in terms of density and biomass of exploited species [2]. We investigate the effects on the community structure of a fishing closed area in a muddy fishing ground located in the Roses Gulf (NW Mediterranean Sea).

The closing fishing area has a surface of 70 km^2 and was located at 140 m depth in the NW Mediterranean. This closed zone was protected against fishing during two years (from February 2014 to March 2016). Monthly, four trawls were conducted on board fishing vessels; two inside the closed area (C) and two in a neighbour zone where fishing was allowed (F). All hauls (n=43) were conducted at the same bathymetric range (120-140m) and using the same net characteristics (OTMs, squared 40mm size mesh). On board, all commercial species were identified, counted and measured whereas the discard was analysed in the laboratory. All data were normalized to an area of 1 km2 using vessel speed and average horizontal opening of the gear. Non-metric multidimensional scaling (MDS) was performed to the standardized species abundance matrix (fourth root transformation, Bray-Curtis similarity index, PRIMER software) [3]. The SIMPER analysis was used to determine the contribution of the different species to the average dissimilarity between samples [3].

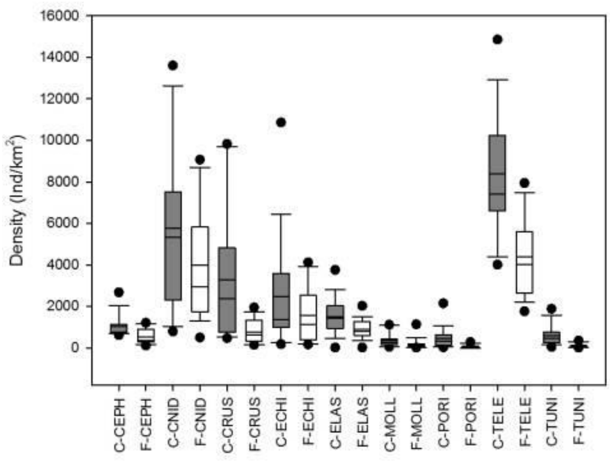

Fig. 1. Boxplot diagram related to density values (ind/km2) of the principal taxonomic groups in the closed fishing area (C: in grey) and the fishing area (F: in white)

Teleost fishes (C = 180.247 ind/km^2; F = 86.939 ind/km^2) were the most abundant taxonomic group in both zones followed by Cnidarians (C = 111.097 ind/km^2; F = 83.839 ind/km^2), Crustaceans (C = 62.948 ind/km^2; F = 14.810 ind/km^2) and Echinoderms (C = 166.715 ind/km^2; F = 29.904 ind/km^2). The boxplot results showed marked density differences between the closed zone and the fishing zone (Fig. 1). All taxonomic groups showed significant higher densities (Wilcox-Test; $p<0.05$) in the closed zone (Fig. 1).

The MDS showed two well-defined assemblages corresponding to the fishing allowed and the closed zone (Fig. 2). The hermit crab *Pagurus prideauxi* and their associated anemone *Adamsia carcinopados*, together with the crinoid *Leptometra phalangium* and the gurnard *Lepidotrigla cavillone* were the species that contributed more to the dissimilarity between both zones, showing higher densities inside the closed fishing zone. However, a minimum of 14 species were required to account for more than 20% of the dissimilarity.

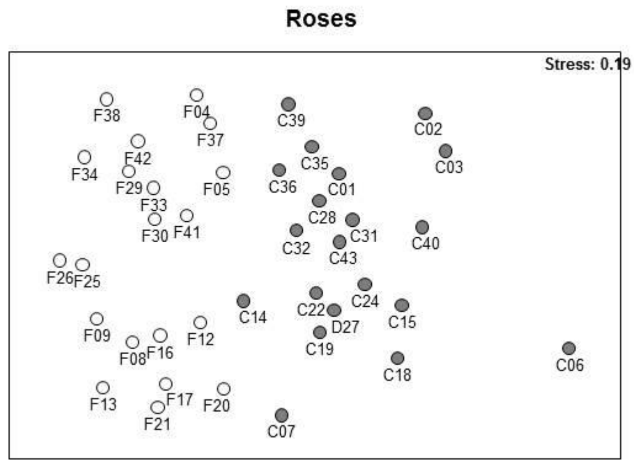

Fig. 2. Non-parametric multidimensional scaling analysis (MDS) of all hauls from the closed fishing area (C: in grey) and the fishing area (F: in white)

The present study suggest that the fishing closures measures have positive effects in the community. Furthermore, a longer closure period would allow the growth and built of more structured systems.

References

1 - Murawski S. A., Brown R., Lai H. L., Rago P. J. & Hendrickson L., 2000. Large-scale closed areas as a fishery-management tool in temperate marine systems: the Georges Bank experience. *Bulletin of Marine Science*, 66: 775-798

2 - Guidetti P., Baiata P., Ballesteros E., Di Franco A., Hereu B., Macpherson E., Micheli F., Pais A., Panzalis P., Rosenberg A., Zabala M. & Sala E., 2014. Large-scale assessment of Mediterranean marine protected areas effects on fish assemblage. *PLoS One*, 9 (4): e91841

3 - Clarke K. & Warwick R., 2001. A further biodiversity index applicable to species lists: variation in taxonomic distinctness. *Marine Ecology Progress Series*, 216: 265-278

GAPS IN BIOLOGICAL KNOWLEDGE OF THE MEDITERRANEAN MARINE FISHES

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Abstract
We estimated the current level of knowledge concerning several biological characteristics of the Mediterranean fishes by performing a gap analysis based on information extracted from FishBase, aiming to identify research trends and future needs in the field of Mediterranean fish biology that can be used in ecosystem based fisheries management.

Keywords: Growth, Mediterranean Sea, Diet, Mortality, Spawning

The ecosystem approach to fisheries management requires that decision making should be based not only on the characteristics of a particular stock, but on all components of the ecosystem [1], as fish species respond differently to protection according to their life-history and ecological traits [2]. This holistic approach demands, apart from large scale research on commercial fish life-history traits, studies of regional interest and on a wide number of species, including non-commercial ones. It seems though that such studies are considered of low interest and are therefore discouraged by major scientific publishers, thus creating a knowledge gap in the Mediterranean Sea, especially in its southern part [3].

In order to examine what is already known about Mediterranean marine fishes and what remains to be studied (i.e. gap analysis, Figure 1), we collected data on all fish species that have been recorded in this large marine ecosystem as listed in FishBase [4]. We came up with a list of 714 species, after having excluded the ones that were misidentified or questionable (i.e. excluded 35 species). For each species the available information on age and growth (growth parameters, length-weight relationships, and maximum age), mortality rate, reproduction (spawning, size at maturity, and fecundity) and diet composition was recorded.

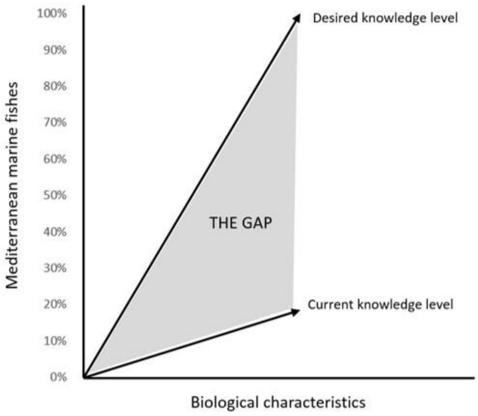

Fig. 1. Gap analysis regarding biological knowledge of the Mediterranean marine fishes.

According to our gap analysis, the most studied Mediterranean fish species were the European hake *Merluccius merluccius*, the surmullet *Mullus surmuletus*, the red mullet *Mullus barbatus barbatus*, the European pilchard *Sardina pilchardus*, and the annular seabream *Diplodus annularis*, all of which belong to the most diverse and well studied Mediterranean families (Sparidae, Mullidae, Merlucciidae, Clupeidae, and Labridae) [5]. There is no information of any biological characteristic for half (50%) of the Mediterranean fish species, while for approximately 18% of them there is information about just one characteristic. As far as the various biological characteristics are concerned, length-weight relationships are the most common ones as they have been studied for 34% of the species, followed by spawning (28%), growth parameters (23%), diet composition (19%), maturity (17%), and maximum age (13%) (Figure 2). Information on mortality and fecundity is scarce, with each characteristic accounting for 6% of the species (Figure 2).

Our analysis shows that the majority of the studies focus on fish species of high commercial interest and specifically on length-weight relationships, while at the same time a high proportion of the Mediterranean fishes and important biological characteristics are being neglected (6). Regarding future research priorities, we suggest that scientists focus on the biological characteristics of non-commercial and not exploited species and especially mortality and fecundity, which are the least studied ones. Primary research in fish biology should be encouraged, as the more knowledge about the species inhabiting the Mediterranean Sea, the better the understanding of this complex ecosystem and therefore the more realistic and effective the fisheries management plans that can be developed and implemented.

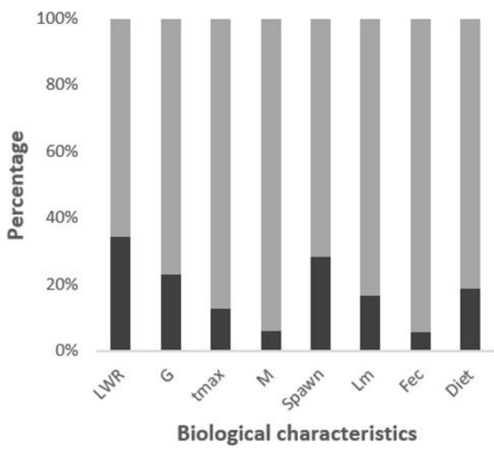

Fig. 2. Percentage of Mediterranean fish species with (dark) and without (light) information on several biological characteristics (LWR: length-weight relationship, G: growth parameters, t_{max}: maximum age, M: mortality, Spawn: spawning period, L_m: size at maturity, Fec: fecundity).

References
1 - Garcia SM, Zerbi A, Aliaume C, Do Chi T, Lasserre G 2003. The ecosystem approach to fisheries. Issues, terminology, principles, institutional foundations, implementation and outlook. *FAO Fish Tech Pa* 443.

2 - Claudet J, Osenberg CW, Domenici P, et al. 2010. Marine reserves: Fish life history and ecological traits matter. *Ecol Appl*, 20: 830-839.

3 - Stergiou KI, Tsikliras AC 2006. Underrepresentation of regional ecological research output by bibliometric indices. *Ethics Sci Environ Polit*, 2006: 15-17.

4 - Froese R, Pauly D 2016. FishBase. World Wide Web electronic publication. www.fishbase.org, 8 January, 2016.

5 - Tsikliras AC, Stergiou KI 2014. Size at maturity of Mediterranean marine fishes. *Rev Fish Biol Fisher*, 24: 219-268.

6 - Baran E 2002. The importance of non-commercial fish. *In:* Safran P (ed.) Fisheries and Aquaculture: Towards Sustainable Aquatic Living Resources Management. UNESCO. EOLSS Publishers, Oxford UK.

DIFFERENCES BETWEEN CULTURED AND WILD BLACK SEA TROUT (*SALMO TRUTTA LABRAX*) OTOLITHS: A COMPARATIVE STUDY

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Abstract
The salmonids are very common and most cultured species in the World. Therefore, there are a lot of study about culture, growth, mortality, meat yield and spawning performance of this species but very few studies about age determination. The aim of this study, differences of otoliths characteristics in cultured Black Sea trout and wild ones were investigated from samples obtained in the Black Sea region. This research is the first study about to comparison of irregular increments in the otoliths of cultured and wild Black Sea trout.

Keywords: Aquaculture, Black Sea, Fisheries

Introduction
The Salmonidae family has contains very popular fish species for aquaculture sector [2]. The first cultured salmonid species is *Salmo trutta* in the Europa. The production of Black sea trout (*Salmo trutta labrax* PALLAS, 1811) is being an endemic fish species in Turkey is getting more and more widespread all over the country especially Eastern Black Sea region [1]. Otoliths are important structure for fish and fisheries researchers because of demonstrate whole life cycle via annual growth increments in the otoliths. There are several factors can be effect on growth rate (sex, maturation, feeding, behavior, environmental conditions). Some changes in the growth rates are recorded on the otoliths [4, 5]. The annulus increments increased with the age of fish. This can be a man-made in the cultured fishes (unlimited food availability, optimum water temperature) [6].

Material Methods
Data for *S. t. labrax* were collected from the rivers caught by throw net, electro-shocker and traps from rivers of Rize and Trabzon (Fírtina, Caglayan, Kapistre, Iyidere and Solakli) in the northeastern Black Sea region, between 1998 and 2001 for cultured process (Figure 1). A total of 205 specimens were examined for analysis. Sagittal otoliths from each fish were removed, cleaned and stored in elisa plates. Size of the otoliths was measured by digital calipers sensitive to 0.01 mm. Age readings were carried Leica binocular microscope with digital camera and Leica Application Suite software by three different readers. The growth parameters were obtained from the von Bertalanffy growth model.

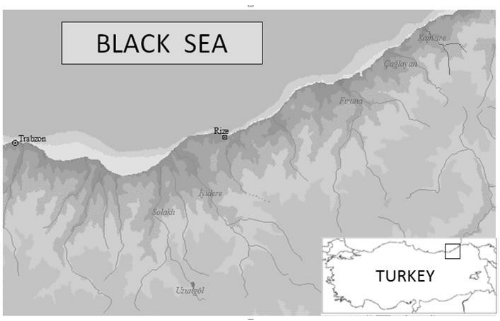

Fig. 1. Sampling Stations.

Results
It was concluded that there were observed differences in the annulus rings of the otoliths. The otolith rings of wild Black Sea trout were showed regular structure while the cultured ones were seen irregular rings starting from the 1st hyaline rings. Besides, false annulus rings were common seen in the cultured specimens. It is thought that the reason of irregular and false rings can be caused cultured Black Sea trout transported from seawater to freshwater in order to the complete the life cycle (to developing the gonads) in the certain period. These periods were identified according to sea water temperature (>20°C) especially between June and December. There are a lot of effects changing the environment on this species. The lengths and width of the cultured Black Sea trout otoliths were found as 7.34 – 4.38 mm and 4.64 – 2.72 mm, respectively. The lengths and width of the wild ones otoliths were found as 8.56 – 2.56 mm and 5.34 – 1.47 mm (Figure 2). It was seen that the cultured Black Sea trout has more opaque annual ring than the hyaline ring in the otoliths.

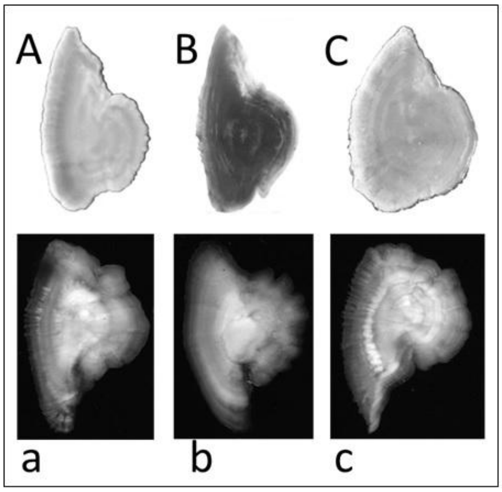

Fig. 2. Wild and cultured Black Sea Trout otoliths (Uppercase is wild trouts; lowercase is cultured ones) A-a:4 ages; B-b: 5 ages; C-c: 6 ages.

References
1 - Ovenden J.R., Bywater R., White R.W.G., 1993. Mitochondrial DNA nucleotide sequence variation in Atlantic Salmon (*Salmo salar*), Brown Trout (*Salmo trutta*), Rainbow Trout (*O. mykiss*) and Brook Trout (*Salvelinus fontinalis*) from Tasmania, Australia. *Aquaculture*, 114: 217-227.
2 - Aydin H., Yandi I., 2002. The general status of spawning areas of Blacksea trout in the East Blacksea regions (*Salmo trutta labrax* Pallas, 1811). *E.U. Journal of Fisheries & Aquatic Sciences*, 19 (3-4): 501 – 506.
3 - Waldron M. E., Kerstan M., 2001. Age validation in horse mackerel (*Trachurus trachurus*) otoliths. *ICES Journal of Marine Science*, 58: 806–813. doi:10.1006/jmsc.2001.1071.
4 - Larraneta M. G., 1963. Acriterion locate rings in ctenoid scales. *Proceed. of the Gen. Fisheries Council of the Mediterranean*, 7: 57-61.
5 - Beamish R. J., McFarlane G. A., 1983. The forgotten requirement for age validation in fisheries biology. *Transactions of the American Fisheries Society*, 112: 735-743.
6 - Machias A., Tsimenides N., Kokokiris L., Divanach, P., 1998. Ring formation on otoliths and scales of Pagrus pagrus: a comparative study. *Journal of Fish Biology*, 52: 350-361.

FINE-TUNING PREDICTION MECHANISM FOR SMART ANCHOVY FISHING - SCIENTIFIC BASELINE

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Abstract
With future monitoring and modelling efforts, based on scientific research that revealed autumnal environmental conditions inducing specific winter ones, which showed impacts on annual Adriatic anchovy catch, a fine-tuning prediction mechanism for smart anchovy fishing could be developed.

Keywords: North Adriatic Sea, Circulation, Fisheries, Phytoplankton, Zooplankton

February anticyclonic circulation (FAC) in the northern Adriatic (NA) favours nutrient enriched freshwater spreading from the Po River delta towards the eastern coast (Fig. 1.a). Freshwater remains restricted in the NA favouring high phytoplankton abundance, which is positively correlated to annual catch of one of the most important commercial Adriatic fish species, *Engraulis encrasicolus* (L.) - anchovy [1]. Annual zero- and one-year-old anchovy correlate with FAC of the same year, and with both winter and annual microzooplankton [1], thus indicating the importance of favourable pre-spawning environmental conditions for juvenile anchovy (in February to April period [2]).

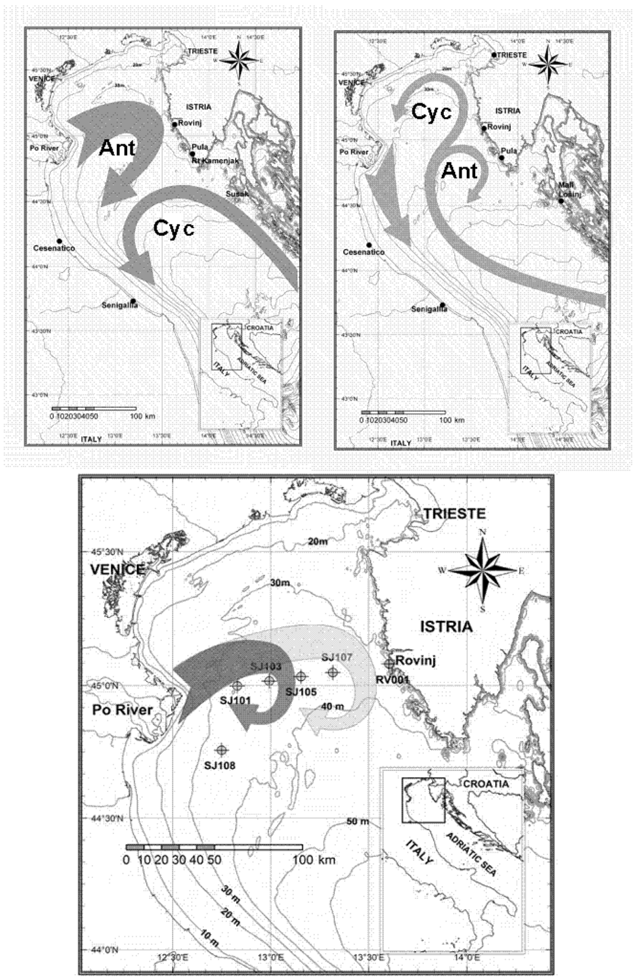

Fig. 1. Circulation patterns in the NA: (a) winter type A with large anticyclonic (Ant) and cyclonic (Cyc) gyres, (b) winter type B with large cyclonic and anticyclonic gyres and (c) winter type A of small intensity (dark grey arrow) and of large intensity (light grey arrow) with sampling stations along the Po River delta - Rovinj profile.

Annual microzooplankton (at SJ101 and SJ107) is highly impacted by March fraction, indicating this month environmental conditions as important for the annual anchovy stock [3]. Depending on the circulation intensity (Fig. 1.c) phytoplankton production is high (dark grey arrow) or extremely high (light grey arrow) [1, 3].

In 2004, a year of an exceptionally intense FAC, winter spreading with extremely high concentration of total inorganic nitrogen and orthophosphate at the eastern part [4] resulted with extremely high annual anchovy catch. Continuing effects of this favourable year for anchovies were observed throughout high generational catch: zero-year-old catch in 2004, one-year-old catch in 2005, two-year-old in 2006, as well as three-year-old in 2007 [3]. While correlations of anchovy to circulation pattern in the western NA are stable [5]**,** correlations to the central NA disappear upon removal of outstanding values. However, as the case of 2004 shows, outliers are highly important as the stock increases (or decreases) highly in extreme environmental situations [3]. This is further supported by the fact that February microzooplankton at SJ101 seems to be irrelevant for the annual microzooplankton, contrary to the one at SJ107, which proves to be highly correlated. This is in line with observation that intense freshwater spreading from western to the eastern coast results with exceptionally high phytoplankton production [1].

The idea of possible prediction of anchovy stock was developed as impacts of autumnal meteorological conditions favour development of specific NA winter type; moderate cooling and *sirocco* (SSE wind) in autumn, and, more specifically, low evaporation rates in November, favour winter type A (Fig. 1. a [6, 7]). Afterwards, followed the idea of *smart fishing*. Namely, continuous anchovy stock monitoring along with the autumn and winter conditions could prove as worthwhile efforts in planning fishery activities in the Adriatic for a sustainable and responsible economical development. We anticipate a novel approach to monetary stimulation that could be beneficial for the environment and economy: *a fine-tuning prediction mechanism*. In the case of Adriatic, we would suggest that the anchovy fishery should be monetary stimulated in the favourable years, not stimulated in average ones, and in the poor years stimulated for non-fishing [3]!

References

1 - Kraus R. and Supic N., 2011. Impact of circulation on high phytoplankton blooms and fish catch in the northern Adriatic (1990-2004). *Estuar. Coast. Shelf Sci.*, 91 (2): 198-210.
2 - Regner S., 1996. Effects of environmental changes on early stages and reproduction of anchovy in the Adriatic Sea. *Sci. Mar.*, 60 (Suppl. 2): 167-177.
3 - Kraus R., Supic N., Lucic, D. and Njire J., 2015. Impact of winter oceanographic conditions on zooplankton abundance in northern Adriatic with implications on Adriatic anchovy stock prognosis. Estuar. Coast. Shelf Sci., 167: 56–66.
4 - Djakovac, T., Kraus R., Precali R. and Supic N., 2010. Winter trends in the northern Adriatic, Rapp. Comm. Int. Mer Medit., 39: 739.
5 - Santojanni A., Arneri E., Bernardini V., Cingolani N., Di Marco M. and Russo A., 2006. Effects of environmental variables on recruitment of anchovy in the Adriatic Sea, *Clim. Res.*, 31: 181–193.
6 - Supic N., Kraus, R., Kuzmic, M., Paschini, E., Precali, R., Russo, A. and Vilibic, I., 2012. Predictability of northern Adriatic winter conditions. J. Marine Syst., 90 (1): 42-57.
7 - Kraus R., Supic N. and Precali R., 2016. Factors favouring large organic production in the northern Adriatic: Towards the northern Adriatic empirical ecological model. *Ocean Sci.*, 12: 19-37.

