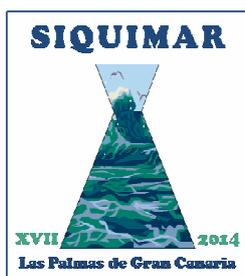




Book of Abstracts submitted to the IV Congress of Marine Sciences. Las Palmas de Gran Canaria, June 11th to 13th



Title: Book of Abstracts submitted to the IV Congress of Marine Sciences. Las Palmas de Gran Canaria, June 11th to 13th. 488 pp.

ISBN - 10: 84-697-0471-0

ISBN - 13: 978-84-697-0471-4

Contents

Contents	3
Invited talks	7
Oral Communications	19
1 Wednesday, June 11th	19
IV International Symposium of Marine Sciences	19
Coastal Management	19
Biological Oceanography	28
Biological Oceanography	32
XVII Seminario Ibérico de Química Marina	39
Biogeochemical Processes	39
Oceanography	45
Encuentro de la Oceanografía Física Española 2014	55
Large-scale processes	55
Oceanography and Marine Climate	60
Coastal Processes - Small Scale Processes	65
2 Thursday, June 12th	71
IV Internacional Symposium of Marine Sciences	71
Biological Oceanography	71
Biodiversity	81
Special Session. 100 years of the Instituto Español de Oceanografía	88
XVII Seminario Ibérico de Química Marina	102
Marine Ecotoxicology and Pollution	102
Biogeochemical Processes	114
Marine Pollution and Ecotoxicology	121
Encuentro de la Oceanografía Física Española 2014	135
Remote Sensing Oceanography - Technology for the environment	135
Mesoscale Processes	142
Ocean and Climate Change - Operational Oceanography	148
Operational Oceanography	152
3 Friday, June 13th	161
Sala Tenerife	161

	Physical Oceanography - Technology	161
	Ocean Modelling - Coastal Management	171
	Marine Cultures	179
	Geological Oceanography	185
Sala Gran Canaria		196
	Geological Oceanography	196
	Chemical Oceanography	210
	Geological Oceanography	216
	Fisheries	222
Sala Jerónimo Saavedra		229
	Biological Oceanography	229
	Biodiversity	237
	Biological Oceanography	246
	Biodiversity - Biotechnology	251
Poster's Abstracts		257
1	Wednesday, June 11th	257
	General Topics	257
	Biodiversity	260
	Biotechnology	262
	Marine Cultures	266
	Coastal Management	270
	Biological Oceanography	272
	Geological Oceanography	285
	Fisheries	292
	Marine Pollution and Ecotoxicology	300
	Oceanography	325
	Biogeochemical Processes	327
2	Thursday, June 12th	330
	General Topics	330
	Biodiversity	332
	Marine Cultures	341
	Coastal Management	351
	Biological Oceanography	357
	Geological Oceanography	363
	Fisheries	377
	Submarine Eruption at El Hierro	378
	Ocean and Climate Change	388
	Operational Oceanography	394
	Remote Sensing Oceanography	398
	Large-scale Processes	403

	Small-scale Processes	408
	Coastal Processes	411
	Mesoscale Processes	414
	Technologies for the environment	420
3	Friday, June 13th	421
	General Topics	421
	Biodiversity	423
	Biotechnology	427
	Marine Cultures	433
	Coastal Management	437
	Ocean Modelling	445
	Biological Oceanography	449
	Physical Oceanography	460
	Geological Oceanography	463
	Chemical Oceanography	473
	Fisheries	477
	Climate Change	486

Fueling the biological pump

Jorge L Sarmiento¹, Jaime B. Palter², Greg de Souza¹, and Carolina Dufour¹

¹Program in Atmospheric and Oceanic Sciences, Princeton University, Princeton, New Jersey 08544, USA

²Department of Atmospheric and Oceanic Sciences, McGill University, Quebec, Canada

Abstract

Sediment traps suggest that about one-third of the particulate organic matter flux at 200 m continues past the base of the main thermocline. If nutrients lost by this particle sinking were not replaced, thermocline nutrients would be depleted within 50 years. How do these nutrients return from the deep ocean back to the thermocline and thence to the surface? In this presentation, I will provide an overview of recent descriptive and modeling studies of the large scale meridional overturning circulation and eddy mixing processes that bring the nutrients up from the abyss and transport them into the surface regions where they are again available to fuel the biological pump.

Earth System Models and Upwelling Systems: Advances and Implementation in the Study of the California Current Ecosystem

Francisco Werner¹ and Enrique Curchitser²

¹*Southwest Fisheries Science Center, NOAA, La Jolla, CA, USA*

²*Rutgers University, New Brunswick, NJ, USA*

Abstract

Eastern Boundary Upwelling Systems (EBUS, such as the California Current, the Peru-Humboldt, the Benguela and the Canary Current) are highly productive and are subject to physical forcing at short scales (e.g., local winds and topography on scales of kms and weeks), remotely forced intermediate scales such as *El Niño*, interdecadal basin scales such as the Pacific Decadal Oscillation (the PDO), and secular climate change. To properly capture the physical response of EBUS requires that the atmospheric, land and ocean components be dynamically coupled. Similarly, the biological component requires that bottom-up drivers (such as lower trophic biogeochemical processes) and top-down drivers (such as harvesting by fishing fleets) be included simultaneously. The explicit inclusion of these processes requires an Earth System Modeling formulation, which will be described in this presentation using the California Current Ecosystem as a case study.

La investigación del mar en España: reflexiones desde Finis Terrae.

Emilio Fernández

Gestor del Plan Nacional de Ciencia y Tecnología Marina. Secretaría de Estado de Investigación, Desarrollo e Innovación.

Abstract

Las ciencias y tecnologías marinas españolas han experimentado un notable desarrollo y una profunda transformación en las últimas dos décadas. Este cambio profundo se evidencia en el número y nivel de excelencia de nuestros investigadores, en la calidad de los productos que de ellos emanan y en la modernización de las infraestructuras de investigación. Sin embargo, a pesar de este significativo avance, nuestro sistema de I+D todavía presenta debilidades estructurales y barreras institucionales que dificultan su desarrollo, limitan su proyección internacional y, en definitiva, restan energía para afrontar los retos que debemos afrontar en los próximos años. En la presentación, se aportarán datos y reflexiones personales sobre el marco estratégico en el que se inserta la investigación de los océanos tanto en Europa como en España, sobre los instrumentos de financiación y sobre el papel de las infraestructuras singulares de investigación, entre otros. Finalmente, y con el ánimo de suscitar el debate en la comunidad investigadora, docente y en los alumnos, compartiré algunas ideas y propuestas en tres ámbitos particularmente sensibles: la arquitectura institucional de nuestro sistema de I+D marino, la organización, visibilidad e impacto social de los profesionales que estudian el mar y la planificación, con visión estratégica, del proceso de formación de las nuevas generaciones de oceanógrafos.

B-vitamins: Past, present and future in the study of the coenzymes that built and maintain a habitable planet

Sergio Sañudo-Wilhelmy, Danielle Monteverde and Laura Gomez-Consarnau

Department of Biological Sciences and Department of Earth Sciences. University of Southern California. Los Angeles, California, 90089-0371, USA

Abstract

The B-vitamins (thiamin (B1), riboflavin (B2), niacin (B3), pyridoxine (B6) biotin (B7) and cobalamin (B12)) are organic molecules, similar to micronutrients in that they are required in trace amounts by all cells, although the requirement for a specific vitamin varies across organisms. Despite the fact that B-vitamins are the most frequently required growth factors by marine microorganisms, their concentrations as well as the processes controlling their distributions in the ocean are still unknown. The objective of this presentation is to show the importance of these coenzymes in oceanographic studies with respect to their evolutionary relevance on the different pathways of carbon fixation as well as on the efficiency of the so-called “biological pump of carbon”. We have used genomic information of marine microorganisms generated in the last few years to hypothesize the existence of other vitamins in the ocean that have not been measured yet such as pantothenic acid (vitamin B5).

Henry Melson Stommel: from pioneer to classic

Gregorio Parrilla Barrera

Instituto Español de Oceanografía

Abstract

Stommel has been the most important physicist oceanographer of the second half of the XX century. Builder, to a great extent, of the present Dynamical Oceanography. He contributed to the transformation of the Oceanography from a sort of appendix of the studies of the Atmosphere to a new specialty of Geophysics. After graduating in Astronomy in Yale in 1942 he started his research participating in the WWII effort, collaborating together with many other future oceanographers, in support of the USA Navy. Research that was carried out in the Woods Hole Oceanographic Institution (WHOI). Between 1959 and 1978 he was professor of oceanography in Harvard U. first, and later in the Massachusetts Institute of Technology, returning to WHOI where he stayed until his death. Stommel established important and fundamental theories on the ocean global circulation and studied many other oceanographic phenomena. This theoretical activity he combined with not a less important observational one. He received many awards and honors, including the Craadford prize, equivalent to the Nobel in Geosciences.

100 años del Instituto Español de Oceanografía

Eduardo Balguerías

Instituto Español de Oceanografía

Abstract

Fundado por el profesor Odón de Buen en 1914, el Instituto Español de Oceanografía ha cumplido 100 años de existencia. En esta presentación se hace una sucinta revisión de su trayectoria científica, desde sus orígenes hasta la actualidad, intentando identificar las situaciones históricas que la condicionaron. Finaliza con una exposición de los retos científicos potenciales a los que se enfrenta la institución en el futuro inmediato y con una reflexión sobre los riesgos que pudieran dificultar el cumplimiento de su misión.

Submarine emissions on the seafloor: from cold seeps to hot vents

Juan Tomás Vázquez

Instituto Español de Oceanografía, Centro Oceanográfico de Málaga. Puerto Pesquero S/N. 29640 Fuengirola

Abstract

The main types of submarine geological emissions are classified as cold seeps (hydrocarbons and brines) and hot vents. These processes result in the emission of geological fluids: brine, gases (mainly hydrocarbons), sediments and rocks. Submarine emissions are associated with an intensive geological, geochemical, thermal and biological activity (Judd and Hovland, 2007), and constitute a key process in the dynamics of the global cycles of the planet Earth. These systems play a major role in the exchange of matter and energy between the Geosphere and Hydrosphere, contributing to the greenhouse gases and affecting the ocean chemistry (Dimitrov, 2002; Alt, 2003). They also control the evolution of continental margins and oceanic basins (Paull y Dillon, 2001), and can produce the formation of significant and strategic mineralizations, as well as focus the development of specific habitats (Boetius et al., 2000) and provide an insight of deeper parts of the crust.

Cold-seep systems are usually rich in hydrocarbons and have been described throughout the world in both rifted and convergent margins. They can display a wide variety of morphological features, structures and related deposits, which include diapirs, mud volcanoes, brine pools, pockmarks, carbonate mounds and accumulations of authigenic precipitates. The most spectacular structures are mud volcanoes which are built by rapid extrusion of fluid and sediments from an overpressure unit, controlled by tectonics pathways (Kopf, 2002). Lithification by bacterial oxidation of hydrocarbons, mainly methane, are frequent in these systems. Crusts, chimneys and other aggregates of authigenic carbonates are generated as well as nodules and crusts of Fe-Mn, also linked to this oxidation, and patches of sulphides formed by sulfate-reducing bacteria. Furthermore, there is an heterogeneity of habitats and biological communities associated to cold-seeps with highlighting chemosynthetic species (e.g., *Siboglinum*, *Solemya*, *Bathymodiolus*, etc..) and aggregations of cold water corals and sponges.

Hot vents systems have been described on convergent margins, accretion rift axes, transform faults and hotspot volcanic chains, where fluid emissions can be formed in connection with magmas and/or hydrothermal circulation systems ranging from high temperature (400 °C), relative to magmatic and hydrothermal processes, to relatively low (<40 °C), in relation to serpentinization processes of the oceanic crust or subcortical mantle and generating abiogenic methane. Fluids associated to magmas are primarily gaseous: CO₂, H₂O, CO, SO₂, S₂, H₂S and occasionally methane, especially in processes of peridotitic serpentinization. Hydrothermal activity results of the water warming in contact with magma and hot volcanic rocks, leaching large amounts of chemical elements (e.g., Fe, Mn, Ni, Cu) traversing rocks towards the seafloor (Scott, 1997). These systems have mineral deposits, as massive sulphides, metalliferous muds, Mn crusts, magmatic sulfides and carbonates derived from abiogenic methane. Hydrothermal systems occur where seawater percolates through fissures and fractures in sediments and rocks at different depths and favor the development of associate habitats characterized by high productivity, high degree of endemism of species and high structural complexity (German et al., 2011).

This dissertation has been improved through the development of the projects LIFE+ INDEMARES/CHICA (LIFE07/NAT/E/000732), CADHYS (P08-RNM-03581), MONTERA (CTM2009-14157-C02), VUL-

CANO (CTM2012-36317) and SUBVENT (CGL2012-39524-C02).

References

- Alt, J.C., 2003. Hydrothermal fluxes at mid-ocean ridges and on ridge flanks, *Geochemistry* 335, 853-864.
- Boetius, A., Ravensschlag, K., Schubert, C.J., Rickert, D., Widdel, F., Gieseke, A., Amann, R., Joergensen, B.B., Witte, U., Pfannkuche, O., 2000. A marine microbial consortium apparently mediating anaerobic oxidation of methane. *Nature* 407, 623-626.
- Dimitrov, L.I., 2002. Mud volcanoes-the most important pathway for degassing deeply buried sediments. *Earth-Science Reviews* 59, 49-76.
- German, C.R., Ramírez-Llodra, E., Baker, M.C., Tyler, P.A., Chess Scientific Steering Committee., 2011. Deep-water chemosynthetic ecosystem research during the census of Marine Life decade and beyond: A proposed deep-ocean road map. *PLOS one* 6(8), 1-16.
- Judd, A., Hovland, M., 2007. *Seabed Fluid Flow: The impact on Geology, Biology and the Marine Environment*. Cambridge University Press, United Kingdom. 475pp.
- Kopf, A., 2002. Significance of mud volcanism. *Review of Geophysics* 40, 1-52.
- Scott, S.D., 1997. Submarine hydrothermal systems and deposits, In: Barnes, H.L. (Ed.), *Geochemistry of Hydrothermal Ore Deposits*, 3rd edition. Wiley, New York, pp. 797-962.

The secrets of publishing your article in Journal of Geophysical Research (Oceans)

Eric Desmond Barton

Instituto de Investigaciones Marinas de Vigo, CSIC

Abstract

The editorial and review processes along the road to publication are described in general terms. The construction of a well-prepared article and the manner in which authors may maximise the chances of success at each stage of the process towards final publication are explored. The most common errors and ways of avoiding them are outlined. Typical problems facing an author writing in English as a second language, including the need for grammatical precision and appropriate style, are discussed. Additionally, the meaning of plagiarism, self-plagiarism and duplicate publication is explored. Critical steps in manuscript preparation and response to reviews are examined. Finally, the relation between writing and reviewing is outlined, and it is shown how becoming a good reviewer helps in becoming a successful author.

‘Suspended’ particulate organic matter: A major unconsidered carbon sink in the ocean?

Javier Arístegui

Marine Sciences Faculty, University of Las Palmas de Gran Canaria, Spain

Abstract

The majority of particulate organic matter (POM) in the ocean is thought to be formed by fine ‘suspended’ (slow-sinking) particles (sPOM), which might be exchanged through isopycnal transport. Nevertheless, studies on organic carbon fluxes and biogeochemical models in the global ocean are mostly based on fast-sinking particles collected with sediment traps, in spite of the frequently reported imbalance with oxygen consumption rates in the dark ocean. Recent evidence indicates, however, that in eastern and western boundary currents sPOM is on average 4-5 μM higher in the 200-2000 m than in the central Gyres, yielding a significant carbon pool susceptible of being respired or exchanged with the ocean interior. In the mesopelagic zone, marked peaks in sPOM, microbial abundances and metabolic activity are observed, coinciding with stability gradients between water mass interfaces or with frontal structures related to mesoscale features. Estimates of horizontal transport and consumption of suspended carbon (sPOC) in the subtropical Northeast Atlantic indicate that lateral sPOC fluxes in the mesopelagic zone may be up to three orders of magnitude higher than vertical fluxes collected with sediment traps, largely contributing to the dark ocean respiration. These results suggest that boundary currents may support higher lateral export of coastal-produced organic carbon than previously assumed. A large fraction of this sPOC would however be remineralized in the upper 1000 m of these regions instead being transported to the ocean interior of the subtropical Gyres: a hypothesis supported by recent findings of a preferential life mode of prokaryotes in association with suspended particles. If the lateral sPOC fluxes estimated in the NE Atlantic are confirmed for other boundary regions, the coastal-open ocean sPOC transport might play a key, but previously unconsidered, role in the global carbon cycle of the oceans.

The Oceanic Platform of the Canary Islands: an infrastructure to boost the marine-maritime R&D+I and its contribution to sustainable growth

Octavio Llinás

Plataforma Océánica de Canarias. Canary Islands, Spain

1 Wednesday, June 11th

IV International Symposium of Marine Sciences

Coastal Management

Gestión Costera Sostenible del Ayuntamiento de Las Palmas de Gran Canaria

Adelina González Muñoz

Concejala Delegada de Ciudad de Mar, Ayuntamiento de Las Palmas de Gran Canaria

Abstract

The litoral of Las Palmas de Gran Canaria has 42 km, there are marine reserves, the biggest port of the Mid Atlantic, a fishing refuge and four beaches. The born of the Ciudad de Mar Department done by the City Hall in 2011 has enabled the development of its strategy based on four pillars (a. Open sea city; b. Develop the sea culture; c. Promote the sea culture; d. Maximize the business and growth opportunities) that consolidate the focus on the sustainable management and the empowerment of the endogenous assets. This paper describes the methodology and remarks some examples like the Santa Catalina Maritime Park, FIMAR, the Cono Sur's development litoral plan or the microarea ecoturistim in the beach of Las Canteras.

Evolution and dynamical behaviour of a barrier-lagoon system (Cies Island, NW Spain): what to achieve for preservation?

Alejo, I.¹, Pérez-Estévez, C.¹, Costas, S.², Villacieros-Robineau, N.³, Pérez-Arlucea, M.¹, Nombela, M.A.¹, Francés, G.¹, Sanz, V.⁴, Mena, A.¹, González-Villanueva, R.¹

¹Marine Geoscience Dept., Marine Sciences Faculty, University of Vigo, Spain

²LNEG (National Laboratory for Energy and Geology), Lisbon, Portugal

³Instituto de Investigaciones Marinas, CSIC, Vigo, Spain

⁴Master in Oceanography 2013-14, Marine Sciences Faculty, University of Vigo, Spain

Abstract

Present work is focus on the dynamic behaviour of a peculiar barrier-lagoon system located in a National Park (Maritime-terrestrial National Park of Atlantic Islands of Galicia), in order to predict its future evolution and contribute to its preservation. This system is backward orientated from the exposed coast (where is permanent communication, which has been restricted since the last decades) and facing the sheltered margin of the islands. Fresh water input is only controlled by the rain-fall and feeding by rivers is inexistent.

This system had registered important morphological changes since 1949, showing severe erosion problems together with an intensive lagoon infilling which seems to be related with the total extinction of the seagrass community (*zostera* sp.) within the last 5 years. This fact constitute a great lost for the ecosystem riches of the National Park and make a worry point about which will be the near future of the lagoon.

Erosion problems are located at the northern part of the sand barrier which is the area where an ephemeral inlet is developed under stormy periods and spring hightides. Erosion comprise beach retreat, dune destruction and the decrease of the berm height making it every year more vulnerable to overwash processes. Under the exposed circumstances, the ultimate goal of the present study is to evaluate the possibility of restoration the lagoon ecosystem and prevent the erosion problem at the sand barrier.

Previous studies have been carried out dealing with the barrier building, in a geological time scale: basin infilling, transgressive deposits and sand barrier instauration and aggradation. Studies about the beach dynamic have been also previously achieved, revealing a low-energy sheltered beach which morphology is inherited from high-energy events showing a non equilibrium state with the prevailing conditions.

For the present study several techniques have been applied: Water level in and out the lagoon monitored since September 2009 with Pressure Transducers to control daily/seasonal marine water exchange and tidal prism behavior inside the lagoon; SMS-wave model to characterize open sea wave patterns; current meters to evaluate sediment transport into the lagoon; anemometer column to evaluate aeolian sediment supply from the barrier; topography/bathymetry surveys.

A 3D topographic model was obtained with Terrestrial Laser Scanner, together with seasonals bathymetric surveys for both lagoon and nearshore area. Additional surveying was made at inlet area under different marine climate conditions, with both closed and open inlet. Several maps, including flooding and falling models, has been produce using several programs to evaluated water volume exchange and associated sediment distribution under different wave climate situations, using the recorded water stages.

Acknowledgements: This research was supported by the CATARINA Project (CTM2010-17141/MAR), Spanish MICINN and FEDER 2007-2012.

Suitability of the BOPA index for the assessment of the ecological quality status of the coastal waters off the Gulf of Valencia**Damián, A., Tena, J. & Torres, J.***INDEMAR. Catholic University of Valencia***Abstract**

The European Water Framework Directive (WFD) encourages the use of the Ecological Quality Status (EQS) as a qualitative measure to facilitate environmental evaluation and application of conservation policies. For the past 9 years, both the BOPA and the AMBI indices were used to assess the EQS of the coastal waters off the Gulf of Valencia. The BOPA index has been criticized for its tendency to overestimate the ecological quality. However, the use of BOPA has several advantages such as its lesser cost; independence from the sampling method used, and reduced chance of bearing identification errors. Furthermore, its ability to detect changes in organic matter content and hydrocarbons in marine sedimentary communities has been confirmed. AMBI is a multivariate index which integrates information from the abundance of a myriad of annelid, mollusk, crustacean and echinoderm species comprised in the list updated by AZTI. AMBI accounts on many representatives of the benthic community, so it has been regarded as a reference index against which other indices can be compared. Here we attempt to evaluate how far BOPA overestimates AMBI, what are the underlying factors for this difference, and how to improve its accuracy in our region. Results show that it is possible to overcome the inaccuracies by adding a corrective factor to the index. Moreover, it is observed that amphipod frequencies fail to identify shifts in the ecological quality and therefore should be left aside from the equation, using a constant instead. The application of these amendments would render a cheaper and more accurate indicator of the EQS for the Valencian waters. Hence, the application of a modified index, the ValenBOPA, is proposed for its use in further studies of the ecological quality of this area.

Reducing ship strike risks while monitoring cetaceans in the Canary Islands and Strait of Gibraltar**Mayol, P., Couvat, J., Gauffier, P., Barajas, B.***Universidad de Las Palmas de Gran Canaria***Abstract**

Between 1950 and 2010, world shipping increased by 5% per year. In 2010, it was 17 times as big as in 1950 (Stopford, 2010). Since 2009, the world shipping fleet increased by 37% (UNCTAD, 2012). And this traffic is expected to keep rising in the coming years.

This intense shipping traffic sometimes overlaps with areas of high large cetacean density. These areas can be important feeding grounds (Baker and Madon, 2007), breeding grounds (Martinez and Guzman, 2008; Notarbartolo di Sciara et al., 2008) or for their migration between them (Whitt et al., 2013). Because of this overlap, ships sometimes collide with cetaceans. Worldwide, collisions between ships and large cetaceans have been increasing for several decades. In this sense, according to number of recorded and validated cases in the International Whaling Commission, collisions in the 1950s were almost nonexistent, but in the 2009s have become almost 200. There are many places in the world that present regular occurrence to collisions: USA, Canada, Japan and the Mediterranean Sea.

In Spain, the two areas most at risk of collision are the Canary Islands and the Strait of Gibraltar, because of the overlap between an intense maritime traffic and a very high diversity and concentration of cetaceans. According to the Canary Islands Government between 1998 and 2005, 54 cases of collision of vessels with cetaceans were reported, especially with sperm whales (Consejería de Medio Ambiente y Ordenación Territorial. Gobierno de Canarias, 2009). This fact can endanger the conservation of these populations at medium and long term.

Today, eleven species are considered to be susceptible to ship strikes (Van Waerebeek and Leaper, 2008). These can even represent a real or potential threat to several large cetacean populations around the world (De Stephanis and Urquiola, 2006). The population most emblematic is the North Atlantic right whales, but fin whales, sperm whales, humpback whales, blue whales and Bryde's whales are also regular victims of these accidents.

These ship strikes can also be detrimental to shipping companies. They can cause significant damage sometimes necessitating dry dock repair. In addition to repair costs, these damages lead to a shortfall for the company (IWC, 2008). The public image of the company, in terms of environmental impact and on-board safety, can also be deteriorated. Indeed, several ship strikes led to passengers and crew members being more or less severely injured (Laist et al., 2001) and two cases of death were reported following a collision with a cetacean (De Stephanis and Urquiola, 2006).

Many international organizations like the International Whaling Commission (IWC), the International Maritime Organization (IMO) and ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area) agreements, among others, share the same objectives of reducing the risk of collisions between ships and large cetaceans (Couvat and Gambiani, 2013).

Worldwide, several measures have been implemented in order to reduce the risk of collision, as advised the International Maritime Organisation. As a result, among other measures, shipping lanes in the many places were modified to limit traffic within whale habitat and speed limitations in some areas with high concentration of whales. Also, they have been designed a lot of technological tools like, for example, infrared vision system or passive acoustic systems, but normally are very expensive system or are inefficient.

Particularly, in Spain, the shipping lanes moved offshore in Cabo de Gata to improve maritime navigation in the Traffic Separation Scheme (TSS) and reduce the amount of shipping in a Special Area of Conservation for bottlenose dolphins. In addition, in the Strait of Gibraltar, due to the construction of a new harbor on the Moroccan coast (Tanger Med) the TSS was modified. In order to reduce the risk of collisions, a Notice to Mariners was published in 2007 by the Hydrographic Institute of the Spanish Navy, where measures were recommended within an area most frequented by sperm whales called "Critical Area". They recommend to all ships to navigation with caution and limit their speed to 13kn between April and August (IHM, 2007). However, these measures aren't sufficient to minimize the threat to large cetaceans.

Among the solutions developed to reduce the risk of ship strikes is the REPCET (REal-time Plotting of CETaceans) system: a collaborative computer tool for use in commercial shipping. The concept is simple: every sighting of large cetaceans by watchkeeping personnel on board a vessel equipped with REPCET is transmitted by satellite in real-time to a server located on land. The server then centralises the data and sends out an alert to equipped vessels that are likely to be affected. The alerts are displayed cartographically on a dedicated screen on board.

In addition to accurately positioning the whale sightings, the system calculates and displays associated risk zones. These shaded, evolving circular areas correspond to the risk of encountering the initially detected animal.

The database is thus built up over time, and is made available to all scientific community with a twofold objective: to improve our knowledge of cetaceans over monitoring of cetaceans, and eventually to improve the performance and precision of the REPCET system.

Currently, the REPCET system is being developed in the Pelagos Sanctuary, in the Ligurian Sea. There are already 11 ships equipped with the REPCET system but to obtain greater efficacy to reduce the risk of collision is necessary to increase the number of ships equipped.

In Spain, The REPCET system is supported by the Spanish Environment Ministry, the ACCOBAMS agreement, the Spanish Institute of Oceanography and Las Palmas de Gran Canaria University, among others.

References

- Baker, A.N. and Madon, B. (2007) - Bryde's whales (*Balaenoptera cf. brydei* Olsen 1913) in the Hauraki Gulf and northeastern New Zealand waters.
- Couvat, J. and Gambiani, D. (2013) – Evaluation of the technical solutions and management measures implemented at the international level to reduce the risks of collisions between ships and large cetacean. September 2013. 100p.
- De Stephanis, R. and Urquiola, E. (2006) - Collisions between ships and cetaceans in Spain. International Whaling Commission Scientific Committee. Document SC/58/BC5.
- Gobierno de Canarias. Consejería de Medio Ambiente y Ordenación Territorial. Activities on cetaceans carried out by the Canary Islands Government in 2008 and Review of historic data records of cetaceans and ship strike in the canary islands. IWC/61/cc16-(sp). Junio 2009.
- IHM (2007) - Avisos a los Navegantes, Grupo 05, 03. Insitituto Hydrografico de la Marina. Seccion 4.1. Febrero 2007. 2pp.
- IWC (2008) - Third Progress Report to the Conservation Committee. Ship Strike Working Group. 60th Annual Conference of the International Whaling Commission. IWC/60/CC 3. May 2008. 15p.
- Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. (2001) - Collisions between ships and whales. *Marine Mammal Science*. 17: 35-75p.
- Martinez, D.P. and Guzman, J. (2008) - Whales and the city: A southern right whale ship strike scenario in Peninsula Valdes? 60th Annual Conference of the International Whaling Commission. Scientific Committee. Santiago, Chile. SC/60/BC4.18p.
- Notarbartolo di Sciara, G., Agardy, T., Hyrenbach, D., Scovazzi, T. and Van Klaveren, P. (2008) - The Pelagos Sanctuary for Mediterranean marine mammals. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 18: 367-391p.
- UNCTAD (2012) - Review of maritime transport 2012. United Nation Conference on Trade And Development. 196p.
- Van Waerebeek, K. and Leaper, R. (2008) - Second report of the IWC Vessel Strike Data Standardisation Working Group. SC/60/BC5. International Whaling Commission Scientific Committee. 8pp.

Whitt, A.D., Dudzinski, K. and Laliberté, J.R. (2013) - North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, USA, and implications for management.

Environmental quality of sediments affected by wastewater discharges at Spanish coastal areas during the summer season.**Maranho, L. A.^{1,2}, DelValls, T. A.¹, Martín-Díaz, M. L.^{1,2}**¹Andalusian Centre of Marine Science and Technology (CACYTMAR), University of Cádiz, Polygon Río San Pedro, s/n, 11510, Puerto Real, Cádiz, Spain²UNITWIN/UNESCO/WiCoP, Physical Chemical Department, Faculty of Marine and Environmental Sciences, University of Cádiz, Polygon Río San Pedro, s/n, 11510, Puerto Real, Cádiz, Spain**Abstract**

Municipal effluents are complex mixtures of chemical contaminants being distinguished in two groups: nutrients and pollutants. While the release of nutrients may produce eutrophication events, other substances such as metals, hydrocarbons, pesticides and pharmaceutical and personal care products (PPCPs) are found in wastewater discharges. The removal efficiency of xenobiotics from the influents of wastewater treatment plants (WWTPs) varies greatly with the seasonality, the quantities of PPCPs that are being used for the population, the function of the properties of the individual contaminant and the type of wastewater treatment being applied. The municipal effluents from the cities located in the Bay of Cádiz (SW, Spain) are considered important sources of contamination for the local marine and estuarine environments by industrial, domestic and agriculture residues. The population comprises 460.000 inhabitants which increases around 30% in the summer period. These anthropogenic substances are discharged constantly in aquatic systems and can accumulate at bottom sediments which play an important environmental role as a sink and/or source of contaminants. Sediments can be remobilized, and contaminants may be bioavailable to the water column affecting the associated biota. General guidelines for environmental risk assessment (ERA) of sediment describe bioassays specified in standards procedures for dredged material, as the ones chosen in the present study. It is recommended for ERA of sediments the evaluation of different sediment phases. In the present study, bulk sediment toxicity tests were applied by using two organisms and two endpoints: *Ampelisca brevicornis* amphipod mortality and the bioluminescence inhibition of the bacteria *Vibrio fischeri* (Microtox® Solid Phase Test – SPT). Sediment elutriate toxicity tests were applied by using four organisms and three endpoints: bioluminescence inhibition of *V. fischeri* (Microtox® Basic Phase Test - BPT), embryogenesis success of the sea-urchin *Paracentrotus lividus* and the growth rate of the microalgae *Isochrysis galbana* and *Tetraselmis chuii*. This study was carried out using sediments from six different sampling stations during the summer season, including five areas in salt-marsh directly affected by wastewater discharges (P1 – P5) and one control site (P6). The cities involved are located in the Bay of Cádiz (SW, Spain): Chiclana de la Frontera - P1, Puerto Real - P2, Cádiz - P3, El Puerto de Santa María - P4 and P5, and Rota - P6 (control site).

Significantly ($p < 0.05$) higher percentage of amphipod mortality in comparison with the control was registered in P1, P2 and P4. It was possible to classify the stations according to the level of toxicity using Microtox® SPT: $P1 > P4 > P2 > P3$, concerning the IC₅₀ recorded at 30 minutes. It was not possible to calculate the IC₅₀ applying Microtox® BPT due to hormesis. For sea-urchin embryolarval development assay, sediments from P1, P3 and P5 showed high percentage of abnormal development compared to the control ($p < 0.05$). Sites P1, P2 and P4 inhibited the growth rate of *T. chuii* compared to the control ($p < 0.05$).

Sediment affected by WWTP in Chiclana de la Frontera (P1) was considered the most toxic studied area, followed by Puerto Real (P2), El Puerto de Santa María (P4) and Cádiz (P3). The results highlighted the importance of a multi-trophic battery of bioassays applied to different sediment phases, species and exposure-times. It is recommended the design of a battery of acute toxicity (e.g. survival of amphipods)

and sublethal tests (e.g. reproduction of sea-urchins, growth rate of microalgae's) representative of the predominant routes of exposure in order to assess environmental quality of sediments affected by wastewater discharges.

Genetic characterization of *Zostera noltii* seagrass populations along the Atlantic Moroccan Coast and the Canary Island**Zarranz Elso M¹, Manent P², Ramdani M³, Robaina RR¹.**¹*University of Palmas de Gran Canaria. Canary Islands, Spain*²*Instituto Canario de Ciencias Marinas. Canary Islands, Spain*³*Institut Scientifique Rabat. Rabat Agdal. Maroc***Abstract**

Seagrass meadows provide an essential ecological service in coastal ecosystems worldwide, although they are sensitive to many human factors having been documented a serious global regression. Along the Atlantic Moroccan Coast we found 5 coastal lagoons with maximum environmental interest characterized by the presence of intertidal seagrass *Zostera noltii* meadows that shelter great biodiversity throughout the year (Larache, Moulay Bouselham, Sidi Moussa, Oualidia and Nayla). In the Canary Island, only one single *Z. noltii* population has been located on the coast of Lanzarote (Arrecife), which has been included in the “Canary Island Catalogue of Endangered Species” as “threatened with extinction” (BOC 2001/097). In order to suggest future management strategies that promote the conservation of these highly sensitive and valuable areas, the present project has studied the genetic characterization and the connectivity between Moroccan and Canarian populations (0111-TECHMARAT-2-A, POCTEFEX-FEDER). Special handling deserves the single Lanzarote population to establish a restoration guidelines for its urgently recovery.

Zostera noltii populations are shown to be highly isolated due to low long and short-term gene flow and high distance between optimal habitats. Bio-geographical analysis supported the clustering of *Z. noltii* subpopulations into four groups corresponding to four different geographical regions: R1-Northern Morocco (Larache and Moulay Bouselham), R2-Central Morocco (Oualidia and Sidi Moussa), R3-Southern Morocco (Nayla) and R4-Canary Island (Lanzarote). The clear definition of seagrass clusters along the Atlantic Moroccan Coast should be considered for the future management of these spaces, defining Management Units that could be used to improve restoration techniques, avoiding translocation and mixing of very different populations (outbreeding depression), or to prioritize population units for conservation due to the limited economical resources. Several recommendations to effectively restore the remaining Lanzarote population are also suggested, such as the employment of alternative restoration methods (e.g. seeds and seedlings cultivation), and the election of an appropriate starting plant material according to its genetic variability and genetic relation to recipient population.

Biological Oceanography

***In situ* gaping activity of subtidal bivalves in nontidal seas: how does the environment affect their behavior?**

Garcia-March JR¹, Jimenez Gutierrez S², Sanchis Solsonas MA¹, Monleon S¹, Surge D³, Lees J³, Tena Medialdea J¹

¹*Universidad Católica de Valencia*

²*Instituto de Ecología Litoral*

³*University of North Carolina at Chapel Hill*

Abstract

In a study designed to evaluate the importance of biomonitoring in situ behavior of subtidal bivalves in the Mediterranean Sea previous to the development of manipulative experiments, we found synchronized behaviour of gaping activity in the bivalve *Pinna nobilis*. This study encouraged the preparation a more complex experiment including an increased number of animals, longer biomonitoring periods and the simultaneous monitoring of environmental parameters. After c. two years of study of 6 individuals, we could confirm the synchronization of gaping activity and characterize a clear and abrupt change in two gaping activity modes, one during winter/spring and the other during summer/fall. The time series recorded in both periods showed significant ($p < 0.05$) autocorrelation peaks of activity at 24 h in all individuals. As observed in our previous study, the summer/fall mode was strongly influenced by Sun and Moon light. Furthermore, activity was strongly influenced by current intensity and water turbidity, confirming that wave action and sediment resuspension are important factor in the ecology of *P. nobilis*. This study reflects that the results from manipulative experiments in laboratory can be biased by the season when the study is conducted and that it is important to understand natural behaviour previous to develop in vitro experiments. Furthermore, the occurrence of a marked boundary between the two activity modes could be used as a signature for the biomonitorization of the effects of climate change on marine communities.

Role of internal waves on mixing, nutrient supply and phytoplankton composition during spring and neap tides in the Ría de Vigo (NW Iberian Peninsula)

Marina Villamaña¹, Beatriz Mouriño-Carballido¹, Paloma Chouciño¹, Bieito Fernández¹, Rocío Graña¹, Emilio Marañón¹, Renate Scharek², Mikel Latasa², Pedro Cermeño³

¹*Universidad de Vigo*

²*Instituto Español de Oceanografía-Xixón*

³*Instituto de Ciencias del Mar-Barcelona (CSIC)*

Abstract

Increased vertical mixing and nutrient fluxes into the photic zone are frequently observed in continental shelves, particularly during spring tides, due to the activity of internal waves. Changes in nutrient supply underpin horizontal and vertical gradients in the phytoplankton community, with strong implications for fisheries and the export of particulate organic carbon. The shelf edge of NW Iberian Peninsula is very steep and favorable for the generation of internal waves. However, the effect of nutrient inputs due to internal wave activity and their role on phytoplankton composition and size-structure remain unexplored. In order to cover a gradient in the frequency of nutrient pulses driven by internal waves, intensive sampling of physical, chemical and biological variables was carried out in the outer part of the Ría de Vigo, during spring and neap tides, as part of the CHAOS (Control of the structure of marine phytoplankton communities by turbulence and nutrient supply dynamics) project in August 2013. Observations were conducted in summer because internal wave activity is stronger during this period, as shallow pycnoclines act as waveguides along which internal waves propagate. Spring (20-22th August) and neap (27-29th August) tides sampling included continuous measurements of dissipation rates of turbulent kinetic energy (yo-yo), by using a microstructure profiler, covering a complete tidal cycle (25 hours). Every hour the yo-yo was interrupted to collect samples for inorganic nutrient concentration at 12 depths, with higher vertical resolution at the nutricline. Microturbulence and nutrient concentration data were combined to compute the input of nutrients into the euphotic zone driven by vertical diffusivity processes. Size-fractionated chlorophyll-a and pigment composition samples were taken at the beginning and at the end of each tidal cycle for the determination of phytoplankton community structure. Preliminary analysis of these data show enhanced mixing in the thermocline during the spring tide. No significant differences between the two periods were found in phytoplankton community structure, which was dominated by large ($>20 \mu\text{m}$) diatoms and seemed to be mainly controlled by the upwelling conditions predominating in late August.

The effect of a strong warm year on zooplankton biomass and indices of grazing, respiration, and growth in subtropical waters**Inma Herrera¹, José López-Cancio², Lidia Yebra³ and Santiago Hernández-Léon¹**¹*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas de Gran Canaria, Spain*²*Grupo de Estudios Atmosféricos, Departamento de Ingeniería de Procesos, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain*³*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero s/n, 29640 Fuengirola, Málaga, Spain***Abstract**

Mesozooplankton biomass, as dry weight, and indices of grazing (gut fluorescence), respiration (electron transfer system activity) and growth (aminoacyl-tRNA synthetases activity), were measured from February to June 2010 in the oceanic waters north off the Canary Islands. Temperature was always above 19°C, promoting a strong stratification and quite low values of chlorophyll during winter-spring. The late winter bloom, typical in these waters, was not observed. The indices of grazing and respiration showed low values compared to previous years. However, relatively higher mesozooplankton biomass was observed during the post bloom period. This paradox was explained by the input of dust deposition from the Sahara desert. These findings show how climatic warming and dust events may interact affecting the intensity of the winter-spring bloom in subtropical waters.

To click or to call: Different modes of acoustic communication in short-finned pilot whales (*Globicephala macrorhynchus*).

Jacobo Marrero Pérez¹, Frants H. Jensen^{2,3}, Laia Rojano-Doñate^{1,4}, Natacha Aguilar de Soto^{1,5}.

¹BIOECOMAC. Department of Animal Biology, La Laguna University, La Laguna 38206, Tenerife, Canary Islands, Spain

²Ecology and Evolutionary Biology Dept., Princeton University, Princeton, NJ 08544, USA

³Biology Dept., Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

⁴Zoophysiology, Department of Bioscience, Aarhus University, 8000 Aarhus, Denmark

⁵Sea Mammal Research Unit, Scottish Ocean Institute. University of St. Andrews, Scotland, UK

Abstract

Toothed whales depend on a pneumatic sound generator to produce a suite of acoustic signals for echolocation and communication. Increasing hydrostatic pressure at depth seems to limit the amplitude and duration of tonal calls but not echolocation clicks, suggesting that an increased emphasis on click-based communication signals might help transfer information at depth. To test this hypothesis, we attached acoustic and movement recording DTAGs to 27 wild short-finned pilot whales. We investigated four types of communication signals, which form a continuum between tonal and pulsed sounds: low and high frequency calls (mean frequency of 1.7 and 3.3 kHz, respectively), two-component calls (mean frequency of the low and high frequency component of 2 and 9 kHz) and rasps (mean inter-click interval, ICI, 23 ms). Rasps are structurally similar to buzzes because they are constituted by series of clicks produced at a fast rate. However, they showed clear differences in their ICI (Unpaired T test, $P < < 0.01$) and duration (Unpaired T test, $P < < 0.01$) resulting in a higher duration and number of clicks per signal in buzzes (mean 617, max. 63 to 1782, SD 360) with respect to rasps (mean 21, max. 68, min. 4, SD 10). Most rasps occur outside of echolocation periods and are not associated with increased acceleration rate in contrast to foraging buzzes, suggesting that rasps are used for communication. Rasps are produced significantly deeper than calls and their duration and amplitude is not reduced with depth, supporting the hypothesis that clicks may help transmit certain types of information to conspecifics. The occurrence of some calls at depth may indicate that these transfer information not encoded in rasps and that these social toothed whales need to balance their communication requirements against the restrictions of a pneumatic sound generator.

Biological Oceanography

Structural and chemical defenses win against nutritional contents of algae on the feeding behavior of juveniles sea urchins.

Adriana Rodríguez¹, Sabrina Clemente¹, José Carlos Hernández¹, Irma García², Alberto Brito¹ and Mikel C. Becerro³.

¹Biodiversidad, Ecología Marina y Conservación. Dpto Biología Animal, Edafología y Geología. UDI Ciencias Marinas. Facultad de Biología. Universidad de La Laguna

²Dpto. Biología Animal, Edafología y Geología. UDI Fisiología Animal. Facultad de Biología. Universidad de La Laguna

³Instituto de Productos Naturales y Agrobiología. Centro Superior de Investigaciones Científicas (IPNA-CSIC)

Abstract

Herbivory is a strong force controlling the structure of ecosystems. Grazers consume over 20% of global annual net primary productivity. This pressure depends in part on their feeding preferences, which vary among and within herbivore species. Herbivory in benthic marine systems is more intense than in terrestrial systems, up to three times higher than in terrestrial vegetation. Seaweeds are producer species that facilitate the functioning of whole communities (providing habitat, refuge and food), and their relative dominance often depends on grazing pressures. Some seaweeds can deter herbivores by morphological, nutritional and chemical defenses, and several defensive mechanisms may be functioning simultaneously. However, little is known about the relative importance of these mechanisms simultaneously. To address these issues, we focused on studying feeding behavior on two key mesograzers: juveniles of the sea urchins *Diadema africanum* and *Paracentrotus lividus*.

We chose 15 species of algae commonly found in benthic ecosystems of the Canary Islands: seven brown algae (*Colpomenia sinuosa*, *Cystoseira abies-marina*, *D. dichotoma*, *Halopteris scoparium*, *Lobophora variegata*, *Padina pavonica* and *Stypopodium zonale*), four red algae (*Asparagopsis taxiformis*, *Coralina elongata*, *Gelidium canariensis* and *Lophocladia trichocladus*) and four green algae (*Cladophora liebertreei*, *Codium intertextum*, *Ulva compressa* and *Ulva rigida*). We studied the nutritional content of each algal species estimating the proportion of carbohydrates, lipids, proteins and ashes. By means of laboratory experiments we studied consumption rates by sea urchins, either with structure (fresh algae), without structure (artificial food), and with chemical extracts of each species of algae.

Results of each feeding experiment were expressed as percentage of consumption of each algae by each of the two sea urchin species. Given that each experimental trial (with structure, without structure, and chemical extracts) was run independently, we used a meta-analysis to combine all results and to compare the magnitude of morphological or chemical defenses of algal species in deterring herbivores.

Our result showed differences in feeding behavior between species of juvenile sea urchins. There was not any relationship between the nutritional contents and consumption rates of any of the studied species of algae. However, the structure and chemical defenses of algae species played an important role on the feeding behavior of the studied herbivores. The structure of algae species was a limiting factor for juveniles of *P. lividus* and the chemical factor did not deter herbivorism in any species of juvenile sea urchins.

Ecophysiological responses of *Cystoseira tamariscifolia* and *Ellisolandia elongata*: in situ transplant experiment**Celis-Plá¹, P., Korbee, N.¹, Quintano E.², García-Sánchez M.³ Martínez, B.⁴, Figueroa, F.L.¹**¹Department of Ecology, Faculty of Science, University of Málaga, 29071Málaga, Spain²Department of Plant Biology and Ecology, Faculty of Science and Technology, University of the Basque Country (UPV/EHU). PO Box 644, 48080 Bilbao, Spain³Department of Ecology and Hidrology, Faculty of Biology. Regional Campus of International Excellence "Campus Mare Nostrum", University of Murcia, 30100 Murcia, Spain⁴Biology and Geology Department, Rey Juan Carlos University, 28933Móstoles, Spain**Abstract**

Short-term ecophysiological and biochemical responses to solar irradiance and nutrients of *Cystoseira tamariscifolia* Papenfuss (Phaeophyceae, Fucales) and *Ellisolandia elongata* (Ellis & Solander) Hind & Saunders (Florideophyceae, Corallinales) were analyzed in situ in oligotrophic coastal waters by transferring macroalgae growing at 0.5 and 2.0 m depth to surface waters under two different irradiances (100% and 70% of the surface irradiance) and nutrient (enriched and non-enriched) conditions. Physiological responses of both species were affected by both irradiance and nutrient conditions, with significant interactions between both factors. *C. tamariscifolia* collected at 0.5 m and exposed to 70% surface irradiance showed the highest maximum electron transport rate, saturated irradiance (EkETR) and Chla content and the lowest antioxidant activity. Under the same conditions, *E. elongata* showed increases in EkETR, antheraxanthin and β -carotene. In 100% surface irradiance conditions, *C. tamariscifolia* collected from 2.0 m depth showed increases in all photosynthetic parameters as in antheraxanthin and polyphenol contents. In contrast, *E. elongata* showed increase only in the photosynthetic efficiency. Under enriched nutrient conditions, an increase in phenolic compounds, several carotenoids and internal N content were observed in *C. tamariscifolia* collected from both depths. However, in *E. elongata* (from 2.0 m depth waters) at 100% surface irradiance treatments showed an increase in internal N content and mycosporine-like amino acids. In conclusions, our results show that the ecophysiological responses of *C. tamariscifolia* responds rapidly to light, suggesting a high acclimation to changes in ambient irradiance. However, in *E. elongata*, the photosynthetic parameter did not change in the transplant, in contrast to biochemical variables. The higher values found under nutrient enrichment indicate more favorable status to respond to environmental stress conditions.

Short-term variability of planktonic composition in subtropical waters off the Canary Islands**Franchy, Gara, Alicia Ojeda, and Santiago Hernández-León***Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria, Islas Canarias***Abstract**

The planktonic community composition in oligotrophic waters off the Canary Islands was studied from November 2010 to June 2011 carrying out a weekly sampling and covering the productive period in these waters. The characteristic late winter bloom took place from February to April 2011, when the cooling of surface waters promoted the deepening of the mixed layer, and chlorophyll a concentration and primary production increased at the surface. The planktonic community was dominated by picoplankton, especially *Prochlorococcus* and heterotrophic prokaryotes, except during the productive period, when *Synechococcus* and picoeukaryotes dominated the picophytoplankton. During the bloom, diatoms were the major contributors to total autotrophic biomass and they were probably responsible for the highest rates of primary production. The planktonic variability was driven by bottom-up forces at a seasonal scale through the nutrient enrichment during winter. Additionally, a short-scale variability of phytoplankton biomass and productivity was observed even during stratified conditions. Short-term variability would also result from top-down processes such as feeding and grazing by nano- and microheterotrophs. In this sense, a significant correlation was found between the latter and their potential preys: bacteria and autotrophic picoeukaryotes and nanoflagellates. These results showed the need to sample at short-time scales to account for the total variability of the planktonic communities in subtropical waters. As an example, the striking and ephemeral diatom peak observed here, which would be probably not detected in a monthly sampling.

Migration and diving behavior of Atlantic bluefin tuna determined with satellite archival tags: from the Mediterranean spawning grounds to the North Atlantic feeding areas**Guillermo Aranda, Francisco J Abascal, Antonio Medina***Universidad de Cádiz***Abstract**

Pop-up satellite archival tags were implanted on 46 Atlantic bluefin tuna (*Thunnus thynnus*) at the beginning of the breeding season (early June, years 2009, 2010 and 2011) to ascertain spawning and post-spawning behavior around the Balearic Islands. The fish were tagged underwater and released within the school, thus allowing us to monitor shoaling behavior and migratory patterns. After completion of spawning, most of the tuna described the same backward migratory pathway from the Balearic Islands to the North Atlantic crossing the Strait of Gibraltar. Discrepancies between the migratory tracks reconstructed from this and previous studies suggest that the Mediterranean population of bluefin tuna may comprise distinct units that would exhibit different dynamics. Synchronous spatial and temporal patterns were observed in tagged fish that belonged to the same school. The diving behavior varied depending on the oceanic region where the tuna swam. During the spawning season, the fish preferentially occupied shallow waters and warm water masses in the Balearic breeding ground. A characteristic diving pattern, which seems to reflect courtship and spawning activity, was observed during nighttime in this area. The reproductive parameters inferred from the patterns observed in such depth and temperature profiles are consistent with previous studies based on biological samples. The deepest behavior took place at the Strait of Gibraltar, reaching in some cases the bathymetric limit of the region (900 m). This fact could be related to the special features of the deep water circulation in this area, which would be used to facilitate swimming or for orientation. Nevertheless, other hypotheses must be considered. Stomach content analysis of bluefin captured in this area revealed high content of mesopelagic fish and crustaceans suggesting that the Strait could be a foraging area. During the transition along the West Iberian coast towards the North Atlantic, the bluefin exhibited periodic V-shaped profiles which could indicate transiting, or searching behavior. In the North Atlantic, the fish remained in the surface during the night and descended to depths greater than 300 m at daytime. The bluefin thus mirrors the vertical migrations of the small nektonic organisms of the deep scattering layer that they prey on.

Zooplankton biomass and metabolism: Response in the Namibian upwelling**I. Fernández-Urruzola¹, N. Osma¹, T.T. Packard¹, M. Gómez¹ and L. Postel²**¹*Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, 35017, Canary Islands, Spain*²*Zooplankton Ecology Group, Baltic Sea Research Institute, D-18119 Rostock, Warnemünde, Germany***Abstract**

Zooplankton biomass and potential metabolic rates in terms of electron transport system (ETS) and glutamate dehydrogenase (GDH) were analyzed in four size fractions (100-200 μm , 200-500 μm , 500-1000 μm and >1000 μm) along a cross-shelf transect in waters off northern Namibia. The highly variable dynamics of upwelling filaments promoted short-term fluctuations in the zooplankton distribution. Maximum values were characteristically found over the shelf-break, where zooplankton biomass as dry mass (DM) reached peaks of 64.5 mg m^{-3} within the upper 200 m in late August. Two weeks later, the zooplankton-DM decreased by more than a third (19 mg DM m^{-3}). Zooplankton potential respiration and NH_4^+ excretion averaged $234 \mu\text{mol O}_2 \text{ m}^{-3} \text{ d}^{-1}$ and $169 \mu\text{mol NH}_4^+ \text{ m}^{-3} \text{ d}^{-1}$ in the Namibian shelf, respectively. High protein-specific ETS activities even in the low-chlorophyll waters outside the filament suggested a shift into greater omnivory towards the open ocean. This would also explain the decrease of zooplankton biomass and the higher protein-catabolism seaward. In this light, zooplankton elemental and isotopic compositions were used to investigate the pelagic food web interactions. They evidenced spatial changes in the carbon resource for zooplankton as well as in the form of nitrogen that fueled the biological production in aging advected waters. Overall, the zooplankton respiration consumed a small proportion of the daily primary production (0.9 - 9.3%), which argued for the autotrophy of the system during the intense wind-forcing season. Parallel with the respiration, zooplankton NH_4^+ excretion only contributed from 1 to 12% to the total nitrogen requirements for primary production. This may reveal a major remineralization pathway through microheterotrophs in these Namibian waters.

Transparent exopolymer particles production in the Pacific Ocean related to *Prochlorococcus* sp. decay**Iuculano F.¹, Mazuecos I.P.², Reche I.² and Agustí S.^{1,3}**¹*Instituto Mediterráneo de Estudios Avanzados (IMEDEA), CSIC-UIB, Esporles, Balearic Islands, Spain*²*Departamento de Ecología and Instituto del Agua, Universidad de Granada, 18071 Granada, Spain*³*The UWA Ocean Institute and School of Plant Biology, The University of Western Australia, 35 Stirling Highway, Crawley 6009, Perth, Western Australia***Abstract**

Transparent exopolymer particles (TEP) are organic particles composed of acidic polysaccharides, mostly released by phytoplankton and bacteria and recognized as an important component of the biological carbon pump in the Ocean (Passow 2000). Although the importance of these gel particles in biogeochemical processes is increasingly recognized, their link with photo-processes it is still not clear and it is poorly investigated. During the *Malaspina 2010 Expedition* we analyzed the concentrations of exopolimeric particles and their production rates in the oligotrophic Atlantic and Pacific Oceans. We also experimentally tested the hypothesis that pico-phytoplanktonic cell death induced by solar radiation may enhance the production of TEP in the surface Ocean.

We assessed this hypothesis by performing 10 experiments sampling surface water of five of the biogeographical provinces crossed during the *Malaspina 2010 Expedition*: (i) PEQD, Trades-Pacific Equatorial Divergence; (ii) PNEC: Trades-North Pacific Equatorial Counter-current Province; (iii) CARB: Caribbean Province; (iv) NATR: Trades-North Atlantic Tropical Gyral Province; (v) NASE: North Atlantic Sub-Tropical Gyral Province. We exposed surface waters to three different light treatments: dark (DARK), control exposure to full solar radiation (FULL) and completely removing the ultraviolet radiation (-UV) to test for the differences in TEP production while simultaneously analyzing pico-plankton (pico-phytoplankton and heterotrophic bacteria) populations.

Initial TEP concentrations in the Pacific Ocean were significantly higher (mean (\pm SE): $24.45 \pm 2.3 \mu\text{g XG Eq L}^{-1}$) than in the Atlantic Ocean (mean (\pm SE): $8.18 \pm 4.56 \mu\text{g XG Eq L}^{-1}$) and initial abundances of pico-plankton were also generally higher in the stations sampled in the Pacific Ocean than those in the Atlantic.

The area investigated is oligotrophic with in situ chlorophyll a concentrations ranging from $0.05 \mu\text{g L}^{-1}$ in the NASE station to $0.31 \mu\text{g L}^{-1}$ in the equatorial station of PEQD. UVB daily doses received during Pacific Ocean experiments (mean (\pm SE): $43.6 \pm 3.1 \text{ KJ m}^{-2}$) were significantly higher than those received during the Atlantic experiments (mean (\pm SE): $30.5 \pm 2.5 \text{ KJ m}^{-2}$; t-test, $p < 0.05$).

Daily TEP production rates were higher in the Pacific experiments (mean (\pm SE): $44.3 \pm 14.2 \mu\text{g XG Eq L}^{-1}\text{d}^{-1}$) than in the Atlantic experiments (mean (\pm SE): $6.6 \pm 1.1 \mu\text{g XG Eq L}^{-1}\text{d}^{-1}$). Moreover, during all the experiments performed in the Pacific Ocean we detected a significant effect of FULL ($p = 0.003$) and -UV ($p = 0.008$) on TEP production rates in comparison with DARK treatment after the 24 hours incubation. By contrast TEP rates in the Atlantic experiments did not differ significantly among treatments.

The maximum concentration of TEP was observed in the FULL solar radiation treatment in the experiment run with water of the equatorial Pacific, reaching values of $187.3 \mu\text{g XG Eq L}^{-1}$.

Furthermore, populations of *Prochlorococcus* sp. in all the experiments in the Pacific Ocean were negatively affected by solar radiation ($p = 0.02$), resulting in the decay of the populations with time (h^{-1}). While no difference was observed in decay rate between FULL (mean(\pm SE): $-0.05 \pm 0.01 \text{ h}^{-1}$) and -UV treatments (mean (\pm SE): $-0.07 \pm 0.009 \text{ h}^{-1}$), those decay rates were significantly higher than

those observed in DARK treatments (mean (\pm SE): $-0.01 \pm 0.002 \text{ h}^{-1}$). By contrast, *Synechococcus* and heterotrophic bacterial cells presented lower cell decays and did not show statistical differences among treatments, suggesting a stronger resistance and adaptation to induced solar radiation damages with respect to *Prochlorococcus* taxon. Finally, TEP production fitted a significant correlation with the decay rates of *Prochlorococcus* ($p= 0.003$) for the Pacific experiments.

This research provides the first evidence of the coupled association of TEP and pico-phytoplanktonic cells death induced by solar radiation: sunlight induces mortality of *Prochlorococcus* sp. significantly enhancing cellular lysis with a consequent release of exudation products, including exopolysaccharides, which thereby facilitates the aggregation and polymerization into TEP. However, this same process does not explain the results from the experiments performed in the Atlantic Ocean, where a-biotic processes may control the gel particles dynamics.

XVII Seminario Ibérico de Química Marina

Biogeochemical Processes

Seasonal hypoxia in Cádiz Bay shallow systems

Burgos, M., Forja, J.M., González-Mazo, E., Ortega, T., Ponce, R., Gómez-Parra, A.

Dpto. Química-Física, CACYTMAR, Universidad de Cádiz, Campus Río San Pedro, s/n, Puerto Real (Cádiz), Spain

Abstract

The shallow systems surrounding Cadiz Bay occupy an area of about 6 000 HA and they generally show an important permanent oxygen deficit. This hypoxia is significantly enhanced during the summer months owing to the temperature increase. During the warmer months, anoxia episodes are detected near to the bottom in determinate zones, as well as an intense SH₂ emission, which could affect the productivity in such locations.

This situation in Cadiz Bay shallow systems, which is common in several coastal environments, is motivated by the high organic matter inputs from adjacent areas. The organic matter comes from both urban effluents from a population of about 650000 inhabitants and effluents from the intensive fish farm activity taking place in Cadiz Bay.

The present work shows hypoxia levels that marshes and tidal channels belonging Cadiz Bay currently bear. These results are compared with previous studies carried out at the same zone during the years 1978 and 1993. Database analysis allows quantifying the environmental impact of hypoxia in tidal channels and its temporal evolution. Improved sanitation network and the aquaculture intensification in the last decades are facts correlated with hypoxia temporal variations.

Keywords: hypoxia, shallow system, organic matter, dissolved oxygen

Anthropogenic activity effects on benthic greenhouse gases production in the Cádiz Bay natural park (SW Spain)**Ortega, T., Burgos, M., Ponce, R., Gomez-Parra, A., Forja, J.M.***Dpto. Química-Física, CACYTMAR, Universidad de Cádiz, Campus Río San Pedro, s/n, Puerto Real (Cádiz), Spain***Abstract**

Cádiz Bay Natural Park is a protected area of 10,522 ha with a great ecological value, which bears human pressures from the nearby population of about 600,000 inhabitants. The Bay receives large amounts of anthropogenic organic matter (OM) from urban and fish farm effluents as well as from agricultural discharges. An important part of these OM inputs reaches the sediments where is mineralized through different oxidative pathways leading to significant benthic fluxes of nutrients, carbon and greenhouse gases into the water column. Therefore, water column is greenhouse gases supersaturated provoking that the Natural Park acts as an atmospheric source of CO₂, CH₄ and N₂O. Three systems belonging Cadiz Bay are the main sites contaminated with organic matter: Rio San Pedro tidal creek, Sancti Petri Channel and Guadalete Estuary owing to they receive several fish farm effluents without previous treatment, wastewater and agricultural discharges. Methane and nitrous oxide sediment profiles have been studied in those coastal systems as well as other associated variables. Two sampling stations were established in each environment at different distances to the organic matter input. Polycarbonate cores (60 cm long, 9.5 inner diameter) were taken at each station and they were carefully maintained in vertical position during transportation to the laboratory. Two cores were used to establish pore water dissolved CH₄ and N₂O profiles in duplicate. Methane and nitrous oxide concentrations were determined by gas chromatography. CO₂ concentration in interstitial water has been obtained through pH and total alkalinity measurements. Cores taken at the same stations were different, elucidating the spatial heterogeneity of the studied zones. The three systems showed higher dissolved inorganic carbon, CH₄, N₂O and CO₂ in the cores from the station closer to the OM discharge points. Almost all stations increased the concentrations of CH₄, N₂O and CO₂ with depth. N₂O profiles presented a concentration maximum below 5 cm depth likely due to denitrification/nitrate-reduction processes. This maximum has been found in marine sediments of other coastal systems. It is worth noting that methane in the Guadalete River sediments closer to the OM discharge point (1.2-4.0 mM) was six orders of magnitude higher than dissolved methane in the water column (30-4000 nM). Methane and nitrous oxide diffusive fluxes differed considerably between the three studied systems. The greatest diffusive flux has been measured in the Guadalete Estuary, followed by Rio San Pedro Creek and Sancti Petri Channel. Methane diffusive fluxes in Guadalete River varied between 1.2 - 3.4 $\mu\text{mol m}^{-2} \text{d}^{-1}$ at the seawater influenced station, whereas flux at station nearby to the organic matter input from the sewage reached three orders of magnitude higher, varying the fluxes between 4.7 - 8.3 $\text{mmol m}^{-2} \text{d}^{-1}$. Nitrous oxide diffusive fluxes ranged between 2.1 and 111.2 $\mu\text{mol m}^{-2} \text{d}^{-1}$. The highest values were measured at the more contaminated station. CH₄ benthic fluxes from Rio San Pedro Creek and Sancti Petri Channel varied between 10-70 $\mu\text{mol m}^{-2} \text{d}^{-1}$ and 0.3-2.0, respectively. N₂O fluxes were negative (range of -2.5- (-0.1) $\mu\text{mol m}^{-2} \text{d}^{-1}$ in Rio San Pedro Creek and -0.6-0.2 $\mu\text{mol m}^{-2} \text{d}^{-1}$ in Sancti Petri Channel) indicating that those sediments were sinking nitrous oxide from the overlying water.

Keywords: greenhouse gases, diffusive fluxes, coastal systems

Seasonal variability of nutrient behavior and fluxes of dissolved oxygen and CO₂ in the Guadalete river estuary (SW Spain)**Ponce, R., Burgos, M., Ortega, T., Forja, J.M., Gómez-Parra***Dpto. Química-Física, CACYTMAR, Universidad de Cádiz, Campus Río San Pedro, s/n, Puerto Real (Cádiz), Spain***Abstract**

The study was carried out at eight sampling stations located along 18 km in the estuary of the Guadalete River (SW Spain). The estuary is characterized by semidiurnal mesotides (average tidal range 0.98-3.20 m). Surface water was collected seasonally, along the year 2013 (25th February, 9th May, 23rd July and 18th November) at the eight sampling stations. Samplings were done in low tide with high tidal coefficient (between 0.82 and 1.06) in order to find maximum impact of the anthropogenic inputs.

Concentrations of nutrients, dissolved oxygen (DO) and CO₂ have been analyzed in each sampling station. Temperature was measured in situ. Additional parameters such as organic matter, total suspended solids and chlorophyll were determinate as well, in order to understand the relationship between physicochemical and biological processes.

Overall, nutrients increased from the river mouth to the inner estuary in all seasons, which is observed in their variation ranges. Summer showed the lowest nutrient concentrations as a result of the chlorophyll's maximum. Nitrate presented high concentrations in spring and winter (average of 194.4 μM and 154.5 μM , respectively), representing 70.6% and 65.4% of the total dissolved inorganic nitrogen (DIN), respectively. It was lower in fall, with a mean value of 67.6 μM , which was 29,3% of DIN. Nitrite decreased in summer and fall (average of 6.7 μM and 3.0 μM , respectively); and remained relatively constant in winter and spring, with an average of 8.6 μM . It is worth noting that a nitrate maximum was measured with a value of 18.8 μM in the fourth station during the summer sampling. In contrast, ammonium was high in fall with a mean value of 160.3 μM and concentrations reaching 200 μM in the inner estuary. Mean values in spring and winter were about 75 μM , although the estuary gradient was stronger in winter. Ammonium concentration was lowest in summer (48.2 μM was averaged). Phosphate was higher in fall and winter (mean concentrations of 1.3 μM and 1.4 μM , respectively) than in spring and summer (0.9 μM and 0.7 μM , respectively). Finally, silicate showed the highest concentration in spring (average of 126.8 μM), decreased in summer and fall (71.8 μM and 49.2 μM , respectively) and it increased again in winter (110.7 μM). In general, nutrient concentrations decreased with salinity showing a conservative behavior during all the seasons. Ammonium measured in winter was the single nutrient that showed a non-conservative behavior with losses at low salinity.

Dissolved oxygen concentrations presented the highest values in the cold months ($> 250 \mu\text{M}$) and decreased in the warmer months ($\sim 200 \mu\text{M}$). It has been found oxygen undersaturation values in most of the samples, mainly in autumn and winter related with lower salinity stations.

The system acts as a source of CO₂ to the atmosphere, with fluxes ranging between 0.8 and 110.0 mmol m⁻² d⁻¹. The highest values were found in the upper parts of the estuary with low salinities. CO₂ fluxes showed important seasonal variations. During spring, fluxes became 10 times greater than those found in winter. Dissolved oxygen fluxes ranged between 206.0 and 45.2 mmol m⁻² d⁻¹ and in general the estuary acted as atmospheric oxygen sink. However, some stations seawater influenced were an oxygen source. The greatest oxygen uptake has been found in the freshwater stations during the spring and summer, showing a seasonal pattern. These results highlight that the Guadalete River estuary has behaved as a heterotrophic system along the year 2013.

Keywords: nutrients, dissolved oxygen, CO₂, estuary.

Optimization of CO₂ injection conditions in cultures of marine microalgas: *Nannochloris atomus* and *Tetraselmis chuii*.**Gurgel H., Forja J.M., Gomez A.***CACYTMAR. Dpto. Química-Física, Facultad de Ciencias del Mar y Ambientales. Universidad de Cádiz, 11510 Puerto Real, Cádiz, Spain***Abstract**

The use of photobioreactors for CO₂ sequestration requires optimization of injection conditions for its return to the atmosphere. For this study, we used two photobioreactors pilot scales (550 L each one) and cultures of marine microalgae *Tetraselmis chuii* and *Nannochloris atomus*. The cultures were performed at controlled temperature (22°C) and without limitation for available nutrients (2 mM of NO₃ and 0.12 mM of HPO₄²⁻). For the illumination system, we used focus LEDs (red and blue) with a photon flux of 35 μmol m⁻² s⁻¹. There has been a continuous monitoring of the evolution of the culture (cell density, biomass) and conditions of the culture medium (dissolved oxygen, pH, temperature, light intensity, turbidity and nutrients). To establish the balances of C inside the photobioreactor has been quantified CO₂ concentrations at the inlet and outlet of air in the degassing tank, and the concentrations of inorganic and organic carbon in the culture medium.

Were obtained growth rates ranging from 0.24 day⁻¹ for *Nannochloris atomus* and 0.11 day⁻¹ for *Tetraselmis chuii*. In the experimental conditions, the capacity of CO₂ capitation varied from 1,5 - 3,6 mg L⁻¹d⁻¹ y 1,7 - 5,1 mg L⁻¹d⁻¹ for *Nannochloris atomus* and *Tetraselmis chuii* respectively.

Injection of CO₂ was adjusted to maintain the constant pH in the culture medium. For this purpose, set a control cycle between the additions of gases (CO₂ or gas for industrial applications) and pH variations using mass flowmeters provided of a regulator and a IRGA connected to gas outlet. We found a clear dependence between the values of pH control and return to the atmosphere of CO₂ in the degassing reactors. For the pH control between 8.0 and 8.2, the concentration of CO₂ at the exit of the photobioreactor varies between 490 and 350 ppm respectively, depending of microalgae type and gas injected gas composition. In this regard, injection of pure CO₂ at low flow is more efficient in terms of the capitation in the photobiorreactor than the higher injection flow from industrial gas (13% CO₂).

The effect of *Dunaliella tertiolecta* organic exudates on the Fe(II) oxidation kinetics in seawater**A.G. González, J.M. Santana-Casiano, M. González-Dávila, M. Suárez de Tangil, N. Pérez-Almeida***Departamento de Química, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, Campus de Tafira, 35017 Las Palmas, Spain***Abstract**

The role played by the natural organic ligands excreted by the green algae *Dunaliella tertiolecta* on the Fe(II) oxidation rate constants was studied. The concentration of dissolved organic carbon was measured for each day of growth demonstrating that the concentration increased over time. The oxidation kinetics of Fe(II) was studied under the different physico-chemical conditions such as dissolved organic carbon produced by cells ($2.1\text{-}7.1\text{ mg L}^{-1}$), pH (7.2-8.2), temperature (5-35°C) and salinity (10-36.72). The rate constant always decreased in the presence of organic exudates respect to that in the control seawater. The Fe(II) rate constants were also studied in the context of Marcus theory, where ΔG° was 39.31-51.48 kJ mol⁻¹. A kinetic modelling approach was applied for computing the equilibrium and rate constants for Fe(II) and exudates present in solution, the Fe(II) speciation and the contribution of each Fe(II) species to the overall oxidation rate constant. The best fit model took into account two types of ligands with pKa,1 = 9.45 and pKa,2 = 4.9, capable of complexing Fe(II). The Fe(II) complexing constants were KFe(II)-LH = 3×10^{10} and KFe(II)-L = 10^7 and the corresponding computed oxidation rates were 68 ± 2 and $36 \pm 8\text{ M}^{-1}\text{ min}^{-1}$, respectively.

Comparative study of the chemical composition and caloric value of *Ulva* ssp. collected in two different areas of the Bay of Cadiz**Josefina Sánchez, Irene Ibáñez, Víctor M. Palacios, Ana M. Roldán***University of Cádiz, Spain***Abstract**

Seaweeds are a rich source in protein, fiber, vitamins, minerals, polyunsaturated fatty acids and essential amino acids. They also contain a variety of components that possess technological properties (agar, carrageenan, alginates) and functional ones (carotenoids, terpenes, polyphenols) such as antioxidant, anticancer and antiviral effects. These nutritional, functional and technological characteristics make seaweeds a very interesting product in different fields (food, cosmetics, pharmaceuticals, etc). In recent years, the demand has increased, particularly in the field of food which is consumed as fresh and processed (dried, canned, prepared dishes, etc.).

However, numerous studies have shown that the nutritional composition of the seaweeds is variable depending on environmental factors, such as water temperature, salinity, light, and nutrients. Most of these environmental parameters vary with the season and ecological conditions. So, the biosynthesis of various nutrients would be stimulated or inhibited. Therefore, proximal composition of seaweed and their calorific value are related to the area and time of collection.

The Cádiz coast and its marshes are a source of marine resources which are not currently used, including a large number of species of seaweeds such as *Ulva* ssp.

The geographical location of the Gulf of Cádiz is a particular area due to the influence from the Mediterranean and Atlantic streams, the wind system and marshes in the Bay of Cadiz. These characteristics could influence on the nutritional composition of seaweeds which are developing in these areas.

The main of this work was to establish the influence of the environment in the proximal composition of *Ulva* ssp comparing two collecting areas of Cádiz such as the marsh "The Pastorita" in Chiclana de la Frontera, and in an area close to the estuary of Bárbate (Bay of Cadiz). Moisture, protein, fat, carbohydrates, ash and fiber were analysed according to different methods for determination of food nutrients.

The results showed that the moisture content (84.7% of estuary and 86.5% of marsh) and carbohydrate content (11.7% of estuarine and 14.2% of saltmarsh) were very similar. However, significant differences were found for protein content (7.2% of estuary and 1.5% of marsh), fat content (3.4% of estuary and 6.4% of marsh), ash content (34.2% of estuary and 52.7% of marsh) and fiber content (9.5% of estuary and 3.1% of marsh). On the other hand, caloric values for *Ulva* ssp. in both areas (106.5 Kcal/100g of estuary and 120.5 Kcal/100g of marsh) showed low values. Therefore, *Ulva* ssp. could be considered a healthy product with high nutritional value.

In short, the proximate composition of seaweed depends largely on the collection area, being the salt-marsh a good alternative for growing and harvesting seaweed for human consumption.

References

- Gressler, V., Yokoya, N.S., Fujii, M.T., Colepicolo, P., Filho, J.M., Torres, R.P. and Pinto, E., 2010: Lipid, fatty acid, protein, amino acid and ash contents in four Brazilian red algae species. *Food Chemistry*, 120, 585-590.
- Peña-Rodríguez, A., Mawhinney, T.P., Ricque-Marie, D. and Cruz-Suárez, L.E., 2011: Chemical composition of cultivated seaweed *Ulva clathrata* (Roth) C. Agardh. *Food Chemistry*, 129, 491-498.
- Yaich, H., Garna, H., Besbes, S., Paquot, M., Blecker, C. and Attia, H., 2011: Chemical composition and functional properties of *Ulva lactuca* seaweed collected in Tunisia. *Food Chemistry*, 128, 895-901.

Oceanography

CO₂ fluxes off Northwest Africa

M. González-Dávila, J. M. Santana Casiano and F. Machín

Instituto Universitario de Oceanografía y Cambio Global, University of Las Palmas de Gran Canaria, Spain.

Abstract

CO₂ fluxes variability is explored off West Africa, an area dominated by the presence of the Mauritanian upwelling. Surface data autonomously taken by instruments installed on ships of opportunities over three years, 2005-2008, are used in the domain from the Canaries to 10°N. The observed temperature decreased with latitude and had its minimum value in the upwelling, with 17-18°C. Salinity increases with latitude, and had its minimum of 33 in autumn south of 15°S, due to heavy rainfall during that season. The fugacity in seawater showed significant spatial and temporal variability dominated by the presence of the upwelling, reaching maximum values of 750 matm in spring. CO₂ fluxes indicated that this area was a source of CO₂ throughout the year, acting as a sink just north of 24°N in winter and spring. Maximum fluxes took place in the upwelling area with values up to 3000 mmol m⁻² in spring. Between 20°-21°N, CO₂ fluxes decreased gradually over time, at an average rate of 650-700 mmol m⁻² y⁻¹. SST and fCO₂^{sw} decreased whe fCO₂^{atm} increased for the period 2005-2008.

Trends in anthropogenic CO₂ in water masses of the Subtropical North Atlantic Ocean

Elisa F. Guallart¹, Noelia M Fajar², Ollie Legge³, Peter Brown^{3,4}, Carles Pelejero^{1,5}, Marie-Jose Messias^{3,6}, Ute Shuster^{3,6}, Eva Calvo¹, Andrew Watson^{3,6}, Aida F. Ríos² and Fiz F. Pérez²

¹*Institut de Ciències del Mar, CSIC, Barcelona, Spain*

²*Instituto de Investigaciones Mariñas, CSIC, Vigo, Spain*

³*Centre for Ocean and Atmospheric Science, School of Environmental Sciences, University of East Anglia, Norwich, UK*

⁴*British Antarctic Survey, Cambridge, UK*

⁵*Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain*

⁶*College of Life and Environmental Sciences, University of Exeter, Exeter, UK*

Abstract

The North Atlantic Ocean has the largest anthropogenic CO₂ (Cant) storage rate of all oceans. The key mechanisms contributing to this are the formation of deep water masses in the North Atlantic Subpolar Gyre and the transport of warm subtropical waters that contain high Cant concentrations to these northern latitudes through the upper limb of the Meridional Overturning Circulation. The North Atlantic Subtropical Gyre becomes thus relevant for the evaluation of the North Atlantic sink when its prevailing role in the Cant uptake from the atmosphere is considered.

Here we evaluate the variability in the oceanic Cant storage within the main water masses of the Subtropical North Atlantic on decadal timescale along 24.5°N. To this aim, CO₂ system and chlorofluorocarbons measurements from five cruises of the WOCE A05 section (including two previously unpublished datasets) are used to investigate changes in Cant between 1992 and 2011. To better constrain the accumulation of Cant this was estimated using four methodological procedures that include back-calculation (ΔC^* , TrOCA, $\Phi CT0$) and tracer (TTD) approaches. Possible spatial differences in the Cant accumulation along the section were also addressed by splitting it into different regions each side of the Mid Atlantic Ridge to differentiate eastern and western patterns. Overall, we find good agreement between the results obtained using chlorofluorocarbons and CO₂ measurements: higher concentrations and greater decadal storage rates are observed in the upper layers, both values decreasing with depth. Central waters present the greatest Cant enrichment, with their upper and lower limbs showing, respectively, a mean accumulation of about $\sim 1 \mu\text{mol kg}^{-1} \text{yr}^{-1}$ and $\sim 0.5 \mu\text{mol kg}^{-1} \text{yr}^{-1}$. In the uppermost layer, our results suggests that, over the course of the last two decades, Cant was absorbed more intensely in the western side of the North Atlantic Subtropical Gyre although Cant concentrations are greater in the east. These findings are in accordance with data reported for BATS and ESTOC fixed Time Series Stations, which are located at both sides of the Gyre. Intermediate and deep layers show much lower mean storage rates, all lesser than $\sim 0.25 \mu\text{mol kg}^{-1} \text{yr}^{-1}$. These become more relevant when longitudinal differences in the Cant accumulation are considered. West of 70°W, we find noticeable Cant storage rates for the more recently ventilated waters that move southward within the Deep Western Boundary Current, compared with the regions of the ocean interior. If a transient stationary state of the Cant distributions is considered, significant bi-decadal trends in the Cant storage rates are detected for the deepest North Atlantic waters.

Carbon dioxide. Spatial and seasonal variability in the southwestern Spanish mediterranean

García-Martínez, M.C.¹, Moya, F.¹, Vargas-Yáñez, M.¹, Serra, M.², López-Jurado, J.L.², Aparicio, A.², Tel, E.³, Balbín, R.², Amengual, B.², Alvarez, M.⁴

¹Instituto Español de Oceanografía, IEO. Puerto Pesquero, s/n.29640-Fuengirola

²Instituto Español de Oceanografía, IEO. Muelle de Poniente s/n 07015.-Palma Mallorca

³Instituto Español de Oceanografía, IEO. C/Corazón de María, 8. 28002-Madrid

⁴Instituto Español de Oceanografía (IEO) Paseo Marítimo Alcalde Fco Vazquez 15001 A Coruña

Abstract

RADMED monitoring program, implemented by the Spanish Institute of Oceanography, carries out four cruises per year (one per season) from the Straits of Gibraltar to Barcelona, including Balearic islands.

Temperature, salinity, dissolved oxygen, chlorophyll-a, inorganic nutrients, phyto and zooplankton abundance and taxonomic composition along the water column are sampled in all the oceanographic stations.

Carbon dioxide (CO₂) is the most important anthropogenic green house gas and the carbonate system in seawater plays an important role in the biogeochemical cycles, being intimately linked to the processes of photosynthesis and respiration. Therefore, pH, Total Alkalinity (TA) and partial pressure of carbon dioxide in air (pCO₂) have been included in the RADMED sampling since 2010. The pH and total alkalinity measurements are determined using a potentiometric method using a titrator and a potentiometer, and partial pressure of carbon dioxide in the air (pCO₂) is measured with a SUNDANS analyzer (Surface UNDERway carbon Dioxide partial pressure AnalySer). This instrument determines the partial pressure of carbon dioxide in air that is in equilibrium with a flowing stream of seawater.

The above mentioned variables were monitored in the northern continental shelf and slope of the Mediterranean Sea from Cape Pino (western Alboran Sea) to Cape Palos in the South East Spanish Mediterranean coast. The measurements were obtained from the sea surface to the bottom during six oceanographic surveys extending from summer 2010 to winter 2014. The main goal of this work is to describe both geographical (Southwest-Northeast) and vertical gradients and seasonal variability in the total Alkalinity of sea water. The geographical area studied is affected by the progressive transition from waters highly influenced by the incoming Atlantic jet to waters modified by their circulation within the Mediterranean Sea. At the same time, the thermohaline circulation of the Mediterranean establishes the presence of clearly distinctive water masses at the sea surface, at intermediate waters (200-600m) and at the deep waters. The six oceanographic surveys analyzed extended along a whole seasonal cycle. In the present work it is analyzed the influence of Atlantic versus Mediterranean waters, the depth dependence and the seasonal variability on the total Alkalinity.

Summer air-sea CO₂ fluxes in the Arctic Ocean shelves obtained during the Tara Oceans Polar Circle 2013 expedition**X.A. Padin¹, D. Ruiz-Pino², A.M. Cobo-Viveros¹, A. Bouvet^{2,3}, F. F. Pérez¹, A. F. Ríos¹**¹*Instituto de Investigaciones Marinas, CSIC, Eduardo Cabello 6, E-36208 Vigo, Spain*²*LOCEAN, Université P&M Curie, Courrier 134, 4 pl. Jussieu, 75252 Paris Cedex 05, France*³*SIO (Second Institute of Oceanography), SOA (State Ocean Administration), Hangzhou, People Republic of China***Abstract**

The Arctic Ocean was in the 20th century a potentially high sink for atmospheric carbon dioxide (CO₂) contributing from 5 to 14% to the global balance. The capacity of the Arctic Ocean to uptake CO₂ is expected to increase in response to sea-ice loss and an actively growing phytoplankton community although mitigated somewhat by surface warming in the Arctic. But increased melting of glaciers and freshwater flows provided by rivers in consequence of the climate change could instead convert the Arctic ocean in a source of CO₂ to the atmosphere. The harsh polar climate and difficult logistical support have limited most studies of the marine carbon cycle to opportunistic icebreaker surveys. The under sampling and the many uncertainties about the physical and biological processes that control the air-sea CO₂ fluxes in the Arctic make important to monitor changes in the ocean CO₂ uptake.

The Tara Oceans Polar Circle 2013 expedition conducted on board R/V Tara circumnavigated the Arctic Ocean covering 25.000 km via the Northeast and Northwest passages from May 2013 to December 2013. This oceanographic cruise expedition represented a unique opportunity to analyse from a quasi-synoptic point of view in situ pCO₂ measurements in surface waters along Arctic Ocean shelves. The first underway measurements along the Arctic Ocean shelves of sea surface molar fraction of CO₂ were performed with an autonomous device, Pro-Oceanus CO₂ sensor. Moreover, ancillary data was also obtained from different autonomous equipment such as a thermosalinograph, fluorometer, oxygen sensor and pH-meter, which were connected to the same uncontaminated seawater supply. Phytoplankton abundance, taxonomy and genetic were also obtained in summer 2013, a period of strong sea and continental ice melt.

The Arctic Ocean surface waters mostly acted as sinks of atmospheric CO₂ in spite of showing a high variability of CO₂ in surface water during the sea ice-free period. Low values, around 210 μatm, were reached in the Norwegian and Chukchi Sea where high nutrient-rich waters coupled with abundant light sustain high rates of primary production. However minimum pCO₂ values close to 175 μatm were observed in Kara Sea, which is highly influenced by both Siberian river (Yenisey) and exchanges with other close shelves. Only low productive coastal waters of the East Siberian and Beaufort Seas were notably supersaturated with CO₂. The supersaturation could be due to the remineralization of organic matter introduced from the Kolyma River and the Mackenzie River, respectively. The Canadian Archipelago has been poorly sampled regarding to carbonate parameter and had seawater pCO₂ conditions close to equilibrium with the atmosphere.