LANDINGS TREND AND SSB-R RELATIONSHIP IN THE NW MEDITERRANEAN BOAT SEINE SAND EEL FISHERY

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Abstract
Sand eel fishery in the Catalan coast is a traditional small scale fishing activity. Over 2000-2015 landings displayed marked variations and a sharp decrease was observed in the last two years 2014 and 2015. A significant relationship was found between landings at the end of the fishing season in mid-December (taken as spawning stock biomass proxy) and landings at the opening of the fishing season in March (recruitment proxy). The regulations in force would not explain the landings decrease in the last two years.

Keywords: Fisheries, North-Western Mediterranean, Recruitment

The sand eel fishery targeting *Gimnammodytes cicerelus* (locally called blue sand eel; *sonso blau*) is a traditional small-scale activity in the central and northern Catalan coast (NW Mediterranean). This fishery is carried out by a specific boat seine fleet, 26 vessels at present. Boats operate on a daily trip basis, going to fish five days a week early in the morning when sand eels leave their holes. The catch is sold the same morning upon the arrival of boats to port. *Gimnamodytes semisquamatus* (blond sand eel; *sonso ros*) is also present in the catch, in very low amounts. By- catch is low and most of it can be released alive [1]. The overall characteristics of the boat seiners are: length between perpendicular (m) = 8.05±1.75 and power (kw)= 42.55±20.60. Two or three fishermen work on board. To fulfil with the EC fishing regulations, a co-management committee was appointed in 2012 to carry out a scientific study that would support a management plan for this fishery [2]. This committee consists of public administrations, fishermen's associations, researchers and NGOs. The measures in force include, among others, a quota for the fishing season, monthly harvest control rules and the limitation of fishing effort. A closed season is implemented for mid- December to the end of February, in coincidence with the reproduction period of the target species.

Data on sand eel landings for the period 2000- 2015 were obtained from the daily slips from the sale at the auction (data source: fishing statistics elaborated by the Fisheries Department of the Generalitat de Catalunya). Considering the dominance of *G. cicerelus* in the landings (98% in weight), the data are assumed to correspond to this species.

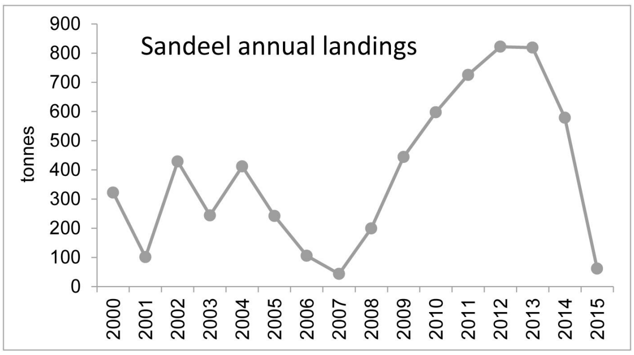

Fig. 1. Sand eel landings trend over 2000-2015 in the Catalan coast (NW Mediterranean).

Over the studied period, the annual landings fluctuated between around 100 annual t in 2001 and 2006, and a minimum of 43 t in 2007, and a maximum of 819 t in 2012 (figure 1). The fishery was closed in July 2015 because of the very low abundance of sand eel. The yield at the start of the fishing season has been shown to be significantly related to the yield at the end of the previous fishing season (Spawning Stock Biomass - Recruitment relationship; $p<0.01$; figure 2). Note that the highest value of this relationship corresponds to highest annual landings (2012-2013), and vice versa (lowest values in 2006-2007 and 2014-2015). The sharp landings decrease in 2014 and 2015, despite the limitations in catch and effort that were being implemented, seems to suggest that factors other than the fishing activity would be affecting sand eel abundance. In this regard, it is worth mentioning that within the Mediterranean, the distribution of sand eel is limited to the colder areas (e.g. our study area, Ligurian and Aegean seas), that is, they are at limit of their range, where the influence of environmental factors is likely to be more important than near the center of a species range [3].

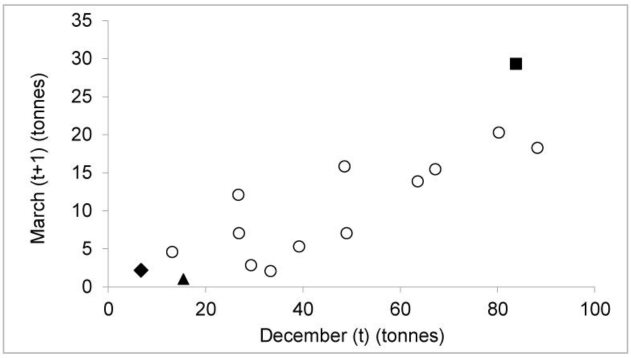

Fig. 2. Sand eel SSB-R relationship. Landings at the end of the fishing season in mid-Dec are taken as a proxy for the spawning stock biomas, and landings at the opening of the fishing season in March are taken as a proxy for recruitment (diamond 2014-2015; triangle 2006-2007; square 2012-2013).

References
1 - Lleonart J., Demestre M., Martín P., Rodón J., Sainz-Trápaga S., Sánchez P., Segarra I., Tudela S., 2014. The co-management of the sand eel fishery of Catalonia (NW Mediterranean): the story of a process. *Sci. Mar*. 78S1: 87-93. doi: http://dx.doi.org/10.3989/scimar.04027.25A
2 - Sainz-Trápaga S., Allue R., Demestre M., Guarga J.L., Lleonart J., Martín P., Ojeda C., Pulido M., Rodón J., Sánchez P., Segarra I., Trias Ll., Tudela S. and Velasco B., 2015. The Co-management Committee of the Catalan sand-eel fishery: a bottom-up approach successfully delivering on sustainability for fish and fishing. *FAO Fish. Aquacul. Proc*. 39: 193-199.
3 - Myers R.M., 1998. When do environment- recruitment correlations work?. Rev. Fish Biol. Fish., 8:285–305.

STATUS OF HAKE (*MERLUCCIUS MERLUCCIUS*) IN THE MEDITERRANEAN SEA BASED ON CATCH AND RESILIENCE

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Abstract

A newly developed method that combines biomass and landings data was used to assess the current stock status of hake (*Merluccius merluccius*) in the Mediterranean Sea. The results were in line with previous assessments and provide a reasonable basis for sustainable management of hake in the area.

Keywords: Stock assessment, Fisheries, Fishes, Mediterranean Sea

There is a need for simple stock assessment methods for data-poor fisheries and stocks, for which estimates of maximum sustainable yield (MSY) are unavailable [1]. The Mediterranean Sea is among the least studied areas with a limited number of species being routinely assessed [2]. According to these stock assessments, the percentage of overexploited species exceeds 80%, with European hake (*Merluccius merluccius*) being one of the most heavily exploited species [3]. The aim of this work is to re-assess the Mediterranean stocks of hake using a newly developed method (CMSY) [4] and to compare the findings with previous assessments.
CMSY is a Monte Carlo method, which uses catch and productivity to estimate biomass, exploitation rate, MSY, and related fisheries reference points. The CMSY software also includes a Bayesian Schaefer model (BSM), which performs an independent assessment if time series of abundance are available. In this study, results from both methods are combined to use both, the information contained in a long time series of catches and the information contained in a typically shorter time series of abundance estimates.
We used CMSY and BSM to assess stocks of hake in four ecoregions, namely western Mediterranean, Adriatic Sea Ionian Sea and central Mediterranean, and Aegean and Levantine Seas. Hake landings data were extracted for 1970 to 2013 from the GFCM database. Resilience of hake was derived from FishBase [5] and biomass data for 1995 to 2006 were extracted from MEDITS bottom trawl survey data. Priors for stock status of hake, which are needed by CMSY and BSM, were estimated as Low for all stocks.

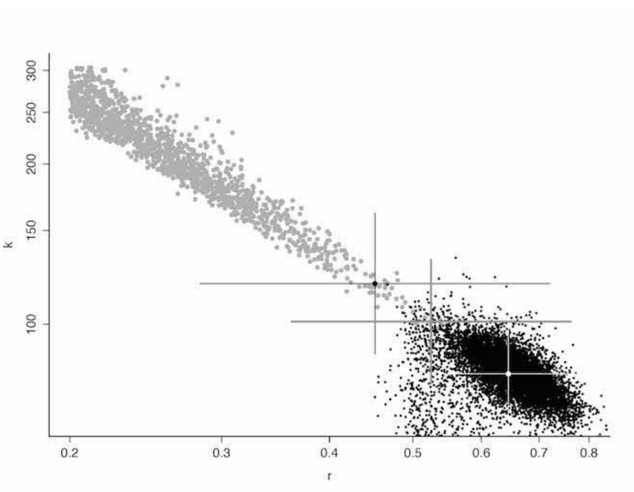

Fig. 1. The estimation of reference points for European hake (*Merluccius merluccius*) in the northern part of the western Mediterranean Sea (k: unexploited stock size, r: the maximum intrinsic rate of population increase).

The estimation of reference points for hake in the northern part of the western Mediterranean is shown in Figure 1, where k is the unexploited stock size and 0.5 k is the stock size than can produce the maximum sustainable yield (MSY), and where r is the maximum intrinsic rate of population increase and 0.5 r equals the maximum fishing mortality rate (F_{msy}) that can produce MSY. The grey dots show r-k pairs that are compatible with the 1970-2013 time series of landings used by the CMSY method and the black cross indicates the best estimates of r and k, with 95% confidence limits. The black dots show the r-k pairs that are compatible with the 1995-2006 time series of landings and biomass used by the BSM method, with the white cross indicating the best estimate. The intermediate grey cross is a combination of CMSY and BSM estimates which, should be used by management and which allows a combined estimation of current stock status.
Results of both CMSY and BSM for reference points and stock status were very similar and in line with previous assessments [3]. The combined results of CMSY and BSM provide a reasonable basis for sustainable management of hake in the Mediterranean Sea within the Common Fisheries Policy of the European Union.

References

1 - Martell S, Froese R 2013. A simple method for estimating MSY from catch and resilience. Fish Fish, 14: 504-514
2 - Tsikliras AC, Dinouli A, Tsiros V-Z, Tsalkou E 2015. The Mediterranean and Black Sea fisheries at risk from overexploitation. PLoS ONE, 10: e0121188
3 - Colloca F, Cardinale M, Maynou F, Giannoulaki M, Scarcella G, Jenko K, Bellido JM, Fiorentino F, 2013. Rebuilding Mediterranean fisheries: a new paradigm for ecological sustainability. Fish Fish, 14: 89-109
4 - Froese R, Demirel N, Coro G, Kleisner KM, Winker H, submitted. Estimating fisheries reference points from catch and resilience
5 - Froese R, Pauly D 2016. FishBase. World Wide Web electronic publication. www.fishbase.org, 1 March, 2016

SELECTIVITY IN A MEDITERRANEAN BOTTOM TRAWL FISHERY: IS THE COUNCIL REGULATION (EC) Nº1967/2006 ENOUGH FOR FULFILLING THE LANDING OBLIGATION?

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Abstract
This study aimed at comparing catches and size composition, both from landings and discards, obtained by three different mesh types in the codend of bottom trawlers in the western Mediterranean. Information was obtained under commercial conditions in the Balearic Islands. Our results suggested that the two recently implemented meshes do not have an equivalent selectivity but, in general, both are more selective than the traditional mesh. Although the benefits of this management measure are demonstrated, with a clear reduction of discards in some of the strata, they are not enough for improving the exploitation pattern of many species and thus, additional measures should be implemented.

Keywords: Fisheries, Demersal, Monitoring, Balearic Islands, Coastal management

Discarding, returning unwanted catches to the sea, has adverse ecological impacts in marine ecosystems, even posing in risk the sustainability of current fisheries [1]. One of the objectives of the new Common Fisheries Policy is doing away with discarding through the obligation to land all the catches of those species with minimum sizes (landing obligation). The improvement of bottom trawl selectivity is one of the key points for reducing discards and improving the exploitation pattern of species, which cannot only be achieved by a simple reduction in the current fishing mortality [2]. The Council Regulation (EC) Nº1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean, established a change of the mesh type in the bottom trawl codend, from the traditional 40 mm diamond mesh (40D) to a 40 mm square mesh (40S). This measure also established the exemption of using 50 mm diamond mesh (50D) if its selectivity is equivalent to or higher than that of 40S. Although most fleet adopted this, the scientific information on selectivity of 50D in the western Mediterranean is almost nil.

The objective of this study was to compare catches and size composition, landings and discards, obtained by the three mesh types under commercial conditions. The specific objectives were: i) to analyze if the selectivity of the 40S and 50D are equivalent, and compare them to the 40D and ii) to assess the usefulness of the new meshes for the landing obligation. Data were obtained from the monitoring of the bottom trawl fleet (2009-2013) in the Balearic Islands, where bottom trawlers operate along a wide bathymetric range (50-800 m), from the shallow shelf to the middle slope, in four different fishing tactics. Data were analyzed using several univariate and multivariate techniques.

At community level, no differences were detected in the species composition with the three mesh types, but significant differences were detected in the biomass indices in the shallow shelf and middle slope, including a clear reduction of discards mainly with the 40S (Figure 1).

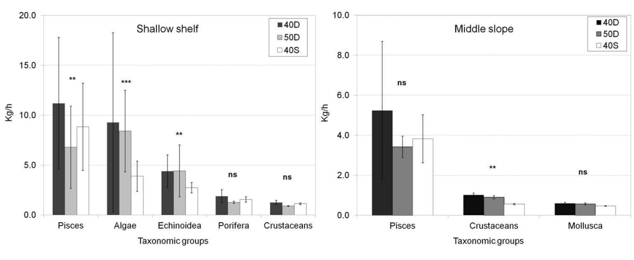

Fig. 1. Yields of standardized biomass for the main taxonomic groups of the discarded fraction for the shallow shelf and for the middle slope. 40D: 40 mm diamond mesh; 50D: 50 mm diamond mesh; 40S: 40 mm square mesh; ns: not significant; *: p<0.05; **: p<0.01; ***: p<0.001.

Significant differences were also found in the abundance and biomass indices for some species, although they species did not respond similarly to the mesh change and their performance can be related to other factors, such as their population dynamics or morphological issues. Differences in size composition by mesh type have also been detected for some species, as well as a decrease in the abundance of undersized and immature individuals caught with the recently implemented meshes (Table 1). However, the most selective mesh type is the 40S, followed by the 50D, while the 40D is the less selective. According to that, the current exemption of using 50 mm diamond mesh codend is not fully justified.

Although this study reflects the potential benefits of these management measures, with a reduction of the discarded catches and an improvement of the exploitation pattern, this improvement does not affect equally to them all. For most of the target species, a large part of the catches is still under their length at first maturity and, for some, even under their minimum conservation reference size (Table 1). In this sense, this management measure would barely help to the landing obligation enforcement for species such as *Merluccius merluccius*, and is still not enough for ensuring an improvement of the exploitation pattern of many species. Thus, additional measures should be implemented.

Tab. 1. Percentage of the abundance (Ab%) of individuals under Minimum Conservation Reference Size (MCRS) and under length at first maturity (L_{50mat}) related to total catch. 40D: 40 mm diamond mesh; 50D: 50 mm diamond mesh; 40S: 40 mm square mesh. Fish: total length, cm; crustaceans: carapace length, mm; cephalopods: mantle length, cm.

Species	MLS	Ab % <MCRS			L_{50mat}	Ab % <L_{50mat}		
		40D	50D	40S		40D	50D	40S
M. surmuletus	11	1.9	0.6	0.7	15♂; 17♀	52.5	53.9	39.5
S. smaris	11	3.7	4.1	0.7	15.3♀	24.3	45.2	10.4
M. merluccius	20	55.0	31.8	66.6	32	97.8	97.0	98.3
N. norvegicus	20	0.0	0.2	0.0	30	17.9	21.1	10.2
L. boscii	15	42.4	60.5	81.4	11♂; 14♀	33.1	56.8	70.6
L. vulgaris	-	-	-	-	16♂; 19♀	96.4	94.9	97.7
S. canicula	-	-	-	-	43♀; 44♂	93.9	93.7	95.1
O. vulgaris	-	-	-	-	8♂	52.1	54.8	56.8
G. melastomus	-	-	-	-	44♂; 49♀	99.9	99.5	100
A. antennatus	-	-	-	-	19♂; 25♀	25.4	25.7	25.7
P. blennoides	-	-	-	-	19♂; 20♀	86.2	76.5	64.8

Acknowledgements
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References
1 - Bellido, J.M., 2011. Fishery discards and bycatch: solutions for an ecosystem approach to fisheries management? *Hydrobiologia* 670, 317–333.
2 - Colloca, F., Cardinale, M., Maynou, F., Giannoulaki, M., Scarcella, G., Jenko, K., Bellido, J.M., Fiorentino, F., 2011. Rebuilding Mediterranean fisheries: a new paradigm for ecological sustainability. *Fish Fish.* 1–21.

CIESM Congress Session : Ocean policies - local implementation
Moderator : Wendy Bonne, JPI Oceans, Brussels, Belgium

Moderator's Synthesis

In this session four examples of applied research tailored to serve national and European marine and maritime policy at different geographical scales – at a local (bay), national (beaches), regional (trilateral country agreements) or European context - were presented. The speakers all had substantial experience in exchange with policy makers as end-users. Some studies were even initiated on request of the end-users like fishermen.

The response from the audience indicated that roughly one third of them would like to actively perform applied research, which is the same ratio as performed through an audience survey at the ECSA conference in 2014. Still, the ratio of experts currently active as such was lower, mainly working in institutes involved in policy advice. They also indicated that the majority had experienced acceptable rewards for their work (already a higher ratio than at the ECSA conference 2 years ago), including some at universities.

There was a general consensus that more effort should be invested in well organised applied research. All recommended that applied research should be co-designed from the start with managers and stakeholders, not as a teaching exercise but as a co-learning experience. Policy makers also need to communicate better what the needs are to researchers. A need for extra assistance at European level to disseminate research was expressed, as well as for cooperation at wider international level for example through Future Earth and Belmont Forum.

DEVELOPMENT OF AN INVENTORY OF HELLENIC BEACHES

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Abstract

The present investigation introduces the development of a beach inventory in Greece, which records gather and depict information for beaches. The inventory constitutes a valuable tool for the sustainable use, exploitation and the management of beaches according to the national and EU legislation and directives. The information recorded in the database comprises the spatial characteristics (i.e. shoreline length and orientation, beach width and area), artificial structures and land use (i.e. touristic and residential data) of the broader coastal zone. Along the Hellenic coastline (with the exception of the deltaic shorelines) 7384 beaches have been identified, digitized and statistically analyzed, with a total length of some 2700 km and a total area of ~52 sq. km.

Keywords: Coastal management, Gis, North-Eastern Mediterranean

Introduction

The Hellenic coastline, which accounts more than 16000 km, hosts hundreds of beaches that constitute a great touristic destination and a significant economic asset [1]. On the other hand beaches appear to be very vulnerable systems with 36% of the Hellenic beaches to be currently under erosion [2]. However, until recently, no organized quantitative information existed on their physicogeographical characteristics. Therefore, the development of a database that incorporates all relevant data, in the form of a National Inventory, can be a valuable tool for the sustainable use and exploitation of the coastal zone and the management of beaches according to the national and EU legislation and directives (e.g. Directive 2014/89/EU - Marine Spatial Planning, Directive 2008/56/EU - Marine Strategy).

Methodology

A GIS-based dynamic database of the Hellenic beaches has been constructed, based on the orthorectification and digitization of satellite images available through *Google Earth*. The information recorded in the database comprises the spatial characteristics (i.e. shoreline length and orientation, beach width and area), together with information concerning artificial structures, and land use (i.e. touristic and residential data) of the broader coastal zone (see fig.1). The initial information extracted from satellite imagery is gradually verified and enriched with field measurements and observations. Other beach attributes (e.g. beach sediment type) are also stored in the database, using data from photographic material of the *Google Earth* application and in situ observations.

Results and Discussion

Along the Hellenic coastline (with the exception of the deltaic shorelines) 7384 beaches have been identified and digitized with a total length of some 2700 km and a total area of ~52 km^2. More than 50% (3950) of these are island beaches. A preliminary statistical analysis of their attributes showed that Hellenic beaches are generally limited in size (max beach width) with >67% of all beaches being less than 25 m wide and only 24% having widths between 25 and 50 m. Moreover, <6% of the beaches have widths of 50 - 75 m, ~2% of 75 - 100 m and ~1% >100 m.

With respect to beach material, about 40% of the beaches are sandy, about 28% consist of gravel and about 25% have mixed material (sand and gravel). The remaining 7% relates to beachrocks, artificial beaches and low-lying rocky coasts. Considering the economic product of the beaches, approximately 56% of them have little or no tourist activity and ~22% present limited tourist development. Almost 19% of the beaches are touristicaly developed and an additional 3% are extensively exploited. No direct relationship was found between the degree of tourist development of a beach and the sediment type of the beach zone. On the other hand, more than 70% of the coastal zones with existing coastal residential areas are associated with intensively exploited beaches. These beaches frequently (>75%) incorporate also some kind of artificial structures.

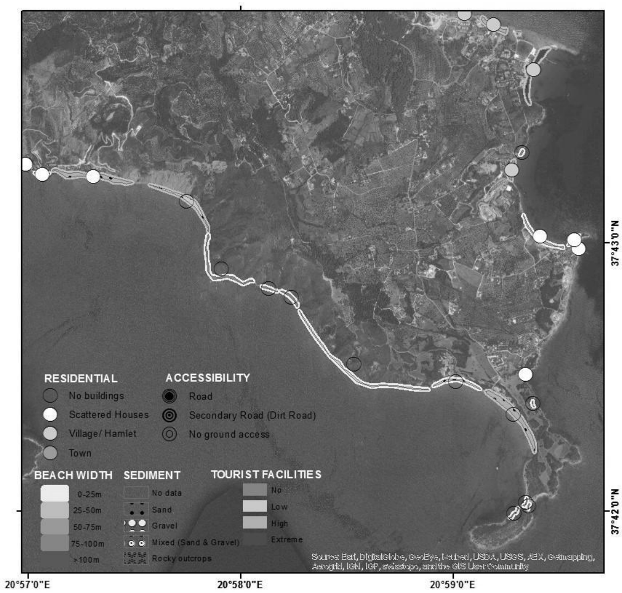

Fig. 1. Visual of the GIS-based inventory of the Hellenic beaches (Laganas Gulf, Zakynthos, scale 1.25 000).

Acknowledgements

The study was supported by the project BEACHTOUR (11SYN-8-1466) of the Operational Program Cooperation 2011, Competitiveness and Entrepreneurship" co-funded by the European Regional Development Fund (ERDF) and the Ministry of Education and Religious Affairs and the project THALES-ISLA of the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) Research Funding Program.

References

1 - UNECE (2013) Climate Change Impacts and Adaptation for International Transport Networks. Expert Group Report, Inland Transport Committee. United Nations Economic Commission for Europe ECE/TRANS/238.

2 - Alexandrakis, G., Ghionis, G., Poulos, S.E., and Kampanis N.A., 2013. GREECE, in Coastal erosion and Protection *In* Europe: A Comprehensive Overview, E. Pranzini, A. T. Williams (Eds.), EARTHSCAN Ltd, London, UK, 355-377.

MEASURES FOR THE CONSERVATION AND MANAGEMENT OF MARINE BIOLOGICAL RESOURCES OF ELOUNDA BAY (CRETE ISLAND)

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Abstract
Although a management plan including measures for the conservation and maintenance of marine biological resources of Elounda Bay was proposed in 2007 by the Hellenic Centre for Marine Research (HCMR), no progress has yet been made for the implementation of the proposed or any other similar measures. Despite the financial crisis in Greece, the regional/local authorities still retain a crucial role regarding the management procedures in terms of leading and engaging with the local community and the private sector in order to promote the protection of this specific marine ecosystem and the sustainable development of the area.

Keywords: Coastal management, Conservation, Fisheries, Cretan Sea

The economy of Elounda, located in the northeastern part of the island of Crete, was based on farming, fishing, salt extraction from the Venetian saltpans and emery mining until the 1970s when it was discovered by tourism. Elounda then developed into a resort renowned for beautiful scenery and its world-famous luxury hotels. Elounda Bay itself covers a surface area of 6.5 km^2, while its inner shallow part (2-9 m depth), sheltered from waves and currents occupies an area of 4.7 km^2, which is covered by a dense monospecific *Caulerpa prolifera* meadow (Fig.1). Elounda Bay is connected to the outer Mirabello Bay through three straits: two northern ones are located between the north coasts of Mirabello bay, Spinalonga and Kolokitha Islands; the south strait was artificially created in 1897. The uninhabited Spinalonga Island is a popular tourist attraction (historical Venetian fortress, abandoned leper colony settlement), with large boats transferring tourists to and from the island on a daily basis during the summer period. The local authorities (i.e., the former Lasithi Prefecture), after several consultations with local fishermen, in an effort to implement restrictive measures for the fisheries exploitation of Elounda Bay, funded an HCMR (Hellenic Centre for Marine Research) study (2006), the aim of which was to update the historical scientific data available for the region in order to propose a management plan allowing for the protection of its marine ecosystem and the sustainable exploitation of its marine biological resources. Sampling on a bimonthly basis was carried out at 22 stations in the study area (2006-2007) using a local fishing boat (Fig. 1). The abiotic (e.g. nutrients, chloroplastic pigments, organic carbon) and biotic (e.g. macrobenthos, zooplankton, demersal fish) variables in the water column and/or the surface bottom sediments of the study area were measured, analysed and described in detail in the final report of the study [1]. In addition, a field experiment was designed to investigate the rates of sediment resuspension and deposition along the itinerary of the boats transferring tourists to and from Spinalonga Island during the summer period.

The results of the project led to the following recommendations for the formulation and development of a management plan for the area: 1) The inner part of Elounda Bay is a very important habitat for the development of juvenile fish as well as certain cephalopod species, thus contributing to the conservation and maintenance of the marine biological resources of the Bay [2]. Therefore, Elounda Bay should be awarded a special fisheries regime for its protection and conservation. 2) High speed of the large tourist boats should be reduced to a minimum, in order to minimize the resuspension rate of the sediments caused by the propellers, especially in their approach to the shallow areas of the bay. This type of environmental disturbance could have a negative effect on nature conservation and the sustainable management of the marine biological resources of this specific semi-closed marine ecosystem. 3) The competent authorities in co-operation with HCMR could fund a long-term monitoring programme of the Elounda Bay ecosystem to include an annual survey, especially during the summer period, leading to an environmental impact assessment of the area. 4) A feasibility study should be carried out in order to investigate the development and operation of a Fisheries Cooperative Enterprise (principal shareholders to be the professional fishermen of Elounda) for the cultivation and marketing of the edible bivalve Arca noae, to compensate for the proposed fishing ban in the inner part of Elounda Bay. The feasibility study (duration 18 months) should include a study of the growth rate of the molluscan species, its life cycle characteristics, its ecological preferences as well as different technologies and methods for its cultivation. It should be noted that this molluscan species is almost exclusively present in large quantities in the whole inner part of Elounda Bay. According to the results of the previous study [1], the carrying capacity of this marine ecosystem could support a profitable enterprise for cultivation and marketing of these bivalves. This initiative could also be used for the revival of traditional local customs and therefore as a tourist attraction, since the bivalve used to be served as a “special delicacy” by traditional cafeterias and taverns in “Clean Monday” (a moveable feast which marks the beginning of Lent in the Greek Orthodox Easter calendar). However, no progress has been made since 2007 for the implementation of the proposed or any other measures. A loss of confidence in those institutions that have failed to provide the public with an economic and social umbrella against the financial crisis is strongly expressed nowadays. Despite the merging of some of the regional/local authorities (Lasithi Prefecture, Region of Crete), they still retain a crucial role regarding the sustainability of this management process in terms of leading and engaging with the local community and private sector (professional fishermen, owners of the tourist boats, hotel owners and other stakeholders).

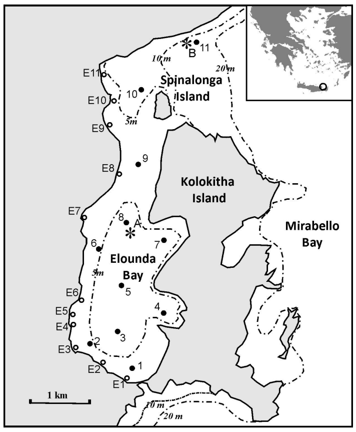

Fig. 1. Location of sampling stations in Elounda Bay (Crete Island)

References
1 - Dounas C., 2007. Environmental Study of Elounda Bay. Lasithi Prefecture, Crete (Greece). HCMR Technical Report. Pp. 316 (In Greek).
2 - Koulouri P., Kalogirou S., Maidanou M., Koutsoubas D., Dounas C., 2015. Fish and cephalopod assemblage structure of green alga *Caulerpa prolifera* (Chlorophyta) meadow in the eastern Mediterranean Sea (Elounda Bay, Crete Island). Regional Studies in Marine Science, 3: 33-41.

EUTROPHICATION ASSESSMENT AND MANAGEMENT

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Abstract
For the eutrophication assessment and management purpose a simple approach that can be applied to a station, area or region was designed.

Keywords: Eutrophication, North Adriatic Sea

For the eutrophication assessment purpose a simple approach that can be applied to a station, area or region was designed and it is now part of the Croatian national legislation [1]. Here we will only discuss it at the station level. It consists of two parts a) the annual station eutrophication profile and b) the station eutrophication profile. All the threshold from the national classification scheme [2] is plotted on the eutrophication profiles to simplify the assessment.

The annual station eutrophication profile shows us the development of the main eutrophication components (pressure – nutrients levels – total dissolved inorganic nitrogen, orthophosphate and orthosilicate concentration in the water column; state or effect – dissolved oxygen and chlorophyll *a* concentration in the water column; and the N/P ratio that indicate the limitation of one of the nutrient component) through the year. From this the change of the eutrophication components can be assessed for a particular year.

The station eutrophication profile is the representation (Box and Whisker) of historical data of the main eutrophication components (trophic index, concentration of chlorophyll *a*, total inorganic nitrogen, total phosphorus, oxygen saturation and the ratio between total inorganic nitrogen and orthophosphate - N/P) at a certain station. A simple classification scheme is (Tab. 1) maintained and the status for a single component on the basis of the national classification scheme assessed as the ongoing trends to. The assessment criteria are under development and will be implemented with in mind the management purpose.

Tab. 1. Station eutrophication profile, with an assessment of trends and ecological status for station SJ107 situated 13 Nm off Rovinj in Croatia.

Parameter	Status description	Trend (10 a)	Status
Trophic index	Systematically in the range for oligotrophic coastal sea	absent	very good
c(Chla)	Significant variability in the limits for oligotrophic coastal sea	absent	very good
O_2/O_2'	Significant variability in the limits for oligotrophic coastal sea	absent	very good
c(Tini)	Significant variability in the limits for oligotrophic coastal sea	absent	very good
C(TP)	Significant variability in the limits for oligotrophic coastal sea	absent	very good
N/P	Significant variability in the limits for oligotrophic coastal sea, increasing trend in the last 10 years	increasing	

An example for the approach is presented on Fig. 1 for station SJ107 situated 13 Nm off Rovinj in Croatia.

Moreover, the station eutrophication profile allows us the management of the mitigation measures through the identification of changes in the main components of eutrophication. It is also important to design a robust classification scheme with a well-defined pressure to response relationship. Both profiles are open to the integration of new indicators as they emerge, specifically in the biodiversity field.

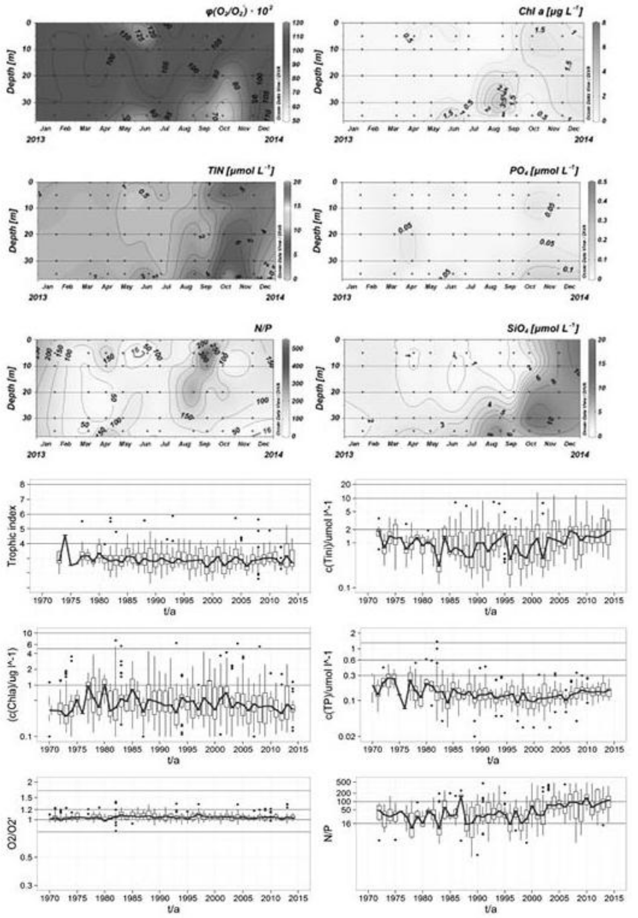

Fig. 1. Top: Annual station eutrophication profile - the distribution of oxygen saturation ($\varphi(O_2/O_2')$), concentration of chlorophyll *a* (Chl *a*), total dissolved inorganic nitrogen (TIN), orthophosphate (PO_4) and orthosilicate (SiO_4), and the ratio of N/P with depth at station SJ107 (13 Nm W off Rovinj) during 2013. Bottom: Box and Whisker representation of trophic index, concentration (*c*) of chlorophyll *a*, total inorganic nitrogen (Tini), total phosphorus (TP), oxygen saturation (O_2/O_2') and the ratio between total inorganic nitrogen and orthophosphate (N/P) for the period 1970-2014 at station SJ107. Limits of classifications are from the Regulation on water quality standards [2].

References
1 - Decision on the adoption of the Coastal and Marine Management Strategy Action Programme: Monitoring and observation system for continuous assessment of the state of the Adriatic Sea, Official Gazette RH 153/14
2 - The Decree on Water Quality Standards (Official Gazette RH 73/2013, 151/2014 and 78/2015)

GOVERNING BOTTOM TRAWLING IN THE MEDITERRANEAN SEA – A MALTESE CASE STUDY

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Abstract
A case study approach was used to investigate the effectiveness of the current legislative framework, and the implementation of management measures which govern bottom trawling in the central Mediterranean Sea. The general perception amongst key stakeholders interviewed in the Maltese Islands was that the current legal framework is sufficient, but that improvements in regional enforcement and control are required if shared stocks are to be exploited sustainably.

Keywords: Fisheries, Demersal, Conservation, Mediterranean Sea

Introduction
Several scientific studies show that bottom trawling negatively impacts the marine environment [1, 2, 3], and that such impacts can potentially affect entire ecosystems [4, 5]. The Mediterranean region has a long and active tradition of fishing, and is characterized by high fishing intensity and vulnerability of resources [6]. Consequently, it is of great importance to assess whether or not the legislative framework and fisheries management measures currently in place are providing an adequate basis to achieving sustainable stock exploitation rates, and protecting vulnerable species and habitats. In addition, potential barriers to achieving sustainability for the bottom trawling industry in the Central Mediterranean need to be identified, together with the means of addressing such barriers.

Materials and Methods
A desk-based study of legislation governing the bottom trawl fishing industry in the Mediterranean Sea in general and the Maltese Islands in particular was complemented with semi-structured interviews of key stakeholders. Interviewed stakeholders included scientists, NGO representatives, government employees and fishing cooperative representatives. A SWOT analysis based on perceptions of interviewed Maltese stakeholders was used to evaluate the strengths, weaknesses and opportunities of, as well as threats to the current bottom trawling management regime.

Results and Discussion

Strengths	***Weaknesses***
• Malta's 25 nautical mile FMZ and related management regime of bottom otter trawlers. • Small size of Maltese fishing industry (possibility of good communication). • Small size of Maltese trawling fleet and consequent low levels of exploitation. • Necessary support by local law enforcement bodies to improve compliance.	• Characteristics of bottom trawling as a fishing gear – potential for high environmental impacts. • Short data time series, limited data to support implementation of EAFM. • Lack of political will in implementing stricter measures to protect stocks and the environment. • Poor financial incentives for best practices. • Limited stakeholder participation in design of management measures and management processes.
Opportunities	***Threats***
• Existing legislative framework (local, EU, regional laws). • EU steer towards collective goals at regional level. • Ongoing efforts to increase implementation of EAFM at regional level. • Ongoing development of regional fisheries management plans at GFCM level. • Regional cooperation projects and programmes.	• Increasing number of vessels from third countries fishing in the Central Mediterranean • Lack of enforcement and control of management measures at regional level and inadequate corrective measures in cases of non-compliance. • Continued existence of IUU fishing in the region. • Challenging economic/political situations in several Mediterranean countries.

Fig. 1. SWOT- analysis on achieving sustainable bottom trawling in Malta and the central Mediterranean Sea based on perceptions of interviewed stakeholders. Abbreviations: EU – European Union; EAFM – Ecosystem Approach to Fisheries Management; FMZ – Fisheries Management Zone; GFCM – General Fisheries Commission for the Mediterranean; IUU – Illegal, Unreported and Unregulated.

Stakeholders generally consider the legislative framework applicable in the central Mediterranean sufficient to ensure sustainable levels of resource exploitation. However, a perceived lack of implementation, due to poor levels of enforcement and control on a regional level was a concern for stakeholders. The main barrier identified on a local level by some stakeholders was that further improvements in fostering stakeholder participation in the design and implementation of management measures are required in the Maltese Islands.

Stakeholders noted that some barriers hampering the management of fishing resources in the Mediterranean are related to the current economic and political challenges in the Mediterranean region, which clearly extend beyond the remit of fisheries managers. Stakeholders attributed other barriers, such as the perceived limited participation of stakeholders in governmental processes, limited financial incentives for best practices, and inadequate corrective measures in cases of non-compliance, to political will at both local and regional levels.

There was agreement between stakeholders that legislative frameworks will remain ineffective without adequate levels of compliance based on effective implementation, enforcement, and control. The fact that it is difficult to evaluate the effectiveness of specific regulations when management measures are only partly implemented, implemented too late, or not implemented at all was identified to be a critical issue. Given the poor status of fisheries resources [7], it is clear that current levels of monitoring, control and surveillance need to be stepped up in order to eradicate IUU fishing and to achieve sustainable stock exploitation levels in the Mediterranean Sea.

Acknowledgements
This research stems from interviews with different Maltese stakeholders. We are grateful to all the stakeholders who provided their expertise on the topic.

References
1 - Hinz H., Prieto V. and Kaiser M.J., 2009. Trawl disturbance on benthic communities: chronic effects and experimental predictions. *Ecol. Appl.*, 19(3): 761-773.
2 - Hiddink J.G., Johnson A.F., Kingham R. and Hinz H., 2011. Could our fisheries be more productive? Indirect negative effects of bottom trawl fisheries on fish condition. *J. Appl. Ecol.*, 48: 1441-1449.
3 - Rijnsdorp A., Eigaard O.R., Hintzen N.T. and Engelhard G.H., 2015. The evolution of the impact of bottom-trawling on demersal fish populations and the benthic ecosystem. Book of Abstracts, Oceans Past V, 49 pp.
4 - Olsgard F., Schaaning M.T., Widdicombe S., Kendall M.A. and Austen M.C., 2008. Effects of bottom trawling on ecosystem functioning. *J. Exp. Mar. Biol. Ecol.* 366: 123-133.
5 - Palanques M., Puig P., Guillén J., Demestre M. and Martín J. 2014. Effects of bottom trawling on the Ebro continental shelf sedimentary system (NW Mediterranean). *Cont. Shelf Res.*, 72: 83 - 98.
6 - Oliver P., 2004. Which fishery policy for the Mediterranean Sea? *New Medit*, 4: 2 - 4.
7 - STECF, 2014. Consolidated Advice on Fish Stocks of Interest to the European Union. Scientific, Technical and Economic Committee for Fisheries. STECF-14-24. *Publications Office of the European Union*, Luxembourg, EUR 27028 EN, JRC 93360, 747 pp.

CIESM Congress Session : Coastal pollution hotspots

Moderator : Anastasia Miliou, Archipelagos, Inst. of Marine Conservation, Samos, Greece

Moderator's Synthesis

This session focused on the links between scientific research and pollution management. The five speakers covered a wide range of marine pollution sources in various parts of the NE Mediterranean including oil spills, marine debris and harbour activities. Alarming results were shown in the specific studies, as oil and detergent contamination were measured in high concentrations in Prince islands of Marmara Sea; the ecological impact in zoobenthos from harbour activities is of great magnitude in Turkish coastal areas; the coastline of Lesbos island has been highly impacted by marine debris aggregated as a result of the refugee crisis and finally, beaches of W. Greece showed litter and microbiological pollution deriving from urban/domestic/recreational activities.

The presentations stimulated a constructive discussion on the links and gaps between research and the control mechanisms in the various countries, specifically on the enforcement of management and pollution control measures. Methods of monitoring were also discussed, such as the use of remote sensing coupled with ground-truth data as a powerful monitoring tool for marine litter. For a more integrated picture, a possible inclusion of Marine Litter in the European Marine Observation and Data Network phase 3 report, was also mentioned. Moreover, the engagement of specific stakeholder groups such as fishermen was proposed. A general agreement was reached that scientists can and need to acquire a more active role in order to better contribute to the enforcement of pollution management and controlling strategies.

BACTERIAL LOAD AND BEACH SEDIMENTS CHARACTERISTICS IN 10 TOURISTIC BEACHES OF W. GREECE

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Abstract
Over a six-month period, a beach sediment sampling survey, from 10 touristic beaches of Achaia prefecture, W. Greece, was undertaken. The abundance of bacteria (Total coliforms, *E. coli* and *Enterococcus spp.*) in sediments together with grain size parameters were measured in order to define the bacterial load of the beaches and to figure out the correlation between microbial and physical characteristics of the coastal sediments.

Keywords: Bacteria, Sediments, Beach, Mediterranean Sea

Introduction
Beach sediments are a well-recognized reservoir for enteric microorganisms, whose increase depends on a variety of physical processes as much as of the human activity. Exposure poses a risk to swimmers in recreational waters [1]. In order to reduce the risk of exposure, sediment quality at recreational beaches is assessed by regulatory agencies using indicator microbes, such as *E. coli*, *Enterococcus spp.* and Total coliforms [2].

Field work and methods
The beaches were selected taking into account the touristic activity and the presence of potential pollutant sources (hotels, restaurants, cafeterias, etc.). All beaches chosen for this study are characterized by different sediment grain size characteristics (sand, pebbles, cobbles) and experience a large tourist influx during warmer weather, with the highest usage occurring in July and August, while beach usage declines during the winter months. Ten beaches in Achaia Prefecture were surveyed; one (Kalogria, A1) at the Ionian Sea, three (Niforeika, A2, Rogitika, A3, Paralia, A4) at the southern coast of Patras Gulf, two (Plage, A5, Bozaitika, A6) at the proximity of the Patras city, two (Rion, A7, Dimorigopoulos, A8) at the vicinity of Rion-Antirion Straits and two (Ag. Vasilios, A9, Alykes, A10) at the Gulf of Corinth (Fig. 1).

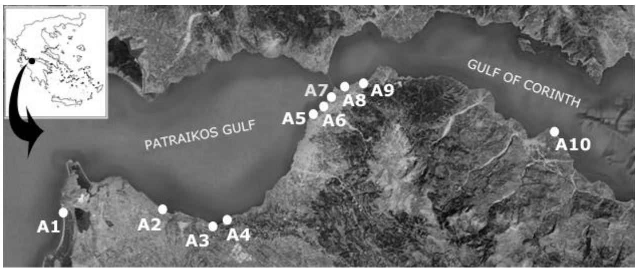

Fig. 1. Map showing the sampling locations at ten touristic beaches of Achaia Prefecture.

Sampling process was being performed once a month, from February to August on the 10 touristic beaches. The main environmental parameters (i.e., air and sediment temperature, humidity, and weather conditions) were also recorded. All the sediment samples were analyzed according ISO standard methods for the detection of Total coliforms (ISO 9308-1:2000), *E. coli* (ISO 9308-1:2000), and *Enterococcus spp.* (ISO 7899-02:2000). On the condition that samples had high bacterial load, was preceded the Successive Dilution Method. In order to extract microbes from sediment grains, a part of each sample (10 g) was aseptically transferred into a sterile bottle containing 100 mL of sterile distilled water and stirred vigorously at least 50 times [2]. After allowing the sediment to settle (2 min), eluents were filtered [3]. Counts were expressed as colony forming units (CFU) per gr of dry sediments. Grain size analysis of sediments was conducted utilizing the dry sieve method [4]. The calculation of grain size statistical parameters (i.e., mean size, standard deviation, sorting skewness and kurtosis) was achieved by the moment method. Furthermore, sphericity and roundness of the sediment grains were determined with the use of a stereoscope and a canvas (20x20 cm) that was manufactured in laboratory.

Results
Total coliform loads range from 0 to 1200 CFU/gr and *E. coli* loads from 0 to 580 CFU/gr, with an average of 486 CFU/gr and 17 CFU/gr, respectively. *Enterococcus spp.* loads run from 0 to 1040 CFU/gr, with an average of mean 69 CFU/gr. The existence of bacteria depended on the season as well as the human crowding on beaches. Mean values of bacteria range greatly between the winter/spring and summer seasons. Total coliform as well as *Enterococcus spp.* mean values increase impressively during warm months, while *E. coli* mean values decrease in the summer. Specifically, Total coliforms and *Enterococcus spp.* increase from 63.9 and 49.2 CFU/gr to 1034.7 and 69 CFU/gr, respectively. *E. coli* mean shows a clear decline from 23 to 9.7 CFU/gr. Sediments with increased Total coliform loads were recorded during the warmer months, in six (Kalogria, Rogitika, Paralia, Bozaitika, Plage, Dimorigopoulos) out of ten beaches. Enhanced *E. coli* load was observed in Bozaitika during the summer and high *Enterococcus spp.* values were measured in Rogitika, Bozaitika and Plage also in the summer. Four beaches out of ten were observed with bacterial load higher than the maximum acceptable limits. Specifically, during winter/spring season, Rogitika and Bozaitika beaches were found to have higher *Enterococcus spp.* load than the maximum acceptable limit. Additionally, total coliform load was above the maximum acceptable limit at Dimorigopoulos and Bozaitika beaches during the summer. Similarly, Bozaitika, Rogitika and Plage showed higher *Enterococcus spp.* load compared to maximum acceptable limit in summer season. It should be mentioned that the highest bacteria loads were noticed at beaches which are located near hotels, beach houses and recreation nuclei, for instance Bozaitika and Dimorigopoulos beaches. The Spearman correlation coefficient between bacteria load and the grain size characteristics of the sediments did not show any significant correlation. However, Total coliforms and *E. coli* showed a weak correlation (r=0.3-0.4) with mean grain size and sphericity of the grains of the beach sediments.