These observations obtained during one of the summer's largest sea ice free surface will serve as a basis for answering the question if the CO₂ uptake in Arctic shelves is increasing or decreasing. The conversion of the Arctic into a source of CO₂ producing a positive feedback, which would induce, in next decades, an increase of atmospheric CO₂.

Air-waters fluxes of greenhouse gases (CO₂, CH₄ and N₂O) in the north-eastern shelf of the Gulf of Cádiz**Forja, J.M.¹, Ferrón, S.², Ribas, M.³, Ortega, T.¹, Ponce, R.¹, Gómez-Parra, A.¹**¹*Dpto. Química-Física, CACYTMAR, Universidad de Cádiz, Campus Río San Pedro, s/n, Puerto Real (Cádiz), Spain*²*Department of Oceanography, University of Hawaii, Honolulu, Hawaii, USA*³*Ocean and Earth Sciences. University of Southampton, National Oceanography Centre, Southampton***Abstract**

The distribution of greenhouse gases (CH₄ and N₂O), inorganic carbon system parameters and its controls were investigated in the coastal waters of the north-eastern shelf of the Gulf of Cádiz during four cruises that took place in June 2006, November 2006, February 2007 and May 2007. Water column samples were collected at 63 stations to measure total alkalinity (TA), pH, dissolved oxygen, dissolved organic carbon, nutrients and chlorophyll-a. Additionally, on line pCO₂ was registered in superficial waters.

Gulf of Cadiz northwestern continental shelf behaves as an atmospheric source of CH₄ and N₂O during the whole year, with saturations values ranging between 73–1820% and 99–344%, respectively. Both gases distribution vary seasonally, presenting higher concentrations in summer and fall than winter and spring. Water column CH₄ and N₂O concentrations show significant horizontal and vertical spatial variability, which is mainly influenced by continental inputs and benthic fluxes. Tidal exchange seem to affect noticeable the CH₄ and N₂O distributions in the studied coastal zone of the Gulf of Cadiz (the lower estuary of Guadalquivir Estuary and Bay of Cadiz) along the whole year. Particularly, during rainy seasons it has been observed an increase in both gas concentrations associated with continental water inputs. Mean annual flux has been estimated from surface water database, being 8.3-14.1 μmol of CH₄ m⁻² d⁻¹ and 8.1-14.7 μmol of N₂O m⁻² d⁻¹. Benthic fluxes of methane and nitrous oxide, if they are extrapolated to the entire study zone, about 20% and 45% of the atmospheric fluxes, respectively.

Intra-annual variability of pCO₂ was assessed and is discussed in terms of mixing, temperature and biology. In the study area of the shelf, thermodynamic control over pCO₂ predominates from early May to late November, and this is opposite and similar in magnitude to the net biological effect. However, biological control over pCO₂ predominates during winter. The results suggest that surface waters in the coastal area are under-saturated with respect to atmospheric CO₂ during most of the year; therefore they represent a sink for atmospheric CO₂ between November and May (-1.0 mmol m⁻² day⁻¹), but a weak source in June (1.3 mmol m⁻² day⁻¹). In contrast, the coastal ecosystems studied (the lower estuary of Guadalquivir Estuary and Bay of Cadiz) acted as a weak sink for atmospheric CO₂ during February (-1.3 mmol m⁻² day⁻¹) and as a source between May and November (2.6 mmol m⁻² day⁻¹). The resulting mean annual CO₂ flux in the north-eastern shelf of the Gulf of Cadiz was -0.07 mol m⁻² year⁻¹, indicating that the area acts as a net sink on an annual basis.

TA concentrations range between 2313 and 2450 μmol kg⁻¹, the highest values reached in summer and the lowest in winter. In addition, dissolved inorganic carbon was calculated and its variability was employed to determine rates of net ecosystem production (NEP). The highest rates of NEP (14 mmol C m⁻² d⁻¹) occurred off Guadalquivir Estuary in the winter-spring period. A total NEP rate of 1.2 mmol C m⁻² d⁻¹ was estimated for the studied area, which makes it autotrophic in an annual scale.

Keywords: Greenhouse gases, methane, nitrous oxide, pCO₂, inorganic carbon system, air–water fluxes, seasonal variations, Gulf of Cádiz

Seasonal variations on greenhouse gas emissions from coastal systems located in Cádiz Bay (SW Spain)**Burgos, M., Forja, J.M., Ortega, T.***Dpto. Química-Física, CACYTMAR, Universidad de Cádiz, Campus Río San Pedro, s/n, Puerto Real (Cádiz), Spain.***Abstract**

Dissolved concentrations of CO₂, CH₄ and N₂O have been seasonally measured in three coastal systems of Cadiz Bay: Guadalete River estuary, Rio San Pedro tidal creek and Sancti Petri tidal channel. Coastal areas are subject to a great anthropogenic pressure causing organic matter inputs, which intensifies greenhouse gas emissions into the atmosphere. Carbon dioxide, methane and nitrous oxide emissions into the atmosphere are especially interesting in these coastal systems, with different hydrodynamic characteristics, since they receive large anthropogenic inputs such as urban effluents and direct discharges from agriculture. Guadalete River estuary has been intensely contaminated since 1970. Currently it receives wastewater effluents from cities as well as inputs from nearby agriculture crop. Rio San Pedro Creek is tidally controlled. Due to its little freshwater input, the creek is essentially a marine system. Several fish farms are distributed on its banks discharging effluents without previous treatment. Sancti Petri Channel is a flow channel-ebb tides extending from the inner Cadiz Bay to the Atlantic Ocean along 17 Km. Organic matter pollution sources in this environment are straggly. There exist anthropogenic inputs such as aquaculture's effluents and sewage discharges coming through Iro River, which flows into the channel central part. In addition there are natural organic matter inputs from surrounding marshes. Four seasonal sampling were conducted along the year 2013. The pCO₂ values were obtained through measurements of total alkalinity and pH. The concentrations of CH₄ and N₂O were measured using a gas chromatograph connected to an equilibration system. Greenhouse gas values vary widely between 193.1 and 3778.3 μatm, 6.0 and 4201.1 nM and 7.1 and 292.0 nM for pCO₂, CH₄ and N₂O, respectively. Seasonal distribution of the studied gases was influenced by the precipitation regimen and their concentrations increased in the vicinity of the anthropogenic organic matter and nutrients inputs. The environments act as greenhouse gas sources into the atmosphere along the whole year. It has been estimated mean fluxes of 20.3 mmol m⁻² d⁻¹ of CO₂, 166.9 nmol m⁻² d⁻¹ of CH₄ and 52.4 nmol m⁻² d⁻¹ of N₂O.

Keywords: greenhouse gases, air-water exchange, coastal systems

Tropical tuna Spanish fisheries**María Soto Ruiz***Instituto Español de Oceanografía, Spain***Abstract**

Spanish tropical tuna fisheries operates in the Atlantic Ocean since th 1980s, fishing the three tropical tuna species: yellowfin (*Thunnus albacares*), skipjack (*Katsuwonnus pelamis*) and bigeye (*Thunnus obesus*). These species are mainly caught for the fish cannery industry. After that, the Spanish fisheries extended to the Indian and the Pacific oceans. These highly migratory stocks are managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC), the Inter American Tropical Tuna Comisión (IATTC) and the West Central Pacific Fishery Commission (WCPFC). The European Union is a contracting party of all of them, and the Spanish Oceanographic Institute participates in the scientific advice for the management of these three tropical tuna stocks.

The highly uncertainty stock assesments of tropical tunas is mainly due to the lack of direct abundance indices that could provide a reliable image of the tuna stocks populations in the sea. For these highly migratory species, there are no fishing surveys to provide direct abundance indices, and the available information used comes from commertial data. This implies that abundance indices are biased by the constant improvement of technology and the lack of correspondence between the fishing season/area and the global distribution of tunas populations.

The Spanish tropical tuna fisheries have experienced important technological improvements since 1980s, developping in the 1990s a fishing mode on floating objects that took advantage of the tunas behaviour of aggregation under any artifitial or natural object. Since the last two decades, the increasing use of drifting fishing aggregative devices (FADs) by the purse seine fleets has changed the length distributions of the tunas tropical landings. In contrast to non-associated school sets which target large fish (mainly yellowfin, *Thunnus albacares*), FADs fishing operations concern skipjack (*Katsuwonnus pelamis*) and juveniles of yellowfin and bigeye tunas (*Thunnus obesus*). In the last decade, the use of satellite buoys associated to FADs has become an extremely powerful fishing mode that vessels use to improve their fishing strategy. In order to regulate this fishing mode, the Spanish Oceanographic Institute has participated in the implementation of the Fish Aggregating Device National Management Plan undertaken by the Spanish General Secretariat of Maritime Fisheries, which is compulsory since January 2011 for the Spanish freezer purse-seine fleet targeting tropical tuna in the Atlantic, Indian and Pacific oceans.

Its a challenge for fishery scientist to developpe direct abundande indices for tropical tunas from the acoustic information of buoys associated to FADs. The elaboration of new direct indices its the big deal that could improve stock assessment of tropical tunas in the absence of survey information. Nowadays, the Spanish Oceanographic Institute is involved in several reseach projects related with this issues, namely, the EU project CECOFAD and TUNABAI. As a result, uncertainty in the status of tropical tunas would be reduced and reflected in the improvement of the difficult management of these stocks.

Development of an analytical methodology for the determination of B-vitamins in seawater**Barber-Lluch E.¹, Fernández E.¹, Nieto O.²**¹*Departamento de Ecología e Biología Animal, Universidade de Vigo, 36310 Vigo, Spain.*²*Departamento de Química Analítica y Alimentaria, Universidade de Vigo, 36310 Vigo, Spain.***Abstract**

Many species of primary producers grown in cultures have been reported to be auxotrophic for B-vitamins. However, little is known on role of these organic compounds on the control of natural phytoplankton assemblages. Recent studies carried out by our group in a coastal system demonstrated that, under certain circumstances, stimulation of phytoplankton biomass and production after additions of inorganic nutrients only occurred when heterotrophic bacteria were active, presumably releasing organic molecules required by microalgae. This investigation line is focused on the hypothesis that B-vitamins could be a limiting factor for phytoplankton growth in coastal systems in some oceanographic periods.

Aiming to know more about the B-vitamins concentration in coastal natural waters, a reliable analytical method has been developed for the direct determination of this group of compounds using reversed phase high-performance liquid chromatography (HPLC) with photodiode array detection (UV-vis). With this methodology, 8 different B-vitamins can be separated and quantified: thiamine (B1), riboflavin (B2), nicotinic acid (B3), nicotin amide (B3), pantothenic acid (B5), pyridoxine hydrochloride (B6), pyridoxamine (B6), pyridoxal-5-phosphate (B6), biotin (B7), folic acid (B9) and cobalamine (B12).

Previously to the HPLC determination, sea water samples collected in the Ría of Vigo have been adjusted at different pH values in order to perform a solid-phase extraction with a C18 silica column, retaining different B-vitamins groups, and followed by elution with methanol (Okbamichael & Sañudo-Wilhelmy, 2004). The B-vitamins separation performed in the HPLC system is carried out in gradient mode with acetate buffer at pH 5 and methanol as mobile phases. The gradient starts with 100% of aqueous phase with a slightly increase of methanol percentage over the first 30 minutes, reaching 20% of methanol in the last 10 minutes gradient. UV-vis detection using a diode array detector allows the determination of different B-vitamins levels based on the absorbance at their correspondent wavelengths.

This new method is applied to a study of temporal and depth distribution of B-vitamins in coastal water samples of the Ría of Vigo.

References

Okbamichael, M.; Sañudo-Wilhelmy, S.A. (2004) A new method for the determination of Vitamin B12 in seawater. *Anal Chim Acta* 517(1-2):33-38

Corrosion rates of metallic underwater archaeological materials: affection assessment of environmental conditions in coastal marine environment**Fernández-Montblanc, T.¹, Bethencourt, M.¹, Izquierdo, A.²**

¹*Department of Materials Science and Metallurgical Engineering and Inorganic Chemistry, University of Cadiz, Marine Science and Technological Center of Andalusia, International Campus of Excellence of the Sea (CEI-MAR), Avda. República Saharaui s/n, Puerto Real, 11510 – Spain*

²*Applied Physics Department, University of Cadiz, Marine Science and Technological Center of Andalusia, International Campus of Excellence of the Sea (CEI-MAR), Avda. República Saharaui s/n, Puerto Real, 11510 – Spain*

Abstract

Underwater archaeological material deterioration and corrosion rates are closely related with chemical, physical, biological and sedimentary conditions in the archaeological sites. Specially, in underwater archaeological sites located on coastal areas, these conditions may vary widely according to different processes and timescales, affecting to archaeological materials stability and degradation process.

The aim of this work is evaluate the contribution of environmental marine conditions in the degradation process of underwater archaeological metallic materials, using for this purpose modern materials with similar characteristics.

In the present works preliminary results of the corrosion rates measurement in modern metallic materials (iron, iron cast, copper and brass) subject to different environmental conditions was presented. In addition, to evaluate the contribution of environmental factors in the archaeological metallic materials, monitoring of chemical, physical, biological and sedimentary conditions was conducted.

This study was carried out selecting two wrecks with the same chronology, but under very different environmental conditions was selected like studies areas. Fougoux Site and Bucentaure Site, both identify with two French ships, sunk during the Trafalgar Battle Ship 1805, in the vicinity of Cadiz Bay. The methodology used to assess the environmental conditions impact on archaeological materials was as follows. On the one hand the degradation rates of different modern materials samples (iron, iron cast, copper and brass) subject to dissimilar environment (permanent burial, continuously exposed, and alternatively reburial and exposed) were periodically evaluated after various exposition time in the two study sites. Electrochemical measurement in laboratory and weight loss test was conducted. The identification of corrosion product was effected by X-ray diffraction (XRD) technique. On the other hand, on both studies areas, chemical, physical, biological and sedimentary conditions were motorized. Hydrochemical characterization of the whole water column was done whit periodical measured of pH, redox potential, temperature, salinity and dissolved oxygen. Geochemical characterization of surface sediment layer was conducted taking core samples of both areas. Thus, pH, redox potential and organic matter concentration was measured. Furthermore, hydrodynamics conditions, current and waves was measured using ADCP and EM current meters. Biological community characterization in artificial metallic samples was carried out. Finally, samples of sediment were analyzed, enabling the grain size characterization and sediment mobility assessment in both areas.

Acknowledgements. This work was found by the Ministry of Economy and Competitiveness throughout the project ARQUEOMONITOR: Study of the influence of physical, chemical and biological conditions deterioration and safeguarding in Underwater Cultural Heritage (CTM2010-16363).

What to do when a protected species eats your fish? A quantitative assessment of the interactions of dolphins and fishermen**Efraín Morales, Manuel Alduán, Ninoska Adern, Borja Reyes, Natacha Aguilar de Soto***BIOECOMAC. Dept. Animal Biology, Geology and Edaphology. University of La Laguna, Tenerife, Canary Islands.***Abstract**

Interactions between cetaceans and fisheries occur in many areas of the world. They can have consequences on the local economy and on the conservation of the species. In the Canary Islands this problem has a strong impact on the artisanal fishery of “el alto”. This is a deep-sea fishery using long-lines with 10-20 hooks to catch demersal species at 400-800 m depth. The main targeted species are Alfonsino (*Berix decadactylus*), Alfonsino splendens (*Beryx splendens*), Oilfish (*Ruvettus pretiosus*), Rabbitfish (*Promethichtys prometheus*) and Blackbelly rosefish (*Helicolenus dactylopterus dactylopterus*). In the archipelago, the fishery of “el alto” is most common in the western Canary Islands of La Palma and El Hierro and lower degree in Fuerteventura and Lanzarote. In these islands there are deep waters near the coast and it is possible to access the deep-water resources from small artisanal boats. Fishermen started complaining about dolphins taking fish from the lines in La Palma in the 1990’s, ten years earlier than in El Hierro. There are also some complains in Fuerteventura and Lanzarote. Here we quantify the level of dolphin interactions in El Hierro, their economic impact and the observed impacts on the dolphins. Also, we evaluate the potential effect on the level of interactions of a one-year long moratoria to fishing in El Hierro (2011-2012) following an underwater volcanic eruption. Data were gathered seasonally by dedicated observers on-board the fishing boats from May 2012 to May 2014 (n=44 boardings in 35 fishing days). Results show that two cetacean species are involved in the interactions: the common bottlenose dolphin (*Tursiops truncatus*) and the rough-toothed dolphin (*Steno bredanensis*). Dolphins take fish from the “el alto” fishery during a mean of 30% of the fishing days, with seasonal variability. This creates significant economic losses for the fishermen most specialized in the el alto fishery (some 10,000 euros per year for a fisherman). Also, the interactions have implications for the sustainability of the local fisheries when fishermen increase fishing effort on coastal species to substitute losses in the fishery of el alto. The impact on the dolphins is high also: dolphins suffer direct attacks from fishermen with explosives and harpoons (in La Palma and in El Hierro in the past), and can get entangled in the lines (at least two entanglements recorded in summer-autumn 2013). These impacts are relevant as dolphins are protected under the Canary Islands and Spanish catalogues of protected species, and under the European Habitats Directive. Moreover, the interactions with the fishery of “el alto” often occur within Special Areas of Conservation designated by the Habitat Directive to protect bottlenose dolphins.

The one year-long pause on fishing created by the volcanic eruption provided an ideal opportunity to test the hypothesis that a stop on fishing could have a positive effect by reducing the interactions with the dolphins when the fishery re-starts. Our results show that dolphins did not forget the acquired foraging method of interacting with fishing lines in the year with no or little fishing. Follow up work includes providing fishermen with quantitative data on the economic losses they experience due to the interactions with the dolphins, to base potential requirements of the fishermen for economic compensations in order to prevent further illegal attacks to protected species. Also, we will develop and test a mechanical device to reduce the access of dolphins to the fishing lines. This study is part of the project “Canarias con la Mar” funded by Fundación Biodiversidad.

Encuentro de la Oceanografía Física Española 2014

Large-scale processes

Two Modes of Gulf Stream Variability Revealed in the Last Two Decades of Satellite Altimeter Data

Pérez-Hernández, M. Dolores¹, Terrence M. Joyce²

¹*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Las Palmas, Spain*

²*Department of Physical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts*

Abstract

Monthly mapped sea level anomalies (MSLAs) of the NW Atlantic in the region immediately downstream of the Gulf Stream (GS) separation point reveal a leading mode in which the path shifts approximately 100 km meridionally about a nominal latitude of 39°N, producing coherent sea level anomaly (SLA) variability from 72° to 50°W. This mode can be captured by use of a simple 16-point index based on SLA data taken along the maximum of the observed variability in the region 33°–46°N and 45°–75°W. The GS shifts between 2010 and 2012 are the largest of the last decade and equal to the largest of the entire record. The second group of EOF modes of variability describes GS meanders, which propagate mainly westward interrupted by brief periods of eastward or stationary meanders. These meanders have wavelengths of approximately 400 km and can be seen in standard EOFs by spatial phase shifting of a standing meander pattern in the SLA data. The spectral properties of these modes indicate strong variability at interannual and longer periods for the first mode and periods of a few to several months for the meanders. While the former is quite similar to a previous use of the altimeter for GS path, the simple index is a useful measure of the large-scale shifts in the GS path that is quickly estimated and updated without changes in previous estimates. The time-scale separation allows a low-pass filtered 16-point index to be reflective of large-scale, coherent shifts in the GS path.

On the influence of Subtropical Highs in the development of Atlantic Niños**Marta Martín-Rey^{1,2}, Irene Polo³, Belén Rodríguez-Fonseca^{1,2} and Alban Lazar⁴**¹*Instituto de Geociencias (CSIC-UCM), Facultad de CC. Físicas, Plaza de Ciencias 1. 28040-Madrid, Spain*²*Universidad Complutense Madrid, Departamento de Física de la Tierra Astronomía y Astrofísica I, 28040 Madrid, Spain*³*NCAS-Climate, University of Reading, Reading, United Kingdom*⁴*LOCEAN-IPSL, University of Paris VI, Paris, France***Abstract**

The Atlantic Niño is the leading mode of interannual Tropical Atlantic SST variability during boreal summer. It has been shown that changes in Sta Helena High play a role in the development of this mode, in such a way that anomalous geostrophic winds associated with a weakening of this High pressure System are observed previously to the Atlantic Niño evolution. Nevertheless, recent observational studies also suggest that the Azores High could contribute to its development, although the processes involved are still unknown.

The objective of the present work is to understand the contribution of both Subtropical Highs in the development of the Atlantic Niño after the 1970s, when changes in its spatial structure, amplitude and frequency have been reported. To this aim, a set of experiments with the NEMO OGCM are performed. Firstly, an interannual simulation is run considering observational winds for the period 1991-1999, a representative decade of increased SST variability over the equatorial Atlantic. The observed Atlantic Niño events are well reproduced, suggesting the important role of the wind forcing in generating the SST anomalies. In particular, we present the analysis of the oceanic processes at work in the development of a case study.

On the origin of the seasonal and interannual T-S variability of the inflow through the Strait of Gibraltar

Jesús García Lafuente, Cristina Naranjo, Ricardo Sánchez, José C. Sánchez Garrido, Simone Sammartino

University of Málaga, Spain.

Abstract

During several years of the last decade, the hydrological properties of the Atlantic inflow through the Strait of Gibraltar were monitored at a station located over the Moroccan continental shelf south of Camarinal sill. The station, deployed and maintained by the Centre Oceanologique de Marseille in collaboration with SHOMAR (Morocco) was part of the HydroChanges monitoring network sponsored by the CIESM¹ and collected a good quality set hydrological observations at 80 m depth from 2003 to the end of 2008, when the scientific equipment was lost. In an interesting paper, Millot (2007) analyzed the time subseries spanning from 2003 to early 2007 and showed an indisputable seasonal signal in the Atlantic inflow and a trend of the salinity of the Atlantic water that was flowing toward the Mediterranean Sea at the depth of the station. Since the inflowing water comes from the Gulf of Cadiz, any signal detected in the inflow must be present in that area, a fact that has inspired the present work, which makes use of different experimental (ARGO Global Marine Atlas, Altimetry, QuickScat winds, and the whole time series at Camarinal), re-analysis (NCEP-NCAR) and numerical (ECCO model) data to address the topic.

The seasonal local signals of temperature and salinity in the Gulf of Cadiz, both of them neatly depicted in the analyzed data, show up different origins. The temperature oscillation is accounted for by the surface heat flux to a very great extent (more than 80%), while the salinity signal is not sensitive to any surface flux at all, but to advective fluxes. ARGO Global Marine Atlas and ECCO model data strongly suggests that the seasonal fluctuations of the position and extension of the North Atlantic Subtropical Gyre are driving the seasonal salinity signal observed in the Gulf of Cadiz, which is later advected into the Mediterranean Sea through the Strait of Gibraltar. The important conclusion to be drawn is that the interannual variations of the seasonal fluctuations of the Gyre will generate short-term trends of the seawater properties observed in the Gulf of Cadiz (intra-decadal variability) and, hence, in the Strait. Actually, the ECCO database indicates that such a short-term trend of the Gyre position to be displaced to the east took place during the same years as the salinity trend in the inflow reported by Millot (2007). Thus the salinification mentioned by this author would have its origin in the large scale dynamics of the North Atlantic Subtropical Gyre, since the more to the east the Gyre reaches, the easier will be to find saltier water in the Gulf of Cadiz. To this regard it is worth noting that the trend of the North Atlantic Subtropical Gyre to be displaced to the east stopped in year 2007, which coincides with the end of the short-term trend that was being detected by the monitoring station. Millot's analyses embraced the period from February 2003 to February 2007, which ended before the trend changed, and he could not envisage that change.

As far as the salinity of the inflow is a fundamental ingredient of the thermohaline circulation of the Mediterranean Sea, the understanding of the mechanism that causes the interannual variability of the seasonal pattern of the North Atlantic Subtropical Gyre would be critical for studies of the interannual variability of the Mediterranean Sea circulation. The issue is currently under study although large scale wind field in the North Atlantic posits is the most likely candidate.

¹<http://www.ciesm.org/marine/programs/hydrochanges.htm>

Ten years of marine current observations in Espartel Sill, Strait of Gibraltar**S. Sammartino , J. García Lafuente, J.C. Sánchez Garrido, C. Naranjo, J. Delgado***Physical Oceanography Group, University of Málaga. Campus de Teatinos s/n. 29071, Málaga***Abstract**

Almost ten years of Acoustic Doppler Current Profiler (ADCP) observations of the outflowing currents in the southern channel of the Espartel Sill in the Strait of Gibraltar have been analyzed to make a long-term estimation of the Mediterranean outflow through that section. A total of 25 moorings have been deployed from September 2004 to April 2014 nearly continuously, with a one-year break in August 2011, due to a temporary change of the mooring location in the Camarinal Sill, and few sporadic gaps in January 2009 and January 2011 due to the partial loss of the line. All data sets have been submitted to a careful quality control in order to address issues related to the coherence of the measured data, with the aim to check the inter-comparability of the different time series. A slightly different configuration set has been used throughout the years in order to test the robustness of the measurement and the good homogeneity of the whole dataset has been verified. Tilt range of variation and horizontal velocity error based on a statistical estimate of the ensemble standard deviation have been carefully assessed and the latter has been used to filter the residual spikes mostly concentrated in the upper bins of the vertical profiles. The missing mooring has been reconstructed by inferring velocities from a parallel mooring deployed contemporarily in Camarinal Sill and Espartel Sill, basing on a combination of subinertial correlation with atmospheric forcing and the reconstruction of the tidal dynamics by harmonic analysis. Finally a three-dimensional high resolution numerical model, widely validated over the area of interest, has been used to aid the assessment of the possible overestimation of the flow by the ADCP observations through the entire section of the Espartel Sill and the reconstruction of the missing mooring in 2011.

On the temporal and spatial coherence of coastal upwelling**A. Benazzouz¹, J. L. Pelegrí², H. Demarcq³, F. Machín⁴, E. Mason⁵, A. Orbi¹, J. Peña-Izquierdo²**¹*Institut National de Recherche Halieutique, Boulevard Sidi Abderhamanne, BP 20030, Casablanca, Morocco*²*Institut de Ciències del Mar, CSIC, Passeig Marítim de la Barceloneta, 37-49, 08003 Barcelona, Spain*³*Institut de Recherche pour le Développement, BP 5045, 34032 Montpellier cedex 1, France*⁴*InvestigAdHoc, Telde, Gran Canaria, Spain*⁵*Institut Mediterrani d'Estudis Avançats, Carrer Miquel Marquès, 21, 07190 Esporles, Illes Balears, Spain***Abstract**

In a two-dimensional world, with depth and cross-shore distance as the only spatial axes, coastal upwelling responds quite fast to the along-shore sea-surface winds, on time scales of the order of hours to days. This is the reason why coastal upwelling indices, used to predict the intensity of upwelling at some coastal location, are often calculated in terms of the instantaneous along-shore local winds, i.e. the Bakun (1973) index and some of its variations simply assess the intensity of cross-shore Ekman transport. This approach ignores along-shore pressure gradients, internal friction and, most important for our analysis, the advection of upstream momentum.

In this work we first examine under which circumstances, and how much, the upstream momentum can play a role similar to the along-shore wind stress in the sustainment of coastal upwelling. The key condition for the maintenance of upwelling beyond the wind intermittency turns out to be the advective temporal scale (related to the spatial coherence of the wind), which has to be longer than the local temporal scale, i.e. the spatial coherence of the along-shore coastal jet is capable of replacing the temporal intermittency of the cross-shore Ekman transport.

Second, we apply these ideas to the coastal upwelling region off NW Africa. For this purpose we use time series of sea-surface temperature (SST) differences (between the coast and offshore regions) and coastal winds. We calculate the temporal and spatial auto-correlations for the wind and SST differences, and the cross-correlations between both variables. It turns out that off NW Africa the advective time scale is often longer than the local temporal scale, which brings a characteristic temporal memory of the order of 1-2 months.

Finally, we define a cumulative upwelling index as the integration of past cross-shore Ekman transports over a time scale which brings the maximum correlation with the SST differences. This time scale, consistent with the time scale for maximum cross-correlations between SST differences and local Ekman transport, is the temporal memory of the upwelling system.

References

Bakun, A. (1973) Coastal Upwelling Indices, West Coast of North America, 1946–1971, U.S. Department of Commerce, NOAA Technical Report NMFS–SSRF–671.

Oceanography and Marine Climate

Review of sea level processes along the Spanish coast for the altimetry period

Begoña Pérez Gómez¹, Irene Pérez González², Philip L. Woodworth³, Enrique Alvarez Fanjul¹

¹*Puertos del Estado, Spain*

²*SIDMAR Bernhard Pack S.L.*

³*National Oceanography Centre (Liverpool, UK)*

Abstract

Since the beginning of the 1990's there has been a significant increase of sea level measurements from tide gauge networks and the different altimetry missions, two systems of observation that perfectly complement each other. For the Spanish coast, this has been possible in part due to the establishment of the REDMAR network in 1992, composed today of 36 stations. It is now possible, therefore, to obtain a much better spatial characterization and detailed analysis of the different sea level processes along the Spanish coast, including the Canary and the Balearic Islands, for the so-called altimetry period (1992-2013). The objective of this work is to present a comprehensive review of this variability, updating or confirming the results of previous studies published for the region. The combination of data from in-situ coastal gauges and altimetry data at the open-sea, in spite of its difficulty and the need of careful interpretation, is also introduced here as a tool for a better understanding and mutual quality control of both types of measurements. Observed differences between altimetry and tide gauges, including their different trends and their correlation are presented, as well as the evolution of extremes (percentiles), harmonic constants and sea level anomalies for the last 20 years. Other aspects are also studied such as the spatial variation of the seasonal cycle, the influence of the meteorological component or the relation to climate indexes such as the North Atlantic Oscillation.

As an example of the main results, tide gauge relative sea level trends since 1992 show a large spatial coherence alongshore, increasing progressively from 0.1 to 0.25 cm/y in the North, to 0.3 to 0.4 cm/y in the South and significantly larger values (between 0.5 and 0.6 cm/y) in the Mediterranean and Canary Islands stations. At the same time, at the latter stations the sea level trends are larger and sometimes double the ones of the altimeter. In spite of the uncertainties of these trends, that reflect of course the natural variations for the period of study, a discussion is made of this difference, the influence of the Glacial Isostatic Adjustment (GIA) or of the local movements at the stations. The analysis of the spatial variation of the correlation altimeter-tide gauge reflects the different degree of complexity of the circulation patterns near the tide gauge: higher values are found for the islands (over 0.9) and lower values in the Gibraltar Strait and the Alboran Sea (lower value: 0.7).

Most of the results presented (harmonic constants evolution, seasonal cycle variation) are in general consistent with previous publications. A clear relation to the North Atlantic Oscillation Index (NAO) is observed in the mean sea level anomalies, explaining the positive peaks in mean sea level in 1996 and 2010 (negative phase of the NAO) and the negative peak in mean sea level in 2012 (positive phase of the NAO), according to the opposite sign relation NAO – sea level along the Spanish coast. A negative trend in the NAO index could in fact explain part of the positive trend observed for the REDMAR tide gauges since 1992 up to now. Finally the temporal evolution of the extremes reveals a different trend in the higher levels (practically null or negative) with respect to the ones in mean sea level and lower water levels (positive) that should be further investigated in the future.

Dynamics of the Iberian waters derived from MyOcean IBI products (forecasted and reanalyzed) for the period 2002-2012.

Sotillo M.G.¹, Cailleau S.², Cotelo C.³, Lorente P.¹, Levier B.², Aznar R.¹, Amo-Baladrón A.¹, Reffray G.², Alvarez-Fanjul E.¹

¹*Puertos del Estado. Av Partenón, 10 28042 Madrid, Spain*

²*Mercator-Ocean. Parc Technologique du Canal. 8-10 rue Hermès 31520 Ramonville St-Agne FRANCE*

³*CESGA -Centro de Supercomputación de Galicia- Avenida de Vigo, s/n, 15705 Santiago de Compostela, Spain*

Abstract

The MyOcean IBI-MFC (Monitoring & Forecasting Center) provides since mid-2011 continuous ocean state estimates and forecast products for the IBI (Iberian-Biscay-Irish) waters. The IBI-MFC ocean forecast service is based on a regional NEMO model application which includes high frequency processes of paramount importance to characterize regional scale marine processes (i.e. tidal forcing, surges and high frequency atmospheric forcing, fresh water river discharge, etc.). This 1/36° eddy resolving application, is forced with the up-to-date meteorological forecast data from ECMWF and nested in the MyOcean GLOBAL system.

In June 2014, a new IBI Reanalysis product covering the so-called altimetric decade (2002-2012) will be disseminated to users through MyOcean user interfaces. The IBI-REA products comprises both physic and bio-geo-chemical variables (results from the latest, generated through the PISCES model, will not be shown in the present paper).

The physic IBI-REA products were generated through an ocean reanalysis system based on a NEMO model application analogous to the daily IBI ocean forecast service. The system is also free-surface and includes same tidal forcing than the Forecast system. The reanalysis run was forced with ECMWF 3-h atmospheric forcing (ERA-Interim data instead of the met forecasts used in the daily IBI runs), including atmospheric pressure and surface heat and fresh water exchanges. Boundary conditions were imposed from MyOcean GLOBAL reanalysis products. Horizontal resolution decreases in the IBI-REA system (1/12°), whereas the vertical one is increased from the 50 levels currently used in the FC system to 75 z-levels.

The data assimilation component used is the SAM2 (developed by Mercator-Ocean and based on the reduced-order Singular Extended Evolutive Kalman filter –SEEK-, an -Incremental Analysis Updates-IAU method and a 3D-Var scheme, corrected for the slowly evolving large-scale biases in temperature and salinity). The data assimilation system allows constraining the model in a multivariate way with Sea Surface Temperature (AVHRR, plus Multi-satellite high resolution datasets), together with all the available along-track satellite sea level anomaly data, and with in-situ observations from the CORA-03 database, including ARGO floats temperature and salinity measurements.

Both IBI products (the forecasted and reanalysis ones) are generated by systems able to deal with a large range of physical processes (from tidal to seasonal circulations). The skill of both systems to reproduce main features located over Iberian waters is evaluated. Several assessments of model skill have been performed using data not assimilated into the IBI-REA system. To this aim, statistics and metrics using high frequency measured data over the 10-yr period across the 16 moorings from the Puertos del Estado network are shown and discussed. Overall, IBI performances are quantified and discussed with emphasize on surface circulation features at short-time scales (hourly to daily).

This validation exercise with independent, in the sense of non-assimilated in the IBI-REA system, in-situ observational data is quite useful to verify the IBI-REA products. The interest of this long-term

high-frequency validation increases when is considered the very limiting and scarce availability of observational data remaining after discarding the observational data sources already assimilated.

Furthermore, the comparison of both MyOcean IBI solutions (the fully-free forecasted and the reanalyzed one) focusing on near-shore processes around Spanish coastal areas provides a measure of what the oceanographic community can expect from regional model systems (with and without data assimilation) to assess the real state and dynamics of the regional coastal seas on short scales.

The evaluation of the regional and coastal predictive capabilities of the currently existing MyOcean IBI ocean model systems is mandatory for the MyOcean IBI-MFC, not only to increase the understanding of the ocean dynamics at different scales over Iberian waters, but also to inform MyOcean end-users about the confidence that can be placed in the products generated through such IBI operational services. Indeed, the examples provided in this study may be considered as initial steps towards the definition of the short-term plans to upgrade the MyOcean IBI forecast system, by means of the inclusion of a new data assimilation scheme similar to the one used in the generation of the IBI reanalysis.

Argo-Inferred Velocity Probability Density Functions.**Miquel Rosell-Fieschi, Jérôme Gourrion, J.L. Pelegrí***Institut de Ciències del Mar, CSIC, Barcelona***Abstract**

An improved knowledge of the statistical distribution of ocean velocities has an important role in a better understanding of the ocean dynamics, and a remarkable impact on ocean models and simulations. The non-Gaussian behavior of the Probability Density Function (PDFs) of ocean velocities was first remarked by Lilly (1969). Since then, other studies have looked at these PDFs, calculated either from Lagrangian floats, altimetry, or current-meter measurements. The principal aim of these studies has been to determine if the ocean velocity PDFs follow a Gaussian distribution: Are the ocean velocities locally Gaussian? And what does local mean? It has been demonstrated that lateral and temporal inhomogeneities can lead to non-Gaussian distributions, with exponential-like tails, but can we consider these deviations from Gaussian behavior to arise because of geographical and temporal data integration? Or the exponential tails are indeed an intrinsic property of the ocean velocity PDFs? In this work we address these questions using the ocean velocities as inferred from the Argo floats. We show that Gaussian ocean velocity behavior depends largely on the area considered, both its size and location. To test the hypothesis of local Gaussian behavior beyond the empirical data, we have developed a model that allows reproducing the empirical PDF with reasonably good accuracy; the model considers the ocean velocities to be locally Gaussian, and assumes that non-Gaussian behavior is due to lateral and temporal residual inhomogeneity. On the basis of the work made by Conrad(2004) and Lyon (2013), we launch the hypothesis that the Gaussian ocean velocities distribution arises from the dissipation processes in the ocean, where the gain of entropy is maximized by the Gaussian distribution of the ocean velocities, being the Gaussian PDF the distribution that gives the highest entropy for a finite domain and a given standard deviation.

References

- Conrad, K., 2004. Probability distributions and maximum entropy. *Entropy* 6, 1–27.
- Lilly, D. K. 1969 Numerical simulation of two-dimensional turbulence. *High-speed computing in fluid dynamics*. *Phys. Fluids Suppl.* 11, 240-249.
- Lyon, A., 2013. Why are Normal Distributions Normal? *Br. J. Philos. Sci.* 1–25.

New evidences of surface water circulation patterns in the southeastern Bay of Biscay from HF radar data**L. Solabarrieta¹, A. Rubio¹, S. Castanedo², R. Medina², L. Ferrer¹**¹*AZTI-Tecnalia, Herrera Kaia, portualdea z/g, 20110 Pasaia, Spain*²*Instituto de Hidráulica Ambiental "IH Cantabria", C/Isabel Torres, 15, Parque Científico y Tecnológico de Cantabria, 39011, Santander, Spain***Abstract**

The detailed and quantitative description of the spatial patterns observed at the southeastern part of the Bay of Biscay, since 2009, is done using the Basque Country HF radar data. New evidence is given on the main ocean processes, at different time scales, affecting a study area where surface currents show marked temporal and spatial variability (Solabarrieta et al. 2014). A clear seasonality in terms of sea surface currents and along-slope circulation is observed, with cyclonic and anticyclonic patterns during the winter and summer months, respectively. From the analysis of lowpass filtered currents, a key component of this seasonal variability is associated with the surface signature of the slope current (Iberian Poleward Current (IPC)). Clearly intensified over the upper part of the slope, this current circulates eastward off the Spanish coast and northward over the French shelves in winter. The presence of mesoscale structures over the area is also reported. At higher frequencies, the analysis of the inertial band-pass filtered data reveals the complex spatial and temporal patterns associated with these processes and allows to quantify the relative contribution of the high frequency to the total variability. Overall, inertial currents represent between 10 and 40% of the total variability; their contribution is significantly greater in summer and over the deeper part of the slope.

In addition to EOF (empirical orthogonal function) analysis, the preliminary results obtained using Self Organizing Map (SOM) on the HF radar data reinforce the previous observations and offer a deeper insight into the surface circulation patterns.

Coastal Processes - Small Scale Processes

Modelling the oceanographic conditions during storm following the Battle of Trafalgar

Fernández-Montblanc, T.¹, Izquierdo, A.², Bethencourt, M.¹

¹*Department of Materials Science and Metallurgical Engineering and Inorganic Chemistry, University of Cadiz, Marine Science and Technological Center of Andalusia, International Campus of Excellence of the Sea (CEI-MAR), Avda. República Saharaui s/n, Puerto Real, 11510 – Spain*

²*Applied Physics Department, University of Cadiz, Marine Science and Technological Center of Andalusia, Marine Science and Technological Center of Andalusia, International Campus of Excellence of the Sea (CEI-MAR), Avda. República Saharaui s/n, Puerto Real, 11510 – Spain*

Abstract

Immediately after the Trafalgar battle, on 21st October 1805, a violent storm struck the coast of Cadiz, hitting hardily the damaged and battered British and Combined Spanish-French fleets. As a result, several ships run aground or sunk in different locations close to the coast of Cádiz. The identification and location of the shipwrecks remains, as well as the interpretation of the historical chronicles about the Battle of Trafalgar are closely related to the impact of that storm on the fleets. Due to its historical significance, this storm has been widely studied from the meteorological point of view. However, the oceanographic conditions related to that event have not been modelled up to our knowledge.

We simulate the oceanographic conditions occurring during the storm following the Battle of Trafalgar using the Delft3D-FLOW model, which has a 3D, free-surface ocean hydrodynamic module that can be coupled to a wave module, allowing for wave-current interaction. The atmospheric forcing is taken from a run of a MM5 meteorological model setup with high resolution over the Gulf of Cadiz. This meteorological run simulated a severe storm from the south-west that occurred on December 24th 2009, which had similar characteristics to the storm following the Battle of Trafalgar, according to logbooks and other historical sources.

The Flow 3D model setup was carried out using vertical sigma coordinates and a horizontal domain decomposition approach, where successively more detailed horizontal grids allowed in-creasing resolution and refining our model solution in the area of interest. The coarser grid is a cartesian grid with 252 m resolution that extends from Trafalgar Cape to Chipiona coast. The tidal open boundary conditions include 6 main tidal constituents in the area taken from a global tidal model AG95.1.

The Wave model setup was run upon the same horizontal grids. Wave parameters at the open boundary were set using data from a wave directional buoy pertaining to REDCOS network, Puertos del Estado.

The model results show a good comparison with observed sea-level, current velocity, wave and wind data.

Acknowledgements. This work was funded by the Ministry of Economy and Competitiveness throughout the project ARQUEOMONITOR: Study of the influence of physical, chemical and biological conditions deterioration and safeguarding in Underwater Cultural Heritage (CTM2010-16363)

Water Circulation Response to Strong Cross-Shelf Winds. Sant Jordi Bay Case (NW Mediterranean Sea)

Manuel Espino, Manel Grifoll and Agustín S.- Arcilla

Laboratori d'Enginyeria Marítima. Universitat Politècnica de Catalunya. C/ Jordi Girona, 1-3. Edifici D1, Campus Nord, 08034 Barcelona (Spain)

Abstract

The inner- and mid-shelf circulation response to strong cross-shelf winds is studied in Sant Jordi Bay (Catalan Sea) where those seaward winds are prevalent during fall and winter. Strong evidences of cross-shelf circulation correlated with cross-shelf winds are obtained from a one-year current meter record at 43.5 m deep. During severe storms under unstratified conditions, the observations exhibit offshore flow in the entire water column resulting from a complex convergence in the along-shelf circulation. Under stratified conditions, the predominately two-layer cross-shelf flow is intensified by cross-shelf winds. Along-shelf wind-driven circulation in Sant Jordi Bay was weak. From coupled atmosphere-wave-ocean numerical simulations (Warner et al., 2010), a complex flow is appreciated with the circulation pattern being a highly-dependent of the stratification conditions.

Long time series of high-frequency measurements of the response to coastal upwelling in the Ría de Vigo

Barton, E.D.¹, Villaceros-Robineau, N.¹, de la Granda, F.¹, Alonso-Pérez, F.¹, Graña, R.², Piedra-coba, S.², Torres, R.³, Largier, J.⁴ and Gilcoto, M.¹

¹*Instituto de Investigaciones Marinas (IIM-CSIC), Spain*

²*Universidad de Vigo, Spain*

³*Plymouth Marine Laboratory, UK*

⁴*Bodega Marine Laboratory, University of California Davis, USA*

Abstract

Nearly one year of high frequency (2 kHz) current sampling has been recorded since 20 June 2013 in the center of the Ría de Vigo, at 43m depth, with a rate of availability close to 95%. This multi-gigabyte dataset includes 60 vertical cells of 75 cm height distributed from 2.2 meters above bottom to 47.5 mab (ensuring that the tide does not outrange the sea surface) measured with an RDI Acoustic Doppler Current Profiler, a 600kHz WorkHorse Sentinel unit with WavesArray module. The current meter was bottom deployed in a gimbaled pyramid in a fixed position and supplied with energy and communications by a submarine cable.

This long and high quality time series of currents includes a wide spectrum of physical processes, ranging from wave currents to subtidal remote wind induced currents. In fact, the length and sampling frequency of the time series will allow the best tidal current analysis ever made in a Galician ría. Most likely, this record set will also allow us to study short-time processes as the turbulence.

Here we will focus on the well known effect of the remote wind on the residual circulation of the Ría de Vigo. Coastal upwelling and downwelling events have long been identified as the first order forcing of the subtidal ría circulation but this data set reveals for the first time that the response to this forcing is as short as a few hours.

Rethinking the gradient Richardson number**J. L. Pelegrí and P. Sangrà**

Institut de Ciències del Mar, CSIC, 08003 Barcelona; Instituto Universitario de Oceanografía y Cambio Global, Universidad de Las Palmas de G. C., 35017 Las Palmas de Gran Canaria, Spain.

Abstract

The gradient Richardson number, Ri , is the classical index for dynamic vertical instability. It is generally viewed as a ratio between the stabilizing effects of buoyancy versus the destabilizing role of the (squared) vertical shear. The gradient Richardson number is small (subcritical when its value is less than one) when stratification is small enough and/or vertical shear is sufficiently large; under these circumstances the flow becomes unstable, prone to mixing. In this communication we carefully explore an alternative perspective, which arises in isopycnic coordinates: the gradient Richardson number is now a ratio between the inverse of vertical stratification and the (squared) shear in density coordinates (named the diapycnal shear). From this point of view the flow becomes unstable in well stratified conditions as long as the diapycnal shear remains moderately large (Pelegrí and Csanady, 1994; Pelegrí and Sangrà, 1998; Pelegrí et al., 1998).

One important limitation of Ri , as an indicator of mixing, is that it cannot differentiate between mixing in stratified regions versus flow instability in already well-mixed waters. The isopycnic approach suggests that diapycnal shear is a most relevant variable for flow stability, yet it alone cannot assess the existence of unstable conditions. Therefore, we rewrite the instability condition as a reduced squared diapycnal shear, which is a function of both Ri and the stratification, and decreases monotonically with stratification.

The above concepts are illustrated using data from three distinct regions: the shelf break south of Gran Canaria, the Gulf Stream and the Mediterranean outflow. It turns out that very often for Gran Canaria and the Mediterranean outflow, and only very rarely for the Gulf Stream, the conditions are subcritical. The variables are non-dimensionalized by means of the background stratification. The vertical shear, diapycnal shear and the reduced squared diapycnal shear are then plotted, as cloud points, as a function of stratification. The results confirm a dependence of the squared reduced diapycnal on stratification, which is characteristic for each particular flow dynamics.

References

- Pelegrí, J. L. and G. T. Csanady, 1994. Diapycnal mixing in western boundary currents. *J. Geophys. Res.*, 99, 18275-18304.
- Pelegrí, J. L., and P. Sangrà, 1998. A mechanism for layer formation in stratified geophysical flows. *J. Geophys. Res.*, 103, 30679-30693.
- Pelegrí, J. L., A. Rodríguez-Santana, P. Sangrà, and A. Marrero-Díaz, 1998. Modeling of shear-induced diapycnal mixing in frontal systems. *Appl. Sci. Res.*, 59, 159-175.

Vertical Mixing in the Atlantic Equatorial Undercurrent**A. Rodríguez-Santana¹, J.L. Pelegrí² and M. Emelianov²**¹*Departamento de Física, Universidad de Las Palmas de Gran Canaria, Spain.*²*Departament d'Oceanografia Física, Institut de Ciències del Mar, CSIC, Spain.***Abstract**

With the objective to study vertical mixing in the Atlantic Equatorial Undercurrent (EUC), a total of 14 microstructure vertical profiles, down approximately to 400 m, were done with a free-fall microstructure profiler (turboMAP-L). The data set was collected from 11 to 18 April 2010, during the first part of MOC2-Ecuatorial cruise (project MOC2), carried out with R/V Hespérides. A total of 47 conductivity-temperature-depth (CTD) casts, down to 1500 m or the sea floor, and velocity data acquired with the 75-kHz vessel-mounted Acoustic Doppler Current Profiler (ADCP) using bins of 8 m until about 500 m depth, were done in the equatorial region (Claret et al, 2012).

In most cases, the EUC maximum velocity was near 70 m. We found high values of mean turbulent kinetic energy dissipation rates, ϵ , on $5 \times 10^{-7} \text{ m}^2 \text{ s}^{-3}$ between 20 and 60 m, low values on $4 \times 10^{-9} \text{ m}^2 \text{ s}^{-3}$ between 60 and 120 m through the EUC core, and moderate values on $6 \times 10^{-8} \text{ m}^2 \text{ s}^{-3}$ just below the core. We also found differences between western and eastern stations along EUC. A western station on 38.5°W shows a maximum velocity on 0.64 m s^{-1} with an irregular vertical salinity profile below the core with various steps, while an eastern station on 33°W shows a maximum velocity on 0.96 m s^{-1} with a vertical salinity profile less irregular. The estimations of density ratio, R_ρ , and gradient Richardson number, Ri , suggest that the sources of the vertical mixing are the vertical shear above and just below the EUC and salt fingers below it. Parameterizing the vertical diffusivity as a function of Ri and R_ρ jointly with observations of ϵ , we can estimate the vertical fluxes of different properties through the EUC in order to know the role of the different vertical mixing processes (Wang and Müller, 2002; Zaron and Moum, 2009; Claret et al, 2012).

Acknowledgements. This research has been funded by the Spanish Ministerio de Ciencia e Innovación through project MOC2 (CTM2008-06438-C02-01).

References

- Claret M., R. Rodríguez and J.L. Pelegrí, 2012: Salinity intrusion and convective mixing in the Atlantic Equatorial Undercurrent. *Scientia Marina*, 76S1: 117-129.
- Wang D., P. Müller, 2002. Effects of equatorial undercurrent shear on upper-ocean mixing and internal waves. *Journal of Physical Oceanography*, 32: 1041-1057.
- Zaron E.D., J.N. Moum, 2009. A new look at Richardson number mixing schemes for equatorial ocean modeling. *Journal of Physical Oceanography*, 39: 2652-2664.

On how tides affect the biological productivity of the Strait of Gibraltar-Alboran sea system: a numerical model study**José C. Sánchez Garrido, C. Naranjo, D. Macías, S. Sammartino, J. García Lafuente***University of Málaga, Spain.***Abstract**

The Mediterranean is an oligotrophic sea that exhibits a decreasing biological productivity pattern from West to East. The Alboran Sea (AS) is its most productive sub-basin as shown by in situ measurements, satellite images, and basin-scale numerical simulations. All these sources reveal a mean state characterized by an incoming jet of Atlantic Water meandering around two mesoscale anticyclonic gyres as it progresses to the Mediterranean. Differently to the gyres, which are largely oligotrophic, the jet and its surroundings are zones of great biological productivity. Given that Atlantic Waters are poor in nutrients such high productivity is explained by an active submesoscale dynamics, with potential to pump nutrients to the photic zone.

The above scenario is based on a hypothetical quasi-steady circulation and does not consider tides, particularly relevant in the Strait of Gibraltar. Tides in the Strait can (1) fertilize the incoming jet through the advection of mixed water from Tangier Basin at the lee side of Camarinal Sill (with origin in an internal hydraulic jump), or facilitate the entrainment of Mediterranean Water by the jet at the narrowest section of the Strait. In addition, (2) tides export nonlinear internal waves and other ageostrophic flows to the AS, giving rise to a more energetic submesoscale circulation. The role that these two processes play on the biological productivity of the AS is investigated with an ecosystemic Nutrient-Phytoplankton-Zooplankton-Detritus (NPZD) model embedded with a submesoscale-resolving tidally-driven circulation model. Results reveal that the join contribution of (1) and (2) increases the biological productivity of the AS in a factor of two.

2 Thursday, June 12th

IV International Symposium of Marine Sciences

Biological Oceanography

The role of diel vertical migrants in the oceanic carbon pump

Santiago Hernández-León

Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria. Islas Canarias.

Abstract

Active flux performed by migrant biota is still a gap in the knowledge of the biological pump in the ocean. These organisms feed upon epipelagic zooplankton and transport this carbon due to their feeding at the shallower layers and their defecation, respiration, excretion and mortality at depth. Diel vertical migrants (DVMs) in subtropical waters promote a lunar cycle in epipelagic zooplankton biomass, and a rough estimation of this mortality by predation suggests values similar to the mean passive flux. The recent finding that mesopelagic fish biomass in the ocean is one order of magnitude higher, and the discovery of high acoustic backscatter from the surface to bathypelagic depths (4000 m depth) in the equatorial waters of the Atlantic and Pacific Oceans, suggests that active flux is barely known. Evidence of the so-called “Ladder of Migration” below 1000 m depth is presented, shedding some light about the capacity of DVMs to promote true carbon sequestration in the ocean.

Biochemical responses determined in *Hediste diversicolor* exposed to sediment spiked with fluoxetine and 17 α -ethynylestradiol.**Maranho, L. A.^{1,2}, André, C.³, DelValls, T. A.¹, Gagné, F.³, Martín-Díaz, M. L.^{1,2}**¹Andalusian Centre of Marine Science and Technology (CACYTMAR), University of Cádiz, Polygon Río San Pedro, s/n, 11510, Puerto Real, Cádiz, Spain²UNITWIN/UNESCO/WiCoP, Physical Chemical Department, Faculty of Marine and Environmental Sciences, University of Cádiz, Polygon Río San Pedro, s/n, 11510, Puerto Real, Cádiz, Spain³St. Lawrence Centre, Environment Canada, 105 McGill Street, 7th floor, H2Y 2E7, Montreal, Quebec, Canada.**Abstract**

Estuaries drive large volumes of effluents containing numerous contaminants. Sediments can act as a sink and/or a source for a variety of these compounds. There is a lack of data on pharmaceutical exposures to estuarine and marine biota; despite coastal areas are the major receptor of wastewater and supports the most human populated areas in the world. It is well known that municipal effluents contain a variety of pharmaceutical and personal care products (PPCPs), including neuroactive drugs (e.g. fluoxetine) and hormones (e.g. 17 α -ethynylestradiol). Pharmaceuticals compounds are designed to alter physiology at low doses and they are considered particularly emergent and potent contaminants. Previous studies showed that pharmaceutical compounds are more suitable to provoke sublethal effects than acute toxicity. Thus, the polychaetes *Hediste* (= *Nereis*) *diversicolor* appears as a key species in estuarine ecosystems. This bioindicator is considered an essential component of ecotoxicological toolboxes for sediment quality assessment, due to their abundance, ecological relevance and constantly contact with contaminants in the sediment and water column.

In a way to evaluate the suitability of the bioindicator *H. diversicolor* and the use of chronic responses for the risk assessment of pharmaceutical compounds in the sediment quality evaluation, an extensive battery of biomarkers was applied. Polychaetes *H. diversicolor* were exposed for 15-days to five concentrations of fluoxetine (FLU) and 17 α -ethynylestradiol (EE2) spiked in marine sediment samples, including the environmental concentrations (underlined): 100 $\mu\text{g L}^{-1}$, 10 $\mu\text{g L}^{-1}$, 1 $\mu\text{g L}^{-1}$, 0.1 $\mu\text{g L}^{-1}$, 0.01 $\mu\text{g L}^{-1}$. Following the experimental period, significant mortality ($p < 0.05$) of *H. diversicolor* was observed in replicates of sediment samples spiked with FLU (1 $\mu\text{g L}^{-1}$) and EE2 (100 $\mu\text{g L}^{-1}$, 10 $\mu\text{g L}^{-1}$). Concentrations of FLU ($p < 0.05$) and EE2 ($p < 0.01$) were positive correlated with mortality.

Two types of biomarkers were proposed to measure PPCPs effects in the environment. The first are biomarkers encompassing the effects of drugs with no assumption of their mechanism of action and specificity. This set of biomarkers included two phases of the metabolism: Phase I that involves cytochrome P450 (CY450) enzymes (ethoxyresorufin O-deethylase - EROD and dibenzylfluorescein dealkylase - DBF) and Phase II measured by glutathione S-transferase (GST) enzymes. Also included responses related to oxidative stress as antioxidant enzymes (glutathione peroxidase (GPx) and glutathione reductase (GR)), neurotoxicity (acetylcholinesterase - AChE), lipid peroxidation (LPO) and DNA damage (strand breaks). The second class of biomarkers proposed are those that are related to the mode of action of the drug in question, with possible effects on an organism's survival, immune function and reproduction. This set of biomarkers were composed by the assessment of cyclooxygenase activity (COX), monoamine oxidase activity (MAO), mitochondrial electron transport (MET), levels of vitellogenin-like proteins (Vg) and total lipids (TLP).

Concerning the responses of enzymatic biomarkers of CYP450, EROD activity was induced by FLU and EE2 concentrations ($p < 0.05$) confirming the involvement of CYP450 in the metabolism of degradation of these pharmaceuticals. Phase II GST enzymatic activity did not respond to the pharmaceutical

products tested. Neurotoxicity was induced in polychaetes exposed to FLU and EE2 ($p < 0.05$). Oxidative stress (LPO and DNA damage) was observed after the exposure to FLU and EE2 ($p < 0.05$). LPO increased with the FLU concentration; however LPO decreased with EE2 concentration. DNA damage was significantly lower than the control ($p < 0.05$) for both pharmaceutical products tested. Polychaetes exposed to FLU and EE2 did not show significant differences compared to the control for MET activity or TLP, which means that these pharmaceutical products did not stimulate energy reserves or spend through MET activity in this bioindicator. Vg-like proteins levels were significantly decreased for polychaetes exposed to FLU when compared to the control ($p < 0.05$), which was inversely proportional to the concentration. The decrease of Vg-like proteins levels also happened with the increase of EE2 concentrations, even no significant differences were determined. All the animals chosen in the present study were not in the maturation phase. Because of this fact, there was no increase of Vg-like proteins levels between the different concentrations of pharmaceutical products tested. Monoamines are important mediators of gamete maturation and spawning, however organisms exposed to FLU and EE2 showed significantly decrease of MAO activity compared to the control ($p < 0.05$). FLU and EE2 have recently been found to possess anti-inflammatory properties, although it was not determined in the polychaetes exposed to FLU. On the other hand, polychaetes exposed to EE2 concentrations showed significantly lower COX activity than the control ($p < 0.05$) confirming its anti-inflammatory properties.

The quantification of biochemical parameters was shown to provide important insights on toxicant-induced changes in key physiological mechanisms. Our results indicated the toxicity of low-level pharmaceutical-spiked sediment and recommended the battery of biomarkers used in the bioindicator specie *H. diversicolor* for the sediment quality assessment of chronic responses related to pharmaceutical compounds and marine ecosystems. As a whole, this investigation highlighted the need of focusing future research efforts on possible physiological impairments caused by exposure of marine benthic species to pharmaceutical products.

Measuring Metabolic Rates of Marine Fish Larvae: Progress and Challenges**Marta Moyano, Myron A. Peck***University of Hamburg, Germany***Abstract**

Metabolic costs are extremely high in young marine fish larvae and knowledge on how intrinsic and extrinsic factors affect metabolic costs (and how best to estimate those costs) is important if we hope to understand environmental constraints on early growth and survival. We provide an historical perspective on measurements of larval marine fish respiration including methods (Winkler, manometric, polarographic, optodes) and systems (closed system to intermittent-flow). We perform a meta-analysis of results (metabolic rates, ontogenetic changes, taxonomic differences) obtained from 61 studies examining 53 species from 30 families. Standard (anaesthetized or darkness), routine and active respiration rates were reported in 14, 94 and 8% of the studies and much more work has been performed on larvae of temperate (80%) compared to tropical (14%) and polar (4%) species. More than 35% of the studies have been published since 2000 owing to both advancement in oxygen sensors and the growing emphasis on understanding physiological impacts of environmental change. Common protocols are needed to facilitate cross-taxa comparisons such as the effect of temperature (Q10 1.47 to 3.47), body mass (slope of allometric changes in R from 0.5 to 1.3), and/or activity level on metabolic costs as measured via respiration rate.

Comparing respiration-based vertical carbon flux with sinking POC in the Namibian Upwelling system**N. Osma¹, I. Fernández-Urruzola¹, T.T. Packard¹, L. Postel², M. Gómez¹, F. Pollehne³**¹*Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, 35017, Canary Islands, Spain*²*Zooplankton Ecology Group, Baltic Sea Research Institute, D-18119 Rostock, Warnemünde, Germany*³*Benthopelagic Coupling Group, Baltic Sea Research Institute, D-18119 Rostock, Warnemünde, Germany***Abstract**

Both loss of material from the water column and gain to the sediment are important processes in marine ecology and biogeochemistry, as the transport balance between water and sediment controls quantity and quality of marine life on local and global scales. Upwelling systems, as hotspot of marine productivity, are particularly interesting in this concern. Here, we have studied the short-term variability of vertical carbon flux (C-flux) by two alternative approaches at two stations on the Namibian shelf (20°S) during August/September 2011. The first approach was based on modeling the respiratory organic carbon consumption in the water column, by means of the integration of vertical profiles of the respiratory electron transport system (ETS). Temporal variability in the respiration (RO₂) profiles proved to be stronger than the effect of distance between the sediment traps. Thus, two of the three vertical samplings were characterized by water arising from the upwelling filament, with the highest respiration rates due to microplankton and small zooplankton. The other profile, in contrast, was associated with a later temporal stage of the upwelled waters (in essence, more oligotrophic waters), where the respiration of large zooplankton dominated the water column. Modeled vertical C-fluxes (F_c) were determined by converting the RO₂ into carbon units and integrating them from below the euphotic zone to the seafloor. F_c at the sediment-trap depths were 2.57 mmol C m⁻² d⁻¹ in the more oligotrophic water and 3.67 ± 0.33 mmol C m⁻² d⁻¹ in the upwelling filament influenced waters. In the second approach, automatic sediment traps with daily sampling periods were moored successively for 13 days and 10 days. Fluxes of all variables (C, N, P, Si and dry mass) showed high temporal variations, which could be identified with periods of high and low particle export. Differences in qualitative properties of the sinking material like species composition of microalgae (diatoms/coccolithophorides), C/N, C/Si in bulk material or the opal/carbonate ratios of single particles coincided with these high/low flux situations, which were likewise attributed to transit periods of either filaments of upwelling water or oligotrophic waters. Mean daily C-flux in both traps was 1.43 ± 0.35 mmol C m⁻² d⁻¹ in oligotrophic water and 7.85 ± 1.83 mmol C m⁻² d⁻¹ in upwelling filaments. Although both approaches yielded similar values during the two basic situations, differences between them were mainly attributed to changes in the composition of the sinking particles and consequently, in their settling velocities. When the productivity and the diatoms abundance were high, the fast sinking particles predominated in the water column and the F_c approach underestimated the total flux. In the low productivity scenario, however, the sediment traps values did not balance the estimated respiratory carbon demands. In combination, both approaches served the requirements for understanding the quantitative and qualitative aspects of the northern Benguela upwelling system functioning at short timescale. The F_c approach was further applied to zooplankton samples collected on a cross-shelf transect during the same cruise, in order to quantify their importance in the particulate organic carbon attenuation.

Short-term variability of picoplankton across the wind-shear region south of Gran Canaria**Nauzet Hernández & Javier Arístegui***Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria***Abstract**

We have studied the short-term variability -at temporal scale of days and spatial scale of 5 km- of the hydrographic field, organic and inorganic nutrients, chlorophyll and picoplanktonic abundances, across a 40 Km section crossing a frontal system south of Gran Canaria, where anticyclonic eddies in early-stages of formation and convergent fronts have been widely reported in the past. Each cruise consisted in a 3-4 daily-repeated section, and was carried out at the same period of the year (May) during two consecutive years (2011 and 2012). The main goal of our study was to analyze the picoplankton response to short-term variability at scales not considered in regular oceanographic samplings, even in regions with complex hydrographic fields. Our results show that both daily and submesocale (below the local Rossby radius of deformation) variability were significant, ranging on average 2 fold across the different stations and between days, being in some cases of the same magnitude of the interannual variability. Our data support theoretical simulations that suggest that submesocale processes at frontal systems would modulate biogeochemical budgets and plankton distributions in the ocean, by intensifying nutrient fluxes, subducting organic material or enhancing horizontal stirring. We conclude that in order to study the influence of oceanographic processes on planktonic communities, at least in regions of high hydrographic variability, we need to address a sampling strategy with a spatial resolution at the scale of frontogenesis (the submesoscale) rather than at a scale of eddies (the mesoscale).

Juvenile albacore distribution and oceanographic conditions in the northeastern Atlantic during the 2013 fishing campaign**Nerea Goikoetxea¹, Ainhoa Caballero², Almudena Fontán², Haritz Arrizabalaga², Luis Ferrer², Josu Santiago¹**¹AZTI–Tecnalia, Marine Research Unit, Txatxarramendi ugarteia z/g, 48395, Sukarrieta, Basque Country, Spain²AZTI–Tecnalia, Marine Research Unit, Herrera Kaia Portualdea z/g, 20110, Pasaia, Basque Country, Spain**Abstract**

Albacore (*Thunnus alalunga*) is a highly migratory tuna with a wide geographic distribution, covering the North Atlantic Ocean up to 55°N. Although it is a temperate species, it occupies both temperate and tropical waters depending on the season. Both adults and juveniles spend the winter in central tropical waters of the North Atlantic Ocean. In spring, with the onset of the sea water warming, adults migrate to the Sargasso Sea for reproduction. Spawning takes place from April to September. In late spring, immature individuals start a trophic migration to higher latitudes, towards productive waters of the Bay of Biscay and the southeast of Ireland.

Despite its large geographic distribution, albacore shows environmental preferences to optimise its physiologic functions. One characteristic is its thermoregulatory capacity, which allows it to keep an internal warmer temperature in comparison to the environment; this characteristic enables it to swim through water masses in a wide range of temperatures, both horizontally and vertically. In the North Atlantic Ocean, albacore latitudinal migrations follow the isotherms-range between 16 and 21°C. Further, thermal preferences are different according to the age. The variability of the latitudinal distribution of the warm Gulf Stream current (as measured by the Gulf Stream Index, GSI) might explain some of the variability in the tuna fisheries of the Northeast Atlantic.

Albacore CPUE distribution is not only related to water temperature, but also to chlorophyll concentration at the sea surface. What is more, previous studies suggested a potential association between albacore catches and chlorophyll high gradient magnitude areas in the Bay of Biscay. In addition, albacore observations in the northwestern Pacific Ocean were found to occur in waters with high Eddy Kinetic Energy (EKE) and strong geostrophic currents, showing that tuna aggregations could be related to anticyclonic gyres.

In its trophic migration to northern latitudes, albacore is fished by the Basque surface fleet, since it is a commercially important species. Actually, approximately 25-30% of the total catch of albacore stock is exploited by this fishing fleet. It targets juveniles of 1-4 ages. Fishing season starts in late-May or June, in waters close to Azores Islands (25-30°W); and then it moves northeastwards, following the seasonal trophic migration of albacore, to finally reach the Bay of Biscay and the south of Ireland in mid-summer. The fishing activity finishes in October, when albacore leaves Northeast Atlantic waters to go back to central Atlantic waters, where it overwinters.

In 2013, a high part of the fishing effort of the Basque vessels was located in the Bay of Biscay, as shown by CPUE data collected from logbooks. At present, the main fishing gears used for albacore fishing are trolling line and baitboat. Trollers operate in a wide area covering the Bay of Biscay and the adjacent oceanic waters, whereas baitboats mainly centre their activity within the Bay of Biscay, occasionally reaching waters south of Ireland. Data available for 2013 comprise 5,030 daily observations from 90 vessels (3,386 observations for trollers and 1,644 for baitboats). In the case of trollers, whilst from May to June albacore catches were mainly located in the oceanic area, from August to October, most of the

catches were associated to the Spanish-French-English continental shelf and slope. July was a transition month when albacore was found both in oceanic and slope/shelf areas; and, during November, catches were concentrated in the Spanish shelf/slope. In the case of baitboats, catches distribution was different. From May to June and in October, catches were located within the Bay of Biscay. In July, they also found albacore in the oceanic area west of the Bay of Biscay. Finally, during August and September, they fished both in the Bay of Biscay and in waters south of Ireland. The representation of albacore catches superimposed to EKE maps show that the location of those catches registered during summer 2013 may be related to eddy edges, where frontal conditions are found. With regard to the GSI, from January to July 2013, it was mostly negative, favouring the albacore distribution in the study area.

During part of the albacore fishing season, a two-month oceanographic campaign (so-called GESSEB), from 23 July to 24 September 2013, took place within the southeastern Bay of Biscay. During this campaign, data from a Slocum-1000 type glider (equipped with a CTD and dissolved oxygen and fluorescence-turbidity sensors), two drifters with a holey sock drogue centred at 50 m depth and altimetry, as well as near-real time SST (AVHRR 1 km) and Chlorophyll-a concentration (MODIS 1 km) maps were obtained. These measurements will allow us to study the vertical structure of the water column within the southeastern Bay of Biscay, as well as to better characterise its mesoscale activity during the study period. Preliminary results show that the seasonal thermocline during the study period was located around 50 m depth, where the fluorescence was maximum. At this same depth, there was also a relative maximum in the dissolved oxygen concentration, below which the concentration decreased significantly.

The present work intends to improve our knowledge regarding optimal habitat as well as spatial distribution of albacore in the Bay of Biscay. Particularly, it will study if the albacore distribution within the Bay of Biscay is related to the presence of mesoscale structures in the area. Further, the structure of the water column will be studied in order to look for links between oceanographic conditions at different depth levels and the presence/absence of albacore. Finally, the information collected during the GESSEB campaign will be used to obtain in situ environmental 3D data of the water around the place and date of these catches.

Salinity effects respect to the synthesis of MAAs in *Pocillopora capitata***Maidel Justel Díez and Marco Agustín Liñan Cabello***University of Vigo***Abstract**

Like some marine organisms, corals have the ability to accumulate and synthesize a variety of UV absorbing substances called mycosporines like amino acids (MAAs). However, it has not been fully demonstrated the osmoregulatory ability of these molecules in organisms subjected to continuous changes of salinity in their environment, particularly in hermatypic corals. In order to evaluate the physiological responses related to the synthesis of MAAs and indicator of physiological state like green fluorescent protein (GFP) under a salinity gradient in both cnidarian and zooxantella of the hermatypic coral *Pocillopora capitata*. In order to know if the background of anthropogenic and environmental impact of a coral patch, can influence the physiological responses of these biochemical indicators, coral fragments from two communities (La Boquita and Carrizales) which differed in their history exposed environmental stress. Initially, specimens were quarantined for three days after that and under controlled conditions were exposed to a decrease in the salinity of the environment (32 ups) to 30 ups and subsequently increased salinity to 34 ups for 12 hours. Biochemical analyzes in the zooxanthellae and cnidarian showed that specimens from the Carrizales community showed significant increases in the concentration of MAAs in both exposure and decreased with increasing salinity relative to a control treatment previously established. For its part, the organisms from La Boquita showed significant increases following the increase in salinity from control. The results with respect to what reported by other authors with regard to the ability of physiological adjustment that may have those organisms continuously exposed to stressors is discussed, and it is considered that the specimens from La Boquita have an adjustment mechanism more limited than organisms from Carrizales. Analysis of indicators of physiological state like GFP can give us a better understanding of the ability acclimation of *P.capitata* respect to salinity effect.

Bycatch of cetaceans with gillnets in Ecuador

Patricia Rosero Ramírez *Universidad de Las Palmas de Gran Canaria*

Abstract

Biodiversity

From metabolism to social life: ten years of research on the acoustic ecology of deep-diving cetaceans in the Canary Islands

N. Aguilar de Soto¹, P. Madsen², P. Arranz^{1,3}, J. Marrero¹, and M. Johnson³

¹BIOECOMAC (Biodiversidad, Ecología Marina y Conservación), La Laguna University, Tenerife, Spain

²Bioacoustics Lab. Dept. Zoophysiology. Aarhus University, Denmark

³SMRU (Sea Mammal Research Unit), University of St. Andrews, Scotland

Abstract

The Canary Islands harbour year-round populations of at least four species of deep-diving cetaceans. A research line on the acoustic ecology of these species started at ULL in 2003 using miniaturised digital tags (DTAGs) to investigate their acoustic ecology. DTAGs record sound, depth and three dimensional movements of the whales, enabling studies using multiple layers of information about the activity of the animals. DTAGs were attached with suction cups to 100 pilot whales and 14 beaked whales in the archipelago. Novel results from this research include the description of the echolocation signals (buzzes and clicks) of short finned pilot whales and Blainville's beaked whales, recording for first time for an echolocating animal echoes from its prey and other organisms in the water column. These echoes and echoes from the seafloor, providing data on the altitude of the whales when foraging, were used to uncover that beaked whales feed at depths from 400 to 1300 m, both in the deep scattering layer (DSL) and benthic boundary layer (BBL) as close as 5 m from the seafloor, while short-finned pilot whales feed on mesopelagic prey at depths from 200 to in excess of 1000 m, and on the migratory layer ascending to epipelagic waters during the night. Short-finned pilot whales and the similar-sized Blainville's beaked whale forage with very different strategies. The average foraging dives of these species differ in duration (15 versus 50 min), number of prey-capture attempts per dive (1.3 versus 25) and swimming speeds (up to 9 m/s versus 3 m/s). The sprinting behaviour of short-finned pilot whales has deserved them the nickname of "cheetahs of the deep sea". This behaviour seems adapted to exploit a niche formed by large and caloric prey with high movement capabilities, including giant squid which may be specially abundant in the Canary Islands. The behaviour of beaked whales is very different, they have specialized in performing long dives at low speed to target more abundant and lower energy prey. Respirometry data show that the mass-specific field metabolic rate of short-finned pilot whales is four times higher than that of beaked whales. Thus, pilot whales are more expensive to maintain but capture less prey, clearly suggesting differences in the type of targeted prey. Different movement indicators of the cost of dives (acceleration rate, dynamic body acceleration and drag-related swimming cost) can be used to predict oxygen consumption after each dive, providing an estimation of the relative cost of the dive. Considering this cost and the number of prey-capture attempts per dive, prey targeted by pilot whales in sprinting dives can be 20 times more caloric than prey targeted by the same species at low speed or by Blainville's beaked whales. The foraging behaviour of pilot whales has strong circadian and depth differences in the caloric value of prey. In contrast, Blainville's have specialized in less caloric but more abundant and stable resources, exemplifying top-predator niche segregation in the deep-ocean. This niche segregation has implications for the spatial distribution of the species in areas of the archipelago with different oceanographic and bathymetric characteristics. Moreover, both cetacean species are strongly relying for their foraging in the deep scattering layer (DSL) and on the predators of the organisms in the DSL. This suggests that exploiting resources of the DSL in the Canary Islands, such as the exploratory fisheries of myctophids elsewhere, may conflict with the conservation of the important populations of deep-diving top-predator cetacean species in the archipelago.

Sound plays an essential part in cetacean communication. DTAGs record sound up to the ultrasonic range in tandem to sensor data, making possible to link the vocal output with the behavioural context of the vocalizations. Short-finned pilot whales and Blainville's beaked whales produce the deepest tonal sounds recorded in any marine mammal, challenging the limitations imposed by increasing hydrostatic pressure at depth on a pneumatic sound generation system. Short-finned pilot whales live in large and cohesive social groups and are highly vocal both at the surface and when diving, probably to maintain group cohesion. But they reduce the duration and output of their calls with depth in response to the lower volume of air available for sound production. In contrast, Blainville's beaked whales produce few sounds apart of echolocation signals, and the communicative signals of these species (whistles and rasps) are only produced at depth. We proposed that this behaviour has evolved to avoid detection by acoustically sensitive predators such as orcas. And this is supported by a recent observation of an attack of orca to beaked whales in La Palma resulting in the death of the two calves in the group. The late age of sexual maturation of beaked whales and long inter-calf interval pose an adaptive premium in avoiding predator detection for this species living in small groups with little social defence from predators.

In summary, the research on deep diving cetaceans works towards an integration of eco-physiology and behaviour of these species to understand how they have evolved to cope with the challenges of living in a deep-water environment for air-breathing mammals.

Contribution to the bioecology of *Abraliopsis morsii* Verany, 1839 (Cephalopoda, Enoploteuthidae) off the Canary Islands**Santos-Bethencourt, R., V. Hernández-García, S. Borrás-Fuentes, C. Díez, A. Barrera, F. Bordes and J.J. Castro***Departamento de Biología, Edif. Ciencias Básicas, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, C. P 35017, Tafira Baja, Las Palmas de Gran Canaria, Spain.***Abstract**

In the Atlantic Ocean, *Abraliopsis morisii* (Vérany, 1839) is distributed along the tropical and subtropical zones. The species is relatively abundant and plays an important role in the trophic web of oceanic waters. The present work is based on individuals caught in 1997, 1999, 2000 and 2002 by the S/V La Bocaina, including two trawl series of 4 tows at four discrete levels during day and night times, using a commercial fishing gear.

Sexual dimorphism was observed, being males smaller than 30 mm mantle length, while females reached larger sizes. The average number of ripe oocytes was 564 (range 420 - 692 oocytes), and the average number of spermatophores was 33, oscillating between 14 and 69. The length of the spermatophores ranged between 6.5 and 12 mm. This short life span species is abundant along the year around the islands. This species fed on small zooplankton. Squid showed nocturnal migrations to surface and the species was more abundant around eastern islands. This is the first contribution to the biology of *Abraliopsis morisii* in the Canary Islands zone, the northeast part of its distribution area.

Larval abundance of *Crassostrea* (Mollusca: Bivalvia) in the Marirrío Bay, Gulf of Urabá (Colombian Caribbean)**Jairo Zapata¹, Valeria Aristizábal², Jenny Leal², Paula Urán¹, Jairo Guillermo Vásquez³**¹Universidad de Antioquia, Corporación Académica Ambiental, Grupo Gismac Medellín²Universidad de Antioquia, Corporación Académica Ambiental, Grupo Gismac, Turbo³Corporurabá, Apartadó**Abstract**

This constitutes the first study aiming to determine the abundance of *Crassostrea larvae*, caught using zooplanktonic trawls nets, for 12 months at five (5) workstations at the Marirrío bay, southwest side of the Gulf of Urabá. *Larvae* were present throughout the sampling period at all stations sampled, but the greatest abundance was register in July 2013 with 77.72 larvae/m³. The *larvae* distribution pattern showed no significant differences among either seasons or sampling periods, showing therefore, a canonical correlation of the total larval abundance. Seston instead, showed the highest the statistical variation of the larval abundance pattern of *Crassostrea*.

Stomach content of a female sperm whale (*Physeter macrocephalus*) off the Canary Islands**Díez, C., V. Hernández-García, S. Borrás-Fuentes, R. Santos-Bethencourt, J.J. Castro***Departamento de Biología, Edif. Ciencias Básicas, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, C. P. 35017, Tafira Baja, Las Palmas de Gran Canaria, Spain***Abstract**

The stomach content of a female sperm whale (*Physeter macrocephalus*), found in April 1996, after crashing with a ferry, is reported. This stomach content was composed only by cephalopods. These ones were indentified to the lowest taxonomic level possible using the lower beak, muscles and other hard remains, attempting to report knowledge about the diet of this sperm whale. Thus, this is the first contribution to Canary Islands inhabiting sperm whale's diet. The beaks of the cephalopod identified gave the following results: The family Histioteuthidae was predominant in number (78%) and biomass in the diet, in agreement with the fact of being one of the most common middle-sized cephalopods in Canary Islands waters. The 22% remained beaks belonged to different species of Cranchiidae (12%), Octopoteuthidae (3%), Lepidotheutidae (4%), Ommastrephidae (1,5%), Pholydotheutidae (1,5%), Architheutidae (1%) and Alloposidae (1%) families. The diversity of cephalopod species identified together with the available data of depth and geographical distribution enabled the reconstruction of feeding behaviour of this sperm whale during its last days of life.

How Fire Coral arrived to the Canaries?

López C, Clemente S, Hernández JC, Almeida C and Hernández M

Universidad de La Laguna

Abstract

Many species have experienced recent range expansions due to human-mediated processes, such as the unintentional transport on recreational and commercial ships, plastic waste and ocean warming. Actual seawater temperature increase in higher latitudes facilitates that many tropical species can tolerate living beyond their normal limit of distribution, exerting a potential impact on autochthonous assemblages. In September 2008 three colonies of the fire coral *Millepora sp.* (Cnidaria: *Hydrozoa*) were found at the southeastern coast off Tenerife (Canary Islands). This species shows a circumtropical distribution, being the Cape Verde Islands its northern limit of distribution in the eastern Atlantic, where *Millepora* plays an important role in the organization of coastal benthic communities. A plausible explanation of its presence in the Canaries (11°N) could be through the rapid movement of warm water masses that took place during 1998; however, other hypotheses need to be taken into consideration. Therefore, the aim of this study was to determine the origin of these colonies using the variation of the cytochrome oxidase subunit I (COI) gene as molecular marker. In order to do that, a total of 9 individual samples from Tenerife and 30 from three different localities from Cape Verde Islands (Tarfal -Santiago Island-; Ilheu dos Passaros and Baia das Gatas -São Vicente Island-) were analysed. In addition, COI sequences from Caribbean samples deposited in the GenBank were also included in the analysis.

Our results showed that all the specimens collected in Tenerife were genetically identical, suggesting the possibility that all of them could be clonal descendants from a unique individual. Therefore, the colonization of Canaries by *Millepora sp.* can be the result of a very recent and strong founder effect. The nucleotide sequences of the samples from the Cape Verde Islands and the Canary Islands were closer to the Caribbean than between themselves, pointing to the Caribbean population as the population source for both archipelagos. The presence of *Millepora sp.* in the Canaries could be explained by free dispersal of pelagic larvae through the Gulf Stream current or by ships ballast water. However, the fact that *Millepora sp.* arrived to Cape Verde before to Canaries suggests that the habitat requirements for the species did not exist before in the Canarian Archipelago. Then, the rising seawater temperatures recently registered in the Canary Islands could have facilitated the settlement of reef corals drifting across the two basin of the Atlantic.

Effects of a submarine eruption on the performance of two brown seaweeds**Séfora Betancor¹, Fernando Tuya¹, Teba Gil-Díaz¹, Félix L. Figueroa², Ricardo Haroun¹**¹*Centro en Biodiversidad y Gestión Ambiental, Marine Sciences Faculty, Universidad de Las Palmas de Gran Canaria, Las Palmas, Canary Islands, Spain*²*Departamento de Ecología, Facultad de Ciencias, Universidad de Málaga, Campus Universitario de Teatinos s/n, 29071 Málaga, Spain***Abstract**

World oceans are becoming more acidic as a consequence of CO₂ anthropogenic emissions, with multiple physiological and ecological implications. So far, our understanding is mainly limited to some species through in vitro experimentation. In this study, we took advantage of a recent submarine eruption (from October 2011 to March 2012) at 1 nautical mile offshore El Hierro Island (Canary Islands, central east Atlantic) to determine whether altered physical–chemical conditions, mainly sudden natural ocean acidification, affected the morphology, photosynthesis (in situ Chl-a fluorescence) and physiological performance (photo-protective mechanisms and oxidative stress) of the conspicuous brown seaweeds *Padina pavonica*—a species with carbonate deposition – and *Lobophora variegata*—a species without carbonate on thallus surfaces –, both with similar morphology. Seaweeds were sampled twice: November 2011 (eruptive phase with a pH drop of ca. 1.22 units relative to standard conditions) and March 2012 (post-eruptive phase with a pH of ca. 8.23), on two intertidal locations adjacent to the eruption and at a control location. *P. pavonica* showed decalcification and loss of photo-protective compounds and antioxidant activity at locations affected by the eruption, behaving as a sun-adapted species during lowered pH conditions. At the same time, *L. variegata* suffered a decrease in photo-protective compounds and antioxidant activity during the volcanic event, but its photosynthetic performance remained unaltered. These results reinforce the idea that calcareous seaweeds, as a whole, are more sensitive than non-calcareous seaweeds to alter their performance under scenarios of reduced pH.

Special Session. 100 years of the Instituto Español de Oceanografía**TPEA Project: maritime spatial planning in the Gulf of Cadiz****Gómez Ballesteros, M.¹, Tello, O.¹, De Armas, D.¹, Prado, I.¹, Torres, M.² and TPEA Working Group**¹*Instituto Español de Oceanografía / C/ Corazón de María, 8, 28020 Madrid*²*Instituto Español de Oceanografía /Muelle de Levante (Puerto Pesquero) Apdo. 2609 11006 Cádiz***Abstract**

Maritime Spatial Planning (MSP) is coming to prominence as a new approach to the governance of the seas and oceans. It is taking on international importance as maritime nations exert greater control over their territorial waters and, in many cases, over much more extensive exclusive economic zones (Jay, 2010; Schaefer & Barale, 2011). This is in the interests of reversing the environmental degradation of the seas and facilitating the sustainable use of marine resources, both for traditional uses, such as fishing and navigation, and newer uses, such as renewable energy and mariculture (Douvere, 2008). MSP is being encouraged worldwide by inter-governmental bodies, NGOs, stakeholder organisations and marine scientists and managers (Agardy, 2010; De Santo, 2011; HELCOM & OSPAR, 2003), and a growing number of nations are drawing up spatial plans to regulate the use of their marine territories, in a way analogous to land-use planning.

In encouraging cross-border cooperation, regard must therefore be had to the different national frameworks that are developing, and means of finding agreed solutions to cross-border issues must be developed. MSP in a transboundary context must therefore be not just a technical exercise of allocating marine space efficiently to different uses, but also a deliberative process of understanding the various approaches at work, engaging with the concerns of the governmental and stakeholder bodies involved, and of facilitating institutional dialogue across borders. This is the importance of cross-border cooperation to ensure consistency of plans across marine political boundaries, administrative and natural as well the need to avoid conflict and create transboundary synergies.

In this context, the Transboundary Planning in the European Atlantic (TPEA) project is developed as response to the European Commission (DG Mare's) call for a Project on Maritime Spatial Planning in the Atlantic, including Celtic Sea and Bay of Biscay, in order to reflect the aim of the project, which is to deliver a commonly-agreed approach to cross-border MSP in the European Atlantic region. This approach will be trialled in two distinct geographical and political contexts, linked by their shared regional identity, and will provide detailed recommendations and guidelines for the evaluation of cross-border MSP. This project seeks to embrace the diversity of realities across the region, and develop the implementation of transboundary MSP in two distinct, but related contexts: a southern focus (Portugal-Spain), where MSP experience is already gaining ground and a consensus is emerging for cross-border solutions; and a northern focus (Ireland-UK) where more policy-centred traditions of planning are pointing in the direction of broader, and less prescriptive, MSP outcomes (see map, below). By capturing this range of approaches, the project will articulate the potential for transboundary MSP within the European Atlantic as a whole and demonstrate options for cross-border initiatives elsewhere. Moreover, in recognising the varying stages of implementation of MSP within the region, the project respects the autonomy of member states in conducting MSP for national waters and the non-binding nature of planning outcomes resulting from the project. In the southern context the Gulf of Cadiz is the proposed and analyzed pilot area, from the environmental, economic and social axis, taking into account the geographical characteristics, human pressures, priorities policies and traditions planning uses.

ReferencesAgardy, T. (2010) *Ocean Zoning*, Earthscan, London

- De Santo, E. (2011) Environmental justice implications of Maritime Spatial Planning in the EU, *Marine Policy* 35, 34–38
- Douvere, F. (2008) The importance of marine spatial planning in advancing ecosystem-based sea use management, *Marine Policy* 32 (5) 762– 771
- HELCOM & OSPAR (2003) Towards an Ecosystem Approach to the Management of Human Activities, unpublished document
- Jay, S. (2010) Built at Sea: Marine management and the construction of marine spatial planning, *Town Planning Review*, 81 (2), 173-191
- Schaefer, N. & Barale, V. (2011) MSP: opportunities & challenges in the framework of the EU integrated maritime policy, *Journal of Coastal Conservation*, 15, 237–245

European initiatives to disseminate the Geo-information of marine environment: EMODNET. Marine Knowledge 2020. IEO contributions

Tello, M.O., Mata, D., Serrano, A., Tel, E., Lavín, A., Nogueira, E.

Instituto Español de Oceanografía

Abstract

Marine Knowledge 2020 brings together marine data from different sources with the aim of helping industry, public authorities and researches find the data and make more effective use of the to develop new products and services, and improving our understanding of how the seas behave.

On this way, it is necessary to develop tools and platforms to provide accessibility to marine information. The UE is developing several initiatives on this way. EMODnet is an initiative from the European Commission Directorate-General for Maritime Affairs and Fisheries (DG-MARE) as part of its Marine Knowledge 2020 strategy.

The EMODnet aim is to unlock fragmented and hidden marine data resources and to make these available to individuals and organizations (public and private), and to facilitate investment in sustainable coastal and offshore activities through improved access to quality-assured, standardized and harmonized marine data. There are six sub-portals in operation that provide access to marine data from the following themes: bathymetry, geology, physics, chemistry, biology, and seabed habitats. IEO are implicated in the collecting data about bathymetry, physics, chemistry, biology and seabed habitats.

The importance of scientific knowledge for the Environmental Impact Assessments (EIA). A case study.**Vargas Poncini, José Luis***Instituto Español de Oceanografía***Abstract**

Environmental Impact Assessment (EIA) are processes that are regulated by different legislation at the European; State and Regional level, mainly by European Directives and their transposition into the legislation of our country.

In this context the Government, specifically the public administrations (AAPP) that are in charge of those environmental assessment processes, need to make decisions about projects, plans or programs that are initiated not only by individuals but also by the own AAPP.

Such decision making occurs mainly in two consecutive phases of the EIA, an initial "consultation phase" and, unless the process ends before, a second "public information" phase. In both phases the AAPP which lead the EIA process need to consult with third parties that help them in their decision making. The above-mentioned environmental impact assessment legislation only mentions the obligation to consult, in such processes, the "affected public sector" and "interested persons", specifying only, in regards to the AAPP, "those with responsibilities related to the activity which environmental impact is being assessed".

However experience shows that, on many occasions, the AAPP responsible for environmental assessment processes address their consults to public research institutions (belonging to State; Regional or Local Government). Its main purpose is to gather the maximum scientific accurate judgments, so to take decisions the more objective possible. Hence, for example, the consults to public research institutions as it is the case of the Spanish Oceanographic Institute ("Instituto Español de Oceanografía, IEO"), are often considered, beyond any indication in the specific legislation, as if it is "obligatory".

In this communication we first find a presentation and an explanation, in a simple way, of the normative framework of the EIA and its structure, with special attention to the marine and coastal environment. Some practical cases are showed later, cases of projects and/or plans or programmes relating to activities in the sea upon which the IEO was consulted in the process of EIA. Emphasis is placed in an example where the role of researchers of this Institute is considered not only that it has been key to help the public manager in its decision making that, even, it has been key in a such way that the developer of the project has made changes that are considered very beneficial for the preservation of the environment.

Implementation of the Marine Strategy Framework Directive in Spain: The role of the IEO

Juan Bellas¹, Alberto Serrano², Francisco Velasco², Francisco Alemany³, María Soto⁴, Izaskun Preciado², Jesús Mercado⁵, César González-Pola⁶, Juan Antonio Campillo⁷, Lucía Viñas¹, Jesús Gago¹, Demetrio de Armas⁴ and the rest of the Marine Strategy-Team from the IEO.

¹*Instituto Español de Oceanografía, Centro Oceanográfico de Vigo. Apdo.1552, 36280 Vigo, Spain*

²*Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Promontorio San Martín s/n, 39004 Santander, Spain*

³*Instituto Español de Oceanografía, Centro Oceanográfico de Baleares. Moll de Ponent, s/n, 07015 Palma de Mallorca, Spain*

⁴*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero, s/n, Apdo. 285, 29640 Fuengirola, Málaga, Spain*

⁵*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero, s/n, Apdo. 285, 29640 Fuengirola, Málaga, Spain*

⁶*Instituto Español de Oceanografía, Centro Oceanográfico de Gijón, Avenida Príncipe de Asturias 70 bis, 33212 Gijón, Spain*

⁷*Instituto Español de Oceanografía, Centro Oceanográfico de Murcia, Varadero nº 1 Apdo. 22, 30740 San Pedro del Pinatar, Murcia, Spain*

Abstract

The Marine Strategy Framework (Directive 2008/56/EC, MSFD) came into force in 2008 as the key environmental instrument of the European Union maritime policy, and establishes that Member States shall adopt the necessary measures to achieve or maintain the good environmental status (GES) of the marine environment by 2020. The central part of the MSFD is formed by the ‘marine strategies’, which have to be developed by the Member States for the marine waters under their jurisdiction.

The MSFD states that Member States must incorporate the provisions of the Directive into their national law. In Spain, the Law 41/2010 on the protection of the marine environment (LPME), is the standard transposing MSFD into national law, adapting the text of the Directive to the national scenario. The LPME provides the general legal framework for the conservation and protection of the marine environment in Spain, with the aim of achieving the GES of the marine waters, and ensuring the sustainable use of marine resources. In addition, this Law includes the regulation of other aspects related to the protection and planning of the marine environment, such as the creation and management of a Spanish network of Marine Protected Areas, and the control of discharges into the sea. To facilitate the implementation of marine strategies, the LPME establishes, on the basis of particular biogeographic, oceanographic and hydrological characteristics of each region, five subdivisions within these regions and subregions, so called “marine demarcations”. The Atlantic region includes the North Atlantic demarcation, the South Atlantic demarcation and the Canary Islands demarcation; whilst the Mediterranean region includes the Levantine-Balearic demarcation and the Gibraltar Strait and Alborán Sea demarcation.

The authority responsible for the implementation of the MSFD in Spain is the Ministry of Agriculture, Food and Environment (MAGRAMA). The MAGRAMA coordinates the marine strategies in collaboration with the involved administrations. The scientific support for the marine strategies was provided by the Spanish Oceanographic Institute (IEO). The Marine Strategy-Team from the IEO started to work on the scientific implementation of the MSFD in January 2010, within the framework of a Fund Management Agreement between the IEO and the Ministry of Environment and Rural and Marine Affairs (now Ministry of Agriculture, Food and Environment). The IEO is mentioned in the LPME as a resource and technical service of the General State Administration, through which the activities of the marine

strategies will be implemented. The IEO carried out, so far, the initial assessment and the development of the eleven descriptors of good environmental status.

An expert responsible for each MSFD descriptor was designated from scientists in different IEO laboratories with experience in the scientific areas covered by the Directive, since an organization in working groups for each descriptor was needed. Results of previous research provided a lot of useful information, but in many areas of knowledge the data did not meet the requirements set by the Directive. In fact, as important as the assessment work was the identification of gaps of knowledge and the identification of future research needs. The first three steps of the implementation cycle of marine strategies (initial assessment, GES definition and establishment of environmental targets) concluded in 2012, with contributions of more than 80 researchers from all oceanographic centers of the institution.

The next task to be addressed in order to implement marine strategies is the elaboration of the monitoring programs (Article 11, MSFD). The general aim of these monitoring programs is the continuous assessment of the status of the marine environment, and will be used to estimate the distance between the environmental status and the GES, based on the elements listed in Annex III and following the principles contained in Annex V of the MSFD.

Here we describe the work carried out by the IEO within the implementation process in Spain, which represents a demanding task in the integrative assessment of marine ecosystems, and we discuss the main difficulties and challenges encountered so far.

The submarine volcano eruption at the island of El Hierro: more than 2 years registering physical-chemical anomalies

E. Fraile-Nuez¹, J.M. Santana-Casiano², M. González-Dávila², C. Presas-Navarro¹, A. Rodríguez-Santana², D. de Armas¹

¹*Instituto Español de Oceanografía. Centro Oceanográfico de Canarias. Santa Cruz de Tenerife. Spain*

²*Universidad de Las Palmas de Gran Canaria. 35017 Las Palmas de Gran Canaria. Spain*

Abstract

On October 10 2011 an underwater eruption gave rise to a novel shallow submarine volcano south of the island of El Hierro, Canary Islands, Spain. During the eruption large quantities of mantle-derived gases, solutes and heat were released into the surrounding waters. In order to monitor the impact of the eruption on the marine ecosystem, periodic multidisciplinary cruises were carried out with different projects: Bimbache, Raprocan, Cetobapth and Vulcano.

The extreme physical-chemical perturbations caused by this event during the first six months, comprising thermal changes, water acidification and deoxygenation, resulted in significant alterations to the activity and composition of local plankton communities. Our findings highlight the potential role of this eruptive process as a natural ecosystem-scale experiment for the study of extreme effects of global change stressors on marine environments.

On the other hand, and due to the fact that the degasification phase is still active, a post-eruptive monitoring were necessary in order to have a completely view of the system variability. In this way, in January 2013, the Spanish Government together with FEDER funded approved VULCANO project (CTM2012-36317) with three multidisciplinary cruises (March, October 2013 and March 2014), which have already proved and quantified that the physical-chemical anomalies are still present in an area of 200 meters radio around the main crater of the submarine volcano.

References

Fraile-Nuez et al., 2013. The submarine volcano eruption at the island of El Hierro: physical-chemical perturbation and biological response. *Scientific Reports* 2:486.

Santana-Casiano et al., 2014. The natural Ocean acidification and fertilization event caused by the submarine eruption of El Hierro. *Scientific Reports* 3:1140.

Banco de La Concepción: A new Natura 2000 Marine Site off Canary Islands

Martín-Sosa, P., González-Porto, M., Almón, B., Acosta, C., Arrese, B., González-Irusta, J.M., Barreiro, S., Jiménez, S.

Instituto Español de Oceanografía, Centro Oceanográfico de Canarias

Abstract

The main objective of the LIFE+ INDEMARES project is to contribute to the protection and sustainable use of the biodiversity in the Spanish seas through the identification of valuable areas for the Natura 2000 Network. The Spanish Institute of Oceanography (IEO) has been in charge of implementing scientific surveys to map sensitive habitats of seven of the ten INDEMARES areas, and to determine the fisheries footprint over these areas.

Banco de La Concepción is one of the areas chosen to be depicted in the frame of INDEMARES project. Located at 71 km to the NE of Lanzarote, at the coordinates 29° 55' Latitude N and 12° 45' Longitude W, Banco de la Concepción raises from 2,541 m up to its summit at 170 m deep.

The biological richness of Banco de la Concepción is very influenced by the deep water up-welling phenomena, which create a high productivity, attracting a multitude of pelagic species, such as cetaceans, turtles, sharks, and tunas looking for food. In its vicinity, fishery resources such as goraz, anglerfish, and hakes, are abundant, and a rich invertebrate fauna cohabits in their bottoms. Banco de la Concepción is a traditional fishing area of oceanic pelagic species, and very good to catch demersal fish; it is highly visited by Galician and Portuguese drifters and long liners that fish in Mauritania, and mainly by the Andalusian longliners. In general, its main impacts are related to uncontrolled fishing pressure. The available information on the anthropogenic impact of the area was scarce, and its level of research was very poor as well, before INDEMARES project.

Methodology approach complies with a multidisciplinary perspective, having described the area from geological, oceanographic, biological and fisheries points of view. Several surveys have taken place since 2009 to 2013 at Banco de La Concepción waters. Traps, longlines, beam trawls, benthic dredges and box corers have been used to sample benthic fauna. These last two, plus EM 3002 multibeam echosounder, PS 18 parametric sub bottom profiler, EA600 monobeam sounder, Seapath 200 positioning sensor and SV Plus sound velocity calibration sensor were used to make a geophysical study which provides a range of environmental factors. CTD was used to depict physical conditions of the water column. Finally, Remote Operated Vehicle Liropus 2000 and different photogrammetric tugged sleds were used to make a great effort of visual sampling.

Data from VMS (Vessel Monitoring System) were used, combined with interviews to users (fishers), to describe the fishery uses in the area.

Results from all this field work provide enough information for the administrations to establish a new Natura 2000 area, trying to reconcile protection of biodiversity and artisanal local economic activities. This establishment should take place at the end of a process of public consultation to stakeholders which is taking place in the present and which will help to shape the future Management Plan which will give details about permitted and prohibited uses.

Present knowledge and perspectives in the paralarval culture of *Octopus vulgaris***E. Almansa¹, D. Garrido¹, M.V. Martín¹, J.R. Cejas¹, C. Rodríguez², S. Jerez¹.**¹*Instituto Español de Oceanografía. Centro Oceanográfico de Canarias, Vía Espaldón, Dársena Pesquera, Parcela nº 8, 38180 Santa Cruz de Tenerife*²*Dpto. Biología Animal, Universidad de La Laguna, 38206, La Laguna, Santa Cruz de Tenerife***Abstract**

The common octopus is one of the species with greatest interest for marine aquaculture, given its rapid growth and good adaptation to captivity, among other favorable characteristics. However, the high mortality of paralarvae represents the main obstacle for the development of large-scale culture. Unlike benthic adults, new hatchling paralarvae are pelagic. This phase of the cycle usually lasts about two months, at the end of which begins to acquire benthic life habits, developing typical adult morphology and behavior. However, under culture conditions the mortality is 100% in most studies. Nutritional deficiencies seem to be one of the main causes of these results. However, other factors should not be ignored. One of the first aspects to consider is the variability of the spawning quality, which seems to be caused by factors such as geographical area, size, female feed and incubation temperature. Other important aspects are the rearing conditions.

In relation to feeding and nutrition, the best results were achieved by feeding paralarvae with decapod zoeae which are their main prey in nature. However, the use of these zoeae is not economically viable and current research focuses on *Artemia* enrichment with phytoplankton or marine phospholipid give poorer results than those obtained with decapod zoeae. Recent studies in OCTOPHYS project (MICIIN.AGL-2010-22120-C03) showed that octopus has little or no capacity for synthesis of highly polyunsaturated fatty acids, suggesting an important requirement of these fatty acids in the diet. Regarding proteins, previous studies suggested that the main requirements in this aspect may be covered by *Artemia*, although more studies are needed. Another important nutrient is copper, which is an essential component of their respiratory pigments, showing lower contents in the *Artemia* than in decapod zoeae. It must be also highlighted that the requirements of most vitamins have not been yet addressed (except for vitamin A and E). Finally, and concerning the use of inert diets, there are many issues to be resolved related to the composition and the encapsulation type.

An important limitation is the lack of biomarkers to detect and quantify the welfare and nutritional condition of paralarvae and there is little information on pathology, immune response and the stress condition. Several potential biomarkers such as digestive enzymes reactive oxygen species (ROS), heat shock proteins and RNA/DNA ratio have been tested. Massive data analysis (genomics, proteomics and transcriptomic) have been conducted in order to improve our knowledge of this species. In this regard, all issues related with experimental research on cephalopods have recently been regulated by a European Directive on animal welfare (Directive 2010/63/EU).

In conclusion, the planktonic lifestyle and high growth rate of the paralarvae result in very high energetic and structural demands. Furthermore, paralarval diet should take into account not only the nutritional requirements but also digestion, absorption and metabolism physiology of the paralarvae. Other important factors to improve the paralarval culture are the environmental conditions, behavioral and physiological changes associated with the paralarval development and differences in the spawning quality.

Identification of indicators suitable to be applied to the coastal environmental assessment in the Canary Islands. OMARCOST Project

Gustavo González-Lorenzo, Sonsoles González, Sebastián Jiménez, José F. González, Carlos L. Hernández, Pablo Martín-Sosa, Olvido Tello, Jaime Rodríguez, Cristina Boza, Aurora Bartolomé, Yulimar González, Erika L. González, Demetrio De Armas and M.T.G. Santamaría.

Instituto Español de Oceanografía

Abstract

The identification of indicators that will be appropriate for the environmental evaluation of the coastline in the Canary Islands is an action research framed in the activities of the Project “Strategy for the Environmental Sustainability of the Litoral Border” (OMARCOST), funded by the European Operational Programme “Spain-External Borders Cross-Border Cooperation Programme” (POCTEFEX). The general aim of the project might be defined as the impulse of the environmental sustainability of the coastal zones, by means of both the management and integrated development of the coastal system, as well as the growth of revitalizing sectors. By using a multisystemic approach and multicriteria ecosystem analysis we will try to study and harmonize the socioeconomic development and the economical growth with the conservation of the ecosystems and the sustainability of the coastal resources. Although the model used in this project integrates the environmental, social and economical aspects, this presentation will be focus only in the environmental features.

The first approach was to select the appropriate tools to analyze the state-of-the-art of the Canary Islands coastal shoreline, in a process to adapt the Guidelines contained in the European Framework Directive of Marine Strategy to the regional context of the islands. In this sense, the initial evaluation of the environmental status of the Canarian coastline made in compliance with such legislation, detected lagoons of information and therefore, needs for more advanced studies. Therefore, we have tried to be homogeneous in the selection of indicators under this global approach, and at the same time to normalize and standardize the used methodology to mitigate these deficiencies, producing adequate information for the design of mandatory monitoring plans at this current state of development of this European directive.

The criteria used in the selection of the environmental indicators were to be preferably quantitative and ease to measure, to have an spatial and temporal dimension as well as to have capacity of response to variations of any kind that may be reflected in environmental changes. In addition, those that can be implemented in geographic information systems were prioritized, as they can be further compared to other kind of indicators (e.g. those of socioeconomic origin) in future multicriteria analysis or in the design of management plans.

The information needed to develop this work has been obtained through research surveys, both in the intertidal and subtidal zones, through the use of diving techniques and the embarkment of observers on vessels of the local artisanal fishing fleet of El Hierro and Fuerteventura islands. These two islands represent the two extremes or boundaries of the longitudinal geographical gradient existing in the Canary Islands marine environment.

Based on their conservation status or its ecological importance, both species and habitats as well as coastal communities have been studied to be used in future monitoring plans: examples are endangered species such as the true limpet *Patella candei* (lapa majorera) and the brown spiny lobster (*Panulirus echinatus*, langosta herreña) or structuring species such as the seagrass *Cymodosea nodosa* and the brown algae *Cystoseira abies-marina*. Besides, anthropogenic pressures such marine debris accumulation or coastal fishing activity were also studied.

All these actions will be very useful in a close future as they will allow the study of the usefulness and reliability of the selected indicators and therefore, to create an initial database to be used in the development of monitoring plans for coastal marine ecosystem evaluation.

Marking *Octopus vulgaris* beaks: age validation and life-event recording

C. Perales-Raya¹, E. Almansa¹, A. Bartolomé¹, B.C. Felipe¹, J. Iglesias², F.J. Sánchez², J.F. Carrasco³ and C. Rodríguez³.

¹*Instituto Español de Oceanografía (Centro Oceanográfico de Canarias). Vía Espaldón, Dársena Pesquera Parcela 8, 38180, Santa Cruz de Tenerife, Spain*

²*Instituto Español de Oceanografía (Centro Oceanográfico de Vigo). Subida a Radio Faro nº 50, 36390 Vigo, Spain*

³*Centro de Experimentación Pesquera. Consejería de Agroganadería y Recursos Autóctonos. Avda. Príncipe de Asturias, s/n, 33213, Gijón, Spain*

Abstract

As with other harvested species, sustainable management of the common octopus rests on an understanding of life history and modelling of the dynamics of wild populations, which in turn rest on age determination and knowledge of growth patterns. This study aims to validate the daily deposition of increments in *Octopus vulgaris* beaks across full ontogenetic range for both, the lateral wall surfaces (LWS) and the rostrum sagittal sections (RSS). The exploited size range was validated by chemical and environmental markings induced in wild adults kept in captivity. Moreover, despite the high mortality rates observed in *O. vulgaris* paralarval culture some techniques have been successful in rearing paralarvae. They provided us with known-age paralarvae, juveniles and adults hatched under laboratory conditions, for a study aimed at confirming, for the first time, absolute ages in hard structures of *O. vulgaris*. Forty-nine marked wild animals kept in the aquaria (weight range of 158-3521 g) and 24 reared individuals of known-age (paralarvae of 0-98 days old and adults of 200-734 days old) were studied, encompassing for the first time the full age range of the species including known-age individuals older than one month. The daily deposition of beak increments was validated in the LWS by injection of Calcofluor, and in the RSS by environmental marking (thermal, confinement, capture and stress of the chemical marking process).

A total of 111 successful validations, where beak increments precisely corresponded to days elapsed, were achieved. The maximum validated periods were 57 days in LWS and 112 days in RSS. During the pelagic stages and the transition to the settlement, a new pattern of micro-increments that record age has been demonstrated in the lateral hood surfaces (LHS) of upper jaws, where stress checks were observed. This could be crucial to understanding the causes of the low survival rate of the common octopus in captivity and the reasons preventing the settlement stage. In the benthic stage, tip erosion in beak RSS results in some underestimation of age, however RSS shows clear checks as a response to stressful conditions. It may prove useful in future research to ascertain the effects of environment and other potentially stressful factors during the life cycle of both wild and reared octopuses. Furthermore, as beaks are present in all existing cephalopod species, they may be suitable for determining their age and life events.

First steps towards developing an open access software designed for the recognition of daily microstructures used in ageing fish**Navas, E.¹, Rey, J.², Clemente, C.¹, García, A.², Otero, P.¹ and Piñeiro, C.³**¹*Escuela Técnica Superior De Ingenieros Malaga (ETSI). Universidad de Málaga. SPAIN*²*I.E.O. (C.O. Málaga) 29640 Málaga. SPAIN*³*I.E.O. (C.O. Vigo) 36200 Vigo. SPAIN***Abstract**

Ageing methods for most of the exploited fish species are not validated, and consequently age data series often have important gaps and uncertainty manifesting its consequences on age-based fisheries assessment.

Amongst the most recognizable otolith microstructures are those corresponding to daily growth increments producing reliable estimates of larval and juvenile growth in an ample number of fish species. From the temporal perspective, otoliths are the only calcified structures that show growth marks at two different scales, the seasonal and daily markings. Seasonal rings or otolith macrostructure is mostly used to age juvenile and adult individuals while microstructure is typically used in larvae, because the DGI in adult otoliths are too numerous and cumbersome to count. Nonetheless, in several hake species DGI have been counted and measured in juveniles by interpreting daily increments through thin transversal sections of the otolith (50-100 μ). Since these sections can only be obtained after a process of otolith resin embedding, section precision cutting and final polishing, the main handicap lacking today is the appropriate digital tool for counting and measuring otolith DGI widths.

In this communication, the research multidisciplinary team of researchers from the research fields of fisheries and engineering plans to develop a new tool designed to add efficiency in the weighty task of estimating the age of fishes based on DGI analysis. The technique is based on new computer algorithms that interpret DGI patterns, whether it be in a semi-automatic way or in such a manner that otolith readers are allowed to interact with the system or run automatically when the technique finds determined types of otolith structural patterns considered consistent and reliable. The technique, when registered, will be made available freely to the international scientific community in the open access mode. Although some image analysis software is available in the market nowadays, including some centered in otolith image processing, they all show at least two main restrictions: they do not manage 'live' images which allow to specifically focus determined microstructures at great magnification, and moreover, the high costs of the software. We present here the first results on the development of this forthcoming software which is expected to resolve the before mentioned limitations.

Larval and adult otoliths measure from some hundred μ m to several mm, respectively, while DGI widths fluctuates from slightly less than 1 μ m increments close to the nucleus in larval otoliths to more than 15 μ m in juveniles and adults. In order to discriminate DGI, light microscope magnification varies from x1000 in larvae to x200 in juveniles and adults. As a consequence, most of the times the whole otolith or section cannot be represented on a single image and thus, several images are needed to construct a sole image to get the vision of the total otolith size that can be measured where most DGI counts can be included. In these cases, the image series should be tiled as a panoramic view or mosaic, where each section superposes with adjacent ones. The first step in the software development has been a superposing routine, identifying automatically common areas between adjacent images. Once a single high quality image is set by otolith at an acceptable magnification some arrangements on contrast, brightness, etc. can be implemented when desired. The next stage is the controlled or semi-automatic counting of DGI along a growth trajectory. Expert readers particular interpretations could be matched to those made automatically and eventually adjust the software reading standards. Finally, DGI counts and measurement data are recorded and also exported to work files, where further analysis could be performed.

As soon as having ready an appropriate and affordable tool to count and measure daily growth increments in an automatic or semi-automatic way, otolith microstructure analysis can have a reliable age estimation method that can be extended and applicable to age adult fish. Although, in its present form the technique is focused in otolith microstructure analysis, further developments of the initiated software development intends to extend its application to other calcified structures, namely bivalve shells and cephalopod peaks.

XVII Seminario Ibérico de Química Marina

Marine Ecotoxicology and Pollution

A multi biomarker approach for the assessment of the physiological condition of *Solea sp* populations in NW Mediterranean fishing

M. Solé¹, M. Blázquez¹, R. Siscar², A. Torreblanca², J. Pertusa², L. Tort³, L. Berdié⁴, V. Piquer⁵, E. Mañanós⁵, I. Varó⁵

¹Instituto de Ciencias de Mar (ICM-CSIC)

²Departamento Biología Funcional y Antropología Física. Universitat de València.

³Department of Cell Biology, Physiology and Immunology. Universitat Autònoma de Barcelona

⁴Unitat de Cromatografia de Gasos-Espectrometria de Masses Aplicada. Centres Científics i Tecnològics (CCiTUB)

⁵Instituto de acuicultura Torre la Sal (IATS-CSIC)

Abstract

The use of biomarkers comprising several levels of biological organization (biochemical, immune, histological and physiological) as indicators of exposure and/or effect to environmental pollutants, allows for a very comprehensive understanding of alterations that might compromise essential physiological processes. This multibiomarker approach was applied to a benthic fish species of great commercial interest. The sampling of sole, *Solea solea* and *Solea senegalensis* was carried out using artisanal fishing techniques with the collaboration of local fisherman. Immediately after fishing, biological traits such as total length and weight were recorded for the determination of their condition factor. Blood was taken right after capture and the fish immediately sacrificed and dissected. Tissues and organs including brain, muscle, gills, liver, kidney, gonad and bile were snap frozen in liquid nitrogen for further biochemical analyses. In addition, portions of liver and gonads were preserved in Bouin-hollande fixative for histological analysis. Liver and gonad weight were also recorded for hepatosomatic and gonadosomatic index calculations. The comprehensive set of biomarkers included: vitellogenin (VTG) and sex steroid plasma levels, immune markers and cell counts, metallothionein content, activities of the enzymes acetylcholinesterase (AChE), lactate dehydrogenase, carboxylesterase, glutathione S-transferase, ethoxyresorufin O-deethylase (EROD), antioxidants such as catalase, glutathione peroxidase, glutathione reductase and lipid peroxidation (LP) levels in several target tissues/organs. Seven sampling sites along the Northern Western Mediterranean coast from Costa Brava to Ebre Delta were studied. The sites were selected according to the possible presence of organic contaminants and metals since some of them could be end points for run offs from local discharges.

Of the selected species and locations, the most significant differences in biomarker responses were associated to *S. senegalensis* sampled at the most distant locations: Costa Brava and Garraf as it was reflected in the principal components analysis plot considering most biomarkers involved in xenobiotic's detoxification in liver and gill (e.g. EROD activity). The indicator of oxidative stress damage (LP) in muscle also reflected site differences for *S. senegalensis*. Metallothionein as indicative of metal exposure was related to toxic metals (e.g. Hg, Cu and Cd) in kidney in both species, but no signs of neurotoxicity, measured as AChE inhibition in brain, were detected. No indication of endocrine disruption was evidenced as plasmatic VTG was absent in males and sex hormone levels varied accordingly to the maturity status of the gonads. Lack of significant physiological alterations was in line with low levels of organic pollutants present in sediment and also with levels in sediment and bile of the endocrine disruptor nonylphenol, all being present at levels lower than those reported to cause biological disturbances. Only to remark some immune alterations in fish from specific sites, such as a concomitant cell counts suppression and

an elevated oxidative stress response, that could not be associated to any particular chemical exposure. The study also highlights the importance of biological traits such as sex, developmental status and fish size in the biomarker responses and confirmed an overall good physiological condition of sole fish in traditional fishing grounds, in sites where pollution gradients are small.

Acknowledgements: CTM2010-16611.

Passive samplers and biomarkers to assess metal labile concentrations and the associated biological effects: case studies in the**N Montero¹, M Baudrimont², P González², P-Y Gourves², MJ Belzunce-Segarra¹**¹Marine Research Division, AZTI-Tecnalia. Herrera kaia, Portualdea z/g 20110 Pasajes, Spain²Marine Station of Arcachon, University of Bordeaux, UMR CNRS EPOC 5805, Aquatic Ecotoxicology. Place du Dr Peyneau, 33120 Arcachon, France**Abstract**

The European Water Framework Directive (WFD; 2000/60/EC) and the Marine Strategy Framework Directive (MSFD; 2008/56/EC) refer to contaminants bioavailability and ecotoxicological effects. However, current methods to measure bioavailability suffer from many inadequacies that can lead to incorrect assessment decisions. This issue has resulted in greater demand for in situ testing approaches. The passive sampler Diffusive Gradient in Thin-films (DGT) enables the in situ measurement of labile metal concentrations in waters (1), which is a better proxy to potential biological adverse effects than the routinely measured dissolved metal concentrations (2). On the other hand, the use of bivalves is widely extended because metals accumulated in their tissues reflect environmental concentrations (3) and the associated biochemical and physiological alterations (*i.e.* biomarkers) can be used as early indicators of the effects of the chemical compounds on the biota (4).

In this study, the use of DGTs is combined with bioaccumulation and biomarker studies in transplanted oysters (*Crassostrea gigas*) in estuarine and port waters located in the Basque-French coast. The objective is to establish cause-effect relationships between labile metal concentrations and biological effects for an integrated evaluation of the ecosystem health.

Metal analyses (Al, Cd, Co, Cr, Cu, Ni, Mn, Pb and Zn) of DGTs and oyster tissues were performed by ICP-MS and ICP-OES, respectively. The mercury accumulated in DGTs and in oyster tissues was measured by CV-AAS (AMA 254). The toxicological responses were studied at three levels: physiological impacts (growth, state of reproduction and the condition index of oysters), biochemical responses (metallothioneins (MTs) concentrations: detoxification proteins scavenging metals ; malondialdehyde (MDA) production: final product of lipid peroxydation), and transcriptomic responses (by Quantitative PCR: to quantify the expression of several genes implied in different cellular functions, such as detoxification (isoforms of MTs: mt1, mt2, multixenobiotic resistance protein:mxr, glutathione-s-transferase: gst), mitochondrial metabolism (subunit 1 of the cytochrome c oxydase: cox1, ribosomal gene 12S), oxidative stress (mitochondrial superoxide dismutase: sodmt, cytoplasmic superoxide dismutase sod, glutathione peroxydase: gpx)). Three organs were studied: gills, digestive gland and the rest of tissues.

Differences in contamination in both areas of study were detected by means of DGTs, which is in accordance with the different contamination sources present at each site. Also, different bioaccumulation patterns in oysters and specific toxic responses at different levels were observed. The results show higher concentrations of Pb, Zn, Al, Hg and Co in port waters which are related with higher bioaccumulation in the oysters' gills. The protein and genetic responses also show larger alteration in oysters exposed to the port waters. The cause-effect relationships between metal concentrations in DGTs and the effects in oysters were also established.

In summary, the integration of chemical and biological tools allowed a comprehensible water quality assessment of these complex systems. Besides, the study demonstrates that the DGT technique provides excellent information on the bioavailability and potential toxicity of metals.

References

1. Davison, W., Zhang, H., 1994. In situ speciation measurements of trace components in natural waters using thin-film gels. *Nature*

367:546-548.

2. Meyer, J.S., 2002. The utility of the terms 'bioavailability' and 'bioavailable fraction' for metals. *Mar. Environ. Res.* 53:417-423.
3. Baudrimont, M., Schäfer, J., Marie, V., Maury-Brachet, R., Bossy, C., Boudou, A., Blanc, G., 2005. Geochemical survey and metal bioaccumulation of three bivalve species (*Crassostrea gigas*, *Cerastoderma edule* and *Ruditapes philipinarum*) in the Nord Médoc salt marshes (Gironde estuary, France). *Sci. Total Environ* 337:265-280.
4. McCarthy, F., Shugart, L.R., 1990. *Biomarkers of environmental contamination*. Lewis Pub., Chelsea USA

Contemporary ^{14}C radiocarbon levels of O-PBDEs isolated in sponge-cyanobacteria associations**Carlos Guitart^{1,5}, M. Slattery^{2,3}, S. Ankisetty¹, M. Radwan³, S.J. Ross³, R.J. Letcher⁴, C.M. Reddy⁵**¹*Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA*²*University of Mississippi, Department of Pharmacognosy, Oxford, MS 38677-1848, USA*³*University of Mississippi, National Center for Natural Products Research, Oxford, MS 38677-1848, USA*⁴*Ecotoxicology and Wildlife Health Division, Wildlife and Landscape Science Directorate, Science and Technology Branch, Environment Canada, National Wildlife Research Centre, Carleton University, Ottawa, Ontario, Canada K1A 0H3*⁵*Instituto Español de Oceanografía – IEO, Centro Oceanográfico de Murcia, c/Varadero 1, Lo Pagán, 30740 San Pedro del Pinatar, Murcia, Spain***Abstract**

Considerable debate surrounds the sources of oxygenated polybrominated diphenyl ethers (O-PBDEs) in wildlife as to whether they are naturally produced or result from anthropogenic industrial activities. Natural radiocarbon (^{14}C) abundance has proven to be a powerful tool to address this problem as recently biosynthesized compounds contain contemporary (i.e. modern) amounts of atmospheric radiocarbon; whereas industrial chemicals, mostly produced from fossil fuels, contain no detectable ^{14}C . However, few compounds isolated from organisms have been analyzed for their radiocarbon content. To provide a baseline, we analyzed the ^{14}C content of four O-PBDEs. These compounds, 6-OH-BDE47, 2'-OH-BDE68, 2',6-diOH-BDE159, and a recently identified compound, 2'-MeO-6-OH-BDE120, were isolated from the tropical marine sponges *Dysidea granulosa* and *Lendenfeldia dendyi*. The modern radiocarbon content of their chemical structures (i.e. diphenyl ethers, $\text{C}_{12}\text{H}_{22}\text{O}$) indicates that they are naturally produced. The existence of potentially different sources of O-PBDEs in the environment (i.e. synthetic, natural and transformed), challenges the issue of the source and the potential risks to exposed wildlife. Therefore, elucidation of sources is a key to understanding the environmental occurrence, transformation processes, transport processes and bioaccumulation of O-PBDEs. The molecular level radiocarbon technique (by Accelerator Mass Spectrometry, AMS) allows discriminating between these origins. The baseline data presented in this study provides evidence of natural production in marine sponge–bacteria associations.

References

1. C. Guitart, M. Slattery, S. Ankisetty, M. Radwan, S.J. Ross, R.J. Letcher and C.M. Reddy, "Contemporary ^{14}C radiocarbon levels of oxygenated polybrominated diphenyl ethers (O-PBDEs) isolated in sponge–cyanobacteria associations", *Mar. Poll. Bull.*, 62, pp.631-636, 2011.
2. C.M. Reddy, L. Xu, R.K. Nelson, T.I. Eglinton, D.J. Faulkner, R. Norstrom, P.S. Ross, S.A., Tittlemier, "Radiocarbon evidence for a naturally produced, bioaccumulating halogenated organic compound". *Env. Sci. Technol.*, 38, pp.1992–1997, 2004.

DEGRADABILITY OF ANIONIC SURFACTANTS IN DIFFERENT ANOXIC MARINE SEDIMENTS**Corada-Fernández, C., González-Mazo, E., Lara-Martín, P.A.***Department of Physical-Chemistry, Faculty of Marine and Environmental Sciences, University of Cadiz, Campus of International Excellence of the Sea (CEI.MAR), Río San Pedro, Puerto Real, 11510, Cádiz, Spain***Abstract**

During the last decades there has been a growing concern on the behavior (sources, transport, distribution, transformation and interaction with biota) and environmental risk of synthetic surfactants, used for many applications such as wetting agents, emulsifiers, detergents, personal care products, paint and pesticide additives. Linear alkyl benzene sulfonates (LAS) are the anionic surfactants showing the highest production volume worldwide. Their removal in aerobic wastewater treatment plants is very efficient (1), typically more than 99%, and aerobic degradation in water (2) and soils (3) takes place in a few days by the generation of sulfophenyl carboxylic acids (SPCs) resulting from the omega-oxidation of the alkyl chain and then consecutive alpha- and beta-oxidations. However, a considerable fraction of the total LAS discharged ends up in riverine and coastal sediments because this surfactant has a high adsorption capacity as a consequence of its affinity for the organic carbon in the sediment. These sediments tend to present anaerobic conditions below a topmost layer a few millimeters thick in the case of aquatic areas subjected to pollution. It is generally assumed that this compound is not biotransformed in these kinds of anoxic environments because of the high concentrations (of the order of several g/kg) found in anaerobic sewage sludge; not having any laboratory assays which evidence this fact (4). On the other hand, previous studies undertaken in recent years by our group have shown that the degradation of LAS in absence of oxygen may be possible, especially by marine bacteria from sewage-impacted sediments (5). Furthermore, an anaerobic degradation pathway was described recently (6), showing that LAS can be transformed into SPCs in absence of oxygen by fumarate addition to the alkyl chain.

The present work aims to characterize the degradation processes of LAS in marine sediments free of contamination (where bacteria are presumably not adapted to the presence of this surfactant) and under anaerobic conditions following the OECD TG 308 guidelines ("Aerobic and anaerobic transformation in aquatic sediment systems"). The anaerobic assays proposed by these guidelines simulate a water-sediment system that allows studying the anaerobic transformation of an organic compound in an aquatic system. In this work, the anaerobic degradation of LAS has been studied in 2 types of marine sediments with different texture (6.5% and 84.7% of sand content) and organic carbon content (4 % and < 1%, respectively). They were collected within the natural park of Cadiz Bay (Southwest, Spain) and introduced in microcosms where, under controlled conditions, degradation tests were performed. Oxygen was removed from the water before the beginning of the experiments by using N₂. Gas generation (CH₄, CO₂ and H₂S), LAS disappearance and generation SPCs, as well as pH, TOC, elemental analysis (C, H, N, S), and redox potential were monitored in sediments. In addition, water samples were characterized and sampled, measuring not only LAS and SPCs concentrations but also temperature, pH, TOC, oxygen, redox potential and nutrients (NO²⁻, NO³⁻, NH⁴⁺). For sandy and low organic carbon content sediments (experiment 1), 63% of the original amount of LAS was degraded into SPCs 160 days after the beginning of the experiment. Generation of SPC was confirmed to take place by fumarate addition to LAS alkyl chain, which generates methyl-sulfophenyldicarboxylic acids (Me-SPdC). These compounds, which were detected in water samples from both degradation experiments, are later degraded to SPCs. Moreover, a notable and constant increase of the concentrations of these metabolites was observed to occur, accompanied by a decrease of LAS levels in both water and sediment phases. Regarding muddy and

high organic carbon content sediments (experiment 2), anaerobic degradation of LAS was also observed 160 days after the beginning of the experiment, but to a much lower extent (20%). Regarding additional parameters, pH remained fairly stable over the entire duration of the experiment (7.09 ± 0.11 and 7.06 ± 0.12 for experiments 1 and 2, respectively), as well as redox potential (-262 ± 168 and -419 ± 119 mV for experiments 1 and 2, respectively), which shows negative values (higher values for muddy sediments). Oxygen content in the reactors was zero, ensuring that the degradation tests were performed under strict anaerobic conditions. Most of the gas measured in the headspace was nitrogen ($> 95\%$) as all sample manipulation and incubation was carried out in an anaerobic chamber filled with that gas. Generation and presence of methane, carbon dioxide and hydrogen sulfide were confirmed during the experiment, being higher in experiment 2 than in experiment 1, which implies a more active microbial community in muddy sediments. In the case of hydrogen sulfide, its levels were comparable to those for methane, reaching concentrations in the headspace up to 9212 ppm.

Overall, results from these experiments show that LAS can be degraded in non-polluted marine sediments under anaerobic conditions. The extension and speed of the degradation process, however, is severely affected by different organic carbon content, texture of sediments and microbiological populations. These results are therefore relevant for future environmental risk assessments of LAS and other anionic surfactants in aquatic environments.

References

1. McAvoy, D.C. Dyer, S.D.; Fendinger, N.J.; Eckhoff, W.S.; Lawrence, D. L.; Begley, W.M. *Environ. Toxicol. Chem.* 1998, 17, 1705-1711.
2. León, V.M.; Gómez-Parra, A.; González-Mazo, E. *Environ. Sci. Technol.* 2004, 38, 2359-2367.
3. Elsgaard, L.; Pojana, G.; Miraval, T.; Eriksen, J.; Marcomini, A. *Chemosphere* 2003, 50, 929-937.
4. Wagener, S.; Schink, B. *Water Res.* 1987, 21, 615-622
5. Lara-Martín, P.A.; Gómez-Parra, A.; Köchling, T.; Sanz, J.L.; Amils, R.; González-Mazo. E. *Environ. Sci. Technol.* 2007, 41, 3573-3579.
6. Lara-Martín, P.A.; Gómez-Parra, A.; Sanz, J.L.; González-Mazo. E. *Environ. Sci. Technol.* 2010, 44, 1670-1676.

Biomagnification of metals and organic pollutants in sea snail from cockle in the Mar Menor lagoon (SE Spain)

León, V.M.¹, Moreno-González, R.¹, Besada, V.², Martínez, F.¹, García, V.¹, Schultze, F.², Campillo, J.A.¹

¹Instituto Español de Oceanografía, Centro Oceanográfico de Murcia, Apdo. 22, C/ Varadero 1, 30740 San Pedro del Pinatar, Murcia, Spain.

²Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Subida Radio Faro 50. 36390 Vigo, Pontevedra, Spain.

Abstract

The bioaccumulation of pollutants occurs in some organisms and a significant increase of their concentration is favored in the next trophic level (biomagnification). This process has been observed in persistent pollutants along the trophic chain, such as metals or organochlorinated pesticides. In this study, the concentrations of metals (As, Cd, Cu, Hg, Pb and Zn), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and organochlorinated pesticides (OCPs) in sea snail (*Murex trunculus*) and cockle (*Cerastoderma glaucum*) from Mar Menor lagoon were characterized. Sea snail is a natural predator of cockles in the Mar Menor lagoon and consequently the biomagnification of metals and organic pollutants was assessed in different areas from this lagoon.

Two sampling campaigns were performed in spring and autumn of 2010, considering three sampling points in each Mar Menor area (the north area with the higher influence of Mediterranean Sea, the south one that is the most confined one and the intermediate area). Water, sediment, cockle and sea snail were simultaneously sampled in each area. The bioaccumulation of organochlorinated contaminants in cockle is lower than in oyster and noble pen shell in this lagoon (León et al., 2013) but similar PAHs bioaccumulation levels were detected in the three bivalve species. However no previous information is available about their concentrations in sea snail and their possible biomagnification in this system.

The distribution of metals and organic pollutant was heterogeneous in Mar Menor lagoon depending on the location of the different pollutant sources, the physicochemical conditions and the hydrodynamism of this system. The highest concentrations of PAHs in cockle and sea snail were detected close to the main ports and urban nuclei and to the El Albuñón Watercourse mouth. In the case of p,p'-DDE the highest bioaccumulation was detected in the central and south part of Mar Menor lagoon for both organisms, especially in the influence area of El Albuñón watercourse. However the highest concentrations of metals in cockle and sea snail were detected in the influence area of El Beal wadi (residues from Cartagena/La Unión mining areas).

Biomagnification factors (BMF) in sea snail from cockle (sea snail-cockle concentration ratio) were higher than 5 for metal and organochlorinated compounds. Concretely BMF varied between 4 and 16 for p,p'-DDE, Cd and As, between 2.8 and 7.0 for CB153 and between 1 and 30 for Pb. The highest BMF were detected close to each pollutant source, El Albuñón watercourse area for organochlorinated pesticides and El Beal wadi for metals. However similar concentrations were observed in both species for PAHs due to gastropods capability of metabolize these pollutants.

Acknowledgement: This work has been supported by the Spanish Inter-Ministerial Science and Technology Commission through 'DECOMAR' project (CICYT, CTM2008-01832) and by Seneca Foundation (Region of Murcia, Spain) through 'BIOMARO' project (15398/PI/10).

References

León, V.M., Moreno-González, R., González, E., Martínez, F., García, V., Campillo, J.A. 2013. Sci. Total Environ., 463-464, 975-987.

LIMPETS versus WILD MUSSELS: Tool for monitoring metals in the Canary Islands (Spain)**Besada, V., Schultze, F., López, M. and Bellas, J.***Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Subida a Radio Faro 50, 36390 Vigo, Spain***Abstract**

The Marine Strategy Framework Directive (MSFD, 2008/56/EC), is the main instrument for the protection of the marine environment in Europe. According to the MSFD's descriptor 8, the concentrations of contaminants should be at levels not giving rise to pollution effects. The Spanish initial assessment of the quality status of their national marine waters by the end of 2012, for compliance with MSFD, has revealed several gaps and lack of information and knowledge regarding descriptor 8, being more pronounced in one of the five marine subdivision of the Spanish jurisdictional waters, the Canary region².

The schedule marked by the MSFD highlight the need for the development and implementation of monitoring programs (by July 15, 2014) and measures (by 2016), to continuously assess the status of the marine environment and to verify if the Good Environmental Status is achieved or maintained. Within this framework, and in order to respond to descriptor 8 it would be crucial to include the evaluation of the levels of trace metals in all Spanish coasts.

From the early 90s, the Instituto Español de Oceanografía (IEO) use wild mussels (*Mytilus galloprovincialis*) as "biomonitors" of coastal pollution in the Atlantic and in the Mediterranean areas (CEMP-OSPAR Commission and MEDPOL-Barcelona Convention), because it is a widely distributed species, sessile and, more importantly, accumulates high levels of chemical pollutants in their tissue, reflecting the surrounding environmental conditions. These time series were used in both areas to develop the descriptor 8 in the initial assessment of the MSFD. However, the Canary Islands are not covered by a marine pollution monitoring program, because they are not included on the mentioned regional seas convention, or in other international agreements. Moreover, there is a great difficulty to find wild mussels in the Canary Islands coastal region, so it is necessary to seek for a good indicator species that could replace mussels.

The limpet, *Patella spp.* is among the considered alternative organisms. To validate its use on the Marine Strategy monitoring program it is necessary to carry out studies to assess the suitability of these organisms as indicators of pollution, including the potential development of quality criteria for environmental assessment.

The first aim of this study was to evaluate the trace metals levels in mussels and limpets collected in different sampling sites from the Spanish Marine Pollution Monitoring Programme (Atlantic-Galicia and Northern coasts), where levels and geographical distribution of metals are well defined after many years of surveillance, so locations have been selected with a gradient of metal pollution. A second objective was to compare the trace metal concentrations in limpets from this area with those from sampling sites located on the seven Canary Islands.

Mussels (*Mytilus galloprovincialis*) and limpets (*Patella spp.*) collection was performed manually, during low tide, in the sampling sites selected from the North Atlantic subregion (Arousa, Ferrol, Suances and Fuenterrabia). In Canary Islands, limpets (*Patella spp.*) were collected by hand from 7 sites distributed along the coastal zone.

²<http://www.magrama.gob.es/es/costas>

Each sample was prepared from more than 20 individuals representing the available size range existing in the sampling point. The soft tissues were separated from the shells, triturated with an Ultraturrax homogeniser and freeze-dried.

Samples were digested with nitric acid in microwave ovens (Besada et al., 2011). Selected metals (As, Cd, Cu, Pb, Zn, Cr and Ni) were analyzed with a Perkin-Elmer AAnalyst 800 spectrophotometer, equipped with a Zeeman background correction. Total mercury was determined by cold vapour technique, employing a Perkin-Elmer FIMS-400 system (SnCl₂ as reducing agent).

The quality of the chemical analyses is demonstrated by the results obtained in different intercalibration exercises that take part on a regular basis, such as QUASIMEME. The internal laboratory QC includes analyses of duplicate samples and procedural blanks as well as control charts of CRMs.

The study from the North Atlantic Spanish coast indicated that, in general, limpets showed higher levels for As, Cu, Cr and Ni than mussels. With respect to Cd, limpets presented higher concentrations in the locations from the Galician than in the Cantabrian coast.

Regarding Hg and Pb, both species showed similar levels and the same spatial distribution. In contrast to the other metals, Zn presented higher concentrations in mussels than in limpets. Also, in this area, limpets presented the same geographical distribution of target metals than mussel.

Comparing both areas (North Atlantic coast and Canary Islands), metals concentrations in limpets were clearly lower in samples from the Canarian Archipelago, except for Cd. Samples from the Galician coast (Arousa and Ferrol) presented similar values to those obtained in the limpets from La Gomera, La Palma and Hierro. Cd show a different behavior from the rest of the metals, since the prevalent upwelling on both areas (Galicia and Canary Island) transports high quantities of this metal to the surface.

It can be concluded that limpets can be used as an indicator species of the metal levels in the Canary Islands and the results can be compared with those obtained in other Spanish regions, where mussels are used as indicator organisms. However, more research is needed to determine the spatial distribution and seasonal variation of metals, and to establish background levels and develop environmental quality criteria for this species.

References

Besada, V., Andrade, J.M., Schultze, F., González, J.J., 2011. Comparison of the 2000 and 2005 spatial distributions of heavy metals in wild mussels from the North-Atlantic Spanish coast. *Ecotoxicology and Environmental Safety* 74, 373-381.

Phenolic profile of microalgae growing under copper stress

Milagros Rico, Aroa López, Magdalena Santana-Casiano, Aridane G. González, Melchor González-Dávila

Departamento de Química. Facultad de Ciencias del Mar. Universidad de Las Palmas de Gran Canaria

Abstract

Planktonic algae are an important component of natural surface waters. They can regulate the speciation and bioavailability of trace metals through the production and release of organic ligands. These organic ligands bind more than 99% of the total iron and copper in natural waters.

Phenolic compounds are natural products involved in responses to different kinds of biotic and abiotic stresses. There is considerable evidence with respect to the implications of phenolic compounds in plants growing in conditions of metal deficiency and stress. Plants accumulate elevated amounts of phenolic compounds for protection and recovery from heavy metal injury. The main chemical process where polyphenols are involved is in the scavenging of Reactive Oxygen Species (ROS). However, few reports have focused on the identification and quantification of polyphenols in microalgae. Determining how polyphenol concentrations change in response to high metal levels will demonstrate the role of these compounds in microalgae and might be useful to help explain the dynamics of this important class of compounds in seawater.

The phenolic profile of exudates and extracts of marine microalgae *Phaedactylum tricornutum* and *Dunaliella tertiolecta* harvested in natural seawater in the presence and absence of Cu additions was studied, at metal levels of environmental relevance. The experimental findings show changes in the concentrations and types of polyphenols as a function of the metal concentration. The most relevant results show the following: 1) the differences between *P. tricornutum* and *D. tertiolecta* owing to their different sensitivities to metal stress; 2) the great increase in phenolic compounds at the highest copper concentration, which may reflect the involvement of these compounds in protection against conditions of copper toxicity; and 3) the phytomedicinal potential of microalgae is underlined by the antioxidant activity of extracts and high contents of phenolic compounds. These microalgae may be exploited for the production of health foods and as an antioxidant carrier in the food and pharmaceutical industries.

***In vitro* inhibition by organophosphorus compounds of gilthead seabream (*sparus aurata*) muscle cholinesterases and theoretical approach to the enzyme-inhibitor interactions**

Valimaña Traverso, J.M., Soto Mancera, F., Albendín García, M.G., Manuel Vez, M.P., Arellano López, J.M., Arufe Martínez, M.I.

Grupo de Toxicología Ambiental y Analítica, Facultad de Ciencias del Mar y Ambientales, Universidad de Cádiz, Puerto Real (Cádiz).

Abstract

Organophosphorus pesticides (OPs) cause a long-term inhibition of acetylcholinesterase (AChE) by phosphorylating a serine hydroxy group at its active site. This causes accumulation of the enzyme at synaptic cleft and results in overstimulation of cholinergic pathways and subsequently neurotoxic effects. Acetylcholinesterase inhibition has been widely used as biomarker of OP and carbamate (CB) pesticide exposure, even though the knowledge of AChE-OP interactions is still scarce in marine species. Butyrylcholinesterase (BChE) is another sort of cholinesterase whose biological function is not well-known, but it has been reported that this enzyme shows a higher affinity for OPs than AChE, therefore, BChE could have a protective role against AChE inhibition. Several techniques that use organisms as bioindicators have been developed because of the fact that OP insecticides are also toxic to nontarget species including fish. The *in vitro* studies include the determination of pesticide concentration (or active metabolite) that inhibits the enzyme by 50%, i.e., IC₅₀. In order to compare the *in vitro* sensitivity of the gilthead seabream muscle AChE and BChE to inhibition by several OPs fenitrothion and parathion phosphorothioates and the corresponding phosphates fenitrothion-oxon and paraoxon, biochemical studies were undertaken, i.e., characterization studies using specific inhibitors (Eserine, BW284c51 and iso-OMPA) and IC₅₀ determination for OP compounds, which could be useful to provide basal information for environmental monitoring in coastal and marine areas. Several factors, i.e., steric effects, solubility, electronic density and bond length, have been compared among the OPs studied in the present work, in order that it could be possible to explain in a theoretical approach the experimental results of the enzyme-inhibitor interactions. Enzymatic activity measured in gilthead seabream muscle was mainly owing to cholinesterases and not to other type of esterases. AChE activity was found to be higher than BChE activity in *S. aurata* muscle. According to the results, inhibitory potency of fenitrothion was higher than inhibitory potency of parathion, and the same result was observed when the phosphates corresponding to these compounds were assayed. Furthermore, these oxonphosphates were more powerful inhibitors than the phosphorothioates studied. The conclusions of the analysis of the aforementioned factors were consistent with the experimental results.

Biogeochemical Processes

The natural ocean acidification and fertilization event caused by the submarine eruption of El Hierro

J. M. Santana-Casiano¹, M. González-Dávila¹, E. Fraile-Nuez², D. de Armas²

¹IOCAG-Grupo QUIMA. Universidad de Las Palmas de Gran Canarias. 35017 Las Palmas de Gran Canaria. Spain

²Instituto Español de Oceanografía. Centro Oceanográfico de Canarias. Santa Cruz de Tenerife. Spain

Abstract

The shallow submarine eruption which took place in October 10th 2011, 1.8 km south of the island of El Hierro (Canary Islands) allowed the study of the abrupt changes in the physical-chemical properties of seawater caused by volcanic discharges. In order to monitor the evolution of these changes, seven oceanographic surveys were carried out over six months (November 2011-April 2012) from the beginning of the eruptive stage to the post-eruptive phase. The pH in total scale at 25°C (pH_T), total dissolved inorganic carbon (C_T), and total alkalinity (A_T), were measured together with temperature, salinity, dissolved oxygen and total sulfur reduced species. Nutrients, ferrous iron and pCO_2 were also analysed on most of the cruises.

Important changes in the water column chemistry including large decreases in pH, striking effects on the carbonate system, decreases in the oxygen concentrations and enrichment of Fe(II) and nutrients were produced. As a result of the ongoing magmatic activity, the submarine eruption produced an unprecedented episode of severe acidification and fertilization.

The findings highlight that the same volcano which was responsible for the creation of a highly corrosive environment, affecting marine biota, has also provided the nutrients required for the rapid recuperation of the marine ecosystem.

In January 2013, the Spanish Government approved the project VULCANO in order to study the post-eruptive phase in the submarine volcano of El Hierro. Three cruises were planned (March and October 2013 and March 2014). Physical-chemical anomalies are still being observed close to the volcano area.

Acknowledgements. This work was supported by the Instituto Español de Oceanografía, by the European Project CARBOCHANGE-264879 and by the Spanish Ministerio de Economía y Competitividad, through the ECOFEMA CTM2010-19517 and the VULCANO CTM2012-36317 projects.

References

Fraile-Nuez et al., 2013. The submarine volcano eruption at the island of El Hierro: physical-chemical perturbation and biological response. *Scientific Reports* 2:486. Santana-Casiano et al., 2014. The natural Ocean acidification and fertilization event caused by the submarine eruption of El Hierro. *Scientific Reports* 3:1140.

Natural enrichment of coastal waters: the influence of the geological basement on trace metal levels in the NW Iberian Peninsula

Juan Santos-Echeandía¹, Patricia Bernárdez², Miguel Caetano³, Ricardo Prego¹

¹*Marine Biogeochemistry Group, Marine Research Institute (CSIC), Eduardo Cabello 6, 36208 Vigo, Spain*

²*Marine Geosciences and Land Management Department, University of Vigo, Vigo, Spain*

³*IPMA—Portuguese Institute for Sea and Atmosphere, Av. Brasília, 1449-006 Lisboa, Portugal*

Abstract

The ocean margin is the critical land–ocean interface. At its inner boundary, coastal waters are characterized by steep physical and chemical gradients although being highly dynamic over short time-scales [1]. Several studies have shown that coastal waters contain higher trace element concentrations than open ocean waters [2]. Natural weathering processes at basins of major worldwide rivers have been pointed as major supplier of dissolved and particulate material to the ocean [3]. The enrichment of coastal waters in trace metals has been ascribed to river discharges, atmospheric transport, and anthropogenic sources. Major internal sources are diagenetic exchanges of trace elements across the water–sediment interface and upwelling of bottom waters. In addition, accidental episodes of contamination may lead to punctual enhancement of trace-element concentrations. Examples are Aznalcollar mining spill [4], Erika and Prestige oil spills [5]. The intensity and extension of these contaminating events could not be determined if baseline concentrations are not previously established.

The Water Framework Directive aims to establish the trace metal maximum levels allowed in transitional waters. If these levels are exceeded, actions should be implemented to reduce concentrations. However, in some cases, the geological basement itself makes these levels to increase “naturally”.

The Northern Galician coast contains the Cape Ortegal Ultramafic Complex composed of ultrabasic rocks [6] enriched in chromium (Cr) and nickel (Ni) minerals [7]. The hypothesis that the weathering of the geological basement will increase Cr, and Ni dissolved and particulate concentrations in the adjacent coastal waters was tested in this northwestern area of the Iberian Peninsula.

Four sampling cruises were conducted in the estuarine waters of the Ortigueira and Barqueiro rias during 2008. In addition and during the same periods as for the estuaries, the main rivers and sewage treatment plant (STP) flowing into these two rias were sampled.

Once at the on-shore lab, samples were filtered through a 0.2 μM polypropylene pore-filter inside a “clean” laboratory to avoid contamination. Filters were frozen and stored at -20°C until particulate metal analysis while filtrates were acidified to pH 2 (HCl, Suprapur) for dissolved metal analysis.

Dissolved trace metal concentrations in estuarine waters were determined by means of stripping voltammetry after UV digestion to breakdown the organic matter. The simultaneous determination of cobalt (Co) and Ni was performed by Adsorptive Cathodic Stripping Voltammetry [8]. In the case of copper (Cu), the method developed by [9] was used. Finally, Cr was analyzed with the method set up by [10]. The accuracy of the analytical procedure was assessed by the analysis of two different certified reference materials (CRMs) (CASS-4 and SLEW-3).

Filters were mineralized and concentrations of Co, Cr, Cu and Ni in the filters, together with the dissolved fraction in the rivers and STP were determined using a quadrupole ICP-MS (Thermo Elemental, X-Series). The precision and accuracy of each metal concentration measurements were determined through repeated analysis of CRMs (MESS2 and PACS2).

The values of Cr and Ni both in the dissolved and particulate fraction are higher in the rivers flowing into the Ortigueira (7.4–10.6 nM Cr and Ni 74.8–180 nM) than in the Barqueiro Ria (0.1–1.43 nM Cr and

Ni 11.7-25.5 nM). However, in the case of Co values are higher in the river that flows into the Barqueiro Ria and in the Ortigueira Sewage Treatment Plant. Finally, in the case of Cu, the values are similar in the tributaries flowing to both rias.

Regarding their mark in estuaries, it seems that the only effect observed in the Ortigueira waters respect to Barqueiro is on the dissolved Ni levels, especially at low tide, which gives an idea of its continental origin and non-marine. No major differences in the Co and Cu concentrations were detected, as expected because their levels are similar and in the effluents of both estuaries.

The case of chromium is curious because dissolved levels are similar in both estuaries but particulate concentrations are higher in Ortigueira. This may be explained by its high affinity for particles (high log KD).

Although dissolved and particulate metal levels are not very different between the two estuaries they are relatively high compared with other estuarine or coastal waters of the Iberian Peninsula, mainly in the case of Ni and Cr.

References

1. Braungardt, C., E.P. Achterberg, M. Nimmo, 1998. On-line voltammetric monitoring of dissolved Cu and Ni in the Gulf of Cadiz, south-west Spain. *Anal.Chim.Acta.*,377,205-215.
2. Landing, W.M., G.A. Cutter, J.A. Dalziel, A.R. Flegal, R.T. Powell, D. Schmidt, A. Shiller, P. Statham, S. Westerlund, J. Resing, 1995. Analytical intercomparison results from the 1990 intergovernmental oceanographic commission open ocean baseline survey for trace metals: Atlantic Ocean. *Mar.Chem.*,49,253-265.
3. Martin, J.M., M. Meybeck, 1979. Elemental mass-balance of material carried by major world rivers. *Mar.Chem.*,7,173-206.
4. Grimalt, J.O., M. Ferrer, E. Macpherson, 1999. The mine tailing accident in Aznalcollar. *Sci.Total.Environ.*,242,3-11.
5. Santos-Echeandía, J., R. Prego, A. Cobelo-García, 2009. Influence of the heavy fuel spill from the Prestige tanker wreckage in the overlying seawater column levels of copper, nickel and vanadium (NE Atlantic ocean). *J.Mar.Syst.*,72,350-357.
6. Gil-Ibarguchi, J.I., M. Mendia, J. Girardeau, J.J. Peucat, 1990. Petrology of eclogites and clinopyroxenegarnet metabasites from the Cabo Ortegal Complex (northwestern Spain). *Lithos*,25,133-162.
7. Moreno, T., W. Gibbons, H. Prichard, R. Lunar, 2001. Platiniferous chromitite and the tectonic setting of ultramafic rocks in Cabo Ortegal, NW Spain. *J.Geol.Soc.*,158,601-614.
8. Santos-Echeandía, J., 2011. Direct simultaneous determination of Co, Cu, Fe, Ni and v in pore waters by means of adsorptive cathodic stripping voltammetry with mixed ligands. *Talanta*.85,506-512.
9. Campos, M.L.A.M., C.M.G. van den Berg, 1994. Determination of copper complexation in sea water by cathodic stripping voltammetry and ligand competition with salicylaldoxime. *Anal.Chim.Acta.*,284,481-496.
10. Boussemart, M., C.M.G. Van den Berg, M., Ghaddaf, 1992. The determination of the chromium speciation in sea water using catalytic cathodic stripping voltammetry. *Anal.Chim.Acta.*,262,103-115.

Trace Metal distribution in the Surface Microlayer of the Mediterranean Sea

Antonio Tovar-Sánchez¹, Jesús M Arrieta¹, Carlos M. Duarte¹, Sergio A. Sañudo-Wilhelmy²

¹*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.*

²*Department of Biological Sciences and Department of Earth Sciences. University of Southern California. Los Angeles, California, 90089-0371, USA*

Abstract

Atmospheric deposition represent a fundamental input of trace metals to the ocean [1,2], although the impact of dust deposition on biological processes such as oceanic primary production [3,4] and nitrogen fixation [5] is not well understood. While the lack of an immediate biological response to atmospheric inputs of bioactive trace metals have been attributed to a lag-time in the dissolution kinetics of dust particles metals [6], the role of the sea surface microlayer (SML), a thin, but fundamental component modulating that air-sea exchange of materials [6,7] has not been properly evaluated. Our study revealed that Mediterranean Sea's SML is enriched in bioactive trace metals (i.e. Cd, Co, Cu and Fe), ranging between 12 (for Cd) to 4700 (for Fe) times higher, relative to the surface dissolved water metal pool. These results demonstrate that the concentration and retention of aerosols material in the SML is significant and usually not quantified using the traditional sampling protocols applied in most marine trace metal studies. Our study suggests that the SML must be considered to better constrained the effect of atmospheric inputs on biological processes in the ocean.

References

1. Heimbürger et al. (2014). *Deep Sea Research I* 87, 14–23;
2. Landing, & Paytan (2010). *Marine Chemistry* 120, 1–3;
3. Jickells. et al. (2005). *Science* 308, 67–71;
4. Young, et al. (1991). *Global Biogeochemical Cycles* 5, 119–134;
5. Mills et al. (2004). *Nature* 429, 292–294;
6. Boyd et al. (2010). *Marine Chemistry* 120, 128–143;
7. Baker, A. R. & Croot, P. L. (2010). *Marine Chemistry* 120, 4–13;

Iron partition in surface waters of a large-scale summer bloom south of the Antarctic Polar Front

Laglera LM¹, Santos-Echeandia J², Klaas C³, Wolf-Gadrow DA³

¹*Department of Chemistry, University of the Balearic Islands, Palma, Spain*

²*Instituto de Investigaciones Marinas (CSIC), Vigo, Spain*

³*Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany*

Abstract

During the Eddy Pump cruise (Southern Ocean, Jan-Mar 2012) we had the opportunity to monitor in situ for 2 weeks the evolution of a large-scale bloom at 52°S, 13°W (Atlantic sector of the Southern Ocean, south of the Antarctic Polar Front) with stable chlorophyll concentrations (1.5-2 mg m⁻³, 200 mg m⁻²) comparable to blooms in iron-replete coastal regions. The bloom was already developed at our arrival and showed slow evolution during the sampling period (3 weeks) with vertical and intensity variations.

Total dissolved iron (<0.2 μm) and 48 hours leachable iron (unfiltered, pH=2.0) were determined in the upper 300 m of the water column. Dissolved iron profiles were not substantially different with nearly flat profiles in the mixed layer (down to 100 meters). Comparison of the concentrations obtained in the bloom with those from one station chlorophyll depleted outside the bloom showed no major differences. However, concentrations of leachable iron (>0.2 μm) were considerably different: outside-bloom 0.16±0.22 nM, inside-bloom 0.44±0.42 nM. Samples from some bloom stations were partitioned in 0.2-0.4 μm, 0.2-3 μm and 0.2-53 μm size fractions where iron in the fractions 0.2-0.4 μm and 0.2-3 μm was negligible and results from the 0.2-53 μm size-fraction were nearly equal to >0.2 μm. This was indicative of the absence of Fe in inorganic aggregates (<0.2 μm) and the rapid recycling of iron in the upper water column.

Iron and copper competitions during redox reactions in natural waters

Norma Pérez-Almeida, Aridane G. González, J. Magdalena Santana-Casiano, Melchor González-Dávila, Guillermo Samperio

Universidad de Las Palmas de Gran Canaria. Departamento de Química. Facultad de Ciencias del Mar. 35017, Tafira. Las Palmas de G.C.

Abstract

Laboratory and field work have demonstrated the relevance of trace metal interaction in the redox chemistry of essential metals like copper and iron. However, the competition of both metals has not been studied in solution. The oxidation-reduction of both, copper and iron was studied under air-saturated conditions bubbling ultra-pure air thorough the solution for 1 h previous and during the experiments. The redox kinetics of copper was studied at constant pH and temperature and as a function of Fe concentration (0-200 nM) and H₂O₂ (0-300 nM). In the case of iron redox reactions, the competition between Fe(II) and copper species has been studied in seawater at different initial Cu(II) and Cu(I) concentration (0-200nM). In addition, the effect of pH (6.2-8.5), bicarbonate concentration (2-9 mM) and H₂O₂ concentration (0-500 nM) on the Fe(II) rate constant were also studied.

The oxidation rate of Cu(I) was retarded in the presence of Fe(II) and accelerated when Fe(III) was also in solution. The log k' (min⁻¹) as a function of Fe(II) and Fe(III) concentrations revealed slopes of $-2.7 \pm 0.2 \times 10^{-4}$ and $8.0 \pm 0.5 \times 10^{-5}$, respectively. On the other hand, the reduction of Cu(II) underwent significant changes. The Cu(II) back-reaction formed 20 nM of Cu(I) over 40 min. The reduction achieved 40-60% in the first 2 min of reaction when Fe(II) was present in solution and the Cu(I) regenerated was oxidized. The Cu(I) oxidation rate was lower than that for the experiments where Cu(I) was initially added. In addition, the half-life time was independent of the initial Fe(II) levels in solution. Moreover, Fe(III) did not present any effect on the Cu(II) reduction.

The Fe(II) oxidation is accelerated in the presence of copper, and a first-order pH dependence was always observed. The rate constant of Fe(II), without copper, was a second order pH dependent function at pH over 7.5 and a first order function for lower pH values (6.2-7.5). Thus, in the presence of copper, the speciation of Fe(II) is affected. FeOH⁺, FeCO₃ and probably FeHCO₃⁺ are involved in the process. In addition, Fe(II) oxidation rate was increased only when both carbonate and Cu(II) concentrations was over 6 mM and 100 nM, respectively. The effect of H₂O₂ concentrations was also function of the initial Cu(II) additions, but the oxidation rate was equally affected by H₂O₂, thus the observed effect must be only due to the presence of copper species in solution

The role of nutrients speciation on the oxidation rate of Fe(II) in seawater

Samperio-Ramos, G., Santana-Casiano, J.M., González-Dávila, M. & González, A.G.

Departamento de Química, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, Campus de Tafira, 35017 Las Palmas, Spain

Abstract

The effects of nitrate, phosphate and silicate in the oxidation of Fe(II) by molecular oxygen have been evaluated using a UV-Vis spectrophotometric system equipped with a long liquid waveguide capillary flow cell. The Fe(II) oxidation process was studied in UV-seawater enriched with nutrients (SWEN) and oligotrophic UV-seawater (SW) as a function of pH (7.2-8.2) and temperature (5-35°C). The results showed that the oxidation rates was faster in high nutrient concentrations, reducing the lifetime of Fe(II) in nutrient rich waters in the different experimental conditions. The highest values in the apparent oxidation constants, were at pH = 8.2 ($\log k_{app-SWEN} = 3.85 + 0.01 \text{ M}^{-1} \text{ min}^{-1}$ and $\log k_{app-SW} = 3.71 + 0.01 \text{ M}^{-1} \text{ min}^{-1}$ at 35 °C), while the minimum oxidation rates were achieved in the lower values of pH ranges of study ($\log k_{app-SWEN} = 1.26 + 0.01 \text{ M}^{-1} \text{ min}^{-1}$ and $\log k_{app-SW} = 1.32 + 0.01 \text{ M}^{-1} \text{ min}^{-1}$ at 15 °C). The apparent rate constant was fitted under the experimental conditions of pH (free scale) and temperature (°K), in SW and SWEN samples. The different in the Fe(II) oxidation rate between SWEN and SW ($\Delta \log k_{app} = \Delta \log k_{app-SWEN} - \Delta \log k_{app-SW}$) was constant along the pH range studied. Nevertheless $\Delta \log k_{app}$ varied throughout the temperature range examined. A kinetic model was applied to the experimental results, in order to account for changes in the speciation and to compute the fractional contribution of each Fe(II) species to the overall rate constant, as a function of pH and temperature. In the Fe(II) oxidation in seawater enriched with nutrients was considerate both the silicate as phosphate effect. The rate constants for the most kinetically active species (Fe^{2+} , FeOH^+ , Fe(OH)_2 , FeCO_3 , $\text{Fe(CO}_3)_2^{2-}$, $\text{FeH}_3\text{SiO}_4^+$, FePO_4^-) in seawater and seawater enriched with nutrients have been determinate as a function of temperature. Neither Fe-silicate reactive specie ($\text{FeH}_3\text{SiO}_4^+$) nor Fe-phosphate reactive species (FePO_4^- , FeHPO_4 and $\text{FeH}_2\text{PO}_4^+$) played a key role in the Fe(II) speciation. At high temperatures, model results shown that when the concentration of silicate is $1.4 \times 10^{-4} \text{ M}$, $\text{FeH}_3\text{SiO}_4^+$ was the specie that dominated the Fe(II) oxidation process between pH 7.4 and 8.0. The thermodynamic effect over the $\text{FeH}_3\text{SiO}_4^+$ ion pair constant has been fitted to an equation that provides the theoretical coefficients for seawater ($S\%_o = 37.09$). Therefore the effect of nutrients, especially silicate and phosphate, must be considered in any further study in seawater media cultures and eutrophic coastal waters.

Marine Pollution and Ecotoxicology

Response of Phototrophic Biofilm to the presence of silver nanoparticles in natural waters

Stéphane Mombo¹, Aridane G. González^{1,2}, Lidia Fernández-Rojo¹, Joséphine Leflaive¹, Alexandre Lamy¹, Oleg S. Pokrovsky², Jean-Luc Rols¹

¹EcoLab/OMP, Université Paul Sabatier – CNRS-INPT, 118 route de Narbonne, 31062 Toulouse, France

²GET/OMP, Université Paul Sabatier - CNRS-IRD, 14 Avenue Edouard Belin, 31400 Toulouse, France

Abstract

Silver is one of the most toxic metals for aquatic biota although it is relatively rare in aqueous systems. Silver can be found both as nanoparticles (AgNPs) and ionic form (Ag⁺) in the natural environment. Benthic phototrophic biofilm is the first biological surface that accepts the impact of pollutants in aquatic systems. Natural biofilms are microbial aggregates on solid substrates composed of heterotrophic and phototrophic microorganisms embedded in an extracellular polymeric matrix basically formed by exopolymeric substances (EPS). The present study addresses the effect of AgNPs and AgNO₃, used from 0.1 to 100 $\mu\text{g L}^{-1}$ of Ag, on two samples of biofilms harvested in a Rotating Annular Bioreactor (RAB), a mesocosm environment simulating the natural conditions found in rivers.

Two independent experiments were carried out, one for silver nanoparticles (AgNPs) and the other for ionic silver (AgNO₃), and the biofilm structure has been independently characterized for each experiment. The biofilms were initially dominated by three classes of algae: Chlorophyceae, Cyanophyceae and Diatomophyceae. These three classes were represented by: *Chlamydomonas sp.*, *Scenedesmus ecorinis*, *Scenedesmus spinosus*, *Heteroleibleinia sp.*, *Leptolyngbya margaretheana*, *Achnanthes exigua* and *Diatoma moniliformis*.

The dry biomass did not decrease in the presence of Ag⁺ and it means that the surface of the biofilm is replacing the loss of *Diatomophyceae* and *Cyanophyceae* by *Chlorophyceae*. Accordingly, Ag⁺ was poisoning the superficial species on the biofilm, formed by diatoms and cyanobacteria, while keeping these habitats for *Chlorophyceae*. The toxicity of AgNPs was due to small particles (20 nm) that can pass through the cell wall and reach the plasma membrane. Besides, after adsorption, AgNPs could produce ionic Ag and reactive oxygen species that also invoke cell damages.

Measuring of the concentration of total silver during the experiments revealed that the accumulation capacity of biofilm is more important when the source of silver is AgNPs compared to AgNO₃. In fact, the concentration of total silver in biofilm was practically the same for exposition to 10 and 100 $\mu\text{g L}^{-1}$ of AgNPs, despite the fact that the capacity to adsorb nanoparticles was at its maximum.

In addition to biofilm culture experiments, we studied single-axenic cultures of three species: *Uronema confervicolum* (green alga), *Nitzschia palea* (diatom) and *Leptolyngbya sp.* (Cyanobacteria). These results help to demonstrate the role of each group of microorganisms under silver stress conditions and the capacity to accumulate AgNPs in their cell surfaces.

Toxicity of silver and gold-silver alloy nanoparticles in marine and freshwater microalgae

Sara Pérez¹, Ignacio Moreno-Garrido¹, Luis Fermín Capitán-Vallvey², Alejandro Lapresta-Fernández², Luis M. Lubián¹, Julián Blasco¹

¹Instituto de Ciencias Marinas de Andalucía CSIC, Campus Río San Pedro, 11510 Puerto Real (Cádiz), Spain

²ECsens, Department of Analytical Chemistry, Campus Fuentenueva, University of Granada, 18071 Granada, Spain

Abstract

The development of the nanotechnology has promoted the use of metal nanoparticles (MNPs) and nano-materials (NMs) for a wide range of areas and applications. In the daily life are being extensively used in household products (cosmetics or sunscreens) or in industrial uses (paints, catalysts, coatings, packaging material, electronics, etc.). Since the NMs are in continuous growth, the emerging market is estimated to exceed one trillion dollars by 2015 (DEFRA, 2007).

Nanoparticles (NPs) occurrence in the environment might cause adverse effects over the ecosystems health and consequently, these effects need to be assessed. Ecotoxicological methods should be developed in order to assess the NPs risks. Their effect over life is largely influenced not only by their interaction with the surrounded aquatic media but also by the physico-chemical properties of the NPs. In aquatic media, the NPs mostly tend to be dissolved in their ions or to suffer different aggregations, which largely determines its toxicity. The extent of this aggregation mainly is dependent on the surface charge, particles morphology (shape and size), pH and the ionic strength of the medium. In seawater the increasing salinity, and therefore ionic strength, reduces the negativity of electrophoretic mobility of the particles to encourage aggregation (Batley et al., 2013).

Most studies have been conducted with freshwater species such as *Daphnia magna* (Lovern and Kapler, 2006) and *Pimephales promelas* (Zhu et al., 2006). Unfortunately, in spite of the high importance into the trophic structure of ecosystems, just a few marine species and photosynthetic organisms (Navarro et al., 2008) have been checked in these kind of studies.

Traditionally, gold nanoparticles (AuNPs) have been widely considered as non-toxic particles although their potential toxicity has not been fully assessed, yet. On the opposite, the toxicity of the silver nanoparticles (AgNPs) has raised an increasing attention. Some of the most important factors related to the toxicity of both types of NPs are the oxidative stress and the effect on DNA, lipids and certain metabolic activities (Lapresta-Fernandez et al., 2012).

Therefore, an ecotoxicity study was carried out for some living species in the presence of AgNPs, dissolved silver (Agdis) and silver-gold alloy nanoparticles (AuAgNPs). Interestingly, by modifying the NPs composition, the toxicity of the NPs can be fine-tuned. In order to assess the toxicity of AgNPs and Agdis, a 72 hours exposure testing growth inhibition was performed over two marine diatoms species (*Phaeodactylum tricorutum* and *Cylindrotheca closterium*) and two freshwater microalgae species (*Chlamydomonas reinhardtii* and *Nitzschia palea*). Moreover, AuAgNPs toxicity responses were studied in *P. tricorutum* and *N. palea*.

The results show AgNPs toxicity (in terms of EC50) is smaller with Agdis for all species tested. Higher EC50 is also observed in marine species. *N. palea* is the most sensitive species (EC50Agdis = $0.081 \pm 0.017 \mu\text{M}$ and EC50AgNP = $0.707 \pm 0.198 \mu\text{M}$); while *C. closterium* is the most resistant species (EC50Agdis = $0.043 \pm 1.074 \mu\text{M}$ and EC50AgNP = $2.219 \pm 0.159 \mu\text{M}$). In the case of AuAgNPs, the EC50 values found for the random species studied are $3.286 \pm 1.217 \mu\text{M}$ for *N. palea* and $0.990 \pm 0.231 \mu\text{M}$ for *P. tricorutum*.

Finally, additional research is required to understand the mechanisms involved in the adsorption, internalization and toxicity of AgNPs and AuAgNPs on marine and freshwater microalgae.

Acknowledgements: This work was supported by grants from PAIDI RNM-7812 and Spanish National Research Plan (MINECO) CTM2012-38720-C03-03.

References

- Batley, G.E., Kirby, J.K., McLaughlin, M.J., 2013. Fate and risks of nanomaterials in aquatic and terrestrial environments. *Accounts of Chemical Research*, 46 (3), 854 - 862.
- DEFRA, 2007. *Characterising the Potential Risks posed by Engineered Nanoparticles. A Second UK Government Research Report.* Department for Environment, Food and Rural Affairs (DEFRA). London.
- Lapresta-Fernández, A., Fernández, A., Blasco, J., 2012. Nanoecotoxicity effects of engineered silver and gold nanoparticles in aquatic organisms. *Trends in Analytical Chemistry*, 32, 40 - 59.
- Lovern, S. B. and Klaper, R., 2006. *Daphnia magna* mortality when exposed to titanium dioxide and fullerene (C60) nanoparticles. *Environmental toxicology and chemistry*, 25, 1132 - 1137.
- Navarro, E., Baun, A., Behra, R., Hartmann, N. B., Filser, J., Miao, A.-J., Quigg, A., Santschi, P. H., Sigg, L., 2008. Environmental behavior and ecotoxicity of engineered nanoparticles to algae, plants, and fungi. *Ecotoxicology*, 17, 372 - 386.
- Zhu, S., Oberdörster, E., Haasch, M. L., 2006. Toxicity of an engineered nanoparticle (fullerene, C60) in two aquatic species, *Daphnia* and fathead minnow. *Marine environmental research*, 62 Suppl, S5 - S9.