References
1 - Gerba, C.P., 2000. Assessment of enteric pathogen shedding by bathers during recreational activity and its impact on water quality. *Quant Microbiol.*, 2: 55–68.
2 - Sinigalliano, C.D., Fleisher, J.M., Gidley, M.L., Solo-Gabriele, H.M., Shibata, T., Plano, L., Elmir, S.M., Wang, J.D., Wanless, D., Bartowiak, J., Boiteau, R., Withum, K., Abdelzaher, A., He, G., Ortega, C., Zhu, X., Wright, M., Kish, J., Hollenbeck, J., Backer, Fleming, L.C., L.E., 2010. Traditional and molecular analyses for fecal indicator bacteria in non-point source subtropical recreational marine waters. *Water Research*, 44(13):3763-3772. doi:10.1016/j.watres.2010.04.026.
3 - U.S. Environmental Protection Agency, 2006. Enterococci in Water by Membrane Filtration Using Membrane-Enterococcus Indoxyl-β-D-Glucoside Agar (MEI). *EPA-821-R-06-009.* U.S.EPA,Washington, DC.
4 - Alekseeva, T.N., Sval'nov, V.N., 2005. The refined wet sieving method for the analysis of fine-graded sediments. *Lithology and Mineral Resources*, 40(6): 564-576.

PETROLEUM AND DETERGENT CONTAMINATION IN COASTAL SURFACE WATER FROM PRINCE ISLANDS, MARMARA SEA

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Abstract
Oil and detergent pollution of the Prince Islands in Marmara Sea was investigated at 6 stations in October 2015. Total hydrocarbons were determined against chrysene standard using spectrofluorophotometer. Detergent contamination was investigated using spectrophotometer. The highest oil and detergent contaminations were found as 32,28 µg/L at Sivriada and 67,16 µg/L at Büyükada, respectively. According to results oil concentrations in all stations are much higher than limit value. There is no a limit value for detergent studies. Any study on chemical pollution was not found in Prince Islands in the literature. Therefore the results will be database for further studies of whole islands group.

Keywords: Marmara Sea, Detergent, Petroleum, Pollution

The Prince Islands (Adalar), a chain of nine islands on the southeast of Istanbul in the Marmara Sea, are much more preferred for recreational activities and bathing. Almost 100,000 people a year visit the Prince Islands [1]. Despite that high number of people, few studies have been conducted at the local level for the water quality of the islands by the related agencies [2]. For petroleum determination 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) [3-6]. For detergent analysis seawater samples were alkalinized with 0.1 N NaOH, acidified with 0,1N H_2SO_4. Following extraction with chloroform they were shaken by wash solution and filtered. The filtrate volume was adjusted to 100 ml with chloroform, analyzed by UV spectrophotometer (Shimadzu, UV-1800) at 652 nm. Names of the stations are listed as Yassiada, Sivriada, Kinaliada, Heybeliada, Burgazada, Büyükada (Figure 1).

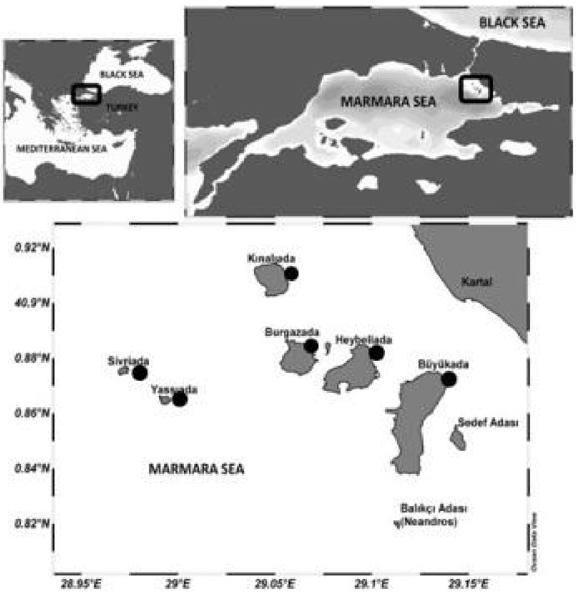

Fig. 1. Sampling Stations in Prince Islands

The oil and detegent pollution levels examined in sea water are shown in Figure 2. T-PAH contaminations relating the oil pollution were investigated at Büyükada [7], in Kinaliada [8,9] previously. Limit value of oil in sea water is reported as 2,5 µg/L by WHO. The highest oil levels were found at Sivriada and Yassiada as 32,28 µg/L and 30,2 µg/L, respectively. This case can be related either vessels and boats due to the construction activities on these islands or an instant contamination. According to findings oil concentrations in some stations are much higher than limit value.

The highest detergent pollution was found in Büyükada as 67,16 µg/L due to its high population. In other islands detergent concentrations are found as close values. Detergent value of Kinaliada has been found as 43,86 µg/L which exceeds the highest value (35,97 µg/L) in the same station of 2012 [10]. Detergent is a pollution parameter which is completely synthetic. There is no limit value for detergent concentration in seawater. This study showed that Prince Islands expose to high pollution even though they are much more preferred for recreational activities and bathing. For that reason, studies are strongly recommended for the monitoring programs.

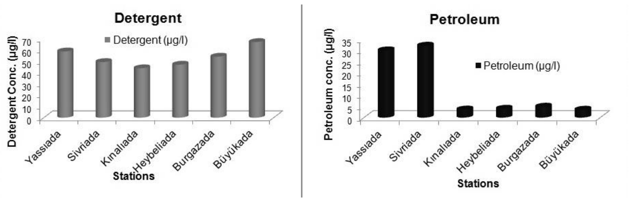

Fig. 2. Oil and detergent concentrations in the samples (µg/L)

References
1 - Adalar (2009). Adalar Municipality internet page. http://www.adalar.bel.tr
2 - Türkdogan, I.F., Kanat, G. and Bayhan, H. 2012. Sea water quality assessment of Prince Islands' Beaches in Istanbul. Environ. Monit. Assess., 184: 149-160.
3 - Cumali,S. and Güven,K.C. 2008. Oil pollution of Golden Horn seawater. J. Black Sea/Mediterranean Environment. 14:15-23.
4 - Yilmaz A. Saydam, A.C., Basturk, O. and Salihoglu, I., 1991. Transport of Dissolved/dispersed petroleum hydrocarbons in the Northeastern Mediterranean. *Toxicological and Environmental Chemistry* 31-32, 187-197.
5 - Yilmaz, A., Salihoglu, I. and Yayla, M. 1991. Assesment of oil pollution in eastern Mediterranean. *International conferance oil spills in the Mediterranean and Black Sea regions* 15th- 18th September 1998, Istanbul.
6 - Yilmaz, K., Yilmaz,A., Yemencioglu, S., Sur, M., Salihoglu, I., Karabulut, Z., Telli Karakoç, F., Hatipoglu, E., Gaines, A.F., Philips, O., Hewer, A., 1998 Polynuclear aromatic hydrocarbons (PAHs) in the Eastern Mediterranean Sea. *Marine Poll. Bull*. 36: 922-925.
7 - Karacik, B., Okay, O.S., Henkelmann, B., Bernhöft, S., Schramm, K-W. 2009. Polycyclic aromatic hydrocarbons and effects on marine organisms in the Istanbul Strait. *Environment International* 35: 599–606.
8 - Balcioglu, E.B., Aksu, A., Balkis, N., Öztürk, B. 2014. T-PAH contamination in Mediterranean mussels (*Mytilus galloprovincialis*, Lamarck, 1819) at various stations of the Turkish Straits System, *Marine Poll. Bull.* 88: 344-46.
9 - Balcioglu, EB., 2013. Oil Pollution In Coastal Surface Water From Various Regions Of Marmara Sea. *Rapp. Comm. Int. Mer Medit*., 39.
10 - Balcioglu, E.B., 2014. Anionic Detergent, Las Pollution In Coastal Surface Water Of The Turkish Straits System, *J. Black Sea/Mediterranean Environment,* pp.25-32.

THE IMPACT OF HARBOR USE ON ZOOBENTHOS

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Abstract
In 7 different region which represent most used harbors, ports and fishing shelters in the Sea of Marmara and Black Sea in Turkey coasts. Ecological Quality Status was assesed by sampling soft-bottom macrozoobenthos from 22 stations in 2014.

Keywords: Zoobenthos, Pollution, Black Sea, Marmara Sea, Bio-indicators

Introduction
Human pressure on the seafloor in coastal marine environments is particularly intense in harbors,fishing shelters and ports.These environments share some characteristics in common such as; highly stratified water column, limited water circulation and high amounts of organic and chemical pollutants. The impacts of those human-induced pressures on the environment will be generally represented by indicators of biotic attributes of the seafloor integrity (e.g: species composition). Principally the response of some zoobenthic species (such as; polichaeta, crustaceans etc.), to pressures, indicate ecosystem shifts or the level of degradation from healthy status.

Material and Methods
In order to assess the Ecological Quality Status (EcoQS), 22 samples were collected from soft sediment in 7 distinct regions (Fig.1): Kumport, TUPRAS Oil Refinery, Tuzla Shipyard harbors, Bostanci Fishing Shelter (BBB) in the Sea of Marmara and; Rize Port, Samsun Harbor and Yakakent Fishing Port (YKB) in the Black Sea by using Van Veen grab (0,1 m^2) while measuring some physicochemical parameters of water column. The macrozoobenthic data was estimated statistically by using; Shannon-Weiner Diversity (H' (log_2)), Pielou Evenness (J'), Margalef (d) and Bray-Curtis Dissimilarity Indexes with the use of Primer 6. As Marine Strategy Framework Directive (MSFD) require [1], EcoQS of the benthos was assessed by using BENTIX, AMBI and M-AMBI classification indices.

Fig. 1. Sampling Regions

Results and Discussion
In all stations, 128 species belonging to 9 taxa were identified. Among all taxonomic groups and at every region polychaeta present dominancy except for Rize Port where polychaeta and mollusca share equal percentages. Kumport stations were characterized by tolerant species thus M-AMBI values range from 0,33 to 0,87 at station KP14 where the diversity reaches its highest number among all the sampling regions within the Sea of Marmara (Table 1).

Despite the water quality is in acceptable limits in BBB according to MSFD [1], the percentage of sensitive species is 22,4% as maximum. Biological diversity achieves maximum 2,34 (Table 1) at Tuzla Shipyard and the region was dominated by second-order opportunistic species as the EcoQS changes between "MODERATE" and "POOR" indicates high level of human impact on marine environment.
Yet TUPRAS Oil Refinery is located in a highly used narrow bay where saturated oxygen level can be lower than 30% at the bottom layer, the stations of refinery TRF8 and TRF9 are polluted and present an unbalanced benthic community, dominated by second-order (85,71%) and first order (85,51%) opportunistic species, respectively. Besides the biodiversity is at minimum levels such as; 0,59 to 0,76 in these stations and TRF9 is dominated by a first-order opportunistic genus with a great individual number of *Capitella* sp. M-AMBI values for Samsun Port ranges from 0,61 to 0,24 indicate an affected area by port activities. YKB is not an extremely used area, where lowest index value is 0,39.

Tab. 1. Results of diversity and quality indexes according to regions

	Sample	d	J'	H'(log2)	BENTIX	AMBI	M-AMBI	Status
KUMPORT	KP 1	1.59	0.13	0.479	2.08	3	0.3331	POOR
	KP 7	2.25	0.32	1.298	2.08	3.17	0.4467	MODERATE
	KP 8	2.95	0.57	2.339	2.49	2.99	0.5612	GOOD
	KP14	5.38	0.59	3.126	2.43	2.8	0.869	HİGH
BOSTANCI FISHING SHELTER	BBB 01	1.62	0.49	1.631	2.08	3.58	0.3896	POOR
	BBB 03	3.08	0.75	2.793	3.39	3.67	0.5317	GOOD
	BBB 05	1.62	0.58	1.839	2.60	4.33	0.3618	POOR
TUZLA SHIPYARD HARBOR	TZ 03	2.89	0.35	1.507	3.46	2.84	0.5148	MODERATE
	TZ 17	1.89	0.74	2.341	2.52	3.78	0.4406	MODERATE
	TZ28	1.29	0.48	1.234	2.00	4.71	0.2508	POOR
TUPRAS OIL REFINERY HARBOR	TRF 8	0.38	0.59	0.592	2.00	4.29	0.1685	BAD
	TRF 9	1.23	0.23	0.755	2.02	5.56	0.1982	BAD
YAKAKENT FISHING SHELTER	YKB 2	0.91	0.85	1.352	3.78	1.67	0.3909	MODERATE
	YKB 3	4	0.71	3.140	2.67	2.97	0.6827	GOOD
	YKB 6	3.03	0.55	2.287	2.41	3.57	0.5358	GOOD
	YKB 8	3.02	0.58	2.435	2.65	3.08	0.5759	GOOD
SAMSUN HARBOR	SL 01	1.26	0.47	1.329	2.00	5.36	0.2369	POOR
	SL 06	2.64	0.71	2.706	2.12	3.43	0.5452	GOOD
	SL 15	3.49	0.75	3.054	2.67	3.03	0.6127	GOOD
	SL-34	1.23	0.7	1.816	2.27	3.36	0.38	POOR
RİZE PORT	RL - 01	1.67	0.82	2.109	5.00	1.2	0.5213	MODERATE
	RL 18	1.53	0.68	1.905	3.28	3.15	0.9992	HİGH

As the Sea of Marmara and the Black Sea represent high eutrofication [2], the BENTIX which was proposed for oligotrophic Mediterranean Sea, was not applicative for our study area. On the other hand M-AMBI is suitable for indicating EcoQS significantly

Acknowledgements
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References
1 - Rice, J., Arvanitidis, C., Borja, A., Frid, C., Hiddink, J., Krause, J., ... & Trabucco, B. 2010. Marine Strategy Framework Directive–task group 6 report seafloor integrity. *Luxembourg, Office for Official Publications of the European Communities*.
2 - Marine Dredging Applications and Environmental Management of Dredged Materials (DIPTAR), 3rd Progress Report (in Turkish), Project No: 111G036, TÜBITAK KAMAG 1007 Project, Gebze, Kocaeli, Turkey, 2015.

SYSTEMATIC BEACH STRANDED LITTER MONITORING AND SOURCE ESTIMATION IN TWO CONTRASTING BEACHES IN W. GREECE, EASTERN MEDITERRANEAN

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Abstract
Beach litter (BL) were monitored and their sources were estimated in two contrasting beaches in Western Greece, using the master list of categories of the TGML/JRC guidance document. This study proved that plastic is the dominant litter material (75%-92%) while plastic caps from water/beverage bottles and cigarette butts are the most abundant litter types per item in each beach, respectively. Urban/domestic activities, recreational activities, and fishery comprise the main litter sources.

Keywords: Pollution, Beach, Plastics, Gulf of Corinth, Mediterranean Sea

Introduction
Marine litter are identified as a global environmental issue that poses a threat to marine ecosystems and negatively affects marine-based human activities. In this study, the results of the systematic BL monitoring and source identification in two beaches are presented; Dafnes (A) and Agios Vassilios (B) located in Western Greece, in Gulf of Patras and of Corinth, respectively (Fig.1). These two beaches are characterized by different geomorphological settings and uses. More specifically, beach A has been formed by an ephemeral river that flows to the Gulf of Patras and is a non organised and occasionally recreational beach, while beach B is a popular, organised, touristic beach. Both beaches are mainly composed of pebbles.

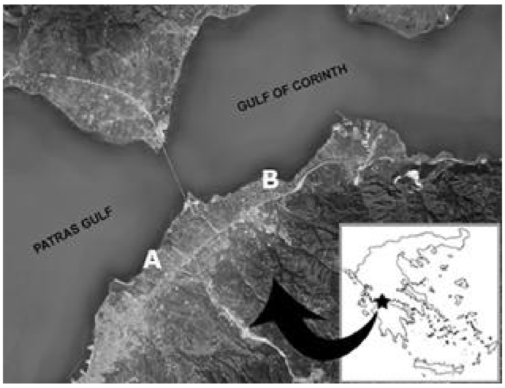

Fig. 1. Map showing the location of the two studied beaches; A and B.

Methodology
All BL were collected from each beach almost on a weekly basis during winter/spring and summer period; from December 2014 to March 2015 and in August 2015. All BL (>2.5cm) were counted and classified in terms of litter type according to the master list of categories of the TGML/JRC guidance document [1]. All data were statistically processed, and source indicative litter types were clustered, in order to identify the main litter sources in each beach and monitoring period (winter/spring and summer).

Results
A total number of 937 and 6,977 litter items was counted in beaches A and B, respectively. Higher BL abundance was identified during the winter/spring months (Fig. 2). Plastic was the dominant material in both beaches (A:75%; B:92%) in accordance with a previous study performed on Greek beaches [2]. In beach A, plastic caps (16%) from water/beverage bottles, appeared to be the most abundant litter item, followed by straws and stirrers (12%), plastic bottles >0.5 L (12%), and plastic bags (11%). This beach appears to be affected by a combination of recreational activities, stemming from the high abundance of litter related to that source (beverage containers, food packaging) [2] and domestic activities, based on a high abundance of litter items related to domestic use (plastic bags, home use products) [2]. The two sources contribute almost equally during winter/spring (~13%). Whilst, pollution related to recreation was found to affect the beach strongly during August contributing with 38% of total litter items, as opposed to domestic activities that have a much lower effect during the summer (6%). In beach B, the dominant litter type was cigarette butts (52%), followed by plastic caps (10%) from water/beverage bottles, and straws and stirrers (8%). The main litter sources seemed to be recreation activities, which is the dominant source in all monitoring periods, contributing with 12-25% of all BL items, followed by fishery, with ropes, nets etc. contributing with 3% of BL, and urban/domestic sources contributing with ~1% of all items. In beach B, much higher abundance of the total amount of BL, from all 3 sources, was observed during the winter/spring period (6,773 items) than in August (204 items), due to beach cleanings performed on this popular swimming beach during the summer. Both beaches show the same tendencies (Fig. 2; highest and lowest values) during the winter/spring months, showing that they both are affected by the same meteorological and oceanographic regime (predominant direction of wave propagation, longshore currents), due to their proximity. The different geomorphological setting and use of each beach is apparent from the contribution of each BL source. In beach A, although the main littering source is recreation throughout the monitoring periods, the contribution of urban sources, is much higher than in beach B, especially during the winter/spring, probably due to the ephemeral river. In beach B, there is a much higher abundance of BL related to recreational activities and there is a lower contribution of urban sources than in beach A.

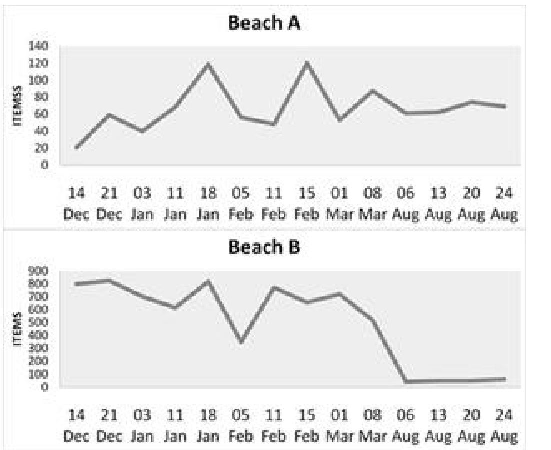

Fig. 2. Chart showing total litter items per beache in each recording date.

References
1 - Galgani et al., 2013b. Guidance on Monitoring of Marine Litter in European Seas. MSFD Technical Subgroup on Marine Litter (TSGML).
2 - Kordella, S. et al., 2013. Litter composition and source contribution for 80 beaches in Greece, Eastern Mediterranean: A nationwide voluntary clean-up campaign. Aquat Ecosyst Health Manag 16 (1) 111–118.

PRELIMINARY STUDY ON THE EMERGING MARINE LITTER PROBLEM ALONG THE EASTERN COAST OF LESVOS ISL., GREECE

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Abstract

A preliminary study has been undertaken on the assessment of the extent of littering of the coastal waters of eastern Lesvos isl. A UAV was used combined with diving and underwater camera drops for ground-truthing in two areas of different environmental conditions. The results show that litter concentrations varied along the coastline in terms of their distribution over the dry beach and the nearshore seabed. Areas with poor or no access show small quantities of litter on the dry beach but extensive littering on the nearshore seabed. The seabed off cliff coasts was found to be full of diverse litter probably due to local hydrodynamics. Specialized geophysical equipment are needed for the quick and precise detection of the deeper-seated debris so as to implement clean-up and protection actions.

Keywords: Aegean Sea, Mapping, Coastal waters, Pollution

Introduction - Methodology: In the last year, the Greek islands of the eastern Aegean Sea have been the main entrance points used by refugees arriving in the EU. The crossing of the straits between Turkey and the Eastern Aegean Sea islands is carried out using mostly small inflatable boats but also wooden and plastic vessels of various sizes; these are abandoned at the beaches upon arrival together with other items such as lifejackets, inflatable tubes and clothing. In beaches with good access, most of the litter is removed by regular clean-ups of the "dry" beach. Some of these items remain on site (both sub-aerially and at the nearshore seabed) and may progressively fragment into smaller pieces making their removal much more difficult at a later stage. Some of these items will inevitably end up either buried in the nearshore seabed or as floats dispersing in the Aegean Sea. Sunk boats can also cause significant short- and medium-term pollution due to their bunker oils or even by highly toxic chemicals as some of the outboard engines have been found to be powered by large batteries. It has been estimated that the associated litter amounts to about 8 tons per 1000 arrivals [2]. Although there is no specific study on the impacts of this type of coastal litter, there have been many reports in the scientific literature on the impacts of marine litter on biodiversity, economy and human health [1,3]. Economic costs of marine litter are associated with actual expenditure for beach cleanups, damages to or loss of fishing gear and boat motors, welfare costs, loss of revenue from tourism and fishing and losses associated with the deterioration of coastal landscape aesthetics [4]. The objectives of this preliminary study were to assess: (i) the extent of this new type of marine litter problem along the eastern coast of Lesvos; and (ii) the efficiency and cost-effectiveness of new technologies to provide quick, accurate and quantitative assessments of the marine litter distribution. Following visual inspection/recording of the marine litter problem along large stretches of the eastern and northern coast of Lesvos, 2 pilot areas (Kratigos and Tsonia) representing diverse coastal environments in terms of physiography and accessibility and also characterized by large number of arrivals, were finally selected for further investigation. Kratigos beach is close to the city of Mytilene (approximately 10Km) and easily accessible by car. Tsonia is an isolated coastal stretch, parts of which are accessible only by boat. The pilot surveys were carried out using aerial images collected by a Vertical Take-off and Landing (VTOL) quadrotor configuration (UAV) and they were validated by underwater "ground truth" data. Five autonomous survey missions were carried out: 2 for video-producing and 3 for beach surveying. HD videos were produced, whereas the beach survey image resolution (GSD – Ground Sample Distance) was set to 2.96cm. Geo-referencing of ground control points was by an RTK GPS. A series of dives and underwater camera drops operated from a shallow-hull boat were undertaken in order to identify/'ground truth' targets selected from the UAV imagery.