Benzotriazole UV stabilizers in seawater and marine sediments: a first approach of the situation in Gran Canaria island

Sarah Montesdeoca Esponda, Zoraida Sosa Ferrera, Jose Juan Santana Rodriguez

Departamento de Química, Universidad de Las Palmas de Gran Canaria, 35017, Las Palmas de G.C., Spain

Abstract

The growing concern about the link between sunlight exposure and skin cancer has led to an increased use of Benzotriazole ultraviolet stabilisers (BUVSs) in sunscreens, soaps, shampoos, lip gloss, hair dyes and makeup. BUVSs are a group of UV absorbing compounds employed in different personal care products, which are considered emerging contaminants that reflect and absorb the solar radiation (UVA 320-400 nm and UVB 290–320 nm) [1]. The usual concentration of UV filters in cosmetics is between 0.1 and 10% [2].

After be used, these compounds can reach the environment through recreational activities such as swimming and bathing in oceans, lakes or rivers (direct inputs) [3] or after passing throughout wastewater treatment plants without be removed. It has been demonstrated that can present negative effects over aquatic systems, such as they are mutagenic in bacterial systems and toxic in plants [4], and can exert adverse effects on the fecundity and reproduction of fish [5].

Despite this, no information is available regarding the contamination of these pollutants in environmental samples of Gran Canaria Island. We evaluated for first time the presence of seven BUVSs in liquid and solid environmental samples using on-line solid-phase extraction (On-line SPE) and microwave-assisted extraction followed by On-line SPE (MAE-On-line SPE) as clean up step, respectively, both coupled to ultra-performance liquid chromatography with tandem mass spectrometry detection (UHPLC-MS/MS). The LODs achieved were in the range of 0.9-4.4 ng L⁻¹ in seawater and between 53.3 and 106 ng kg⁻¹ in the sediments.

The analysed liquid samples were 12 seawater samples while we selected 3 samples of beach sand and 4 samples of sediments close to a marine outfall as solid samples, all of them around the Gran Canaria Island.

We quantified several BUVSs in sediments around the marine outfall between 0.18 and 24.0 ng g⁻¹, while no compound was detected in the beach sand samples. The concentrations of BUVSs measured in the outfall marine sediments are higher closer to the outfall than in the farthest sample, which suggests that there is a dispersion of analytes from wastewater discharged. Regarding the seawater samples, we detected two BUVs in most of the beaches, in the range 2.8–5.2 ng L⁻¹.

References

1. Díaz-Cruz MS, Llorca M, Barceló D. *Trends in Analytical Chemistry* 2008; 27:873-887.
2. De Orsi D, Giannini G, Gagliardi L, Porra R, Berri S, Bolasco A, Carpani I, Tonelli D. *Chromatographia* 2006; 64:509–515.
3. Balmer ME, Buser HR, Müller MD, Poiger T. *Environmental Science and Technology* 2005; 39:953-962.
4. La Farré M, Pérez S, Kantiani L, Barcelo D. *Trends in Analytical Chemistry* 2008; 27:991-1007.
5. Kunz P, Fent K. *Aquatic Toxicology* 2006; 79:305-324.

Silicon-based passive samplers for monitoring hydrophobic emerging contaminants in the marine environment

Pintado-Herrera, M.G.¹, Allan, I.J.², González-Mazo, E.¹, Lara-Martín, P.A.¹

¹Department of Physical-Chemistry, Faculty of Marine and Environmental Sciences, University of Cadiz, Campus of International Excellence of the Sea (CEI-MAR), Río San Pedro, Puerto Real, 11510, Cadiz, Spain

²Norwegian Institute for Water Research (NIVA), Oslo Centre for Interdisciplinary Environmental and Social Research. Gaustadalléen 21, NO-0349 Oslo, Norway

Abstract

There is a growing interest on knowing the concentration and distribution of a large group of new non-regulated organic compounds (emerging contaminants) in the environment, many of them used in consumer goods, such as antimicrobials, fragrances, UV filters or flame retardants. Some of these chemicals share some physicochemical properties with other regulated compounds (i.e., polycyclic aromatic hydrocarbons, organochlorine pesticides) in terms of high octanol-water partition coefficients (K_{ow}) and low solubility in water. Knowing the partitioning of these hydrophobic organic contaminants in the environment is important to understand and predict their transport and fate. However, analyzing freely dissolved concentrations in waters samples is often a difficult task if conventional (active) sampling is employed. For example, results could be affected by the presence of colloids or dissolved organic carbon in water, where these compounds can be adsorbed [1], therefore overestimating the real concentrations in the aqueous phase. In this sense, the use of passive samplers represents an alternative to the traditional sampling as they only capture the freely dissolved fraction of chemicals in water. Another advantage is that these samplers can provide time-integrated concentrations of the analytes in the environment, as they can be deployed from a few weeks to several months. So far, different types of passive samplers have been used: semipermeable membrane devices (SPMDs), polydimethylsiloxane (PDMS), polyethylene (PE), and silicon rubber. We choose to use the last one, silicon rubber, in this study.

The main objective of this work was to calibrate passive samplers to relate the concentrations of several emerging contaminants in the sampler with their free dissolved concentrations in water [1]. To calculate the dissolved concentration of any analyte is necessary to know two main parameters: passive sampler-water partition coefficients (K_{sw}) and sampling rates (R_s). The transport of analytes from the water to the passive sampler is diffusion-controlled, and only freely dissolved substances are adsorbed to the passive sampler. The diffusion coefficient (D) in these polymers is proportional to the mass transfer and therefore is also important to know it to calculate the concentration of hydrophobic contaminants in water samples. We were able to determine K_{sw} values and diffusion coefficients (used later to estimate R_s) for a group of emerging contaminants, including fragrances, UV-filters and organophosphate flame retardants, which are hydrophobic enough ($\log K_{ow} > 3$) to be captured by this type of passive samplers based on silicon rubber. Several experiments were carried out in the laboratory by spiking silicon rubber with known concentrations of target compounds. The co-solvent model, one of the established methods for increasing the equilibrium of non-polar chemicals in the aqueous phase, was used to perform these experiments and, therefore, determine K_{sw} values later after solid-liquid extraction using pentane and analysis of target compounds by gas chromatography-mass spectrometry (GC-MS). After determining K_{sw} values, we also observed that they were positively correlated either with K_{ow} values (for organophosphate compounds ($R^2 > 0.6$) and nitro musks ($R^2 > 0.9$)) or the molecular weight (for organophosphate compounds ($R^2 > 0.7$) and polycyclic fragrances ($R^2 > 0.7$)). Additionally, a second batch of experiments consisting on studying the diffusion of target compounds between a stack of spiked and non-spiked silicone rubber sheets was performed to calculate diffusion coefficients (D). In

general, the diffusion coefficient decreased when molecular weight increased. Finally, a sampling campaign was carried out using passive samplers to calculate the freely dissolved concentration of emerging contaminants in Norwegian fjords.

References

1. F. Smedes, R. W. Geertsma, T. van der Zande, K. Booij. *Environ. Sci. Technol.*, 2009, 43 (18), pp 7047–7054

Antifouling booster biocides in sea mullet (*Mugil Cephalus*) sampled in harbours of Gran Canaria Island (Canary Islands)

Alejandro Franco-Barrios, María Esther Torres-Padrón, Zoraida Sosa-Ferrera, José Juan Santana-Rodríguez

Departamento de Química, Universidad de Las Palmas de Gran Canaria, 35017, Las Palmas de Gran Canaria, Spain.

Abstract

Biofouling is a problem for any structure placed in the aquatic environment that it can be controlled through chemical biocides like antifouling paints. According to the Biocides Directive (98/8/EC) [1], biocides are active substances or preparations that are intended to destroy, deter, render harmless and exert control or prevent the action of any other harmful organism through chemical or biological means. The widely use of booster biocides in antifouling paints represents an important source of pollution to the marine environment and the transfer of these toxic pollutants to the higher trophic levels is a topic of major concern.

This work present the monitorization of two booster biocides commonly employed, Irgarol 1051 and Diuron, in samples of muscle and liver tissues of *Mugil cephalus*. The proposed sentinel organism could be used in tropical and subtropical regions for a continuous biomonitoring of booster biocides during long time of periods. This could be a useful tool to improve the ocean and coastal management.

Samples were collected bimonthly in different harbours of Gran Canaria island (Muelle Deportivo de Las Palmas and Puerto de Mogán) and processed using a previously optimized method based on a microwave assisted extraction followed by solid phase extraction as preconcentration and clean-up step (MAE-SPE) coupled with liquid chromatography-tanden mass espectrometry (LC-MS/MS) [2, 3].

Highest levels of Irgarol ($6,9 \pm 1,03 \text{ ng g}^{-1}$) were found in the liver, whereas Diuron was not detected in this tissue. However, Diuron was found in muscle ($1,41 \pm 0,45 \text{ ng g}^{-1}$).

References

1. European Parliament. Directive DIRECTIVE 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market (1998).
2. A. Franco-Barrios, M. E. Torres-Padrón, Z. Sosa-Ferrera, J. J. Santana-Rodríguez. Journal of AOAC International 97 (2014) 197.
3. A. Sánchez-Rodríguez, Z. Sosa-Ferrera, J.J. Santana-Rodríguez. International Journal of Environmental Analytical Chemistry. 91 (2009) 1166.

Ecotoxicological assessment of wastewater effluents in marine environments: before and after Advanced Oxidation Process (POA) and Photobiodepuration Treatment

B. Díaz-Garduño¹, J.A. Perales², M.A. Manzano², E. García-Luque¹, C. Garrido², M. L. Martín-Díaz¹

¹Chemical Physical Department, Centro Andaluz de Ciencia y Tecnología Marinas (CACYTMAR), Campus de Excelencia Internacional del Mar (CEI•MAR), University of Cádiz, Campus Universitario de Puerto Real, 11510 Puerto Real, Cádiz, Spain

²Department of Environmental Technology, Centro Andaluz de Ciencia y Tecnología Marinas (CACYTMAR), Campus de Excelencia Internacional del Mar (CEI•MAR), University of Cádiz, Campus Universitario de Puerto Real, 11510 Puerto Real, Cádiz, Spain

Abstract

Municipal sewage effluents are recognized as a major source of many environmental contaminants, including polyaromatic hydrocarbons, pesticides, surfactants, steroids, and metals. Recently, pharmaceuticals and personal care products were identified as an emerging class of potential pollutants for the aquatic environment. Most domestic and some industrial wastewaters are processed by municipal wastewater treatment plants. Despite the improvements in wastewater treatment, effluents are still considered important sources of pollution for both marine and freshwater ecosystems. Municipal sewage effluents are complex mixtures that are known to compromise the health condition of aquatic organisms. Moreover, the environmental repercussions of the discharge of disinfected effluents are still poorly understood (Hébert et al., 2008a,b).

The main aim of this study was to determine the environmental risk to the aquatic biota in the Bay of Cadiz (SW, Spain) of municipal sewage effluents and various wastewater disinfection processes: a) Advanced Oxidation Process (POA)-Hydrogen Peroxid Photocatalysis, and b) Photobiodepuration-microalgae culture. Three residual water treatment plants discharging to this Bay were selected: a) Puerto Real (urban-hospital wastewaters), b) Chiclana I- (urban wastewaters), and c) Chiclana II (industrial wastewaters). The ecotoxicological assessment of selected effluents was performed applying standardized and recommended short-term toxicity tests using four different organisms and endpoints. Organisms from different trophic levels were chosen as bioindicator species: the bioluminescence response in the bacteria *Vibrio fischeri*, survival in the fish *Spaurus aurata*, fertilization and embryo-larval development in the sea-urchin *Paracentrotus lividus* and growth inhibition in the microalgae *Isochrysis galbana*.

Results obtained confirmed the suitability of the use of the selected short-term toxicity tests to assess ecotoxicology of selected effluents, being the sea urchin larval development the most sensitive endpoint. Effluents from the different wastewater treatment plants resulted to increase significantly toxicity ($p < 0.05$) after exposure, since bacteria bioluminescence, survival, growth and reproduction were negatively affected compared with control treatment. On the other hand, both disinfection treatments, significantly reduced effluents ecotoxicity ($p < 0.05$). Different dilutions of the effluents were analyzed in order to propose the most suitable one to be discharged to the marine environment, being found the possibility of using higher dilutions when disinfecting the effluent.

References

Hébert N., F. Gagné, P. Cejka, B. Bouchard, R. Hausler, D.G. Cyr, C. Blaise, and M. Fournier, 2008a: Effects of ozone, ultraviolet and peracetic acid disinfection of a primary-treated municipal effluent on the Immune system of rainbow trout (*Oncorhynchus mykiss*). *Comp Biochem Phys C*, 122-127. Hébert N., F. Gagné, P. Cejka, D. Cyr, D.J. Marcogliese, C. Blaise, J. Pellerin, M. Fournier, 2008b: The effects of a primary-treated municipal effluent on the immune system of rainbow trout (*Oncorhynchus mykiss*): Exposure duration and contribution of suspended particles. *Comp Biochem Phys C*, 258-264.

Booster biocides in marine environment. A new challenge after TBT age.

Á. Sánchez-Rodríguez, Z. Sosa-Ferrera and J.J. Santana-Rodríguez

Departamento de Química, Universidad de Las Palmas de G.C., 35017 Las Palmas de G.C. Spain

Abstract

From beginning of sailing, humans have faced an important issue in the development of naval activity. The undesirable growth of organisms on submerged surfaces (biofouling) carries with it some negative effects, including increased fuel consumption and corrosion, as well as the potential introduction of foreign species into new ecosystems [1]. To prevent its occurrence, antifouling paint coatings have been traditionally used. In the past, these antifouling paints were based on lead, arsenic, organic compounds of mercury or pesticides like DDT [2]. From the 70s, organotin compounds like tributyltin (TBT) and triphenyltin (TPT) began to be extensively used in paint formulations with excellent results. These compounds showed a high efficacy as antifouling agents. Unfortunately, they exhibited a high toxicity over non-target organisms [3]. For this reason, several restrictions were introduced by countries and international organizations like International Marine Organization (IMO) or European Community. Nowadays and from 2008 it is not allowed to sail in European community waters with organotin based coatings.

In order to replace organotin compounds in antifouling paint formulations, manufacturers based their products on copper as the active component. However, it does not show a toxic activity for the full spectrum of fouling organisms, so other biocides are added to formulations to improve their efficacies [4]. These biocides are known as booster biocides and some of them have been previously used in agriculture or industrial activities. Nonetheless, when they began to be used as antifouling paints, there were not available data about their possible impacts over marine environment.

In this study we present an overview about the analysis and control of booster biocides in marine environment. Analytical methodologies, levels and toxicity effects of booster biocides will be reviewed.

References

1. D.M. Yebra, K. Dam-johansen, Antifouling technology—past, present and future steps towards efficient and environmentally friendly antifouling coatings, 50 (2004) 75–104.
2. S.M. Evans, A.C. Birchenough, The TBT Ban: Out of the Frying Pan into the Fire?, 40 (2000) 204–211.
3. C. Alzieu, Environmental impact of TBT: the French experience, *Sci. Total Environ.* 258 (2000) 99–102.
4. I. Omae, General aspects of tin-free antifouling paints., *Chem. Rev.* 103 (2003) 3431–48.

Geochronologies of emerging contaminants in sewage-impacted coastal settings (Jamaica Bay, NY)

Pablo A. Lara Martín^{1,2}, Eduardo González Mazo¹, Bruce J. Brownawell²

¹*Department of Physical Chemistry, Faculty of Marine and Environmental Sciences, University of Cadiz, Puerto Real, 11510, Spain*

²*School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, 11794-5000, New York, United States*

Abstract

Aquatic systems are often subjected to the influence of urban and/or industrial wastewater discharges, which may contain significant amounts of organic contaminants. Among them, pharmaceuticals and personal care products (PPCPs) have been the focus of many researchers within the last decade. Most of these studies deal with the identification and distribution of these chemicals in water bodies, but data on their presence in particulate matter and sediments are still relatively scarce. The present study deals with the identification, distribution and fate of a wide range of surfactants and PPCPs in dated sediment cores, offering a new insight that allows reconstructing the history of the contamination of an aquatic system by these compounds.

Sediment sampling was carried out in Jamaica Bay, adjacent to NYC and impacted by 6 waste water treatment plants (WWTPs) discharging 1.1×10^9 L/day biologically treated sewage. Nine surface sediment samples and a sediment core were sampled in 2008. The sediment core was sectioned at 2 cm intervals. All sediment samples were also dried in an oven at 35°C and stored at room-temperature pending analysis. ¹³⁷Cs, derived from global fallout from atmospheric testing of nuclear weapons was used for dating. The bottom of the core dated to approximately 1948. Sixty four different pharmaceuticals (PhACs) were analyzed in surface and core sediment samples, including a variety of different analgesics, antiinflammatories, antihypertensives, lipid regulators, antibiotics and psychiatric drugs. Linear alkylbenzene sulfonate (LAS), an anionic surfactant widely used in personal care products and cleaners, was also considered, as well as polyethyleneglycols (PEGs). Analytical protocols are described in references [1] and [2], and are based on the use of liquid chromatography – mass spectrometry (LC-MS) after ultrasonic or pressurized liquid extraction of target compounds and later purification by solid phase extraction. Limits of detection were usually below 0.1 ng/g.

The highest levels of target compounds in surface sediment samples, up to 80 ng/g of PhACs and 9.5 mg/kg of LAS, were measured in the inner part of Jamaica Bay, characterized by very high burial rates, virtually no benthic infauna, and little biological or physical mixing, with anoxic or hypoxic conditions prevailing in the near-bottom waters that favor preservation of organic contaminants. The sediment core was taken in that area. There, the vertical distribution of LAS along the sedimentary column was investigated in order to confirm the dating of the sediment core by radionuclides and also to study changes over time in the WWTP efficiencies and inputs. The vertical profile for LAS concentration indicates a first appearance of this compound in the sediment record around 1960, when it started replacing the poorly biodegradable branched alkylbenzene sulfonates (BAS) (also detected in the sediment core from 1954 to 1967). Two different maxima are observed in the time history of LAS concentration corresponding to the mid-late-1980s (75 μg/g), and the mid 1960s (250 μg/g). These changes over time are attributed to upgrades in treatment performance of the local Jamaica WWTP that occurred in 1963 and 1978 [3]. The profile of LAS concentration remains fairly stable following 1978, so any changes in the concentration of any other organic contaminants are interpreted as resulting primarily from changing inputs to the WWTPs surrounding Jamaica Bay, which cover largely residential portions of Queens and Brooklyn Boroughs of New York City.

With respect to pharmaceuticals, their concentrations are much lower (< 100 ng/g) than those for anionic surfactants (up to 250 $\mu\text{g/g}$) in the same samples, mainly as a consequence of their lower production and consumption. However, PhACs, as well as PEGs, show a growing trend over the last decades, in agreement with the continuous increase in the production and use of these chemicals. Only 16 of the 64 pharmaceuticals that were analyzed could be detected. Their sediment records are consistent with first use dates for pharmaceuticals. As an example, ibuprofen is an anti-inflammatory drug that was first sold in 1974, and it has been very popular since then, so its presence can be observed in sediments from that date until today showing an average concentration of 10 ng/g. Beta-blockers such as metoprolol and propranolol are used for hypertension treatment. Propranolol was the first beta-blocker successfully developed in the 1960s, but then it was replaced during the 1980s for more effective compounds such as metoprolol (developed in 1978). This is in agreement with the concentration profiles that we can observe for both compounds along the sediment core. Thus, concentration of propranolol increases to 3 ng/g from 1977 to 1985, and then it decreases towards the surface of the core. Moreover, metoprolol became a generic product in 2006, which improved its sales recently and can explain the exponential increase in its concentration from 5 to 35 ng/g over the last decade. This is true also for some other pharmaceuticals, such as the antibiotic clarithromycin, developed in 1991 and gone generic in 2005 (its maximum concentration was detected in the core surface, being 16 ng/g). Psychiatric drugs, such as carbamazepine or fluoxetine, which are slowly biodegraded in the water column, can be also detected in sediments in spite of their high solubility at concentrations between 2 and 10 ng/g.

Overall, analyzing PPCPs in dated sediment cores collected from sewage polluted areas allows obtaining historical records of these contaminants. This can be considered as a powerful tool for monitoring the exposure of aquatic systems to PPCPs during several decades, and also reflects any changes that may occur in their use and consumption by nearby populations.

References

1. Jelic A, Petrovic M, Barceló D. 2009. *Talanta* 80: 363-371.
2. Lara-Martín PA, González-Mazo E, Brownawell BJ. 2011. *J Chromatogr A* 1218: 4799-4807.
3. Ferguson PL, Bopp RF, Chillrud SN, Aller RC, Brownawell BJ. 2003. *Environ Sci Technol* 37: 3499-3506.

Implementation of an environmental Monitoring network in the coastal system of Cape Verde: Preliminary Studies

Abu-Raya, Mara de Castro¹, Nieto, Óscar²

¹Department of Engineering and Marine Science. University of Cape Verde. 163 São Vicente. Cape Verde

²Department of Analytical Chemistry. University of Vigo. 36310 Vigo. Spain

Abstract

The Cape Verde archipelago, posted as an average developing country, has had major economic, social and industrial advances. Presently the Government of Cape Verde is working on implementing the cluster of the sea, which will improve the development in fisheries, aquaculture, expansion and modernization of port infrastructures and naval industry, as well as the establishment of high value-supporting industries. Therefore, in addition to the socio-economic development, it is necessary to carry out the implementation of environmental monitoring programs, the assessment of the current environmental quality of coastal areas, the establishment of environmental quality standards and the promotion of proper management actions for coastal waters. Few studies highlighting the necessity of carrying out these issues, included Abu-Raya (2009) and Pinheiro (2010). The present project consists of four main sequential parts: (1) Chemical analysis of contaminants in the water column, sediments and biota (*Persististrombus latus* and *Phallusia nigra*); (2) Embryo toxicity bioassays with *Echinometra lucunter* and *Phallusia nigra*; (3) Integration of chemical and biological parameters; (4) Development of a control network to implement an environmental monitoring program in Cape Verde. The first sampling period was conducted in four stations: Calhau, defined as control area, and Port Grande in São Vicente island; Port Novo in Santo Antão island, Port of Palmeira in São Vicente island.

The analysis of metals in the water column by voltammetry shows the highest concentrations of Zn on the surface of Port Grande (122.8 $\mu\text{g/L}$). In addition, the concentrations of Cu were above the EPA recommendation (3.1 $\mu\text{g/L}$) on all stations and the Pb concentrations were below 7.9 $\mu\text{g/L}$. The determination of organochlorine compounds by gas chromatography on the digestive gland of *P. latus* showed highest concentrations of Aldrin and Heptachlor in Port Grande and Port Novo. The analysis of PAHs and PCBs on the muscle and digestive gland were below the limit of detection.

Embryo larval bioassays with mussels (*M. galloprovincialis*), ascidiae (*C. intestinalis*) and sea urchin (*P. Lividus*) have been initially performed in the water column samples. The toxicity found in the samples could be attributed to the high concentrations of metals detected.

References

- Abu-raya, M. (2009). Avaliação da contaminação por metais em gastrópodes, *Strombus latus*, da Baía do Porto Grande da ilha de São Vicente, Cabo Verde. Análise Proteómica. Tese de Mestrado em Recursos do Mar e Gestão Costeira. Universidade de Cabo Verde.
- Pinheiro, N. (2010). Avaliação da contaminação de petróleo na Baía do Porto Grande pela determinação de hidrocarbonetos aromáticos policíclicos (PAHS) na tainha, *Chelon bispinosus*. Tese de Mestrado em Recursos do Mar e Gestão Costeira. Universidade de Cabo Verde.

Caffeine and ibuprofen induced responses of stress and effect on *R. philippinarum*

Aguirre-Martínez, G.V.^{1,2}, Del Valls, T. A.¹ and M. L. Martín-Díaz^{1,2}

¹Cátedra UNESCO/UNITWIN/WiCop. Fac. Ciencias del Mar y Ambientales. Universidad de Cádiz, Polígono Rio San Pedro s/n. P. Real, Cádiz, Spain

²Centro Andaluz de Ciencia y Tecnología Marinas (CACYTMAR). Edificio Institutos de Investigación. Campus Universitario de Puerto Real. 11510 Puerto Real (Cádiz)

Abstract

After the curing effect of pharmaceuticals, they are excreted by the human body making its way into the sewage, and later released into the aquatic environment via waste water effluents where they are found at low but detectable concentrations (ng/L to $\mu\text{g/L}$) [1,2]. Adverse effects of pharmaceuticals on aquatic life have been demonstrated even at low concentrations [3,4]. Bivalves are at high risk of exposure to such contamination because they can filter high volumes of water [5].

This research aimed to evaluate sublethal responses and general stress on the Manila clam *Ruditapes philippinarum* exposed to different concentrations of caffeine and ibuprofen (including environmental concentrations) under laboratory conditions during 14 days. Sea water was spiked every two days with caffeine (0; 0.1; 5; 15; 50 $\mu\text{g/L}$) and ibuprofen (0; 0.1; 1; 5; 10; 50 $\mu\text{g/L}$). Stock solutions of pharmaceuticals were diluted in DMSO (0.001 % v/v). General stress was evaluated in vivo in clam's haemolymph by the application of the neutral red retention time (NRRT) assay [6]. While enzymatic responses were studied in digestive gland tissues using a battery of biomarkers of exposure and effect, including Phase I: Ethoxyresorufin O-deethylase enzyme activity (EROD) [7] and dibenzylfluorescein dealkylase enzyme (DBF) [8]; Phase II: glutathione S-transferase enzyme (GST) [9]; oxidative stress enzymes glutathione peroxidase (GPX) and glutathione reductase (GR) [10], lipid peroxidation (LPO) [11] and DNA damage [12]. At the end of the assay mean NRRT in haemocytes from clams (n = 8) exposed to control and DMSO was 128 ± 8 min and 110 ± 23 min respectively. A concentration-dependent response was observed in clams exposed to caffeine ($p < 0.01$; $r^2 = 0.95$) and ibuprofen ($p < 0.01$; $r^2 = 0.88$). NRRT was significantly reduced ($p < 0.05$) compared with controls when exposed to environmental concentration of caffeine 15 $\mu\text{g/L}$ (34 ± 13 min). These clams were considered to present diminished health status (NRRT < 45 min). Significant decrease on retention time was observed in clams exposed to ibuprofen at environmental concentration 10 $\mu\text{g/L}$ (60 ± 13 min). These clams were considered stressed but compensating. Caffeine and ibuprofen induced significantly EROD activity ($p < 0.05$) while decreased significantly DBF activity ($p < 0.05$) in digestive gland tissues compared with controls following a concentration-response relationship. Decrease of DBF activity might suggest the metabolization of these compounds. GST activity and antioxidant enzymes were significantly induced ($p < 0.05$) in clams exposed to caffeine at environmental concentration and to ibuprofen at the highest concentration tested (50 $\mu\text{g/L}$) compared with controls, indicating oxidative stress. Injurious effects were recorded in clams exposed to caffeine and ibuprofen concentrations as LPO significantly differ from the response observed in controls ($p < 0.05$). DNA damage significantly increased ($p < 0.05$) in clams exposed to caffeine at 50 $\mu\text{g/L}$ while ibuprofen seems to decrease significantly this response compared with controls ($p < 0.05$). Bivalves have the capacity to biotransform foreign organic chemicals such as phase I and II biotransformation enzymes. Phase I and Phase II studied in this research indicated that environmental concentration of caffeine and ibuprofen had a measurable impact on the health status of *R. philippinarum*. Results from the present research indicated that NRRT assay, Phase I, Phase II, antioxidant enzymes, lipid peroxidation and DNA damage selected as sublethal responses, constituted suitable measurements to be incorporated in a battery of biomarkers to assess toxicity of pharmaceuticals in marine environment. Digestive gland tissues studied in this work resulted to be a reliable tissue for biomarker analysis.

Caffeine and ibuprofen at environmental concentrations seemed to affect the health status of *R. philippinarum*. Finally, the data reported herein including metabolic responses from Phase I and II represent important ecotoxicological information and will provide a useful reference for assessment of effects of pharmaceuticals might have in marine organisms, using as bioindicator species the clam *R. philippinarum*.

References

1. Daneshvar, A., Svanfelt, J., Kronberg, L., Prévost, M. and G. A. Weyhenmeyer, 2010: Chemosphere Seasonal variations in the occurrence and fate of basic and neutral pharmaceuticals in a Swedish river–lake system. *Chemosphere*,80(3),301–309.
2. Fent, K., Weston. A. and D. Caminada, 2006: Ecotoxicology of human pharmaceuticals. *Aquat. Toxicol.*,76,122–159.
3. Nakada, N., Tanishima, T., Shinohara, H., Kiri, K. and H. Takada, 2006: Pharmaceutical chemicals and endocrine disrupters in municipal wastewater in Tokyo and their removal during activated sludge treatment. *Water. Res.*,40,3297–3303.
4. Grung, M. K., ällqvist, T., Sakshaug, S., Skurtveit, S. and K. V. Thomas, 2008: Environmental assessment of Norwegian priority pharmaceuticals based on the EMEA guideline. *Ecotox. Environ. Safety*,71,328–340.
5. Gagné, F., Bouchard, B., André, C., Farcy, E. and M. Fournier, 2011: Evidence of feminization in wild *Elliptio complanata* mussels in the receiving waters downstream of a municipal effluent outfall. *Comp. Biochem. Phys.*,C,153,99–106.
6. Martínez-Gómez, C., Benedicto, J., Campilloa, J. A. and M. Moore, 2008: Application and evaluation of the neutral red retention (NRR) assay for lysosomal stability in mussel populations along the Iberian Mediterranean coast. *J. Environ. Monitor.*,10,490–499.
7. Gagné, F. and C. Blaise, 1993: Hepatic metallothionein level and mixed function oxidase activity in fingerling rainbow trout (*Oncorhynchus mykiss*) after acute exposure to pulp and paper mill effluents. *Water. Res.*,27,1669–1682.
8. Quinn, B., Gagné, F. and C. Blaise, 2004: Oxidative metabolism activity in *Hydra attenuata* exposed to carbamazepine. *Fres. Environ. Bull.*,13,1–8.
9. Boryslawskyj, M., Garrood, A. C., J. T. Pearson, 1998: Elevation of glutathione-S-transferase activity as a stress response to organochlorine compounds, in the freshwater mussel, *Sphaerium corneum*. *Mar. Environ. Res.*,23,101–104.
10. McFarland, V. A., Inouye, S. L., Lutz, C. H., Jarvis, A. S., Clarke, J. U., and D. D. McCant, 1999: Biomarkers of oxidative stress and genotoxicity in livers of field collected brown bullhead, *Ameiurus nebulosus*. *Arch. Environ. Contam. Toxicol.* 37,236–241.
11. Wills, E. D., 1987: Evaluation of lipid peroxidation in lipids and biological membranes. In: Snell K, Mullack B. (Eds.), *Biochemical Toxicology: a Practical Approach*. IRL Press, Oxford, pp. 127–152.
12. Olive, P. L., 1988: DNA precipitation assay: a rapid and simple method for detecting DNA damage in mammalian cells. *Environ. Mol. Mutagen.*,11,487–495.

Encuentro de la Oceanografía Física Española 2014

Remote Sensing Oceanography - Technology for the environment

SMOS: ocean salinity measured from space. What is achieved after four years of data acquisition?

J. Font *SMOS Barcelona Expert Centre (CSIC-UPC). Institut de Ciències del Mar CSIC, Barcelona*

Abstract

SMOS (Soil Moisture and Ocean Salinity), launched on November 2, 2009, is the first satellite mission addressing sea surface salinity measurements from space. Its unique payload is MIRAS (Microwave Imaging Radiometer using Aperture Synthesis), a new two-dimensional interferometer designed by the European Space Agency (ESA) and operating at the microwave L-band. In this presentation we address the quality of the salinity products now being operationally delivered, following algorithm improvements achieved from the analysis of four years of data. The pioneer nature of this mission, both from the technological and data processing points of view, implies many challenges and several issues that are still being addressed by the SMOS team. These are mainly related to low level data processing (instrument calibration stability, interferometric image reconstruction, contamination from external radiation) but also to the retrieval of salinity from radiometric measurements, with the need to correct for other geophysical effects as the impact of sea surface roughness in ocean L-band emission. Detailed analysis of the SSS fields retrieved by SMOS (reprocessed according to the present stage of algorithms development), and comparison to other data sources like the Argo array of profiling floats or ship data, evidence that in tropical/subtropical regions, provided that large scale seasonal biases are removed, the precision of SMOS salinity at monthly/100km scale is 0.2, while in some regions the results are degraded due to geophysical unfavourable conditions (cold waters where the brightness temperature sensitivity to salinity is smaller, difficult roughness correction under high or very low winds, impact of land or RFI contamination). Some examples will be presented of the use of SMOS salinity data in different oceanographic applications where the available in situ data have too coarse spatial or temporal resolution or do not provide information on salinity in the very top ocean layer.

Synergy between remote sensing variables: Level 4 research products of Sea Surface Salinity and Chlorophyll-a

Marta Umbert, Sebastien Guimbard, Joaquim Ballabrera, Marcos Portabella and Antonio Turiel
Institut de Ciències del Mar, CSIC, Passeig Marítim de la Barceloneta, 37-49. 08003 Barcelona, Spain

Abstract

Remote sensing imagery of the ocean surface provides a synoptic view of mesoscale signatures from different ocean scalars advected by the oceanic flow. The most probable origin of the observed structures is the turbulent character of the oceanic flow as they slowly evolve and are very persistent over time scales compatible with ocean mesoscale dynamics. At spatial scales of kilometers, turbulence is regarded as a two-dimensional phenomenon, with a complex geometry. Such complexity emerges in remote sensing images as filaments and eddies of different sizes. This is seen in images of surface chlorophyll-a concentration (Chl-a) and sea surface salinity (SSS), as well as the better-resolved sea surface temperature (SST) and sea surface height (SSH).

A fusion technique has been recently proposed to exploit these common turbulent signatures between variables. This technique is theoretically based on the geometrical properties of advected tracers [Turiel et al., 2005b]. Coherent vortices in a turbulent flow strongly interact, leading to permanently stretch and fold small-scale filaments ejected from vortex cores, and generate small-scale tracer gradients between eddies. Therefore the spatial structure of a tracer inherits some properties of the underlying flow. This leads to an organized geometry of the flow as a hierarchy of fractal sets, called singularity manifolds, each one of them associated to a singularity exponent; this is the so-called multifractal formalism for fully developed turbulence. This geometrical arrangement of the flow is intimately linked to the energy cascade.

A key point in this approach is the assumption of a multifractal structure in ocean images [Lovejoy et al., 2001]. It is assumed that singularity lines of ocean variables coincide [Umbert et al., 2013]. In turn, the gradient of both variables can be related by a smooth function. As a first and simple approach, the relating function is expressed as the identity, leading to a local regression scheme. This simple approach allows reducing the error and improving the coverage of the resulting Level 4 product of one variable using another variable as a template. Moreover, information about the statistical relationship between the two fields can also be obtained.

This methodology is been applied to daily Aqua MODIS Level-3 chlorophyll maps using MODIS SST maps as template, to SMOS SSS using OSTIA SST as template, and to Aquarius SSS using SSH from AVISO as template. Resulting SSS and Chl-a Level 4 products contain the mesoscale structures seen in SST and SSH maps, exhibit a significant reduction of the uncertainty, and allow extrapolation to cloud-affected areas.

A new sea surface height based code for mesoscale oceanic eddy tracking**Evan Mason¹, Ananda Pascual¹, James C. McWilliams²**¹*IMEDEA (UIB-CSIC), Spain*²*UCLA, Los Angeles, USA***Abstract**

We present a software tool that enables the identification and automated tracking of oceanic eddies observed with satellite altimetry in user specified regions throughout the global ocean. As input, the code requires sequential maps of sea level anomalies such as provided by Archiving, Validation and Interpretation of Satellite Oceanographic data (AVISO). Outputs take the form of (i) data files containing eddy properties including position, radius, amplitude, and azimuthal (geostrophic) speed; and (ii) sequential image maps showing sea surface height maps with active eddy centers and tracks overlaid. We show results from a demonstration in the Canary Basin region of the northeast Atlantic that are comparable with a published global eddy track database. Some discrepancies between the two datasets include eddy radius magnitude, and the distributions of eddy births and deaths. The discrepancies may be related to differences in the eddy identification methods, and also possibly to differences in the smoothing of the sea surface height maps. The code is written in Python, and is made freely available under a GNU license at³.

³<http://www.imedea.uib.es/users/emason/py-eddy-tracker>

Steric effect on the Gulf of Cadiz sea level seasonal cycle**Irene Laiz, Begoña Tejedor, Jesús Gómez-Enri, Alazne Aboitiz, Pilar Villares***Dept. of Applied Physics, Univ. of Cadiz, Campus Rio San Pedro, 11510; Puerto Real, Cadiz, Spain***Abstract**

The steric contribution on the sea level seasonal cycle has been explored in the Gulf of Cadiz (GoC) for the period 1997-2008. Sea level anomaly maps from altimeter (AVISO) were retrieved for the GoC for the period 1997-2008, along with sea level time series from three tide gauge stations located along the eastern coast. In order to remove the atmospheric pressure contribution, tide gauge data were corrected using the inverted barometer (IB) method. The AVISO monthly maps were initially de-corrected using the Dynamic Atmospheric Correction product and then corrected using the same IB method. Steric height (ssh) time series were computed by combining a high resolution climatology ($0.1^\circ \times 0.1^\circ$) with monthly maps of AVHRR sea surface temperature considering a reference depth of 500 m at the open ocean and the bottom depth for shallower areas. The ssh values interpolated to the AVISO grid resolution were considered as the local steric effect. The open ocean steric effect was computed by averaging all the steric heights corresponding to grid points located over the 500 m isobath and deeper. The Eastern / Western continental shelf steric contribution was obtained by averaging over those grid points located within each continental shelf. Finally, a basin-wide steric effect was computed by averaging the steric heights all over the GoC. The potential contribution of each of the defined steric effects on the pressure-adjusted sea level was evaluated. Excluding the southwestern corner of the domain, the percentage of explained variance was larger offshore and decreased toward the coast in all cases. The open ocean contribution explained the highest percentage of variance all over the basin with the exception of the western shelf, where the best results were obtained with the local contribution, supporting the idea that the cell of cyclonic circulation found off Cape San Vicente is a local feature. The fact that the eastern and western shelves responded differently to the steric contribution supports the idea that they hold different oceanographic processes. After correcting for the best steric contribution at each grid point, the amplitude of the remaining offshore annual signal fell within one standard deviation of the mean ($0.5-1.0 \pm 1$ cm), indicating that they were negligible. In fact, the percentage of variance not explained by the combined effect of atmospheric pressure and steric effect in that region was rather small (15-20%). Over the continental shelves, the highest remaining annual signal (about 3 cm) was observed along the GoC western shelf as well as in the region covering the Strait of Gibraltar and the North African shelf. Those regions are characterized by large wind stress curl annual amplitudes ($> 3.5 \times 10^7$ N m⁻²), related to quasi-permanent positive wind stress curl. Thus, the remaining sea level annual signal there is probably related to piling of water along the coast due to Ekman transport. As for the eastern shelf, about 2.5 cm of the annual signal remained unexplained, probably due to local effects related with the shelf dynamics. The three tide gauge stations showed results consistent with those obtained with the altimeter data, with the open ocean contribution explaining the highest percentage of pressure-adjusted sea level variance. This suggests that the sea level seasonal cycle at the eastern continental shelf is highly related to the large scale circulation system seasonal cycle. Furthermore, results obtained with one of the tide gauge stations, which is located within the Guadalquivir river estuary, suggested that part of the remaining sea level annual signal within the eastern shelf could be related to the Guadalquivir river plume spreading over the area.

Oceanographic data management at SOCIB

C. Troupin¹, J. P. Beltran¹, B. Frontera¹, S. Gómara¹, S. Lora¹, D. March², K. Sebastian¹ and J. Tintoré^{1,2}

¹*SOCIB, Palma, Spain.*

²*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.*

Abstract

The Balearic Islands Coastal Ocean Observing and Forecasting System (SOCIB, <http://www.socib.es>), is a multi-platform Marine Research Infrastructure (ICTS, MINECO in Spain) that provides free, open and quality-controlled data from nearshore to the open sea. SOCIB consists of three major infrastructure components: 1) a distributed multi-platform observing system, 2) a numerical forecasting system and 3) a data management and visualization system.

One of the major goals of the Data Centre (DC) is to provide users with a system to locate and download the data of interest and to visualize and manage the information. According to SOCIB principles, data have to be: 1) discoverable and accessible, 2) freely available, and 3) interoperable and standardized. For these reasons, SOCIB DC Facility has implemented a general data management system to meet international standards, quality assurance and interoperability.

The DC is responsible for the different stages of data management, ranging from data acquisition using SOCIB platforms (gliders, drifters, HF radar, ...), numerical models (hydrodynamics, waves, ...) or information generated by other divisions, to distribution and visualization through dedicated web and mobile applications. The system implemented relies on open source solutions.

SOCIB data services and applications have been developed in line with EU funded initiatives such as MyOcean2, Perseus, Jerico, Groom, Medsea-Checkpoint. in order to provide response to scientific and societal needs (e.g. European initiatives such as Emodnet or Copernicus), by targeting different user profiles (e.g. researchers, technicians, policy and decision makers, educators, students, and society in general). For example, SOCIB has developed applications to:

- allow researchers and technicians to access oceanographic information;
- provide decision support for oil spills response;
- disseminate information about the coastal state for tourists and recreational users;
- present coastal research in educational programs;
- offer easy and fast access to marine information through mobile devices.

In conclusion, the organizational and conceptual structure of SOCIB DC and the developed components provide an example of marine information systems within the framework of new ocean observatories and/or marine research infrastructures.

Surface circulation patterns in the Ibiza Channel from HF Radar data**Arancha Lana¹, Vicente Fernández², A. Pascual¹, A. Orfila¹ and J. Tintoré^{1,2}**¹*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain*²*SOCIB. Illes Balears. Spain***Abstract**

A High Frequency (HF) Radar system which consists of two CODAR stations - located in Ibiza and Formentera Islands - provides real time information of the variability of surface circulation patterns in the Ibiza Channel. This area is a well-known biodiversity hot spot in the Mediterranean Sea, and dynamically relevant due to the interaction of water masses coming from the Atlantic Ocean - ascending through the Iberian Peninsula coast - with the older Mediterranean waters descending from the Gulf of Lion. The HF Radar system operates operationally since June 2012 up to now, providing hourly surface current maps with a spatial resolution of approximately 3 km and coverage up to 70 km offshore. Radial data from each antenna, as well as the combined total surface currents are Quality-Controlled in order to ensure that the data being produced are of the highest quality. Initial results from validation of HF Radar data against drifter-derived velocities; satellite altimetry and current meter from a fixed mooring provide confidence in the HF Radar data. A quantitative description of the spatial patterns observed by the HF Radar at different temporal scales (inertial, sub-inertial and tidal) and their contribution to the total kinetic energy (KE) has been analysed for the first time in the area. Inertial currents have a lower contribution to the total KE during winter, compared with the summer period. Additionally, the spatial distribution of the inertial component to the total KE varies seasonally, and according to the bathymetry. The low-pass (sub-inertial) filtered HF Radar currents show a predominant Northern current during the summer months in the channel, and a mean Southern current during the winter period. The semidiurnal tidal component amplitude shows a distribution deeply related to the bathymetry of the area. These results will be analysed, discussed and related to the external forcing and the regional bathymetry.

SOCO: Establishing a real-time observing system of currents and waves for STRAMIX

M Gilcoto¹, F de la Granda¹, N Villaceros-Robineau¹, F Alonso-Pérez¹, RF Graña², S Piedracoba², R Torres³, J Largier⁴, ED Barton¹

¹*Instituto de Investigaciones Marinas (IIM-CSIC), Spain*

²*Universidad de Vigo, Spain*

³*Plymouth Marine Laboratory, UK*

⁴*Bodega Marine Laboratory, University of California Davis, USA*

Abstract

On 30 September 2011 the deployment of an ADCP, close to the Bouzas Terminal breakwater of the Port of Vigo, was the prelude of the so called SOCO: *Sistema de Observación de Corrientes y Oleaje* (Observing System of Currents and Waves). From that Self-Contained ADCP to the actual Direct-Reading ADCP providing real-time observations to STRAMIX research project have gone some 2.5 years and much time, resources and enthusiasm have been invested.

We were encouraged by the long-time desire of having records of profile currents and waves parameters taken in the inner reaches of the Ría de Vigo. Thus, we made several battery powered and internal memory data stored (Self-Contained) ADCP deployments. But, an ADCP measuring waves must be configured to sample at 2Hz and will require a high amount of power since the energy it drains is proportional to the sampling rate. The memory storage requirement is also high. Therefore, it is clear, that the most suitable and cost effective way to provide energy and communications is a submarine cable. A Direct-Reading ADCP configuration is needed.

During 2011, while the Self-Contained ADCP deployments were active, a WIFI link was installed between the main building of the Instituto de Investigaciones Marinas (IIM-CSIC) and the water pump station that the IIM has in the Bouzas Terminal breakwater. Later on, a 100m long submarine cable was laid offshore from the breakwater to some 13 meters depth. Finally, a 600kHz BroadBand WhorkHorse Sentinel RDI ADCP with WavesArray module, installed in a gimballed pyramid, was plugged at the end of the submarine cable. On the 31 January 2012 this instrument started to send real-time data of currents and waves to the IIM and established the SOCO inception.

The next milestone in SOCO history is its incorporation to the STRAMIX project. In order to provide high frequency current observations and wave parameters to STRAMIX project, SOCO was redeployed in the middle of the Ría de Vigo. It was necessary to lay 950 meters of submarine cable to reach the new deployment position, at 43.64 meters of mean depth. SOCO has been sending real-time observations from this position since the 20 June of 2013 and with approximately a 95% of availability rate. In addition, a website⁴ has been created where the SOCO real-time observations can be plot and downloaded.

⁴<http://www.iim.csic.es/soco>

Mesoscale Processes

Vertical exchanges between the Atlantic and Mediterranean layers through the Strait of Gibraltar

A. Sánchez-Román¹, G. Jordà¹, G. Sannino² and D. Gomis¹

¹IMEDEA, UIB-CSIC, Mallorca, Spain

²ENEA, UTMEA-CLIM. Rome, Italy

Abstract

The Mediterranean Sea is dynamically connected to the Atlantic Ocean through the Strait of Gibraltar, where a very energetic baroclinic exchange between Atlantic and Mediterranean waters occurs: fresh and warm Atlantic waters enter into the basin while salty and cold Mediterranean waters outflow to the Atlantic. Those water fluxes fluctuate at different timescales (from semi-diurnal to interannual) forced by different factors (tides, winds, atmospheric pressure, and the seasonal and inter-annual variations of the baroclinic structure). Moreover, incoming and outgoing waters change their properties during their passage through the Strait due to mixing and entrainment between Mediterranean and Atlantic waters. This transformation of the water masses determines the net heat and salt exchanges of the Mediterranean with the global ocean.

In this work, the physical mechanisms involved in the vertical transfers of volume between the Atlantic and Mediterranean waters along their path through the Strait of Gibraltar are explored based on the outputs of a three-dimensional, fully non-linear, hydrostatic numerical model. The model covers the entire Mediterranean basin (1/16° of spatial resolution) with very enhanced resolution in the area of the Strait (1/200°). Another distinctive feature of the model is that it includes a realistic barotropic tidal forcing (diurnal and semidiurnal) and atmospheric pressure, as well as heat and water fluxes at the sea surface. A second numerical simulation only forced through the specification of both the atmospheric pressure and heat & water fluxes at the sea surface is also used to further investigate the role played by tides in the vertical transports between layers.

Mean vertical transfers present different sign at each side of the main sill of Camarinal (CS), a bottle-neck for the exchange throughout the Strait. West of CS the vertical flow brings Atlantic water towards the Mediterranean outflowing layer, whereas east of CS Mediterranean water is conveyed to the inflowing Atlantic layer. In both cases these vertical fluxes translate in entrainments of water from the slowly-flowing (passive) layers into the fast-flowing (active) ones. We have quantified both transports. East of CS entrainments present the same amplitude than vertical transports at tidal frequencies so the whole vertical fluxes computed between layers can be considered as water dragged towards the Mediterranean or the Atlantic depending on the tidal cycle. On the contrary, west of CS entrainments are weaker than the whole computed vertical fluxes as a result of a stronger tidal forcing. This fact promotes periodically water reversions in the passive Atlantic layer according to the tidal cycle. On the other hand, results obtained from the non-tide simulation reveal a drastic reduction in the vertical transports close to CS, where the along-strait maximum values are obtained. This fact echoes in the entrainments having impact on the exchange of heat and salt between layers.

Thermohaline changes in waters of the eastern Gulf of Cadiz.**Bellanco M.J. & Sánchez-Leal R.F.***Instituto Español de Oceanografía. Centro Oceanográfico de Cádiz. Cádiz, Spain***Abstract**

Thermohaline changes and the variability in the water column in the sub-basin connecting the Atlantic Ocean and the Mediterranean Sea have been little studied. This fact may be partly due to the scarce availability of in-situ data time series, particularly in relation to the study of seasonal variations, given the reduced availability of winter observations.

Since 2009, the Cadiz Center of the Spanish Institute of Oceanography (IEO) has been sampling along three standard hydrographic sections perpendicular to the coast as a part of the Gulf of Cadiz Ocean Time-Series Study (GoCATS). With the aim to making progress in the study of the thermohaline changes and their variability, we have been focused on one of these hydrographic sections, which have been carried out at least three times per year.

In order to analyze the temperature and salinity variations in the water column, as well as the processes that drive them, we have applied the method proposed by Bindoff and McDougall (1994) in this section. According to this method, the thermohaline changes at isobaric levels (isobaric change) can be decomposed in vertical displacement of the isopycnals (heave) and changes along isopycnals (isopycnal change).

The above mentioned approach, combined with the study of the sea-bed hydrography in the eastern Gulf of Cadiz, based on 2005-2013 near-bottom CTD observations (Bellanco & Sánchez-Leal (Submitted November 2013)), and the analysis of the variations in the transport along the GoCATS section (on-going study), will enable us to a deeper understanding of seasonal and inter-annual variations of the thermohaline properties of Gulf of Cadiz waters.

What drives the spreading pattern of the Mediterranean Outflow Water (MOW) in the eastern Gulf Of Cadiz, SW Iberian Peninsula?**Ricardo F. Sanchez-Leal, Maria Jesus Bellanco-Esteban, Jose Carlos Sanchez-Garrido, Manuel Ruiz-Villarreal, Cesar Gonzalez-Pola***Instituto Español de Oceanografía, Spain***Abstract**

The inverse estuarine circulation through the strait of Gibraltar is responsible for the overflow of dense, saline MOW towards the Atlantic basin. The classical views divide MOW dynamics in an initial descent phase along the first 100 km as an entraining gravity undercurrent followed by a damped geostrophic flow phase. West of 8°W it is seen as a multi-layered, buoyant plume parked at depths ranging 800-1300 m. Recent MB bathymetry has revealed a complex seafloor morphology that questions this classical view. Sinuous submarine channels and sharp depth falls are expected to play a relevant role in the definition of the NACW-MOW interface and the MOW spreading pattern. In this work we analyze more than 4500 QCd CTD and 950 LADCP observations taken in the eastern Gulf of Cádiz to study of the small-scale features of the MOW spreading pattern as well as the secondary circulation associated with sharp current bends. Data show that small-scale depth falls, abrupt channel turns and current-submarine mount interaction may bring the MOW to high Rossby number situations. Most of these may also drive the flow to subcritical and enhance large amounts of mixing past the initial plunging phase, which seems non negligible as compared with tidal stirring, shear instability and double diffusion along the MOW pathway.

Propagation of super-inertial waves from submesoscale fronts**Mariona Claret, Amit Tandon, and Amala Mahadevan***Woods Hole Oceanographic Institution, USA***Abstract**

Wind-generated inertial motions are strongly modified by their interaction with submesoscale ocean fronts. Vertical vorticity ζ shifts the wave frequency from inertial to near-inertial and gradients in ζ cause wave packets to propagate downwards. Wave packets generated on the anticyclonic side of fronts are subinertial and experience trapping and amplification at critical layers in the vertical. Here, we propose a new mechanism by which these trapped subinertial wave packets radiate out from the front as super-inertial waves through wave-wave interactions. Our inferences are from the analyses of solutions of a non-hydrostatic process study ocean model forced by a wind impulse that agree well with observations from the north wall of the Gulf Stream. The mechanism that will be described can have major implications by explaining wave energy transfer from the ocean surface to depth.

QG vertical motion from satellite and in situ observations: Impact on South Eastern Pacific nitrates distribution through a Lagrangian simulation**Barceló-Llull, Bàrbara^{1,2}, Mason, Evan¹, Pascual, Ananda¹**¹*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.*²*University of Las Palmas de Gran Canaria, Spain.***Abstract**

The objective of this study is to improve our understanding of the influence of mesoscale vertical exchanges on ecosystem dynamics. In particular, we aim to investigate the influence of vertical velocity on ocean tracer distributions in the South Equatorial Pacific. Previous remote sensing studies in this region have revealed that chlorophyll distributions within mesoscale eddies are characterised by dipole-like patterns, with extreme values found at the eddy peripheries.

An observations-based product, ARMOR3D, is used to obtain an estimate of 3D currents. Horizontal velocities are derived from application of the thermal wind equation to 3D fields of temperature and salinity obtained from the ARMOR3D reanalysis that combines satellite (SST and altimetry) and in-situ (Argo profiling floats, XBT, CTD and moorings) data. Vertical velocities are estimated from quasi-geostrophic (QG) dynamics by integrating the QG Omega Equation with ARMOR3D fields. Finally, a Lagrangian particle tracking model, forced by the derived 3D currents, is used to study passive tracer dispersion and its influence on the distribution of biochemical properties such as nitrates. The Lagrangian results show that the impact of vertical advection on nitrate distribution is non-negligible as they account for about 30% of the contribution of horizontal advection.

Characterization of the energy cascade using high resolution multichannel seismic data**Mojica, Jhon. F.¹, Sallares, Valenti.¹, Biescas, Berta.^{1,2}, Klaeschen, Dirk.³, Bornstein, Guillermo.¹**¹*Instituto de Ciencias del Mar ICM-CSIC, Barcelona, Spain*²*Dalhousie University, Halifax, Canada*³*Geomar, Kiel, Germany***Abstract**

We analyze multichannel seismic data acquired around the thermocline (30 to 150 m deep) along profiles of 30 km using a high resolution system with a peak frequency of 150 Hz. The lateral and vertical resolution is 13 m and 2 m respectively, allows us to characterize the energy cascade of the Alboran Sea with unprecedented lateral resolution.

The spectral analysis shows characteristics of three different processes. At largest horizontal wavenumbers, (1 to 10 km⁻¹), the spectral slope is -2.01 ± 0.09 in agreement with that described for internal waves, whereas at the shortest wavenumbers (32 to 70 km⁻¹), we obtain a slope of -1.54 ± 0.56 , which corresponds to a turbulent spectra. In between, it can be distinguished a third domain with slope of -2.89 ± 0.32 in the range of [10.2 to 30.4 km⁻¹]. The slope, the wavenumber range and the fact that our data was acquired in an area with significantly strong stratification and shear due to the constant exchange of Atlantic and Mediterranean waters, suggest that this domain could be dominated by the formation of Kelvin-Helmholtz instabilities.

Ocean and Climate Change - Operational Oceanography**ANÁLISIS DEL CAMBIO CLIMÁTICO EN LAS COSTAS ESPAÑOLAS A LO LARGO DEL SIGLO XXI**

Enrique Álvarez Fanjul, Damia Gomis, Ernesto Rodríguez Camino y los equipos de Vanimedat II y Escenarios

¹*Puertos del Estado, Spain*

²*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.*

³*Agencia Estatal de Meteorología, Spain.*

Abstract

Puertos del Estado, Imedeia, AEMET

Se presentan los resultados de los estudios de cambio climático en las costas españolas realizados a lo largo de la última década en los proyectos Vanimedat, Vanimedat II y ESCENARIOS. En los mismos se ha analizado, mediante modelado numérico, la evolución de las principales variables físicas marinas (oleaje, nivel del mar, corrientes, temperatura del agua y salinidad), así como de aquellas variables atmosféricas con mayor incidencia en la dinámica marina (viento, presión atmosférica y flujos de calor y agua dulce). Para ello, se han realizado integraciones de largo periodo con modelos estado del arte: WAM para oleaje, Nivmar para residuo de nivel del mar, RCA para atmósfera y NEMO para Nivel del mar, circulación e hidrografía. Los dominios de integración abarcan el Mar Mediterráneo y un sector del Atlántico NE que incluye todas las costas españolas. Estos códigos han estado anidados, en los casos en que ha sido necesario, a los resultados de modelos globales generados por otras instituciones. Cabe destacar que el empleo de modelos baroclínicos tridimensionales anidados y el análisis ulterior de sus datos ha requerido un análisis teórico novedoso sobre los métodos para reproducir el nivel del mar con estas herramientas y, más concretamente, el impacto de los cambios en los flujos de masa en el nivel total. Aparte de las simulaciones realizadas por el equipo, se han analizado los resultados de modelos similares desarrollados por otras instituciones. El conjunto de datos obtenidos, así como los métodos desarrollados para su análisis, ha permitido obtener una imagen consistente y de alta resolución de la evolución del cambio climático en las costas española. Entre los resultados más importantes que se expondrán destaca un importante incremento del nivel del mar y de las temperaturas superficiales del agua, así como cambios menores en el régimen de oleaje. El impacto en la salinidad está condicionado, fundamentalmente, por los cambios de las condiciones de contorno derivadas del modelo global, que varían notablemente de una ejecución a otra. Los resultados obtenidos son consistentes con los del IPCC, pero tienen la ventaja de su alta resolución al estar obtenidos a partir de modelos regionales y no globales. En su conjunto, los escenarios obtenidos muestran la necesidad de desarrollar políticas de adaptación en nuestras costas.

Impact of the atmospheric climate modes on wave climate in the North Atlantic

Adrián Martínez-Asensio¹, Michael N. Tsimplis², Marta Marcos¹, Xiangbo Feng², Damià Gomis¹, Gabriel Jordà^{1,2} and Simon Josey²

¹*IMEDEA(UIB-CSIC), Spain*

²*National Oceanography Center, Southampton, UK*

Abstract

This study establishes the relationships between the mean modes of atmospheric variability in the North Atlantic and present wave climate. The modes considered, namely the North Atlantic Oscillation (NAO), the East Atlantic pattern (EA), the East Atlantic Western Russian pattern (EA/WR) and the Scandinavian pattern (SCAN), are obtained from the NOAA Climate Prediction Centre. The wave data sets used consist of buoy records and two high-resolution simulations of significant wave height (SWH), mean wave period (MWP) and mean wave direction (MWD) forced with ERA-40 (1958-2002) and ERA-INTERIM (1989-2008) wind fields. The results show the winter impact of each mode on wave parameters which are discussed regionally. The NAO and EA pattern increase winter SWH up to 1 m per unit index at the Scottish and Spanish coasts, respectively, during their positive phase; while EA pattern causes clockwise changes of winter MWD up to more than 60 degrees per unit index at the Bay of Biscay during its negative phase. EA/WR and SCAN patterns have a weaker impact.

Operational Oceanography with the Spanish Institute of Oceanography (IEO) AGL buoy**D. Cano, C. Rodríguez and A. Lavín***Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Spain***Abstract**

From 1991, shelf and slope waters of the Southern Bay of Biscay are regularly sampled in a monthly hydrographical line north of Santander to a maximum depth of 1000m, as part of the IEO Radiales project. From 2003, a deep hydrological standard sections (part of the VACLAN project) is occupied twice a year extending the Santander section 90 miles offshore. Measurements include CTDO₂, nutrients and currents from vessel-mounted ADCP and LADCP. The data base in the area hold by IEO is complemented with a current meters line moored in 2003 at 43°48'N, 3° 47'W sampling temperature, salinity and currents at the core of Central, Mediterranean and Labrador Sea water.

On June 2007, an ocean-meteorological Buoy was moored at the Santander Section, 22 miles north of Santander at about 2850m depth, to complete the ocean information with the ocean-atmosphere interaction. The Santander section and AGL Buoy data highlight that heat and salt show a quite different behaviour in terms of their balance in the upper layers of the Bay of Biscay.

At interannual and seasonal time scales temperature is mainly determined by the atmospheric forcing while salinity is more closely linked to advection processes.

Severe storms happen every year in the North coast of Spain. If certain weather and oceanic conditions match, they can be quite destructive, both for ships and structures on the sea and buildings, cars, people or city furniture on land.

Systems of meteorological and oceanographic observations are fundamental tools for improve the prediction models and help to reduce the impact of storms on ships, coastal structures and people and improve the security at sea and along the coast. On November 2010 a severe storm took place at the southern Bay of Biscay causing important damage.

The relevant aspects of this storm will be studied and compared with previous storms in December 2007, March 2008 and January 2009, leaving this last one a record wave of 26.13m measured at the Augusto González de Linares (AGL) buoy.

Products derived from this buoy include but not only annual cycles of multiple variables as well as anomalous values, both seasonal or prompt. Also more particular ones such as heat air-sea fluxes, salinity and water temperatures anomalies, sub inertial currents series, chlorophyll surface series, estimates of the mixed layer depth and wind and currents roses.

Towards an integrated acquisition and management of thermosalinometers continuous data records for the IEO operated vessels

E. Tel¹, J. M. Cabanas², A. Cabrero², G. González- Nuevo², A. Lavin³, M. Ruiz-Villareal⁴, A. Vitoria³

¹*Instituto Español de Oceanografía, Servicios Centrales, C/ Corazón de María 8, 28002, Madrid, Spain*

²*Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Subida a Radio Faro, 50-52, 36390, Vigo, Spain*

³*Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Promontorio San Martín, s/n, 39004, Santander, Spain*

⁴*Instituto Español de Oceanografía, Centro Oceanográfico de Coruña, Pso F.Vazquez. A Coruña, Spain*

Abstract

Along the last years, the Spanish Institute of Oceanography (IEO) has performed an important effort in order to gradually fit out their research vessels with equipments and systems for continuous data recording that allow getting the maximum advantage out of the entire ships track. In particular, thermosalinometers, those register the seawater sub- superficial characteristics. This information is systematically sent to the Data enter for its control, storage and dissemination. At present, the IEO is doing an important and continuous effort in automating routines and rotocols in order to assure in near real-time the data quality and their free availability for operational purposes. In addition, research activities in he framework of RAIA project on the northwest Spanish coast are developing new routines that imply new steps in open data access through THREDDS server. Besides, delayed-mode quality controls are realized on them before its definitive incorporation to the IEO oceanographic database which fulfils all the international standards, according to the European project SeaDataNet.

The acquired data from these vessels has allowed some products in specific areas. 10 years of monthly vessel tracks on Cantabria and Asturias coastal waters has been result on a coastal temperature and salinity atlas for the area (Vitoria, 2012) that is freely available. Ranges of coastal values according to the season have been founded based on this time-series and maps of measured variables for the covered area have been drawn up and results are stored in netCDF CF-compliant. Recently, this quality control methodology has being applied to the whole dataset from R/V Navaz that operates on the Rias Bajas coastal waters in order to develop similar products for the area.

References

Vitoria, A (2012). Atlas Costero de Temperatura y Salinidad superficial en el Cantábrico. Trabajo Fin de Master. Univ. Vigo.

Operational Oceanography

Risk maps for oil spill accidents in the Mediterranean Basin

J. A. Jiménez Madrid, Antonio García-Olivares & Emilio García-Ladona

Institut de Ciències del Mar, CSIC, Barcelona

Abstract

In case of an oil spill accident the most pressing issue is to know whether the oil slick will reach any shoreline in the days following the spill. Oil spill forecasting models are state of art tools to answer this question and some of them have been compiled in a single tool by the MEDESS-4MS project.

However, the prediction horizon of forecasting models is about 5-7 days, because this is the prediction horizon of meteorological data. If the 7-days forecast obtained from those models does not take the slick to any shoreline, it is difficult to foresee which are the most exposed coastal segments in the long term (1 month to 1 year), as past accidents (i.e., Prestige, Deepwater Horizon) have shown. In this situation the initial condition forecast does not help authorities to take a fast response, such as to bring or not the ship to a refuge port. To assess the authorities and decision makers to select an efficient response, it is important to have statistical information of the coastal segments that are most exposed (in the scale of months) to spills coming from different sea positions.

In this work a Lagrangian model for the evolution of oil slicks is proposed and illustrated with some cases in the Mediterranean Basin. The Lagrangian model makes use of data for the sea surface velocities and wind stresses coming from NEMO (1/12°, daily) climatological runs covering a time period ranging from October 1998 to November 2007. A set of coastal risk maps are generated, with frequency of beaching on the Mediterranean coast for oil spills taking place at selected points along main tankers paths and at marine oil and gas platforms.

These risk maps will complement the short-term (up to a week) forecasting made with the models included in whichever oil spill system, and they together will constitute a tool able to improve the management of emergency situations.

A new operational oil-spill multi-model forecast capability for the Mediterranean Basin: The MEDESS-4MS Service

MG Sotillo¹, D Conti², A García-Olivares³, D Pérez⁴, P Rodríguez-Rubio⁵, A Rietz⁶, E Padorno¹, A Orfila², E García-Ladona³, F de los Santos⁵, E Álvarez¹

¹*Puertos del Estado. Avda. Partenón, 10 28042 Madrid, Spain*

²*IMEDEA C/ Miquel Marquès, 21 07190 Esporles - Islas Balears, Spain*

³*ICM-CSIC. Passeig Marítim de la Barceloneta, 37-49. E-08003 Barcelona, Spain*

⁴*INNOVAMAR. C. Basílica, 17 28020 Madrid, Spain*

⁵*Autoridad Portuaria Bahía de Algeciras, Avda. de la Hispanidad, 2, 11207, Algeciras, Spain*

⁶*ASEMAR. C. Fruela, 3 28011, Madrid, Spain*

Abstract

MEDESS-4MS is an EU MED-Program project dedicated to the prevention of risks and strengthening maritime security in relation to oil spills in the Mediterranean. Its main goal is to build an operational tool that integrates different existing oil spill models and met-ocean data provided by different operational forecast services.

The present contribution shows the Mediterranean MEDESS-4MS multi model oil spill prediction service. The MEDESS-4MS service is based on a complex interconnected network of data repositories that archives and provides access to all available environmental and oil spill data. It is connected to established services, both at European (MyOcean Marine Core service) and at national and regional level (ocean forecasting systems). Likewise, the service will be connected to existing monitoring platforms (i.e. EMSA-CSN, AIS). The User Interface of the integrated system is through a unique access web portal with different functionalities and user profiles, multi-model data access and interactive capabilities.

23 partners from 7 Mediterranean countries are collaborating in building this MEDESS-4MS service. Related to the Spanish contribution, Puertos del Estado (PdE) plays the role of regional focal point for dissemination and promotion of the MEDESS-4MS tool in the western Mediterranean. Furthermore, PdE is one of the 5 oil spill forecast service provider, and responsible of developing and maintaining the oil spill service capabilities. PdE and IMEDEA-CSIC are both ocean-met data providers, and both together with ICM-CSIC responsible of developing tasks for the scientific validation of the service. Moreover, ICM-CSIC and INNOVAMAR are participating in data collection of vessel traffic characteristics and location of response equipment and environmental characterization of the area, for further analysis and inclusion of this information in risk analysis procedures. The results of these analyzes, in the form of maps of vulnerability and potential risk, will be very useful for the MEDESS-4MS tool. Finally, the Port Authority of Bahía de Algeciras (APBA) included in the MEDESS-4MS partnership, plays a key role as targeted end-user, focusing their works on developing port management tools from the MEDESS - 4MS System and its derived products and services.

In order to validate the model components and test the MEDESS-4MS service functionalities different ocean measuring campaigns (named "Serious Games", after the MEDESS-4MS terminology used for these campaigns) are being organized. In Spanish waters, the first Serious Game was organized by IMEDEA in September 2013 in the Balearic Sea. A second Serious Game is being organized to be developed over the Gibraltar Strait area. In this exercise, the Spanish MEDESS-4MS partners will count with the valuable support of SASEMAR.

The availability and combination of met-ocean operational products together with oil-spill and transport models outputs and observations from specific measuring campaigns makes of this MEDESS-4MS scientific calibration/validation framework, not only an useful (and required) procedure to evaluate reli-

ability of the systems and to enhance confidence in the MEDESS-4MS service and its products, but also a way to increase our knowledge of the Spanish Mediterranean waters.

Modelled Sea Surface Currents Validated Using Satellite Pop-Up Tags for Fish Tracking

L. Ferrer¹, I. Fraile¹, A. Del Campo¹, C. Hernández¹, A. Caballero¹, A. Rubio¹, J. Mader¹, S. Donne²

¹AZTI-Tecnalia, Marine Research Division, Herrera Kaia, Portualdea z/g, 20110 Pasaia, Spain

²Seismology Laboratory, School of Geological Sciences, University College Dublin, Belfield, Dublin 4, Ireland

Abstract

In the summer of 2012, an operational protocol was established in the Southeastern Bay of Biscay (focused along the Basque Country coast) for the sighting and tracking of Portuguese men-of-war. In this operational protocol, the drifting of these organisms is estimated using the Sediment, Oil spill and Fish Tracking model (SOFT). This is a Lagrangian particle-tracking model in which input data are hourly sea surface currents. In this case, these currents are estimated from data (winds and currents) of two models: the first one is the Weather Research and Forecasting model (WRF), and the second one is the Regional Ocean Modeling System (ROMS). The WRF and ROMS configurations used for the Bay of Biscay have horizontal resolutions of 12 and 4 km, respectively. The latter uses atmospheric forcing inputs from the former to obtain 3D currents. Until now, a combination of the ROMS currents and WRF winds was used in SOFT to estimate the final drifting of Portuguese men-of-war.

For the SOFT validation, it would be necessary to use data from Portuguese man-of-war shaped drifting buoys. But at present, there are no data from this type of buoys. Currently efforts are being made to design these types of buoys. In this study, the SOFT validation was carried out with available trajectories from satellite pop-up tags for fish tracking in the North Atlantic. These tags pop free of the fish at a preprogrammed time, float to the sea surface and beam their accumulated data via satellite to scientists to reveal where the fish moved and what ocean temperatures they favoured. During a period between a few days and four weeks (when the battery is exhausted), these tags are floating at the sea surface and are advected by the currents, sending their locations. Therefore, their trajectories during this period can be used for model validation. The tags used in this case have a length of approx. 31 cm (including the antenna), a maximum diameter of 3.2 cm and a weight of 40 g. Therefore, their drifting will be similar to the movement of particles in the upper water layer (i.e. highly complex). Some comparisons between the SOFT results and available trajectories from tags show that the sea surface drifting of these objects is controlled mainly by wind and can be explained by a simple current model. In this model, sea surface currents are estimated as a percentage of the WRF winds (2%) and do not include the ROMS currents. The use of the ROMS currents in SOFT does not improve the results obtained with the simple current model. Therefore, the accuracy of wind fields used as input in SOFT is crucial to obtaining a robust result. Although sea surface drifting depends on the characteristics of the object being moved, the obtained results are of great interest to understand sea surface water circulation in the oceans. To our knowledge, it is the first time these tags are used for model validation purposes in the Bay of Biscay.

Pinzón's path plans for the first transoceanic glider Scarlet Knight RU-27 derived from ESEOO's regional ocean model forecasting data of an inertial oscillations field in the NE Atlantic

A.G. Ramos¹, J. Cabrera¹, E. Fernández¹, D. Hernandez¹, J. Coca¹, A. Redondo¹, J. Isern¹, A. Dominguez¹, M. Sotillo², E. Álvarez-Fanjul², S. Glenn³, O. Schofield³, J. Kohut³, D.K. Aragon³, N. Strandkov³

¹División de Robótica y Oceanografía computacional (SIANI). Facultad de Ciencias del Mar. Campus de Tafira, 35017-Las Palmas de GC. Spain

²Área de Medio Físico. Organismo Público Puertos del Estado. 28042 Madrid, Spain

³Coastal Ocean Observation Lab (COOL). Institute of Marine Sciences. Rutgers University, New Brunswick, USA

Abstract

Unmanned Underwater Vehicles (UUVs) are used in Oceanography due to their relative low cost and wide range of capabilities. Gliders, being UUVs change their buoyancy to dive and climb describing a vertical saw tooth route. It produces an effective but low horizontal speed. As result it makes them strongly sensitive to the ocean dynamic, and therefore might have to adapt the heading using confident 4D current data sets.

In this paper, it is outlined the first transoceanic path planner software for glider piloting for named Pinzón in honor of the captain of La Pinta (1492-93) Martín Alonso Pinzón. Pinzón path planner was engineered to assist RU-27 Scarlet Knight navigation of the first transatlantic glider flight (221 days, 7409 km). She crossed an inertial oscillation during her last stint in the NE Atlantic domain (1st Nov-4th Dec 2009).

Pinzón path planner integrated a novel path planning algorithm called CTS-A* (Constant-Time Surfacing A*) that managed real time 3D current fields (1°/20) forecast (+3 days) provided by the ESEOAT regional ocean model in the North East Atlantic's domain. Pinzon/ESEOAT planning outputs were validated with those provided by the RU27 ground true paths. He was programmed allowing any bearing angle and integrating each 8 hours (RU-27 surfacing period), the ground true given by the glider location each 8h/surfacing. Pinzón managed continuous space and time domains with realistic and validated hourly forecasts (3-days) of different oceanographic variables provided by the Spanish ESEOO Regional Ocean Forecasting System (IBI Myocean).

Results showed that hourly ESEOAT 3D (Myocean IBI) forecasts captured the high current variability (inertial oscillations) reported by RU-27 on the 14°W to 12°W arriving Spain. Pinzón provided confident routes that were confirmed by the ground true paths reported by the glider before her recovering in the Spain's ZEE (4th Dec 09)⁵. This combination of path planning tools has shown to be especially useful for future long range transoceanic glider missions (Challenger glider mission⁶).

Keywords: North Atlantic Crossing. Autonomous Underwater Vehicles (AUVs). Path plan. Inertial oscillations.

⁵<http://www.i-cool.org/?p=4846>

⁶<http://www.i-cool.org/?cat=77>

Quality and accuracy assessment of HF radar-derived surface current measurements in the Strait of Gibraltar

P. Lorente¹, S. Piedracoba², J. Soto-Navarro¹, E. Alvarez-Fanjul¹

¹*Puertos del Estado, Madrid*

²*Dpto. de Física Aplicada - Facultad de Ciencias - Universidad de Vigo, Pontevedra*

Abstract

The Strait of Gibraltar constitutes a first order geostrategic spot as entrance gate to the Mediterranean Sea from the Atlantic Ocean, with subsequent commercial concerns in terms of decisive logistic platform for layover, bunkering and container transfer. Besides, the Strait of Gibraltar represents a region of paramount oceanographic interest where an exchange of shallow and relatively fresh Atlantic inflow and a cooler and saltier Mediterranean outflow takes place.

The steep orography along both seashores (channeling and strengthening the wind) and the bottleneck-shape of the strait give rise to extremely intense current pulses, above 150 cm s^{-1} . With the aim of improving the operational oceanography infrastructure in the Strait of Gibraltar and enhancing a quick response to emergency situations (oil-spill accidents, etc.), a High Frequency (HF) radar system was installed in 2011 within the framework of TRADE project (Trans-regional RADars for Environmental applications), as a result of a cooperative program between Spain and Portugal (POCTEP), and has been supported by European FEDER funding. This HF radar network, deployed in order to efficiently monitor the surface current field in the near real time, consists of three shore-based 27 MHz short-range Seasonde CODAR sensors (Ceuta, Carnero and Finisterre), that provides radial measurements representative of current velocities in the upper 0.5 m of the water column. The maximum horizontal range is set to 40 km, and the nominal range and angular resolutions are 1 km and 5° , respectively.

The main goal of the present work is to evaluate the accuracy of HF radar-derived surface currents and to quantify intrinsic uncertainties related to this technology. According to this purpose, a comparison between single-point ARG-SL current meter (installed in Algeciras coastal buoy, called hereafter B1) measurements and HF radar current data has been carried out for a 47-day period, comprised between October 18th and December 4th 2013.

Firstly, hourly radial vectors from each antenna have been compared with current meter measurements projected onto the direction of each site. Likewise, the impact of using ideal (IDEAL) or measured (MEAS) antenna patterns in sites performance has been thoroughly investigated. Complementarily, the geometry of the emplacement gives the chance to analyze radar-to-radar overwater baselines in order to evaluate intrinsic velocity uncertainties in HF radial estimates. This methodology states that, in the absence of errors, two facing sites should provide the same estimates of radial velocities (differing only in the sign) at the midpoint of the baseline that joins them, since the range resolution and the angular distribution are similar. From the three different radar-to-radar baselines available (TARI-CARN, TARI-CEUT and CARN-CEUT), the first one has been rejected from the analysis due to be positioned over the coastline. The second one has been also dismissed as CEUT site is oriented to the northeast and its range arcs do not reach the midpoint of the baseline defined between itself and TARI. Therefore, only CARN-CEUT has been analyzed in the present consistency check, leading to correlation coefficient and RMSE values of -0.55 and 38.22 cm s^{-1} , respectively.

Eventually, hourly total currents time series from the radar grid point closest to B1 location have been directly compared with current observations from B1 for the studied period. Comparisons have been undertaken using zonal (U) and meridional (V) components in order to evaluate the agreement between

both instruments measurements by means of the computation of a set of statistical metrics: correlation coefficients are 0.61 and 0.45 for U and V, respectively, whereas RMSE values are in the range [10-20] cm s^{-1} for both components, in concordance with the extremely intense currents registered in the study area.

Zonal component of radar surface currents (U) tracked B1 subsurface component fairly well, consistent with previously reported values, with a positive average flow W-E. However, meridional velocities (V) are only moderately well reproduced by the HF radar. There is a variety of limiting factors that might play a relevant role in reducing radar measurements accuracy, like the sampling differences between both instruments or B1 thorny location, moored near the shoreline, in the edge of HF radar coverage domain and rather close to CEUT-CARN baseline. Complementary validation works could benefit from the recalibration of CEUT site and the employment of drifters or ADCPs moored in strategic areas within HF radar domain, far from its boundaries and baselines.

The methodology exposed in the present work allows to routinely assess the degree of reliability of each antenna performance and fosters the subsequent development of added-value operational tools (oil-spill, backtracking, etc.) in such a key region as the Strait of Gibraltar represents.

Ensemble wave forecast for Gijon, Barcelona and Tenerife harbours**C. Toledano Lozano¹, M. Gómez Lahoz², C. Bunney³, A. Pomaro⁴, C. Santos Burguete¹**¹*Spanish Meteorological Agency, Madrid, Spain*²*Puertos del Estado, Madrid, Spain*³*MetOffice, Exeter, UK*⁴*Institute of Marine Science, Venice, Italy***Abstract**

MyWave is an EU project that aims at significantly improving the European capability of forecasting ocean waves and how it should be presented to the public. One of his objectives is to apply different ensemble techniques in wave forecast and assessing for Mediterranean Sea and North-Atlantic areas their performance and increased information with respect to a deterministic approach.

Aemet-PdE has done a direct application to determinate the advantages of the ensemble approach for the management of commercial harbours. Three locations have been considered, one on the European Atlantic coast (Gijon), one on the Canary Islands (Tenerife) and one on the Mediterranean coast (Barcelona).

Atlantic harbour applications are driven by the UKMO initial conditions. The UK wave-EPS is forced using MOGREPS-G wind data from the control and 22 forecast members. It runs with WAVEWATCH III model.

The Ensemble Transform Kalman Filter (ETKF, Bowler et al., 2008) technique is already run in operational mode at the Met Office as part of the Met Office Global-Regional Ensemble Prediction System (MOGREPS). Since the technique uses a weighted linear combination of members at each forecast re-initialization, the resulting forecasts retain some 'memory' within members of the atmospheric forecast from run to run. This also allows downstream models (e.g. wave and storm surge models) to be one-way coupled with the atmospheric data and to retain sensible levels of spread at short forecast ranges. The performance of the system in basins of different scales has been assessed, with focus on the results of the wave model and their validation versus remotely sensed and in-situ measured data.

Mediterranean harbour application is driven by both systems, UKMO (United Kingdom Met Office) and ISMAR (Institute of Marine Science, Italy). The second approach, run by the Italian Meteorological Service (USAM) together with ISMAR, is technically different, but similarly based on the Ensemble Kalman Filter (EnKF). The Local Ensemble Transform Kalman Filter (LETKF, Hunt et al., 2007) is already implemented in the USAM numerical weather prediction analysis and prediction system (Bonavita et al., 2008, 2010). This data assimilation method is suitable also for short-range ensemble forecast applications. The USAM Local Ensemble Transform Kalman Filter (LETKF) algorithm makes use of a 40 member ensemble, updated every six hours with the new observational data, and driven by lateral boundary conditions from the IFS deterministic forecasts and perturbed using EPS data. Each member of the ensemble forces a high resolution of the ECMWF-WAM wave model (NETTUNO) in the Mediterranean Sea, in so doing obtaining an ensemble of wave forecasts. Detailed results are available in the open sea and at very coastal locations.

At this moment, the three harbour applications are operational with SWAN model.

Gijon and Tenerife systems have been configured taking into account forcing files from UKMO, so they run with the same time resolution as UKMO wave-EPS is defined: 4 runs (0z/6z/12z/18z), and control member+22 members. At 0z/12z members 1-11 run out to full forecast, 12-22 perform short update cycle, and at 6z/18z members 2-22 run out to full 72h forecast, 1-11 perform short update cycle. The restart dumps produced at T+6. Therefore, only the control and half of 22 forecast members run out to

full forecast length at any one forecast cycle, the remaining members run in a short cycle step of 7 hours in order to maintain continuity. During the next cycle, the members that ran a short-step previously are now run to a full forecast and vice-versa. The full 22 member ensemble product can then be generated using overlapping full forecast members from the last two runs.

Barcelona application driven by ISMAR conditions runs with the same time resolution as NETTUNO-EPS is defined, it consists of 40+1 members, integrated at 00 UTC up to 48 hours forecast. The ensemble is run once a day at 00 UTC.

Control members of harbour applications have been validated with PdE buoy network.

In these direct models, the applicability of the ensemble systems will be evaluated. Based on PdE harbour wave forecast system, different tools have been developed that are used by the harbour authorities for their daily management, as for instance an alert system. All these tools will be adapted in order to use probabilistic information instead of deterministic one. After some time, the harbour feedback will be gathered in order to evaluate the new approach.

3 Friday, June 13th

Sala Tenerife

Physical Oceanography - Technology

Challenger Glider Mission: 20000 Leagues under the sea (2008-2020)

A.G. Ramos¹, N. Strandskov², J.R. García-Martel², S. Glenn², O. Schofield², J. Kohut², D. Aragon², T. Haskins², C. Haldeman², A. Redondo¹, J. Coca¹

¹División de Robótica y Oceanografía computacional (SIANI). Facultad de Ciencias del Mar. Campus de Tafira, 35017-Las Palmas de GC. Spain

²Coastal Ocean Observation Lab (COOL). Institute of Marine Sciences. Rutgers University, New Brunswick, USA

Abstract

Ocean forecasting models are an extremely valuable tool for understanding Earth's oceans. Current ocean forecast models assimilate satellite and in situ multi-source data sets from the Argo network of over 3,000 drifters. Though assimilating datasets from these drifters is pertinent, it does create some limitations. Observing System Simulation Experiments routinely indicate that additional profile data, especially profile data that crosses frontal features, are the most influential at reducing forecast uncertainty. Since Argos drifters cannot be controlled and are subject to the oceans currents, areas that would provide critical data to ocean forecasting models are often under sampled. A potential solution to this would be to implement datasets provided by Slocum Gliders into the ocean forecasting models. These Autonomous Underwater Gliders are not as limited by the conditions of the oceans as Argos drifters are. Through their ability to sample virtually anywhere in the ocean, they will be able to bridge the gap left by using Argos drifters.

Here we present an ambitious project named "The Challenger Glider Mission" (>2008) led by the RUTGERS Univ (NJersey, USA) and ROC-SIANI division (Fac CC Mar, ULPGC)⁷. Challenger missions belong to the Integrated Ocean Observing Systems of Spain (Lab de predicción de clima, Puertos del Estado) and USA (IOOS, NOAA, NAVY, NASA..). Technical assistance is conducted by Teledyne and assisted by Plocan. Our target (120,000 km over 12 years) is to traverse the world's ocean with 16 Slocum Gliders⁸

In 2008, the first attempt to cross the Atlantic with a glider (RU17) in the history of oceanography⁹. In 2009 we completed the first transoceanic glider crossing, RU27, Scarlet Knight from New Jersey - Baiona, Vigo over 221 days and 7410 km resulting in an exhibit in the Smithsonian Museum of Natural History and a replic in the Naval Museum of the town of Baiona (Vigo, SPAIN)¹⁰. In 2010 we tried an attempt at crossing the North Atlantic along the 26.5°N line with a prototype Thermal Glider named 'Cook'¹¹. During the EGO International glider meeting (las Palmas GC, 2011), a decision to fly a Slocum glider named Silbo from the arctic to the tropics of the Atlantic was made. From June 2011 to August

⁷<http://www.youtube.com/watch?v=Td8kyWiW0Tw>

⁸<http://www.youtube.com/watch?v=F3ShWMiS9nA>

⁹<http://www.i-cool.org/?p=1533>

¹⁰<http://www.i-cool.org/?p=4846>

¹¹<http://www.i-cool.org/?p=6007>

2013, Silbo flew from Iceland to Barbados over 610 days, 12030 kms over 3 missions (Iceland –Azores-Canaries- Barbados). Following the success of Silbo and RU27, we have launched RU29 from South Africa in January 2013, which will arrive in Brazil this year (400 days/sea, 8000 km)¹².

La Challenger Glider Mission has completed after 2008, more than 35000 km and 1600 days/sea of the 115000 km to fly until 2020 (20700 marine leagues)¹³

¹²<http://www.i-cool.org/?p=12923>

¹³<http://www.i-cool.org/?cat=77>

Past, present and future of coastal altimetry

J. Gómez-Enri¹, P. Villares¹, B. Tejedor¹, A. Aboitiz¹, I. Laiz¹, J. Coca¹, S. Vignudelli², P. Cipollini³, M. Passaro³

¹*Departamento de Física Aplicada. Universidad de Cádiz. España*

²*Instituto de Biofísica de Pisa. CNR. Italia*

³*Centro Oceanográfico de Southampton. NERC. Reino Unido.*

Abstract

Satellite altimetry has become a mature discipline as a tool for a better understanding of our Oceans. In the last years, there is a growing interest from the scientific community to improve the accuracy of altimeter data near the coast. Two main issues still need a more detailed analysis when using altimeter data (sea level and significant wave height) in the foreshore. On one side, the local characteristics of each coastal region imply that certain corrections applied to the altimetry measurements need to be reanalysed. On the other side, the radar signal retracking algorithms need to be improved because the Brown's model, designed for deep waters, does not account for the shallow water processes occurring over continental shelves and the effect of land contamination over the altimeter footprint's area. More than 20 years of data near the coast are still unexploited from past and present satellite missions (ERS1/2, Topex/Poseidon, GFO, Envisat, Jason-1/2).

The ESA mission Cryosat was launched in April 2010 being still in operation. The radar instrument on-board Cryosat improves the capabilities of previous pulse-limited altimeters, such as ENVISAT RA-2. The Spanish-funded ALCOVA project aims to analyze and correct the altimetry measurements obtained from Envisat and Cryosat missions. Regarding the RA-2 data a new prototype retracker -ALES- has been developed under the frame of the ESA-DUE eSurge project aiming to improve their precision and resolution. Two pilot regions are proposed, namely, the Gulf of Cadiz and the Strait of Gibraltar in the Southwestern Iberian Peninsula. Cryosat data (in SAR mode) and the newly corrected RA-2 data (based on ALES) are being validated with available in-situ data (sea level height and significant wave height) to ensure their correct performance in the selected coastal areas.

Past and present initiatives in the last decade (COASTALT, PISTACH, X-TRACK, e-Surge, ALCOVA, among others) will improve the capabilities of future altimetry missions (SWOT) especially in the coastal zone.

UCA-OceansMap: an Operational Oceanography System for the Andalusian Coast developed in the framework of the ARCOPOLplus and ARC**Carlos J. González, Emma Reyes, Carlos Dastis, Jesús Gómez-Enri, Begoña Tejedor, Miguel Bruno, Alfredo Izquierdo, Rafael Mañanes, Óscar Álvarez***University of Cádiz, Spain***Abstract**

UCA-OceansMap is an Operational Oceanography System (OOS) developed in the framework of the ARCOPOLplus (2012-2014) and ARCOPOLplatform (2014-2015) projects of the European Commission (ERDF) by the Research Group “Physical Oceanography: Dynamics” (PAI: RNM205) of the University of Cadiz. The OOS integrates meteorological and oceanographic data from numerical models and field stations into a web-based GIS environment, in order to provide historical data, real-time information, and forecasts of the main oceanographic and meteorological processes throughout the Andalusian marine regions (namely Gulf of Cadiz, Strait of Gibraltar, and Alboran Sea). The principal aim of the OOS is to become a useful tool for authorities, decision-makers and general public in case of necessity, as oil-spill accidents, shipwrecks, commercial and sport navigation, etc. The OOS, developed within the ARCOPOLplus project, is intended to be maintained and improved in the framework of the presently-working ARCOPOLplatform project. The possibility of incorporating Coastal-RADAR surface-currents fields into the OOS, as well as developing new assimilation routines from satellite-altimetry data to the numerical models, will be also discussed.

Statistical study of relaxation oscillations. A quest to find a real early warning signal in climate change**Carmen Herrero, Antonio García-Olivares, Patricia De La Fuente and Josep Lluís Pelegrí***Institut de Ciències del Mar (CSIC). Pg. Marítim de la Barceloneta, 37-49, 08003 Barcelona***Abstract**

There are many known complex systems with a relaxation oscillation behavior, characterized by a periodic phenomenon where relatively stable periods are interrupted abruptly by a sharp transition when a critical point is reached, shifting to a contrasting state. Some examples of these complex systems are Van der Pol Oscillator, Lotka-Volterra equations, both showing this stable to unstable shifting, or even glacial - interglacial changes in the Earth System, which may also obey to the dynamics of a relaxation oscillator rather than to a critical bifurcation.

For this work, an exhaustive analysis of Van der Pol and Lotka-Volterra oscillators has been carried out to find a statistic methodology that allow us to predict the critical point at which the shifting between stable and unstable states will be produced, with the aim of apply that methodology to the glacial-interglacial oscillations of the climate system.

First of all, oscillator's attractor has been analyzed to study the stability of the system in front of noise, giving us an idea of how stable is the system to small perturbations. Then, several statistic descriptors have been analyzed such as autocorrelation at lag 1, variance or autoregression, used to show if there is any characteristic slowing down of the fluctuations previous to unstable shift.

The resulting methodology has been applied to a model of glacial-interglacial oscillations (Garcia-Olivares and Herrero 2013) to analyze the relaxation oscillations of CO₂ and global ice volume time series.

References

García-Olivares, A. and Herrero, C., Simulation of glacial-interglacial cycles by simple relaxation models: consistency with observational results. *Climate Dynamics* 41(5-6) (2013) 1307-1331

Ichthyoplankton transport from the African coast to the Canary Islands

Timothée Brochier^{1,2}, Evan Mason², Marta Moyano², Amina Berraho³, Francois Colas⁴, Pablo Sangrà², Santiago Hernández-León², Omar Ettahiri³, Christophe Lett⁵

¹*CNRS, UMR LOCEAN, Unité Mixte de Recherche 7159 CNRS/IRD/Université Pierre et Marie Curie/MNHN, Institut Pierre Simon Laplace, France*

²*Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, Canary Islands, Las Palmas de Gran Canaria, 35017, Spain*

³*Institut National de Recherche Halieutique, 2 Rue Tiznit, Casablanca, Morocco*

⁴*Institute of Geophysics and Planetary Physics (IGPP), University of California Los Angeles, Los Angeles, CA, USA*

⁵*Institut de Recherche pour le Développement, UMIIRD209UMMISCO, Centre de Recherche Halieutique Méditerranéenne et Tropicale, France*

Abstract

The Canary Upwelling System (CUS), a major eastern boundary upwelling system, sustains large cross-border fisheries of small pelagic fish, which poses the question of stock connectivity. Studies suggest that ichthyoplankton transport from the northwest African coast to the Canary Islands (CI) is facilitated by coastal- upwelling associated filaments. Here we analyze connections between larval supply to the CI and sardine and anchovy populations that spawn over the continental shelf. For both species, ichthyoplankton observations (1) at the shelf and (2) near the island of Gran Canaria (GC) are used. Predictions of ichthyoplankton transport to GC are obtained from the Ichthyop Lagrangian transport model, which is forced by a high-resolution hydrodynamic model (ROMS) that reproduces the regional circulation. Results show that upwelling filaments play an important role in the transport of larvae to GC. However, (1) filaments are not the only mechanism, and (2) filament presence does not necessarily imply larval transport. Anchovy and sardine larval presence at GC appears to be independent of the respective adult spawning seasonality. Combining of observed and modeled data does not succeed in reproducing the observed larval patterns at GC. Various hypotheses are proposed to explain this discrepancy in larval transport to GC.

Monitoring Oceanographic Parameters and Submesoscale Structures of the El Hierro Volcano with Satellite Remote Sensing Imagery

Francisco Eugenio¹, Javier Marcello¹, Javier Martín¹, E. Fraile-Nuez²

¹*Instituto Oceanografía y Cambio Global, Universidad de Las Palmas de G.C., Campus Universitario de Tafiira, 35017 Las Palmas de Gran Canaria, Spain*

²*Instituto Español de Oceanografía, Centro Oceanográfico de Canarias, 38180 Tenerife, Spain*

Abstract

Satellite study of volcanoes can provide data for large areas of the Earth's surface with a range of modalities ranging from visible to infrared, radar and beyond. Satellite sensing can also access remote locations and hazardous regions without difficulty. Accordingly, this work is not intended as a comprehensive treatment of the application of remote sensing to the selected natural hazards but rather as recognition of the contributions of satellite remote sensing to understanding underlying phenomena and providing critical information for decision support by emergency managers and the disaster response community. In this context, satellite remote sensing systems have proven useful for a range of applications including the capabilities to improve the understanding of submarine volcanic processes by means of remote sensing images.

A regular multidisciplinary monitoring of the El Hierro underwater volcano has been carried out in order to quantify the environmental impact by analyzing low resolution remote sensing images providing more frequent observations and scientific information at a wide variety of wavelengths. Multisensor and multitemporal satellite data obtained from MODIS (MODerate resolution Imaging Spectroradiometer) and MERIS (MEDium-spectral Resolution Imaging Spectrometer) sensors have been the main source of information to improve the understanding of El Hierro submarine volcanic processes. MODIS instruments, flying on both the TERRA and AQUA satellites, provide excellent temporal coverage with 2 daylight and 2 night overflights per 24 hours. On the other hand, MERIS, aboard the ENVISAT satellite, is a programmable, medium-spectral resolution, imaging spectrometer operating in the solar reflective spectral range. One important capability of MERIS is the provision of full resolution data at 300 m resolution. These remote sensing data have played, as well, a fundamental role during field campaigns guiding the Spanish government oceanographic vessel to the appropriate sampling areas.

A milky green plume water in the El Hierro volcano area stretched 25-30 kilometers at its widest and, approximately, 100 kilometers long, from a large mass near the coast to thin tendrils as it spreads to the southwest. This plume has provided a unique and outstanding source of tracer. In our work, low and high-resolution satellite images obtained from MODIS, MERIS and WORLDVIEW 2 sensors have been processed to provide information on the concentration of a number of oceanographic parameters, specifically, chlorophyll-a (Chl-a) and diffuse attenuation coefficient (K_d).

Chl-a concentration can be properly estimated from remotely sensed data in open ocean waters. Unfortunately, the accurate monitoring of chlorophyll concentration by remote sensing is not possible during a submarine eruption due to the specific conditions and the alterations provoked in the water composition. By comparing MODIS and MERIS algorithms with in situ measurement, we can conclude that MODIS and MERIS open ocean models completely fail while the MERIS ALGAS-2 coastal algorithm performs slightly better, but only in areas with moderate turbidity.

Respect to the diffuse attenuation coefficient (K_d) parameter, we examined two existing K_d (490) models (MODIS and MERIS) for waters surrounding the El Hierro submarine volcano area. Results, using the in situ measurements obtained from four cruises around the island of El Hierro, were not satisfactory and the K_d(490) values achieved were clearly underestimated. Thus, improved algorithms were developed for turbid waters and applied to MODIS and MERIS bands showing a good correlation between real K_d

(490) values and estimations from low-resolution satellites. Concerning Very High Resolution imagery, a novel algorithm to extract the diffuse attenuation from the original bands was proposed and validated with previous data. This new $K_d(490)$ operational algorithm, developed for high resolution WorldView-2 data, has demonstrated a good performance in this particular situations.

In addition, satellite image sequences obtained from MODIS and MERIS sensors have been processed to analyze the volcanic submesoscale front-like and filament-like structures and also to monitor their evolution. First, accurate geometric correction, land masking, and filtering, to remove noise without edge deterioration, are applied. Next, thresholding methods are implemented to properly segment the structures. Finally, morphological image processing operators and other post-processing techniques are included in the methodology to properly define the submesoscale structures. This detection approach has been validated over a database of MERIS and MODIS oceanographic products and it has demonstrated an excellent performance and robustness.

References

1. Eugenio, F., Martin, J., Marcello, J. and Fraile-Nuez, E. (2014). Environmental monitoring of El Hierro Island submarine volcano, by combining low and high resolution satellite imagery. *International Journal of Applied Earth Observation and Geoinformation*, 29, 53–66.
2. Eugenio, F., Martin, J., Marcello, J. and Bermejo, J.A. (2012). Atmospheric correction models for high resolution WorldView-2 multispectral imagery: A case study in Canary Islands, Spain. *Proceedings SPIE Remote Sensing*, Edimburgh, September 2012.
3. Fraile-Nuez, E., González-Dávila, M., Santana-Casiano, J. M., Arístegui, J., Alonso-González, I. J., Hernández-León, S., Blanco, M. J., Rodríguez-Santana, A., Hernández-Guerra, A., Gelado-Caballero, M. D., Eugenio, F., Marcello, J., de Armas, D., Domínguez-Yanes, J. F., Montero, M. F., Laetsch, D. R., Vélez-Belchí, P., Ramos, A., Ariza, A. V., Comas-Rodríguez, I. and Benítez-Barrios, V. M. (2012). The submarine volcano eruption at the Island of El Hierro: physical-chemical perturbation and biological response. *Scientific Reports*, 2.
4. Joyce, K., Belliss, S., Samsonov, S., McNeill, S and Glassey, P. (2009). A review of the status of satellite remote sensing and image processing techniques for mapping natural hazards and disasters. *Progress in Physical Geography*, 33, 2, 183–207.
5. Tralli D. M., Blom, R. G., Zlotnicki, V., Donnellan, A. and Evans, D. L. (2005). Satellite remote sensing of earthquake, volcano, flood, landslide and coastal inundation hazards. *ISPRS Journal of Photogrammetry and Remote Sensing*, 59 (4), 185-198.

Upwelling influence on the frequency of extreme hot SST events along the Canary Upwelling ecosystem

F. Santos, M. deCastro, M. Gómez-Gesteira and X. Costoya

University of Vigo, Spain

Abstract

Increase in sea surface temperature (SST) is especially important in coastal areas due to its severe impact in coastal ecosystems [Honkoop et al., 1998; Diederich et al., 2005; Burrows et al., 2011]. It was detected that the warming is not homogeneous through the year. The ocean warming has already affected global fisheries during the last four decades. This warming is not detected in changes in mean temperature, the frequency of extreme sea temperatures such as extremely hot or cold events is fundamental to understand changes in coastal marine ecosystems and to determine scenarios and policies to mitigate those changes [i.e. Philippart et al., 2003; Frank et al., 2005; Thielges, 2006; Occhipinti- Ambrogi, 2007]. The analysis of extreme hot SST trends in upwelling regions constitute an important step in developing plans to assess the warming impact on economy and food security of coastal areas.

The question addressed in this work is the analysis of changes observed in the frequency of extreme hot days along the Atlantic Iberian sector and the Moroccan sub- region of the CUE over the period 1982 – 2012 by means of SST data retrieved from NOAA OI1/4 Degree. The analysis will focus on the Atlantic Iberian sector and the Moroccan sub- region where upwelling is seasonal (spring and summer) or permanent, respectively. Trends were analyzed both near coast and at the adjacent ocean where the increase in the number of extreme hot days is higher. Changes are clear at annual scale with an increment of 9.8 ± 0.3 (9.7 ± 0.1) days dec^{-1} near coast and 11.6 ± 0.2 (13.5 ± 0.1) days dec^{-1} at the ocean in the Atlantic Iberian sector (Moroccan sub-region). The differences between near shore and ocean trends are especially patent for the months under intense upwelling conditions. In the Atlantic Iberian sector, differences in the excess of extreme hot days between coast and ocean are higher (3 days dec^{-1}) south of 39°N linked to a remarkable increase in coastal upwelling ($60\text{-}90 \text{ m}^3\text{s}^{-1} \text{ km}^{-1} \text{ dec}^{-1}$). At northern latitudes, these differences are negligible coinciding with a no significant increase or even a decrease in coastal upwelling. In the Moroccan sub- region, the highest differences in the excess of extreme hot days (2-3 days dec^{-1}) between coast and ocean are observed south of 27°N and around 32°N linked to a significant increase in coastal upwelling intensity ($80 \text{ m}^3\text{s}^{-1}\text{km}^{-1}\text{dec}^{-1}$ and $60 \text{ m}^3\text{s}^{-1} \text{ km}^{-1} \text{ dec}^{-1}$, respectively).

References

- Burrows, M.T. et al., (2011), The pace of shifting climate in marine and terrestrial ecosystems. *Science* 334, 652- 655. DOI: 10.1126/science.1210288.
- Diederich, S., G. Nehls, J. E. E. van Beusekom and K. Reise (2005), Introduced Pacific oyster (*Crassostrea gigas*) in the northern Wadden Sea: Invasion accelerated by warm summers? *Helgoland Mar. Res.* 59, 97– 106.
- Frank, K. T., B. Petrie, J. S. Choi, and W. C. Leggett (2005), Trophic cascades in a formerly cod-dominated ecosystem, *Science* 308, 1621–1623.
- Honkoop, P. J. C., J. Van der Meer, J. J. Beukema and D. Kwast (1998), Does temperature-influenced egg production predict the recruitment in the bivalve *Macoma balthica*?, *Mar. Ecol. Prog. Ser.* 64, 229–235.
- Occhipinti-Ambrogi, A. (2007), Global change and marine communities: Alien species and climate change. *Mar. Pollut. Bull.* 55, 342–352.

Barotropic and baroclinic tide generation for the ocean off the Espírito Santo state, Brazil.**Jesus, L. C., Chacaltana, J. T. A.***Universidade Federal do Espírito Santo (Brasil), Centro Tecnológico, Departamento de Engenharia Ambiental***Abstract**

Tide is one of the major physical processes for the ocean mixing and a large fraction of the variance in the oceanographic variables, as temperature, salinity, chlorophyll, velocities, etc. Accurate tidal elevations, currents and the energetic behavior are indispensable for many practical and scientific applications such as shipping, pollution dispersal, determination of the ocean termohaline circulation and mixing, among others. The barotropic astronomical tide and the baroclinic tidal generation were studied in this work.

The mass and momentum equations based Delft3D numerical model was employed to hindcast the astronomical tidal velocities and elevations to the region off the state of the Espírito Santo (Brazil), with the submarine mounts of the Vitória-Trindade chain and the Abrolhos Bank within. The results were compared with pre-existing data from tidal stations and moored buoy in the study site.

Elevation and current time series were transformed to the frequency spectrum through Fourier harmonic analysis and the energy conservation equations were solved to estimate the energy conversion rates, barotropic and baroclinic fluxes and dissipation.

The numerical results show that the major tidal ellipses are located at the Abrolhos bank and the Vitória-Trindade chain and the tidal harmonics are essentially progressive in the study site. The major rates (up to 0.4 W/m^2) of tidal energy conversion, dissipation and focusing were located at the Vitória-Trindade chain. The energy flux follows the bathymetric contours, with magnitudes up to 1.5 kW/m in the region off the Vitoria-Trindade Chain between the depths of 2500m to 3500m. The focusing of the energy in seamounts produces beams.

In whole analyzed area, most of the barotropic input (273 MW) is dissipated into deep ocean turbulence and cascade (211 MW). From the total dissipated energy, 207 MW is dissipated by barotropic dissipation and a small part (61.4 MW) by baroclinic dissipation. Just a small part (65.7 MW) of the barotropic energy is converted into the baroclinic mode, which 4.49 MW is irradiated out of the computational domain.

The numerical model successfully reproduced the tidal phase and elevations, as well as the density fluctuations. Most of the barotropic and baroclinic energy is dissipated. The submarine mounts of the Vitória-Trindade chain are a key geomorphologic feature in the tidal energy transformations.

Ocean Modelling - Coastal Management

Biophysical model coupling ROMS and PISCES in the Canary Current Ecosystem

Yeray Santana Falcón, Javier Arístegui Ruiz et al.

Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria

Abstract

Biophysical modeling is a useful tool to understand the high temporal and spatial variability observed in Eastern Boundary Currents both at large- meso- and submeso-scale levels. In the recent years, physical-biogeochemical coupled models have been successfully applied in the Humboldt and, especially, in the California Current ecosystems; however, the Canary Current Ecosystem (CCE) has been poorly studied so far. To help covering this lack, we have coupled a Regional Ocean Modeling System (ROMS) solution with the biogeochemical model PISCES (Pelagic Interaction Scheme for Carbon and Ecosystem Studies) for the first time in the CCE. The model was carried out using roms2roms, a nesting technique that employs a lesser-resolution widely validated ROMS solution to force a higher-resolution ROMS-PISCES solution in order to improve final reliability. We have used a 4 km horizontal resolution with 50 vertical levels that allows us to study the seasonal variability of the main biogeochemical processes that occur in the region. Several biology-related parameters have been tuned to enclose the particular conditions that rule the dynamic of the CCE. Physical variables coincide with real measurements both in situ and derived from remote sensing data. Due to the inherent difficulty in measuring biogeochemical variables, chlorophyll has been traditionally used to check the behavior of biogeochemical models due to their easy-access data. We have used the modeled inferred chlorophyll and observed that the temporal patterns of distribution closely agree with surface chlorophyll observations derived from remote sensing, although concentrations in the coastal area seem to be underestimated.

Storm river discharge contribution to sea level in the Bay of Biscay**Irene Laiz¹, Luis Ferrer², Theocharis A. Plomaritis^{3,4}, Guillaume Charria⁵**¹*Department of Applied Physics, Faculty of Marine Science and Environment, University of Cadiz, Campus Río San Pedro s/n, 11510 Puerto Real, Spain*²*AZTI-Tecnalia, Marine Research Division, Herrera Kaia, Portualdea z/g, 20110 Pasaia, Spain*³*Department of Earth Science, Faculty of Marine Science and Environment, University of Cadiz, Campus Río San Pedro s/n, 11510 Puerto Real, Spain*⁴*CIMA, Universidade do Algarve, Campus de Gambelas, Portugal*⁵*DYNECO – Laboratoire de Physique Hydrodynamique et Sédimentaire, IFREMER, B.P.70, 29280 Plouzané, France***Abstract**

The effect of river discharge storm events on daily mean sea level in the Bay of Biscay was evaluated using two different approaches: (1) through the analysis of time series of tide gauges placed within river mouths; and (2) through numerical simulations using the ROMS model (Regional Ocean Modeling System). The river systems considered represent cases of small (Nervi3n; 1,900 km²), medium (Adour; 16,880 km²) and large (Gironde; 8,4811 km²) watershed basins.

Typical storms generate water discharge rates of 150, 700, and 1,100 m³ s⁻¹ for the Nervi3n, Adour, and Gironde rivers, respectively. The corresponding tide gauges are located at Bilbao for the Nervi3n river (Spain), and at Boucau-Bayonne for the Adour river and Port-Bloc for the Gironde river (France). The effect of other forcing factors on sea level, such as atmospheric pressure, zonal and meridional wind, and steric height, was also addressed by performing stepwise multiple regressions. Overall, atmospheric pressure is the best predictor, explaining approximately 66%, 46%, and 60% of the mean sea level variability at the Bilbao, Boucau-Bayonne, and Port Bloc tide gauges, respectively. Two statistical methods were used in order to study the relationship between river discharge and pressure-adjusted sea level (ASL), namely the Cross Wavelet Transform (XWT) and the "peak-over-threshold" (POT) analysis. XWT results show a common annual cycle between river discharge and ASL, as well as sporadic common events associated with heavier river discharges taking place during spring and autumn (Bilbao), autumn (Boucau-Bayonne), and winter (Port Bloc). POT results indicate that extreme river discharge values result in higher ASL values at the three tide gauge records. River runoff extreme events are more notable at the two tide gauges located within the largest rivers (Adour and Gironde), where approximately 13% and 53.6 % of the pressure-adjusted sea level variance is explained by those events. The ROMS model results show that the main effect of river discharge storm events occurs as a response to the input of lower salinity water. This plume of overlaying less dense water would produce a sea level increase around the river mouth and along the coast, suggesting the generation of a coastal density current through the balance between the Coriolis force and the cross-shore pressure gradient. The main area of influence of the selected river discharges is confined to the river mouth for the Nervi3n case, but extends up to approximately 28 and 33 km offshore for the Adour and Gironde rivers, respectively, before turning northward to flow as a density current along the coast.

Assessment of flood risk Boca Barranco Beach, Canary Islands, Spain

Guilherme Clarindo Marcos¹, Germán Rodríguez Rodríguez¹, Conceição Juana Fortes², María Teresa Reis² & Javier Santana Ceballos²

¹FIMATA – Física Marina y Teledetección Aplicada - Departamento de Física – ULPGC

²LNEC / DHA – Laboratorio Nacional de Engenharia Civil – Lisboa, Portugal – Departamento de Hidráulica e Ambientes

Abstract

Coastal areas embrace a vast historical and cultural heritage, associated with defence functions of economic and social activities that have been located in these areas, throughout the development of the Spanish society. Spain has an extensive coast which is totally exposed to the severity and randomness of the sea agitation regime, which promotes a constant state of alert to emergency situations in coastal and port areas. Taking this into account, it is essential the implementation of efficient procedures of planning and management by the responsible entities, such as warning systems and preparation of risk maps to decrease damage to buildings and equipment, or loss of human lives.

The present study aims to evaluate the occurrence of phenomena such as floods and overtopping on beaches and coastal defence structures existing in Boca Barranco Beach, located in East Coast of the island of Gran Canaria.

Thus, the methodology applied in the present study is based on a good characterization of sea agitation, based on the sea agitation hindcasts supplied by the numeric model WAN, provided by SIMAR-44/WANNA system, adjusted for “PUERTOS DEL ESTADO”, which are subsequently transferred to an area by the coast.

For this transference we rely on the SWAN spectral model, which is validated with the data measured in situ by a float-sea wave graph positioned to the east of Las Palmas II. The study period is from 1992 to 2009.

Once obtained the characteristics of the sea agitation along the coast, the run-up and the overtopping are calculated, respectively, in the beach area and in the beach/structure area. Afterwards, the maximum level of flooding in the beach area is calculated, as well as the average flow overtopped by linear metre of structure in the adherent structure.

The risk evaluation takes into account the product between the occurrence probability degree and the consequence degree. The risk degree is attributed by means of consulting tables. In the tables, the preliminary descriptions of the occurrence probability and of the occurrence consequences are represented. The risk degree is obtained through an intersection matrix of the degrees previously described. Once the risk degree has been attributed it is possible to obtain the acceptability of that degree of risk.

Regarding the results, it was verified that the degree of risk varies according to the characterization of the sea agitation that is implemented in the run-up calculations on the beach area.

Keywords: Risk, flooding, run-up, run-up/overtopping, empirical and numerical models, SWAN model.

Coastline changes in the Esquintla region of Guatemala's Pacific coast derived from anthropogenic actions

Laura L. Cabrera Vega, Noelia Arto Cuesta, Rosana Álvarez Vázquez

elittoral, Estudios de Ingeniería Costera y Oceanográfica

Abstract

A temporal comparison with aerial photographs over the period 1965-2013 was used to analyze changes in the Esquintla region of Guatemala's Pacific coast. The study area is a complex system with two rivers (Achiguate river at the west and María Linda river at the east) and a sandy coast which has been modified from 19th century in order to develop this area in terms of economy. Regarding this, in 1886 a channel was built (Chiquimulilla channel) parallel to the coast line connecting both river mouths. At this time it was created an artificial inlet to evacuate María Linda's water, next to a saline lake located in the middle of the studied area. Later, in 1980, at the same time with the population development of this area, this channel was interrupted by the construction of a port (Puerto Quetzal), at the saline location, which is nowadays a strategic point for trade and tourism.

This channel interruption has created several problems in this area derived from the sedimentary processes generated in Puerto Quetzal west side due to the littoral drift that goes from W to E, and the strong erosion generated in the beaches at the east of this port.

Another significant problem is the sedimentation in Chiquimulilla channel on both sides of this port. This problem has been generated several seasonal floods in the urban areas close to this channel, which have been generated significant health problems because of the lack of a right drainage system of sewage which are poured directly to the channel.

In order to drain the water of both rivers it was created three fixed artificial inlets, one at the west of Puerto Quetzal (Zanjón Chilate), and other two artificial inlets on the east side, San Marino and Maria Linda, being the last one at the west of Maria Linda's seasonal mouth.

Apart from the creation of those inlets, and with the aim of diminish the erosion at the east side, several breakwaters was constructed, but none of this actions have been capable to stop this problems.

All this coast line changes are analyzed in this study with aerial photographs comparing between 1965 (before Puerto Quetzal construction), 2006 and 2013. From 1965 to 2006, the sedimentation rate between Achiguate river and Puerto Quetzal port was 5.7 m/y in the river mouth of Achiguate, changing from an estuary to a delta morphology; 3.6 m/y closer to Puerto Quetzal being modified by the Zanjón Chilate inlet construction; and 2.3 m/y in the middle part between these two areas.

On the contrary, at the east side of the port, the erosion rate was 2.3 m/y between Puerto Quetzal east breakwater and San Marino inlet, and 3.8 m/y at the east of it.

Moreover, between 2006 and 2013 this trend continued, although the sedimentation rate at the west side of the port increased in both ends, being close to Achiguate river 7.4 m/y and close to Puerto Quetzal 4.1 m/y while in the middle part this rate diminished to 1.1 m/y.

On the other hand, between 2006 and 2013, at the east side of this port, the erosion rate between Puerto Quetzal east breakwater and San Marino inlet diminishes to 1.6 m/y probably because of the coast rigidification, while this rate increased at the east of San Marino inlet, to 6.1 m/y becoming the most problematic area. In this latter area, it can be observed the effects of three breakwaters, that far from retaining sediment it seems that they increase the erosion effect.

These processes of accretion and erosion can be observed in the subtidal zone as well, comparing 2001 and 2013 bathymetries. It can be observed that in general the -5m, -10m and -20m isobaths in 2013 at

the west side of Puerto Quetzal, are further away from the coast than in 2001, while at the east side of this port the contrary occurs, being all these isobaths closer to the coast, with the difference that the -20m isobaths is more constant in this side than in the west side.

At the east of Puerto Quetzal, the combination of the erosion effects on the coast side and sedimentation in the channel generates severe problems. On one hand, in the present, boats in several occasions are not capable of using the inlets and navigating through the Chiquimulilla channel being detrimental to the economy of this area. On the other hand, if the sand bar, which separates the urban areas (mostly tourist resorts) from the Pacific Ocean, disappears, these urban areas will be exposed directly to the effects of the sea, and having this erosion rates into account, they will disappear in a short period of time.

As a result, the management carried out until nowadays does not stop these problems and a severe study of the whole zone, should be taken into account to manage this area correctly.

Ancient coastal lagoon in Maspalomas dune field (Gran Canaria). Evidences from sedimentology, vegetation and historical data.**I. Alonso, A. Benavides, S. Rodríguez, A.I. Hernández-Cordero, J.F. Betancor, M.J. Sánchez and M. Casamayor***Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria***Abstract**

Maspalomas is the only area covered by active dunes in Gran Canaria. This dune field is located on top of a fan delta formed in the embouchure of Fataga-Maspalomas ravine, just on the southernmost part of Gran Canaria Island. This fan delta is formed by alluvial deposits, which can be observed in several outcrops throughout the interdune areas of the dune field.

The western boundary of the dune area is limited by the watercourse of this ravine, which at the present time is artificially channelized and ends at the Charca de Maspalomas. This is a small (c. 3 ha) and shallow (1-2m depth) coastal lagoon, which is the result of groundwater water seepage from inland and infiltrations of seawater through the sand bar.

Detailed cartography of the different underlying materials beneath the dunes has allowed differentiation between eolianitic, alluvial and lagoonal materials. Present paper deals with the lagoonal type of deposits, which have been found on small spots all through an area of c. 4 ha located about 200 m north-east the Charca de Maspalomas. Some of these spots can be found in between a small grove of native vegetation.

Superficially these deposits are constituted by grayish sandy silt, and some surface sedimentary structures formed by flowing water can be observed. Desiccation cracks are also present, as well as fossils of terrestrial gastropods, such as *Hemicycla cf ethelema* (Mabille, 1882) and *Canariella sp.* The upper layer of these deposits is slightly compacted, and it can be disaggregated under finger pressure.

The upper 60 cm of the vertical sequence is formed by alternating layers of medium-fine sands 20-30 cm thick and thin layers of clayed sandy silt only 1-2 cm thick. This sequence indicates the fluctuation between ponding processes associated to superficial runoff during rainy periods, and aeolian processes which generates the arrival of large amount of sand from the nearby dunes. The whole deposits has been interpreted to be an ancient coastal lagoon, where the inputs of sand have progressively contributed to fill it up, so that at present times this lagoon has completely disappeared.

Why this ancient lagoon could have disappeared while the Charca de Maspalomas is still a functional coastal lagoon? To answer this question several factors should be considered. First the relative location of both lagoons, so that the one which is closer to the dunes receives much more sand than the other one. Furthermore, it has to be considered the westward movement of the dunes, thus it is not strange the silting up of the eastward lagoon due to the displacement of the dunes. Other factors are related to freshwater inputs to this area. Some of them are the construction of several hundreds of wells and galleries in the period 1900-1960, and the building of four large dams in 1950-73 along the Fataga ravine. All these hydraulic works were carried out in order to guarantee water supply, initially for the agriculture and later on for the tourist resorts, but they have also led to a drastic decrease of runoff in the lower part of the ravine.

In fact, the dunes movement is the reason that explains how the silty surface area has been preserved: The aerial photographs evolution shows that in the decades of 1950 and 1960 most of the area was covered by mobile dunes, and the actual grove was not present at all. Nevertheless, by mid 60s some vegetation began to appear. In the 70s some hotels and touristic resorts were built in this area. Even

though it has not been proved, it is very reasonable to assume that sediment from nearby dunes was used as raw material during construction, and therefore a huge amount of sand was eliminated before it could reach the Charca de Maspalomas. These hotels were dismantled in 1989, and since the 90s it is clearly visible the vegetation growth. Nowadays this small patch of vegetation has evolved into a very dense small forest that includes many different species, such as *Phoenix canariensis*, *Juncus acutus* and *Typha dominguensis*. It has to be focused that this type of vegetation has very high requirements of freshwater, and this is the only place in the whole dune field where *T. dominguensis* may be found. The colonization of this particular area by this type of vegetation indicates that groundwater level is very close to surface, which could also be related to the pre-existence of an old lagoon in this place.

In fact, there are historical documents which indicate that there were two coastal lagoons in Maspalomas at the beginning of XIX century. Probably the best one comes from Webb and Berthelot (1838), who made a very detailed chart of Gran Canaria where some irregular hills are drawn over the coastal plain in the southernmost end of the island, which clearly corresponds with the dunes. In the center of this plain there are two coastal lagoons named “Lagunas de Maspalomas”, both fed by Maspalomas ravine after channel bifurcation.

To summarize, this is first time since 1838 that this ancient coastal lagoon in Maspalomas dune field is mapped.

The CICMAR - Caribe: an institutional strategy to help the Colombian Caribbean Sea**Ceballos Sandoval, Jairo Antonio***Universidad Simón Bolívar, Centro de Investigación en Ciencias del Mar del Caribe Colombiano – CICMAR Caribe*²*Instituto de Ciencias Marinas de Andalucía, ICMAN (CSIC). Campus Universitario Río San Pedro, 11510 Puerto Real, Cádiz. Spain.***Abstract**

The CICMAR Caribe is the Center of Research in Marine Sciences of the Colombian Caribbean, (CRMSC – Caribbean), located in Barranquilla, Colombia. Formed by 4 institutions, Simón Bolívar University, Costa University, Atlántico University and Navy ARC Barranquilla, that seeks to unite the integrated management of Coastal, with the science and the community, respond to the need to assume the littorals area from a holistic view, where the universities, with the public participation are key elements of integrated littorals area management. The coastal zone represents a unit because it is supported by network of people, good and ecosystem services, cultures, traditions and social structure characteristic. The objectives are promoting sustainable development of ocean and littorals areas, by structuring and concert implementation of strategies to ensure full management, economic exploitation, public benefit, environmental conservation, cultural development, monitoring and control of these areas. The CICMAR Caribe, looking for multisectoral and multidisciplinary approach for the integrated management of ocean and littorals areas, require the involvement of different sectors and disciplines whose common denominator is the sea, the CICMAR Caribe concur in the development of strategies to respond to the challenges arising from interest maritime's national and international.

The entities that form the CICMAR Caribe, formulate, evaluate and disseminate the impact of scientific research, marine technology and innovation efforts in the country, enabling the solution of national or global issues relating to quality improvement and sustainable use of ecosystems, marine resources and standards of living of Colombians.

Keywords: CICMAR – Caribe, Integrated management of coastal, sustainability, culture, knowledge, sea, community

Marine Cultures

Environmental effects on the gonadal condition in the Peruvian scallop *Argopecten purpuratus* (L, 1819) Paracas Bay, P

Rosa Cueto¹, Jaime Mendo¹, Juan Argüelles², Jonathan Flye-Sainte-Marie³, Frédéric Jean³, Arturo Aguirre³

¹Universidad Nacional Agraria La Molina, Lima- Perú

²Instituto del Mar del Perú, Callao- Perú

³Université de Brest: CNRS (CNRS/INSU) UMR 6539 Lemar, IUEM, Rue Dumont d'Urville, 29280 Plouzané, France

Abstract

Gonadosomatic index (GSI) prediction in commercial culture of *Argopecten purpuratus* is a key parameter to decide the harvest time (maximum performance) and for seed collection in natural seed collection. From September 2012 to March 2013 a monitoring was performed at two depths (bottom and in suspended culture at two meters above the bottom) in aquaculture area in Paracas Bay, Peru, in order to identify environmental variables that explain the variations in the GSI of *A. purpuratus*. Two batches of scallops, differing in size, were placed in pearl nets and installed for each depth. Every week 1854 individuals were sampled, measured (mm, shell height) and weighted (gr, tissue weight); then the GSI was calculated for each depth. During the experimental period, temperature, oxygen saturation, salinity, chlorophyll-a and turbidity were recorded at high temporal resolution. The lunar cycle was also recorded.

Datasets from this monitoring were examined through time series and multiple regression analyses.

Data analysis indicated that the variables that mostly influence the GSI are temperature, dissolved oxygen, turbidity and currents ($P < 0.05$). On standard conditions (normoxia and enough food), a cyclic variation of GSI was detected and it appeared that the decrease of GSI was influenced by lunar cycles ($P < 0.05$): spawning events occurred about 7 days after the new moon on average and we recommend to harvest scallops before this period to avoid the gonadal weight fall in commercialized scallops. Results also evidenced that during events of hypoxia (lower 20% oxygen saturation) and high relative turbidity events, the GSI remained lower and the recovery of the gonadal weight was delayed (below to 20% for 4 weeks).

Implications of physical key factors in the early rearing of the long-snouted seahorse *Hippocampus guttulatus*

A. Blanco, A. Chamorro and M. Planas

Institute of Marine Research. National Council of Scientific Research (IIM-CSIC)

Abstract

Seahorse rearing is a potential tool to reduce trade pressure on wild populations and also to diminish natural population declines. Although breeding conditions are rather well established for some seahorse species (*Hippocampus spp.*), only few studies are available on the rearing of *Hippocampus guttulatus* juveniles. Zootechnics and the effect of non-biological factors are still unknown for that European seahorse species. The present study is focussed on the effects of aquarium type/design, photoperiod regime and aeration level on the early performance (growth and survival) of *H. guttulatus* juveniles.

To fulfil one of the main challenges for sustainable aquaculture, the aquaria design should consider that the fish must be kept under the best conditions for growth and welfare with minimum resource consumption. Despite evenness fish distribution is related to rearing aquarium design, there are no previous studies on the survival and performance efficiency of different aquaria shapes in the rearing of seahorses. Three aquarium types were evaluated: *Pseudokreisel*, spherical and rectangular. Juveniles grown in *Pseudokreisel* aquaria showed lower growth rates but significantly higher survivals ($69 \pm 15\%$) at day 30 after male's pouch release (30 DAR) when compared to either spherical ($30 \pm 22\%$) or rectangular ($16 \pm 12\%$) aquaria. Survival enhancement in *Pseudokreisel* aquaria was mainly related to the very low proportion of juveniles showing swim bladder hyperinflation during the first days of life. The use of *Pseudokreisel* aquaria, similar to those used here, has also been reported in others seahorse rearing (Koldewey, 2005). In the other aquarium types, both aeration and water inlet did not impede juveniles to remain near water surface and to gulp air in excess for swim bladder inflation.

The effects of light regime were assayed in juveniles reared in all three aquarium types. Even though adequate light cycles might enhance growth and survival rates, there is high controversy on the establishment of the most adequate photoperiod regime. Olivotto et al. (2008) pointed out that *Hippocampus reidi* juveniles cultured in rectangular aquaria on a mixed diet including copepods performed and survived better when exposed to extended photoperiods than those reared under natural photoperiod conditions. On the contrary, survivals in *H. abdominalis* reared under a 16L:8D cycle did not differ from those achieved under either extended or shortened photoperiods, though juveniles grew better under a day-night cycle (Martinez-Cardenas and Purser, 2012). Due to its species-specific effects, the determination of the optimum photoperiod regime for each species becomes of main interest. The application of extended (continuous light) or natural photoperiods (day-night cycle; 16h Light: 8h Dark) did not affect significantly survivals nor growth in *H. guttulatus*. Increasing levels of activity were accompanied by increasing energy expenditure for foraging and swimming (Fielder et al., 2002). However, under a day-night light regime, the energy saved at night due to a reduced locomotion activity might be used for growth, which would be especially advantageous during the first critical days of life in seahorse juveniles, when the efficiency of food digestion and assimilation is still scarce (Blanco et al., 2011, 2013). Altogether, the results achieved in growth and survival of *H. guttulatus* juveniles under both natural and extended photoperiod regimes might be explained through an imbalance between the ingested and mobilized energy.

The effect of aeration levels on seahorse juveniles were studied in juveniles reared in PseudoKreisel aquaria. Average weight and size in 15 DAR juveniles were 25 ± 4 mm and 21 ± 11 mg, respectively for strong aeration levels and 28 ± 2 mm and 32 ± 7 mg, respectively, in seahorses reared under

weak aeration. Juveniles under strong aeration showed significantly ($p = 0.04$) higher weight than those reared under weak aeration from 15 DAR onwards, while no effect was shown for SL at 30 DAR, when the experiment ended. Survivals in 30 DAR seahorses reared under strong aeration were significantly higher ($p < 0.001$) than when reared under weak aeration ($86 \pm 10\%$ and $46 \pm 11\%$, respectively). Strong aeration levels enhanced the distribution of juveniles in the aquaria and diminished both their over-exposition to water surface and the resulting appearance of hyperinflation problems, which would otherwise, die in the following days (commonly from 10 to 20 DAR) due to the impossibility to feed normally. In general, juveniles growth was initially (0 - 15 DAR) enhanced in weakly aerated conditions, probably due to a higher energy demand for swimming and hunting under strong water turbulence (Oshima et al., 2009).

The overall results suggest that the best rearing conditions are met when *H. guttulatus* juveniles grew in Pseudokreisel aquaria under both a strong aeration level and, to a lesser extent, a natural photoperiod regime.

References

- Blanco, A., Planas, M., Moyano, F.J., 2013. Digestive enzyme activities of juvenile seahorses *Hippocampus guttulatus* fed on different live prey. Aquaculture Europe 2013, Trondheim, Norway.
- Blanco, A., Quintas, P., Planas, M., 2011. Enhancement in the rearing of the seahorse *Hippocampus guttulatus* by feeding on copepods, 5th International Zoo and Aquarium Symposium The Husbandry, Management and Conservation of Syngnathids, Chicago, Illinois (USA).
- Fielder, D.S., Bardsley, W.J., Allan, G.L., Pankhurst, P.M., 2002. Effect of photoperiod on growth and survival of snapper *Pagrus auratus* larvae. Aquaculture. 211, 135-150.
- Koldewey, H., 2005. Syngnathid Husbandry in Public Aquariums: 2005 Manual, with chapters contributed by members of the Syngnathidae Discussion Group. Project Seahorse and Zoological Society of London, London, UK.
- Martínez-Cárdenas, L., Purser, G.J., 2012. Effect of stocking density and photoperiod on growth and survival in cultured early juvenile pot-bellied seahorses *Hippocampus abdominalis* Lesson, 1827. Aquaculture Research. 43, 1536-1549.
- Olivotto, I., Avella, M.A., Sampaolesi, G., Piccinetti, C.C., Navarro Ruiz, P., Carnevali, O., 2008. Breeding and rearing the longsnout seahorse *Hippocampus reidi*: Rearing and feeding studies. Aquaculture. 283, 92-96.
- Oshima, M., Kato, Y., Masuda, R., Kimura, S., Yamashita, Y., 2009. Effect of turbulence on feeding intensity and survival of Japanese flounder *Paralichthys olivaceus* pelagic larvae. Journal of Fish Biology. 75, 1639-1647.

Identification of the scuticociliate *Porpostoma notata* Moebius, 1888 in reared *Hippocampus hippocampus* (L.) seahorses**Claudia Ofelio, Andreu Blanco, Alvaro Roura, Santiago Pascual, Jose Pintado, Miquel Planas***Instituto de Investigaciones Marinas – Consejo Superior de Investigaciones Científicas (IIM-CSIC), Vigo, Spain***Abstract**

Even though some of the 34 recognized seahorse species (*Hippocampus spp.*) can be reared successfully, huge mortalities may in early developmental stages of the cultured seahorses. Moribund *Hippocampus hippocampus* (L.) juveniles showing symptoms of lethargy, anorexia, rubbing, dark body pigmentation, lateral and water surface swimming were sampled from rearing with mass mortality events. A ciliate parasite infestation was detected in the ascitic fluid and orbital cavities of affected seahorses. After amplification of the genomic small-subunit 18S rDNA, the ciliate sequences showed a 99% of similarity with the 18S rRNA of *Porpostoma notata* (HM236335). The systematic position of the ciliate was determined among thirty-eight scuticociliatia sequences available in GenBank and integrated in the phylogenetic analysis.

The histophagous parasite *Porpostoma notata* has been never reported before in seahorses. Previously, the ciliate parasite has been only isolated from seawater samples and from dead cultured crabs. Further studies would be necessary to determine if *P. notata* is a primary causative agent of mortality in seahorse juveniles and to define its pathogenicity. Nucleotide sequence data reported in this study are available in the EMBL database under the accession number HG326610.

Closing the life cycle of the European long-snouted seahorse *Hippocampus guttulatus* Cuvier 1829**A. Blanco, A. Chamorro and M. Planas**

Marine Research Institute. National Council of Scientific Research

Abstract

Wild populations of many seahorse species are declining due to several reasons, depending on the geographical region considered. Some species, mainly from Asia, are overexploited (Traditional Chinese medicine and aquarium trade) whereas others, such as European species, are suffering the loss of their natural habitats due to anthropogenic effects. Populations of European seahorse species (*Hippocampus guttulatus* and *H. hippocampus*) are also declining even that they are not commercially exploited. The production ex-situ of seahorses is a potential tool for the recovery of wild populations and also a way to fulfil aquarium trade needs. Seahorse aquaculture has been strongly dependent on wild populations supply (Tlustý, 2002), particularly on pregnant wild-caught males as a source of viable fry to successfully close the life-cycle of the species (Wilson and Vincent, 2000; Hora and Joyeux, 2009; Murugan et al., 2009). The European Fish and Aquatic Invertebrate Taxon Advisory Group (FAITAG) initiated Aquatic Sustainability Programmes (ASPs) and prioritized the successfully and repeatedly closure of the life cycle of the two European seahorse species to ensure the welfare of wild populations (Koldewey, 2005). Currently, difficulties remain for successful closing the life cycle in many seahorse species due to the lack of information on husbandry requirements and management practices (Koldewey and Martin-Smith, 2010; Olivotto et al., 2011).

Efforts have been made by Proyecto Hippocampus in last years to develop a viable rearing technique for *H. guttulatus*. Until recently, high mortalities were achieved due to the high proportion of juveniles showing swim bladder hyperinflation. However, improvements in several aspects (mainly zoothechnics and feeding) of the rearing technique have significantly enhanced survival and growth rates. As a result, this study reports for the first time the achievement of the life cycle closure in *H. guttulatus* by applying a reliable rearing methodology. Survival rates as high as 90% were reached at day 30 by optimizing temperature level (about 19°C) (Planas et al., 2012) feeding regime (Blanco et al., 2013) in aquarium type (modified pseudoKreisel) (Blanco et al., 2014). Eight F2 batches from eight F1 pairs were raised in captivity until the sub-adult stage. Although the parents of F1 and F2 were fed on the same diet and their average size was similar, average batch size and newborn size/weight were smaller in F2 (178 newborn) than in F1 (486 newborn) batches. The finding was probably due to the first maturity status in F2-newly mature males. Similar findings were also reported in *H. trimaculatus*, in which the batch size was clearly higher in F1 (495 newborn) than in F2 males (65 newborn) (Murugan et al., 2009). F1 and F2 newborn were rather similar in size (15.8 ± 0.9 and 14.9 ± 1.1 mm, respectively) and weight (6.4 ± 1.0 and 5.5 ± 1.2 mg, respectively). Mean survivals at day 30 after male's pouch release in F1 batches were higher than in F2 batches (51 ± 25 and 25 ± 15 %, respectively), probably due to the use of different diets in the enrichment of *Artemia nauplii* since differential mortalities occurred after the start of feeding on *Artemia metanauplii* at day 11. Mortalities occurred in F1 juveniles from days 40-50 could be related with suboptimal nutritional status but, more feasible, to pathogens (Ofelio et al., 2013). In spite of that constrain, a large number of F2 survivors reached the adult stage. First sexual differentiation in F1 males occurred at the age of 4 months (8.7 mm; 1.4 g) whereas first maturation age in both males (first batch size = 140 newborn) and females (first clutch release = 465 eggs) occurred at 8 months.

Closing the life cycle in *H. guttulatus* opens the door to the introduction of *H. guttulatus* into the aquarium trade and, more importantly, will allow the production of the necessary individuals to ensure future plans for the recovery of wild populations (reinforcement or repopulation) under adequate management

of breeders in order to preserve genetic diversity and avoid inbreeding in conservation breeding programs.

References

- Blanco, A., Planas, M., 2014. Improvements in the rearing of the seahorse *Hippocampus guttulatus* Cuvier 1829 by the use of copepods. IV Congreso de Ciencias del Mar. 11-13 Junio 2014, Las Palmas de Gran Canaria, Spain
- Blanco, A., Planas, M., Moyano, F.J., 2013. Digestive enzyme activities of juvenile seahorses *Hippocampus guttulatus* fed on different live prey, Aquaculture Europe 9-12 August 2013, Trondheim, Norway.
- Koldewey, H., 2005. Syngnathid Husbandry in Public Aquariums: 2005 Manual, with chapters contributed by members of the Syngnathidae Discussion Group. Project Seahorse and Zoological Society of London, London, UK.
- Koldewey, H.J., Martin-Smith, K.M., 2010. A global review of seahorse aquaculture. *Aquaculture*. 302, 131-152.
- Murugan, A., Dhanya, S., Sreepada, R., Rajagopal, S., Balasubramanian, T., 2009. Breeding and mass-scale rearing of three spotted seahorse, *Hippocampus trimaculatus* Leach under captive conditions. *Aquaculture*. 290, 87-96.
- Ofelio, C., Blanco, A., Roura, Á., Pintado, J., Pascual, S., Planas, M., 2013. Isolation and molecular identification of the scuticociliate *Porpostoma notata* Moebius, 1888 from moribund reared *Hippocampus hippocampus* (L.) seahorses, by amplification of the SSU rRNA gene sequences. *Journal of Fish Diseases*.
- Olivotto, I., Avella, M.A., Sampaolesi, G., Piccinetti, C.C., Navarro Ruiz, P., Carnevali, O., 2008. Breeding and rearing the longsnout seahorse *Hippocampus reidi*: Rearing and feeding studies. *Aquaculture*. 283, 92-96.
- Planas, M., Blanco, A., Chamorro, A., Valladares, S., Pintado, J., 2012. Temperature-induced changes of growth and survival in the early development of the seahorse *Hippocampus guttulatus*. *Journal of Experimental Marine Biology and Ecology*. 438, 154-162.
- Tlusty, M., 2002. The benefits and risks of aquacultural production for the aquarium trade. *Aquaculture*. 205, 203-219.
- Wilson, M., Vincent, A.J., 2000. Preliminary success in closing the life cycle of exploited seahorse species, *Hippocampus* spp., in captivity. *Aquarium Sciences and Conservation*. 2, 179-196.

Geological Oceanography

Megalandslides on the Atlantic islands of Fogo (Cape Verde) and El Hierro (Canary Islands): a review.

Alejandro Lomoschitz¹, Inés Galindo²

¹*Departamento de Ingeniería Civil. Escuela de Ingenierías Industriales y Civiles. Universidad de Las Palmas de Gran Canaria*

²*Instituto Geológico y Minero de España. Unidad de Canarias. Las Palmas de Gran Canaria*

Abstract

In recent times, a number of large landslides have been recognized on the volcanic Atlantic islands of Cape Verde and the Canary archipelago. They have such a wide variety of morphologies and deposits that only once they have been studied in depth we have known the different types of movements which probably occurred on these islands.

Apparently, all these landslides show simple morphologies at first sight, above all on their head area, where large horse-shoe shaped escarpments are common. However, from detailed studies of different authors we have known that both the morphologies (emerged and submarine) and the internal structures of these landslide deposits are complex, and many times are the result of composite movements. Consequently, all these landslides are difficult to interpret.

The aim of this review is to progress in addressing this problem, and for this purpose two outstanding cases of Atlantic islands with megalandslides have been chosen: Fogo (Cabo Verde) and El Hierro (Canary Islands). We carry out do an update of current knowledge from the available scientific literature and we focus our review on three topics: (a) general and interest aspects; (b) morphological and geological characteristics; (c) similarities and differences between these two islands.

Both islands have good examples of large flank landslides, which deposits are 50-200 km³ in volume, occurred within the Pleistocene epoch and they represent the latest lateral collapses of this magnitude in the Atlantic Ocean.

Besides, the two areas have other characteristics in common: they are within an intraplate region (NW African plate), they are composed of basaltic shield volcanic edifices, they were built from a seabed more than 3,000 m deep and they have large circular shaped depressions on their emerged areas, corresponding to the upper slide scars.

On the other hand, the main differences between these two islands are: on one side, Fogo is circular in shape and is larger in extension (476 km²) and in height (2,829 m), it has 1-2 landslides moved eastward and its geological structure corresponds to a stratovolcano. On the other side, El Hierro is triangular in shape and is shorter in extension (278 km²) and in height (1,501 m), it has 4-5 landslides radially distributed and its geological structure has three volcanic-rifts at a 120° angle.

On the whole, the geological structure and the distribution of eruptive vents (central vs. radial) are the main different features between these islands. They were the conditioning factors for creating different types of volcanic building (more homogeneous and stable in the case of Fogo) and also so different lateral collapses, in number and spatial distribution.

Summing up, two main conclusions are obtained: (1) Fogo and El Hierro islands have many characteristics in common: geotectonic context, size, geological age and large flank landslides; and (2) the main different aspects are: general morphology, height, geological structure, and the number of landslides. Finally, it has been found that geological structure is the predominant characteristic, because once it is well known is possible to explain the different evolution of these islands and, in other words, their building processes, landslides generation and, as a result, the current morphology.

Keywords: volcanic island, landslide, geomorphology, stratovolcano, volcanic-rift.

Characteristics of the shelf at Gran Canaria island, with evidences of tectonic, volcanic and sedimentary features.

Echevarrieta-Legrand, L.¹, Masdeu-Navarro, M.¹, Sánchez-García, M.J.², Alonso, I.², Castro-Rodríguez, M.A.¹, Hernández-Acosta, C.N.¹, Melián-Ramírez, A.¹, Santiago-Villalba, J.¹, Santos-Bethencourt, R.¹, Suárez-González, E.¹, Montoya-Montes, I.³

¹Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas (Spain)

²Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas (Spain)

³Instituto Oceanográfico da Universidade de São Paulo, 05508-120 São Paulo (Brasil)

Abstract

Gran Canaria is one of the central islands of the Canary archipelago. It has a diameter of about 45 km and it is located at 28°N and 15°35'W. The subaerial part of the island has been formed within the last 15 My (McDougall and Schmincke, 1976) during three major magmatic/volcanic phases. The first one began during the Miocene (14 My), the second one during the Pliocene (4 My) and the third one occurred during the Quaternary, centered this one in the Northern part of the island (Ye et al., 1999).

Due to its young age, it has to be expected that the island shelf will not be much developed (Criado et al., 2002). For this reason, the northern part of the island, principally formed by Quaternary eruptions, has practically an inexistent shelf. The continental margin of Gran Canaria is mainly formed from turbidity currents and hemipelagic deposits, but avalanche flows and volcanic material can also be found (Acosta et al., 2005).

In order to characterize the shelf of Gran Canaria, a digital elevation model (DEM) has been generated. Bathymetric data proceed from two different sources: the bathymetry from 0 to 50 m with isolines each 1 meter from the "Estudio Ecocartográfico de Gran Canaria" (MMA, 2002a, 2002b), while bathymetric contours from 100 to 600m were digitalized from "Repositorio de Datos Marinos Integrados de Canarias (REDMIC)" (www.redmic.es). The DEM of the shelf was performed with ArcGis 10.1 software. Three different information layers were constructed: the shaded relief, the gradient (slope) and the last layer with the isobaths.

Based on the resulting layers, the limit of the island shelf was established from the change in the slope, so that the areas with the slope lower than 4% were considered part of the shelf, while steeper slopes were considered out of the shelf. This limit is very reasonable considering the volcanic origin of this island. Once the outer limit was fitted, the shelf was divided in two main areas according to its width. These areas are separated by two very significant geographical elements: Punta de Sardina in the NW and Punta de Gando in the E. The shelf between these two points through the N-NE has a coastal length of 82.7 km and its width is extremely narrow (2650 m). On the other hand, the island shelf through the W-S-SE has a coastline of 126.1 km and the average width is much higher (7800 m). Such difference between both areas is related to the isostatic uplift generated by the island of Tenerife 3.5-3.8 My ago (Menéndez et al., 2008).

These two main areas can be subdivided according to platform singularities. The N-NE shelf can be subdivided in two areas of very similar length. Firstly, a northern region, where shelf reaches 100 m depth and the average width is 2740 m. Along this area different volcanic structures can be identified, such as submarine volcanic cones and lava flows. The second subsector ranges between La Isleta and Punta de Gando, and it is characterized by an average shelf width of 2560 m and the outer limit goes down to a medium depth of 90 m. The slope is quite constant from the coast to the shelf limit.

Regarding the W-S-SE shelf, it can be also subdivided in three main sectors. The SE sector, from Gando Point to Maspalomas lighthouse (44.4 km coastline), where the shelf is much wider than the previous

zones. It has a regular slope with a medium width of 6450 m and a standard depth of 100 m. The Southern sector is the smaller one, since it only covers 15.7 km of coastline, from Maspalomas lighthouse to Anfi resort. It is characterized by Pasito Blanco sandbank, whose average depth is about 20 m. This sector is clearly related to sedimentary deposition processes. Finally, the Western sector covers all the westward limit of the island along 66 km coastline. The average width is 8300 m and the depth reaches 150 m.

To conclude, the analysis of the shelf characteristics and morphology reflects tectonic, volcanic and sedimentary features, which are of great importance to better understand the geological history of the island.

References

- Acosta, J., Uchupi, E., Muñoz, A., Herranz, P., Palomo, C., Ballesteros, M. 2005. Geologic evolution of the Canarian Islands of Lanzarote, Fuerteventura, Gran Canaria and La Gomera and comparison of landslides at these islands with those at Tenerife, La Palma and El Hierro. *Marine Geophysical Research*, 24, 1-40.
- Criado, C., González, R., Yanes, A. 2002. Rasgos sedimentológicos de los fondos marinos de Maspalomas (Gran Canaria). *Vegueta*, 6, 191-200.
- McDougall, I., Schmincke, H.U. 1976. Geochronology of Gran Canaria, Canary Islands: Age of shield building volcanism and other magmatic phases. *Bulletin of Volcanology*, 40, 57-77.
- Menéndez I., Silva P.G., Martín Betancour M., Pérez Torrado F.J., Guillou H. and Scaillet S. (2008). Fluvial dissection, isostatic uplift, and geomorphological evolution of volcanic islands (Gran Canaria, Canary Islands, Spain). *Geomorphology*, 102, 189-203.
- Ministerio de Medio Ambiente 2002a. Estudio ecocartográfico de la zona sur del litoral de Gran Canaria. Madrid, Secretaría de Estado de Aguas y Costas, Dirección General de Costas.
- Ministerio de Medio Ambiente 2002b. Estudio ecocartográfico de la zona norte del litoral de Gran Canaria. Madrid, Secretaría de Estado de Aguas y Costas, Dirección General de Costas.
- Ye, S., Canales, J.P., Rihm, R., Danobeitia, J.J., Gallart, J. 1999. A crustal transect through the northern and northeastern part of the volcanic edifice of Gran Canaria, Canary Islands. *Geodynamics*, 28, 3-26.

Volcanism and ferromanganese deposits on seamounts and new volcanoes from the Canary Archipelago

F. J. González¹, L. Somoza¹, T. Medialdea¹, R. León¹, J.T. Vázquez², E. Marino¹, E. Bellido¹, J. Reyes¹ and the DRAGO and SUBVENT Scientific Parties

¹*Marine Geology Dv/ Geological Survey of Spain (IGME). C/ Ríos Rosas, 23 28003-Madrid (Spain)*

²*Centro Oceanográfico de Málaga/ Instituto Español de Oceanografía (IEO). 29640-Málaga (Spain)*

Abstract

New data and discoveries of marine Co-rich ferromanganese deposits from the Canary Islands recovered during the DRAGO 2011, SUBVENT 2013 and SUBVENT 2014 cruises are reported. These mineral deposits coat seamounts and submarine volcanoes from the southwest of the Canary Archipelago (Lat. 23°-27°N). The volcanic rocks are largely covered with ferromanganese crusts forming pavements up to 20 cm thick on six seamounts (Las Hijas, Bimbache, Echo, The Paps, Drago and Tropic) at 500 to 2500 m water depths. The rock outcrops are formed by submarine alkaline volcanic rocks with similar petrology and chemistry to the subaerial volcanism from the Canary Islands. The ferromanganese crusts have a botryoidal surface texture and colloform, laminar, and massive internal structures formed by vernadite, asbolane, todorokite, busserite and goethite. The average chemical composition shows a predominance of Mn (14.3 wt%) and Fe (20.82 wt%) with considerable amounts of Ti (0.86 wt%), Co (0.42 wt%), Ni (0.25 wt%), REEs (0.3 wt%) and V (0.21 wt%). The contents of other strategic metals (e.g., Tl, Mo, Te or Platinum group elements) are important. The geochemical characteristics indicate a hydrogenetic origin or mixed hydrogenetic and hydrothermal origin for some samples.

In the south of El Hierro Island (La Restinga) we have studied submarine ROV images, rocks and mineralizations recovered at the underwater lavas erupted in 2011-2012 from the new volcano. Several metric chimneys have been discovered at the top of the volcanic cone. These chimneys, with columnar to conical morphology, show lateral and terminal degasification open pits. Chimneys are formed by basanites and they are densely covered by thin gel-like iron oxy-hydroxide films. The ferruginous films, orange in color, coat surrounding lavas around the chimneys. These films could be the result of mineral precipitation, with possible mediation of iron-oxidizing bacteria, from the low-temperature hydrothermal vent activity in the chimneys during the last phases of the submarine volcanic eruption. Reduced iron and other metals like manganese are coming out in the vent fluids, being oxidized by bacteria and forming biofilms or bacterial mats that rapidly cover the chimneys and lavas.

This work has been funded by SUBVENT (CGL2012-39524-C02-02) and EMODNET-Geology (2012/S 96 -158476) projects.

Provenance analysis of sediments and sedimentary rocks at coastal outcrops of Corralejo Natural Park (NE Fuerteventura Island)**García Sanjosé, Patricia, Mangas, José, Pérez-Chacón, Emma, Hernández-Calvento, Luis, Menéndez, Inmaculada***Instituto de Oceanografía y Cambio Global (IOCAG). Universidad de Las Palmas de Gran Canaria, Las Palmas, Spain***Abstract**

The textural, mineralogical and petrological analysis of sediments and sedimentary rocks that outcrop in littoral areas of the Corralejo Natural Park (NE of Fuerteventura Island), allow recognize better the provenance of clastic components, the sedimentary environment where they were formed and their evolution over geologic time.

Therefore the aim of this research is to know the nature and relative abundance of the different components (bioclasts, lithoclasts and cements) forming sediments and sedimentary rocks. Thus, 18 samples of sands from the intertidal and supratidal zones of different beach-dune systems have been collected and also 38 samples of sedimentary rocks from different outcrops that appear in the coastal strip of this park. These rocks presents between them certain differences in the degree of cementation, in the sedimentary structures and the textural characteristics and they correspond to calcarenite strata of beachrocks, paleobars and eolianites, silty sandstone of paleosols and marine fossiliferous conglomerates of the Upper Pleistocene and Holocene in age.

Several analytical techniques were carried out in coastal sediments, such as petrography, dry sieving and calcimetry, to determine the textural characteristics, carbonate content, and the nature and relative abundance of bioclastic and lithoclast components. Otherwise, it has been made geochemical analyses of sedimentary rocks cements using EMPA (Electron Microprobe Analyzer), and it has been defined their crystal morphology with SEM (Scanning Electron Microscope). This enables to determine the cement composition, the morphology of cysts and its cementation environments.

The results of granulometric parameters obtained in the 18 sand samples, shown homogeneities in the average grain size and sorting between intertidal and supratidal zones. Even so, the grain size in the supratidal zone (aeolian sands) is classified like medium sands (0.25 and 0.5 mm) and show better sorting values (between 0.5 and 1). This is due to the wind action as transport and sedimentation agent, being more selective than wave's action, tides and currents. The calcimetry analysis confirms a high carbonate content >80% (usually the obtained data are higher than 90%), evidencing the biogenic sand composition with scarce of lithic fragments provided by a terrigenous source area.

The petrographic analysis of sediments, with the object of identifying microscopically the nature of the grains and its relative abundance counting points, shows that the sands contain bioclasts and lithoclasts. The bioclasts are mainly fragments of red seaweed meshes and mollusks and, in a minor proportion, foraminifers, equinoderms and bryozoos. The lithoclasts are essentially constituted by fragments of mafic volcanic rocks (basalts) and sedimentary rocks (intraclasts) and, in a minor proportion, fragments of mafic minerals (olivines, augites and Fe-Ti oxides) and glasses, and felsic minerals (feldspars). Also, the sediments have shown a great homogeneity of grain nature, in the two sub-environments, intertidal and supratidal. In relation to sedimentary rocks, petrographic results confirm similarity to marine sands but with a greater abundance of sedimentary intraclasts in the northernmost stretch coast of the park, which indicate the erosion of coastal calcarenite substrate. On the other hand, the low abundance of lithoclasts, both in sediments and sedimentary rocks, marks that erosion and transport agents have not acted significantly on the various volcanic rocks outcrops (middle Pleistocene basaltic lava flows, with

porphyritic and aphyric textures, and containing olivine and clinopyroxene phenocrysts) and that appear discontinuously along the actual coastline. Also, it is rare the detrital grain inputs associated to incipient gullies that cross the Natural Park from west to east, eroding the underlying volcanic and sedimentary substrate.

Considering the geochemical and mineralogical studies of sedimentary rock cements, these indicate a high-magnesium calcite cementation (HMC) with MgCO_3 values of $> 5\%$ (data vary from 8.1 to 18.5%) and Sr contents between 1,186 and 1,563 ppm, demonstrating that these carbonate cements have been produced in a marine environment. Regarding to cements morphology, it has been observed isopach microsparite and sparite crystals (bladed) around the grains, filling intragranular fossils cavities of gastropods, foraminifera and bryozoans, and intergranular voids, pointing phreatic marine conditions. Moreover, the existence of mainly bioclastic calcarenite layers (grainstones and biosparites well sorted and with textural maturity) and, to a lesser extent, of calcirudites with rounded pebble of basalt and calcarenite groundmass, indicate shallow coastal sedimentation environments (beach and bars) with high energy. In addition, there are backshore sedimentation environments with calcarenites containing dunes planar cross lamination and browned paleosols levels characterized by silty sandstones with terrestrial molluscs and rizoliths. These sedimentary paleoenvironments are very similar to sedimentary coastal environments that appear today in the Natural Park of Corralejo.

Acknowledgements: This research received financial support from the Spanish governments through the projects CSO2010–18150 and SEJ2007-64959/GEOG, and the economic funding received from the SGA (Servicio de Geología Aplicada of the Fundación Universitaria de Las Palmas, FULP) and IOCAG (Instituto de Oceanografía y Cambio Global) of the University of Las Palmas de Gran Canaria.

The reconstruction of the geomorphologic evolution for the coast and inner shelf of the Gulf of Valencia during the Quaternary

S. Albarracín¹, J. Alcántara-Carrió¹, A. Fontán¹, I. Montoya², J. Rey³

¹IMEDMAR, Catholic University of Valencia

²Universidade de Sao Paulo

³ESGEMAR

Abstract

A reconstruction of the Quaternary geomorphological evolution of the continental shelf of the Gulf of Valencia has been carried out by analyses of the detailed bathymetry obtained with multibeam echosounder data, high-resolution seismic profiles, sediment and rock samples, the analysis of the dominant oceanographic and climatic conditions, and through the spatial analysis of all the geographic information. The construction of a model for the geomorphological evolution and a curve for regional average sea levels oscillations in the Gulf of Valencia in the Quaternary is determined by the spatial dimension (vertical position) of the depositional sequences. The magnitude of the eustatic oscillations determine the depth and formation ages of the deposits within the oscillation curve. The identification of the outer limits and the discontinuities in depositional seismic facies, allows us to distinguish between intersecting and non-intersecting surfaces (identification of eroded surfaces that are regionally distributed) and seismic units, by grouping them according to sedimentary systems tracts (HST, FRW, LST, TST) based on the stacking of geological strata.

Tectonic activity and above all, subsidence mechanisms that have been present during the evolution of the basin, have been significant factors in the geomorphologic evolution of the shelf, in such a way that a system of distension faults sub-parallel to the coast have determined the overall morphology of the coast. The movements and tilting of blocks during the Quaternary have in many cases altered the spatial distributions and thicknesses of depositional sequences. Hence, the presence of Pleistocene deposits of varying ages indicates the existence of differential movements in the deposition units throughout most of the shelf. Sea level oscillations have led to continuous and alternating changes in the geomorphology of coastal area and continental shelf in the Gulf of Valencia over the last 200,000 years.

At MIS 7 the sea level was comparable to present. However, due to the considerable subsidence of the Gulf of Valencia, the oldest identified barrier-lagoon deposit systems (sedimentary systems tracts) were found buried and have resulted in coastal deposit formations. At a later stage, during the regression of the MIS 6, the barrier-lagoon deposit systems became cemented as they were exposed. The transgressive erosional surface identified above these deposits is considered as formed by a rapid initial rising before MIS 5. These elements make up a significant area of paleo-relief, upon which sediment deposition during the Holocene has taken place. The surfaces FRW2 and FRW1 and the regressive depositional units in downlap were formed at a later period than the formation of the sand barrier systems, given that the oldest barrier dates from 120,000 years ago in a stable period of high sea levels that did not give rise to surfaces with coarse depositions, because of its deep shelf location. The relative sea level position during the time these deposits took place is situated at the intermediate period before the transgressive Flandrien rising. Therefore it corresponds to different fluctuations in the descending phase before the last regressive stabilization of the sea level in MIS 2 during the Last Glacial Maximum.

In the Holocene transgression during the last warm isotopic stage (isotopic stage 1) occurred the landward migration that destroyed the majority of morphologies formed during the last regressive Pleistocene stage, forming T1 and T2 transgressive to correspond baseline for the Holocene rising in the Gulf of Valencia. However, Holocene transgression did not take place continuously as there were pauses in the

rising process related to climatic-eustatic changes as occurred in the last neoglacial period of Younger Dryas. During that period the sea-level stabilized (stillstand) favouring the formation of sand waves.

Morphodynamic study of an artificial inlet in Langue de Barbarie (Senegal) from 2003 to 2014 using Landsat images

S. Rodríguez¹, I. Alonso¹, M.J. Sánchez¹, M. Casamayor¹, L. García-Weil², B.A. Sy³, A.A. Sy³, C.A.T. Faye³

¹*Instituto de Oceanografía y Cambio Global (IOCG). Las Palmas de Gran Canaria, Spain*

²*Departamento de Física. Universidad de Las Palmas de Gran Canaria, Spain*

³*Laboratorio Leïdi. Université Gaston Berger de Saint-Louis, Senegal*

Abstract

The Senegal River is the second largest river in West Africa. It has a length of 1800 km and a watershed of 337000 km². Born in Mali resulting from the confluence of two rivers (the Bafing River and the Bakoye River), it crosses through Guinea and finally along the border between Mauritania and Senegal, before flowing into the Atlantic Ocean.

All along this coast the prevailing NW swell generates a southward longshore drift that has contributed to the formation of a sandy spit with an average width of 300 m, which runs parallel to the coast along more than 45 km, starting in South Mauritania and ending in North Senegal.

This spit covers an area of approximately 15 km² and it is characterized by low topography vegetated dunes, around 5 m in the higher areas. The soil is infertile and consists on medium and fine quartz sands. The vegetation is Sahelian, characterized by *Ipomoea pes-caprae*, *Sea Alternanthera*, *Sporobolus spicatus* and *Sesuvium portulacastrum*. In 1976 the southern part of this sand barrier was declared as Langue de Barbarie National Park by ecological reasons. The weather is marked by two distinct seasons: The wet season takes place from July to October, and the dry season the rest of year. This is reflected in the river discharge, so that during the wet season average discharge is 1500-2000 m³/s, while during the dry season it is around 200 m³/s. In 1986 the Diama dam was built, which changed the hydrological conditions in the river mouth.

In October 2003 heavy rains originated the flood in the estuary of the Senegal River, endangering the surrounding population and the city of Saint Louis (Capital of Senegal from 1872 to 1957 and World Heritage Site by UNESCO). Due to this situation the authorities decided to open a channel through the spit to facilitate river discharge. The channel dimensions was 4 m wide, 200 m long and 1.5 m deep, and it was located approximately 7 km south of Saint Louis.

The pressure of the river water flowing at very high speed originated the quick channel widening, so that two days after opening it was 80 m wide and three weeks later it was about 330 m. Since then the morphodynamic change in this area has been very fast. Few months after the opening, the artificial channel evolved to form the new river mouth, and the ancient embouchure was naturally closed due to the weakness of river flow and the strong longshore drift.

Nowadays the inner zones of the lagoon that are opposite the new mouth are completely exposed to wave action, and therefore they are suffering very strong coastal retreat. This strong erosion has forced people to leave their properties, as in the case of Doun Baba Dièye, where the whole village has completely disappeared and people were forced to move inland (Sy., 2010).

This paper aims to assess how it has been the evolution of this highly dynamic system since the situation previous to the new opening to nowadays. To cope with this task a small area 12 km long was selected, covering the whole new mouth and adjacent areas. 17 Landsat images with a spatial resolution of 30 m were used, covering most of the study period. These images were treated with ArcGis 9.3.

Since the opening of the drainage channel, the spit was divided into two fragments, located north and south relative to the new mouth, which have evolved in different ways. To quantify the changes three

parameters were measured: shoreline length and area in each of the two spit sectors, and amplitude of the river mouth. The first image analyzed corresponds to April 5, 2003 previous to the channel, so there is a single polygon with 4050000 m² area and perimeter of 26.4 km.

During the early days from the channel formation, as mentioned above, the change in the gap was very fast, reaching 330 m in three weeks. In November 15, 2006 the river mouth was about 1750 m wide and the loss of total area was 760000 m² (19% of the initial area). In February 2014 the area loss is 1310000 m², approximately 33% less than the initial study area, since the opening has reached 5250 m length.

Nevertheless changes at both sides of the gap shows opposite pattern. The southern coast suffers constant erosion on its outer face, due to the waves attack and longshore drift. Therefore the spit becomes narrow and overwash processes may take place, with the subsequent spit fracture and temporal formation of small islands that finally disappear. Coastal retreat is approximately 7 km from the opening and the average erosion rate is 580 m²/day.

On the contrary, the northern coast shows a net progradation due to the sedimentation of particles pulled by littoral drift due to the hydraulic barrier produced by the river flow on its way out to the ocean. This effect produces sand accumulation upstream of the gap in the form of sandy hooks. Average accretion is 290 m²/day, due to a net southward displacement of the river mouth by 1750 m.

To summarize, the Senegal River mouth migrates southward as a result of the slow progradation north of the gap and the rapid erosion at the south.

References

Sy, B. A., 2010, L'histoire morphodynamique de Doun Baba Dièye du Sénégal. Revue Perspectives & Sociétés, N°1, ISSN: 1840 - 6130

Sala Gran Canaria

Geological Oceanography

Geomorphology of the giant submarine landslides and salt diapirs that appear in the seabed around Fuerteventura and Lanzarote Islands (Canary Islands)

Daniel Cuñarro¹, José Mangas¹, Juan Acosta², Jesús Rivera², Levi García¹

¹*Instituto de Oceanografía y Cambio Global (IOCAG). Universidad de Las Palmas de Gran Canaria. 35017 Las Palmas de Gran Canaria, Spain*

²*Instituto Español de Oceanografía, Corazón de María 8, Madrid, 28002, Spain*

Abstract

In this study we are describing the seabed around the Canary Islands of Fuerteventura and Lanzarote, using multibeam echosounder data taken mainly during four oceanographic surveys made by the Spanish Institute of Oceanography (IEO, Instituto Español de Oceanografía) and the Hydrographic Institute of the Navy (IHM, Instituto Hidrográfico de la Marina) between 1998 and 2011, using R/V Hespérides and R/V Vizconde de Eza.

We are focusing on the study of the geomorphology of the giant submarine landslides that are found on the west side of these islands and the (salt) diapirs that appear in the J.M. Fuster Casas sedimentary trough (between Africa and Fuerteventura-Lanzarote Islands).

On one hand, submarine landslides are relatively frequent events in volcanic oceanic islands associated with mantle plumes such as the Canary Islands (Watts and Masson, 1995; Masson et al., 2002; Acosta et al., 2003a, etc.), Cape Verde, Reunion and Hawaii, being Hawaii Islands the first place where they were studied (Lipman et al., 1988; Moore et al., 1989). Landslides play an important role in the evolution and destruction of oceanic intraplate volcanic islands. They start as subaerial or submarine instabilities that displace a huge amount of igneous rocks, sedimentary rocks and sediments, which are deposited in the submarine island slopes and/or the abyssal plains.

Two main landslides have been recognized in the western submarine slope of Fuerteventura Island: 'Puerto del Rosario' and 'Southern Puerto del Rosario'. The first one, with an estimated surface of 3700 km², is one of the largest landslides that has been found in the Canary Islands and has kilometeric blocks in diameter and hundreds of meters in height. We also delimit several kilometeric channels with hundreds of meters of slope. Paleodebris avalanches generate these sedimentary deposits.

In addition, a slump is located to the west of Lanzarote. In this surface, up to 11 volcanic cones have been measured and identified. They are probably related to recent volcanism during the 18th and 19th century in Lanzarote (Acosta et al., 2003a).

On the other hand, at least 13 mounds and salt diapir mounds were found in the east off the islands of Fuerteventura and Lanzarote. The salt diapir mounds are related to evaporite deposits formed in the Proto-Atlantic Ocean during the Late Triassic age (Acosta et al., 2003b; Uchupi et al., 1976). Some of these evaporitic deposits reached the seabed by plastic flow, forming the salt domes observed in swath bathymetry images. These salt intrusions affect to the entire stratigraphic column.

The studied diapirs range from 57 to 357 meters in height, from 5 to 63 km² in surface area and from 0.15 to 16 km³ in volume (Table 1). They show a NE-SW orientation and are located within a range of 1200 m depth.

References

Acosta, J., E. Uchupi, A. Muñoz, P. Herranz, C. Palomo, M. Ballesteros, A. Carbó, A. Muñoz-Martín, J. Martín-Dávila, M. Catalán, J. A.

Table 0.1: Table 1. DM=Diapir Mound. M=Mound

Name	Surface (km ²)	Height (m)	Volume (km ³)
DM01	8,71	95,72	0,55
DM02	12,13	98,97	1,09
DM03	12,37	177,53	0,87
DM04	43,97	156,17	5,21
DM05	20,56	189,91	2,21
DM06	42,77	189,45	5,59
DM07	21,05	57,67	1,67
DM08	24,09	120,32	2,22
DM09	6,60	86,20	0,26
DM10	4,28	81,15	0,15
M01	46,46	339,37	7,62
M02	35,64	304,72	9,22
M03	63,04	356,99	16,52

Marín, F. Pérez-Carrillo, and C. Maté (2003a), Geologic evolution of the Canarian Islands of Lanzarote, Fuerteventura, Gran Canaria and La Gomera and comparison of landslides at these islands with those at Tenerife, La Palma and El Hierro, *Mar. Geophys. Res.*, 24(1-2), 1-40.

Acosta, J., E. Uchupi, A. Muñoz, P. Herranz, C. Palomo, M. Ballesteros, A. Carbó, A. Muñoz-Martín, J. Martín-Dávila, M. Catalán, J. A. Marín, F. Pérez-Carrillo, and C. Maté (2003b), Salt diapirs, salt brine seeps, pockmarks and surficial sediment creep and slides in the Canary Channel off NW Africa, *Mar. Geophys. Res.*, 24(1-2), 41-57.

Lipman, P. W., W. R. Normark, J. G. Moore, J. B. Wilson, and C. E. Gutmacher (1988), The giant submarine alika debris slide, Mauna Loa, Hawaii. *Journal of Geophysical Research*, 93(B5), 4279-4299.

Masson, D. G., A. B. Watts, M. J. R. Gee, R. Urgeles, N. C. Mitchell, T. P. Le Bas, and M. Canals (2002), Slope failures on the flanks of the western Canary Islands, *Earth-Sci. Rev.*, 57(1-2), 1-35.

Moore, J. G., D. A. Clague, R. T. Holcomb, P. W. Lipman, W. R. Normark, and M. E. Torresan (1989), Prodigious submarine landslides on the Hawaiian Ridge, *Journal of Geophysical Research*, 94(B12), 17,465-17,484.