Results and Discussion: UAV imagery from Kratigos beach showed large quantities of litter on the dry beach and, particularly, on the nearshore seabed. This area, which is associated with a large number of arrivals, is easily accessible and the dry beach litter is regularly cleaned by volunteers, NGOs and the municipal refuse service. However, this is not the case with the nearshore seabed, which appears to be very significantly polluted by a variety of litter including plastic parts and outboard engines of sunk inflatables as well as plastic containers and discarded lifejackets and clothing. In Tsonia area although there was substantial littering on the dry beach, the nearshore seabed has shown to be quite litter free (at least down to water depths of 3 to 4m), with the major exception of a partially submerged shipwreck. It must be noted that this beach is not easily accessible by cleanup operators, which may explain the proliferation of the "dry" beach litter. Nevertheless, as there has been no record of a cleanup operation of the nearshore seabed, the apparent absence of litter in a shallow submarine part of a beach may suggest that they have either been buried under the nearshore sediments or, more likely, moved offshore (in deeper water depths), where would be undetectable by aerial imagery; it might also be possible that the litter has been dispersed along the neighboring coast. In order to answer this question both the offshore waters and two neighboring areas were surveyed by divers and underwater camera drops. These surveys showed that there are significant amounts of litter both in the deeper waters (down to water depths of about 10m) as well as on the nearshore seabed suggesting alongshore transport of the litter due to hydrodynamic processes (waves and currents); here, there is no landing beach as the coast is formed on steep coastal cliffs. Our results suggest that an integrated effort should be undertaken as soon as possible to efficiently remove the underwater litter before this results in irreversible degradation of the coastal environment/waters of the eastern and northern coast of Lesvos, where most of the sea arrivals are concentrated, with very detrimental long-term consequences for the local economies through cleanup expenditures and large losses of income (from tourism and fishing). Urgent and well planned action is required to avert a long-term environmental and socio-economic disaster at the Eastern Aegean Sea islands facing the same problems. UAV surveying proved to be a very accurate, efficient and low cost method to obtain the geo-spatial information needed for quantifying the litter problem along the coast that is a prerequisite for the efficient planning/implementation of remediation responses. However, the results showed that for deeper than 3-4m waters additional sea surveys are required using specialized echosounding (side scan sonars, multi-beams) and visual inspection (ROVs) equipment.

References

1 - Gall, S.C., Thompson, R.C., (2015). The impact of debris on marine life. *Marine Pollution Bulletin,* 92: 170–179.

2 - Katsanevakis S., (2015). Illegal immigration in the eastern Aegean Sea: a new source of marine litter. *Mediterranean Marine Science,* 16(3): 605–608.

3 - Kühn, S., Bravo Rebolledo, E.L., van Franeker, J.A., (2015). Deleterious Effects of Litter on Marine Life. p. 75–116. In: Marine Anthropogenic Litter. Bergmann, M, Gutow, L., Klages, M. (eds), Springer.

4 - Newman, S., Watkins, E., Farmer, A., ten Brink, P., Schweitzer, J.P., (2015). The Economics of Marine Litter. p. 367–394. In: Marine Anthropogenic Litter. Bergmann, M, Gutow, L., Klages, M. (eds), Springer.

CIESM Congress Session : Coastal observation tools

Moderator : Cordula Göke, Bioscience Dept., Aarhus Univ., Denmark

Moderator's Synthesis

The session had only 3 presentations, one focussing on the data assimilation through the Emodnet data portal, one on improving a biogeochemical model with processes that differ in the coastal zone from the open ocean and the third analysing the effect of ship wakes on erosion with the help of historical data. Besides the concrete scientific content, the three presentations focused on data handling more than data acquisition.

The discussion showed that a central data portal as access point for observation data is helpful and that efforts should be continued to include data from the whole Mediterranean Sea in Emodnet if possible or an alternative portal. Standardization and quality control is important though. Even though it is a requirement for the data providers, some errors become first visible when combing the data e.g. on basin scale. The example of chlorophyll modelling showed that a combination of methods is often necessary, because all methods (e.g. direct measurement, satellite image and model) have their uncertainties. The third example was an example that also historical data sources need to be accessed to estimate the extent of changes if the causing processes are not yet understood. From the GIS side, all levels of data handling are relevant, from pure mapping, to using GIS similar to a model, and participatory mapping, which is becoming increasingly popular,on the one hand because it is relatively cheap, on the other hand, because it gives access to local knowledge.

The session only shows a small fraction of tools and methods used. Many of the talks in other sessions were based on new tools, methods or challenges with acquiring the relevant level of data and information.

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HOW TO USE EMODNET CHEMISTRY TO SUPPORT THE MARINE STRATEGY IN EUTROPHICATION AND CONTAMINANT ASSESSMENT

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Abstract
Thanks to the intensive dialogue between EMODnet community, ICES and MSFD actors, EMODnet Chemistry results, including the regional chemical data collections and the visualization products are tuned and adapted to be used for the assessment of eutrophication (D5) and contamination (D8) as required by the MSFD. The aggregated and validated data collection for the Mediterranean Sea, including nitrate, nitrite, phosphate, silicate and ammonium as well as concentrations of hydrocarbons (PHAs and others), metals, pesticides and antifoulants is produced and made available under dedicated agreement. Besides, the data are dynamically visualized as standards WMS and WPS OGC services. Basin scale concentration maps are computed for the main nutrients with a 10-year moving window spanning from 1960 to 2014 for all standard vertical layers.

Keywords: Eutrophication, Pollution, Nutrients, Mediterranean Sea

The European Marine Observation and Data network (EMODnet) is a long term marine data initiative developed through a stepwise approach aiming to ensure that European marine data will become easily accessible, interoperable and free of restrictions on use. Supported by the European Commission, EMODnet Chemistry (http://www.emodnet-chemistry.eu/) started in 2009 to fulfill the Marine Strategy Framework Directive (MSFD) requirements for the assessment of eutrophication and contaminants [1], following INSPIRE Directive rules. The aim is twofold: the first task is to make available and reusable the big amount of fragmented and inaccessible data, hosted in the European research institutes and environmental agencies. The second objective is to develop visualization services useful for the requirements of the MSFD. With this purpose, aggregated and validated regional dataset are produced for nutrients, pH, alkalinity, dissolved oxygen, chlorophyll-a and contaminants (with hydrocarbons including PHAs and others, metals, pesticides and antifoulants).

With the start of EMODnet phase II, DG MARE, DG ENV and relevant actors met and agreed on a coordinated process and started developing potential contributions to identify how EMODnet can best contribute in practical terms to the MSFD and what concrete actions are required to make this happen. The contribution of ICES, acting as Data Center for a number of large dataset collections related to the marine environment in the North sea and in the Baltic area, is crucial to find complementarities. EMODnet Chemistry extended metadata to easily identify data suitable for inclusion in MSFD reporting (based on QA and QC procedures used in collecting it). ICES, as EMODnet Chemistry partner, is working to complement data in communication with regional sea conventions (RSC) contracting parties and to simplify the data flow. While much of the chemistry and contaminant data are well organized within OSPAR and HELCOM, EMODnet Chemistry has a more useful role in the Mediterranean where these outputs are less well organized. The dialogue with OSPAR and HELCOM helps to share the long established experience in data management and environmental assessment with the other basins and to provide Europe-wide perspectives for benefit to the other regions. A Memorandum of Understanding with the Commission on the Protection of the Black Sea against Pollution (Bucarest Convention) to formalize the cooperation in terms of providing dedicated access to EMODnet Chemistry regional products for supporting management of MSFD indicators as well as increasing participation in the Advisory Groups meetings is under preparation. A similar step is under discussion with the Information and Communication Regional Activity Center (INFO-RAC) through the United Nations Environmental Programme, Coordinating Unit for the Mediterranean Action Plan for the Barcelona Convention (UNEP/MAP).

The first output of EMODnet Chemistry consists in the aggregated and validated regional datasets which have been quality controlled according to standard protocols agreed at EU scale. Data for all European basins are accessible through a user-friendly data portal. Concerning D5 (eutrophication), EMODnet provides (for a geobox relevant for EU waters 80 Lat N;-30 Long W; 20 Lat S; 45 Long E) data of nutrients (phosphates, nitrates and silicates), as well as chlorophyll-a and dissolved oxygen (Fig. 1) from 301010 stations.

The second output consists in visualization products useful for MSFD implementation. In particular, for D5, indicator "Nutrients concentration in the water column", concentration maps of nutrients (nitrate, phosphate and silicate) have been produced using Data-Interpolating Variational Analysis [2].

Fig. 1. Distribution of "Nutrients" stations in the geobox relevant for EU waters, namely 80 Lat N;-30 Long W; 20 Lat S; 45 Long E

In order to facilitate the visualization of spatial and temporal patterns and trends, interpolated maps are available at seasonal scale and are generated as ten years running means and produced for standard vertical depths, from the surface to the bottom. Data available for long term monitoring stations are visualized as dynamic plots which allow rapid identification of long term variability.

Finally, beside the delivery of data and visualization products, the results of EMODnet Chemistry, thanks to the involvement of a wide consortium of institutes for all European Seas, provide a useful starting point for a gap analysis to gain understanding where the future monitoring efforts should be focused.

References

1 - European Commission, 2008, Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

2 - C. Troupin, A. Barth, D. Sirjacobs, M. Ouberdous, J.-M. Brankart, P. Brasseur, M. Rixen, A. Alvera-Azcárate, M. Belounis, A. Capet, F. Lenartz, M.-E. Toussaint, J.-M. Beckers, 2012, Generation of analysis and consistent error fields using the Data Interpolating Variational Analysis (DIVA), Ocean Modell., 52–53, 90–101, doi:10.1016/j.ocemod.2012.05.002.

INTEGRATION OF CHLOROPHYLL COASTAL OBSERVATIONS AND THE COPERNICUS–MED-MFC BIOGEOCHEMICAL MODEL THROUGH VARIATIONAL DATA ASSIMILATION

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Abstract

A variational data assimilation scheme has been developed in order to integrate coastal chlorophyll observations in the Copernicus Marine Environment Monitoring System (CMEMS) biogeochemistry model of the Mediterranean Sea. The chlorophyll concentrations assimilated in the coastal areas are L4 MODIS satellite observations from CMEMS-OCTAC. The new assimilation scheme consists of an upgrade of the 3DVAR variational method already in use in the nominal forecast system for the CMEMS Mediterranean Biogeochemistry. Integration of the new assimilated variable with in-situ coastal data provides a proper description of the coastal-off shore gradient, of the seasonal cycle of chlorophyll and of the occurrence of local bloom events.

Keywords: Mediterranean Sea, North Adriatic Sea, Models, Coastal waters, Ocean colours

Matherials and methods

The integration of model simulations and observations can be an useful tool for an effective description of biogeochemical properties in coastal areas, compensating for the relatively scarcity of homogeneous biogeochemical observation systems and low resolution of basin-wide model system.

The 3DVAR-OGSTM-BFM model routinely provides forecasts of Mediterranean Sea biogeochemistry in the framework of CMEMS, and it is composed by a biogeochemical model specifically developed for the Mediterranean Sea (OGSTM-BFM, [1]) coupled with a variational assimilation system (3DVAR, [2]).

Through the assimilation, satellite observations of chlorophyll concentration in open sea and in coastal areas are integrated in the forecast produced by the model. The assimilation scheme has been developed and operationally integrated in the forecast system during the EU MyOcean and Myocean2 projects and it is based on an opportune decomposition of the background error covariance matrix in three operators: vertical operator, horizontal operator and biogeochemical operator [2].

For the assimilation of coastal observations the background error covariance matrix decomposition has been upgraded inserting new vertical and horizontal operators, which have been designed accounting for the biogeochemical dynamics and statistics of the coastal areas.

The satellite observations used in the assimilation are provided by ISAC GOS CNR (Rome, Italy) through an algorithm specifically developed for Mediterranean case I and II waters [3].

The insitu data to be integrated with the model framework are chlorophyll coastal observation available at the Seadatanet chemistry portal.

Results

The 3DVAR-OGSTM-BFM model with open sea and coastal assimilation of satellite chlorophyll has been run for one year at 1/16° of spatial resolution. The results of the assimilation run have been compared with the available independent observations (in situ), showing that variational data assimilation can successfully integrate model and observations information providing a better knowledge of status and processes in coastal areas.

The integration of model and observations through the assimilation improves the description of the chlorophyll seasonal signal and local events in coastal areas, providing a correction of the timing and magnitude of local blooms. The comparison with in situ observations shows significant improvements in the results in the Northern Adriatic region; in this high productive coastal area the assimilation significantly reduces (up to 50%) the underestimation of chlorophyll concentration of the run without assimilation (Fig. 1).

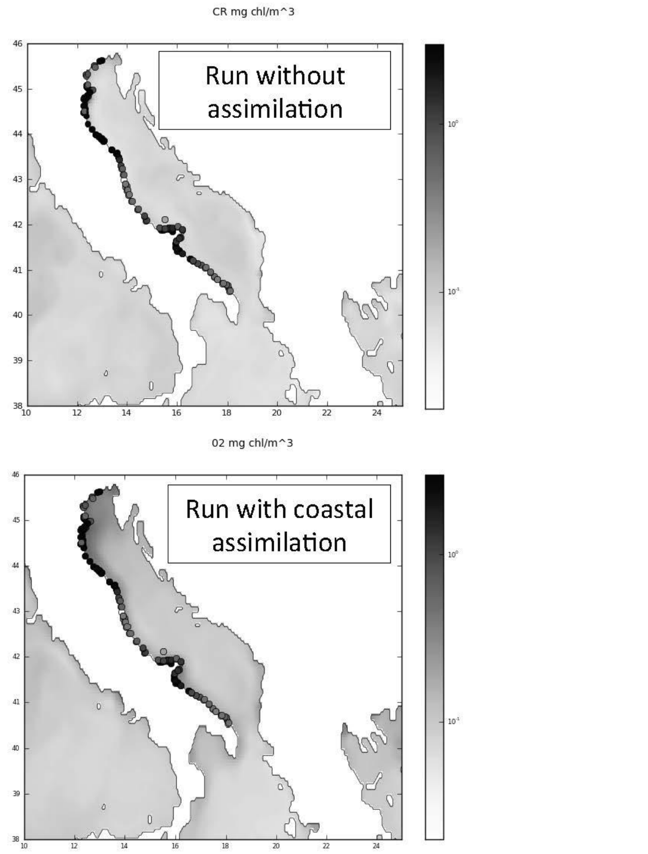

Fig. 1. Annual mean of chlorophyll in Adriatic Sea: model results (colormap) and in situ observations (dots)

References

1 - Lazzari P., Solidoro C., Ibello V., Salon S., Teruzzi A., Béranger K., Colella S., and Crise A., 2012. Seasonal and inter-annual variability of plankton chlorophyll and primary production in the Mediterranean Sea: a modelling approach. *Biogeosciences*, 9: 217-233.

2 - Teruzzi A., Dobricic S., Solidoro C., Cossarini G. 2013. A 3D variational assimilation scheme in coupled transport biogeochemical models: Forecast of Mediterranean biogeochemical properties. *J. Geophys. Res. Oceans*, 119:200-217.

3 - Volpe G., J. Pitarch, S. Colella, V. E. Brando, 2016. CMEMS. OCTAC, Quality Information Document, April 2016. www.marine.copernicus.eu

SHIP-INDUCED DEPRESSION WAKES AND SHORELINE EROSION

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Abstract
Shoreline retreat as an effect of ship wakes was studied in a navigation channel of the industrial port of Venice, Italy: the Malamocco-Marghera Channel. The investigation revealed unprecedented erosion rates, up to 4 m y^{-1}, that determined a total loss of about 1.2 million of m^3 of soil in the period 1970-2015. This interaction between navigation and the channel margins must be considered in order to understand the past evolution of the central Venice Lagoon and for a sustainable management of the port traffic in the future sea-level rise scenario.

Keywords: Gis, Erosion, Waves, Adriatic Sea

Ship traffic is one of the most important human activities in the world oceans and large navigable rivers. Besides underwater noise, pollution, and diffusion of invasive species, ship traffic introduces in the aquatic environment a considerable amount of energy in form of wake waves as vessels move along their routes. This has major morphological consequences in coastal and shallow water areas, as well as rivers and estuaries.

In confined or semi confined navigation channels depression wakes (figure 1) may cause extensive drawdown in the water level [1], propagate far from the channel [2] and play the largest role in sediment resuspension [3] and on the morphology of shoreline. This process is common in many areas worldwide and there are visual evidences of such wakes, for example, in the Elbe River in Germany, near Hamburg, where shoreline erosion is also an issue, the port of Fort Lauerdale in Florida, USA, and the Galveston-Houston Channel in Texas, USA.

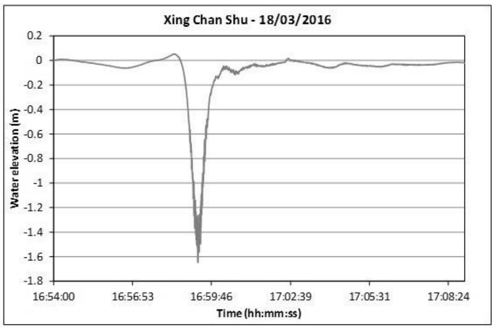

Fig. 1. Depression wake generated by the transit of a cargo ship (Xin Chang Shu, length 280 m, width 40 m, draught 10.3 m), in the Malamocco-Marghera channel, Venice Lagoon, Italy.

A study based on the analysis of historical aerial and satellite imagery combined with in situ measurements revealed a fast shoreline regression on the side of a major waterway in the Venice Lagoon, Italy (figure 2).

The research considered long and short-term recession rates caused by ship-induced depression wakes in an area which was reclaimed at the end of the ’60s for the expansion of the nearby Porto Marghera Industrial Zone and was left unused since then. The GIS analysis performed with the available imagery shows an average retreat of about 4 m yr^{-1} in the period between 1965 and 2015. Field measurements carried out between April 2014 and January 2015 also revealed that the shoreline retreat still proceeds with a speed comparable to the long-term average regardless of the distance from the navigation channel, however is not constant through time. Periods of high water levels determined by astronomical tide or storm surges, more common in the winter season, are characterized by faster regressions. During these periods it is likely that wakes from ships can penetrate further inshore.

The retreat is proceeded by the collapse of slabs of the reclaimed muddy soil after erosion and removal of the underlying original salt marsh sandy sediments and is a discontinuous process in time and space depending on the morphology, properties and vegetation cover of the artificial deposits.

The digitalization of historical maps and new bathymetric surveys made in April 2015 enabled the construction of two digital terrain models for both past and present situations. The two models have been used to calculate the total volume of sediment lost during the period between 1970 and 2015: about 1.2 million of m^3. The results of this study shows that ship-channel interactions can dominate the morphodynamics of the waterway and its margins to a considerable distance and enable a better understanding as to how this part of the lagoon reacted to the pressure of human activities in the post-industrial period. Evaluation of the temporal and spatial variation of the shoreline position is also crucial for the development of future sea-level scenarios and for the management of the lagoon and its shallow water ecosystem.

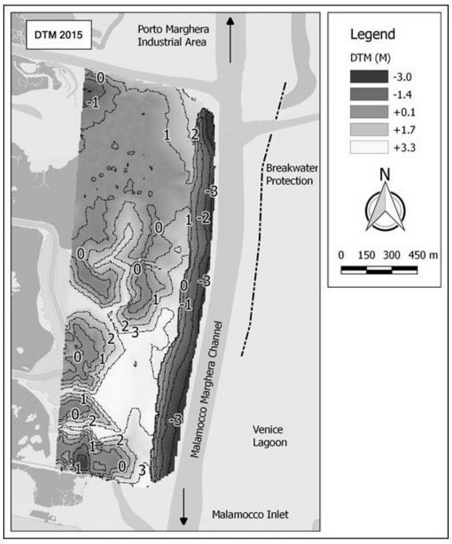

Fig. 2. Digital terrain model (DTM) of the studied area. In dark gray (negative values) the volumes removed from 1970 and 2015.

References
1 - K.E. Parnell, T. Soomere, L. Zaggia, A. Rodin, G. Lorenzetti, J.Rapaglia, G.M. Scarpa, 2015. Ship-induced solitary Riemann waves of depression in Venice Lagoon. Physics Letter A, 379, 555-559.
2 - J. Rapaglia, L. Zaggia, K. Ricklefs, M. Gelinas, H. Bokuniewicz, 2011. Characteristics of ships’ depression waves and associated sediment resuspension in Venice La-goon, Italy. J. Mar. Syst. 85, 45–56.
3 - M. Gelinas, H. Bokuniewicz, J. Rapaglia, K.M.M. Lwiza, 2013. Sediment resuspension by ship wakes in the Venice Lagoon. J. Coast. Res. 29, 8–17.

CIESM Congress Session : Cumulative impacts of stressors
Moderator : Jean-François Cadiou, Ifremer, Toulon, France

Moderator's Synthesis

The five presentations of the session 58 "Cumulative impacts of stressors" have addressed this issue from different angles of view but with a general objective of understanding the effects of one or several pressures on the marine ecosystems. It was also intended to develop new tools able to foresee the evolution of the environmental status and to assess the main risks of degradation and of non achievement of good and sustainable conditions. These aims meet the expectations of public authorities and decision-makers which ask the scientific community to provide a sound basis for setting environmental targets and elaborating management measures.

The discussion showed that is often difficult to establish clear links between one stressor and its impact on the ecosystem. i.e. to determine the cause of an observed change and to foresee the effect of a new management measure on the ecosystem (including the socio-economic component). To address the complexity of the problem, innovative approaches based on modeling (spatial or not) and integrative methods are developing and appear to be promising.

However, models face issues that need to be carefully considered in order to reduce - and possibly quantify - uncertainties and strengthen modeling results : - the scarcity of some observation data imposes certain simplifications and sometimes make difficult model validation - the need for a high quality expertise in various disciplines to configure models (e.g. setting weighting coefficients).

STUDY OF PRESSURES AND IMPACTS IN COASTAL ECOSYSTEMS IN THE MEDITERRANEAN AND THE BLACK SEA

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Abstract
Pressures and their impacts in coastal ecosystems have been studied in fourteen pilot areas of the Mediterranean and Black Seas. Although some anthropogenic pressures are on a decreasing trend it has been shown that others are increasing and represent a major risk of non-achievement of Good Environmental Status in these seas.

Keywords: Mediterranean Sea, Black Sea, Coastal systems, NIS, Pollution

Coordinated studies of pressures and their impact in coastal Mediterranean and Black Seas pilot areas have been carried out within the frame of the EC FP7 project PERSEUS [1]. These studies aimed at a better understanding of the processes involved in the links between main anthropogenic pressures and their effects on marine ecosystems. This work should further foster science-based criteria for defining Good Environmental Status (GES) as well as support the design of efficient management measures, in line with the objectives of the European Marine Strategy Framework Directive (MSFD) [2] and the Ecosystem Approach (EcAp) of UNEP/MAP [3]. New data on pelagic and benthic ecosystems, non-indigenous species and pollution by chemicals, litter and noise have been collected in fourteen areas of the Mediterranean and Black Seas (Figure 1). The analysis of new and historical data sets has provided better understanding of the response of coastal ecosystems to anthropogenic and natural pressures in the Southern European Seas (SES).

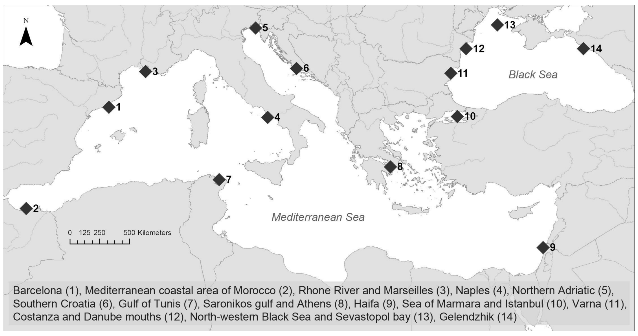

Fig. 1. Coastal study areas in the Mediterranean and the Black Sea

Although the selected study areas differ in their specific natural characteristics, they present the common feature of being under high anthropogenic pressures. Some of them include the mouth of major rivers flowing into the SES. Common methods between all sites were shared for these studies. This approach allows to examine and compare pressures and their impacts in the different areas and where possible, to draw out a basin wide understanding of the coastal ecosystem responses. The trends of change related to anthropogenic and climatic pressures were identified in the coastal marine ecosystems of the SES. The results for six types of pressures in four sub-regions of the SES are summarized in the Table 1.

Tab. 1. Level of impact of six types of pressures in the coastal ecosystems of the SES.

	Level of impact (+: low; ++ significant; +++ high)					
Pressure	Western Med.	Adriatic Sea	Eastern Med.	Black Sea	Trend	Comment
Changes in riverine fluxes	+	++	++	++	=	Climate change could severely affect riverine fluxes
Nutrients and organic enrichment	+	+	+	+	↘	Local problems subsist due to untreated water discharges
Hazardous substances	++	++	++	++	=	Attention should be paid to new contaminants
Physical damages on habitats	++	++	++	++	↗	Urbanization and tourism need to be better controlled
Non indigenous species	++	++	+++	++	↗	Ecosystem and services should deal with the establishment of tropical species
Litter	++	++	++	++	↗	Effort to reduce release at sea required

Generally the nutrient loads, and many of legacy pollutant levels decrease showing thus that effective policy implementation and its improvements lead to positive outcomes. However, it is also evident that policy efforts in these domains must be long-lasting. It has also been shown that some pressures (physical damage/loss of marine habitats, spread of non-indigenous species, emerging pollutants, marine litter and noise) are growing and their impacts may be not well assessed and represent a major risk of non-achievement of GES in the SES. The lack of standardized and accessible observational data as well as knowledge gaps regarding the links between pressures and impacts remain an issue. This key challenge must be met for improving assessments and designing sound ecosystem based management aiming at ecological and economical sustainability in the SES.

References

1 - Crise A. et al, 2015. A MSFD complementary approach for the assessment of pressures, knowledge and data gaps in Southern European Seas: The PERSEUS experience, *Marine Pollution Bulletin* 95, 28-39
2 - European Commission, 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).
3 - UNEP/MAP, 2015. Implementation of the Ecosystem Approach in the Mediterranean

HINDCASTING THE DYNAMICS OF AN EASTERN MEDITERRANEAN MARINE ECOSYSTEM UNDER THE IMPACTS OF MULTIPLE STRESSORS: A BASELINE FOR FUTURE MANAGEMENT SIMULATIONS

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Abstract

In order to analyse the main historical ecosystem dynamics, a temporal dynamic ecosystem model representing the continental shelf of the Israeli Mediterranean coast was developed using Ecosim. Firstly, the model was fitted to available historical data. The historical model predictions satisfactorily matched the observed data, especially regarding the invasive species groups. The model showed an increasing proportion of invasive species in biomass and catch over time. Results highlighted the important role that fishing activities and climate change are playing in the ecosystem. Secondly, the dynamic ecosystem model was used to develop exploratory temporal analysis about future management scenarios. This study represents a baseline from where spatial-temporal simulations can be developed.

Keywords: Food webs, Fisheries, Invasive species, Global change, South-Eastern Mediterranean

The ecosystems of the Israeli Mediterranean coast have undergone significant ecological changes in recent decades caused primarily by the influx of a large number of invasive species through the Suez Canal, intense fishing activities and the effects of climate change (1,2). An important challenge for conservation and managing marine ecosystems is to advance our understanding of how multiple human stressors, environmental factors and marine resources interact and influence each other (3).

In this study, an Ecopath food web model representing the continental shelf of the Israeli Mediterranean coast was calibrated and fitted to the available time series from early 1990's to 2010 using the Ecosim temporal modeling approach. The baseline ecosystem model was composed of 41 functional groups, ranging from primary producers to top predator species and including eight invasive groups (crustaceans and fish species) (4). This model was used to explore the historical dynamics of the ecosystem considering the effect of invasive species, fishing activities and climate change (through historical changes in temperature and salinity) as the main drivers and to evaluate their historical cumulative effects. We then conducted 20yr simulations into the future in which we tested a number of scenarios. The first scenario served as a base run and used current fishing effort and environmental conditions; in the second scenario, the demersal trawl fishery was removed gradually within the first five years of the simulation; in the third scenario the temperature was increased gradually by 1 degree °C over the period of the simulation; and, in the fourth, both scenarios 2 and 3 were combined.

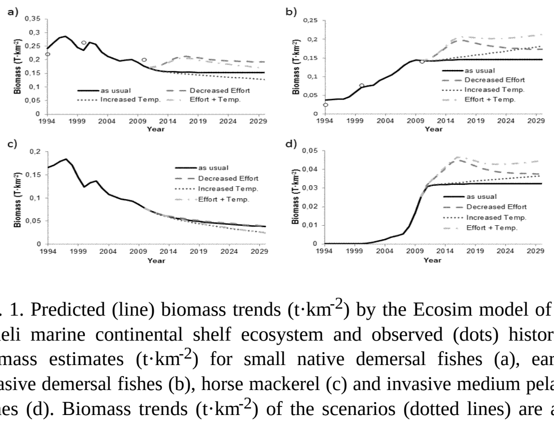

Fig. 1. Predicted (line) biomass trends (t·km^{-2}) by the Ecosim model of the Israeli marine continental shelf ecosystem and observed (dots) historical biomass estimates (t·km^{-2}) for small native demersal fishes (a), earlier invasive demersal fishes (b), horse mackerel (c) and invasive medium pelagic fishes (d). Biomass trends (t·km^{-2}) of the scenarios (dotted lines) are also showed.

The model historical predictions satisfactorily matched available historical data, especially regarding invasive species groups (Fig. 1). The model showed an increasing proportion of invasive species in biomass and catch over time while native species showed a decreasing trend (Fig. 1 and 2), with important effects on the food-web. However, data from the pelagic domain were not available to validate results. Results also highlighted the important role that fishing activities and climate change are playing in the ecosystem through overexploitation and displacements of native groups respectively.

The results of the future scenarios corroborated the large impacts of fishing activities, as a reduction of the trawl effort would show a recovery of several groups, especially high trophic levels organisms (Fig. 1). The increased sea surface temperature scenario would exacerbate the negative trends of native species and would amplify the impacts of invasive species (Fig. 1). In addition, the combination of the scenarios showed the cumulative impacts of the stressors (Fig. 1), suggesting synergistic effects between the impacts of invasive species, fishing and climate change.

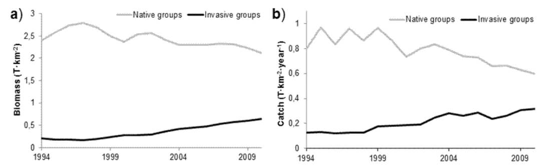

Fig. 2. Biomass trends (T·km^{-2}) (a) and Catch trends (T·km^{-2}·year^{-1}) (b) of native and invasive groups calculated from Ecosim model for the period 1994-2010. For Biomass we included only the groups that we differentiate between native and invasive species (fish, cephalopods and crustaceans (shrimps and crabs)) and therefore, it doesn't include all planktonic groups and benthic invertebrates groups.

Ecosystem modelling tools can provide governmental agencies and stakeholders useful results to explore the impact of potential management alternatives in order to inform the decision making process.

References

1 - Goren, M., D. Shults, and A. Gafni, 2013. The Current State of Fish and Israel's Fisheries in the Mediterranean Sea.
2 - Galil, B.S., 2007. Seeing Red: Alien species along the Mediterranean coast of Israel. Aquatic Invasions, 2(4): p. 281-312.
3 - Breitburg, D.L. and G.F. Riedel, *2005.* Multiple stressors in marine systems, in Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity.Island Press: Washington. p. 167-182.
4 - Corrales, X., et al.Modeling the structure and functioning of the Israeli marine continental shelf ecosystem: the role of invasive species and fisheries. Journal of Marine Systems, In preparation.

MULTI-HAZARD ASSESSMENT OF NATURAL AND ANTHROPOGENIC STRESSORS IN MARINE AREAS: THE CASE STUDY OF THE ADRIATIC SEA

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Abstract
Europe's seas are facing increasing threats and degradation induced by a wide range of human activities as well as climate change. In order to assess the environmental impacts posed by climate drivers in combination with local to regional anthropogenic pressures (e.g. temperature and salinity variation, sands extraction, trawling fishing) a spatially explicit risk approach was developed, allowing a quick scan and ranking of marine targets at risk. The methodology was tested in the Adriatic sea for the scenario 2000-2015, producing a range of GIS-based maps and indicators for selected marine receptors (e.g. seagrasses, aquacultures) useful to identify marine areas where management actions and adaptation strategies would be best targeted.

Keywords: Geohazards, Gis, Global change, North Adriatic Sea

Introduction
In the last few decades the health of marine ecosystems has been progressively threatened by the anthropogenic presence as well as by climate change effects triggering alteration on biological, chemical and physical processes ([1], [2]). An environmental risk-based approach should be developed in order to identify marine areas that are more likely to be at risk of not achieving the Good Environmental Status (GES) [3] due to multiple threats posed by climate and anthropogenic stressors. By integrating a wide array of indicators related to hazard, exposure and vulnerability with Multi Criteria Decision Analysis (MCDA) and Geographic Information Systems (GIS), the assessment lead to develop, for the scenario 2000-2015, a set of spatial maps and statistics representing key risk metrics useful to evaluate progress toward the implementation of the Marine Strategy Framework Directive [3] and identify marine areas where management actions would be best targeted.

Risk-based approach for multi-hazard assessment and management in marine areas
In order to evaluate the environmental impacts produced by human-made pressures in combination with climate-related hazards, a risk-based approach was developed and applied in the Adriatic Sea (Figure 1).

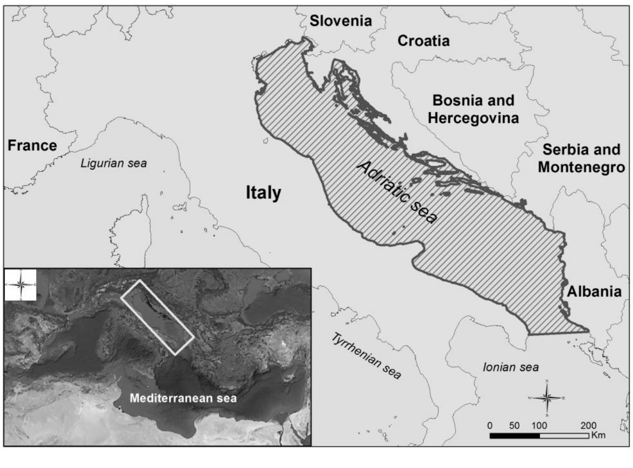

Fig. 1. Adriatic sea case study area

The approach is based upon the three main pillars of risk defined by UNISDR [4] and IPCC [5] and, accordingly, is composed of four consecutive steps. The first phase consists in the hazard assessment which aggregates metrics and scenarios of climate, ocean, bio-geochemical and anthropic pressures (e.g. chlorophyll concentration, temperature and salinity variation, bottom stress) for determining potentially affected marine areas. The exposure assessment selects and localizes key receptors that could be subject to potential losses (adverse consequences) in marine areas (e.g. seagrasses, coral and maërl beds, aquacultures). Subsequently, the vulnerability assessment aims at evaluating the degree to which the receptors could be adversely affected by the considered hazards, based on their specific physical and environmental features (e.g. sensitive habitat extent and typology, biodiversity indexes, seabed typology). Finally, the relative risk assessment combines the information about the considered hazards, exposure and vulnerabilities, in order to identify marine areas and targets at higher risk from multiple pressures.
Results obtained for the Adriatic sea include GIS-based hazard, exposure, vulnerability and risk maps, as well as key risk indicators calculated for the selected marine receptors (e.g. extent of seagrasses and coral habitat potentially affected by human activities, alterations of physical and chemical parameters). The assessment showed that higher hazard scores are linked to climate stressors (i.e. sea surface temperature and salinity variation) while the lower ones resulted from anthropogenic and more localized pressures (e.g. abrasion, input of organic matter). Relatively very high scores were observed for vulnerability over the whole case study for almost all the considered pressures, showing seagrasses meadows, maërl and coral beds as the most vulnerable targets.
These output can be used as decision support tools for planners and local authorities, providing guidance and information on the current state and the main risks in the marine area of concern, thus setting the scene for the design and implementation of targeted management actions that consider spatially relevant issues and are consistent with the objectives of the MSFD [3].

Conclusions
Integrating climate pattern with socio-economic and environmental information of the considered marine area, the proposed multi-hazard methodology supports a semi-quantitative evaluation and relative ranking of areas and targets potentially affected by multiple stressors in the considered marine region. The approach is flexible to be applied in different geographical regions and scenarios, supporting to evaluate both the progress toward the achievement of GES [3] and the potential effects of long-term climate change.

References
1 - EEA, 2015. The European environment — state and outlook 2015: synthesis report, European Environment Agency, Copenhagen.
2 - IPCC, 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.Cambridge University Press, 2014.
3 - EC, 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).
4 - UNISDR, 2009. Terminology on Disaster Risk Reduction, Int. Strat. Disaster Reduct., pp. 1–30, 2009.
5 - IPCC, 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Research Report, pp.1–594. Available at: papers://ef64220a-a077-48ec-ae81-be13b32d2073/Paper/p991.

INTERACTIONS ENTRE L'ÉDIFICATION DU PORT TANGER MÉDITERRANÉE (NORD MAROCAIN) ET LES RESSOURCES HALIEUTIQUES DU DÉTROIT DE GIBRALTAR

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Abstract

Les travaux de la première phase de l''édification du port de Tanger Méditerranée (PTM I, PTM P) ont impacté les ressources halieutiques de la zone du détoit de Gibraltar entre 2002 et 2009. Mais suite à l'aménagement de la seconde phase (PMT II), la situation s'est améliorée à partir de 2010, ce qui pourrait indiquer une restauration de l'écosystème du détroit perturbé auparavant.

Keywords: Gibraltar Strait, Fisheries, Restoration, Coastal management

Le détroit de Gibraltar, voie de passage des grandes espèces (thon rouge, espadon,...), se caractérise par une biodiversité importante [1]. Ce potentiel fait face aux infrastructures lourdes, le port Tanger Méditerranée (PTM) en particulier. L'interaction entre ce complexe portuaire et les ressources halieutiques fait l'objet de cette étude.

Situé à 22 Km à l'Est de Tanger (Maroc), le PTM a été réalisé en deux étapes. La première (2004-2009) consistait à construire une centaine d'ha de terminaux portuaires. La seconde pour son extension, a démarré en 2010.

Outre la grande diversité algale et d'invertébrés, la zone du détroit recèle d'importantes richesses halieutiques avec une faune diversifiée de Cétacés.

L'activité de pêche est concentrée à l'est de Tanger. Celle liée à la capture du thon rouge est la plus importante ; sa production moyenne annuelle est de 271 Tonnes, représentant 10% de la production nationale [2].

L'impact du projet est dû aux activités de dragage et de clapage [3], au trafic et aux bruits émis par les ondes acoustiques. Certaines interactions avec les fonds pourraient détruire des habitats. De plus, les infrastructures produisent une série de rejets liquides préjudiciables à la vie aquatique.

Deux types de données ont été utilisés : statistiques (flottille, production) et enquêtes durant la préconstruction (avant 2004), la construction (2004-2009) de PTM I, PTM P (passagers) et l'extension (2010) pour PTM II.

L'enquête a concerné 77 barques actives (53%) des deux principaux sites de débarquement du détroit, à l'est de Tanger (Ksar Sghir et Dalia).

L'évolution des captures montre une tendance à la baisse. Certaines espèces ont disparues. Les captures ont diminué entre 2002 et 2004 de 35%. Elles ont montré une chute drastique en 2005 et 2006 (96,1%), une augmentation timide en 2007 et une chute en 2008 de 85,88%. En 2005, le thon rouge et le mérou ont baissé respectivement de 97,66% et 85% par rapport à 2004. Bien que ces variations soient dues à l'effort de pêche et à l'environnement, une chute brutale des prises est liée à l'édification du PTM (Fig. 1). Il est admis que les opérations de dragage et de clapage déclinent les stocks [4].

Les enquêtes ont révélé que les zones de pêche ont subi une réduction ; le port a été mis en place au détriment des zones les plus productives sans compter celles sujettes aux travaux. Elles ont confirmé la chute des prises.

Bien que les facteurs classiques de la chute des captures (environnement, prédation par l'orque, réduction du TAC de 50% de 2007 à 2013 et faible quota attribué au segment artisanal) soient admis, tous les enquêtés sont unanimes sur le fait que le PTM a eu un impact négatif sur les ressources en raison de la mortalité en masse durant la phase de construction du port et la destruction des frayères et nourriceries de certaines espèces.

Durant la période 2010 – 2014, la production a connu une hausse importante avec une moyenne annuelle de 125,75 t (Fig. 1). Le thon rouge et la dorade rose représentent respectivement 65% et 17% de cette production ; l'analyse de l'évolution de leur capture montre un aspect similaire à celle de la production totale. Les espèces qui avaient disparues réapparaissent ; d'autres sont apparues (dorade, marbré, turbot), ce qui témoigne d'une forte reprise de la richesse spécifique. Ainsi, il semble que les travaux d'extension du port (PTM II) en cours n'ont pas affecté les débarquements, bien au contraire les captures sont devenues plus importantes. Ce paradoxe peut être expliqué par des différences liées aux : (i) zones, types et opérations de dragage et de clapage, (ii) lieux de pêche d'où proviennent les captures, (iii) disponibilité des poissons suite à un rétablissement des ressources et (iv) périodes de dragage pour l'extension limitées à octobre -décembre ou janvier -mars où les impacts ont été faibles [5].

Par ailleurs, il a été démontré à travers une étude de 9 sites dragués en mer Baltique que la bathymétrie, la topographie et le type d'habitat déterminent la réaction des communautés suite aux opérations de dragage ; les fonds à faible pente sont moins impactés que les fonds plats et l'hydrodynamisme fort conduit à peu d'effets néfastes avec un rétablissement rapide des communautés biologiques [6].

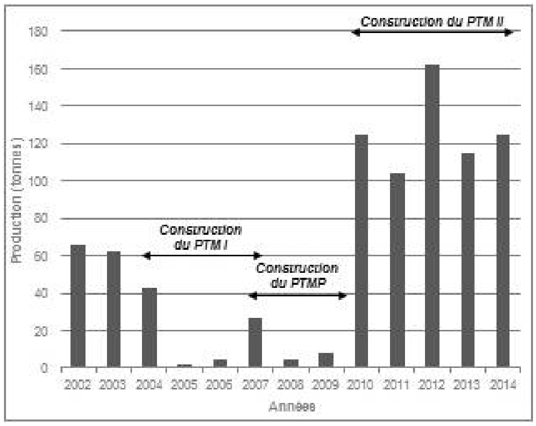

Fig. 1. Evolution annuelle des captures et chronologie de l'édification du complexe portuaire de Tanger Méditerranée

References

1 - CopeMed II, 2012. Report of the Second meeting of the CopeMed II Working Group between Spain and Morocco on blackspot seabream (*Pagellus bogaraveo*) of the Strait of Gibraltar area. *CopeMed II Technical Documents Nº26 (GCP/INT/028/SPA GCP/INT/006/EC). Málaga, 2012. 37pp.*

2 - Malouli Idrissi, M. ; Abid, N. ; Bernardon, M. et Caminas, J.A. 2013. Situation de la pêcherie artisanale au thon rouge dans le Détroit de Gibraltar en Méditerranée marocaine. FAO- ArtFiMed Développement durable de la pêche artisanale méditerranéenne au Maroc et en Tunisie (GCP/INT/005/SPA). *CopeMed II-Technical Documents N° 34. Malaga, 2013. 39p.*

3 - Erftemeijer, P. ; Riegl, B. ; Hoeksema, B. W et Todd, P. T., 2012. Environmental impacts of dredging and other sediment disturbances on corals: A review. *Marine Pollution Bulletin 64 (2012): 1737–1765.*

4 - Newell, R. C, Seiderer L. J. and Hitchcock D. R., 1998. The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanography and Marine Biology: an Annual Review (36): 127-78.*

5 - TMSA, 2012. Extension du port Tanger Méditerranée : dragage de sable marin pour remblais hydrauliques du nouveau port de Tanger Méditerranée. *Etude d'impact environnementale, Agence Spéciale Tanger Méditerranée, 183p.*

6 - Kotta, J., Herkül, K., Kotta, I., Orav-Kotta et H., Aps, R., 2008. Effects of Harbour Dredging on Soft Bottom Invertebrate Communities: Does Environmental Variability Affect the Community Responses? *University of Tartu, Estonian Marine Institute. 6p.*

ECOLOGICAL QUALITY STATUS OF THE GREEK COASTAL WATERS COUPLED WITH ENVIRONMENTAL STRESSORS

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Abstract
In this work we have studied the linkages between different stressors and the status of the Greek coastal marine ecosystems. We have assessed the eutrophication and the ecological status of the coastal marine environments. The ecological quality of the coastal Greek waters couple with eutrophication and climate-environmental stressors.

Keywords: Coastal waters, Eutrophication, Aegean Sea, Ionian Sea

Introduction
Aquatic ecosystems are increasingly stressed by different natural and anthropogenic pressures including nutrient inputs, aquaculture, fisheries, input of hazardous substances, physical disturbance, hydrological alterations etc. It is known that the assessment of pressures and impacts is one of the key features of the EU Marine Strategy Framework Directive (MSFD). In this work we have assessed the eutrophication and the ecological status of the Greek coastal waters and we have studied the relationship between different stressors affected the selected coastal areas and the status of the Greek coastal waters.

Methodology
The eutrophication and the ecological status have been assessed using different tools (TRIX; EQS) as described in [1-3].

Results and Discussion
The eutrophication assessment of the Greek coastal marine environments according to TRIX, showed that 12% of the studied coastal stations were characterized as in HIGH eutrophication status; 51% in GOOD status; 28% in MODERATE status, 8% in POOR status and 2% into the BAD status. The ecological assessment of the Greek coastal sites showed that 54% of the Greek coastal sites were classified into GOOD status, 36% into MODERATE and 4% into HIGH status. It is noteworthy that the HIGH and GOOD sites represent the highest percentage in terms of cost length and/or surface. A Factor analysis, rotated using the Varimax rotation method, was used in order to investigate the relatively importance of the different stressors assessed in this work on eutrophication (TRIX) and the quality status (EQS). The factor analysis resulted to 2 main factors (72% of total system acquired high loadings in the first component TRIX: 0.85; EQS: 0.60; Nutrient input: 0.73; Agriculture: 0.76; Hydrological changes: 0.82). It seems that TRIX and EQS status indices couple with eutrophication stressors and hydrological changes related to climate.