Uchupi, E., Emery, K.O., Bowin, C.O. and Phillips, J.D. (1976), Continental margin off western Africa: Senegal to Portugal, *Am. Assoc. Pet. Geol. Bull.*, 60, 809-878.

Watts, A. B. and D. G. Masson (1995), A giant landslide on the north flank of Tenerife, Canary Islands, *Journal of Geophysical Research*, 100(B12), 24,487-24,498.

A diagnostic tool for detecting pollution in coastal sediment cores: the Itrax™ Core Scanner**B. Rubio, D. Rey, I. Rodríguez-Germade, P. Álvarez-Iglesias, and A. M. Bernabeu***Research group GEOMA. Departamento de Geociencias Marinas y Ordenación del Territorio, Universidad de Vigo, Vigo (Spain). * brubio@uvigo.es***Abstract**

Traditional techniques for the study of chemical composition of sediment cores, are, among others, X-ray fluorescence (XRF) and inductively coupled spectrometry (ICP) applied on discrete samples. The development of non-destructive continuous analysis as XRF scanners such as the Itrax™ core scanner, which allows analyzing humid core-sections with submillimetric resolution, are a great advance in the study of sediments and rocks. These instruments are able to detect the majority of the elements from Al to U, in low concentration, depending on the acquisition conditions.

Most of the studies with these scanners have been focused on palaeoceanographic an/or palaeoclimatic reconstructions from sedimentary records. They provide a general overview of element distribution and variability, driving sample selection into areas of interest where subsequent full quantitative and destructive, analyses will take place. The assumed semi-quantitative nature of these analyses have however hampered the use of this type of instruments to monitor and detect pollution at large; where the availability of a fast diagnostic tool that could substantially reduce analytical time and costs would certainly be a great advantage.

We have explored the sensitivity of the ITRAX™ core scanner from the University of Vigo on highly organic -but not very heavily polluted- sediment records from estuarine-like environments in NW Spain, under several acquisition conditions. Our results show that the ITRAX™ was able to detect Hg concentrations lower than $0.6 \mu\text{g g}^{-1}$ and Cd concentrations around $1 \mu\text{g g}^{-1}$. These values were confirmed by total digestion and subsequent analysis by ICP-OES, CV-AAS and by conventional XRF on pressed pellets. The results show good relationships for most of the trace elements (Zn, Pb, Cu, etc.). Pollution by these elements was restricted to the upper 10-15 cm, corresponding approximately to the last 30-50 yr based on ^{210}Pb and ^{137}Cs profiles obtained by gamma spectrometry. Only Pb and Hg showed concentrations above sediment quality guidelines that could be associated with adverse effects. ITRAX detection levels were proposed for each metal after comparison with alternative quantitative techniques analysed on discrete samples. Different sequential extraction protocols (BCR and NWR) were also applied on those selected samples in order to study bioavailability of these elements. The results confirm the predominance of oxides and residual fractions for Pb and the oxidizable forms (organic-matter and sulphides) for Hg. We have also evaluated the suitability of inc/coh and Br/Cl ratios to assess the influence of organic matter variability on the distribution of metals. Good correlations were observed between the fraction associated to organic matter and the inc/coh ratio for most of the analysed elements.

Our study shows the potential of modern XRF core-scanners such as the ITRAX™ to perform fast high-resolution and relatively inexpensive measurements to screen and identify pollution in coastal environments not heavily affected. Pollution levels can be estimated in a few hours from elements' peak areas avoiding discrete analysis of the whole core. Organic matter-rich levels associated to higher concentration of toxic metals, can be quickly detected by using the inc/coh ratio in sediments dominated by terrestrial organic matter inputs. However, with a predominance of organic matter from marine sources the Br/Cl ratio provides better results than the inc/coh ratio.

Millennial oceanographic changes during the last glacial cycle recorded in the NE Atlantic core KTA-GC-05.**Francés, G.¹, Mena, A.¹, Caínzos, V.¹, Pérez-Arlucea, M.¹, Nombela, M.A.¹, Alejo, I.¹, Estrada, F.², Diz, P.¹**¹*Departamento de Xeociencias Mariñas e Ordenación do Territorio, Universidade de Vigo, Campus Vigo, 36310, Spain*²*Grupo de Márgenes Continentales ICM-CSIC, Paseo Marítimo de la Barceloneta, 37-49, 08003 Barcelona, Spain***Abstract**

A high-resolution multiproxy study of core KTA-GC-05 (46.18595 N, 18.31385 W; 3939 m below sea level; 337 cm long) has been carried out in order to investigate the effects of millennial and submillennial climatic changes on the Northeast Atlantic oceanography during the last climate cycle. This approach includes physical properties (Multi-sensor Core Logger, MSCL, and Computerized Tomography, CT), lithological, sedimentological and geochemical characterization, and oxygen and carbon stable isotope analyses in monospecific samples of planktonic foraminifera *G. bulloides*.

Integrated information from independent proxies that show common trends along the core enables distinguishing three units. The basal unit (at around 120 cm thick) is mainly composed by nannoplankton and foraminifera oozes with three intercalated intervals characterized by higher amounts of coarse and very coarse terrigenous silt. Oxygen stable isotopes ($\delta^{18}\text{O}$) values and micropaleontological features, as well as other proxies suggest this basal unit was deposited during the Last Interglacial (Marine Isotope Stage 5, MIS 5). Many other proxies, as terrigenous markers (Fe/Ti, K/Ti) but also biogenic input (Ca/Ti, TIC) and grain-size parameters fluctuate according the same pattern. Higher values of these markers and lighter $\delta^{18}\text{O}$ could correspond with warmer substages of MIS 5. These data from warmer substages suggest higher contribution of terrigenous particles due to enhanced Atlantic Meridional Overturning Circulation (AMOC), although the pelagic contribution was dominant. On the contrary, intervals characterized by low values of terrigenous proxies and finer grain sizes in the non-carbonate fractions could corresponds with relatively colder substages and weaker bottom currents.

The second unit (at around 190 cm thick) presents darker colors and a broader variety of facies. CaCO_3 content is lower than that of previous unit and conversely the terrigenous component is much higher. Lithology consists of mud and sandy mud being the sand fractions dominated either by terrigenous or bioclastic grains or a mixed of both types. No doubt exists about this unit was deposited during the Last Glaciation (MIS 2-4). The record of glaciation shows strong signals of high-frequency climatic oscillations, as it occurs in other North Atlantic cores. In particular, the stronger recorded events coincide with the more intense stadials (Heinrich Events, HE). HE are clearly identified in the studied core by numerous proxies: high amounts of ice rafted debris (IRD) and the polar planktonic foraminifera *N. pachyderma* (sin), higher values of density, magnetic susceptibility and terrigenous markers, as well as peaks of Zr/Sr and Ca/Sr ratios. Higher values of planktonic $\delta^{18}\text{O}$ occurred at times of H1, H5 and H6, when also very low percentages of TIC are recorded. A reduced productivity as a consequence of the arrival at this latitude of polar and/or melt surface waters, dilution by increased terrigenous input and calcium carbonate dissolution at deep-sea can explain lower carbonate accumulation. Stopped AMOC during extreme cold events favored the influence of corrosive bottom waters and thus carbonate dissolution. As the previous HE, H3 is characterized also by very low calcium carbonate content, but in this case, other proxies suggest it is due to dilution by enhanced terrigenous input.

The youngest unit (25 cm thick) shows similar features than those from the oldest unit. It is composed by sandy calcareous mud where the sand fraction is dominated by planktonic foraminifera although a

smaller amount of siliciclastic grains is also present. The age of this unit is lower Holocene (MIS 1). An increasing trend of TIC, biogenic and terrigenous markers is detected since the deglaciation but these proxies reach similar values than those from MIS 5 during the lower Holocene, pointing to the recovering of surface productivity and strengthen AMOC.

Acknowledgements: This research was supported by the CATARINA Project (CTM2010-17141/MAR), Spanish MICINN and FEDER 2007-2012.

Medium term behaviour and evolution of a beach cusps system in a mesotidal beach, La Victoria (Cádiz, Spain)**Aranda, M., Puig, M., Plomaritis, T.A., Benavente, J.***Earth Science Department. Faculty of Marine and Environmental Science. University of Cádiz. Puerto Real (Cádiz, Spain)***Abstract**

The present study discusses variations in beach cusps formation over a six month period, October 2013 to March 2014, on a dissipative, mesotidal beach: La Victoria, in Cádiz (SW Spain). Beach cusps are rhythmic patterns usually developed in the swash region (Masselink et al., 1996). There are two theories to explain beach cusp formation: standing edge waves and self-organization (Benavente et al., 2011). The edge-wave theory addresses only the flow patterns preceding beach cusp formation and provides an estimate of the spacing on the grounds of representative wave parameters. The self-organization theory includes swash-induced deposition/erosion and the resulting dynamic interactions. Moreover, the cusp formation theories involve an equilibrium state, which in very dynamic, tidal beaches is difficult to attain. However, despite the extensive literature on beach cusps and the several mechanisms proposed for their formation, from Guza and Inman (1975), through Coco et al. (2004) to Voudoukas (2011), particular conditions under which such features appear and evolve remain uncertain. The main objective of this work is to identify which of both theories is better suited to predict cusps formation in the study area. A numerical investigation of “self-organization” (Werner and Fink, 1993) suggests that the feedback process between currents and sediment response can result in “self-organized” patterns and can be used to predict beach cusp formation. Coco et al. (2004) proposed that during falling tide, beach cusp height increases as embayments erode more than horns and cross-shore extent increases.

Data collection was performed by a coastal video monitoring system, consisting of three video cameras, located on the roof of a building in front of La Victoria beach. The cameras acquire coastal imagery every hour during daylight. Standard lens distortion correction and image geo-rectification techniques were used to obtain and process coastal imagery using a specific software called ORASIS, Coastal Video Monitoring System (Voudoukas, 2011).

Furthermore, topographic data were collected, once a month during the study period, using a Real-Time-Kinematic Differential GPS (RTK-DGPS). These data were subsequently used for measuring height and spacing between cusps. Wave data were obtained from offshore wave buoy belonging to Puertos del Estado (Spanish National Ports Authority). The elevations of the extracted shoreline contours were estimated as a function of offshore wave and tidal measurements. Distinct beach cusp systems were observed at the beach, with their evolution being controlled by: (i) wave forcing; and (ii) tidal modulation of the wave power at different levels of the beach (Voudoukas, 2011).

Results obtained confirm the validity of the edge-wave approach and its capacity to predict beach cusp spacing (Coco et al., 2000), with values in fair agreement with the available field measurements, and most of the input parameters primarily affecting the rate of the process rather than the final spacing. Results also showed persistent cusps along the entire study area, with a consistent pattern of morphological changes to the beach cusp system on account of the variety of wave conditions and tidal ranges experienced. These findings highlight the need for longer-term observations of diverse beach morphologies to formulate a global theory regarding beach cusp formation and evolution (Voudoukas, 2011).

References

Benavente, J., Harris, D.L., Austin, T.P., and Vila-Concejo, A., 2011: Medium term behavior and evolution of a beach cusps system in a low energy beach, Port Stephens, NSW, Australia. *Journal of Coastal Research*, 64, 170-174

- Coco,G., Huntley, D.A., and O'Hare,T.J., 2000: Investigation of a self-organization model for beach cusp formation and development. *Journal of Geophysical Research*, 105, 21,991-22,002
- Coco, G., Burnet, T.K., and Werner, T., 2004: The role of tides in beach cusp development. *Journal of Geophysical Research*, 109, C04011
- Masselink, G., Hegge, B.J., and Pattiaratchi, C.B., 1996: Beach cusps morphodynamics. *Earth surface processes and landforms*, 22, 1139-1155
- Vousdoukas, M. I., 2011: Erosion/accretion patterns and multiple beach cusp systems on a meso-tidal, steeply-sloping beach. *Geomorphology*, 141-142 (2012) 64-46
- Werner, B.T.,and Fink, T.M., 1993: Beach cusps as self-organized patterns. *Science*, 260, 968-970

Neogene marine fossils from the eastern Canary Islands**Juan Francisco Betancort Lozano, Joaquín Meco, Alejandro Lomoschitz.***University of Las Palmas de Gran Canaria, Spain.***Abstract**

In the eastern Canary Islands: Gran Canaria, Fuerteventura and Lanzarote are located mio-pliocene marine deposits. These deposits consist in a reddish fossiliferous conglomerate and sandstones with structures and bioturbation, which are interpreted as belonging to a shallow environment. In some sites, these marine deposits appear below lava flows. In Salinas del Janubio (Lanzarote) are under basalts from Tías-Janubio Formation, dated about 6.6 Myr and 8.9 Myr. In the Barranco de Ajuí (Fuerteventura) dated about 4.8 Myr and in the Barranco de Los Dolores and Tamaraceite (Gran Canaria) are associated with pillow lava flows dated as 4.1 Myr.

The study of the fossil fauna shows more than 136 taxa and ichnotaxa, many currently extinct, which provide valuable stratigraphic, paleoclimate and paleoceanographic information. In this list stand up some Upper Miocene and Lower Pleistocene characteristic fossil taxa as the coral *Siderastraea micoenica* Osasco, 1897; the gastropods *Rothpletzia rudista* Simonelli, 1890; *Ancilla glandiformis* (Lamarck, 1822), *Strombus coronatus* Defrance, 1827; *Nerita emiliana* Mayer, 1872 or the bivalve *Gryphaea virleti* Deshayes, 1832. Among fossil swimmers vertebrates list, several species correspond to large predators with migratory capacity and in some cases with pan-oceanic distribution such as *Carcharodon megalodon* Agassiz, 1843; *Carcharodon carcharias* Linné, 1758; *Isurus hastalis* (Agassiz, 1843) and *Galeocerdo aduncus* Agassiz, 1843. Their presence is associated with marine mammals existence that constituted their preferred prey. Other fossil taxa only had migratory capacity in their larval stage as the fish *Diodon sigma* Martin, 1887; the gastropod *Columbella mercatoria* Linné, 1758 and the balanus *Tetraclita aff. rubescens* Darwin 1854. *T. rubescens* Darwin 1854 is characteristic of the Pacific coast of North America from Cabo San Lucas, Baja California, Mexico, to San Francisco Bay. Its presence in the Canaries was only possible before the closure of Panama isthmus circa 3 Myr.

A leap in seamounts geo-characterization: using a multi-technical approach for origin, nature and evolution of Amanay, Banquete and Conception Bank (Canary Islands). LIFE+ INDEMARES (2009-2013)

Quevedo-González, L. Á.¹, Mangas, J.¹, Acosta, J.², Martín-Sosa, P.³, Tauler, E.⁴, Arrese, B.², Rivera, J.², Rodríguez, S.¹, Menéndez, I.¹

¹*Instituto de Oceanografía y Cambio Global (IOCAG). Las Palmas de Gran Canaria / Spain*

²*Servicios Centrales, Instituto Español de Oceanografía (IEO), Madrid / Spain*

³*Centro Oceanográfico de Canarias, Instituto Español de Oceanografía (IEO), Tenerife / Spain*

⁴*Dept. de Cristal·lografía, Mineralogía i Dipòsits Minerals. Universitat de Barcelona / Spain*

Abstract

Seamounts are unique places of increasing scientific interest; although being abundant and exhibiting a global distribution [3], most of them are still showing a lack of research. Besides the physical (i.e.: deep-sea circulation) and biochemical implications (i.e.: as pelagic biodiversity hotspots), there is likewise a greater interest in geological terms, in order to understand origin, nature and evolution of the constituent materials from these submerged edifices, as well as to investigate potential mineral resources [1].

The LIFE+ INDEMARES (2009-2013) national project (<http://www.indemares.es>) led by the ‘Fundación Biodiversidad’ (<http://www.fundacion-biodiversidad.es>) has allowed achieving a deeper knowledge of the biodiversity from several marine areas of the Spanish seas, with the potential to be included in the Natura 2000 network and thus become protected. In addition, selected marine areas in the Canary Islands archipelago focused research aims on particular seamounts, including ‘Conception Bank’ (70 km northeast of Lanzarote I.), as well as ‘Amanay’ and ‘El Banquete’ seamounts (20 km southwest of Fuerteventura I.). The ‘Instituto Español de Oceanografía’ (IEO), as part of the project team, has led the oceanographical campaigns collecting a wide variety of bio- and geological samples. The research group ‘Geología Aplicada y Regional’ (GEOGAR), attached to the ‘Instituto de Oceanografía y Cambio Global’ (IOCAG), at the ‘Universidad de Las Palmas de Gran Canaria’ (ULPGC) has conducted a geological research collaboration in order to broadly characterize, for the first time, about 300 samples of igneous rocks (i.e.: plutonic, subvolcanic and volcanic rocks), sedimentary rocks (i.e.: carbonate clastic rocks and ferromanganese crusts) and unconsolidated sediments.

In regards to the geological objectives for this work, we used a multi-technical approach comprising several disciplines: (i) sediments geo-characterization (i.e.: grain-size, provenance, carbonate, organic matter, microscopy, mineralogy, petrography, geochemistry); (ii) igneous rocks and (iii) sedimentary rocks geo-characterization (petrography, mineralogy, geochemistry). Hence, a number of methods was required for these purposes (e.g.: dry sieving, calcimetry, petrographic microscopy, scanning electron microscopy (SEM), electron microprobe analysis (EMPA), powder X-ray diffraction (XRD) procedures, Raman spectroscopy, ICP/ICP-MS, etc.). Thereby, the foremost objective for this work is to characterize an evident geological diversity, through analyzing textural, mineral and geochemical data, and later combining these results to understand origin, nature and evolution of the seamounts involved. In summary, here we show the main results we have obtained and we discuss the most relevant findings.

Firstly, a set of about 100 igneous rocks confirms a volcanic origin, so as expected, for Amanay, Banquete and Conception seamounts, and therefore, being originated from intraplate (hotspot) volcanism, also responsible of the neighboring islands and seamounts belonging to the ‘Canary Island Seamount Province’ [2]. Further, a petrography study and some geochemical analysis show typical ocean island alkaline basalts series, comprising a wide range of plutonic, subvolcanic and volcanic (lava flows and pyroclasts) rock varieties (e.g.: basalts, trachy-basalts, gabbros) where phenocrysts are typically characterized by the presence or absence of olivine, clinopyroxene, plagioclase and amphibole. Furthermore,

volcanic and diabase-like rocks reveal a considerable geological alteration and mineral neof ormation caused by the action of seawater. Hence, they show mineral alterations on edges (e.g.: Fe-, Mn- and Fe-Mn-oxides coatings), as replacements of phenocrysts but mostly filling rocks vesicles and cracks (e.g.: micritization, zeolitization, phosphatization), as observed from microscopic studies (i.e.: SEM) and confirmed by mineral identification (i.e.: EMPA and Raman spectra).

Secondly, close to 150 samples show a great diversity of sedimentary rocks, comprising mainly carbonated rocks and ferromanganese crusts, but also conglomerates and sandstones. Sedimentary rocks are reflecting both oceanic and geological processes: (i) carbonate rocks are mostly described by a variable fraction of bioclasts (mainly planktonic foraminifera), apart from a varying degree of compaction and porosity (e.g.: mudstone, packstone, grainstone) whereas cementing matrix is characterized by calcite minerals (i.e.: micrite and sparite), in some samples phosphatized too; (ii) ferromanganese crusts appear typically as layered oxides with botryoidal, isopachous and druzy textures (up to 3-4 cm in thickness), where mineralogical analysis (i.e.: XRD and Raman spectra) allow to affirm they are commonly constituted by iron and manganese minerals (i.e.: todorokite, goethite, hematite).

Thirdly, a set of 60 non-consolidated sediment samples was also taken into research. A mineral identification of significant amounts of allochthonous (i) quartz and dolomite; volcanic-related augite and plagioclase, as well as further calcium-magnesium minerals within the silty-clayey fraction, (ii) high levels of carbonate content (close to 90% on average), owing to high ratios of relative contents of bioclasts (up to more than 60% of planktonic foraminifera) and lastly, (iii) the lowly concentrations of REE (by a few tens of ppm) detected in selected samples, are some of the most relevant results concerning the deep-sea sediments.

In conclusion, a seamount-based geological research has provided new geological and extensive data from igneous rocks, sedimentary rocks and sediments; reflecting altogether the volcanic origin and the underwater evolution of these edifices. Hence, these geological features are undoubtedly a record of the bio-geo-physico-chemical processes occurred since both early and late submarine stages. Thereby, the resulting data from this work suggest new goals and chances for further studies, whether for geological purposes (e.g.: combining with geophysical data), as well as for interdisciplinary proposals (e.g.: considering additional layers for statistical modeling of species distribution, specially for such marine protected areas).

Acknowledgements: This work is part of the national research project LIFE+ INDEMARES (2009-2013), within both INDEMARES-CONCEPCION and INDEMARES-FUERTEGC sub-projects. Hereby, the main authors (Q-G., L.Á.; M., J.) want to sincerely thank the ‘Instituto Español de Oceanografía (IEO)’ for supporting the geological research and every collaborator for their contributions to make this work possible.

References

- Hein, J. R.; Conrad, T. A.; Staudigel, H. (2010). Seamount mineral deposits: a source of rare metals for high-technology industries. *Oceanography*, vol. 23 (1), pp. 184-189,¹⁴
- Van den Bogaard, P. (2013). The origin of the Canary Island Seamount Province - New ages of old seamounts. *Nature Scientific Reports*, v. 3, art. num. 2107,¹⁵
- Wessel, P.; Sandwell, D. T.; Kim, S.-S. (2010). The global seamount census. *Oceanography*, vol. 23 (1), pp. 24-33,¹⁶

¹⁴<http://dx.doi.org/10.5670/oceanog.2010.70>

¹⁵<http://dx.doi.org/10.1038/srep02107>

¹⁶<http://dx.doi.org/10.5670/oceanog.2010.60>

Presence of corals [*Siderastrea radians* (Pallas, 1766)*] of the last interglacial (130-120 ka) in the Canary Islands: marine palaeo-biogeographical implications.**Meco, J.¹, Lomoschitz, A.², Betancort, J.F.¹, Soler-Onís, E.¹**¹Departamento de Biología, ULPGC, 35017 Las Palmas de Gran Canaria, Canary Islands, Spain²Departamento de Ingeniería Civil, ULPGC, 35017 Las Palmas, Canary Islands, Spain**Abstract**

The coral *Siderastraea radians* (Pallas, 1766) currently lives in Atlantic tropical regions of the Americas and Africa: between Brazil (Laborel, 1971), the Caribbean Sea and Bermuda islands (Verril, 1907) on the one side; and on the other, between Liberia and Cameroon; in Bioko, Sao Tomé and Annobom (Pagalu) islands and in Cape Verde (Laborel, 1974). This coral is round, spheroidal or hemispheroidal, generally characterized by irregular masses that range between 5 and 12 cm in size, but sometimes can reach 50 cm in diameter. It lives in very shallow waters and intertidal zones. In the Canary Islands, *S. radians* has been found within marine deposits at the following localities: Tachero, Tenerife (García Talavera et al., 1978); Las Playitas, Fuerteventura (Zibrowius & Brito, 1986; Meco, 1986); La Santa, Lanzarote (Meco et al., 2003; 2006) and San Cristóbal, Las Palmas de Gran Canaria (Meco et al., 2006). Some specimens from La Santa have diameters of as much as half a meter.

With the exception of Tachero's deposit, considered Holocene in age (Mellahian-Flandrian), the rest of localities correspond to the last interglacial period or MIS (Marine Isotope Stage) 5.5.

Currently, U-series is the most reliable dating method for last-interglacial-age marine deposits and we have used it to date the fossil corals. One specimen from La Santa has an age of 130.2 ± 0.8 ka and other from San Cristóbal has an age of 120.5 ± 0.8 ka (Muhs et al., 2014). These data confirm they belong to MIS 5.5. Outside the Canaries, fossil specimens of *S. radians* have been also found in Cape Verde Is., the Caribbean Sea (Bahamas, Florida Keys, Puerto Rico, Grand Cayman, Jamaica, Curaçao, Barbados) and possibly Brazil and Bermuda (Muhs et al., 2014). U-series ages at all these localities also correspond to the last interglacial. On the other hand, from the specimens found on the African coast (Mauritania, Senegal and Angola) only one coral from Mauritania was dated by radiocarbon (Chevalier and Hebrard, 1972) but its age (ca. 31 ka) is only a minimum estimate.

Within the localities mentioned above, only those located on the African and Canary coasts exceeded the current boundaries of *S. radians*. Its palaeo-biogeographical distribution thus indicates that in the Upper Pleistocene (MIS 5.5), and along the Canary and African coasts, the Canary Current was likely warmer than today and the Guinean counter-current might be expanded; however, no such change occurred on the Atlantic American coasts, at least to the extent that allowed expansion of the range of *S. radians*. In other words, during the last interglacial there was an expansion of the biogeographical zone of *S. radians* in the central Atlantic, but this change only occurred in the African, or eastern Atlantic region.

Furthermore, the Atlantic Ocean didn't change its geographical configuration, due mainly to tectonic plate movements, in the Upper Pleistocene. Thus, the variations mentioned above might be related to astronomic causes; which changed the amount of sunshine, temperature regime, ice volumes, wind patterns, and ocean currents and, as a consequence, the marine fauna location.

(*1766 *Madreporaria radians* Pallas Elench. Zoöphylacium p. 322)

We wish to thanks Dr. Daniel R Muhs (U.S. Geological Survey) for giving us information on the fossil American corals and critical reading of the manuscript.

References

García Talavera, F., Kardas Jr. S.K., Richards, H.G. 1978. Quaternary marine mollusks from Tenerife, Canary islands. *The Nautilus* 92, 97-102.

- Chevalier, J.P., Hebrard, L. 1972. Découverte de Madréporaires dans le Pléistocène supérieur de Mauritanie. In H.J. Hugot (ed.). Vie Congrès panafricain de Préhistoire et des Études du Quaternaire, Dakar 1967. Imprimeries Réunies. Chambéry, 453-456.
- Laborel, J. 1971. Madréporaires et Hydrocoralliaires récifaux des côtes brésiliennes. Systématique, écologie, répartition verticale et géographique. *Annales de l'Institut océanographique* 47, 171-229.
- Laborel, J. 1974. A West African corals. An hypothesis on their origin. *Proceedings of the Second International Symposium on Coral Reefs*. Brisbane: Great Barrier Reef Committee 1, 425-443.
- Meco, J. 1986. Climatic Change in the Canary Islands during Upper Pleistocene. In H. Faure, L. Faure & E.S. Diop (eds.). INQUA-ASEQUA Symposium International "Changements globaux en Afrique durant le Quaternaire. Passé, Present - Futur" Dakar 21-28 Avril 1986. *Travaux et Documents de l'ORSTOM* 197, 301-304. Paris.
- Meco, J., Ballester, J., Perera, N., Marrero, R., Niz, G. 2003. Paleoclimatología de Lanzarote y La Graciosa (yacimientos paleontológicos). Servicio de Patrimonio Histórico del Cabildo de Lanzarote.
- Meco, J., Ballester, J.F., Betancort, J.F., Cilleros, A., Scaillet, S., Guillou, H., Carracedo, J.C., Lomoschitz, A., Petit-Maire, N., Ramos, A.J.G., Perera, N., Meco, J.M. 2006. Paleoclimatología del Neógeno en las Islas Canarias. Geliense, Pleistoceno y Holoceno. Ministerio de Medio Ambiente - Universidad de Las Palmas de Gran Canaria.
- Muhs, D.R., Meco, J., Simmons, K. R. 2014. Uranium-series ages of corals, sea level history, and palaeozoogeography, Canary Islands, Spain: An exploratory study for two Quaternary interglacial periods. *Palaeogeography, Palaeoclimatology, Palaeoecology* 394, 99-118.
- Verrill, A.E. 1907. Variations and Nomenclature of Bermudian, west Indian and Brazilian Reef Corals, with notes on various Indo-Pacific corals. *Transactions of the Connecticut Academia of Arts and Sciences* 11 (1901-1903), 63-168. 12 The Bermudian Islands; Coral Reefs, 12 (1904-1907), 45-348. Publications of the Yale University. New Haven.
- Zibrowius, H, Brito, A. 1986. First Pleistocene records of the Genus *Siderastrea* (Cnidaria, Anthozoa, Scleractinia) from the Canary Islands. In J. Meco & N. Petit-Maire (eds.). *Le Quaternaire récent des îles Canaries*. Paléoclimatologie. ULL-CNRS. Marseille.

Geologic characterization of sedimentary rocks and sediments associated to shallows of El Confital Bay (NE of Gran Canaria Island, Canary Islands)**Julià-Miralles, Marc and Mangas, José***Instituto de Oceanografía y Cambio Global (IOGAG), Universidad de Las Palmas de Gran Canaria. Campus de Tafira, 35017 Las Palmas de Gran Canaria***Abstract**

The shallows of Fernando, Roquerillos and Zabala are located in the NE of El Confital Bay, in the municipal district of Las Palmas de Gran Canaria. So, Roquerillo is next to La Isleta (UTM Coordinates 28° 09' 29"N, 15° 26' 35"W), Zabala is nearer to Barra de Las Canteras (28° 09' 01"N, 15° 26' 24"W) and Fernando (28° 09' 03"N, 15° 27' 01"W) between them. These shallows appear in depths comprised between -15 and -25m, they form submarine platforms with walls smaller than 4 m and they contain numerous geomorphologies such as erosion caves, holes and corridors. These submarine morphologies together with its varied marine fauna and flora make these shallows are used as sport diving places in Las Palmas de Gran Canaria city.

Up to now, geological studies of these shallows have never been made, consequently this is the aim of this research. To carry out this study we needed 12 immersions in the three shallows, 33 samples of rocks have been collected, 16 stratigraphic columns have been lifted, and we have taken 8 samples of near sands. With all these materials, 41 thin sections have been prepared for the petrographic study with the object of identifying microscopically the nature of the grains and its relative abundance counting points. Mineralogical and geochemical studies had been carried out with EMPA and SEM techniques to determine the composition and morphologies of the cements.

Except the lower part of Roquerillos where we can find volcanic materials (levels of trachytic-phonolitic felsic pyroclasts), the rest of rocks which compose the three shallows are sedimentary detritic rocks, amongst which layers of sandstone predominate, in a lower proportion, some levels of conglomerate appear, and we can hardly find microconglomerate strata. In the walls where there are some layers of conglomerate and sandstone (Fernando and Zabala), the first are below. The conglomerates consist of felsic rounded stones (trachyte-phonolite), and in a lower proportion, mafic (basanite-basalt). These conglomerates have a matrix of bioclastic microconglomerates and sandstones.

The petrographic study of the sandstones of the shallows confirms that in Fernando and Roquerillos lithoclasts grains predominate (data between 88 and 72 %) over the bioclasts (24-10%). The lithoclasts are mainly fragments of felsic rocks, minerals (feldspars) and glass (35-5%), and in lower proportion fragments of mafic rocks, minerals (olivine, clinopyroxene, amphibole and opaque) and glasses (25-2%). The most abundant bioclasts are the rests of fauna (mollusks, bryozoes, equinoderm and foraminifera) with values between 21% and 2% while the flora (red seaweed meshes) between 16% and 1%. Carbonated cements are mainly patches of micrite, sparite and microsparite around the grains (bladed) or as mosaic (blocky), but some fibrous silicate crystals of clays and zeolites also appear. The carbonated cement is essentially LCM with concentrations of CO₃Mg between 4.8 and 1.2% and values of Sr between 600 and 100 ppm. The porosity of these rocks is intragranular and intergranular with data between 13 and 3%. Due to this, these rocks are defined as volcanic lithoarenites.

Referring to Zabala, this shows petrographic features different to its components. So the proportions of lithoclasts and bioclasts are similar, near the 50 % with abundance of felsic (30- 8%) over the mafic (16-5%) and, the rests of flora predominate (31-10%) over the fauna (26-14%). These rocks only have carbonate cements of microsparite and sparite (isopachous and blady) and fibrous (drusy). The poros-

ity is intergranular and intragranular with values between 40% and 6%. Therefore these rocks can be classified as volcanic calcarenites.

The petrography of the samples of sands confirms heterogeneity in the results. So, in Fernando bioclasts sometimes predominate with values between 60% and 42% and some other times lithoclasts between 59% and 32%. The values of grain of bioclasts are variable, where the rests of the flora prevail with results between 58 and 10%, and the fauna rests are between 44 and 6%. Equally, the fragments of lithoclasts of felsic rocks abound and show values between 25 and 3%, while mafic components between 17 and 6%. In Roquerillos deposits of gravel-sized rhodolites are plentiful, and the sands which appear occasionally are felsic lithoclasts (about 77%) predominating over the mafic grains. These sands are bioclast poor (around 22%) with more rests of flora than fauna. The sands of Zabala have similar percentages of lithoclasts and bioclasts, about 50% prevailing one or the other depending on the areas. In the lithoclasts volcanic fragments of felsic rocks and minerals, with data between 26% and 16% while fragments of mafic rocks and minerals are comprised between 20% and 8%. Among the bioclasts there are plenty of rests of flora with values between 31 and 20% and the fauna varies between 25% and 12%. Taking the nature of the components of the sedimentary rocks and sands studied in the shallows and its relative abundance into account, an origin analysis can be carried out, locating the source area which the sediments come from. So, the abundance of fragments of felsic rocks, minerals and glasses in the shallows make us think erosion of the Miocene lava and ignimbrites in the cliffs of El Rincón, the gorges closed to the bay (La Ballena and Boca Barranco) and the subtidal outcrops on El Confital Bay. The mafic lithoclasts can come from the erosion of plioquaternary lava-flows and pyroclasts of the same area and also some similar quaternary materials which conform La Isleta. Referring to the grains of bioclasts, these are of marine flora and fauna, of shallow littoral environments. Moreover, the conglomerates and sandstones existence, together with textural parameters of grain rounding (textural maturity) indicate high energy and shallow marine means (beaches and bars). Also, the carbonated cements with Mg and Sr confirm marine origin and their typologies indicate phreatic conditions of the mineral precipitations. Eventually, the data of the nature of the components of the studied sedimentary rocks, their textural, porosity and cementing features described confirm that Fernando and Roquerillos are genetically similar and they seem to be older than Zabala.

Acknowledgements: This work is part of the research projects CSO2010-18150 and INNOVA 2014. We thank José Casas, Eduardo Grandío and D. Vicente Benítez for their help during fieldworks, and Pilar Calvo for their English translation.

Chemical Oceanography

Emissions of Fe(II) due to the undersea volcano of El Hierro

Carolina Santana-González, J. Magdalena Santana-Casiano, Melchor González-Dávila

IOCAG Grupo QUIMA. Facultad de Ciencias del Mar. Universidad de Las Palmas de Gran Canaria

Abstract

The Fe(II) is an essential micronutrient for the phytoplankton grow, and due to its low solubility in seawater it is found in the 0.2-2 nM range for the north Atlantic ocean. However the eruptive stage process and the subsequent hydrothermal stage occurred in the undersea volcano at the southeast of the El Hierro Island, Spain has risen the concentration of TFe(II) in the waters nearest to the main cone. Two cruises were carried out on March and October 2013, inside the VULCANO project, in order to detect any variation in concentrations of TFe(II) due to emissions after the eruptive process. Flow injection chemiluminescence using luminol as reagent was used to determine the concentrations of TFe(II). The results confirm an important positive anomalies in TFe(II) which coincide with negative anomalies in pH located in a secondary cone, during October cruise. It is also observed maximum values in TFe(II) at the surface associated to chlorophyll a maximum and to the sea bottom, showing the important influence of surface runoff, organic complexation and particle re-suspension processes. Temporal study in the station located over the secondary cone with positively anomalies in pH was carried out during 4 days. It showed an important variability in both pH and TFe(II) concentrations that indicated the volcanic area was affected by intermittent events of hydrothermal fluids in vent that remains in the volcano cone one and a half year after the eruptive phase has ceased. The increased TFe(II) concentrations and the low associated pH values may be acting as an important fertilization event in the seawater around the volcano at the Island of El Hierro providing optimal conditions for the regeneration of the area.

Short-term variability of the Dissolved oxygen and chlorophyll a in the upper waters at ESTOC**López, L., Vega, D., Cianca, A.***Plataforma Oceánica de Canarias (PLOCAN), Telde, 35200 Las Palmas, España***Abstract**

The European Station for Time Series in the Ocean, Canary Islands is located in the Eastern Subtropical North Atlantic Gyre (29°10'N, 15°30'W). It is a logistic and scientific strategy whose main objective is performing a long-term-time series of oceanic observations in order to understand and predict the phenomena happening within, as well as their environmental and socio-economic consequences. In addition with the results the researchers aim to contribute to the marine science and to the ocean health. This effort has to conclude with a significant contribution to the current international networks of the oceanographic knowledge.

The ESTOC sampling program was monthly from 1994 to 2004 and after this time seasonally to the present day, so the studies developed are related to seasonal and inter-annual variability of different oceanographic variables. The time-series analysis from several resolutions is important in order to find out the influence and interactions of different process happening inside the ocean and its relationship with oceanographic variables variations. For this reason in this research we will study the daily variations compared to seasonal and inter-annual changes already published. To this end, we have used observations of temperature, salinity, chlorophyll and dissolved oxygen from surface to 300 m which were obtained with 15 profiles of CTD during period of 36 hours at ESTOC site. Therefore, the first aim in this study is establishing the changes in the chlorophyll and dissolved oxygen (DO) distributions compared to hydrographic variations in the water column. The homogenous layer (Mixed layer) is typical during Winter period and March is the month when this layer starts to disappear due to seasonal thermocline formation. The second aim is determining variations for net community production using the anomaly of dissolved oxygen (ΔO_2 excess above saturation, or the apparent oxygen utilization, AOU, as deficit below saturation) as a tracer. The seasonal distribution of the dissolved oxygen anomaly shows a deep maximum (around 150 m) during summer season. Our interest is to find out if the productive processes, in detriment of the respiration process, show positive values of DO anomaly in the daily resolution and where is located the maximum if this exists. Finally, we will establish the relationship between the DO anomalies values with those from the chlorophyll distribution in the water column.

References

- Cianca, A., Santana, R., Hartman, S.E., Martín-González, J.M., González-Dávila, M., Rueda, M.J., Llinás, O, and S. Neuer, 2013: Oxygen dynamics in the North Atlantic subtropical gyre. *Deep-sea Research II*,93,135–147.
- Copin-Montégut, C., Bégovic, M, and L. Merlivat, 2004: Variability of partial pressure of CO₂ on diel to annual time scales in the Northwestern Mediterranean Sea. *Marine Chemistry*,85,169–189.

A long time-series of atmospheric fluxes of trace metals and nutrients to the Canary Basin.**M.D. Gelado-Caballero¹, P. López-García¹, M.D. Patey¹, C. Collado-Sanchez¹, D. Santana-Castellano¹, J.J. Hernández-Brito²**¹*Chemistry Department, University of las Palmas de Gran Canaria, Spain*²*PLOCAN, Spain***Abstract**

Atmospheric inputs of soluble trace elements and nutrients to the ocean are a key component in biogeochemical cycles. Aerosol inputs to the Canary Basin are among the highest in the world, due to its proximity to the Sahara and Sahel desert regions of Africa. However, to date there have been no long-term aerosol studies in the Canary Basin, with only limited data available from sporadic oceanographic research cruises which have crossed the region, generally as part of larger transects of the Atlantic Ocean. In this study, aerosol samples have been collected at three stations on the island of Gran Canaria (Taliarte at sea level, Tafira, 269 m altitude and Pico de la Gorra, 1930 m altitude) since 2002, representing a valuable contribution to the understanding of deposition of these soluble components in the region. We present a 11-year record of total suspended particles (TSP) collected in Gran Canaria, Spain and an 9-year record of wet and dry deposition measurements. The solubility of Fe, Al, Mn, Ti, Cu, Co, N and P in dust deposited to the ocean by the dry and wet deposition processes is also examined. Solubility measurements from acetate buffer leaching experiments showed the same tendency in the percentage of soluble metals in the samples: a higher percentage of soluble metals in anthropogenic aerosols and at lower dust loading. Data were separated into three different groups and results showed that, despite more than 80% of the days having an African component, the fluxes of soluble Fe derived from anthropogenic aerosols represented an important input of this metal to the ocean (more than 28%). Moreover, flux estimates for aerosol-derived soluble metals reveal that phosphate is highly depleted relative to Fe and N when compared to Redfield ratios. Therefore, aerosol deposition may be an important source of N and trace metals (Fe, Co, Mn and Al) to the NE subtropical Atlantic Ocean.

Recovery and homogenization of marine chemical data from IEO systematic monitoring programs

E. Tel¹, M.J. García¹, D. de Armas¹, J. Bellas², A. Bode³, J.M. Cabanas², M.C. García-Martínez⁴, V.M. León⁵, J.A. Campillo⁵, M.C. Rodríguez⁶, R. Sánchez-Leal⁷, P. Vélez⁸, L. Viñas²

¹*Instituto Español de Oceanografía, IEO. C/Corazón de María, 8. 28002-Madrid*

²*Instituto Español de Oceanografía, IEO. Subida Radio Faro, 50, 36390-Vigo*

³*Instituto Español de Oceanografía, IEO. Pso Marítimo Alcalde F.Vázquez, 10. 15001-A Coruña*

⁴*Instituto Español de Oceanografía, IEO. Puerto Pesquero, s/n.29640-Fuengirola*

⁵*Instituto Español de Oceanografía, IEO Varadero, 1. 30740-S. Pedro del Pinatar*

⁶*Instituto Español de Oceanografía, IEO. Promontorio San Martín, s/n 39004-Santander*

⁷*Instituto Español de Oceanografía, IEO. Muelle de Levante (Puerto Pesquero) 11006-Cádiz*

⁸*Instituto Español de Oceanografía, IEO. Vía Espaldón, dársena pesquera, Parcela 8. 38180-Sta Cruz de Tenerife*

Abstract

In the framework of the project for European Marine Observation and Data Network (EMODNET, chemistry lot, DGMARE/2012/10), the Instituto Español de Oceanografía (IEO) has made an important effort in order to recover, homogenize and validate all the dissolved oxygen, nutrients and pollutant datasets from the different systematic monitoring programs that the institution has been supporting over time.

The main objective of these programs is monitoring the ocean variability at different time scales, from seasonal to interannual ones. Although most measurements were performed on coastal areas (RADIALES, Stoca, RadMed), RaProCan (Canary Deep Oceanic Section) and RadProf (Deep Sections on the North Iberian region), reach deep ocean layers and provide us with valuable information about the behavior of deep water masses and circulation.

Depending on the areas, the datasets can be extended more than 2 decades (RADIALES sections) or must be considered the beginning of a time series regional program (Stoca sections in Gulf of Cadiz). All data were obtained from laboratory analysis of discrete water samples from oceanographic casts, and sediment or biota samples in case of pollutants. Corrected and standardized data has been completely metadated and incorporated to the IEO DataCenter permanent archive. This supports the accessibility and reutilization of data and information and gives them an added value. Also, the IEO as part of SeaDataNet European consortium disseminates all the metadata information thorough the web portal www.seadatanet.org. In addition this infrastructure allows traceable data access when the requirements are fulfilled.

Sunscreen as source of hydrogen peroxide production in coastal waters**David Sánchez-Quiles¹, Ana Manssanet Mayo¹, Antonio Tovar-Sánchez^{1, 2}**¹*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.*²*Instituto de Ciencias Marinas de Andalucía, ICMAN (CSIC). Campus Universitario Río San Pedro, 11510 Puerto Real, Cádiz. Spain.***Abstract**

Titanium dioxide nanoparticles (nano-TiO₂), are widely used in many industrial applications, especially in sunscreens and coatings for UV-protection (1, 2). It is well known that nano-TiO₂ can lead to the formation of reactive oxygen species by photocatalytic reactions under UV radiation (3–6). To prevent photoreactivity, and the consequent reactive effect on the human skin, nano-TiO₂ particles in sunscreens are coated with silica or alumina. Nonetheless, this coating layer is quickly dissolved in aqueous media (7, 8), enabling the production of oxygen radicals (9, 10). Results presented here from field in-situ measurements, and from laboratory and field experiments, demonstrate that small concentrations of commercial sunscreens can lead, under solar UV radiation, to a significant production of hydrogen peroxide (H₂O₂) in seawater. We have demonstrated that commercial sunscreens with inorganic oxide nanoparticles can increase between 31 and 59 times more H₂O₂ production than those without nanoparticles, and that a concentration of H₂O₂ above $1.7 \pm 0.3 \mu\text{M}$ is toxic for marine phytoplankton. We estimated at a Mediterranean tourist beach an extra increase of the H₂O₂ production rates of 270 nM day^{-1} linked to the use of sunscreen. Our results, together with new data of tourism records in Spain, point to UV filters as a major pollutant entering in coastal water with a direct effect on the coastal ecosystem.

References

1. R. T. P. N. US EPA National Center for Environmental Assessment, C. Powers, Nanomaterial Case Studies: Nanoscale Titanium Dioxide (External Review Draft) (available at <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=210206>).
2. F. Piccinno, F. Gottschalk, S. Seeger, B. Nowack, Industrial production quantities and uses of ten engineered nanomaterials in Europe and the world, *J. Nanoparticle Res.* 14, 1–11 (2012).
3. K. Tanaka, M. F. V. Capule, T. Hisanaga, Effect of crystallinity of TiO₂ on its photocatalytic action, *Chem. Phys. Lett.* 187, 73–76 (1991).
4. O. Carp, C. L. Huisman, A. Reller, Photoinduced reactivity of titanium dioxide, *Prog. Solid State Chem.* 32, 33–177 (2004).
5. H. Chen, C. E. Nanayakkara, V. H. Grassian, Titanium Dioxide Photocatalysis in Atmospheric Chemistry, *Chem. Rev.* 112, 5919–5948 (2012).
6. C. Chen, J. Wang, in *Encyclopedia of Environmental Health*, Jerome O. Nriagu, Ed. (Elsevier, Burlington, 2011), pp. 12–21.
7. M. Auffan et al., Structural Degradation at the Surface of a TiO₂-Based Nanomaterial Used in Cosmetics, *Environ. Sci. Technol.* 44, 2689–2694 (2010).
8. J. Labille et al., Aging of TiO₂ nanocomposites used in sunscreen. Dispersion and fate of the degradation products in aqueous environment, *Environ. Pollut.* 158, 3482–3489 (2010).
9. V. Brezová, S. Gabová, D. Dvoranová, A. Staško, Reactive oxygen species produced upon photoexcitation of sunscreens containing titanium dioxide (an EPR study), *J. Photochem. Photobiol. B* 79, 121–134 (2005).
10. Z. A. Lewicka, W. W. Yu, B. L. Oliva, E. Q. Contreras, V. L. Colvin, Photochemical behavior of nanoscale TiO₂ and ZnO sunscreen ingredients, *J. Photochem. Photobiol. Chem.* 263, 24–33 (2013).

Electron Transport System Activity: A Key Measurement in Ecosystem Monitoring**T. T. Packard, F. Maldonado, N. Osma, I. Fernández-Urruzola, I. Martinez, A. Herrera, M. Tames, and M. Gómez***Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria***Abstract**

The activity of the respiratory electron transport system (ETS) in a water, plankton, or sediment sample is arguably the most useful and informative biological variable to measure in the hydrosphere. This is especially true if hydrological background variables such as oxygen, nitrate, nitrite, temperature, light, sulphide, etc have been measured. Without knowing the hydrographic background of a sample the ETS measurement serves as a bio-index of living biomass, a detector of the level of life in the water (Packard, 1985). If the hydrographic background of a sample is known then ETS measurements can be used to calculate respiratory oxygen consumption and CO₂ production, the metabolic organic carbon consumption rate, vertical carbon flux, nutrient retention efficiency (Osma et al., 2014), the ATP production rate, the rate of biological energy generation, the biological heat production rate (Pamatmat et al., 1981), the age and flow rates of deep and bottom waters (Packard, 1985). In anoxic waters, if the background chemistry (Richards, 1985; Pawlowicz et al, 2007) is known an ETS activity measurement can serve as a proxy rate measurement for denitrification (Packard, 1969; Codispoti and Packard, 1979), nitrite production, nitrous oxide production, and sulfide production (Packard et al., 1983), and even for iron and magnesium reduction rates. All are different forms of respiration controlled by the same basic respiratory ETS. Furthermore, because the energy generation of nitrification is based on a variation of this ETS it is likely the under the right chemical conditions the ETS can serve as a proxy for nitrification in water columns or sediments.

Geological Oceanography

Suspended particulate matter in the ría de Vigo (NW Spain) under fair-weather conditions: sediment sources and forcing mechanism

A.M. Bernabeu, A.V. Lersundi-Kanpistegi, D. Rey

GEOMA.NET, Dpto. Geociencias Marinas, Universidad de Vigo, 36310, Vigo, Spain

Abstract

The suspended particulate matter (SPM) dynamics is an important parameter in the comprehension of coastal environments and, consequently, in the development of a suitable management and exploitation of these areas. The analysis of SPM requires estimating the available sediment sources and the relative influence of the different forcing mechanisms involved. The SPM supply in coastal systems can be produced by local sources as the seabed, fluvial discharge or human activities, and external sources. The diversity of forcing mechanisms comprises tides, waves, wind and fluvial discharge. These forces can act simultaneously or predominate individually in the system in a large variety of time scales. The relative influence of each forcing mechanism on SPM varies from one coastal environment to another.

The aim of the present work is to determine the bottom SPM and to examine the relative influence of the different forcing mechanism on the SPM dynamic concentrations in a ría environment. This work analyses the SPM and hydrodynamic data collected during a 14 days survey deployed under fair-weather conditions in the Ría de Vigo, the southernmost of the Rías Baixas.

The data sets and sediment samples were carried out within the FAFU campaign, from 28 June to 11 July 2005. Two mooring stations were deployed: a) the inner station (IS) in the southern side of the longitudinal channel of the mid ria at 30 m depth; b) the outer station (OS) at 27 m depth, in the southern margin of the external sector. The IS was equipped with an instrument located at 1.17 m above bottom (mab), and the OS with other instrument at 1.13 mab. Hydrodynamic (pressure, current velocity and direction) and hydrological (temperature, salinity, turbidity) data were collected using an Aanderaa RCM9 Mk. The instruments measured the data every 5 minutes. Complementary oceanographic and meteorological data was obtained from the Spanish Port Authority database (Ministry of Public Works, www.puertos.es). SWAN (Simulating WAVes Nearshore, Delft University of Technology) modelling software was used to simulate the wave propagation in the ría.

Under summer conditions, the calculated maximum shear stress for waves and currents were well below from the critical values for transport initiation of the bottom sediment in the two studied cases. These results confirm that local erosion of the bottom sediment does not occur and, consequently, the SPM concentration measured in the ría has its origin in an external source. The good correlation between the subtidal SPM and the upwelling index highlight this phenomenon as the main input of the SPM in the ría. Once in the ría, the SPM behavior is controlled by the local forcing mechanisms, that gradually changes landward from wave dominated to tidal dominated sector.

Effects of storms on a composite beach, San Felipe, Gran Canaria**M. Casamayor, I. Alonso, S. Rodríguez, J. Cabrera and M.J. Sánchez***Instituto Universitario de Oceanografía y Cambio Global. University of Las Palmas de Gran Canaria. Spain***Abstract**

San Felipe is a pebble beach placed in the northern coast of the island of Gran Canaria. The morphodynamics of beaches located along this area undergoes variations due to waves generated by Trade winds, from NNE, prevailing since April to October. However, the greatest changes occur during the stormy season. During this period, from November to March, wave direction changes from NW to NE, being waves from NNW the most frequent and which show higher maximum wave heights. Therefore, owing to the magnitude of changes during storms, the aim of this paper is to study pebbles and cobbles dynamics in that period, as well as beach morphological changes associated with the wave regime.

The study area is approximately 200 m long and 40 m average width during winter. San Felipe is a composite beach, according to Jennings and Shulmeister (2002) classification, consisting mainly of phonolitic and basaltic pebbles and cobbles. In the nearshore a submerged sand bar is present, being most of these sediments of basaltic origin.

Pebbles and cobbles tracking is performed using a RFID system, based on that described by Allan et al. (2006). This technology allows the identification of pebbles with a unique number for each of the 198 selected particles. The entire beach was tracked 5 times from 19 December 2013 to 21 February 2014 with an antenna to locate the tagged particles. Temporal spacing between those dates depended on the occurrence of stormy events and tide conditions, but never exceeding a month. Once each individual tagged particle was identified, it was located with a Leica total station TCR307. From the measured coordinates the movement of each individual cobble has been calculated. Topographic data for the whole beach were also collected with the total station.

According to hourly wave data recorded at the deep water wave buoy "Gran Canaria", owned by Puertos del Estado, dominant waves during this study came from N with an average of H_s 2.33 m and T_p 13.56 s. During the 2 months study period, 10 stormy events took place, all them with average H_s higher than 2.70 m. Only 3 of them should be pointed out: First one was a swell storm that took place between 6-7 January, with average T_p 20.29 s and $350^\circ N$ approaching direction. Second event took place between 23-26 January. In this case waves show average T_p 9.92 s and H_s 3.55 m from $36^\circ N$. Third storm was the lasting one. It took place between 15-18 February and average waves were H_s 3.74 m, from $1^\circ N$.

During winter, the sand bar is completely submerged, and it is not until the beginning of the Trade wind season, when it moves onshore covering the cobbles located on the foreshore. For this reason, during the stormy season pebbles and cobbles in the lower foreshore are completely exposed to incident waves, which is the forcing agent for their movement. By contrast, particles located above the berm will be affected only in situations where high waves and high spring tides are coincident, and this type of situations took place in 4 of the considered stormy events.

Sedimentary balance showed two different periods, the first of them from 19 December to 14 January, with the removal of sand from the foreshore and the formation of a shingle berm all along the eastern sector of the beach. The net sedimentary balance was -5160 m^3 , mostly due to the offshore movement of the sand. During the second period both erosion and accretion events took place, with an average value of $\pm 350 \text{ m}^3$. It was at this stage where morphological changes due to pebbles movements occur. In eastern and central parts of the beach, a pebbles berm was formed with sediment gains of 1080 m^3 .

Subsequently this berm moved onshore because maximum Hs coexist with high spring tides. However, the western area had erosive processes until 21 January, when it began the accumulation of 900 m³ of pebbles.

The analysis of tagged pebbles with movement greater than 1m indicates that both time intervals between 19 December and 14 January and 21 to 28 January showed small particle displacements, but the greatest distances travelled took place during periods between 14 to 21 January and 28 January to 21 February. Movement directions changed for each of these periods. At the beginning 36.4% of pebbles and cobbles moved southwards, which confirms the shingle berm formation showed from the topography. During second interval (14-21 January) there was a net eastward transport, since 33.3% and 22.2% of particles moved towards E (38 m average distance) and W (11 m) respectively. During third period (21-28 January), directions E and W had the same percentage of representation, 28.6%, but in this case westward movement had higher average magnitude, 20.7 m. Finally, during fourth interval (28 Jan-21 Feb), the largest and strongest of the different stormy events took place, since Hs greater than 4 m were recorded during 35 consecutive hours. For this reason distances were the largest, with a mean value of 67 m, but with maximum distances up to 160 m. These movements occurred towards W.

Main factor responsible for the movement of shingles are waves. During this study 10 storms have taken place, but two of them have generated the greatest movements and topographic variations. These two storms show maximum wave heights and spring high tides at the same time. The largest sediment transport is longshore, so that when the eastern sector erodes, the western area accretes and vice-versa. However, due to the prevailing northern waves, the cross-shore movements produce significant changes in beach morphology, in particular changes related with the formation, onshore migration and disappearance of the berm.

References

- Jennings, E. and Shulmeister, J., 2002. A field based classification scheme for gravel beaches. *Marine Geology*, 186: 211-228.
- Allan, J.C., Hart, R. and Tranquili, J.C., 2006. The use of Passive Integrated Transponder (PIT) tags to trace cobble transport in a mixed sand-and-gravel beach on the high-energy Oregon Coast, USA. *Marine Geology*, 232: 63-86.

Lithogenic flux and textural analysis of the sediment trap samples collected at 150 m depth in the Canary Basin, Spain.**Maite Báez¹, Alfredo Jaramillo², Inmaculada Menéndez¹, José Manga¹**¹*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria*²*Grupo de Estudios Oceánicos (GEOc), Corporación Académica Ambiental, Universidad de Antioquia, Sede Ciencias del Mar, Turbo-Antioquia, Colombia***Abstract**

Saharan desert dust is the major source of lithogenic fluxes input on the Canary Basin. Throughout the atmospheric lifetime, the dust particles are subject to mixing and ageing. These actions bring about significant changes in the molecular composition of the airborne particles before their removal from the atmosphere on the ocean surface. The “post-depositional” processes began in the ocean surface. This model assumed that once lithogenic particles encounter the micro-layer of the sea surface (made by organic compounds), it produces an important change in the composition of the lithogenic material. Physico-chemical changes occur during particle settling through the water column producing aggregates. The distribution of the lithogenic particles along the water column depends on their size, morphology, density and aggregation processes.

Oceanic samples were collected and analyzed from mesopelagic layer (at 150 m depth), utilizing a P.P.S3/3-24 S time-series sediment trap, with a captation area of 0.125 m², and sampling frequency of 12 hours. The sediment trap was deployed in a drifting system between LCF3 and LCF4 station, 18.5 km apart from Gran Canaria Island, by LUCIFER II project, from January to April of 2011. Oceanic samples in water suspension were filtered using Nucleopore®. These filters were treated with hydrogen peroxide (3%) previously heated at 50°C in order to eliminate organic matter mass and particles. However, jelly masses (agglutinating particles) persisted after treatment. These masses remind to the Transparent Exopolymer Particles (TEPs). The lithogenic particles were characterized using the particle size (grain size) and shape descriptors (Circularity Index (IC), Aspect Ratio (AS)). The particle identification, size and these indexes have been undertaken through image treatment, with ImageJ Program. This treatment allowed to characterize the whole particles size range and to estimate the particles volume. All samples were analyzed and photographed with a Leika® MZ6 stereomicroscope equipped with a photographic camera and non-polarized natural light at an image resolution of 5.0 megapixels. It was selected a 8x zoom to take the photographs and to run the image treatment analysis. A grid of 4 mm was employed to scan through the whole filter. Similar light conditions were fixed for each picture to guarantee a standard process in each filter. Multiple light focuses were used in order to avoid the creation of shadows. To discriminate particles a filter Corel Paintshop Program was used.

Saharan dust events were monitored following the web portal of the Barcelona Super Computing Center¹⁷. Airborne concentrations in the dust events during sampling days were up to 10 µg/m³ and a dust deposition up to 2 mg/m²day. Saharan dust before, during and after the sampling period, permitted to determine the terrigenous input into the Canary Basin and their lithogenic fluxes in Saharan dust events and the lithogenic fluxes at 150 m depth in the mesopelagic layer.

¹⁷<http://www.bsc.es/earth-sciences/mineral-dust-forecast-system/bsc-dream8b-forecast/north-africa-europe-and-middle-ea-1>

PRELIMINAR MORPHOMETRIC CHARACTERIZATION OF THE SUBMARINE VOLCANIC CONES IN THE SOUTHERN PROMONTORY OF EL HIERRO ISLAND

Fernández-Salas, L.M.¹, Vázquez, J.T.², Díaz del Río, V.², López-González, N.², Rueda, J.L.², Fraile-Nuez, E.³

¹*Instituto Español de Oceanografía, Centro Oceanográfico de Cádiz. Muelle Pesquero S/N. 11006 Cádiz*

²*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga. Puerto Pesquero S/N. 29640 Fuengirola*

³*Instituto Español de Oceanografía, Centro Oceanográfico de Canarias. Vía Espaldón. Dársena pesquera PCL 8. 38180 Santa Cruz de Tenerife*

Abstract

Quantitative characterization of the size and shape of volcanic edifices is an essential step towards the understanding of factors controlling volcano growth and morphology (Grosse et al., 2012). The study of volcano morphology can give valuable insights into these processes and their underlying causes, i.e. tectonic/structural setting, magma composition and flux, eruptive style and climate (Davidson and De Silva, 2000; Mitchell, 2001). The aim of this paper is to define a set of morphometric parameters that characterize the size and shape of the volcanic buildings and to permit an interpretation in terms of volcanological processes. This work has been developed in the framework of the VULCANO Project.

Bathymetric digital elevation model (DEM) of the seafloor obtained during the oceanographic cruise VULCANO0313 onboard R/V “Angeles Alvariño” has been analysed. Bathymetric data were acquired by a Kongsberg Simrad EM-710 multibeam echosounder (70 to 100 kHz) with a spatial resolution of 5 m. The used methodology for the extraction of the morphometric parameters of volcanic edifices has been modified of Grosse et al. (2002). In order to carry out morphometric computations, the spatial extent of each volcano was defined combining profile curvature and slope in a single data layer. The generated layer is used to trace the boundary by manually searching for the best path around the edifice. A set of morphometric parameters was calculated as: basal area, major basal axis, perimeter, height, volume, ellipticity index and irregularity index.

A total of twenty-six volcanic cones have been defined in the southern rift of El Hierro island, in the adjacent area to the recent volcanic episode from 2011. The cones are in a water depth ranging between 150 and 1100 m in both flanks of the southern rift. Three main types of edifice shapes can be distinguished based on irregularity and ellipticity indexes: (1) conical edifices, with a more circular and regular shape, (2) composite or subconical edifices, with intermediate values and (3) complex edifices or massifs with irregular shapes. The height/width and height/volume ratios do not separate these three groups. Grosse et al. (2012) used these parameters to distinguish between those groups in emerged Nicaraguan volcanoes, therefore it is possible that the applied methodology need to adapt to submarine environment and may be that seafloor slope is a key factor to explain the different results between marine and terrestrial environment. Some differences between the volcanic edifices on the eastern flank of the rift and on the rift axis can be discerned based on height/width and height/volume ratios. This last ratio seems to show a clustering of edifices indicating a relationship with the meso-scale ridges identified in the southern rift. The cone of the most recent eruption produced in 2011 does not show differentiable parameters with respect to the other. Normally, it shows intermediate values of all parameters, indicating that this new cone does not have a special constructional morphology to other cones generated at previous eruptive events.

The used methodology can produce consistent and comparable morphometric datasets that enable to quantitatively document volcano edifice morphologies. Morphometric data can be used both for detailed analysis of a single or a few volcanoes, and for comparisons at a regional scale. It will be an interesting

task the comparison between submarine and terrestrial emerged volcanoes edifices. Finally, it is necessary to improve the knowledge and investigate about the morphometric parameters as indicators of the constructive and destructive processes acting on submarine and terrestrial volcanoes and their resulting morphologies.

References

- Grosse, P., van Wyk de Vries, B., Euillades, P.A., Kervyn, M. and Petrinovic, I.A. 2012. Systematic morphometric characterization of volcanic edifices using digital elevation models. *Geomorphology*, 136: 114-131.
- Mitchell, N.C. 2001. Transition from circular to stellate forms of submarine volcanoes. *Journal of Geophysical Research*, 106 (B2): 1987-2003.

Fisheries

ROLE OF ONSHORE INFRASTRUCTURE ON FISHING EFFORT AND OVERFISHING: EXAMPLE OF THE CANARY ISLANDS.

José J. Castro¹, Vicente Hernández-García¹, Lorena Couce-Montero¹, Alberto Bilbao-Sieyro² & Antonio Barrera-Luján¹

¹*Departamento de Biología, Universidad de Las Palmas de Gran Canaria, Edf. Ciencias Básicas, Campus de Tafira, 35017 Las Palmas de Gran Canaria, Spain*

²*Gestión del Medio Rural de Canarias (GMR Canarias), Avda. Alcalde José Ramírez Bethencourt, 17, 35004 Las Palmas de Gran Canaria. Spain*

Abstract

Although the fishery management policy in the Canary Islands has been based on the limitation of fishing effort (limiting the type and quantity of certain fishing gear and reducing the number of fishing boats), it has not been successful in reducing overcapacity and overfishing. The increase in fishing capacity as a result of improvements in vessels and the onshore infrastructure to assist the artisanal fleet, as well as the intensification of recreational fishing, has led to a significant growth in the effective fishing effort despite progressive decrease in the number of artisanal fishing vessels and professional fishermen by 59.1% and 80%, respectively, between 1968 and 2012.

The fishing overcapacity has far exceeded the productive capacity of the island waters; thus, the various stocks have been subjected to a progressive decrease in their biomass, which may be the prelude to the collapse of the small-scale fishery. Between 1969 and 2008, the average abundance of benthic-demersal species targeted by the artisanal trap fishery decreased by 89.9%.

Historical evolution of the captures in Canary Islands**David Jimenez Alvarado, José J. Castro***University of Las Palmas de Gran Canaria, Spain***Abstract**

During the last 50 years, we have suffered an important ecologic loss in the aquatic ecosystems. A loss of biodiversity, a decrease in mean length and number of individuals of the fisheries target species. These species have suffered a major pressure from the fishermen, even coming to disappear. To demonstrate this loss in target species is a difficult task because we have not enough information to work whit. The historic photographs provide us so much qualitative and quantitative evidences about the changes at the individual length of every specie as well as the variation trough the years of the target species. We have measured these differences between the species because of the photos of recreational fisheries took in the Canary Islands from the 50s up to the present days, and we have observed a significant decrease in length and quantity of these fish species caught.

The application of the ecosystem approach to fisheries in the Mediterranean and Black Seas**Fontán, L., Leonart, J., Maynou F.***Institut de Ciències del Mar, CSIC, Barcelona, Spain***Abstract**

The FP7 EU Project CREAM concerns improving research in support of scientific advice to fisheries management in the Mediterranean and Black Seas. The project aims to establish an effective collaboration network among key role players in Mediterranean and Black Sea fisheries.

The overall objective is to support the application of the Ecosystem Approach to Fisheries and work fostering integrated collaboration among stakeholders, scientists and fisheries managers to enhance the sustainability of fishery resources.

This was achieved by collecting information on activities carried out by international organizations in relation to the EAF. The CREAM project launched a questionnaire asking decision makers and stakeholders of these organizations about their regional research programmes and management actions. Here we present results obtained from the questionnaires, including concerns about the implementation of EAF to the Mediterranean and Black Sea. Some recognised gaps and shortcomings in the implementation of EAF, for example the need for cooperation and coordination in data collection, assessment advice and management was expressed. The project delivered activities to stakeholders in order to help harmonize data collection and methodologies used in fisheries assessment and management. The project served to establish the guidelines for the application of the EAF, both in EU member states and third countries.

The consortium consisted of 22 institutions, 17 countries, 1 international agency, eight EU countries, nine non EU countries and five International bodies as external participants.

A key objective now is to establish a collaboration network among key role players, fisheries researchers and managers. Moreover training and capacity building activities regarding data collection and methodologies used in fisheries assessment and management are other important aspects that were attempted to achieve.

Population dynamics of *Tivela hians* (Bivalve: Veneridae) in the subtidal zone of Balcones Cape, Talara, Peru.**Carrasco, P.***Facultad de Ciencias Biológicas, Departamento Académico de Pesquería y Zoología Universidad Nacional "Pedro Ruiz Gallo"***Abstract**

The *Tivela hians* mollusk, locally call "White Shell", holds an artisanal fishery of importance growing in the North zone of Peru, but not been scientifically evaluated or has policy for an adequate extraction. Growth and size distribution were analyzed monthly since August 2011 to July 2012 in a population located 4°41' 40.09" S - 81° 18'40.50" W, approximately 3 km of Balcones Cape, Talara, Peru. Samples were obtained from commercial catches, and were measured the high valvar of the individuals collected at the Artisanal Fisheries Laboratory of Sea Institute of Peru–Santa Rosa (IMARPE for its acronym in Spanish). The parameters of the von Bertalanffy growth function (VBGF) and Total Mortality were estimated using la subroutine ELEFAN I and the catch linearized curve Method, respectively, of program FISAT II (FAO-ICLARM Fish Stock Assessment Tools).

The length range was 14 to 68 mm, were more representative individuals with sizes between 36 to 47 mm (63 %). A significant recruitment pulse was detected between January and March, and higher reproductive activity from July to September, months when the sea surface temperature (SST) had the lowest records (17°C on average). The Growth parameters were $L_{\infty} = 71.90$ mm; $K = 0.90$ y^{-1} ; $C = 0.37$ and $WP = 0.61$. Seasonally growth adjusted better in the VBGF ($R_n = 2.47$) and oceanographic conditions, the difference between sea surface temperature in summer was 7°C highest than winter. The Total Mortality (Z), Fishing Mortality (F) and Natural Mortality (M) were 5.12, 4.01 and 1.11, respectively. The Index of exploitation ($E = 0.78$) and fishing mortality suggest that the population of this natural bank is being overexploited.

Keywords: *Tivela hians*, white shell, population dynamics, Talara, growth.

Ecological modelling for the multispecies artisanal fishery of Gran Canaria

Lorena Couce Montero¹, Ángelo Santana del Pino², Lourdes Trujillo Castellano³, José Juan Castro Hernández¹

¹*Departamento de Biología, Universidad de Las Palmas de Gran Canaria, Campus de Tafira s/n, 35017, Tafira, Spain*

²*Departamento de Matemáticas, Universidad de Las Palmas de Gran Canaria, Campus de Tafira s/n, 35017, Tafira, Spain.*

³*Departamento de Análisis Económico Aplicado, Universidad de Las Palmas de Gran Canaria, Campus de Tafira s/n, 35017, Tafira, Spain.*

Abstract

An ecosystem model for the Gran Canaria island is presented with the goal of providing a tool for the understanding of ecosystem dynamics in a multi-species context. We used an Ecopath with Ecosim model to integrate known aspects of the ecosystem and its inhabitants into a single framework, with the aim to gain a better insight into the structure and functioning of the ecosystem and to assess the impacts of fishing in these data-limited fisheries.

A total of 34 ecological groups were included in the model, focusing on the exploited part of ecosystem. Marine mammals, seabirds, turtles, fish groups, invertebrates groups, primary producers and detritus are included in the model.

The structure of the model is discussed and mixed trophic impact analysis was undertaken to determine the direct and indirect effects of biomass changes within and between groups in the system, including the effects of fishing.

Current situation of the resources of Bluefin tuna, *Thunnus thynnus* (L.), in the Northern Atlantic Ocean and Mediterranean Sea

José Luis Cort

Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Spain

Abstract

Atlantic bluefin tuna (ABFT), *Thunnus thynnus* (L.), is a migratory fish that can measure 3.3 m, weigh up to 725 kg and surpass 35 years of age. It is distributed in the Atlantic Ocean and Mediterranean Sea, and its migrations are closely associated with the strong current systems. It has been traditionally fished with tuna traps.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for managing ABFT, and in carrying out this task ICCAT has split the stocks in two, West and East (including the Mediterranean). The boundary between the two stocks is defined as the 45° W meridian. Nevertheless, high and variable rates of mixing of the two stocks from one year to another have been demonstrated. The changing state of eastern stock fishing resources over the last hundred years is discussed in the present study.

Given the enormous amount of information published on the traps of the Strait of Gibraltar and the long time it spans, ABFT catches by this gear were used as indicators of spawning stock biomass (SSB) in times when the data available were not as reliable as those of the present day. This is the case of the standardized abundance indices.

The sustainability observed in the traps fishery for over forty years (1914-1960), with mean catches of around 10,000 t/year, declined in the mid-sixties for two main causes:

1/ The start of purse seine fisheries in northern Europe, particularly in Norwegian waters, which targeted ABFT spawners. These fisheries flourished for just ten years, with catches of around 8,000 t/year.

2/ The massive catch of juveniles using purse seine and baitboat throughout the temperate region of the Atlantic Ocean from the beginning of the fifties. As a result, the annual catch of 18,000 t of spawners (traps + northern Europe), added to the 4,000 t/year of juveniles, was unsustainable and led to the immediate decline of the traps fishery and the collapse of the northern European fisheries.

Something similar happened to western Atlantic ABFT at the beginning of the sixties when Japanese longline fisheries developed off the coasts of Brazil and purse seine targeting juveniles off those of the US.

By the time ICCAT was legally effective in 1969, following its foundation in 1966, Atlantic ABFT fisheries had already been in a state of overfishing for several years, which forced the newly formed Commission to adopt conservation measures from its very beginning. The first of these, in 1975, was a size limit of 6.4 kg.

Over two decades passed, however, before this measure was finally applied in the eastern Atlantic and Mediterranean, and over two decades after having been incorporated into the legislation of its member states, which shows that even though ICCAT had taken preventative steps, there were no means, or perhaps no political will, to limit the illegal fishing of this species. In addition, quotas of < 2000 t per year were adopted in 1982 and are still applied in the western Atlantic fisheries.

From the 1970s the Mediterranean purse seine fishery developed to target ABFT, which had up until then mainly been caught by the numerous traps throughout the Mediterranean. For over two decades (1970-1995) purse seiners exerted very considerable pressure on ABFT (adults and juveniles), reaching a record catch of 50,000 t in 1995, which revealed the vast potential of ABFT resources in the Mediterranean Sea.

From the late 1990s the pressure became even greater as the catch of spawners for fattening farms began, a development which brought with it a great deal of illegal and, therefore, undeclared fishing at a time when the catch of the eastern stock had already become subject to a Total Allowable Catch (TAC) of 32,000 t, introduced in 1998. By then the Mediterranean purse seine fleets had increased alarmingly, mainly those of France and Italy, which had done so under the protection of EU (which adhered to ICCAT in 2000) fisheries policy, a policy that ignored the recommendation made by ICCAT in 1991 to freeze purse seine fishing effort in the Mediterranean. If we take the number of purse seiners as an indicator of fishing effort, only Spain put this conservation measure into practice from the date ICCAT recommended it. There were six Spanish purse seiners 1991, and six remain today.

During the sessions for the assessment of ABFT resources by the experts of ICCAT's Scientific Committee for Research and Statistics (SCRS) in 2006, 2008 and 2010, mention was made of the difficulties in the correct assessment of the eastern Atlantic stock owing to the lack of reliable information on fishing activities in the Mediterranean. Nevertheless, all the scientific indicators available to the SCRS pointed to a fall of over 50% in SSB, and an immediate reduction in fishing pressure was recommended to avoid the collapse of the stock, which forced ICCAT to adopt a Recovery Plan (RP) in 2006. This RP included a gradual reduction of the TAC that reached 12,900 t by 2012, and an increase in the size limit to 30 kg (120 cm, 4 years), which has now eliminated most of the juvenile fisheries.

In the seven years that the Recovery Plan has been in force, scientific activities have intensified, fishing controls have increased and existing conservation measures have been implemented, all of which has contributed to the swift recovery of the stock, as evidenced by the last assessment made by the SCRS in 2012. Under the new scenario, SSB has doubled and juvenile mortality has fallen to the lowest levels of the historical series. The annual mean weight of catches is now at 100 kg (7 years), whereas for the last forty years it has been at 25 kg (3 years).

Despite the evident recovery of the eastern stock, the SCRS report remains highly reserved, and ICCAT has maintained the same TAC as in 2013. Nevertheless, in their September 2014 stock assessment session the ABFT assessment group is likely to recommend that ICCAT increase the TAC for the coming years.

Sala Jerónimo Saavedra

Biological Oceanography

The submarine volcano eruption off El Hierro Island: Effects on the scattering biota and the evolution of the pelagic community

A.V. Ariza¹, S. Kaartvedt², A. Røstad², J.C. Garijo¹, J. Arístegui¹, E. Fraile-Nuez³, S. Hernández-León¹.

¹*Instituto de Oceanografía y Cambio global, Universidad de Las Palmas de Gran Canaria, Las Palmas, Canary Islands, Spain*

²*Red Sea Research Center, King Abdullah University of Science and Technology, Thuwal, Makkah, Saudi Arabia*

³*Instituto Español de Oceanografía, Centro Oceanográfico de Canarias, Santa Cruz de Tenerife, Canary Islands, Spain*

Abstract

The submarine volcano eruption off El Hierro Island (Canary Islands) occurring on 10th October 2011 promoted dramatic perturbations in the water column leading to changes in the pelagic fauna. In order to study the response of the scattering biota, we combined acoustic data with hydrographic profiles and concurrent sea surface turbidity indexes from satellite imagery. We also monitored the evolution of the plankton and nekton communities through the eruptive and post-eruptive phases. Decrease of oxygen, acidification, rising temperature and dumping of chemicals in shallow waters resulted in a reduction of epipelagic stocks and a disruption of diel vertical migration (nocturnal ascent) of mesopelagic organisms. Furthermore, decreased light levels at depth caused by extinction in the volcanic plume resulted in a significant shallowing of the deep acoustic scattering layer. Once the eruption ceased, the pelagic biota restored to baseline levels, but no evidence of a volcano-induced bloom was apparent in the plankton community.

Microsatellite DNA reveals low genetic differentiation among chub mackerel (*Scomber colias*) sampled in Atlantic and Mediterranean**C. Medina-Alcaraz, J. J. Castro and P. A. Sosa**

Departamento de Biología. Facultad de Ciencias del Mar. Universidad de Las Palmas de Gran Canaria. Campus Universitario de Tafira, 35017, Las Palmas de Gran Canaria. Canary Islands, Spain.

Abstract

The family *Scombridae* contains 15 genera and about 51 species of epipelagic and migratory marine fish. One of the most representative species of this family is the mackerel (*Scomber colias*, Gmelin, 1789), which lives in warm waters off the coast of the Atlantic Ocean and Mediterranean Sea but is also prevalent in the African coast from Morocco to South Africa.

Mackerel is an economically and ecologically world interest species, which in 2011 was in the fifth position of the 25 species most captured, reached nearly 1.72 million tons of global captures in the world (FAO, 2011).

The main objective of this work is to assess genetic diversity and population genetic structure of mackerel (*Scomber colias*) comparing Atlantic and Western Mediterranean. Was performed using genetic markers microsatellites described by Yagishita and Kobayashi, 2008.

The results show a high genetic diversity in each population, revealing a high polymorphism and number of alleles per locus. Analyses indicated that a large genetic homogeneity existed among all Atlantic and Mediterranean populations. The low genetic differentiation between the study areas is indicative of a panmictic scenario among all natural populations of *Scomber colias*. The absence of correlation between the genetic distance and the geographic distance indicates that the connectivity pattern among Atlantic grounds does not fit an isolation by distance model (IBD) (Kimura and Weiss, 1964) so the Strait of Gibraltar is a communication way that allows an Atlantic-Mediterranean larval flow (Velasco et al. 2011), as well as a genetic flow between the Atlantic and the Mediterranean.

There is a high gene flow between populations but a slight restriction to this flow was observed at the eastern most side of the Alboran Sea what suggests that the Almeria–Oran Oceanographic Front is an effective barrier keeping apart populations of Atlantic and Almeria of Melilla-Vilanova.

Development of a fluorescent method for the detection in marine organisms of the respiratory electron transport system

F. Maldonado¹, T. Packard¹, M. Gómez¹, J.J. Santana-Rodríguez²

¹Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria

²Departamento de Química, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria

Abstract

Respiration consumes oxygen, produces CO₂, and utilizes organic carbon[1]. It is fundamental to marine life and key to assessing metabolism in the ocean[2]. However, because ocean respiration is nearly undetectable by current technology, an enzymatic method based on the electron transport system (ETS) technique was developed[3, 4]. The problem in using this approach stems from the diffuse nature of ocean plankton and the difficulty and cost in concentrating it. Methodology to minimize these two factors is necessary and explored here.

To improve ETS detection, we test a sensitive fluorometric method using diaphorase as proxy for plankton potential respiration. The detection uses the dye, resazurin that is reduced by the ETS, to form resorufin a fluorescent compound. We optimized the reactant concentrations involved in this reduction.

The reactants and the range of concentration for the reduced pyridine nucleotides were: nicotinamide adenine dinucleotide (NADH), 0.1 to 3 mM; nicotinamide adenine dinucleotide phosphate (NADPH), 0.05-0.5 mM; and the salt of the tricarboxylic acid, sodium succinate, 0.5 to 0.5 M. Diaphorase from *Clostridium kluyvery* was used as reference standard (0.02U).

A series of preliminary tests with zooplankton comparing the classic spectrophotometric method with the one we want to introduce shows that both methods are equivalent. The spectrofluorometric assay shows promise in the detection of the respiratory electron transport of the marine plankton, reducing biomasses, minimizing the time, the effort and the costs of the sampling.

References

1. Lane, N. 2010. Life Ascending. Oxford University Press, New York.
2. Williams, Peter J. le B., et al. The Oligotrophic Ocean Is Autotrophic Annual review of marine science 5 (2013): 535-549.
3. Packard, T.T., 1985. Measurement of electron transport activity of marine microplankton. In: Williams, P.J.LeB., Jannasch, H.W. (Eds.), Advances in Aquatic Microbiology. Academic Press, New York, pp. 207-261.
4. Packard, T.T., 1985. Oxygen consumption in the ocean: measuring and mapping with enzyme analysis. In: Zirino, A. (Ed.), Mapping Strategies in Chemical Oceanography. American Chemical Society, Washington, D.C.

Fitness of generalised maturity scales for elasmobranchs with a practical example of the angelshark *Squatina squatina*.**Filip Osaer^{1,2,3}, Krupskaya Narváez^{1,2,3}, José G. Pajuelo², José M. Lorenzo²**¹*ELASMOCAN, Asociación Canaria para la Investigación y Conservación de los Elasmobranchios*²*Departamento de Biología, Universidad de Las Palmas de Gran Canaria, Edificio de Ciencias Básicas*³*Fundación Colombiana para la Investigación y Conservación de Tiburones y Rayas, SQUALUS***Abstract**

Improvements related to nomenclature, criteria, uniformity and standardization of macroscopic generalised sexual maturity scales for elasmobranchs are presented, based on data from the angelshark *Squatina squatina*. Individuals of angelshark were sampled from incidental captures of the artisanal fishery in the island of Gran Canaria (Canary Islands, Central-East Atlantic). The male reproductive tract consists of paired testes, epididymides, ductus deferens, seminal vesicles and claspers. The female reproductive tract consists of paired ovaries, ostia, and oviducts. Macroscopic condition indices of key organs from the reproductive tract can elucidate five maturity phases in males and females respectively: juvenile, subadult, developing, active / gravid and spent / post-partum. Conflicts to adopt the sexual development of this species to recent proposed generalised maturity scales for viviparous elasmobranchs are useful to enhance the scales. Emphasize is made in comprehensive and unambiguous criteria of macroscopic condition indices while maintaining uniformity in nomenclature with other studies.

The use of image analysis systems for the assessment of zooplankton physiological rates and carbon fluxes: a comparison with enz**Garijo, J. C. & Hernández-León, S.***Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Campus de Tafira. 35017, Gran Canaria, Spain***Abstract**

Measuring zooplankton physiological rates is of paramount importance in biological oceanography in order to assess the role of this community in e.g., carbon fluxes. Classical methods (incubations) are highly time-consuming and impractical to match physical and chemical measurements in oceanography. Attempting to solve this, a variety of methods (egg production, RNA/DNA ratio, enzyme activities, etc.) have evolved over the last decades. These methods also show many uncertainties and hitherto only incubation methods have been widely accepted. Predictive equations relating physiological processes and body weight and temperature, are a rough alternative normally used to ascertain the role of these organisms in the ecosystem. However, using imaging systems and empirical relationships to determine body weight allow the application of physiological models to each individual, obtaining reliable estimations for taxonomic groups and size classes. In this study, the physiological rates assessed from predictive equations in combination with an image-based analysis system (ZooImage) were compared with enzymatic methods. We observed a consistent agreement between both methodologies, the former resulting a faster procedure for the appraisal of community carbon fluxes in large spatial and temporal scales.

Keywords: Zooplankton, image analysis, physiology, carbon fluxes.

Feeding habits of bluefin tuna (*Thunnus thynnus*) in the Strait of Gibraltar: stomach-content and stable-isotope analyses**JM Sorell¹, A Medina¹, N Goñi², H Arrizabalaga², JL Varela¹**¹*Departamento de Biología, Universidad de Cádiz, República Saharaui s/n, Puerto Real, España*²*AZTI Tecnalia, Herrera Kaia Portualdea z/g. Pasaia, España***Abstract**

The Strait of Gibraltar is often viewed as a mere transit area for highly migratory fishes moving between feeding and spawning grounds. Nevertheless, the existence of a commercial fishery of bluefin tuna, *Thunnus thynnus* (Linnaeus, 1758), all year round suggests extended residency of some schools in this area, and hence an important role of the Strait of Gibraltar as a significant foraging ground for bluefin. While most bluefin tuna caught by trap nets during the spawning migration to the Mediterranean Sea show empty stomachs, the specimens caught by baitboat in non-breeding months appear to be active feeders, since a variety of preys are found in their stomachs. In this study, the feeding habits of the bluefin tuna in the Strait of Gibraltar were investigated during two consecutive years using stomach-content (SCA) and stable-isotope (SIA) analyses in combination with isotopic mixing model analysis.