References
1 - Pavlidou, A., Simboura, N., Rousselaki, E., Tsapakis, M., Pagou, K., 2015. Methods of eutrophication assessment in the context of the water framework directive: examples from the Eastern Mediterranean coastal areas, Cont. Shelf Res. 108, 156-168.
2 - Simboura, N.,Tsapakis, M., Pavlidou, A., et al., 2015. Assessment of the environmental status in Hellenic coastal waters (Eastern Mediterranean): from the Water Framework Directive to the Marine Strategy Water Framework Directive. Mediterr. Mar. Sci. 16/1, 46-64.
3 - Simboura, N., Pavlidou, A., Bald, J., Tsapakis, M., Pagou, K., Zeri, Ch., Androni, A. and Panayotidis, P. Response of ecological indices to nutrient and chemical contaminant stress factors in eastern Mediterranean coastal waters, Ecological Indicators (paper under revision).

CIESM Congress Session : Transboundary conservation actions
Moderator : Massimo Ponti, Ecology Group, Bologna Univ., Italy

Moderator's Synthesis

The session was focused on the need of transboundary conservation actions, which arises from the awareness that threats of the oceans know no political boundaries. In this context, presentations highlighted the central role of Marine Protected Areas networks. New tools and approaches in assessing the effectiveness of conservation actions and able to support the development of management plans, including species connectivity measures and biotic indices, were presented.
After the presentations, the discussion was very rich in ideas. Among the main topics discussed there was the species connectivity at basin scale, especially concerning those species targeted by local fisheries, often neglected in transboundary conservation actions (as the case of the sand eels in Catalonia). The debate has shown that the participatory approach should be extended beyond the local boundaries, especially for those MPAs that are located on the borders among different countries, and along the migratory routes (e.g. Pantelleria Island). Moreover, all the participants agreed on the new opportunities offered by the involvement of citizens from different countries in monitoring programs concerning key species and priority marine habitats, also thanks to new technologies available, as in the case of biotic indices derived from observations carried out by scuba divers.

GUIDELINES ON GENETIC CONNECTIVITY AS A TOOL FOR ASSESSSING THE EFFECTIVENESS OF MARINE PROTECTED AREAS

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Abstract

The design and management of Marine Protected Areas (MPAs) and MPA networks should take into account the patterns of spatial distribution and connectivity among populations of the target species. Well-connected and highly diverse populations are more resilient to natural and anthropogenic impacts. In the context of MPA monitoring, genetic analyses are considered a powerful tool for assessing population diversity and connectivity patterns at different spatial scales. Here, two case studies using genetics tools were presented to assess connectivity patterns between protected and unprotected areas in the Mediterranean Sea, providing MPA managers with a set of guidelines to address specific species conservation issues.

Keywords: Genetics, Mediterranean Sea, Marine parks, Conservation

Why and how to monitor genetic connectivity

The design and management of Marine Protected Areas (MPAs) and MPA networks should consider spatial patterns of species distribution and connectivity among populations (1). Connectivity is a fundamental aspect to consider when evaluating the status of existing MPAs and MPA networks, since well-connected and highly diverse populations are more resilient to environmental changes (2). Connectivity patterns can be used as a management tool, providing information on the portion of individuals coming from protected populations retained within MPA borders and the amount of individuals exported from protected populations toward unprotected areas (Fig1).

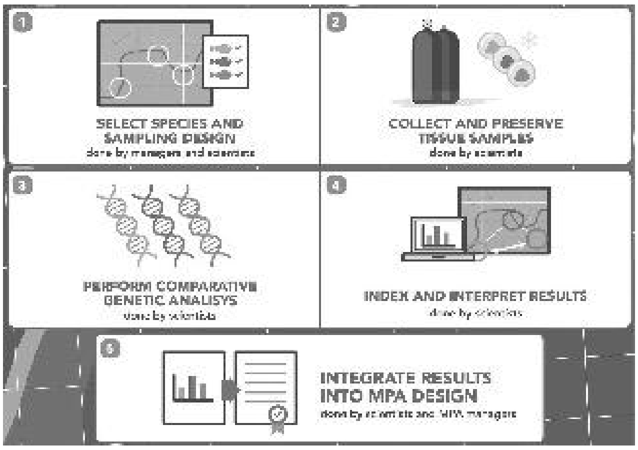

Fig. 1. Schematic standard approach for gathering and integrating genetic data for conservation strategies. Layout and design: La Calle es Tuya, S.C.

In the context of MPA monitoring, genetic tools allow the assessment of connectivity patterns at different temporal and spatial scales, and are possibly non-lethal, allowing their application on endangered species and focal species (3, 4). From this perspective, the number of sampling sites should be defined depending on the geographic extension of the study area. The distance among sites and number of sampling sites would depend on the MPA size, the geomorphological and environmental characteristics and the target species. Specifically, for genetic analyses, at each site, 20-30 individuals per species should be sampled, for instance, within an area of approximately 100 m., separated from 1-10 m apart in the case of sessile individuals or sampling from different shoals in the case of fishes. A small amount of tissue is enough for genetic analysis, which usually can be extracted without harming or killing the individual. Samples should be preserved in 90% ethanol and maintained at 4 ºC until processing. Samples could be extracted and sent to a sequence facility. Since connectivity patterns differ among species, several species should be selected to better address MPA management issues, as well as integrating additional information, such as oceanographic and demographic data.

A case study on fishes: the saddled sea bream

The saddled sea bream (*Oblada melanura*) is an economically important species, widely distributed in Mediterranean coastal ecosystems. Although generally protected within Mediterranean MPAs, population genetic patterns of this species are currently unknown in the Western Mediterranean Sea. Genetic structure of the saddled sea bream and the level of genetic connectivity between protected and unprotected populations was investigated. Spatial patterns of population differentiation were assessed at different spatial scales, considering three MPAs of the Western Mediterranean Sea. Values of population differentiation were non-significant, indicating that, at a relatively local spatial scale, protected populations were in general well connected with non-protected ones. At the regional scale, a subtle population structure that reflects the main oceanographic features was present. These results may have important implications for the conservation biology and fisheries management of saddled sea bream like other coastal fish.

A case study on intertidal invertebrates: the limpets

Limpets have a key ecological role in structuring rocky intertidal assemblages. Therefore their conservation is essential to protect these communities. Genetic variability and population connectivity of two widely distributed limpets (*Patella caerulea* and *P. rustica*) were analyzed inside and outside four MPAs in the western Mediterranean Sea using mitochondrial and microsatellite markers. No effect of protection on genetic variability was observed in either species. Mitochondrial marker reveals for both species limited genetic structure among MPAs in the north-Western Mediterranean. Within each location, different patterns of genetic structure and connectivity were observed depending on the species and local hydrodynamic features. These and future genetic connectivity studies will help to MPA managers for the design of MPAs in order to enhance connectivity and genetic diversity that will increase the resilience of marine populations.

References

1 - Cowen, R.K. and Sponaugle, S., 2009. Larval dispersal and marine population connectivity. *Annu. Rev. Marine. Sci.,* 1: 443-466.

2 - Planes S, Jones, J.G. and Thorrold SR., 2009. Larval dispersal connects fish populations in a network of marine protected areas. *Proc. Natl. Acad. Sci.,* 105: 5693-5697.

3 - Calò, A., Félix-Hackradt, F.C., Garcia, J., Hackradt, C.W., Rocklin, D., Treviño Otón and J., García-Charton, J.A., 2013. A review of methods to assess connectivity and dispersal between fish populations in the Mediterranean Sea. *A.I.O.L.,* 4: 150-175.

4 - Marti-Puig, P., Costantini, F., Rugiu, L., Ponti, M., Abbiati, M., 2013. Patterns of genetic connectivity in invertebrates of temperate MPA networks. *A.I.O.L.,* 4: 138-149.

MONITORING MEDITERRANEAN MARINE PROTECTED AREAS: A SET OF GUIDELINES TO SUPPORT THE DEVELOPMENT OF MANAGEMENT PLANS

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Abstract

With the aim to address some of the complex needs of Marine Protected Areas management, the results of the FP7-PEOPLE-2011-ITN "Monitoring Mediterranean Marine Protected Area" (MMMPA) project are synthesized in timely and original guidelines.

Keywords: Coastal management, Conservation, Marine parks, Monitoring, Mediterranean Sea

Introduction The pivotal role well managed Marine Protected Areas (MPAs) could play as key pilot areas to assess the environmental status of coastal environments is still far to be adequately recognised and exploited. The monitoring systems vary regarding the characteristics of the MPAs, who perform the measuring, where, when and how measures are made. They must be carefully designed and must include good baseline data, robust indicators and possibly control sites. In many cases, the financial resources to adequately structure and achieve the goals are not available. A priority is represented by the need to record changes in the ecology of the MPA, asking for the evaluation of the cascade effects of changes on the local communities. Considering the management discrepancy between the existing Mediterranean MPAs, it is urgent to converge upon concrete monitoring priorities. Indeed, one of the main issues faced by Mediterranean MPA managers relates to ensuring a continuous, long-term basic monitoring of specific indicators. The lack of standardized methodologies for the monitoring of Mediterranean MPAs transforms what should be an institutional task into a real practical challenge.

Material and methods The MMMPA project merged 'traditional' monitoring techniques with approaches from emerging interdisciplinary fields. Building upon this "contamination", the present guidelines can be grouped according to four main topics: habitat assessment, ecosystem functioning, genetic connectivity, and social sciences. Each guideline includes: 1. An introduction highlighting why managers should take the specific topic into account. 2.The methodologies that should be applied to implement the monitoring in the most cost-effective way. 3. A case study provided as an example. 4. General conclusions.

Results and Discussions The main outputs provided by the project are here provided. i) *Cystoseira* species should become a conservation priority in the future context of Mediterranean Sea management and guidelines suggest how to census marine algal forests and when to ask for habitat restoration [1]. ii) The detection of changes on sediment deliveries to a MPA is a "low cost" approach based on open access data, crucial for making effective coastal-land management decisions [2]. iii) The monitoring pressure and impacts from small scale and recreational fishing activity in Mediterranean marine protected areas is a generic framework for long-term monitoring that integrates powerful analysis and visualization, providing a holistic assessment and scientific advice towards ecosystem based fisheries management [3]. iv) A methodological framework for the implementation of monitoring measures for coralligenous assemblages has been delivered, with the aim to provide statistically sound data for management purposes. The method is based on existing standard monitoring assessment currently used in marine benthic habitats [4]. v) Biogeochemical transformations are the basis for the ecosystem functioning. Any alterations or perturbations of it will have cascading effects on the entire system. On the basis of biogeochemistry, the more important variables to be considered were described, to implement a monitoring system in lagoon habitats [5]. vi) Benthic ecosystems play a critical role in relation to the goods and services that marine and coastal ecosystems provide. Benthic macroinvertebrate communities have been proven to be reliable proxies to evaluate Ecological Quality Status of benthic ecosystems [6]. vii) High trophic level predators play an important functional role in marine ecosystems, ensuring the persistence of complex food webs that increase ecosystem resistance to human impacts. The methodologies to assess these dynamics are provided [7]. viii) The assessment and monitoring of species genetic connectivity in the MPA context. can help the establishment of new MPAs and the monitoring of MPA effectiveness over time. The methodologies to monitor these relationships are provided [8]. ix) The social information gap hinders MPA managers' ability to make science-based decisions that include the human environment as well as the natural environment [9]. Early involvement and active participation of stakeholders is a prerequisite strategy that accrues numerous benefits to natural resource management [10]. A set of guidelines for social science research in MPAs is provided.

References

1 - Fianni F. and Mangialajo L., 2016. Guidelines for the conservation, monitoring and restoration of *Cystoseira* forests in the Mediterranean sea. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 9-17.

2 - Mateos-Molina D., Palma M., Ruiz-Valentin I., Panagos P., García-Charton J.A. and Ponti M., 2016. Assessment of land cover changes to determine potential impacts on water quality in coastal Marine Protected Areas. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 19-25.

3 - Markantonatou V., Marconi N. and Cerrano C., 2016. Guidelines for monitoring pressure and impacts from small scale and recreational fishing activity in Mediterranean Marine Protected Areas. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 27-37.

4 - Zapata Ramírez P.A., Marconi M. and Cerrano C., 2016. Guidelines for monitoring measures of coralligenous assemblages within a management context. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 39-53.

5 - Arévalo E., Pino Ibánhez J.S., Papaspyrou S. and Nicolaidou A., 2016. Guidelines for the effective management of lagoons on the basis of biogeochemistry. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 55-61.

6 - Cabana D., Sigala K., Nicolaidou A. and Reizopoulou S., 2016. The use of benthic macroinvertebrate communities as biological quality indicators. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 63-70.

7 - Prato G., Gascuel D. and Francour P., 2016. Guidelines for monitoring high trophic level predators and trophic interactions in Mediterranean MPAs. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 73-79.

8 - Marti-Puig P., Calò A., Costantini F., Villamor A., Abbiati M., Ponti M. and García-Charton J.A., 2016. Genetic connectivity and diversity as a tool to assess the effectiveness of Marine Protected Areas. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 81-87.

9 - Hogg K., Young S., Semitiel-García M. and Noguera-Méndez P., 2016. Set of guidelines for social science research in MPAs. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 89-97.

10 - Young S., Hogg K., Noguera-Méndez P. and Semitiel-García M., 2016. Ethical guidelines and good practice for social research. *In*: MMMPA Board (eds.) MMMPA: A set of guidelines to support the development of management plans. Ancona, pp. 109-114.

PANTELLERIA ISLAND: A TESTING GROUND FOR A PARTICIPATORY APPROACH AIMED AT FOSTERING THE CREATION OF AN MPA PROPOSED AND DEVELOPED BY LOCAL INHABITANTS

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Abstract

The future of MPAs should involve the active participation of local communities through the recovery and preservation of sustainable practices peculiar to local traditions.

Keywords: Marine parks, Conservation, Sicily Channel, South-Central Mediterranean

In the island of Pantelleria (Fig. 1), an experimental participatory process, based on civil society, started in 2013. The first step was to listen the needs of the “stakeholders” of the sea – fishermen, diving centres, free divers, tourist operators and people of the island – who developed an idea of protection based on the needs of their own category. The second step was creating the “Tutela Pantelleria” Workgroup, including each category’s representatives, which developed a common proposal of protection to be submitted to institutions. Human aspects are important to form a group and avoid its disintegration. A process depends not only on its structure, but also on the ability of people to relate to each other and have a common perspective. That’s why the model adopted for Pantelleria is mainly aimed at creating a community of interest around the protection of a common resource, which is the island’s territory. At present, the group is focusing on traditions as a key element for an MPA that aims at safeguarding the environment and biodiversity (Fig. 2). The work group now should become a link between civil society and institutions using the proposal as the starting point of an open participatory debate [1]. Participatory process is fundamental to rebuild local identities trough the protection of traditions and environment, strengthen confidence with institutions and develop a sustainable local economy.

Fig. 1. The Island of Pantelleria is situated right in the center of the Sicily Channel.

Fig. 2. The proposal for the MPA in Pantelleria presented to the Italian Ministry of the Environment.

References

1 - CIESM 2015. MMMPA/ CIESM International Joint Conference on Mediterranean Marine Protected Areas: Integrated Management as a Response to Ecosystem Threats – Conference Report [co-edited by C. Cerrano, Y. Henocque, K. Hogg, P. Moschella, and M. Ponti] 15-17 October 2015, Ancona, Italy, 51 pp.

2 - MMMPA Supervisory Board (2016). Monitoring Mediterranean Marine Protected Areas: A set of guidelines to support the development of management plans. Deliverable of the MMMPA European project (FP7-PEOPLE-2011-ITN g.a. no.: 290056). Ancona, 116 pages.

SPAWNING SEASON OF *GYMNAMMODYTES CICERELUS* AND *G. SEMISQUAMATUS* IN THE NW MEDITERRANEAN

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Abstract
We studied the reproductive biology of the sandeel, *Gymnammodytes cicerelus* and *G. semisquamatus,* on the fishing grounds off the Catalan coast (NW Mediterranean). In the case of *G. cicerelus* the spawing period extended from November to February, while that of *G. semisquamatus* was a little delayed, from December to March.

Keywords: Reproduction, North-Western Mediterranean, Fishes

A Management Plan for a boat seine called "sonsera" used in Catalonia targeting sand eels (*Gymanammodytes cicerellus* and *G. semisquamatus*), but also transparent gobies, is carried out in order to establish an exception to European rules regarding the general prohibition of this type of gears. A Co-management Committee was formally created with the specific mission to ensure a sustainable activity of the fishery. The Committee is composed by Public Administrations, Fishermen Associations, Researchers and NGOs. The process has two phases: first, a comprehensive study of the fishery and subsequent advice for the establishment of a Management Plan and second, the implementation and monitoring of the Management Plan itself.
Data were collected from 95 fishing days on board "sonsera" boats (boat seiners), from August 2012 to December 2016. Sampling was carried out off the five ports with "sonsera" fleet (1). A total of 2864 gonads were examined, (2030 of *G. cicerelus*; 834 of *G. semisquamatus*), the sex determined, and macroscopically assigned to a gonadal stage considering the following scale: I=Immature; II=Resting; III=Developing; IV=Advanced maturation; V=Spawning; VI=Post spawning. Sex was easily assessed macroscopically in mature individuals. The spawning season was established from the gonadosomatic (GSI) index trend, by sex: $GSI = (GNW / TW) \times 100$ Where TW is total weight and GNW gonad weight

Gymnammodytes cicerelus

The monthly trend of the macroscopic classification of the maturity phases revealed the maximum occurrence of advanced maturation females (phase IV) and presence of spawning females (phase V) from November to February, with a maximum peak in January. Females in immature and resting phases (I and II) were found from March to October mainly. Males showed the same pattern as females, with a maximum peak of individuals in phase V in December-January. Gonadosomatic index (GSI) was calculated for mature males and females. The mean GSI for females was highest from November to February, with a peak of maximum activity in January (7.94) (Fig. 1). Males showed the same pattern as females with a peak of maximum activity in January (13.55) The size at-first-maturity (size at which 50% of individuals are mature) was 7.32 cm TL. This value has been obtained fitting a normal cumulative curve to the maturity tax per length.

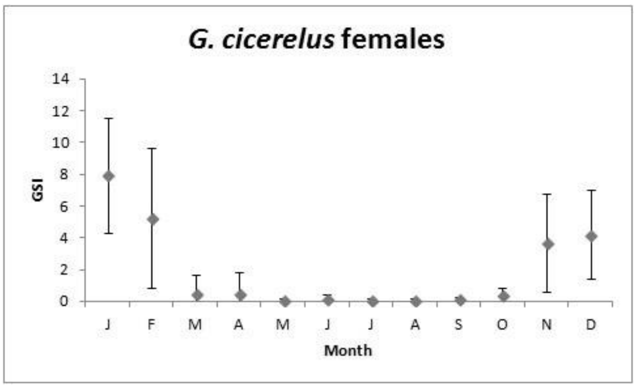

Fig. 1. Monthly changes in the mean gonadosomatic index for females of *G. cicerelus.*

Gymnammodytes semisquamatus

The monthly trend of the macroscopic classification of the maturity phases revealed the maximum occurrence of advanced maturation females (phase IV) from December to March. The presence of spawning females (phase V) was observed from December to March, with a maximum peak in February. Females in immature and resting phases (I and II) were found from March to December. Males showed the same pattern than females, with a maximum peak of individuals in phase V in January-February. The smallest mature female and male were 7.2 cm and 7.6 cm TL respectively. Gonadosomatic index (GSI) was calculated for mature males and females. The mean GSI for females was highest from December to March, with a peak of maximum activity in January (8.39) (Fig. 2). Male showed the same pattern as females with a peak of maximum activity in January (11.27)

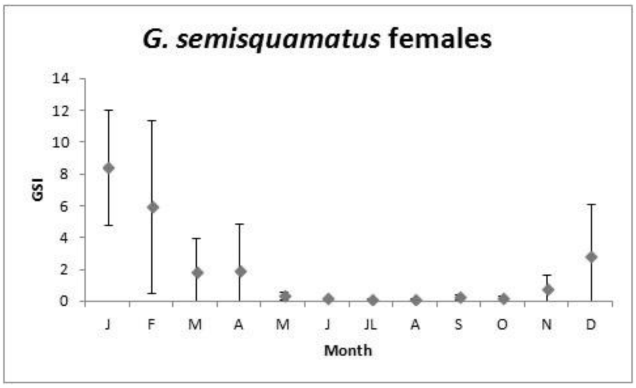

Fig. 2. Monthly changes in the mean gonadosomatic index for females of *G. semisquamatus*

The reproduction period of both species in the area extends from November to February-March and at the end of the fishing season in mid- December the population consists of individuals that have attaint the maturity and are ready to spawn. Therefore, it is advisable to maintain the timing of the currently implemented closed season, from mid- December to the end of February.

References
1 - Sainz-Trápaga S., Allue R., Demestre M., Guarga J.L., Lleonart J., Martín P., Ojeda C., Pulido M., Rodón J., Sánchez P., Segarra I., Trias Ll., Tudela S. and Velasco B., 2015. The Co-management Committee of the Catalan sand-eel fishery: a bottom-up approach successfully delivering on sustainability for fish and fishing. FAO Fish. Aquacul. Proc. 39: 193-199.

FROM CITIZEN SCIENCES TO ENVIRONMENTAL QUALITY ASSESSMENT: THE PORTOFINO MPA CASE STUDY

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Abstract

The proposed Mediterranean Reef Check Species sensitivity (*MRC-Ss*) index, based on data provided by volunteer scuba divers, may represent a proxy of the mean sensitivity of the assemblages toward the natural and anthropic disturb agents indicated by the European Marine Strategy Framework Directive. Its application may represent the occasion to raise public awareness and enhance the collaboration between coastal management authorities (e.g., MPA managers) and dive centres, through a participatory approach.

Keywords: Bio-indicators, Coastal management, Conservation, Rocky shores, Ligurian Sea

Introduction

The involvement of citizens in environmental monitoring is increasing worldwide in the last decades [1]. Citizen science projects have spread up in marine environments, from tropical coral reefs (e.g., Reef Check tropical EcoDiver program and Coral Watch initiative) to temperate seas (e.g., Californian Reef Check and British and Irish Seasearch protocols). In the Mediterranean Sea, subtidal rocky shore and coralligenous concretions are among the most threatened marine habitats [2]. Environmental quality assessment tools for these habitats, based on integrity of marine communities, are not only urgent but also essential to answer to the European Marine Strategy Framework Directive (MSFD, 2008/56/EC). The aims of this study were the development of a biotic index based on data collected by volunteers and its application in the Portofino Marine Protected Area (MPA), Italy.