In 2012 and 2013, 186 bluefin tuna ranging between 63 and 212 cm in fork length were captured in the Strait of Gibraltar by commercial baitboat vessels from October through January. The stomachs were removed and frozen at -18 °C until use. Prey items were classified into large taxonomic categories using specific identification keys based on morphological characteristics, and occasionally molecular methods. For all stomachs the mass, length, digestion stage and occurrence of each identified prey item were recorded. In addition, small pieces (20-50 g) of liver and white muscle were removed from each sampled tuna for further carbon and nitrogen SIA. Samples of the main preys were also collected and frozen at -18 °C in 2012 for isotopic analysis and stable-isotope mixing model. The dietary importance of each prey item was assessed by the following indices: i) percentage of weight (%W), ii) frequency of occurrence (%O), and iii) alimentary index (%AI). The interannual variation in the prey composition of bluefin tuna diet was assessed through a correspondence analysis (CA), a multivariate technique based on decomposing the Chi-square statistic associated with a pivot table into orthogonal factors. In addition, the stable isotope mixing model of Parnell et al. (2010) was applied to estimate the dietary contribution of prey species using the tissue-specific discrimination factors estimated experimentally for bluefin tuna in a previous study.

Of the 186 stomachs analysed, 55 (30.22%) were empty. In terms of %W, %O and %AI, crustacean was the most representative prey group, *Sergia robusta* being the most abundant species. The CA defined three distinct prey groups in the bluefin tuna diet: a) clupeids, b) ommastrephids, and c) all other preys. The outcomes of the stable isotope mixing models using muscle and liver tissues were similar, and showed that mesopelagic fishes (*Chauliodus sloani*, *Myctophum punctatum* and *Maurolicus muelleri*) constituted the predominant prey group. Our results suggest that the Strait of Gibraltar plays a role in the feeding of resident populations of bluefin tuna.

Microzooplankton grazing experiments: What is going on during incubation?**Laia Armengol and Santiago Hernández-León***Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria***Abstract**

Microzooplankton grazing was measured at different time intervals during incubation. Grazing is normally measured in 24 hour experiments following the dilution method. However, knowledge about changes in grazing during incubation is lacking. Time-series experiments were performed in order to study changes in grazing upon picoplankton. Sampling took place during 24-30 hours, and every 2 hours in order to follow grazing variability. Higher grazing rates were found during the first 6 hours of the experiment, mainly upon picoeukaryote cells and increasing during night. We also show opposite patterns between growth and grazing during incubation. Grazing observed clearly showed an important variability during the course of experiments deserving further research in order to improve grazing assessment in the ocean.

Phytosociology of halophilic species from the genus *Tamarix L.* (*Tamaricaceae*) on the island of Gran Canaria**Ana Rosa Barry Gómez***Departamento de Biología. Universidad de Las Palmas de Gran Canaria***Abstract**

Forested *Tamarix L.* species found in the Canary Islands as in the Western Mediterranean Basin and the Saharo-Arabian area are included in the class Nerio-Tamaricetea within the order *Tamaricetalia africanae* order recognized by the Canaries that does not include *Tamarix africana Poir.*, and the halophilic and halotolerant their communities are included in the alliance *Tamaricion boveano-canariensis* with the new partnership *Atriplici ifniensis Tamaricetum canariensis* endemic to the Canary Islands, which is also poor in the characteristic species of the class and to be defined almost exclusively for Tenerife requires a broader review.

There are serious doubts about the location of the species *Tamarix africana Poir.* in the Canary Islands, although their presence has been noted by some authors (Web & Berthelot, Bannerman, Kunkel, Sventenius, Barry, etc.) defining taxonomically to certain areas of Gran Canaria and Fuerteventura. You would think that this species would be grouped in the phytosociological *Tamaricetalia africanae* community, which would be a new community to the Canary Islands with a respective new association that would in itself be different from the mentioned so far. Moreover *Tamarix boveana* Bunge species has recently been cited for the island of Fuerteventura where interesting corological and ecological data of the species are given. It is therefore proposed here provide ecological details phytocenosis, associated species and type of scrub accompanying to *T. africana Poir.*, opening possibilities for comparative phytosociological and syntaxonomical review with the other species of *Tamarix L.* in the Canary Islands.

Biodiversity**First assess of the ecological role of the *Histioteuthidae* (Mollusca, Cephalopoda) at the Central-east Atlantic****Borras-Fuentes, S., V. Hernández-García, C. Díez, R. Santos-Bethencourt and J.J. Castro***Departamento de Biología, Edif. Ciencias Básicas, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, C. P. 35017, Taira Baja, Las Palmas de Gran Canaria, Spain***Abstract**

The role of the *Histioteuthidae* species at the Central-east Atlantic is described in base to data from fishing surveys, and the analysis of stomach contents of small-middle and large sized predators.

From a total of 658 cephalopod beaks found in a single stomach of a sperm whale (*Physeter macrocephalus*), 535 belonged to four *Histioteuthidae* species. These results, together with those from research surveys and other stomach contents, indicate that these squids play an important role in the marine ecosystem at the Central-east Atlantic.

An integrated marine data repository based on the Arc Marine model. A pilot project in the Canary Islands

Antonio Machado, Juan Antonio Bermejo and Ignacio Lorenzo

Observatorio Ambiental Granadilla (OAG), Tenerife, Canary Islands, Spain. info@oag-fundacion.org – www.oag-fundacion.org

Abstract

Marine data are expensive to obtain, and if paid with public money, they should be made available to any interested user (scientists, authorities, fishermen, other sea users, etc.). We aim to offer a regional public repository for marine data in an integrated way that preserves the original data but maximises their potential use (correlations, etc.). In this sense, our GIS is not designed for a specific output or function as is normal practice, and tries to surpass the frontiers of interoperability. The REDMIC project, being centred on the Canary Islands, should be easy to replicate in other marine regions and can be used either as a public repository or as an institutional repository. It is conceived to facilitate data visualization and accessibility.

At present, the conceptual and physical design of the geodatabase is finished and we are working with the user interface and testing cases with available data to tune up the model. In this presentation we focus just on the conceptual framework. The other parts: user access, data policy and embargo regime, analytical basic tools, visualization, etc., would require another more extensive presentation.

For setting the integrated marine geodatabase the Arc Marine model (Wright et al. 2007) was chosen. Redmic also benefited from Arc Marine case examples published by ESRI, and particularly from the initiative of the Irish Marine Institute which also works on the integration of marine data. The end result is a rather complex geodatabase that makes use of all the marine features recognised by Arc Marine, plus one additional type: the radius point. As a strategy, we aim to keep the geodatabase as compact as possible and limit the amount of separate datasets to a minimum (for instance, raster data have to be kept in individualised datasets and linked via the Raster Catalogue).

The general design has a core centred on two basic tables, the activity and the measurement. The activity (= generates a specific kind of marine data) is linked to projects and programs, and classified in activity types to facilitate access. Organisations, contacts and platforms are linked to it and harbour the bulk of administrative metadata. Measurements are related to quantitative data (Instant Data and Time Series) as well as to qualitative data (Observation and Observation Series). These latter can be of physical Objects (stones, debris, ships) or Species, and admit any kind of qualifiers (colour, texture, etc.), metrics (biometry) or analytic data as a second level of related information, in addition to position and counts (first level). A specific development has been made for individual Animals with special histories (recovery, tagging, radiotracking, etc.) and for the census activities in order to face their potential complexity. The recording of bibliographic citations of species is also supported by our model as a type of activity.

Furthermore, lines (incl. tracks) and marine areas can be handled with great flexibility and bear any kind of classifications in sectors or zones (bionomic, uses, geological type, etc.). They may represent individual activities (e.g. setting of protected areas), or be integrated with other geometries in other activities (e.g. a parcel in a survey).

An effort has been made to extract common elements from the data registering subsystems. These supportive groups are: Devices, Samples, Data Definition (parameters), Times Series Definition, Qualifiers & Attributes, and Ancillary Data (for second level data). Devices, for instance, cover sampling devices as well as analytical instruments (with calibration information), and work the same way in any of the

many tables that relate to a device. Samples may be physical (volume of water or sediments, fish catch, etc.) as well as “samples of time” (useful for monitoring and census purposes).

Linked libraries cover video records, photobank, soundtracks and documents. Quality control (Sea-DataNet Vflag + Qflag) is performed in Q-control sessions to which data relate, and qualitative data receive a simple confidence index.

We foresee at least 54 different types of activities, grouped in 7 categories according to the kind of data, namely: Geology-Geomorphology, Hydrology, Meteorology, Physical-Chemical, Biodiversity, Anthropogenic elements, Resource extractions, and Special (video, etc.). The Arc Marine model was generated based mainly on oceanographic and hydrological data, and this is a test of how it can be expanded to cover all kinds of data obtained from the sea, especially those of qualitative nature or related to biodiversity. Redmic has not been tested so far, and it will take time and resources (not yet secured). We present here our project framework in search of constructive criticism and are open to collaboration. During this Symposium, the module of REDMIC for species chorology will be shown to interested people.

The OAG is a Spanish State foundation based in the Canary Islands and created in 2008 as a consequence of a European Commission Decision related to the new industrial port of Granadilla. One of its aims, among others, is to follow-up the biodiversity in waters around the Canary Islands and, by extension, in the archipelagos of Madeira and the Azores.

The application of phylogeographic analysis toward the conservation of marine biodiversity of Macaronesian and Cape Verd islands

Manent P, Quinteiro J, Rodríguez-Castro J, Pérez-Dieguez L, Rey-Méndez M, Gois AR, Alves A, Araújo R, Carreira G, et al

Universidad de Las Palmas de Gran Canaria

Abstract

The long-term conservation of marine biodiversity is still a challenge issue because elucidate the complexity of biological mechanisms, ecological interactions and evolutionary processes underlying the hierarchy of biodiversity are mostly hard to obtain. However, population genetic studies can efficiently incorporate the knowledge of evolutionary processes and the distribution of genetic diversity into a conservation planning. Hence, priority setting for populations within species with: (i) high levels of genetic diversity and (ii) the delineation of Evolutionary Significant Units as historically isolated lineages (sensu Moritz 2002) can be useful information to efficiently preserve both relevant attributes and keystone processes that create and sustain biodiversity.

In the marine realm, oceanic archipelagos are spots which facilitate stepping stone colonization events towards new distant habitats across the oceans expanding the geographic distribution of marine species and/or maintaining genetic connectivity across the landscape. In contrast, marine species living in oceanic archipelagos might not interchange gametes, larvae or adults among other archipelagos and/or mainland, reaching reproductive isolation. Hence, the contribution of oceanic archipelagos to the evolution of marine biota in the central Eastern Atlantic Ocean has been decisive. In this sense, inferences on the levels of genetic diversity and the spatial scale for which gene flow maintains genetic connectivity among oceanic islands across the Eastern Atlantic ocean applied to preserve island marine biodiversity is still scarce.

Thus, the aim of the present study try to understand the genetic structure and the levels of genetic connectivity among the Azores, Madeira, Canary and Cape Verde archipelagos located in the Eastern Atlantic using several benthic and demersal marine species. Those species included the common octopus *Octopus vulgaris*, the Azorean barnacle *Megabalanus azoricus*, the parrotfish *Sparisoma cretense*, the grapsid *Grapsus adscensionis* and the soldier striped shrimp *Plesionika edwardsii*. A total of 50 specimens per archipelago were sampled. After DNA extraction using up to 30 mg of tissue and following the E.Z.N.A. Tissue mollusk kit (Omega Bio-Tek) protocol, the mitochondrial hypervariable non-codifying control region was amplified using both specific primers designed for this study and PCR conditions for each species. After chromatogram revision, the nucleotide sequences were aligned and then nucleotide and haplotype diversity, FST, AMOVA, phylogenetic Neighbour-Joining Tree and haplotype Median Joining Network were performed to resolve the questions and hypothesis related to each analysis. The combination of all above analyses showed a phylogeographic pattern for *M. azoricus*, *G. adscensionis* and *O. vulgaris* in which the haplotypes of Cape verde population reached the highest levels of significant genetic differentiation. This fact clearly manifest that the Macaronesian archipelagos (Azores, Madeira and Canary Islands) have maintained higher levels of genetic connectivity among them, favoured by the oceanic currents of the subtropical gyre in the central northeastern Atlantic. In contrast, *S. cretense* and *P. edwardsii* showed a panmitic population in the whole area, including the capeverdian population for which no significant genetic differentiation was detected. Hence, a mixed effect produced by both the canary current that continuously drive larval dispersal southward and the evolutionary history of the species during the quaternary glaciations could explain the evolutionary history among all archipelagos. Thus, the current geographic distribution of divergent majoritarian haplogroups and genetic diversity estimates

among species and archipelagos were mainly explained by life cycle, habitat availability, demography and dispersal capacity as well as the oceanographic dynamics in the area.

Keeping in mind the main objective regard to conservation genetics should be the maintenance of evolutionary processes and the viability of species and functional landscapes necessary to achieve this. Thus, the above phylogeographic analyses will allow using genetic diversity to highlight discrete genetic units (Evolutionary Significant Units or Conservation Units) as historically isolated lineages considering the landscape across the macaronesian and Cape Verde islands.

An insight into the populations of Blainville's and Cuvier's beaked whales off El Hierro (Canary Islands): abundance estimation and social structure**C. Reyes¹, A. Schiavi¹ and N. Aguilar Soto^{1,2}**¹*BIOECOMAC. Department of Animal Biology, Geology and Edaphology. La Laguna University, Tenerife, Spain*²*SMRU. University of St. Andrews, Scotland***Abstract**

Beaked whales (Fam. Ziphiidae) appear to be highly sensitive to some acoustic sources, which can lead to mass strandings. The lack of knowledge about the population dynamics and reproductive parameters of these species impedes the assessment of potential population-level effects of stranding mortalities. Estimating the abundance and density of beaked whales is more difficult than for many other cetacean species, due to the difficulty in identifying most beaked whales to species level in visual surveys. All this has resulted in few population estimates in the published literature.

El Hierro (Canary Islands) harbours resident populations of Blainville's and Cuvier's beaked whales in deep waters close to the shore. This has made possible to perform one of the few long-term monitoring of beaked whale populations taking place in the world (on-going since 2003). Data have been used to estimate population abundance in the area and to determine life history parameters of the species such as i) age at sexual maturity for females ii) age of first reproduction for females, iii) weaning period for the calves, and iv) inter-calving interval. The combined effort of observers from a coastal cliff and from a boat increases the effective detection of groups of beaked whales. Once a group is detected the boat approaches it for photoID and to gather data on the social composition of the group. PhotoID data are open online in one of the largest individual catalogues available for these species (www.cetabase.info). The marked population, animals with regular to very good photos and recognizable marks in the same area of the body, comprises 51 Blainville's and 51 Cuvier's beaked whales. The sighting history of these animals was used to estimate population size using mark-recapture techniques, resulting in a best estimate of 61 Cuvier's and 50 Blainville's beaked whales. Of the recognizable animals, 40% and 60% of the individuals of each species, respectively, were observed only once during the last decade. Some of these whales may be transients, i.e. they visited the area only once, while others may have been in the area and passed unnoticed, move to other regions of the island or may return to El Hierro after some years. The remaining part of the population can be considered as the core residents in El Hierro, with whales of both species that have been observed in up to nine different years from 2003 to 2014. This includes individuals seen for the first time as young which have achieved sexual maturity and reproduced in the area during the study, providing an age of sexual maturity and first birth for females of 10-11 and 11-12 years, respectively; an average inter-calf interval of 3 years, as low as two years in one case where the first calf was missing; and a weaning age of 2-3 years. Data are scarcer for Cuvier's than for Blainville's beaked whales due to the lower visibility of the teeth used to identify the gender in Cuvier's beaked whales, and the lower number of groups of this species observed with young in El Hierro. Only one adult female was recorded with two young calves, resulting in an inter-calf interval of four years. The high site fidelity observed in El Hierro is consistent with similar results observed in the other study areas where long-term monitoring of these species has been possible: Hawaii and Bahamas. In relation with social structure, Blainville's beaked whales form stable short and medium term associations but these change on the long term. Females associate with different males in consecutive calving periods and associations of several females with young tend to last until females mate again. The social structure of Blainville's seems to be defined by a polygamous breeding system with a long-term fission-fusion strategy. These data show the increasing value of long-term monitoring of beaked whale populations to

obtain novel data about their social structure and reproductive parameters. These data are essential in order to feed transfer functions for PCAD models of population-level impact of acoustic sources.

Are ship strikes sustainable for the population of sperm whales in the Canary Islands?**Fais A.¹, Lewis T. P.¹, Zitterbart D. P.^{2,3}, Álvarez O.^{1,4} and Aguilar de Soto N.^{1,5}**¹*Biología, Ecología Marina y Conservación (BIOECOMAC), Dept. Animal Biology, Geology and Edaphology. La Laguna University, Tenerife, Canary Islands, Spain*²*Ocean Acoustics Lab, Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Germany.* ³*Department of Physics, University of Erlangen-Nuremberg, Germany*⁴*CIMA Canarias, Arzobispo Elías Yanes 44, 38206 La Laguna, Tenerife, Canary Islands, Spain* ⁵*Sea Mammal Research Unit (SMRU), Scottish Ocean Institute, University of St. Andrews, Scotland.***Abstract**

The Canary Islands have one of the highest reported rates of sperm whale ship-strikes in the world. Sperm whales inhabit the archipelago year-round, making it an important area for this species in the North Atlantic. Here we investigate if the rate of ship-strike mortality is sustainable in the archipelago and propose mitigation measures. The absolute abundance of sperm whales in an area of 52933 km², covering the territorial waters of the Canary Islands, was estimated from 2668 km of acoustic line-transect survey using Distance sampling. Biologging data on sperm whale diving behaviour were used to calculate $g(0)=0.92$ (CV of 1.7%), resulting in an estimate of 220 sperm whales (95% log-normal CI 117-412) in the survey area. The minimum annual collision rate recorded in the Canary Islands is likely to exceed the natality of this number of whales. We found that sperm whales aggregated in the same areas within the archipelago for periods of over a decade, suggesting that these important habitats may make the archipelago an attractive sink area. In the absence of data on population structure of sperm whales in the Canary Islands, it is important to apply mitigation measures immediately in order to reduce ship-strike mortality risk. Such measures should include: the relocation of International Maritime Organization designated shipping lanes, which currently cross high-use areas, the monitoring of cetaceans, the implementation of re-routing or speed limit schemes in high-use areas, the reporting of sperm whale detections and a system to inform mariners about whale locations in the archipelago.

Increasing *Cymodocea nodosa* seedling survival at sea after their genesis in vitro.**Francisco Vila¹, Fernando Tuya², Maite Zarranz³, Luis Rieiro Leite¹, Rafael Robaina³ and Óscar Bergasa¹**¹*elittoral SLNE, Estudios de ingeniería costera y oceanográfica*²*BIOGES, Universidad de las Palmas de Gran Canaria*³*Grupo de Investigación en Fisiología vegetal marina, Universidad de Las Palmas de Gran Canaria***Abstract**

The seagrass meadows are globally in decline due basically to anthropic pressure. In Gran Canaria, *Cymodocea nodosa* has suffered a severe regression in recent decades (Tuya et al. 2014). It is for this reason that conservation and propagation techniques of the species to degraded areas are required.

The propagation of the specie with seedlings germinated in laboratory through harvested seeds from a donor meadow is a valid technique. Seeds germinate in vitro (Zarranz et al. 2010) and once they have got a seedling of about 10 cm, they are moved to the sea for its spread.

The CYMOLAB project aims to improve survival of these seedlings in the marine environment. The two bottlenecks that largely condition the success of transplants are herbivory and hydrodynamics. For this reason a new methodology has been developed to minimize the negative effect of both processes. The method consists of surrounding the seedlings with artificial synthetic beams (raffia plastic) that have a similar *C. nodosa* leaf color.

This experience has been tested in two different locations of Gran Canaria: Las Canteras beach and Gando's Bay. Transplants were performed experimentally manipulating two factors: protected seedlings with artificial raffia and unprotected seedlings, and transplanted seedlings with and without fertilizer.

In the monitoring realized, the following biometric were analyzed: Beam length (maximum and average), survival rate, epiphytes and number of bites (bitemarks).

Although the project is still in progress, the results obtained so far are encouraging: an excellent performance of artificial raffia to herbivory (very few bite marks) is observed in comparison with the specimens which had no such protection. Furthermore, the technique has great effectiveness in the protection of transplanted individuals, in the presence of storms, in retention of sediments and speed reduction, once the patches that were protected survived much longer. Additionally an increased of epiphytes on specimens protected regarding unprotected ones wasn't observed. Also, no statistically significant differences between individuals with and without fertilizer were observed.

References

F. Tuya, Ribeiro-Leite, L., Arto-Cuesta, N., Coca, J., Haroun, R., Espino, F. (2014) Decadal changes in the structure of *Cymodocea nodosa* seagrass meadows: Natural vs. human influences. *Estuarine, Coastal and Shelf Science* 137: 41-49.

Zarranz Elso, M., González-Henríquez, N., García-Jiménez, P., Robaina, R.R. (2010). Restoration of *Cymodocea nodosa* (Uchria) Ascherson seagrass meadows through seed propagation. Germination in vitro, seedlings culture and field transplants. *Bot. Mar.* 53 (2): 173-181.

Biological Oceanography

Resilience of benthic assemblages in a marine protected area: the underwater volcanic eruption in El Hierro (Canary Islands)

Sabrina Clemente¹, José Carlos Mendoza¹, Bernat Hereu², Natali Lazzari¹, José Carlos Hernández¹

¹Biodiversidad, Ecología Marina y Conservación. Dpto. Biología Animal, Edafología y Geología. UDI Ciencias Marinas. Facultad de Biología. Universidad de La Laguna

²Departament d'Ecologia, Universitat de Barcelona

Abstract

Natural disturbances create opportunities for species to claim previously utilized space and resources. The widespread and massive disturbance caused by catastrophic events provides ideal conditions for rapid recruitment and spread of certain species. This study was conducted across El Hierro (Canary Islands), an island impacted by an underwater volcanic eruption starting on October 2011. Despite the eruption was 100 m deep off the southwest of the island, it triggered severe mass mortalities of many organisms due to the release of gasses that changed seawater chemistry with severe pH reductions. Nearshore benthic communities were exposed to pulses of changing sea water conditions during the five months of the eruptive processes that could potentially compromise the activity and composition of local communities.

Within this study we mainly focused on the dynamics of the sea urchin *Diadema africanum* given that it is a well-known key herbivore species that determines the structure of benthic ecosystems in the region. Even more, the volcanic event coincided in time with the annual settlement peak of the species. We present data on the recruitment dynamics of *D. africanum* in relation to the disturbance caused by the eruption and the relative abundance of its predators at the first two months post-eruption, as well as at further periodic monitoring of its populations up to 26 months post-eruption.

Results showed significant differences before and after the eruption at the area closer to the impact, while sites within the east and north of the island showed no variation in sea urchin abundances through time. Sea urchin population size distributions, as well as the abundance and composition of urchin predatory fish, significantly differed from pre-eruption levels at the most impacted sites in comparison to non-affected sites. We showed that this initial recruitment pulse may be due to a release from predation control during the post-settlement and recruitment stage related to the disturbance of the benthic systems. However, at about two years following the eruption, the marine protected area showed high resilience, with a high capacity to control the initial pulse of sea urchin recruitment, mainly due to the recovery of fish consumers of juvenile sea urchins. Results suggest that despite sea urchins did comprise the dominant component of the fauna in the early stages of the successional response to the disturbance and assemblages have not yet achieved a complete recovery, protection measures were effective in controlling the sudden recruitment of the species. The higher resilience of the marine protected area accelerated the rebound of benthic assemblages towards a more equilibrated system, avoiding long-lasting structural consequences for the community.

Importance and implications of variability in respiration quotient (RQ): Marine bacterial experiments**V. Romero-Kutzner,¹ T.T. Packard¹, Elisa Berdalet², S. Roy³, May Gómez¹**¹*Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria 35017, Spain*²*Institut de Ciències del Mar (CSIC), Passeig Marítim de la Barceloneta, 37-49, 08003 Barcelona, Spain*³*10 Ryan Court, Embrun, Ontario, Canada K0A 1W0***Abstract**

In the following study respiratory metabolism of two different physiological states in distinct nutrient type grown cultures of two marine bacteria were compared because of the key role respiration plays in ocean processes. Respiration (R) throughout the ocean is ubiquitous; it consumes organic carbon and produces CO₂. For the oxic parts of the world ocean, where R also consumes oxygen during aerobic respiration, we focus on the relationship between CO₂ production and the concurrent utilization of O₂. For the last 500 million years R has balanced oxygenic photosynthesis (P) on the planet (Lyons et al., 2014) and, likely in the marine carbon cycle also. However, until the Winkler O₂ technique was modified (Bryan et al. 1976) R was not well researched because it was so difficult to measure. With this improved technology, oceanographers began to note an excess of R over P in some parts of the ocean, giving rise to the current controversy about the metabolic balance of the ocean (Ducklow & Doney 2013). The quandary is whether the oligotrophic ocean is autotrophic or heterotrophic. Williams et al. (2012) reported in situ observations where the results using natural seawater isotope composition clearly showed an autotrophic state whereby results from modified Winkler analysis on incubated seawater samples (Duarte et al., 2013) showed a heterotrophic one. One reason for this discrepancy could be the assumed value for the respiration quotient (RQ), a key variable of our study and in their calculations. It is used to convert R in oxygen units from the Winkler analysis into respiratory CO₂ production (RCO₂) in carbon units. Without this conversion respiratory O₂ consumption measurements cannot be compared to photosynthetic carbon production or to plankton primary productivity. Consequently, a deep understanding and careful measurement of RQ is essential for progress in resolving, not only this oceanographic quandary, but also for making many other marine ecosystems calculations, including carbon flux (Packard & Christensen 2004, Steinberg et al. 2008, Packard & Gómez 2013).

In Oceanography there are relatively few measurements of RQ (Oviatt et al. 1986, Robinson et al. 2002). As a result, RQs are calculated theoretically by analyzing the stoichiometry of the complete oxidation of substrates (Takahashi et al. 1985, Anderson 1995, and Hedges et al. 2002). In this approach, tissues or whole organisms oxidizing pure carbohydrate have an RQ of 1.0, those oxidizing fat, an RQ of 0.7, and those oxidizing protein, an RQ of about 0.8 (Fruton and Simmonds, 1959; Cantarow & Schepartz 1967, Guyton 1971, Hoar 1975, Stanier & Forsling 1990). Values outside this range (i.e. 0.7–1.0) are relatively rarely encountered, although RQs below 0.7 can be associated with gluconeogenesis, and transient increases above 1.0 can result from the conversion of carbohydrate into fat (Cantarow & Schepartz 1967). This variability in RQ can indicate fundamental shifts in bacterial physiology and carbon consumption that may occur along the environmental gradients and that cannot be deduced from other measurements (Berggren et al. 2012). The majority of studies of respiration in the aquatic ecosystems are based on assumed RQ values ranging from 0.7 to 1.2 (Berggren et al. 2012). To calculate a true RQ value it is important to accurately calculate the respiratory CO₂ production rate (RCO₂). In the past this was difficult and expensive and so was rarely done. Now, with the development of the CO₂ optode, RCO₂ (Mills et al. 1992) measurements are more feasible (Berggren et al. 2012).

We show here that RQ can range higher than the range reported above. To investigate this wide range, we examine time-courses of the physiological respiration rates (RO_2 and RCO_2) and activities of the enzyme, isocitrate dehydrogenase (IDH) and the respiratory ETS (potential respiratory oxygen consumption, ϕ) in acetate and pyruvate-grown *Pseudomonas nautica* and *Vibrio natriegens*.

More in detail, we analyze experiments of 35 hours duration and experiments of 520 hours duration in which time-courses of protein, pyruvate, acetate, RCO_2 , RO_2 , IDH activity, and ϕ were measured. The cultures were monitored through their exponential growth, their steady state, and their senescence phases. RQs were calculated from the ratio of the respiration rates (RCO_2/RO_2). In all cultures, regardless of bacterial species and carbon source, the RQ tended to rise nearly an order of magnitude from values below 1 during nutrient sufficiency to values close to 10 during nutrient deficiency. The respiration rates during the growth period paralleled the biomass increase but after the nutrients were exhausted the respiration rates fell. Through this same transition period the IDH activity and the ϕ remained relatively high for first 10 hours of nutrient deprivation and then fell slowly, along with the biomass, as the nutrient deprivation continued. During this starvation period the biomass specific IDH and ϕ decreased. This finding challenges the idea that IDH and the respiratory electron transport systems (ETS) are constitutive and can be used for biomass proxies. We conclude that the physiological state of the bacteria affects the RQ. These results argue that many ecosystems models, oceanographic calculations of carbon flux, and evaluations of the ocean's metabolic balance need to be reconsidered in light of this newly discovered RQ variability.

An annual cycle of the offshore transport of organic matter and chlorophyll by an upwelling filament off Cape Ghir (NW Africa)**Yeray Santana Falcón, Javier Arístegui Ruiz et al.***Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria***Abstract**

The bi-monthly variability (from December 2008 to October 2009) of the net coastal-ocean export of particulate organic carbon (POC), dissolved organic carbon (DOC) and chlorophyll a (Chl a) has been studied in the Cape Ghir filament, a recurrent feature located in the NW African upwelling system. The estimated flux of excess total organic carbon (the non-refractory pools of DOC and POC) ranged from 4.6×10^8 to 5×10^9 kg C y^{-1} . DOC represented 65% of the excess organic carbon in February 2009 increasing up to a 80% during an upwelling event that took place in April 2009. Assuming these fluxes are representative of the range in a typical year, the yearly offshore transport of total organic carbon would represent at least 9% of the primary production in this area, reaching up to 57% in periods of intense upwelling events. Since the Cape Ghir filament may extend hundreds of km offshore, its seaward flux of organic carbon would contribute to the high microbial respiration rates reported from the nearby oligotrophic open ocean region. Our results highlight the importance of considering the offshore transport of organic matter channeled by filaments in regional carbon budgets, particularly in eastern boundary regions where upwelling filaments are numerous and recurrent throughout the year.

Carbon Flux, Nutrient Retention Efficiency and the Curvature of Respiration Depth-profiles in the ocean water column**T.T. Packard, N. Osma, I. Fernández-Urruzola, and M. Gómez***Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria***Abstract**

Respiration–depth profiles of microplankton and zooplankton below their respiration maximum in the ocean often can be described mathematically by a power function, $RCO_2 = (RCO_2)_0 (z/z_0)^{-b}$. The magnitude of “b” defines the curvature of the depth-profile. When b is greater than zero, $(RCO_2)_0 (z/z_0)^{-b}$ decreases with depth at a rate, $d[(RCO_2)_0 (z/z_0)^{-b}]/dz$, proportional to the magnitude of b. This means that even if water columns have the same RCO_2 at their respiration maximum, the profile with the highest b will have the lowest RCO_2 at 100 m. The significance of this variability is that when b is small the carbon flux from the epipelagic ocean is high, there is little loss to respiration between depths, and the nutrient retention efficiency (NRE) in the epipelagic ocean is low. When the difference in the carbon flux between two layers normalized by the carbon flux of the upper layer is high the NRE is high, when this relative flux difference is low the NRE is low. The b value for the respiration profiles is inversely related to carbon flux transfer efficiency. When the value for b is high, the relative carbon flux difference between two depths is great, but the transfer efficiency is low. The crux of this is that the attenuation of respiration is critical to understanding both vertical carbon flux in ocean water columns as well as understanding the differences in the capacity of epipelagic ecosystems in retaining their organic carbon and their vital nutrients.

Biodiversity - Biotechnology

What do our schoolchildren know about marine environments? Using seagrasses as a case of study

Ramírez M.C., Ariza A., Azcárate P., and Brun F.G.

Faculty of Marine and Environmental Sciences. Department of Biology (Ecology Area). Puerto Real. 11510. Spain

Abstract

Seagrasses are known to provide crucial ecosystem functions and services increasing in a direct way the human wellbeing. However, at present, seagrass meadows are experiencing a worldwide decline mainly as a result of human derived activities. However, we detected a hidden and larger problem that can be in the origin of such degradation: the lack of charisma of such ecosystems making them invisible both to the main public and to coastal managers. Therefore in order to shift such present status it is necessary not only to increase the presence of seagrass meadows in the media, but also to increase our capacity to transfer the scientific information to citizens and public managers in a language easily understandable by the non-experts. Aware of such situation, we consider that a first step is to identify what the different sectors of the society know about marine ecosystems in general and seagrasses in particular, and which are the channels they used to get such information. Our work takes place in this context, focusing in which was the knowledge of schoolchildren from 10 to 14 years old using a distance gradient from the Cádiz bay (where schoolchildren are in permanent contact with coastal environment) to those schoolchildren living in mountain areas.

We passed a questionnaire in a total of 20 primary schools, 13 from Cádiz bay, 3 from the surroundings and 4 from the mountain areas, yielding in total circa of 2000 questionnaires. Our results showed that the schoolchildren had a better knowledge of those marine ecosystems that are more frequently present in the media (e.g. movies, television programs, ect) and textbooks, in spite of being far from the Spanish coasts (e.g. coral reefs). On the other hand, less than the 10% of the schoolchildren known something about seagrasses, in spite of they are growing within the whole Cádiz bay. Moreover, we did not find any significant difference in the replies of the schoolchildren regarding the distance to Cádiz bay. This can be explained because of their learning process is influenced by media and text books, which is independent of the place they are inhabiting. Finally, we thought that a better transference of the importance of these coastal ecosystems to the schoolchildren trough the use of a didactic unit, or the preparation of specific divulgation materials will improve the management of these crucial ecosystems in a long term.

Assessing fish and invertebrates diversity as a function of pressure of recreational SCUBA diving**Cristiano Menci¹, Jose A Sanabria-Fernandez¹, Rodrigo Riera², Mikel A Becerro¹**¹The BITES Lab, Natural Product and Agrobiology Institute (IPNA-CSIC), La Laguna, Tenerife²Centro de Estudios Medioambientales del Atlántico (CIMA, SL), La Laguna, Tenerife**Abstract**

The growth of the human population in the coastal areas has a several consequences in the marine ecosystem because it buildings harbours, hotels. Canary archipelago's a very popular tourism destination. The local population and the tourism does an activities in the marine environment e.g. recreational fishing, diving. These recreational activities have a direct impact on marine biodiversity. The main objective of our study is to determine relationship between different levels of pressure of scuba divers on marine biodiversity (fishes and invertebrates) out whether the variations between low/high levels of SCUBA diving and recreational fishing, using the diversity of fishes and marine invertebrates. We sampled 20 sampling stations around Tenerife, following RLS (Reef Life Survey) procedures (www.reeflifesurvey.com). We consider two levels of pressure (high and low). We used as univariate community descriptors using the Shannon index (H'), abundance individuals (N) and species richness (S). Comparisons between stations and levels of pressure were conducted using one-way ANOVA and multivariate statistical analysis. A high number of species mainly constrained in places with a high pressure of scuba divers, such as, the sea cucumber *Holothuria sanctori*. To the contrary, the abundances of the crab *Percnon gibessi* and the sea urchin *Diadema africanum* were significantly higher in places with a low pressure of scuba divers, is more abundant in areas of low diver. As we observed, the marine realm in the Canary Islands is drastically affected by overfishing, pollution and a high tourism pressure.

Keywords: SCUBA diving, marine biodiversity, Reef Life Survey, *Holothuria sanctori*, *Diadema africanum*, *Percnon gibessi*

Phenolic Profile Of Macroalgae: *Stypocaulon scoparium*, *Corallina elongata* and *Cystoseira abies-marina***Aroa López, Milagros Rico, Miguel Suárez de Tangil, Argimiro Rivero***Departamento de Química. Universidad de Las Palmas de Gran Canaria***Abstract**

The identification and quantification of phenolic compounds in three algae, red and brown species, from Gran Canaria were carried out to examine their antioxidant profile. Crude extracts were prepared using several solvents: methanol, water and water/methanol (1/1). The phenolic composition of algae extracts was determined by using reverse-phase high-performance liquid chromatography and confirmed by comparing retention times (RT) and overlapping UV spectra with those of standard compounds. Significant differences in the total phenolic content were detected. Gallic acid was by far the predominant polyphenol in *Stypocaulon scoparium* extracts; catechin and epicatechin were most abundant in *Cystoseira abies-marina* extracts and epicatechin was found in greater amount in *Corallina elongata*. The total phenolic contents determined with Folin–Cicolteau's phenol reagent ranged from 123.2 to 328.7 mg gallic acid equivalents per 100 g of dry algae powder. Algae extracts showed antioxidant activity measured as inhibition of radical 1,1-diphenyl-2-picrylhydrazyl. The antioxidant activity and the high amounts of polyphenols found indicated that these algae are ideal for use in the pharmaceutical and food industries.

Carbon distribution in semi-continuous cultures of *Nannochloropsis gaditana* under different pH and temperature conditions.**A. García-Fuentes^{1,2}, J. Forja², L.M. Lubián¹**¹*Instituto de Ciencias Marinas de Andalucía (CSIC)*²*Departamento de Química-Física. Universidad de Cádiz.***Abstract**

This study determinates the carbon distribution for the marine microalga *Nannochloropsis gaditana* when submitted to a semi-continuous culture in a closed photobioreactor system (PBR) under different cultivation conditions.

The cultivation system consisted in a PBR (BIOSTAT®PBRs - 2S), with various combinations of temperature (20° and 25°C) and pH (7.5, 8.0 and 8.5). CO₂ injection was modulated with a pH controller. Biomass, dissolved inorganic carbon (DIC) and dissolved organic carbon (DOC) were sampled daily. The CO₂ release into the exhausting airstream from PBR was measured using an infra-red gas analyzer. Carbon content of microalgal cells, dry weight and specific growth rate also were determined daily.

The averaged cell density during the experiment was $788.35 \pm 57.96 \times 10^6$ cell mL⁻¹, with a maximum of $857.06 \pm 23.92 \times 10^6$ cell mL⁻¹ when culture was submitted at pH 7.5 and 25°C. In this condition, also specific growth rate (0.24 ± 0.02 d⁻¹) and carbon content of microalgal cells (53.90 ± 0.49 %w/w) were the highest of the experiment, with significant differences ($p < 0.05$) respect to other tested conditions. However, dry weight in this treatment was the lowest (4.262 ± 0.277 g L⁻¹), but not significant differences were found when conditions were changed. The maximum of dry weight (4.965 ± 0.318 g L⁻¹) was obtained at pH 8.0 and 20°C.

Carbon fixed as biomass ranged from 28.49 to 42.11 mmol C d⁻¹ L⁻¹ at pH 8.5, 20°C and pH 8.0, 20°C respectively, and does not show a clear or well-defined trend between the different conditions. CO₂ release decreased significantly ($p < 0.01$) with increasing pH, with lowest values of 0.80 and 0.17 for 20° and 25°C respectively at pH 8.5. DIC and DOC showed no significant dependences on pH or temperature.

If these carbon outputs (carbon fixed as biomass, DIC, DOC and CO₂ release) are considered as a whole, we can establish the relative contribution in percentage of each compartment to the carbon stock. We consider the contribution of carbon fixed as biomass as the efficiency of sequestration. In this case, we found that the contribution of biomass increased significantly ($p < 0.01$) from pH 7.5 to 8.0 & 8.5, with the highest value ($p < 0.05$) of 91.80% at pH 8.5, 25°C. The percentage of CO₂ release experimented, for an equal pH, a significant increase ($p < 0.05$) when the temperature was 20°C, and also showed an increase with the decrease of pH ($p < 0.01$), reaching a maximum of 28.76 ± 3.15 % at pH 8.5, 20°C. DIC and DOC did not varied significantly with changes in temperature or pH, ranging their contribution from 5.40 to 10.04% and 0.91 to 1.28% respectively.

These results indicate that the percentage of carbon sequestered as biomass by *N. gaditana* is influenced by culture conditions. However, the carbon fixed as biomass did not show dependences on pH due that *N. gaditana* presents an active HCO₃³⁻ transport system. In our working pH, bicarbonate is in excess, so changes in pH did not vary noticeably the availability of bicarbonate to the cells.

Biologically active sponge metabolites from Canary Islands

Pere Ferriol^{1,2}, Francisco J. Toledo^{1,2}, María J. Mediavilla¹, Juan F. León^{2,3}, Ignacio Brouard^{2,3}, Francisco J. Estévez^{1,2}, Rayco Guedes¹, Jose J. Santana¹, Christian C. Toledo^{1,2}

¹Universidad de Las Palmas de Gran Canaria (ULPGC)

²Instituto Canario de Investigación del Cáncer (ICIC)

³Instituto de Productos Naturales y Agrobiología (IPNA)

Abstract

The marine sponge *Myxilla sp* from Canary Islands is a rich source of steroids. The compounds were identified as stigmast-5-en-3 β -ol (β -sitosterol) (75%), stigmast-5,25-dien-3 β -ol (7%), stigmast-5,24(25)-dien-3 β -ol (2%) and stigmast-5,23-dien-3 β -ol (16%). The mixture of stigmasterols has the aspect of a white solid, is homogeneous by TLC and shows the physical properties as the main β -sitosterol: m.p. 277-278°C, $[\alpha]_D^{25} = -15,2^\circ$ (c 0,2; CHCl₃).

Myxilla sp is also a rich source of pyrimidines and ceramides. The compounds were identified as uracil, thymine, a ceramide mixture and a ceramide-1-phosphate mixture. The 1:1 mixture of pyrimidines has the aspect of a white solid and is homogeneous by TLC. Although it had been isolated from sponges from Indonesia, this is the first time described for the genus *Myxilla*. The ceramide-1-phosphate mixture has the aspect of a white solid and also is homogeneous by TLC (Rf in agreement with the bibliography). The structures were confirmed by HRMS, HPLC-MS and two-dimensional nuclear magnetic resonance spectroscopy (COSY, NOESY, HSQC and HMBC).

The marine sponge *Ircinia sp* from Canary Islands is a rich source of sesterterpenes. The compounds were identified as (8Z,13E,18R,20Z)-strobilin and (8E,13Z,18R,20Z)-strobilin. The mixture of strobilins has the appearance of oil and is homogeneous by TLC. In ¹³C-NMR spectroscopy we can see a doubling of signals of the carbons 8 (δ 134.5/ 135.1), 10 (δ 123.5/ 124.5), 13 (δ 134.9/ 135.7) and 15 (δ 123.9/ 125.1), which informs us that the marine natural product is a mixture of the stereoisomers (8Z, 13E) and (8E, 13Z), in agreement with the described in bibliography. The structures were confirmed by HRMS, and two-dimensional nuclear magnetic resonance spectroscopy (COSY, HSQC and HMBC).

The marine sponge *Verongia aerophoba* from Canary Islands is a rich source of bromotyrosine derived cytotoxics. To obtain enough of the bioactive compounds for application in human therapy, sponges have to be cultured. Before sponge mariculture is accepted as a commercially viable method of supplying bioactive metabolites, it must be demonstrated that adequate production of sponge biomass and metabolite is possible. In this study we provide recent data related with both aspects. Sponge growth rates have been measured in terms of projected area, and the production of three main metabolites (11R,17R-epi-Fistularin-3, Verongiolid and Verongic Acid) in different culture conditions in fish farm effluents have been measured by HPLC (reverse phase, methanol/ water as eluent). The results show that the bioprocess is feasible. The progresses towards quantification of cytotoxic and antileukemic factors (Aeroplysin and dienone) also will be presented.

Laboratory culture of *Caespitella pasceri* (BEA 0149) and *Euglena* sp. (BEA 0937), strains with potential use in Aquaculture**A.C. Peñuela Mendoza, C. Pérez Reyes, J.L. Gómez Pinchetti**¹*Banco Español de Algas (BEA), Instituto de Oceanografía y Cambio Global (IOCAG), Universidad de Las Palmas de G.C., Muelle de Taliarte s/n, 35214 Telde, Canary Islands, Spain***Abstract**

Caespitella pasceri (BEA 0149; Chlorophyceae) and *Euglena* sp. (BEA 0937, Euglenophyceae) were cultivated at laboratory scale to test growth, physiological characterization and biotechnological potential. At the stationary phase, biomass was harvested, freeze dried and then extracted to obtain three different fractions in methanol, n-hexane and water, with the objective to determine the presence of compounds with potential antibiotic activity against fish pathogenic bacteria. Assays with *Listonella anguillarum* and *Photobacterium* sp. were performed using the disk diffusion method. Inhibition zones were observed for the organic extracts from *Caespitella pasceri* against both, *Listonella anguillarum* and *Photobacterium* sp., while aqueous extracts from this strain did not show any activity. Regarding the extracts from *Euglena* sp., only aqueous and methanolic extracts presented inhibition activity against *Photobacterium* sp. and no activity against *Listonella anguillarum*. Results show that both strains, *Caespitella pasceri* and *Euglena* sp., might be useful to avoid and/or treat infections caused by fish pathogenic bacteria.

1 Wednesday, June 11th

General Topics

Atlantic Society of Oceanographers - Sociedad Atlántica de Oceanógrafos

Sociedad Atlántica de Oceanógrafos

Abstract

What is the Atlantic Society of Oceanographers?

The Atlantic Society of Oceanographers (SAO) was founded in 2012 and based in Las Palmas de Gran Canaria, aims to promote professionals and companies who develop their work in different fields and sub-disciplines related to the Marine Sciences, such as:

- Oceanography (Physics, Chemistry, Biology and Geology)
- Mariculture
- Fisheries
- Environmental Management, Coastal and Littoral (ICZM-LOICZM)
- Marine Technology and Structures
- Environmental Education

***What are SAO's goals?**

- Develop strategies in order to preserving and protecting the oceans.
- Promote oceanic scientific research.
- Act as meeting point between professionals and companies that focus their activities on Marine Sciences.
- Identify new lines jobs, business and R&D + innovation.
- Promote sustainable development models.
- Generate programs and training activities, spread information as well as education, and environmental awareness.

***What concrete actions have aimed at developing SAO?**

- Conference on environmental education and science.
- Marine Biodiversity Week, from 7th to 14th October 2013, oral communications on various topics (kelp, marine mammals, marine seaweed, sharks, fishery activities, sea algae,...) had been at the same time carried out in 5 different localities on Gran Canaria (Guía, Las Palmas de Gran Canaria, Telde, Arinaga

and Mogán), bringing science and society closer together and showing “state of the art” about main Marine Sciences professionals fieldworks.

-Signature of Jointed Agreement about Protected Marine Micro Areas Project, managed by the company Oceanográfica Divulgación, Educación y Ciencia, S.L. and SAO, for a period of 5 years.

-The SAO Awards ceremony: taking place on 15th November 2013 the SAO awards, known as The Oceanos, were given in three merit categories to Dr. Francisco Rubio Royo (Category of Individual), Spanish Institute of Oceanography (IEO) (Category of Institution/ Company) and the Fishermen's Association of El Hierro (Category of Collective).

-Professional meetings.

-Dissemination and training sessions aimed at students of Marine Sciences.

Contact us and become a member at: <http://www.sociedadatlanticadeoceanografos.org/>

Ciencia Compartida

Biblioteca de la ULPGC (Ciencias Básicas). Facultad de Ciencias del Mar

Abstract

Ciencia Compartida is the name of the weekly seminars that occur every tuesday in the Sala de Grado of our Marine Science Faculty. This 30 minutes talks have a wide spectra of speakers: PhD and Master students, teachers, professors, scientific people from our university or visitors, entrepreneurs, ecologists, or management people related with the ocean environment.

The seminars are recorded and broadcasted in less than 48 hours through ACCEDA¹⁸, the University Library youtube channel¹⁹, Pinterest²⁰ and Facebook.

How to participate? write us at cienciacompartida@ulpgc.es

We'll be willing to hear from you!!

¹⁸acceda.ulpgc.es

¹⁹www.youtube.com/user/BibliotecaULPGC

²⁰<http://www.pinterest.com/bulpgc/ciencia-compartida/>

Biodiversity

A molecular perspective of the *Laurencia Complex* (Ceramiales, Rhodophyta) in Macaronesia region

Machín-Sánchez M.¹, Hernández-Ferrer M.², Le Gall L.³, Rousseau F.³, Neto A.I.⁴, Cassano V.⁵, Senties A.⁶, Fujii M.⁷, Díaz-Larrea J.⁶, Gil-Rodríguez M.C.¹

¹Botany, Department of Vegetal Biology, University of La Laguna, 38071 Canary Islands, Spain

²Department of Genetic, University of La Laguna, Institute of Tropical Diseases and Public Health of the Canary Islands, 38071 Canary Islands, Spain

³UMR 7205 - ISYEB CNRS, MNHN, UPMC, EPHE, Muséum National d'Histoire Naturelle, 75231 cedex 05 Paris, France

⁴CIRN, Biologia, Universidade dos Açores, Rua da Mãe de Deus Apartado 1422, 9501-801 Ponta Delgada (Açores), and Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR), Rua dos Bragas 289, 4050-123 Porto, Portugal

⁵Department of Botany, Institute of Biosciences, University of São Paulo, São Paulo 05508-090, Brazil

⁶Department of Hydrobiology, Metropolitan University Iztapalapa, a. p. 55-535, México, D.F. 09340, México

⁷Institute of Botany, Phycological Research Nucleous, Av. Miguel Estéfano 3687, 04301-012 São Paulo, Brazil

Abstract

In the present study, we undertook an integrative approach, using molecular data to assess the diversity of the *Laurencia complex* in Macaronesian islands (Azores, Madeira and Canary Islands) where speciation events are supposedly common leading to a high endemism.

Identification of species of the *Laurencia complex* based on anatomical and morphological characters is extremely difficult due to phenotypic plasticity and overlaps in many morphological characters. As a consequence, among the 28 species reported so far from these Macaronesian archipelagos, 14 species records have been regarded as doubtful.

We used DNA barcode data (mitochondrial COI gene and partial nuclear LSU marker) as a tool for species delimitation. A third marker (rbcL gene) was also studied and phylogenetic analyses were carried out using the three independent markers as well as the combined data set, in the aim to infer the phylogenetic relationships and biogeographic affinities of members of the complex from Macaronesia.

Our results proved the usefulness of the DNA barcode markers for uncovering several putative new species of the *Laurencia complex* in Macaronesia and phylogenetic results revealed the existence of a potential new genus present in Canary Islands, which adds to the six pre-existing genera: *Laurencia*, *Osmundea*, *Chondrophycus*, *Palisada*, *Yuzurua* and *Laurenciella*.

Decapod assemblages in deep Mauritanian waters

Sara Castillo^{1,2}, Susana S. de Matos-Pita¹, Fran Ramil¹ and Ana Ramos²

¹Facultade de Ciencias do Mar, Universidade de Vigo

²Instituto Español de Oceanografía, Centro oceanográfico de Vigo

Abstract

Crustacean decapods are amongst the dominant groups of megabenthic invertebrates in the Atlantic continental shelf and slope. Although studies on West African decapod fauna are numerous, knowledge on their communities is scarce and focussed in Namibian (Macpherson, 1991), South African (Kensley, 2006) and Guinea-Bissauan (Muñoz et al. 2012) waters. However, nothing is currently known on the structure and composition of the crustacean decapod assemblages off Mauritania.

Between 2007 and 2010 the Spanish Institute of Oceanography (IEO) carried out four annual multi-disciplinary surveys of one month's duration in Mauritanian waters, from Cape Blanc to the Senegal River. Conducted in collaboration with the Mauritanian Institute for Oceanographic Research and Fisheries (IMROP) and the University of Vigo (Spain), these surveys were part of a larger programme (ECOAFRIK) focussing on the study of the biodiversity of African benthic ecosystems. Maurit-0911 and Maurit-1011 surveys sampled five transects perpendicular to the coast at five bathymetric strata using an Agassiz trawl.

We identified a total of 77 decapod species belonging to 36 families. Brachyura was the richest group, with 28 species, followed by *Caridea* (21 spp.), *Anomura* (14 spp.), *Dendrobranchyata* (10 spp.) and *Macrura Reptantia* (6 spp.). The most diverse families were Paguridae, Pandalidae, Inachidae and Pasiphaeidae (with 6-5 spp. each).

We defined four bathymetric main assemblages: continental shelf (<150 m), break shelf and upper slope (150–300 m), middle slope (500 m) and deep slope (1000–1500 m).

Mean species richness decreased with depth from deep shelf to slope (16 to 4 species), while the highest abundance and biomass were found in the break shelf and upper slope. Although the Pielou's evenness index peaked in the deepest strata (>500 m), no clear pattern was observed for the Shannon- Wiener diversity index. The maximum similarity value (47.6%) corresponded to the shelf assemblage due to the abundance of three brachyuran species: *Calappa pelii*, *Inachus angolensis* and *Solenolambrus noor-dendei*. As expected, absolute dissimilarity (100%) was found between the shelf and deep slope assemblages.

Identifying the main features (distribution, structure and composition) of the decapods' communities is a key issue to assess the effects of the trawling pressure on them in Mauritanian fishing grounds.

References

- Kensley, B. (2006) Pelagic shrimp (Crustacea: Decapoda) from the shelf and oceanic waters in the southeastern Atlantic Ocean off South Africa. *Proceed. Biol. Soc. Washington*, 119: 384–394.
- Macpherson, E. (1991) Biogeography and community structure of the decapod crustacean fauna off Namibia (Southeast Atlantic). *Journ. Crust. Biol.*, 11: 401–415.
- Muñoz, I., García-Isarch, E., Sobrino, I., Burgos, C., Funny, R. and González-Porto, M. (2012) Distribution, abundance and assemblages of decapod crustaceans in waters off Guinea-Bissau (north-west Africa). *Journ. Mar. Biol. Ass. UK*, 92(3): 475-494.

Biotechnology

The brown macroalgae *Cystoseira abies-marina* as a natural source of D-(+)-mannitol

Toledo Marante F.J.¹, Pérez Rocha A.¹, Bravo de Laguna I.H.¹, Mioso R.²

¹Universidad de Las Palmas de Gran Canaria (ULPGC, Spain), Grupo de Tecnología Química y Desarrollo Sostenible

²Universidade Federal da Paraíba (UFPB, Brazil), Centro de Biotecnología (CBIOTEC)

Abstract

Cystoseira abies marina is a brown macroalgae that inhabits the coast of the Canary Islands and has caught our attention by our Canary islands Industrial Development Project (DISCAN-2007), due to its potential as a natural source of high added-value products from marine origin. The literature indicated the presence in their organic extracts of high content of polyunsaturated fatty acids 16:3 and 16:4 (w-3), monogalactosyldiacylglycerols, triacylglycerols, phospholipids, sterols (mainly fucosterol), meroterpenes, and sulfated polysaccharides of different molecular weights and sulfate contents which exhibit potent anticoagulant activity. With this background, it was decided to improve the knowledge about the natural product chemistry of this interesting seaweed.

Fresh seaweed biomass of *C. abies marina* was submitted to Soxhlet extraction with acetone followed by concentration on a rotary evaporator. The crude extract upon evaporation afforded a dark-brown syrup. Column chromatography was carried out eluting with n-hexane/ ethyl acetate trough successive increasing amounts of the last solvent. The fractions were monitored by thin layer chromatography (TLC) and joined by similarity. Finally, two fractions were isolated according to their chromatography behaviour: one polar, and other non-polar that were analyzed and characterized.

The so-called "non-polar fraction" was found to be composed of alkanes and fatty acids as revealed by NMR spectroscopy. The "polar fraction" (~2.2% on a wet weight) was found to be formed by D-(+)-mannitol, which was recrystallized from acetone: m.p. 165-166°C: $[\alpha]_{D20} = + 0.32^\circ$ (c= 2.185, water). The acetylated derivative crystallized in the form of transparent hexagonal crystals, and its mix melting point (with authentic mannitol acetate) gave 123-124°C which is consistent with the literature data. The optical rotation also agreed with the literature value: $[\alpha]_{D20} = + 23.32^\circ$ (c= 1.90, chloroform).

As conclusion, *Cystoseira abies marina* offers a great potential natural source of D-(+)-mannitol, an important monosaccharide used in the pharmaceutical industries and nutraceutical companies.

Identification of the conserved motifs in the 5'UTR of the Ornithine Decarboxylase gene involved in reproduction of red seaweeds

Montero-Fernández, M., Robaina, R.R. & García-Jiménez, P.

Departamento de Biología. Facultad de Ciencias del Mar. Universidad de Las Palmas de Gran Canaria. 35017 Las Palmas de Gran Canaria. Canary Islands. Spain.

Abstract

Red seaweeds are organisms commonly found worldwide which represent an important economical resource. As its relevance in the nourishment and nutraceutical industries has been increasing over the years, the employment of biotechnology for molecular investigation has become a powerful tool. The ornithine decarboxylase (OC, EC 4.1.1.17) is a key enzyme in charge of the polyamines synthesis that has been extensively related to the reproduction of red seaweeds, mainly involved in maturation of the cystocarps and spores release. By cloning the ODC gene, the study of different expression patterns in fertile and unfertile thalli has been favored (1). Furthermore, the characterization of the flanking area (5'UTR) of this gene would allow revealing those motifs involved in the up and down-expression of this gene. In this context, by using the inverse Polymerase Chain Reaction (iPCR), the complete structure of this gene is being elucidated. Initially, from the coding partial sequence (1), the 5 flanking region (5' UTR) of this gene has been determined by chromosome walking. Moreover, conserved motifs have been identified according to different databases such as JASPAR Core, RBPDB, among others. These motifs have been mainly related to transcription factors regulated by ethylene, jasmonic acid and light (2, 3).

The characterization and identification of these regions allows obtaining a better knowledge of the complete gene 'machinery' and consequently, designing expression 'vectors' that incorporate in vitro new motifs to overexpress or silence the gene. These resulting cassettes or vectors could be used to study genetic transformations in multiple systems, both heterologous and homologous.

References

1. García-Jiménez, P., García-Maroto, F., Garrido-Cárdenas, J.A., Ferrándiz, C. & Robaina, R. R. 2009. Differential expression of the ornithine decarboxylase gene during carposporogenesis in the thallus of the red seaweed *Grateloupia imbricata* (Halymeniaceae). *J. Plant Physiol.* 166:1745-1754.
2. García-Jiménez, P. & Robaina, R.R. 2012. Effects of ethylene on tetrasporogenesis in *Pterocladia capillacea* (Rhodophyta). *J. Phycol.* 48: 710-715.
3. García-Jiménez, P., Brito-Romano, O. & Robaina, R.R. 2013. Production of volatiles by the red seaweed *Gelidium arbuscula* (Rhodophyta): emission of ethylene and dimethyl sulfide. *J. Phycol.* 49 (4): 661–669.

A Parallel Future for Ocean Research?

May Gómez, Ico Martínez, Ted Packard

BIOCEANSolutions S.L., Las Palmas de Gran Canaria, Canary Islands, Spain

Abstract

Today, science is difficult to pursue because funding is so tenuous. In such a financial climate, researchers need to consider parallel alternatives to ensure that scientific research can continue. Based on this thinking, we created BIOCEANSolutions, a company born of a research group.

A great variety of environmental regulations and standards have emerged over recent years with the purpose of protecting natural ecosystems. These have enabled us to link our research to the market of environmental management. Marine activities can alter environmental conditions, resulting in changes in physiological states, species diversity, abundance, and biomass in the local biological communities. In this way, we can apply our knowledge, to plankton ecophysiology and biochemical oceanography. We measure enzyme activities as bio-indicators of energy metabolism and other physiological rates and biologic-oceanographic processes in marine organisms. This information provides insight into the health of marine communities, the stress levels of individual organisms, and potential anomalies that may be affecting them. In the process of verifying standards and complying with regulations, we can apply our analytic capability and knowledge. The main analyses that we offer are: (1) the activity of the electron transport system (ETS) or potential respiration (Φ), (2) the physiological measurement of respiration (oxygen consumption), (3) the activity of Isocitrate dehydrogenase (IDH), (4) the respiratory CO₂ production, and (5) the activity of Glutamate dehydrogenase (GDH) and (6) the physiological measurement of ammonium excretion.

In addition, our experience in a productive research group allows us to pursue and develop technical-experimental activities such as marine and freshwater aquaculture, oceanographic field sampling, as well as providing guidance, counseling, and academic services.

In summary, this new company will permit us to create a symbiosis between public and private sectors that serve clients and will allow us to grow and expand as a research team.

Determination of polyphenols and antioxidant activity of monoclonal cultures of marine microalgae and cyanobacteria.

Idaira Jerez Martel, Argimiro Rivero Rosales, Miguel Suárez de Tangil Navarro, Juan Luis Gómez Pinchetti

University of Las Palmas de Gran Canaria, Spain

Abstract

Nowhere on Earth exists a biological diversity as large as in the oceans, providing abundant resources for research and development. The special geoclimatic conditions in the Canary Islands, with high solar radiation, represent a challenge for marine photosynthetic metabolism, favoring the development of strategies for the prevention of cellular damage. It has been found that the presence of phenolic derivatives, especially polyphenols, effectively prevents the development of oxidative processes (1). Polyphenols neutralize free radicals that are naturally formed, and which are initiators of cellular oxidative processes. In this regard, single-celled organisms such as marine microalgae and cyanobacteria, offer a high potentiality in terms of obtaining new compounds due to their relative ease of controlled cultivation in laboratory. Although marine macroalgae have received considerable attention in recent years, microorganisms remain enough absent in these studies.

In this work, we propose a study on the potentiality of cultivating microalgae and cyanobacteria for the production of natural antioxidants. For this, we have analyzed five monoclonal samples of microalgae and cyanobacteria from marine waters of the Canary Islands and cultivated in the laboratory under different conditions. These samples were isolated, grown and harvested by the Centro de Biotecnología Marina (Center for Marine Biotechnology) and form part of the collection of the Banco Español de Algas (Spanish Bank of Algae).

The polyphenol content analysis was performed using the Folin-Ciocalteu reagent (2) widely used in such trials. In order to determine the antioxidant activity of the polyphenols produced by these microorganisms, the extracts were subjected to trials of neutralization of radical DPPH (REF).

The results presented show the potentiality of the culture of marine organisms for obtaining new antioxidant systems.

References

- (1) Ferrazzano, G.F., Amato, I., Ingenito, A., Zarrelli, A., Pinto, G. & Pollio, A. (2011). Plant polyphenols and their anti-cariogenic properties: a review. *Molecules*, 16, 1486-1507
- (2) Singleton, V.L., Orthofer, R. & Lamuela-Raventos, R.M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods in Enzymology*, 299, 152-178
- (3) Chu, Y., Chang, Z.L. & Hsu, H.F. (2000). Flavonoid content of several vegetables and their antioxidant activity. *Journal of the Science and Food Agriculture*, 80, 561-56

Marine Cultures

Design, equipment and budget of a pilot training farm for the integral culture of tropical freshwater aquatic animals.

Vergara Martín, J.M., Saúl Lugo Garrido and Raúl Ginés Sánchez.

University of Las Palmas de Gran Canaria, Spain

Abstract

This facility is designed to be part of a Training Centre in Aquatic Biotechnology and Resources for Technicians in the Equatorial Africa. Its overall aim is to support regional economic development through the sustainable exploitation of live aquatic resources. Students will be trained in Tropical freshwater aquaculture, including:

- Design and building of rural aquaculture farms.
- Training in freshwater fish and crustaceans culture.
- Working in aquaculture farms (facilities maintenance, fish and crustacean management and production).
- Working in aquaculture extension services.

In addition, fish produced at this pilot farm will provide broodstock and fry for regional rural farms. Trained personell can be an usefull tool to disseminate tropical freshwater aquaculture in the region through the teaching of how to design , build and manage rural aquaculture farms in locations with aquatic resources such as lakes, rivers or water reservoirs, improving their life standards through the production of cheap, high quality protein for human consumption. In addition, economic profits can be also achieved through the sale of cultured aquatic animals in local markets.

Part of the trained personell can be contracted to maintain this pilot farm, which will be financed in the long term by the sale of produced animals, both in local markets and in rural farms allready existing or developed as a consequence of this project.

Physiologic and metabolic effects of nutrient enrichments on adult *Artemia franciscana*

Martínez I.¹, Packard T.T.¹, Segade A.², Gómez M.¹

¹Plankton Ecophysiology Group (EOMAR). Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain

²Aquaculture Research Group (GIA). Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain

Abstract

Brine shrimp nauplii (*Artemia sp.*) are used in aquaculture as the major food source for many cultured marine larvae, and also used in the adult phase for many juvenile and adult fish. One artemia species, *Artemia franciscana* is most commonly preferred, due to the availability of its cysts and to its ease in hatching and biomass production. The problem with *A. franciscana* is that its nutritional quality is relatively poor in essential fatty acids, so that it is common practice to enrich it with emulsions like SELCO and ORIGO. This “bioencapsulation” enrichment method permits the incorporation of different kinds of products into the artemia. This brine-shrimp’s non-selective particle-feeding habits, makes it particularly suitable for this enrichment process. The bioencapsulation is done just prior to feeding the artemia to a predator organism. This allows the delivery of different substances, not only for nutrient enrichment, but also for changing pigmentation and administering medicine. This is especially useful in culturing ornamental seahorses and tropical fish in marine aquaria.

In this study the objectives were to determine, the relative nutrient value of ORIGO and SELCO as well as the optimal exposure to these supplements prior to their use as food-organisms. Accordingly, a number of brine-shrimp, from a stock culture of adult *A. franciscana*, were starved for 24h and incubated in SELCO emulsion for 6 h. In parallel some adults from the same stock were incubated in ORIGO for the same initial 24h. Then half of these fed-adults were given more ORIGO (at the same concentration) while the other half were given SELCO. All three cultures were then monitored for respiration during the 6h. At the end of the 6h ETS activity and protein were measured in the 3 cultures. The mean R, Φ , and M results at the end of the experiment were: $6.17 \pm 1.27 \mu\text{LO}_2 \text{ h}^{-1} \text{ ind}^{-1}$; $11.52 \pm 1.37 \mu\text{LO}_2 \text{ h}^{-1} \text{ ind}^{-1}$; $0.41 \pm 0.06 \text{ mg protein ind}^{-1}$. These are within the ranges found in the literature. The results show that pre-exposure to ORIGO stimulates respiration in artemia for at least 6 h. They also show that ORIGO stimulates respiration more than SELCO during this same period.

An overview of astaxanthin determination in marine biological samples

Tania Darias-Hernández¹, M^a Esther Torres-Padrón¹, Lidia Robaina-Robaina², Zoraida Sosa-Ferrera¹, José Juan Santana-Rodríguez¹

¹*Departamento de Química, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria*

²*Grupo de Investigación en Acuicultura. Universidad de Las Palmas de Gran Canaria*

Abstract

Astaxanthin (AX) (3,3'-dihydroxy- β,β -carotene-4,4'-dione) is a pigment that belongs to the family of the xanthophylls, the oxygenated derivatives of carotenoids whose synthesis in plants derives from lycopene. AX, which may not be synthesized *de novo* by animals, is one of the main pigments in marine ecosystems found in crustacean, and many fish species. In pelagic marine food webs, copepods are the main producers of AX, being also the principal components of Antarctic Krill pigment. Thus, in the aquaculture industry AX is present in feed formulations for salmonids and other farmed fish species, where represent an important cost of the feeds.

Depending in their origin, AX can be found in association with other compounds. It may be sterified in one or both hydroxyl groups with different fatty acids such as palmitic, oleic, estearic, or linoleic. It may also be found free, that is, with the hydroxyl groups without sterification; or else, forming a chemical complex with proteins (carotenoproteins) or lipoproteins (carotenolipoproteins). Synthetic AX is not sterified while found in algae is always sterified.

AX has an enormous commercial and industrial prospect. Therefore, due the growing demand for natural foods has been stimulated the search for natural sources of AX with potential for industrialization like microalgae, shrimp, krill, crab and langostilla between them. In the aquaculture context, the use of AX for the feeding industry is important not only from the standpoint of pigmentation to increase consumer acceptance but also as a necessary nutrient for adequate growth and reproduction of commercially valuable species.

Therefore, the accurate determination of AX forms in this kind of biological matrices is necessary which involves extraction prior to their determination. In this work, a review of the reported methods for the analysis of AX in marine organisms implied in the aquaculture industry (microalgae, shrimps, crabs and fishes) which are always based on Liquid Chromatography (LC) coupled to different detectors like diode array (DAD) and mass spectrometry (MS) was done. At the same time different extraction and clean-up techniques currently employed are discussed.

Protected all against the radiation: Solar protector for your skin, Mycosporines for the algae

Juan C. Ly, Valentina P. Sandoval, Nelso P. Navarro

Universidad de Magallanes, Chile

Abstract

The decrease of the cap of ozone has brought as consequence an increase of the radiation UVB (280-315 nm) in the surface of the Earth, principally on the regions Antarctic and SubAntarctic. This radiation causes hurts in organic molecules affecting the physiological capacity of aquatic organisms. Without I put the clutch in, many of the organisms that frequently are exposed to the solar radiation possess several mechanisms of protection to minimize the hurts caused by the radiation UV. Between them there is the synthesis and accumulation of photoprotective compounds as the amino acids typemycosporines (MAAs). These compounds are the first line of biochemical defense against the radiation UVB and his effects, as soon as they absorb belonging wave lengths to UVB and UVA. In addition, the MAAs can act like antirust, removing in addition the energy of residues of timina excited, and preparing the formation of photoproducts.

It's for this that we focus our project on the community evaluating levels of mycosporines (MAAs) in-Rhodophyta algae of the zone of Magellan's strait then to do an analysis of because some of them present MAAs's major indexes and others not, this way to create the expectation of in a not very distant future in and which these algae benefit the population for his photoprotective component.

Coastal Management

Evolution of the ecological quality of the coastal waters off the Valencian Community from 2005 to 2010

Torres, J., Tena, J., Damián, A. & Royo, M.

IMEDMAR. CATHOLIC UNIVERSITY OF VALENCIA

Abstract

The European Water Framework Directive (WFD) has set the goal of attaining an Ecological Quality Status (EQS) of at least “Good” for all its natural water masses by 2015. The Gulf of Valencia is a region with a high economic dependence on the quality of its rich coastal ecosystems which supports a significant influx of summer tourism and fishing industries. Hence, the monitoring of the ecological quality in this region is particularly important. Data on the abundance and relative frequency of species from the benthic macrofauna was gathered from soft-bottom sampling stations along the coast of the Valencian Community. Samples were taken with a Van Veen grab sampler. The AMBI index was calculated from the abundance of relevant taxa comprised in the list updated by AZTI. The BOPA index was calculated from the bulk relative frequency of amphipods and opportunist polychaetes in the samples. EQR values drawn from both indices were converted to the EQS qualitative scale. Results show how the EQS of different zones of the Valencian coast has changed over time, indicating the efficiency of the conservation policies applied by each local administration. Further research should focus on the causes of the recent degradation of certain areas. Thus, it is proposed to transfer the environmental policies applied on those areas which have shown a significant recovery to those which are still under the minimum required by the WFD.

Littoral Eco-turistic Micro Area (LEMA) as model of sustainable management. Implantation in Playa Chica (Lanzarote).

J.C. Jimenez-Cabrera & A. Boyra

¹*University of Cádiz, Spain*

²*Oceanográfica S.L.*

Abstract

The interaction between natural land and sea processes that takes place in the coast produce a great number of resources that are extremely useful for humankind. This makes it highly probable for large human settlements to occur in the coast. This fact is associated with a high number of activities that exploit the marine environment and have impacts of varying degrees. Some studies carried out by the Canary Islands Government (Plan REPESCAN) show that 25 species of commercial interest, in the Canary Islands archipelago, are overexploited. This situation makes an intervention extremely paramount in order to better preserve the marine ecosystems in the Canarian coast.

Until now, the coast management was applied to wide protected areas. This entails a high cost for the required management, surveillance and maintenance. This is why we would like to suggest the idea of promoting a Littoral Eco-turistic Micro Area (LEMA) as a complement to the already existing Special Area of Conservation (SAC). This idea is more in line with the integrated management of the coastal areas due to the fact that is being sought through a citizen participation model (bottom-up model). In these small areas, a controlled implementation of activities that don't threaten the ecosystem is possible. The goal is to allow the users of this area to co-manage the Littoral Eco-turistic Micro Area, something that would significantly contribute to the reduction of the costs for the administration.

The methodology to be used is the one that has been applied in other areas in the Canary Islands, namely Las Canteras or La Aldea de San Nicolás, through politics support, citizen participation and a specific methodology.

The suggested area is Playa Chica in Puerto del Carmen, a typical touristic area that is found inside Tías municipality in Lanzarote. The big touristic burden as well as the high ecological value of this area makes evident the pressing necessity of implementing a management model like the Littoral Eco-turistic Micro Area.

This area is located inside the Cagafrecho space, a Special Area of Conservation (SAC) from September 2011. These Zones are protection models established by the Natura 2000 network, whose goal is to guarantee the long-term survival of the most threatened species and natural habitats in Europe.

The objective of this project is to implement the Littoral Eco-turistic Micro Area model in Playa Chica. The initial hypothesis is that this participative management, similar to that developed in Las Canteras also framed inside a Special Area of Conservation, would bring benefits to the different economic and social sectors. Furthermore, it will also promote the conservation of the species and natural habitats found in the ecosystem.

Biological Oceanography

Climate and stratigraphic paleoindicators from the Canary Islands

J.F. Betancort, A. Lomoschitz, J. Coca, A. Redondo, M. Montesinos, A. J. G. Ramos, J. Meco.

University of Las Palmas de Gran Canaria, Spain.

Abstract

The last 5 million years are characterized by global climate changes and are reflected in three ancient fossiliferous marine deposits visible in the Canary Islands. In this work there are considered three main deposits which include characteristic groups of fossil fauna that are proposed to be paleoecological and paleoclimate indicators.

The Mio-Pliocene transit is represented by the coral *Siderastrea micoenica* Osasco, 1897; the gastropods *Rothpletzia rudista* Simonelli, 1890; *Ancilla glandiformis* (Lamarck, 1822); *Strombus coronatus* De-france, 1827 and *Nerita emiliana* Mayer, 1872 and the bivalve *Gryphaea virleti* Deshayes, 1832. These are the most characteristic fossils and typical of a very warm climate and littoral zone. Associated lava flows have been radiometrically dated and provide a range between 8.9 and about 4.1 Ma.

In the Middle Pleistocene a strong global warming caused a sea level rise (Marine Isotope Stage 11). Fossil remains of MIS 11 are preserved on the coast of Arucas (Gran Canaria Is.) and in a tsunami deposit at Piedra Alta (Lanzarote Is.). These fossiliferous deposits contain the bivalve *Saccostrea cucullata* (Born, 1780), the gastropod *Purpurellus gambiensis* (Reeve, 1845) and the corals *Madracis pharensis* (Heller, 1868) and *Dendrophyllia cornigera* (Lamarck, 1816). The former was dated by K-Ar method on pillow lavas (circa 420,000 years) and the latter by Uranium Series method on corals (circa 481,000 years).

The Upper Pleistocene started with another strong global warming, known as the Last Interglacial or MIS 5.5, circa 125,000 years ago. Marine fossil deposits of this stage are present Igueste de San Andrés (Tenerife Is.); El Altillo, Las Palmas de Gran Canaria downtown and Maspalomas (Gran Canaria Is.); Matas Blancas; Las Playitas and Morro Jable (Fuerteventura Is.) and in Playa Blanca and Punta Penedo (Lanzarote Is.). The main fauna of these sites are: the coral *Siderastrea radians* (Pallas, 1766), currently living in the Cape Verde archipelago, the Gulf of Guinea and the Caribbean. The gastropods *Strombus bubonius* Lamarck, 1822 and *Harpa doris* (Röding, 1798), currently living in the Gulf of Guinea.

We also have study the present bio-oceanographic conditions of the areas where are currently living these species. We have managed variables such as the Sea Surface Temperature (SST) and the concentration of Chlorophyll-a pigment (Chl-a). These parameters have been collected by remote sensors and processed by the SEASCanarias. They have allowed us the estimation of the marine conditions during the Pleistocene interglacials.

Keywords: Paleoindicators, Neogene, M.I.S. 11, M.I.S. 5.5, SST, Chl-a.

Temporal variation of the *Capitellidae* (Annelida: Polychaeta) in fine sediments of Ría de Aldán (Galicia, NW Iberian Peninsula)

Fernando Aneiros¹, Juan Moreira², Jesús S. Troncoso¹

¹*Departamento de Ecología y Biología Animal; Facultad de Ciencias del Mar; Universidade de Vigo. Campus Universitario Lagoas-Marcosende, 36310, Vigo (Pontevedra), Spain*

²*Departamento de Biología (Zoología); Facultad de Biología; Universidad Autónoma de Madrid. C/ Darwin 2, 28049, Cantoblanco (Madrid), Spain*

Abstract

Capitellids are sedentary, burrowing, deposit-feeding polychaetes commonly found in different grades of fine sediments. Some species are opportunistic and show highly volatile life cycles, colonizing sediments rapidly after elimination of potential competitors by perturbations such as those due to organic enrichment of the sediment. The Ría de Aldán is located at the SW of the Ría de Pontevedra, in the NW of the Iberian Peninsula, which is the northern limit of the eastern boundary upwelling system of the North Atlantic. Two areas are studied in this work: an 18m-depth muddy sand bottom in the westerly part of the ría, and a 17m-depth organically enriched muddy bottom in its innermost part. Five replicate samples were taken monthly at each site from May 1998 to May 1999 by means of a Van-Veen grab with an operating surface of 0.056 m². An additional sample was taken to measure grain size and both carbonate and total organic matter (TOM) contents of the sediment.

A total of 2124 individuals were found, belonging to 3 species, all of them present at both sites, though unequally distributed. *Capitella capitata* (Fabricius, 1780) was mostly found at the muddy sand bottom, although the highest abundance of it was found in January 1999 at the muddy bottom. *Notomastus latericeus* Sars, 1851 was more abundant at the muddy site, while the opposite was found for *Heteromastus filiformis* (Claparède, 1864), which was the most abundant species at both sites. The highest abundance values were recorded in July 1998 at the muddy bottom, when the sediment found there was much coarser than usual, without a significant reduction in its TOM content. These facts, combined with the results of correlation analyses between the temporal variation of the Capitellidae and that of the characteristics of the sediment at each site, suggest that content of fine sand in the sediment may affect abundance of capitellids, though TOM content may also be relevant. However, the opportunistic behaviour of these organisms, especially *C. capitata*, may offer a better explanation for some of the temporal patterns observed. This would be the case of the abundance peaks observed in the muddy site, which would reflect an opportunistic colonisation after a perturbation in the sediment. Such perturbations are, in fact, observed in the sediment features coinciding with the abundance peaks.

Taxonomic and trophic assembly of the size spectrum in Antarctic plankton

Cristina García-Muñoz¹, Andrés Cózar², Carlos Manuel García², Luis María Lubián¹, Santiago Hernández-León³

¹*Departamento de Ecología y Gestión costera, Instituto de Ciencias Marinas de Andalucía (ICMAN-CSIC), Puerto Real, Cádiz, Spain*

²*Departamento de Biología, Facultad de Ciencias del Mar y Ambientales, Universidad de Cádiz, Puerto Real, Cádiz, Spain*

³*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Islas Canarias, Spain*

Abstract

Antarctic waters are particularly productive, but its trophic web must evolve under extremely cold temperatures and wide environmental variability at seasonal scale. These special features determine a singular predator community since ectothermic vertebrates are physiologically limited and large-sized endotherms, especially those able to accumulate great energy reserves (e.g. emperor penguin) or migrate over long distances (e.g. cetaceans, flying seabirds), find considerable competitive advantages. Although trophic pathways through fish can be regionally significant, their role in Antarctic waters could be considered negligible compared to other similarly productive ecosystems. The lack of planktivorous fish is likely responsible for the successful development of large-sized planktivorous invertebrates. Here, we show how the size classification of the invertebrate organisms in the Antarctic waters get rise to a bumpy biomass distribution with pronounced peaks and troughs, and including exceptionally large organisms. This pattern considerably differs from the size distributions of oligotrophic marine waters but shows strong similarities with the one described for a fish-less temporary lake. Two alternative plankton size spectra were described, one dominated by krill and fueled by large phytoplankton and another one dominated by salps and fueled by small phytoplankton. The biomass accumulations in large size ranges are persistent due to longevity and the complementary wintry foraging strategy of krill. In the case of salps, their short life cycle is balanced with their ability to produce explosive blooms under favorable conditions and their sexual-cycle overwintering strategy. The trophic consequences of a shift from krill to salps dominated Southern Ocean are still unknown but feeding interactions among the main pelagic predators have been discussed to complete a general overview of the Antarctic pelagic realm in the size spectrum.

Abundance and distribution of fish eggs in the Colombian Pacific Ocean during September 2007

López R., Pinto G. and Baldrich A.

Universidad Militar Nueva Granada, Colombia

Abstract

Evaluations of ichthyoplankton (fish eggs and larvae) are important in ecological studies and fisheries prospections, since help to define periods and breeding areas, and because such early stages are a key link within the trophic web of zooplankton and upper levels. For assessing the distribution and abundance of fish eggs in September 2007 along the Colombian Pacific Ocean (CPO), zooplankton was collected by oblique tows to 184 m mean depth with a 60-cm bongo sampler (294- and 520- μ m mesh). The abundances reached 53382/100 m³ in the first net and 631/100 m³ in the second one. The largest aggregations in the neritic south area of the CPO can be associated with spawning of fish stocks, high productivity, and the proximity of mangrove swamps, which are spawning and nursery grounds. The highest abundances in ocean waters could be partially explained by transport and retention processes, as an effect of the complex system of currents in the CPO. Considering both nets, diel variation was not wide (day 2476/100 m³ vs. night 2200/100 m³), suggesting continuous spawning, although many fish have higher spawning at night to avoid predators. Surface water temperature and salinity did not appear to play a significant role on distribution and abundance of eggs. This scenario can change, depending on the sampling month, fish species and the reproductive mode and location and extent of spawning grounds, and because fish spawning behavior is dictated by photoperiod (length of daylight).

Synecological aspects of *Oncaea venusta* and *Oncaea media* (Crustacea: Copepoda) in the Colombian Pacific ocean in summer 2001

Mojica, LH., López RH.

Universidad Militar Nueva Granada, Colombia

Abstract

Although the small planktonic copepods (< 1 mm) are the most abundant metazoans on Earth, and their essential position in marine food webs is recognized, this community has been poorly studied in Colombia. Seeing that *O. venusta* and *O. media* were predominant within the copepod community (60 species) in June-July and August-September 2001 in the Colombian Pacific Ocean, their distribution and abundance were evaluated. Zooplankton samples were collected at the surface with a conic net (50 cm opening, 303 μ m mesh) and the copepods extracted from subsamples of 10 ml. In general terms, both species were widely distributed and showed the highest average abundances in neritic waters in the first period and in oceanic waters in the second one. Salinity and temperature had some influence on their horizontal distribution, and light on vertical migration, since higher abundances were registered by night, full moon and last quarter. Phytoplankton seemed not to be very significant for *O. venusta* and *O. media*, but in further analysis it is necessary consider their feeding ecology, their role as prey for predators at higher trophic levels, and aspects of reproductive biology which allow sufficient reproductive success to counter predation losses. Variations between the two periods were due possibly to these factors and changes of hydrographic conditions. During this study, a weak La Niña event occurred in Ecuador and *O. venusta* was the predominant species mainly near the Galapagos Islands.

Farming Nitrifiers: Main factors and parameters for maintaining a healthy cultures

Mayte Tamés-Espinosa¹, Eduardo Bru¹, Leopoldo O'Shanahan², May Gómez¹, Ted Packard¹

¹*Plankton Ecophysiology Group, Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria 35017, Spain*

²*Instituto Canario de Ciencias Marinas. Gobierno de Canarias. Spain*

Abstract

CO₂ in the ocean is rising due to the increase of atmospheric CO₂ levels. Its greenhouse effect is partially mitigated by terrestrial (plants) and marine (algae, phytoplankton) photosynthetic organisms, but also by the less-known chemosynthetic bacteria.

Within this group, nitrifiers have a direct and indirect impact in carbon fixation because, on one hand, they are autotrophs fixing CO₂ with the enzyme RUBISCO, while on the other hand, they release nitrogen oxides that support the growth of photoautotrophs.