Material and methods

The proposed Mediterranean Reef Check Species sensitivity (*MRC-Ss*) index is based on data provided by volunteer scuba divers applying the Underwater-Coastal Environmental Monitoring (U-CEM) protocol developed and promoted by Reef Check Italia (RCI) non-profit organisation [3]. The protocol provides that the divers, after training and verification of their abilities, make independent observations on the presence / absence and abundance of 43 easily identifiable key taxa. The sensitivity scores of a subset of 25 taxa, toward twenty-four disturb agents indicated by the MSFD, were assessed following the Marine Life Information Network for Britain and Ireland (MarLIN; [4]) approach. Sensitivities scores were calculated by combining the intolerance and recoverability ranks based on benchmarks and available literature. The *MRC-Ss* index represents the mean sensitivity value of the sighted taxa weighted by their observed abundance classes. The index has been calculated for marine sectors larger than 0.25 km^2 including at least 30 observations carried out by four or more independent observers. The index value ranges between 0 and 5. The score increases with increasing of the mean sensitivity of the species sighted and, in less extent, changes with their abundance. Five sensitivity classes were identified using quintiles intervals calculated on the whole available dataset. The index was applied to the monitoring zones designed by the Portofino MPA authority.

Results

Based on the available data, it was possible to apply the *MRC-Ss* index to 8 of 19 monitoring zones in the Portofino MPA. Most of the assessed monitoring zones had assemblages with moderate sensitivity toward the considered disturb agents; two zones were characterised by assemblages with high sensitivity, and only one showed low sensitivity (Fig. 1).

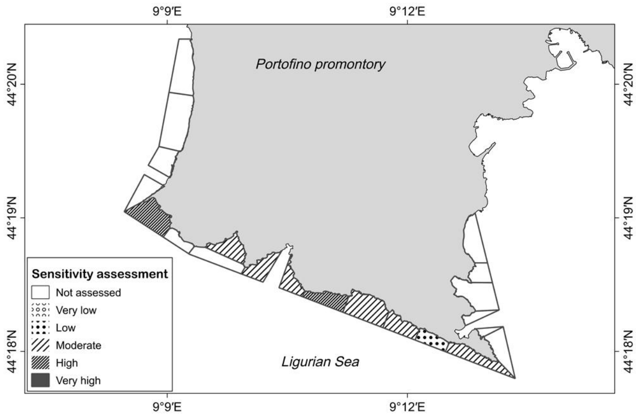

Fig. 1. Sensitivity assessment of assemblages living in Portofino MPA monitoring zones (Mercator projection, WGS84).

Discussion

The *MRC-Ss* index represents the first attempt to derive a biotic index from data collected by volunteers in the Mediterranean Sea. It primarily provides a proxy of the mean sensitivity of the assemblages living in a zone toward the main natural and anthropic disturb agents provided by MSFD. The abundance of very sensitive species testifies reduced pressures and therefore good environmental conditions. The assessed area appears to be in quite good condition although some disturbs, like high sedimentation, intense nautical and diving tourism and increasing urbanization may negatively affect the local assemblages. This index helps to identify areas that require management interventions. The need of many independent observations, in order to apply the index in the selected zones and in time, may represent the occasion to raise public awareness and enhance the collaboration between coastal management authorities (e.g., MPA managers) and dive centres (i.e. stakeholders), through a participatory approach.

References

1 - Conrad C.C., Hilchey K.G. 2011. A review of citizen science and community-based environmental monitoring: issues and opportunities. *Environ. Monit. Assess.*, 176: 273-291.
2 - Micheli F., Halpern B.S., Walbridge S., Ciriaco S., Ferretti F., Fraschetti S., Lewison R., Nykjaer L., Rosenberg A.A. 2013. Cumulative Human Impacts on Mediterranean and Black Sea Marine Ecosystems: Assessing Current Pressures and Opportunities. *PLoS ONE*, 8: e79889.
3 - Cerrano C., Ponti M., Rossi G. 2014. Manuale EcoDiver MAC: Guida al Monitoraggio dell'Ambiente Costiero Mediterraneo. Ver. 4.0. Reef Check Italia onlus, Ancona.
4 - Tyler-Walters H., Rogers S.I., Marshall C.E., Hiscock K. 2009. A method to assess the sensitivity of sedimentary communities to fishing activities. *Aquat. Conserv.*, 19:285-300.

CIESM Congress Session : Local Ecological Knowledge

Moderator : Ernesto Azzurro, ISPRA, Livorno, Italy

Moderator's Synthesis

Local Ecological Knowledge (LEK) can provide precious information at different scales of space and time, generating new grounds for marine research, while stimulating awareness and education (CBD articles 7 and 13). The potential of LEK just started to be disclosed and participants raised a number of potential applications according to their research interests; e.g. fishing grounds; distribution of essential fish habitats; spawning aggregations; marine litter, participatory mapping, periodical monitoring. Contributors unanimously agreed on the need to consolidate a Mediterranean network for LEK, with potential for geographical expansion. Opportunities for partnership with relevant international organizations (such as FAO, …) could be usefully investigated.

New concepts, practical needs, challenges and potentialities would deserve to be explored in detail. Collaboration with fishermen and other local communities should be realized in partnership and based on mutual interests. Scientists called on board should have very good contacts with local communities and be able to 'speak their language'. Interesting information may remain anecdotal if not collected under a scientific thinking/design and the collaboration with social scientists and oral historians is highly required to set appropriate research methods. Benefits for all partners should be clearly stated to set long term actions, this also entails appropriate feedback to both collaborating scientists and local communities. A series of technological tools can be used to engage the different community groups according to specific actions. Communication strategies should follow the principle of cross-mediality and be inspired from the real experience of people: 'people talk, scientists hear'. Data policy needs to be discussed but information should be made available as much as possible.

CATCHES OF THE SPORT FISHING COMPETITIONS ALONG THE MALTESE COAST.

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Abstract
Coastal fish communities suffer from various anthropogenic activities. To improve integrated coastal zone management and conservation, recreational sport fishing along the coast of Malta, unstudied before, is the focus of research that started in July 2012. Results from creel surveys conducted during 35 sport fishing competitions and with 26 hobby anglers are presented here. A total of 13,205 fish were recorded from 64 different species belonging to 25 families. Benthic species were predominant in catches. This first scientific study in collaboration with sports and recreational fishermen allows for conservation measures to be increasingly considered and integrated in the activities of these recreational fishing activities. Stakeholders participate and learn from the scientific process while working closely with conservation scientists.

Keywords: Mediterranean Sea, Fisheries, Coastal waters, Conservation

Recreational fishing is one of the most popular leisure activities in coastal zones in many countries [1], [2] undertaken by approximately 10% of the global population [3], [4] reaching almost 11% in Europe [5] and making up more than 10% of total fisheries production in the Mediterranean [2]. Marine recreational fisheries however, are not monitored as commercial fisheries are [6], [7].

In the Maltese Islands, there is a lack of knowledge regarding recreational and sport fishing along our coasts since licences are not required to fish from the shore. In this study of shore-based recreational sport-fishing in Malta, roving-access creel surveys undertaken during 35 sport fishing competitions between July 2012 and December 2013 were used to quantify catches, catch per unit effort and angling effort. Response rate was 100%.

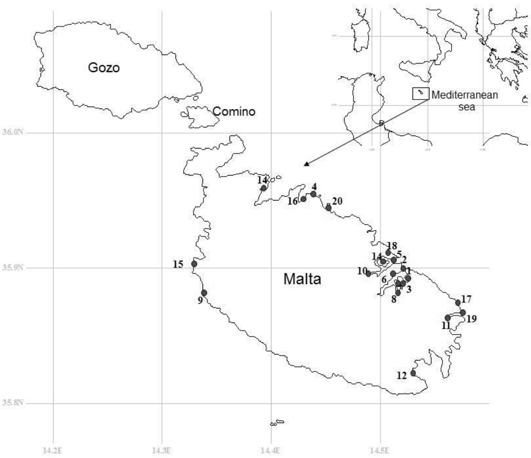

Fig. 1. Map showing sampling locations during sport fishing events between July 2012 and December 2013.

The overall catch-per-unit-effort (CPUE) during sport fishing competitions was 2.21 fish angler^{-1}h^{-1} or 0.09kg angler^{-1}h^{-1} with lower catches by recreational fishermen observed (1.13 fish angler^{-1}h^{-1}).Differences in CPUE by weight and number of fish were observed between 2012 (2.74 fish angler^{-1}h^{-1} or 0.12kg angler^{-1}h^{-1}) and 2013 (2.05 fish angler^{-1} h^{-1} or 0.08kg angler^{-1} h^{-1}), with lower values for the latter also observed in corresponding quarterly periods. Catches were also generally higher in spring and early summer (sea temperature of 19-25^{o}C) decreasing slightly at higher temperatures and showing site variation. Each competition lasted an average of 4.8 hours while hobby anglers fished a mean 3.4 hours per trip. The most popular rig used was the paternoster rig which involved a line with a sinker attached at the extreme end and two hook traces above and used when targeting bottom fish.This was reflected in the catches where the most important species were *Coris julis* and *Diplodus annularis* accounting for 14.2% and 13.4% respectively of the total catches by number. There was a statistically significant difference (Kruskal-Wallis test) in weight (p=0.01) and number (p=<0.01) of fish caught across the different hook sizes with sports anglers using smaller hook sizes. While numbers of fish caught have been found to increase with decrease in hook sizes, smaller sized fish are also being targeted. This is of concern as the more vulnerable juvenile fish are more likely to be caught with greater mortalities.

Catch and release was practiced by sports fishermen where 75% used keep nets with an instant fish mortality rate varying between 5 and 100%. There was a small positive correlation (Spearmans correlation coefficient) between the temperature and mortality, r = 0.274, n = 351, p =<0.001 with high levels of mortality associated with higher levels of sea temperature. Thus, handling and fish air exposure must be more limited during warmer temperatures. Competitions taking place during the summer should also be reduced and of shorter duration so as to limit the effect of temperature and keep net use on the mortality of fish.

Sport fishing clubs hold regular competitions throughout the year and may provide information on catches that allow changes to fish abundance from year to year to be assessed. Through collaboration for scientific research, catch and effort by the sport fishing population is being monitored. The use of minimum hook sizes and barbless hooks during competitions and enforcement of minimum legal sizes (MLS) when retaining fish caught by recreational fishermen is hereby being suggested. Following this research, sports fishing clubs are now inviting scientists to collaborate e.g. during the European Shore Championships organised by the European Federation of Sea Anglers Malta where conservation scientists were invited to carry out research and provide assistance on procedures to limit mortality of fish. Such collaborations are the way forward to ensure that any conservation and management arrangements required for the recreational and sport fishery are implemented fully and expeditiously.

References
1 - Sutinen J. G. and Johnston R. J., 2003. Angling management organizations: integrating the recreational sector into fishery management, *Marine Policy*, 27 (6):471–487.
2 - Morales-Nin B., Moranta J., García C., Tugores M. P., Grau A. M., Riera F. and Cerdà M., 2005. The recreational fishery off Majorca Island (western Mediterranean): some implications for coastal resource management, *ICES Journal of Marine Science: Journal du Conseil*, 62(4):727 –739.
3 - Hickley, P., & Tompkins, H. (1998). *Recreational fisheries: social, economic, and management aspects*. Fishing News Books.
4 - Zischke, M. T., Griffiths, S. P., & Tibbetts, I. R. (2012). Catch and effort from a specialised recreational pelagic sport fishery off eastern Australia. *Fisheries Research*, *127–128*, 61–72.
5 - Arlinghaus R., Tillner R., and Bork M., 2014. Explaining participation rates in recreational fishing across industrialised countries, *Fish Manag Ecol*, 22 (1):45-55.
6 - Font, T., & Lloret, J. (2010). *Environmental impact and socioeconomic features of recreational fishing in the Cap de Creus Natural Park*. University of Girona.

PRELIMINARY RESULTS FROM MONITORING OF SELECTED SPARIDAE SPECIES CAUGHT BY RECREATIONAL AND SPORTS ANGLERS ALONG THE MALTESE COAST.

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Abstract

Conservation research to monitor the catches of *Diplodus annularis*, *Diplodus vulgaris*, *Diplodus sargus*, *Oblada melanura* and *Lithognathus mormyrus* with the cooperation of Maltese hobby and sport shore fishermen. Catches were scientifically measured between July 2012 and December 2013. This year-round scientific research allows assessment of demographic, distribution, habitat selection, diet and reproductive patterns for these species. Catches from 701 hobby and sports anglers were recorded to analyse the exploitation rate. Preliminary results indicate that these species are frequently targeted by these fishermen with no previous records of the catches and effects of these activities on respective coastal populations. This research may fill the gap in knowledge aiding conservation measures for these species.

Keywords: Mediterranean Sea, Conservation, Fisheries, Monitoring

The sustainability of recreational fishing needs to be assessed side by side with considerations of its impact on the coastal fish species monitored. *Diplodus annularis*, *Lithognathus mormyrus*, *Diplodus vulgaris*, *Oblada melanura* and *Diplodus sargus* are economically important littoral fish occurring in the Mediterranean [1], [2] and have a reasonably high commercial and recreational value [3]. Although local commercial available landing data still need to be refined for these species. From this ongoing research on recreational and sports fishing in Malta (Figure 1), *Diplodus annularis* was found to make up 13.4% (2012 - 0.03fish angler^{-1}h^{-1};2013 - 0.01 fish angler^{-1}h^{-1}) of sport fishing catches and 9.3% of recreational fishing catches while *Diplodus vulgaris* comprised 11.5% (2012 - 0.02fish angler^{-1}h^{-1};2013 - 0.01 fish angler^{-1}h^{-1}) and 4.6% respectively. Recreational anglers also targeted the more highly prized *D. sargus* (2.3%), *L. mormyrus* (3.8%) and *O.melanura* (1.2%) for consumption. These 3 species were also observed in the sport fishing catches (1%, 0.2% and 3%, respectively). Such figures show differences in the targeted species by recreational and sport fishermen. When comparing with commercial catches, *D. sargus* and *O. melanura* are the most fished with a yearly mean catch of 8.6 (±1.61) tonnes and 8.4 (±5.42) tonnes respectively. The other 3 remaining species were caught to a lesser extent with 1.13 (±0.71) tonnes for *D. vulgaris*, 1.91(±0.71) tonnes for *D. annularis* and no recorded landings for *L. mormyrus*. The former are more commercially important fish and can reach a much larger size than *D. annularis* so are preferred species for consumption. Nonetheless, figures from sport and hobby fishermen need to be included with the commercial catches so as to obtain the total yearly catch.

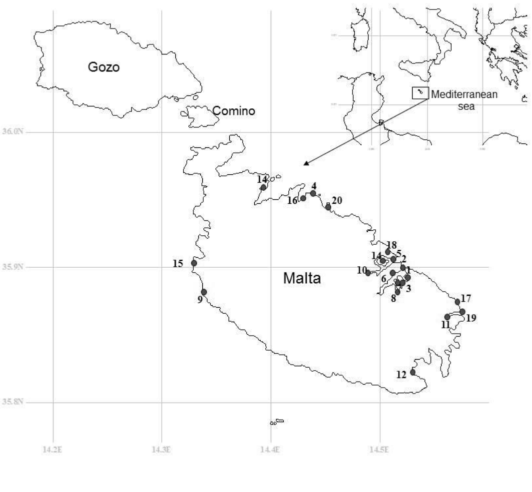

Fig. 1. Map showing sampling locations.

Overall, in this study, the annular sea bream had a maximum size of 22.1cm, the two banded sea bream 30.5cm, the white sea bream 33.4cm, the saddled sea bream 31.3cm and the striped sea bream 22.4cm (Table 1). Around the Maltese Islands, the population of the all the 3 *Diplodus* species and *O. melanura* was dominated by females. *L. mormyrus* exhibited a male dominance however this may be due to the small sample size collected so far. The inequality in the sex-ratio of the *Diplodus* and *Oblada* species can be connected to the sexual patterns of these species which were observed to be hermaphrodites. In this study, through both macroscopic and microscopic analysis, *D. annularis* in the Maltese Islands exhibits protandric hermaphroditism with a spawning period extending from July to November. Work is currently ongoing for the remaining species. All three *Diplodus* species were also observed to be in very good condition while *O. melanura* and *L. mormyrus* show poorer condition values especially the latter (Table 1). Local monitoring of these 2 species is recommended to establish if conservation measures are also required.

Tab. 1. Ratios and values for each species

Species	Observations	Gender ratio (M:F)	Length range	Condition factor (K)
D. annularis	568	1:1.65	6.5 - 22.1	M=1.80; F=1.77
D. vulgaris	358	1:2.07	7.5 - 30.5	M=1.49; F=1.60
D. sargus	58	1:1.33	6.0 – 33.4	M=1.80; F=1.73
O. melanura	85	1:2.5	4.5 – 31.3	M=1.38; F=1.28
L. mormyrus	33	2:1	5.9 – 22.4	M=1.16; F=1.16

Raising angler awareness and knowledge about the status and maturity size of the stocks, and the survival of released fish may contribute to reduce fish mortality. The use of minimum hook sizes together with more enforcement of the minimum legal sizes and fostering of a catch and release practice amongst hobby and sports anglers possibly through an educational campaign should help to reduce the catch and harvesting of undersized fish. However, other measures including the use of periodic site closures during the reproductive period e.g. in marine protected areas, daily bag limits and a licence or fishing ticket is being suggested to census the number of recreational anglers and limit excess catches.

References

1 - Morales-Nin B., Moranta J., García C.,. Tugores M. P, Grau A. M., Riera F., and Cerdà M., 2005. The recreational fishery off Majorca Island (western Mediterranean): some implications for coastal resource management, *ICES Journal of Marine Science: Journal du Conseil*, 62(4):727 –739.

2 - Veiga P., Ribeiro J., Gonçalves J. M. S., and Erzini K., 2010. Quantifying recreational shore angling catch and harvest in southern Portugal (north east Atlantic Ocean): implications for conservation and integrated fisheries management, *Journal of Fish Biology*, 76(9):2216–2237.

3 - Monteiro P., Bentes L., Coelho R., Correia C., Erzini K., Lino P. G., Ribeiro J., and Gonçalves J. M. S., 2010. Age and growth, mortality and reproduction of the striped sea bream, Lithognathus mormyrus Linnaeus 1758, from the south coast of Portugal (Algarve), *Marine Biology Research*, 6(1):53–65.

SCALING UP THE USE OF LOCAL ECOLOGICAL KNOWLEDGE TO THE REGIONAL LEVEL: A MEDITERRANEAN EXPERIENCE

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Abstract
Information gained through Local Ecological Knowledge (LEK) was used to tackle some emerging changes in Mediterranean fish diversity. A transnational team of scientists from six Mediterranean countries cooperated to build a collective dataset, providing new perspectives in the use of LEK for large-scale studies and periodical monitoring.

Keywords: Fisheries, Mediterranean Sea

Introduction
Local Ecological Knowledge acquired every day during a lifetime, is increasingly explored and scientifically analysed to track the distribution and the abundance of marine species, yet with very limited research costs. Specific LEK protocols, originally conceived by the 'CIESM Tropical Signals Programme' [1] were used at the transnational scale, facing the challenge of cultural diversities.

Materials and Methods
Between 2011 and 2016, 15 associates to the CIESM Tropical Signals Programme, and 3 collaborators of the BALMAS project carried out interviews with local fishermen across 19 different locations and 6 Mediterranean countries. A semi-structured questionnaire [1] was used and the central question: '*What fish showed the greatest variation in abundance in the last decades?*'' Semi-quantitative data on species abundances were collected by year, discriminating species that have increased, decreased or fluctuated over the respondent experience period.

Results and discussion
Overall, 506 fishermen were interviewed, accounting for a total of 15,954 yrs of experience at sea. Results included 1322 perceptions on 111 fish taxa. Thermophilic species were confirmed to have increased over large areas of the central Mediterranean, but patterns of change varied much across distant geographical sectors. This large amount of low-cost data, allow investigating patterns of change at different levels: from single to multiple species and from single locations up to the basin scale. Based on these promising results, we promote the use of LEK at the transnational level. The LEK thematic session and the LEK roundtable organized by the CIESM congress are precious opportunities to discuss further potentialities of this approach and to set an international taskforce for Local Ecological Knowledge. Thinking beyond our need of scientific data, we must also consider that LEK builds trust and promotes awareness among its participants, ultimately enhancing the social capacity to adapt to the current environmental challenges.

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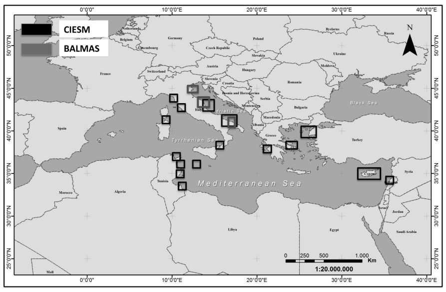

Fig. 1. Study locations in the Mediterranean Sea according to the research projects 'CIESM Tropical Signals' and 'BALMAS' - Adriatic IPA.

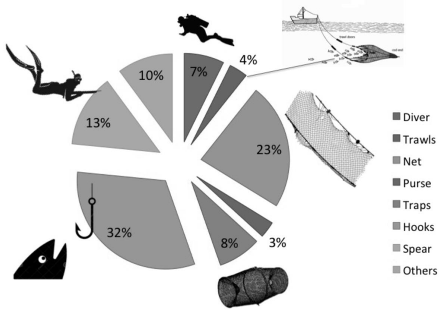

Fig. 2. Percent distribution of fish gears used by the 506 respondents.

References
1 - Azzurro E., Moschella P., Maynou F, 2011. Tracking signals of change in Mediterranean fish diversity based on Local Ecological Knowledge. PLoS One, 6(9), p.e24885.

LOCAL AND TRADITIONAL ECOLOGICAL KNOWLEDGE AS POWERFUL HINT TO UNDERSTAND AND MANAGE MARINE BIODIVERSITY AND FISHERIES

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Abstract
Over the past twenty years, increasing attention has been paid to the potential and real benefits of using local and traditional ecological knowledge (LEK and TEK) in marine science and management. Information collected by people frequenting the sea (fishers and citizens) represent a powerful source of information to be integrated to data collected by scientists in order to achieve a more accurate knowledge of status and dynamics of marine communities and environment. In our contribution we present and discuss examples of LEK and TEK from Sicily, concerning contribution of both fishers and citizens to understand spatial ecology of main commercial species in areas regulated by the Local Fishery Management Plans and occurrence of fish species in the Marine Protected Areas. <\/div>

Keywords: Biodiversity, Fishes, Fisheries, Sicily Channel, Tyrrhenian Sea

Over the past twenty years, increasing attention has been paid to the potential and real benefits of using local and traditional ecological knowledge (LEK and TEK) in marine science and management [1,2]. LEK and TEK have been considered a relevant hints for understanding and managing marine biodiversity in sustainable way, including artisanal fisheries. Information collected by people frequenting the sea (fishers and citizens) represent a powerful source of information to be integrated to data collected by scientists in order to achieve a more accurate knowledge of status and dynamics of marine communities and environment. In our contribution we present briefly examples of LEK and TEK experienced in Sicily, concerning contribution of both fishers and citizens to understand spatial ecology of main commercial species in areas regulated by the Local Fishery Management Plans and occurrence of fish species in the Marine Protected Areas. Some ideas on how to integrate TEK and LEK with information routinely collected by scientists in order to improve understanding of biodiversity and fishery dynamics in coastal areas are presented.

References
1 - Azzurro E., Moschella P., Maynou F., 2011. Tracking signals of change in Mediterranean fish diversity based on local ecological knowledge. *PLoS One*, 6(9), e24885.
2 - Drew J. A., 2005. Use of traditional ecological knowledge in marine conservation. *Conservation biology*, 19(4): 1286-1293.