A new assay which simplifies the quantification of this unique process would improve our knowledge about the CO₂-sequestering capacity of the ocean. Knowing the way to cultivate them from marine water samples provides an excellent base for the development of this new technique.

During six months, we have researched the isolation process of this microbial community from Canary urban-coastal-marine waters. We discovered a way to attain high abundances and high biomasses of nitrifiers which, in turn, fostered the development of new metabolic assays that we are using to improve our knowledge of this special microbial nitrifying community. Now, these cultures are useful as the experimental base for new laboratory investigations focused on understanding the nitrifier's role in the shifting metabolic state of the ocean. We have identified the main factors that affect these nitrifying cultures, and which parameters are the best indicators of the microbes' health.

References

Bollmann, A., French, E., & Laanbroek, H. J. (2011): "Isolation, cultivation, and characterization of ammonia-oxidizing bacteria and archaea adapted to low ammonium concentrations." *Methods in Enzymology*, 486, 55.

Trophic biology of young-of-the-year bluefin tuna in the southern Tyrrhenian Sea

L Ferrer¹, JL Varela¹, N Goñi², H Arrizabalaga², A Medina¹

¹Department of Biology, University of Cadiz, República Saharaui s/n, 11510 Puerto Real, Spain

²AZTI Tecnalia, Herrera Kaia Portualdea z/g, Pasaia, Spain

Abstract

The Atlantic Bluefin tuna (ABFT), *Thunnus thynnus* (Linnaeus, 1758), is a large migratory fish that occurs throughout the North Atlantic Ocean and the Mediterranean Sea and exhibits physiological and morphological adaptations that enable it to exploit a wide range of pelagic environments. Since the 1990s ABFT stocks have become heavily depleted because of overfishing. ABFT stock assessment is currently hampered by an incomplete knowledge of the species' life history and ecology, including foraging habits. The purpose of this study was to gain insight into the trophic ecology of bluefin tuna at early life stages using stomach content and stable isotope analyses in muscle and liver tissues of young-of-the-year (YOY) ABFT captured in the Tyrrhenian Sea.

YOY ABFT (n = 62), ranging between 35 and 43 cm in straight fork length, were caught by baitboat in the southern Tyrrhenian Sea (Italy) in October 2012. The stomachs were collected on board and stored at -20C until analysis. In the laboratory, the stomachs were opened and preys species were identified to the lowest possible taxonomic level. The dietary importance of each food item was assessed by the following indices: percentage of frequency of occurrence (%O), percentage of weight (%W) and alimentary index (%AI). For the isotopic analysis, white muscle and liver tissues samples were randomly selected from 25 YOY ABFT. All samples were split in two sub-samples. One of them was used for $\delta^{15}\text{N}$ analysis, while the other subsample was subjected to total lipid extraction prior to $\delta^{13}\text{C}$ analysis.

The diet composition inferred from SCA comprised at least 19 taxa, including 7 fish, 7 crustaceans and 5 cephalopods. Fish was the most representative prey group, *Engraulis encrasicolus* and *Sardina pilchardus* being the most abundant prey species. The high dietary contribution of *Engraulis encrasicolus* and *Sardina pilchardus* is not unexpected, since Tyrrhenian Sea represents a spawning ground for these species. Otherwise, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of muscle were significantly higher than those of liver. Such differences could be related to the fact that these organs show different turnover rates and, therefore, provide information on feeding at two different time scales.

The results derived from the present study differ from observations made in previous studies performed in the same area, which indicate that the diet of age-0+ bluefin tuna is highly variable and depends on the abundance of preys in the exploited habitat.

Exploring respiration and the respiratory electron transport system (ETS) in *Ulva rotundata*

M.A. Viera-Rodríguez¹, T. T. Packard², M.T. Asensio², F. Maldonado² and M. Gómez²

¹*Centro de Biodiversidad y Gestión Ambiental, Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, Spain*

²*Grupo de Ecofisiología Planctónica, Instituto de Oceanografía y Cambio Global. Universidad de Las Palmas de Gran Canaria, Spain*

Abstract

Respiration is a key ecological index. For either individuals or communities, it can be used to assess carbon and energy, demand and expenditure as well as carbon flow rates through food webs. When combined with productivity measurements it can establish the level of metabolic balance. When combined with measurements of respiratory capacity, it can indicate physiological state. Here, we report pilot studies of the metabolism of the green algae, *Ulva rotundata* that inhabits intertidal pools of Gran Canaria. As a starting point we used the electron transport system (ETS) to differentiate between different growing conditions in the natural environment. We suspected different levels of stress associated with these conditions and looked for the influence of this stress in the ETS measurements. This technique has been successfully applied to study bacteria, phytoplankton and zooplankton in the ocean, but it has not been used to study sessile marine macroalgae. These neritic and littoral macrophytes have major ecological and industrial importance, yet little is known about their respiratory physiology. Such knowledge would strengthen our understanding of the resources of the coastal ocean and facilitate its development and best use. Here, we modified the ETS methodology for *Ulva rotundata*. With this modified ETS assay we investigated the capacity of *Ulva* to resist anoxia. We measured respiration with optodes (Fibox 4, Presens) in the dark to the point of oxygen exhaustion and through 24 h of anoxia. Then we exposed the *Ulva* to light and followed the oxygen increase due to photosynthesis. We discuss here the capacity of *Ulva* to survive during anoxia.

Cephalopods collected in Bentart campaigns between 1995 and 2006

Barreiro, P., Rocha, F. and Escañez, A.

Faculty of Marine Science, Campus As Lagoas-Marcosende, University of Vigo, 36310 Vigo, Spain

Abstract

A total of 137 cephalopods collected during campaigns Bentart 1995, 2003 and 2006 were studied. Sampling was conducted using an Agassiz trawl (2.01 m wide and 1.12 m high, having a mesh size of 10 mm). The studied area corresponds to the north of Livingston Island and Bellingshausen Sea in the Antarctic Peninsula area. Samplings were made between 40 and 3300 meters depth. A total of 21 species belonging to the Psychroteuthidae, Octopodidae and Bolitaenidae families were identified. Most species belong to the Octopodidae family (97%). Within this family the most common taxa were *Pareledone* (52%), *Adelieledone* (14.5%) and *Graneledone* (8.7%).

Pareledone is the most abundant and diverse cephalopod genus in Antarctic Ocean. It is restricted to the continental shelf and slope margins (in depths of less than 1000 m). Members of the genus tend to be small; total length reaches 95 to 350 mm (mantle length 30 to 100 mm). They don't have commercial value. A total of 23 males, 28 females and 19 immature specimens (24-64 cm mantle length) were collected. Species identified belonging to *P. charcoti*, *P. harrissoni*, *P. turqueti*, *P. subtilis*, *P. panchroma*, *P. albimaculata*, *P. cornuta*, *P. aurata* and *P. serperastrata*.

Adelieledone corresponds to benthic species that live in Antarctic Ocean. Genus is defined by have transverse ridges in the ligula groove of hectocotylus and the presence of two longitudinal integumentary ridges on the dorsal mantle. Body is covered with warts and the mantle is saccular. A total of 4 males, 4 females and 12 immature specimens were found in Antarctic oceans. The size mantle length ranged from 22 to 40 cm. Two species, *A. adeliaeana* and *A. polymorpha*, were recorded.

Graneledone species live in the lower bathyal and abyssal ecosystems and have been reported in the southern ocean. *Graneledone* is defined by having the body covered with warts, dorsal side covered with numerous clusters, cartilaginous tubercles. Characteristic composed ocular cirri occur on each eye. Arms have uniserial suckers, ink sac absent and the crop reduced or absent. Males have a small hectocotylus and a well differentiated ligula with a large calamus. Five males, 6 females and 2 immature specimens (mantle length range from 24 to 56 cm) were studied. Three species were identified: *G. antárctica*, *G. macrotyla* and *G. verrucosa*.

Other benthic species were found: *Thaumeledone gunteri*, *Bentheledone rotunda*, *Bentheledone albida* and *Benthoctopus* sp. Also, some neritic species, the incirrated *Bolitaenidae* sp. and the *Teuthoid Psychroteuthis glacialis*, were obtained.

Some aspects about species distribution and habitat in Antarctic Ocean are discussed.

Transport pathways of decapod larvae in the Canary-African Coastal Transition Zone: modelling and field observations.

José M. Landeira¹, Timothée Brochier², Evan Mason³, Santiago Hernández-León¹

¹*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Campus Universitario de Tafira, 35017, Las Palmas de Gran Canaria, Canary Islands, Spain*

²*Institut de Recherche pour le Développement (IRD), ISRA/Centre de Recherche Océanographique de Dakar-Thiaroye (CRODT), UMR 195, BP 1386 Dakar, Senegal*

³*Mediterranean Institute for Advanced Studies (UIB-CSIC), C./Miquel Marquès 21, Esporles, Palma de Mallorca 07190, Spain*

Abstract

Planktonic larvae constitute a vital component of oceanic food webs and represent the early life-history stages of ecologically and economically valued species. Thus, understanding biological and physical mechanisms involved with larval transport is of substantial interest to the fields of ecology, conservation and fishery management.

This study represents an attempt to elucidate the transport pathways of decapod larvae within the C-ACTZ, where larval assemblages are poorly known. The waters downstream of the Canary Island archipelago displayed intense mesoscale activity during the FAX99 cruise. SST images revealed the presence of 14 cyclonic and anticyclonic eddies as well as four upwelling filaments. Our results illustrate a close relationship between these mesoscale oceanographic structures and the distribution of decapod larvae using both field observations and transport modelling. Analysis of plankton samples showed that the C-ACTZ is an area where both Canary and African larvae may be present at the same time. On the other hand, predictions of larval transport are obtained from the Ichthyop Lagrangian transport model, which is forced by a high-resolution hydrodynamic model (ROMS) that reproduces the regional circulation. The simulations support the field observations and the key findings are: (1) Virtual larvae released in the offshore boundary of the upwelling front were advected westward offshore by filaments, reaching all the islands within 28 days; (2) Significant amount of simulated larvae are transported back to the African coast due to eddy circulation; (3) Most of the virtual larvae released from Gran Canaria and Fuerteventura are rapidly transported to the west/southwest by the Canary Current arriving the other islands, (4) while others are transported towards the African coast or (5) northward connecting with the Selvagen archipelago.

Our observations of larval transport introduce new insights for the general understanding of the metapopulation connectivity between the Canary Islands and the African coast.

Fluorescent dissolved organic matter production via microbial respiration: A comparison between the equatorial Atlantic Ocean and the subantarctic zone of the South Atlantic Ocean

De La Fuente, P.¹, Marrasé, C.¹, Álvarez-Salgado, X.A.², Domínguez-Yanes, J.F.³, Canepa, A.¹, Hernández-Guerra, A.⁴, Pelegrí, J.L.¹, García-Olivares, A.¹

¹*Institut de Ciències del Mar, CSIC, Passeig Maritim de la Barceloneta 37-49, 08003, Barcelona, Spain*

²*Instituto de Investigaciones Mariñas, CSIC, Eduardo Cabello, 6, 36208 Vigo, Spain*

³*DC Servicios Ambientales S.L, Emilio Calzadilla 5, 2^aA, 38002, Santa Cruz de Tenerife, Spain*

⁴*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, 35017, Las Palmas, Spain*

Abstract

The distribution of humic-like fluorescent dissolved organic matter (FDOM) at two different Ex/Em wavelengths, 340/440 nm and 320/410 nm, were obtained for both the equatorial Atlantic Ocean and the subantarctic zone of the South Atlantic Ocean. Water samples for FDOM measurements in the equatorial Atlantic Ocean were taken during the MOC2-equatorial cruise, along 7.5°N section. In the subantarctic zone of the South Atlantic Ocean, the FDOM measurements were acquired during the MOC2-austral cruise, which was divided in two transects, one located in the Argentine Basin and the other in the Cape Basin. The relationships of FDOM with Apparent Oxygen utilization (AOU) and with the inorganic nutrients (both as proxies of organic matter mineralization through heterotrophic respiration) are evaluated once the effect of water mass mixing is corrected. In this way, the influence of in situ microbial activity on FDOM variability for intermediate and deep waters is identified. The differences between these two oceanic zones relative to FDOM production through microbial respiration are also discussed.

Bionomic characterization of the sublittoral region off the coast of the province of Castellón

Tena, J.¹, Torres, J.¹, Damián, A.¹, Muruaga, A.² & Diosdado, G.²

¹IMEDMAR. Catholic University of Valencia

²HIDTMA-ECOMAR, S.L.

Abstract

The Spanish province of Castellón has a significant affluence from its fisheries. The breeding and nursing grounds of many commercial fish and crustacean species exploited in the region extend within the sublittoral zone. The distribution of the different benthic communities and facies has been largely understudied. Environmental management strategies require an accurate knowledge of the distribution of the benthic communities and species. The suitability of certain anthropic interventions such as port expansions and coastal jetties should be evaluated on the basis of the fragility and importance of the biological community displaced. The aim of this study is to provide a comprehensive bionomic map of the main sublittoral communities off the coast of Castellón, and a database of the spatial distribution of the local soft-bottom polychaete, mollusk, echinoderm and crustacean species. Samples, together with bathymetric, geomorphological, sedimentological, and hydrological parameters, were taken from an array of stations forming a representative coverage of the sublittoral continental shelf off the shoreline. Geomorphological and sedimentological parameters were compared with the faunal distribution and the main biological communities were delimited. Sites with fine sediments suspected to be under the influence of sewage discharge are discriminated by the presence of species indicators of organic matter enrichment. Results show how fine sand communities dominate the nearshore zone, while *Posidonia oceanica* prairies and thanatocenoses are the most extended offshore habitat.

Positive effects of green tides on seagrass *Zostera noltei* under high ammonium concentrations

Cantero R., Moreno-Marín F., Vergara J.J., Pérez-Lloréns J.L. and Brun F.G.

Faculty of Marine and Environmental Sciences. Department of Biology (Ecology Area). Puerto Real. 11510. Spain

Abstract

High nutrient loads in coastal areas foster indirect (i.e. development of green tides) and direct (i.e. ammonium toxicity) effects on seagrasses. At present, both effects are considered to act synergistically in raising seagrass mortality. However, we hypothesized that the occurrence of moderate amounts of algae can withdraw seawater ammonium, and hence toxicity, affecting positively to seagrasses. Therefore, we studied the effects of different concentrations of ammonium (0, 25 and 50 μ M) and macroalgal standing stocks (0, 1 and 6 layers of *Ulva sp.* overgrowing seagrasses) in an indoor mesocosm experiment using a factorial design. In absence of macroalgae, ammonium enrichment fostered a reduction up to 5 times of gross production of *Zostera noltei* and a shift of net production from positive to negative values. Similarly, the presence of macroalgae in absence of ammonium supply resulted in harmful effects on *Z. noltei* due to the strong light reduction caused by *Ulva mats*. When both factors were assayed together (ammonium load and *Ulva sp.* biomass), moderate standing stocks of *Ulva sp.* at medium and high ammonium concentrations ameliorated the negative effects of ammonium on *Z. noltei*. Gross production was twofold higher under ammonium load in presence of macroalgae than when these were not present. This, a priori, unexpected effect could be explained by the fast ammonium uptake by *Ulva*, reducing ammonium levels in the water and, thus, toxicity on *Z. noltei*. This study demonstrates for the first time that moderate amounts of macroalgae can ameliorate negative ammonium effects on seagrasses. However, a massive green tide bloom limited seagrass growth by shading despite the great reduction of ammonium concentration in seawater. This amelioration effect should be considered for managing these crucial ecosystems.

Geological Oceanography

Temporal variation of the composition and granulometry of a muddy sand bottom in Ría de Aldán (Galicia, NW Iberian Peninsula)

Fernando Aneiros¹, Juan Moreira², Jesús S. Troncoso¹

¹*Departamento de Ecología y Biología Animal; Facultad de Ciencias del Mar; Universidade de Vigo. Campus Universitario Lagoas-Marcosende, 36310, Vigo (Pontevedra), Spain*

²*Departamento de Biología (Zoología); Facultad de Biología; Universidad Autónoma de Madrid. C/ Darwin 2, 28049, Cantoblanco (Madrid), Spain*

Abstract

The Ría de Aldán is located at the SW of the Ría de Pontevedra, in the NW of the Iberian Peninsula, which constitutes the northern limit of the eastern boundary upwelling system of the North Atlantic. The area studied in this work is an 18m-depth muddy sand bottom in the westerly part of the ría. Samples were taken monthly from May 1998 to May 1999 by means of a Van-Veen grab with an operating surface of 0.056m². Granulometric composition of the sediment was determined by means of both a sieving column and sedimentation analysis for the finer fractions. Median grain size (Q50) and sorting coefficient (S0) were calculated for each sample. Carbonate content was estimated by means of a modified Bernard Calcimeter and total organic matter (TOM) content was estimated as the weight loss of samples after combustion at 450°C for 4h.

During most of the study period, sediment was mainly composed by fine sand, with an important proportion of silt and clay, but a low amount of gravel. Carbonate content was particularly high (around 60%) during the whole study period, while TOM content was always low (<5%). The main exceptions to this general trend were found in June, July and November 1998. Sediment was much coarser than usual in June and November, when the dominant fractions were coarse and very coarse sand, respectively, and high amounts of gravel were found, while silt and clay were almost absent; carbonate content also presented its maximum values in these months. As opposed to this, sediment was slightly finer and dominated by very fine sand in July, coinciding with the highest value of TOM content. The changes in June and November might be related to stronger hydrodynamic phenomena, but the meteorological data available do not support this. Therefore, other unknown processes should have led to the aforementioned granulometric changes.

Neogene and Pleistocene fossil brachiopods of the Eastern Islands. Current appointments.

Eduardo González, Juan Francisco Betancort Lozano, Joaquín Meco, Alejandro Lomoschitz

Unviersity of Las Palmas de Gran Canaria, Spain.

Abstract

Numerous specimens of fossil brachiopods have been found in the different fossiliferous outcrops of the Canary Islands. These fossils have been found in the deposits of Mio-Pliocene age of the eastern Canary Islands, described and illustrated in the work of Meco et al. 2005 and in the outcrops interpreted as a tsunami deposits in Piedra Alta, Lanzarote, belonging to the Marine Isotope Stage 11 dated to circa 330 ka.

4 species of fossil brachiopods have been identified: *Terebratula sinuous* Brocchi 1814, *Lacazella Mediterranean* Risso 1826 *Terebratulina caputserpentis* (Zbyszewski, 1957) and *Thecidium cf. digitatum* (Sowerby 1823). These fossils provides stratigraphic and paleoclimatic taxonomic information. Furthermore, in order to compare the fossil brachiopods with present in the Canary Island, a reference collection is defined with specimens obtained from marine sediment surveys at Gran Canaria, La Palma and El Hierro, identifying 3 species: *Argyrotheca barrettia* (Davidson, 1866), *Megerlia truncata* (Linnaeus 1767) and *Pajaudina atlantica* (Logan 1988).

Itrax™ Core Scanner as a tool for detection and monitoring of REEs and related trace elements

I. Rodríguez-Germade¹, B. Rubio¹, D. Rey¹ and J. Borrego²

¹Research group GEOMA. Departamento de Geociencias Marinas y Ordenación del Territorio, Universidad de Vigo, Vigo (Spain)

²Departamento de Geología, Universidad de Huelva

Abstract

The study of the stable rare earth elements (REEs) provide valuable information about diagenetical processes since their mobility is controlled by the precipitation and solution of Fe and Mn in the oxic and suboxic zones of the sediments. Moreover, their characteristic fractionation patterns allow the detection of changes in environmental conditions and they have been used as proxies of sediments' source and to study weathering processes. In addition, their low natural background levels in sediments become them into potential pollution tracers to detect anthropogenic impacts.

REEs analyses in sediment samples are usually made by laborious techniques as instrumental neutron activation analyses or by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). In both cases sample preparation and analyses results in a considerable time investment. However, in the last decades X-ray fluorescence (XRF) scanners like the Itrax™ Core Scanner (Itrax) have been developed as a fast non-destructive alternative to the conventional techniques of sediment analyses. This kind of scanners are able to obtain optical images, X-ray radiographs, and continuous geochemical data with a maximum resolution of 100 μm directly from sediment cores. However, these geochemical results are semi-quantitative (peak areas) and they have been often used in palaeoceanographic and palaeoclimatic studies being hardly ever used to detect sediment pollution and never used to study REEs behaviour.

To our knowledge, this is the first work that uses the Itrax to detect REEs, exploring their distribution and fractionation patterns. To that end, we have analysed a sedimentary core taken in the "Padre Santo Chanel" (Ría de Huelva, SW Spain). This Ría is one of the most polluted areas in Western Europe because of the high acid mining activity together with the chemical industries located in its margins. The acid mining results in low pH values that prevent the adsorption of REEs into the suspended particulate matter causing a depletion of REEs in the sediments regarding to the average crustal REEs abundances. Despite that, we have proved the capacity of the Itrax to detect REEs together with other related trace elements (e.g. As, Cu, Pb, Zn, Y, Th). In this case, we obtained reliable data for La, Ce, Eu, Ho and Er, being the best detection limits reached for Eu ($2 \mu\text{g}\cdot\text{g}^{-1}$) and for Ho ($1 \mu\text{g}\cdot\text{g}^{-1}$). The high sensitivity of the Itrax was also confirmed by comparison of their semi-quantitative results with concentration values obtained from ICP-MS. Moreover, we could estimate the pollution levels for the whole core by establishing equivalences between Itrax data and enrichment factors calculated at certain depths. In fact, we have detected a minor enrichment for Eu (caused by concentrations lower than $7 \mu\text{g}\cdot\text{g}^{-1}$) and even depleted REEs with concentrations lower than $1 \mu\text{g}\cdot\text{g}^{-1}$.

We have found a coincidence of the REEs maximum with the As, Cu, Pb and Zn peaks confirming their known acid mining origin. Moreover, we have found good correlations of REEs with P and Ca profiles confirming a relationship with the leachates from the phosphogypsum deposits generated by fertilizer industries. On the other hand, the lack of correlation of Th vs Ca and P profiles pointed out a different source for this element.

Since the REE fractionation patterns are controlled by pH changes, which in turn are controlled by the degree of mixture between marine and fluvial water contributions, Itrax profiles have allowed studying these fractionation patterns and their causes. In particular, Cl profile shows the variations of salinity and marine influence while Y/Ho profile is a good proxy of sediments' origin. In this way, it is posi-

ble to identify salinity changes and therefore, pH variations that control the adsorption of REEs to the suspended particulate matter.

Taken into account our results, Itrax can be considered a fast and useful tool to detect REEs pollution selecting the most interesting depths that can be studied in detail avoiding a great number of quantitative analyses and saving time and money. Moreover, studying the correlations between REEs and other elements it is possible to identify the origin of the pollution. Finally, Itrax profiles also allow studying the environmental changes that causes REEs fractionation patterns.

Paleoclimatic and paleoceanographic changes through the last 5000 years off NW Iberian Peninsula: SST and SSS reconstructions

González-Álvarez, R., Bernárdez, P., Mena, A., Francés, G.

Departamento de Xeociencias Mariñas e Ordenación do Territorio, Facultade de Ciencias do Mar, Universidade de Vigo, Campus Lagoas-Marcosende, Vigo, 36310, Spain

Abstract

Gravity core SMP02-3 retrieved from the middle Galicia continental shelf (NW of Iberian Peninsula) was analyzed in order to reconstruct the paleoceanographic and paleoclimatic variability of the last 5000 years. The effects of global and regional climatic forcing factors (solar forcing and NAO mode) on SST and SSS, oceanographic regime and continental influence on the shelf were investigated through the analyses of planktonic foraminiferal assemblages, bulk properties of sediments (grain size, content of organic carbon and carbonate) and measurements of oxygen and carbon isotopic composition of *G. bulloides*.

The SST record, obtained applying the MAT to the planktonic foraminiferal assemblages, reveals that most important climatic shifts occurred synchronous with well-known Holocene climatic events pointing to the reliability of the planktonic foraminiferal signal in neritic areas. Warmer SST are recorded at 4500–3500 cal. yr BP, at the RWP (2000 cal. yr BP) and at the MWP (AD 1000–1100), whereas two pronounced coolings occurred at the SB/SA transition (3000 cal. yr BP) and during the LIA (AD 1200–1750). These cold intervals are related to periods of solar minima, in particular, the LIA is recorded as a two-step cooling event reaching the coldest phase during the Maunder minimum in solar activity.

The assemblages composition in core SMP02-3, namely, the dominance of *G. bulloides* and *N. pachyderma* (dex), the isotopic results and the organic carbon content point to high productivity conditions in the Galicia continental shelf derived from the input of nutrients by both upwelling and riverine discharge.

High abundances of *G. bulloides* and *G. glutinata* indicate upwelling-prevailing periods between 4500–3600 cal. yr BP and 2000–1200 cal. yr BP. Reconstructed curves of SST and SSS show that during these periods of enhanced upwelling, both SST and SSS record higher values, pointing to warmer and drier conditions and the upwelling of ENACWst.

Conversely, low SST and SSS and increased clay content in sediment reflect periods of enhanced rainfall and subsequent fluvial discharge to the shelf at 3500–2000 cal. yr BP and during the last 1200 years. Nutrients supplied by riverine discharge would have induced phytoplankton blooms increasing the abundance of *T. quinqueloba* in the middle shelf. *G. inflata* also indicates enhanced influence of IPC and the onset of downwelling conditions during these periods. The most pronounced rainy period and persistent downwelling regime was registered during the first cooling step of the LIA. However a change in oceanographic conditions occurred after 700 cal. yr BP. The onset of a weak upwelling at this age is indicated by the increase in *N. pachyderma* (dex) abundance, linked to the influence of northern waters transported by the upwelling jet to the middle shelf. Upwelling was intensified after 500 cal. yr BP displacing the upwelling jet offshore and the persistent northerly winds led to the upwelling of ENACWsp in the Galician shelf.

The oceanographic and climatic pattern registered in the NW Iberian Margin during the last 5000 years is related to the variability of the NAO mode. Periods of persistent positive phase of the NAO are linked to prevailing northerly winds and enhanced upwelling regime. Rainy conditions and enhanced river discharge are related to the southerly displacement of atmospheric fronts during sustained NAO negative phases.

Late Pleistocene paleoenvironments of East Equatorial Pacific off Costa Rica: preliminary results on hole U1381C

Diz, P., Bernárdez, P., González-Villanueva, R., Pérez-Arlucea, M.,

Departamento de Xeociencias Mariñas e Ordenación do Territorio, Facultade de Ciencias do Mar, Universidade de Vigo, Campus Lagoas-Marcosende, Vigo, 36310, Spain

Abstract

Hole U1381C was recovered in the East Equatorial Pacific during the IODP Expedition 344, off Costa Rica margin at 2064 m of water depth [1]. Assemblages of benthic foraminifera from Hole U1381C were studied in detail at millennial scale resolution (1-2 ka) to infer changes in the primary production and location of the OMZ (Oxygen Minimum Zone) over the Late Pleistocene. Benthic foraminiferal faunas are characterized by high contribution of *Uvigerina auberiana*, *Uvigerina peregrina* and relatively minor contributions of *Cibicides pachyderma*, *Siphogenerina ampullacea* and *Melonis barleaanum*. These assemblages are indicative of high and sustained organic carbon flux to the seafloor. Variations in the relative contributions of these species along the record suggest changes in the quality of the organic carbon arriving at the sea bed from labile to refractory. The percentage of inorganic carbon varies largely along the record indicating changes in carbonate preservation. In a further stage, opal and organic carbon content as well as the carbon and nitrogen isotopic composition of the organic carbon will help us to assess changes in the primary production and the provenance of the organic carbon.

Acknowledgements: The research leading to these results are funded by Xunta de Galicia under the program Axuda para proxectos de Investigación Desenvolvidos por Investigadores Emerxentes (EM2013/012).

References

<http://publications.iodp.org/proceedings/344/344title.htm>

Culture of benthic foraminifera for ocean acidification experiments

Diz, P., Mena, A., Nombela, M.A., Francés, G.

Departamento de Xeociencias Mariñas e Ordenación do Territorio, Facultade de Ciencias do Mar, Universidade de Vigo, Campus Lagoas-Marcosende, Vigo, 36310, Spain

Abstract

The atmospheric CO₂ concentrations have been continuously rising over the last decades. Surface ocean uptake of CO₂ has caused a reduction in seawater pH and carbonate ion concentrations (Pérez et al., 2013). The effects on organisms that build their shells of calcium carbonate (such as benthic foraminifera) are not sufficiently studied and might be detrimental (Khanna et al., 2013). Simulating ocean acidification scenarios in the laboratory is a reasonable way to study their response to decreased pH and carbonate ion concentrations. Two main issues should be considered to carry out ocean acidification experiments with benthic foraminifera: an appropriated experimental set up and a benthic foraminifera species with high survival and growth rates under laboratory cultures. On the one hand, we describe the experimental set up we used to carry out ocean acidification experiments with benthic foraminifera in pH controlled conditions. On the other hand, we show the results of laboratory cultures and decalcification/calcification laboratory experiments on several species of benthic foraminifera.

Acknowledgements: This research leading to these results was supported by the Spanish Ministry of Sciences and Innovation and co-funded by the Fondo Europeo de Desarrollo Regional 2007-2012 (FEDER) through the CATARINA Project (CTM2010-17141/MAR) and GRACCIE. The authors are grateful to the technical staff of the ECIMAT.

References

- Khanna N, Godbold JA, Austin WEN, Paterson DM(2013). The impact of ocean acidification on the functional morphology of foraminifera, PLoS ONE, 8: 1-4, e83118.
- Pérez FF, Mercier H, Vázquez-Rodríguez M, Lherminier P, Velo A, Pardo PC, Rosón G, Ríos AF (2013). Atlantic Ocean CO₂ uptake reduced by weakening of the meridional overturning circulation, Nature Geoscience, 6: 146-152.

Fisheries

The Spanish FADs fishery in the Indian Ocean

Ana T. Santana-Ortega¹, Vicente Hernández-García¹, Unai Ganzedo², & J.J. Castro¹

¹Grupo de Investigación en Biodiversidad y Conservación, Departamento de Biología, Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas de Gran Canaria, Canary Islands, Spain

²Pesquera Echebaster S.A., Muelle Erroxape S/N, 48370 Bermeo (Biskaia), Basque Country, Spain

Abstract

Are presented the results of the analysis of catch data from three purse-seiner vessels operating at the Indian Ocean using traditional and non-entangling FADs to fish tuna. Skipjack was the main species in the reported captures, but also yellowfin (*Thunnus albacares*) and the bigeye tuna (*Thunnus obesus*) were target species. Twelve other species, considered as by-catch, were also caught during the fishing operations.

Results showed that fishing on non-entangling FADs was more sustainable than that carried on traditional (entangling) artificial devices, particularly in relation to the number of sharks (and other marine animals in risk) entangled. However, the efficiency of fishing operations done on non-entangling FADs was not different to that reported on traditional ones. Moreover, the analysis of the by-catch data obtained from operations on different floating devices, showed that this was lower when using the non-entangling FADs.

MYCTOPHIDAE studies around the Canary Island (NE Atlantic)

C.R. Andrade Santana, J.J. Castro Hernández, E. Caudet Menéndez , A. Cruz Makki , R. Ginés Sánchez, A.D. Mathisen García, C. Peña Hernández, A.N. Sarmiento Lezcano, S. Lugo Garrido.

University of Las Palmas de Gran Canaria, Spain.

Abstract

The morphometric analysis of *Higophum hygomii*, *Lobianchia dofleini* and *Notoscopelus resplendens* (Family MYCTOPHIDAE) are shown, together with its the length-weight relationship, in waters of the Canary Islands, from specimens caught in January and February 2013 by the O/V BOCAINA. Information on the geographic and bathymetric distribution of the species in waters of the Archipelago is provided.

Temporal trends of the small-scales fishery of Gran Canaria Island along the XXth century

Antonio Barrera, Angelo Santana, Vicente Hernandez and José Juan Castro.

Universidad de Las Palmas de Gran Canaria, Facultad de Ciencias del Mar, Campus Universitario de Tafira, 35017, Las Palmas de Gran Canaria, Spain.

Abstract

Are presented the historical evolution of fish catches during the twentieth century in the small-scale fishery of Gran Canaria Island. Data has been reconstructed from data given by fishermen associations, reports and grey literature, historical photos and interviews. Catches showed a progressive decreasing a long time but the decreasing tendency is more sloped from 1970 onward.

The striped soldier shrimp *Plesionika edwardsii* (Crustacea: Decapoda: Pandalidae) from the Cape Verde Islands

García-Martín, V.¹, R. Triay-Portella¹, A. Martins², N. Almeida³, C. Monteiro², S. Correia², G. González-Lorenzo⁴, S. Jiménez⁴, J.I. Santana¹, J.G. Pajuelo¹, J.M. Lorenzo¹ & J.A. González¹

¹Grupo de Ecología Marina Aplicada y Pesquerías, Universidad de Las Palmas de Gran Canaria, Spain

²Instituto Nacional de Desenvolvimento das Pescas (INDP) de Cabo Verde

³Departamento de Engenharia e Ciências do Mar (DECM), Universidade de Cabo Verde (Uni-CV)

⁴Centro Oceanográfico de Canarias, Instituto Español de Oceanografía, Spain.

Abstract

This study is part of the PROACTIVA 1-2 (2009-2012) and MARPROF-CV (2010-2014) projects, in the framework of the Canary Islands Government and UE PCT MAC 2007-2013 programmes respectively. Research has mainly focused on the stock assessment of the striped soldier shrimp, *Plesionika edwardsii* (Brandt, 1851), because it has shown moderate to high levels of fishing yield and abundances compatible with the development of a new sustainable fishery in the Cape Verde Islands.

Cruises took place on board the R/V Prof. Ignacio Lozano. Four 15-day surveys have been conducted to date: Cabo Verde 2010-04 (April 2010), Camarão-1 (November 2011), Camarão-2 (March 2012) and Camarão-3 (July 2012). An innovative fishing gear so-called multiple semi-floating shrimp trap (MSFST) was used. Each fishing line was composed by 40-65 traps operating around 2.4 m above the seafloor, using *Decapтерus macarellus* (Carangidae) as unique bait of the traps. Fishing depth was 66-458 m, and effective fishing time was 16-18 h. Each trap was attached to the main bottom line every 15 m, and the maximum attraction of this bait was established to be 100 or 150 m, according to the experience gained from the local fishery for deep-sea lobsters. So density by area was calculated assuming two different areas of attraction of the fishing gear. Initial biomass was estimated from depletion experiments at different abundance stations by applying the Leslie & Davis (1939) method, modified by Ricker (1975). Each fishing operation was classified according to its yield (CPUE in g/trap/night). The potential fishing planar area was estimated between the isobathymetric lines between 90 and 220 m. Total biomasses (Bt) were calculated from areas (km²) and mean minimum/maximum densities (kg/km²). Maximum sustainable yield (MSY) was estimated from Bt using the Beddington and Cooke (1983) model by entering natural mortality (0.6), growth rate (0.53 year⁻¹) and recruitment age (1.32 year), which are the parameters for this target species published for the Canaries. These parameters estimate a biological exploitation rate (β) of 0.262. Interpolations were applied to estimate MSY for insular stocks representing lesser than 5% of the total fishing grounds for this species in the archipelago.

The MSY estimated by depletion were 30.5 tons/year for the stock of São Vicente, Santa Luzia, Ilheus and São Nicolau, 10 tons/year for the stock of Santiago, 138.8 tons/year for the stock of Boa Vista and Maio, and 5.6 tons/year for the stock of Sal. The small stocks estimated by interpolation were: 4.5 tons/year for the stock of Santo Antão, 1.3 tons/year for the stock of Fogo, and 1.8 tons/year for the stock of Brava and Ilheus. In total, 192.5 tons per year was the total MSY for the striped soldier shrimp around the islands of the Cape Verde archipelago, occupying a total area of 1,918 km² of new fishing grounds at between 90 and 220 m of depth. In comparison with the traditional bottom trap used in the Canary Islands, the innovative fishing gear MSFST were proved to be more selective for pandalid shrimps, minimizing the gear impact on the seafloor as well as the by-catch by reducing the discards. Depletion methods are based on the assumption of a closed system, that is with minimum or zero immigration between neighbouring areas. The straight forward decline of CPUEs obtained during the depletion experiments seems to confirm that *P. edwardsii* is a low mobility species, making this assumption valid at least during short-time periods. Because of the bathymetry profile of these islands,

the depth range is from very close (few nautical miles in Santiago) to far away (10-12 n.m. in Boa Vista) to the coastline.

Fishing effort should be controlled on the basis of quotas, number of fishing vessels and a precautionary approach in order to ensure that catching is commensurate with sustainable levels of exploitation. MSY estimates suggest that this new Capeverdean fishery should be carried out by specialized medium-sized fishing vessels. During the last decades a combination of shrimp trawling and industrial trapping activity has threatened over-exploitation in the Mediterranean fisheries targeting on *P. edwardsii*; currently the shrimp collapse has conducted to the decline of these fisheries. Can the Cape Verde regulatory bodies and all the stakeholders involved learn the lessons this teaches us about this resource management?

Minimum legal sizes: Do they protect immature fishes?

Casademont, P., Cosín, A., Cano, J., Cabrera, R., Gómez, MC., Valle, O., C.-Soriguer, M.

University of Cádiz, Spain.

Abstract

The regulation of minimum sizes of catch is one of the oldest and most widely accepted tools for the management of fisheries. The principal justification that has been given for this measure is that it prevents the fishing of immature individuals. It is a technical measure used to manage fishing, with the object of allowing sufficient numbers of juveniles to survive and reproduce. The study described deals with an analysis of the application of this management measure in sixteen species of fish of significant commercial interest, in the Iberian Peninsula. Taking as the basis the studies that currently exist on the sizes of first maturity, these have been compared with the legislated sizes of first catch, attending to possible differences in function of the fishing ground, sex or species, in the event of joint commercial exploitation. In general, statistically significant differences have been found between these sizes, thus demonstrating that the legal minimum sizes have not been defined according to biological criteria.

Keywords: Minimum legal size, Fisheries management, Length at first maturity, Southern Spain.

Notes of the biologic and bathymetric distribution of the family *Diaphus dumerilli* in Canary waters

C.R. Andrade, C. Peña, A.D. Mathisen, S. Lugo, R. Ginés, A. Lezcano, A. Cruz, E. Caudet, F. Bordes, A. Barrera, J.J. Castro

University of Las Palmas de Gran Canaria, Spain.

Abstract

The objective of this work is the distribution of *Diaphus dumerilli* in the vicinity of the Canary Islands (Central-east Atlantic). The length-weight relationship and different morphometric relationships are also described. Data on geographical and bathymetric distribution of the species in waters of the Archipelago are reported. All specimens were captured in the surveys conducted by the R/V Bocaina between 1997 and 2002.

Development of the large fish indicator and associated target for a North-East Atlantic fish community

Larissa Modica, Francisco Velasco, Izaskun Preciado, Maria Soto and Simon P. R. Greenstreet
Instituto Español de Oceanografía, Spain

Abstract

Abstract: The Large Fish Indicator (LFI) was developed to support the North Sea fish community Ecological Quality Objective (EcoQO) pilot study, intended to establish an operational ecosystem approach to management. Subsequently, procedures established in the North Sea were applied to the Celtic Sea to derive an LFI and target specific to this region. The Marine Strategy Framework Directive (MSFD) requires EU Member States sharing marine regions to co-operate using the Regional Seas Conventions (RSCs), and using indicators already adopted by them. The MSFD explicitly suggests the LFI as a food web indicator, but it could equally well be used to monitor biodiversity. Here we apply the established rationale to develop an LFI and target specific to the southern Bay of Biscay. Despite declining in the 1990s, the LFI subsequently recovered to near original values in 2008. Previously, relationships between the LFI and fishing pressure have involved lengthy time-lags. We observe a similar relationship, but with shorter lag. The nature of the large-sized species responsible for much of the change in the LFI may explain this difference, and might also suggest that, in the Bay of Biscay, the LFI is more appropriately used as a biodiversity indicator, rather than a food web indicator.

Marine Pollution and Ecotoxicology

Phenolic Profile of *Dunaliella tertiolecta* growing under iron stress

Aroa López, Milagros Rico, Magdalena Santana-Casiano, Aridane G. González, Melchor González-Dávila

Departamento de Química. Facultad de Ciencias del Mar. Universidad de Las Palmas de Gran Canaria, Spain.

Abstract

The phenolic profile of exudates and extracts of the green alga *Dunaliella tertiolecta* harvested in natural seawater (control) and in natural seawater enriched with Fe(III) ($50 \mu\text{g L}^{-1}$) was investigated. The use of reversed phase high performance liquid chromatography (RP-HPLC) allowed the identification of 14 phenolic constituents. Determining how polyphenol concentrations change in response to high iron levels will demonstrate the role of polyphenols in microalgae and might be useful to help explain the dynamics of this important compound in seawater. The polyphenolic profile showed relevant modifications when *D. tertiolecta* was exposed to iron. The role of several polyphenols is related to the availability of Fe(II) in solution, encouraging its persistence. The in vitro antioxidant activity determined by using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay revealed that the extract of cells from the control exhibited higher radical scavenging activity ($14 \pm 0.5\%$) than the synthetic compound butylated hydroxytoluene (BHT) ($5 \pm 0.1\%$), commonly used in the food industry as preservative. The presence of polyphenols within the cell confirms that *D. tertiolecta* is a rich source of antioxidants to be used in the fields of preventive medicine and food preservatives.

Potential use of native mosses for biomonitoring the metal pollution: a stable isotope approach

Aridane G. González, Oleg S. Pokrovsky, Jérôme Viers

GET/OMP, Université Paul Sabatier - CNRS-IRD, 14 Avenue Edouard Belin, 31400 Toulouse, France

Abstract

Mosses has been used for long time as bioindicators in urban and industrial areas. Due to their ability to reflect the chemical composition of the surrounding atmosphere where they inhabit. This study is focused in the role of four native mosses (*Hypnum sp.*, *Sphagnum sp.*, *P. purum* and *B. rutabulum*) as bioindicator of Zn transfert and deposition via combining physico-chemical characterization of moss surfaces and measuring Zn stable isotopic fractionation during the adsorption process. The acid-base titration of mosses suggested the presence of tentative functional groups such as phosphodiester, carboxyl, phosphoryl, amine, and polyphenols.

The adsorption of Zn as a function of pH yielded the maximal adsorption as 73% at pH = 7.8 for all the species, following and “universal adsorption edge” established earlier for bacteria and recently confirmed for mosses (González and Pokrovsky, 2014). The adsorption capacity can be ranked as following: *B. rutabulum* \geq *Sphagnum sp.* \geq *Hypnum sp.* \geq *P. purum*. In addition, the adsorption as a function of Zn concentration demonstrated that the species could be ranked as: *B. rutabulum* \geq *Sphagnum sp.* \geq *P. purum* \geq *Hypnum sp.* The *Sphagnum sp.* showed the maximum number of binding sites (28.6 mmol g⁻¹).

Zn is emitted to the atmosphere in greater quantities than other trace metals worldwide. The most common sources of Zn are the industries, traffic and urban incinerations. Therefore, it is necessary to identify and test potential bioindicators for tracing the Zn levels and isotopic composition in urban areas. In the current investigation, the stable isotopic fractionation of Zn, was measured during adsorption experiments at different pH values (from 3 to 7) in a wide range of aqueous Zn concentration (from ppm to ug ppb levels). The Zn isotopic results are given in the recommended delta notation for the ⁶⁶Zn/⁶⁴Zn ratio:

$$\delta^{66}\text{Zn} = [((^{66}\text{Zn}/^{64}\text{Zn})_s / (^{66}\text{Zn}/^{64}\text{Zn})_{\text{STD}}) - 1] \times 1000(\text{‰})$$

where s is the sample and STD is the standard solution. In addition, we define the isotopic offset between Zn in solid (mosses) and Zn in solution as:

$$\Delta^{66}\text{Zn}(\text{solid-solution}) = \delta^{66}\text{Zn}_{\text{solid}} - \delta^{66}\text{Zn}_{\text{solution}}$$

The isotopic offset demonstrated slight enrichment of heavy isotopes on the moss surfaces compared to the aqueous solutions. The range of $\Delta^{66}\text{Zn}(\text{solid-solution})$ varied from 0.01 to 0.1‰ for high levels of Zn in solution (ppm-level). In contrast, at lower Zn concentration (ppb-level), $\Delta^{66}\text{Zn}$ varied from 0 to 0.3‰. The ⁶⁶Zn enrichment can be understood in view of the change of Zn coordination upon its reaction with organic functional groups identified in the moss surface cells. Zn is coordinated to six water molecules in aqueous solution and it is coordinated to 4 molecules after interaction with organic ligands such as carboxylate, amine and polyphenols. This is in concordance with zinc structural analysis for marine and freshwater diatoms (Pokrovsky et al., 2005). The $\Delta^{66}\text{Zn}$ values measured during adsorption of Zn on mosses are consistent with those reported for diatoms adsorption (Gélabert et al., 2006) and lichens (Cloquet et al., 2008).

Therefore, mosses can be used as straightforward tracers of environmental pollution since there is very little modification of the isotopic signature of Zn source during Zn uptake or adsorption on moss bags from the aerosols. This finding should increase the potential use of mosses as bioindicators.

References

- Cloquet, C., Carignan, J., Lehmann, M.F., Vanhaecke, F. 2008. Variation in the isotopic composition of zinc in the natural environment and the use of zinc isotopes in biogeosciences: a review. *Anal. Bioanal. Chem.* 390: 451-463.
- Gélabert, A., Pokrovsky, O.S., Viers, J., Schott, J., Boudou, A., Feurtet-Mazel, A. 2006. Interaction between zinc and freshwater and marine diatom species: Surface complexation and Zn isotope fractionation. *Geochim. Cosmochim. Acta.* 70: 839-857.
- González, A.G., Pokrovsky, O.S. 2014. Metal adsorption on mosses: Toward a universal adsorption model. *J. Colloid Interface Sci.* 415: 169-178.
- Pokrovsky, O.S., Pokrovski, G.S., Gélabert, A., Schott, J., Boudou, A. 2005. Speciation of Zn associated with diatoms using X-ray absorption spectroscopy. *Environ. Sci. Technol.* 39: 4490-4498.

Monitoring of booster biocides in marine sediments coming from harbours of Gran Canaria Island

Á. Sánchez-Rodríguez, Z. Sosa-Ferrera and J.J. Santana-Rodríguez

Departamento de Química, Universidad de Las Palmas de G.C., 35017 Las Palmas de G.C. Spain

Abstract

The term “biofouling” refers to the growth of undesirable organisms on submerged surfaces like, for example, vessel hulls. Biofouling has negative effects, such as increasing both fuel consumption and corrosion as well as the introduction of foreign species into new ecosystems [1]. To avoid the presence of biofouling, it has been traditionally used antifouling paints which contain toxic compounds as active ingredient. From the 70s, organotin compounds as tributyltin (TBT) and triphenyltin (TPT) were extensively employed with excellent results. Unfortunately, organotin compounds showed toxic effects for non-target species at very low levels [2]. For these reason, restrictions were adopted about their use. Nowadays and from 2008, it is not allowed sail in European community waters using organotin coatings. In consequence, paint manufacturers began to employ copper components as principal biocides together to other compounds to enhance their effectiveness for the full spectrum of fouling organisms. These compounds are known as booster biocides and most of them are found to inhibit the growth of both fresh and seawaters autotrophs [3]. In fact, some countries as UK, Denmark or Sweden have limited or forbidden the use of some booster biocides [4].

In the present work we study the levels of four common booster biocides (diuron, TCMTB, dichlofluanid and irgarol 1051) in marine sediments coming from harbours of Gran Canaria Island. For this purpose, a microwave assisted extraction (MAE) and solid phase extraction (SPE) purification and preconcentration step combining with LC-MS/MS technique was employed as methodology for their determination.

A monitoring campaign was conducted for one year and five months in five harbours of Gran Canaria Island, including fishing harbours and marinas. Measurable levels of diuron, irgarol 1051 and dichlofluanid were found. These levels ranged from units to tens of ng/g [5].

References

1. D.M. Yebra, K. Dam-johansen, Antifouling technology—past, present and future steps towards efficient and environmentally friendly antifouling coatings, 50 (2004) 75–104.
2. C. Alzieu, Environmental impact of TBT: the French experience, *Sci. Total Environ.* 258 (2000) 99–102.
3. H. Okamura, T. Nishida, Y. Ono, W.J. Shim, Phytotoxic effects of antifouling compounds on nontarget plant species., *Bull. Environ. Contam. Toxicol.* 71 (2003) 881–6.
4. K. V Thomas, S. Brooks, The environmental fate and effects of antifouling paint biocides., *Biofouling.* 26 (2010) 73–88.
5. A. Sánchez-Rodríguez, Z. Sosa-Ferrera, J.J. Santana-Rodríguez, Applicability of microwave-assisted extraction combined with LC-MS/MS in the evaluation of booster biocide levels in harbour sediments., *Chemosphere.* 82 (2011) 96–102.

Assessment of organic booster biocide contamination in seawater from harbours of Gran Canaria Island

A. Sánchez-Rodríguez, Z. Sosa-Ferrera and J.J. Santana-Rodríguez

Departamento de Química, Universidad de Las Palmas de G.C., 35017 Las Palmas de G.C., Spain

Abstract

The term biofouling refers to an undesirable accumulation of microorganisms, plants and animals on artificial surfaces immersed in water. This accumulation causes several problems such as greater frictional resistance and deterioration of the coating with the consequent economic loss [1]. In the 70s, organotin compounds, as tributyltin (TBT), were introduced in ship painting industry with excellent results. However, TBT is considered a persistent and toxic compound. It manifests extreme toxicity in non-target species, such as bivalves and gastropods, some of which are of commercial interest [2]. For this reason organotin based paints have been progressively forbidden. Nowadays and from 2008, in European community waters it is not allowed sail with ships painted with these coatings. As a result, paint manufacturers introduced new products. These compounds are now known as booster biocides and are added to copper oxide-based paints to improve their effectiveness for the full spectrum of fouling organisms. Common booster biocides are growth inhibitors of freshwater and marine algae [3]. In consequence several restrictions has been adopted in some European countries as UK, Denmark or Sweden [4].

Seawater samples from fishing ports, and harbors of Gran Canaria Island were analyzed to determine levels of four booster biocides (diuron, TCMTB, dichlofluanid and irgarol 1051). A monitoring campaign of marine waters was conducted for one year. Diuron and irgarol 1051, with concentrations ranged from units to cents of ng/l, were the most common biocides present in seawater [5].

The method used to determine the levels of the biocides in seawater samples was based on a SPE process combining with LC-MS/MS technique.

References

1. D.M. Yebra, K. Dam-johansen, Antifouling technology—past, present and future steps towards efficient and environmentally friendly antifouling coatings, 50 (2004) 75–104.
2. C. Alzieu, Environmental impact of TBT: the French experience, *Sci. Total Environ.* 258 (2000) 99–102.
3. H. Okamura, T. Nishida, Y. Ono, W.J. Shim, Phytotoxic effects of antifouling compounds on nontarget plant species., *Bull. Environ. Contam. Toxicol.* 71 (2003) 881–6.
4. K. V Thomas, S. Brooks, The environmental fate and effects of antifouling paint biocides., *Biofouling.* 26 (2010) 73–88.
5. A. Sánchez-Rodríguez, Z. Sosa-Ferrera, A. Santana-del Pino, J.J. Santana-Rodríguez, Probabilistic risk assessment of common booster biocides in surface waters of the harbours of Gran Canaria (Spain)., *Mar. Pollut. Bull.* 62 (2011) 985–91.

Monitoring of selected group of pharmaceutical compounds in outfalls from coastal waters of Gran Canaria island (Spain)

Cristina Afonso-Olivares, M^a Esther Torres-Padrón, Zoraida Sosa-Ferrera, José Juan Santana-Rodríguez

Departamento de Química, Universidad de Las Palmas de Gran Canaria, 35017, Las Palmas de G.C., Spain.

Abstract

Since decades, continuous and indiscriminate use of prescription or non-prescription human pharmaceuticals, illegal drugs as well as veterinary drugs has produced the preoccupation between the scientific communities. These pollutants are not included in the different regulations and, for this reason, they are considered emerging contaminant [1,2]. Continuous exposure of these potentially hazardous chemicals has led to many environmental problems that directly or indirectly affect the water cycle. Because they are dispersed through wastewater, whose customary purification systems are not designed to remove it, so that they are discharged in seawater and they can be introduced in trophic chain [3].

The principal aim of this study is to assess the presence of a selective group of pharmaceutical compounds from urban agglomerations in the coastal waters of Gran Canaria Island in order to predict environmental quality. Solid phase extraction (SPE) was used for the extraction and preconcentration of the samples and high performance liquid chromatography coupled to mass spectrometry detection (LC-MS/MS) was chosen for the determination. The developed method was applied to evaluate the presence of seven pharmaceutical compounds belonging to different commonly used therapeutic classes in seawater samples from four outfalls in Gran Canaria Island (Spain) during one year.

The target compounds include atenolol (antihypertensive), acetaminophen (analgesic), norfloxacin and ciprofloxacin (antibiotics), carbamazepine (antiepileptic) and ketoprofen and diclofenac (anti-inflammatory). All parameters involved in solid phase extraction were optimized and the process was validated. The recoveries obtained were in the range of 78.3% to 98.2%, and the relative standard deviations were less than 11.8%. The detection and quantification limits of the method were in the ranges of 0.1–2.8 and 0.3–9.3 ng L⁻¹, respectively.

During the monitoring time, some pharmaceutical compounds were found sporadically, such as diclofenac, acetaminophen and ketoprofen at very low concentrations. However, fluoroquinolones (ciprofloxacin and norfloxacin) were found in a large number of samples in a concentration range of 9.0-3551.7 ng L⁻¹.

References

1. Pal, A., Yew-Hoong, K., Yu-Chen, A., Reinhard, M., 2010: Impacts of emerging organic contaminants on freshwater resources: Review of recent occurrences, sources, fate and effects. *Sci. Total Environ.*, 408, 6062–6069.
2. Kaplan, S., 2013: Review: Pharmacological Pollution in Water. *Crit. Rev. Env. Sci. Tec.*, 43, 1074–1116.
3. Afonso-Olivares C., Torres-Padrón M.E., Sosa-Ferrera Z., Santana-Rodríguez J.J., 2013: Assessment of the Presence of Pharmaceutical Compounds in Seawater Samples from Coastal Area of Gran Canaria Island (Spain). *Antibiotics*, 2, 274-287.

Quantification of fluoroquinolone antibiotics in coastal marine sediments of Gran Canaria island using a green methodology

Sarah Montesdeoca Esponda, Zoraida Sosa Ferrera, Jose Juan Santana Rodriguez

Departamento de Química, Universidad de Las Palmas de Gran Canaria, 35017, Las Palmas de G.C., Spain

Abstract

Fluoroquinolones (FQs) are a class of antibiotics used in human and animal medicine for therapeutic purpose as against both gram-positive and gram-negative bacteria [1]. After their excretion, they are accumulated in wastewater treatment plants (WWTPs) because there are no mechanisms to eliminate them completely. In this way, the pollutants contained in the treated water can be deposited in coastal sediments around wastewater marine outfalls. FQs are resistant to microbial degradation and may be persistent in the environment [2]. Thus, to prevent the growth of resistant bacteria, monitoring FQ concentrations in different kinds of environmental samples is necessary [3], especially in solid samples, where they can be accumulated.

This work present an analytical green approach for the quantification of five FQs (levofloxacin, norfloxacin, ciprofloxacin, enrofloxacin and sarafloxacin) in sediments from coastal points of the south of Gran Canaria island (Spain) that had not been studied previously. The simple area is affected by a marine outfall discharging wastewaters.

We selected microwave assisted extraction (MAE) as extraction technique, replacing the organic solvents by micellar media as extraction agents, being then called Microwave-assisted micellar extraction (MAME). Micellar media are no toxic, biodegradable, less expensive than organic solvents and compatible with the mobile phase used in liquid chromatography (LC). Moreover they can enhance the signal of many compounds in fluorescence detection [4].

Analysis was performed using liquid chromatography with fluorescence detection and electrospray ionization–tandem mass spectrometry detection (LC-FD and LC-ESI-MS/MS, respectively). Under optimal conditions, we obtained recoveries greater than 73% with relative standard deviations below 8%. The limits of detection achieved using MAME-LC-ESI/MS/MS were between 0.15 and 0.55 ng g⁻¹ for the different FQs.

Four fluoroquinolones (levofloxacin, norfloxacin, ciprofloxacin and enrofloxacin) were found in the coastal marine sediments in concentrations between 0.81 and 34.3 ng g⁻¹, which means that the sediment absorbs the antibiotics dissolved in the effluent of the marine outfall, showing also that their accumulation was higher closer to the outfall and lower nearer to the coast.

References

1. Kaur K, Kumar A, Malik AK, Singh B and Rao ALJ. *Critical Reviews in Analytical Chemistry* 2008; 38: 2-18.
2. Mitani K and Kataoka H. *Analytica Chimica Acta* 2006; 562: 16-22.
3. Ferding M, Kaleta A and Buchberger W. *Journal of Separation Science* 2005; 28: 1448-1456.
4. Montesdeoca-Esponda S, Torres Padrón ME, Sosa Ferrera Z and Santana Rodríguez JJ. *Analytical and Bioanalytical Chemistry* 2009; 394: 927-935.

Optimization of an analytical method for the extraction and determination of anti-fouling booster in biological tissues.

Lia Gracy R Diniz¹, Eny M Vieira¹, Teresa CRS Franco², M^a Esther Torres-Padrón³, Zoraida Sosa-Ferrera³, José Juan Santana-Rodríguez³

¹*Institute of Chemistry of São Carlos, University of São Paulo, Brazil*

²*Laboratory of Analytical Chemistry and Ecotoxicology, Federal University of Maranhão, Brazil*

³*Departamento de Química, Universidad de Las Palmas de Gran Canaria, Spain*

Abstract

The biocides used to paints, which act as anti-fouling, are groups of substances potentially adverse to aquatic ecosystems. Anti-fouling paints are treatments to minimize corrosive processes on ships and port's structures, reducing maintenance costs, saving fuel and decreasing the transmission of non-native species of coastal ecosystems [1].

However, the overuse of antifouling paints have triggered a serious environmental problems, such as genetic mutations in molluscs (imposex) and oysters as the phenomenon "Balling", i.e. related with the use of TBT. Although the use of this compound was prohibited in 2003, vessels that had been painted could remain with their paintings until 2008 when the presence of tributyltin (TBT) was definitely forbidden after the ban of the use of organotin [2,3].

Anti-fouling paints industries sought new alternatives and a third generation of biocides have been synthesized, the non-metallic organic compounds. The most research biocides in the world are, 4-chloro-3-methylphenol, chlorothalonil, dichloflunid, diuron, irgarol, thiram and zineb. Although they are less persistent in the environment, many of these compounds have been associated with noxious effects such as metabolic disorders, infertility and inhibition of growth, low in immune defense and death in some organisms [4].

Due to the formation of a dimorphism of male sex organs (penis and vas deferens) in females, the *Stramonita haemastoma* (Linnaeus, 1766) is considered a bioindicator for TBT and Triphenyltin (TPhT), both anti-fouling first generation. The use of their soft tissues can be available option for the chemical analysis of the presence of the new anti-fouling in port areas. For that, this study proposes the development, validation and application of an analytical method for the extraction, preconcentration and determination of selected antifouling biocides (chlorothalonil, dichloflunid diuron, irgarol) in biological tissue samples from *Stramonita haemastoma* [5].

References

1. Castro, I. B.; Westphal, e.; Fillmann, g. Tintas anti-incrustantes de terceira geração: novos biocidas no ambiente aquático. Química Nova, v. 34, n. 6, p. 1021-1031, 2011.
2. Dimitriou, P., Castritsi-Catharios, J., Miliou, H. Acute toxicity effects of tributyltin chloride and triphenyltin chloride on gilthead seabream, *Sparus aurata* L., embryos. Ecotoxicology and Environmental Safety. Vol 54, Pag 30–35, 2003.
3. IMO (International Maritime Organization). Anti-fouling systems. Available in: <http://www.imo.org/OurWork/Environment/Anti-foulingSystems/Pages/Default.aspx>. Accessed on: mar, 19, 2014.
4. Sapozhnikova, Y.; Wirth, E.; Schiff, K.; Brown, J.; Fulton, H. Anti-fouling pesticides in the coastal waters of Southern California. Marine Pollution Bulletin. v. 54, p. 1962-1989, 2007.
5. Garaventa, F.; Pellizzato, F.; Faimali, M.; Terlizzi, A.; Medakovic, D.; Geraci, S.; Pavoni, B. Imposex in *Hexaplex trunculus* at some sites on the North Mediterranean Coast as a base-line for future evaluation of the effectiveness of the total ban on organotin based antifouling paints. Hydrobiologia, Vol. 555, p 281-287, 2006.

Comprehensive study of the Magdalena Bay (México): the relevance of water depuration in an area with water supply deficiency

Juan Santos-Echeandía¹, Rafael Cervantes-Duarte², Juan J. R. Herrera³, Antonio Cobelo¹, Ricardo Prego¹, Judith Marmolejo²

¹*Marine Biogeochemistry Group, Marine Research Institute (CSIC), Eduardo Cabello 6, 36208 Vigo, Spain*

²*Microbiología y Tecnología de Productos Marinos. Marine Research Institute (CSIC), Eduardo Cabello 6, 36208 Vigo, Spain*

³*Centro Interdisciplinario de Ciencias Marinas (CICIMAR), 592, La Paz BCS, Mexico*

Abstract

The Pacific peninsula of Southern Baja California in Mexico houses the Magdalena bay. It is the largest lake system in the region (1875 km²). This wetland consists of a vast complex of bays including dunes, islands and mangrove areas. Two sandbars and two islands limit to this lagoon complex with the Pacific Ocean. Due to its high productivity and biodiversity it was classified as a priority area for conservation both nationally and internationally (CONABIO 1998; CCA 1999). In addition, this wetland has been identified as one of the most important Active Biological Centers of the Mexican Pacific Ocean, and an Important Bird Area (IBA 104; CEC 1999) and one of the nine most important coastal habitats of Mexico (WWF). It is one of the most important areas of birth of the gray whale and feeding ground for several species of turtles in danger of extinction. Its high productivity leads to the presence of significant stocks of fish, molluscs and crustaceans that are exploited by the human being but also attract large numbers of seabirds.

The major population center of the area is Puerto San Carlos (6,000 inhabitants). It is a fishing village, so its economy is based mainly on fishing and the cultivation of bivalve molluscs, accompanied by tourism during whale watching season.

Being an area with a desert-arid climate the water supply is complicated. Furthermore, the absence of desalination plants prevents the use of ocean water that surrounds the bay for domestic or urban use. On the other hand, due to poor infrastructure for debugging, municipal waste is dumped directly to septic tanks or to the bay without any treatment. This can lead to serious health and economic consequences as the bay water governs the life of Puerto San Carlos, both as a direct source of resources (shellfish farming and fishing) and its touristic attraction, and may suffer significant levels of degradation.

To our knowledge, studies of the area have mainly focused on the biology of the species that inhabit the lagoon, both marketable species as sardines/bivalves [1] as protected or endangered species such as whales, turtles and birds. It has also been observed a recent interest in the communities of phytoplankton and zooplankton in the lagoon [2] and the biogeochemical cycle of nitrogen, nutrients and chlorophyll [3].

However, the studies focused on assessing water quality and its impact on human supply and the environment have been scarce. Hardly a study on heavy metals in algae [4] and two on environmental oxidative stress in some organisms [5] have been published. Despite their scarcity, these studies have shown some degree of contamination in algae by heavy metal and important stress levels in lagoon organisms caused by pollution and degradation of marine habitats by human actions. Therefore, it is evident that an anthropogenic influence exists on the lagoon and the only source of pollution in the bay should come from untreated urban discharges.

The main objectives can be summarized in:

1. MONITOR from a biological, chemical and microbiological point of view the waters of supply to

Puerto San Carlos, wastewater discharged into the bay and Bahía Magdalena own waters and sediments and fish and bivalve molluscs intended for human consumption.

2. EVALUATE the ecological health of the environment from the results of biological, chemical and microbiological analysis of the different waters, sediments and biota.

3. ACT, in a controlled and environmentally safe way with different products for bio-remediation to achieve an optimal state of water supply and sewage. Chance of seawater desalination, fine if not for drinking use, whether for livestock or agriculture and not deplete the existent aquifers. A feasibility study will be performed to propose an ecologically desalination system with limited capacity of production for Puerto San Carlos population.

These objectives will be achieved through the following actions:

A. Surveys (March and September 2014). Aquifers and points of discharge of wastewaters to the bay will be sampled. Likewise, several surface water samples will be collected within the bay. Finally sediment samples will be taken at various points of the bay and samples of fish and bivalve molluscs.

B. Analysis. Microbiological, heavy metals, nutrients, organic matter, primary production and chlorophyll analysis will be performed in water samples. In addition auxiliary variables will be measured such as temperature, salinity, oxygen and suspended particulate matter. Heavy metals and organic matter will be measured in sediments and the presence of Salmonella or Escherichia coli, and the concentration of heavy metals in tissues of fish and bivalves will be determined.

C. Remediation. With the results of the analysis, and in collaboration with the company Thesis Galicia, a study at the laboratory at IIM-CSIC for efficacy of different bioremediation products followed by their scaling in Puerto San Carlos will arise during the second visit to Bahía Magdalena in order to see their in-situ efficiency.

References

1. Schweers, T., M. Wolff, V. Koch, and F.S. Duarte, 2006. Population dynamics of *Megapitaria squalida* (Bivalvia: Veneridae) at Magdalena Bay, Baja California Sur, Mexico. *Rev.Biol.Trop.*,54,1003-1017.
2. Hernández-Trujillo, S., G. Esqueda-Escárcega, J.R. Hernández-Alfonso, and R. PachecoChávez, 2010. Daily cycle of zooplankton abundance in Magdalena Bay, B.C.S. Mexico. *Rev.Mex.Biodivers.*,81,913-920
3. Cervantes-Duarte, R., R. Prego, S. López-López, F. Aguirre-Bahena, and N. Ospina-Alvarez, N. 2013. Annual patterns of nutrients and chlorophyll in a subtropical coastal lagoon under the upwelling influence (SW of Baja-California Peninsula). *Est.Coast.Shelf.Sci.*,120,54-63.
4. Riosmena-Rodriguez, R., A. Talavera-Sáenz, B. Acosta-Vargas, and S.C. Gardner, 2010. Heavy metals dynamics in seaweeds and seagrasses in Bahía Magdalena, B.C.S., México. *J.Appl.Phycol.*,22,283-291.
5. Senko, J., A.J. Schneller, J. Solis, F. Ollervides, and W.J. Nichols, 2011. People helping turtles, turtles helping people: Understanding resident attitudes towards sea turtle conservation and opportunities for enhanced community participation in Bahía Magdalena, Mexico. *Ocean.Coast.Manage.*,54,148-157.

Platinum in Salt Marsh sediments: behaviour and biological uptake

C. Almécija¹, A. Cobelo-García¹, J. Santos-Echeandía¹ and M. Caetano².

¹Bioxeoquímica Mariña, Instituto de Investigacións Mariñas IIM-CSIC, 36208 Vigo, Spain

²IPMA-Portuguese Institute of Sea and Atmosphere, Av. Brasília, 1449-006, Lisbon, Portugal

Abstract

Platinum is almost one of the least abundant elements in the earth crust whose average concentration is 510 pg g⁻¹ (Peucker-Ehrenbrink and Jahn, 2001). Although there are some natural sources that involve Pt-rich deposits, the use of Pt in several human activities is increasing the concentration in the surface sediments, especially the use in automobile catalytic converters (Rauch and Morrison, 2008). Previous authors assess the sedimentary behaviour of Pt in anthropogenically-impacted areas whereas natural systems are poorly study (Rauch et al., 2004; Tuit et al., 2000).

This study is aimed to (i) characterize the transport, fate and sedimentary behaviour of the platinum released in coastal environments, (ii) ascertain the role of vegetation on Pt biogeochemical cycle and (iii) check de bioavailability of Pt and the transfer through the food chain.

Several sediment cores were sampled in the salt marshes at the Tagus Estuary under different vehicular traffic conditions, where the behaviour of other metals is well-characterized (Caetano et al., 2008). Pt concentration was analysed in sediment, interstitial water and different tissues -roots, leaves and stem- of *Sarcocornia fruticosa*, typical salt marsh specie, by Catalytic Adsorptive Cathodic Stripping Voltammetry and some other auxiliary parameters –redox potential, dissolved oxygen, total sulphides, Fe and Mn or sedimentary Al- were also determined.

Although surface enrichment of Pt exists in the sediments at Low Traffic Station (2.8 ng g⁻¹), 6 times the background level (below 5 cm, 680 ± 240 pg g⁻¹), the highest enrichment was founded at High Traffic Station where Pt concentration is, in some cases, up to 40ng g⁻¹ independently to be or not vegetated (background value 670 ± 89 pg g⁻¹). However, dissolved Pt in interstitial waters lacks this superficial peak showing quite homogeneous profiles; mean values of Pt at Low and High Traffic Station are 0.21 ± 0.07 pg g⁻¹ and 0.44 ± 0.13 pg g⁻¹ respectively excepting for a not-superficial peak of 2.5 pg g⁻¹ at Low Traffic Station (also detected in Pt concentration in roots) coinciding with the peak of dissolve Fe (II) in water that marks the reduction of iron to degrade organic matter. Concentration of Pt in roots is lower than Pt concentration in sediments in the first 15-20 cm but the same trend, e.g. at Low Traffic Station roots showed 180 ± 150 pg g⁻¹ (n=8) and sediments 500 ± 130 pg g⁻¹ (n=8), although in High Traffic Station there is an important increase with depth reaching values until 1500 pg g⁻¹ maybe due to adsorption process by dead roots. Concentrations of Pt in leaves and stems are in mostly cases under the detection limit and when it is detected is until 44 times lower than Pt in roots (the highest Pt concentration is 130 pg g⁻¹ in leaves from High Traffic Station when roots resented 470 ± 250 pg g⁻¹) while for other elements like Cd, Co, Zn or Cu (Caetano et al., 2008). The geochemistry of the sediment is between the presence of O₂ released by the active alive roots into the first centimetres of the sediment and the degradation of organic matter very important when the dead biomass reaches 20% of the sediment weight, what could reinforce the Pt concentration by adsorption keeping Pt in surface.

We could conclude as a further advance in sedimentary Pt geochemical behaviour that (i) there is an important input of Pt to the system linked to vehicular traffic circulation, (ii) there are some signs that could indicate Pt is sensitive to redox variations, (iii) the role of vegetation is vital to Pt behaviour due to the control of the presence of O₂ in the sediment and (iv) the uptake of Pt by roots is lower than the uptake for other elements and there is no transport though the tissues. Future studies could shed light to other questions related to Platinum behaviour in natural systems.

References

- Caetano, M., Vale, C., Cesário, R., Fonseca, N., 2008. Evidence for preferential depths of metal retention in roots of salt marsh plants. *Sci. Total Environ.* 390, 466–474.
- Peucker-Ehrenbrink, B., Jahn, B., 2001. Rhenium-osmium isotope systematics and platinum group element concentrations: Loess and the upper continental crust. *Geochem. Geophys. Geosystems* 2.
- Rauch, S., Hemond, H.F., Peucker-Ehrenbrink, B., 2004. Recent changes in platinum group element concentrations and osmium isotopic composition in sediments from an urban lake. *Environ. Sci. Technol.* 38, 396–402.
- Rauch, S., Morrison, G.M., 2008. Environmental relevance of the platinum-group elements. *Elements* 4, 259–263.
- Tuit, C.B., Ravizza, G.E., Bothner, M.H., 2000. Anthropogenic platinum and palladium in the sediments of Boston Harbor. *Environ. Sci. Technol.* 34, 927–932.

General stress syndrome analysed in *Corbicula fluminea* exposed to human pharmaceuticals

Aguirre-Martínez, G.V.^{1,2}, Del Valls, T. A.¹, Martín-Díaz, M. L.^{1,2}

¹Physical Chemical Department, University of Cádiz. Faculty of Marine and Environmental Sciences. Polígono Río San Pedro s/n. 11510 Puerto Real. Cádiz. Spain

²Andalucian Center of Marine Science and Technology (CACYTMAR). Campus Universitario de Puerto Real. 11510, Puerto Real. Cádiz. Spain

Abstract

It is a fact that human pharmaceuticals are present in the aquatic environment at low concentration (from ng/L to µg/L) (1), moreover, it has been demonstrated that even at these levels pharmaceutical active compounds can cause adverse effects to aquatic biota (2, 3, 4). To detect adverse effects, standardized short-term, sensitive and low-cost methods are usually applied to estimate chronic toxicity against organisms (5). In this regard lysosomal membrane stability (LMS) has been successfully used as a screening tool to determine the general stress syndrome in aquatic organisms exposed to contaminants (5, 6). *Corbicula fluminea* (fresh water clam) has been described as a suitable filter feeding organism for contamination risk assessment in fresh water environments (8). Clams were exposed to 0, 0.1, 1, 5, 10, 15 and 50 µg/L of caffeine (psychoactive/stimulant), ibuprofen (non-steroidal/anti-inflammatory), carbamazepine (anticonvulsant/mood stabilizing), novobiocin (antibiotic) and tamoxifen (anticarcinogenic) during 21 days in a semi-static 48h renewal assay. Stocks of pharmaceuticals were dissolved in DMSO (0.001 % v/v). Test with this solvent was undertaken to ensure no solvent effect. LMS was evaluated in clam's haemolymph by the neutral red retention time (NRRT) assay every 7 days. No differences in the NRRT were observed between control and DMSO at day 7 (120 and 120 min), day 14 (115 and 120 min) and day 21 (115 and 117 min). Results indicated not only a concentration-response correlation ($p < 0.05$; $r = 0.84$) but also significant time-response relationship ($p < 0.05$; $r = 0.72$) in clams exposed to selected pharmaceuticals. Environmental concentrations of drugs tested affected significantly the LMS compared with controls on day 7, 14 and 21 ($p < 0.01$). Estimated values of EC₅₀ were as follows: ibuprofen 36 µg/L, carbamazepine 0.46 µg/L, novobiocin 0.1 µg/L and tamoxifen 0.08 µg/L, for caffeine EC₅₀ value could not be calculated being above 50 µg/L. *C. fluminea* exposed to environmental concentrations of pharmaceuticals was considered to present general stress syndrome at the end of the assay. Moreover, clams exposed to tamoxifen at 1 µg/L were considered to present a diminished health status (retention time < 45 min). *C. fluminea* seems to be susceptible to the effects of pharmaceuticals as early as one week of exposure, being suitable species for ecotoxicological studies. LMS appears to be sensitive tool that allows evaluation of general stress syndrome in *C. fluminea* exposed to selected drugs and could therefore be used as a reliable biomarker for evaluation of pharmaceutical contamination in aquatic environments.

Keywords: Neutral red retention assay, clams, lysosomal membrane stability, haemolymph, bioassay.

References

- (1) Ternes, T. A., 1998: Occurrence of drugs in German sewage treatment plants and rivers. *Water Res.*, 32, 3245-3260.
- (2) Gagné, F., Bérubé, E., Fournier, M. and C. Blaise, 2005: Inflammatory properties of municipal effluents to *Elliptio complanata* mussels: lack of effects from anti-inflammatory drugs. *Comp. Biochem. Phys. C.*, 141,332-337.
- (3) Quinn, B., Gagné, F. and C. Blaise, 2008: The effects of pharmaceuticals on the regeneration of the cnidarian, *Hydra attenuata*. *Sci. Total. Environ.*, 402,62-69.
- (4) Quinn, B., Schmidt, W., O'Rourke, K. and R. Hernan, 2011: Effects of the pharmaceuticals gemfibrozil and diclofenac on biomarker expression in the zebra mussel (*Dreissena polymorpha*) and their comparison with standardized toxicity tests. *Chemosphere*, 44,657-663.
- (5) Viarengo, A., Lowe, D., Bolognesi, C., Fabbri, E. and A Koehler, 2007: The use of biomarkers in biomonitoring: a 2-tier approach assessing the level of pollutant-induced stress syndrome in sentinel organisms. *Comp. Biochem. Phys. C.*, 146, 281-300.

- (6) Martínez-Gómez, C., Benedicto, J., Campilloa, J. A., M. Moore. 2008: Application and evaluation of the neutral red retention (NRR) assay for lysosomal stability in mussel populations along the Iberian Mediterranean coast. *J. Environ. Monitor.*,10, 490–499.
- (7) Bilos, C., Colombo, J.C. and M.J. Rodríguez Pesa, 1998: Trace metals in suspended particles, sediments and Asiatic clams (*Corbicula fluminea*) of the Río de la Plata estuary, Argentina. *Environ. Pollut.*, 99,1–11.

Risk assessment for frequently used chemotherapeutic agents

Aguirre-Martínez, G.^{1,2}, Okello, C.³, Salamanca, M.³, Garrido, C.², Del Valls, T. A.¹, Martín-Díaz, L.M.^{1,2}

¹Cátedra UNESCO/UNITWIN/WiCop. Facultad Ciencias del Mar y Ambientales. Universidad de Cádiz, Polígono Río San Pedro s/n. P. Real, Cádiz. Spain

²Andalusian Center of Marine Science and Technology (CACYTMAR). Campus Universitario de Puerto Real. 11510, Puerto Real. Cádiz. Spain

³Integrated Geoscience Research Group (IGRG), Interdepartmental Centre for Environmental Sciences Research (CIRSA). Ravenna Campus. University of Bologna. Via S. Alberto 163. 48100, Ravenna. Italy

Abstract

Despite detected concentrations in the environment, most methotrexate (MTX) and tamoxifen (TMX) research is essentially bio-medically orientated with few studies addressing the question of toxicity in aquatic organisms [1,2]. MTX is a commonly used anti-metabolite (folic acid antagonist) in cancer treatment and applied as anti-rheumatic drug, while TMX is commonly used for breast cancer treatment. Both compounds have been determined in the aquatic environment [3,4]. A risk assessment of these chemotherapeutic agents was performed following the European Medicine Assessment (EMA) guidelines (5) including the 2-tier approach proposed by Viarengo et al. (2007) in Phase III (Tier C), applying lysosomal membrane stability (LMS) as screening biomarker in tier 1 and a battery of biochemical biomarkers in tier-2. Results in Phase II (Tier B) indicate that MTX at the concentrations tested is not toxic for bacteria, microalgae and sea urchin thus no need further assessment was required while TMX indicated possible risk. Phase III (Tier C) was therefore performed only for TMX in *R. philippinarum* exposed 14 days to TMX (0.1, 1, 10, 50, $\mu\text{g L}^{-1}$). At the end of the experiment clams exposed to TMX at environmental concentration indicate significant changes in LMS compared with control clams ($p < 0.01$); therefore, a second tier was performed, and significant induction of biomarkers (EROD activity, GST activity, GPX activity, GR activity and LPO) was observed in D. gland tissues of clams compared with controls organisms ($p < 0.01$). Finally this study indicates that MTX was not toxic at environmental relevant concentration while TMX resulted to be potentially toxic for aquatic biota. The use of EMA guidelines and the 2-tier approach proposed by Viarengo et al. (2007) applied as a step in Phase III seems to be suitable and is advisable its use for risk assessment of chemoprevention and chemotherapeutic agents in aquatic environment.

References

1. Liwei, S., Jinmiao, Z., Philip, A.S. and W.Zijian, 2007: Tamoxifen effects on the early life stages and reproduction of Japanese medaka (*Oryzias latipes*), *Environ. Toxicol. Pharm.*, 24(1),23–29.
2. Mater, N., Geret, F., Castillo, L., Faucet-Marquis, V., Albasi, C. and A., Pfohl-Leskowicz, 2014: In vitro tests aiding ecological risk assessment of ciprofloxacin, tamoxifen and cyclophosphamide in range of concentrations released in hospital wastewater and surface water. *Environ. Int.*,63,191–200.
3. Ashton, D., Hilton, M. and K. V. Thomas, 2004: 'Investigating the environmental transport of human pharmaceuticals to streams in the United Kingdom', *Sci. Total Environ.*,333(1-3),167–184.
4. Negreira, N., López de Alda, M. and, D. Barceló, 2013: On-line solid phase extraction–liquid chromatography–tandem mass spectrometry for the determination of 17 cytostatics and metabolites in waste, surface and ground water samples. *J. Chromatogr. A.*, 1280,64–74.
5. Viarengo, A., Lowe, D., Bolognesi, C., Fabbri, E. and A Koehler, 2007: The use of biomarkers in biomonitoring: a 2-tier approach assessing the level of pollutant-induced stress syndrome in sentinel organisms. *Comp. Biochem. Phys. C.*,146, 281–300.

Effect of temperature and salinity on Cd adsorption in a sandy coastal sediment

Julián Blasco¹, Verónica Sáenz-Arreucochea¹, Abelardo Gómez-Parra²

¹*Departamento Ecología y Gestión Costera. Instituto de Ciencias Marinas de Andalucía (CSIC). Campus Río San Pedro. 11510 Puerto Real (Cádiz). Spain*

²*Departamento de Química-Física. Facultad de Ciencias del Mar y Ambientales. Campus Río San Pedro. 11510. Puerto Real (Cádiz). Spain*

Abstract

Metal adsorption in coastal sediments is a well studied process because sediments are the final repository of metal inputs which provokes a decrease in metal bioavailability and toxicity. The scientific literature about this process is wide and metals and sediments from different sources and nature have been studied. However, these studies are focused on sediment with high levels of clay and silt, and less attention has been paid to sediments with coarse granulometry although they represent an elevated percentage in high energy coastal areas, as estuary ecosystems, which are the main route for metal inputs in the oceans.

In this work, Cd adsorption on sandy sediment (5.2% clay, 19.3% silt and 75.5% sand) and the influence of temperature (20-30°C) and salinity (20-35‰) on this process have been measured. Kinetic adsorption has been examined and the time to reach the equilibrium was less than 160 hours. The adsorption thermodynamic constant and the variations of state functions (ΔH° , ΔS° and ΔG°) were determined.

Sediment sample was collected from the south area of Sancti-Petri Channel (Cadiz bay). This area shows low levels of metal contamination. Specific surface area was $8.6 \text{ m}^2 \text{ g}^{-2}$. Experiments were carried out in batch in Pyrex vessels with 0.6 g of sediment and 200 mL of Cd solutions in artificial seawater. The Cd concentration range was selected in logarithmic scale to include the whole range of Cd solubility in seawater. The analyses were carried out by GFAAS (Perkin Elmer 4100 ZL) and background correction with longitudinal Zeeman.

In all cases, the results showed the best fit to Freundlich isotherm (C type). The constant values ranged between 148.80 and 454.36 L kg^{-1} being the exponential term (n) lower than 1. The salinity effect on Cd adsorption is bigger than temperature. The adsorption process decreases with increasing salinity due to competence of alkaline and alkaline earth elements by adsorption sites. The ΔH° ranged between 24.91 and 40.57 kJ mol^{-1} , ΔS° between 106.64 and 230.34 $\text{J mol}^{-1} \text{ K}^{-1}$ and ΔG° between $6 \cdot 10^4$ and $22.4 \cdot 10^4$ kJ mol^{-1} .

An exploratory study of embryotoxic effects on the sea urchin *Paracentrotus lividus* after exposure to microbeads

Martínez-Gómez, C.¹, León, V.M.¹, Calles, S.¹, Vethaak, A.D.^{2,3}

¹*Instituto Español de Oceanografía, Centro Oceanográfico de Murcia, Apdo. 22, C/ Varadero 1, 30740 San Pedro del Pinatar, Murcia, Spain.*

²*VU University Amsterdam, Institute for Environmental Studies, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands*

³*Deltares, Marine and Coastal Systems, P.O. Box 177, 2600 MH Delft, The Netherlands*

Abstract

Although the full extent and consequences is hard to quantify, the accumulation of plastic, including microplastics, in the marine environment is today recognized as a serious, global environmental issue. To date a significant number of personal care products such as scrubs and toothpastes are known to contain thousands of minuscule balls of plastic called microplastics, or more specifically, microbeads. Microbeads are also widely used in air-blasters to remove rust and paint from the hulls of boats. Typically, microplastics are defined as plastic pieces or fibers measuring less than 5 mm. The microbeads found in personal care products are almost always smaller than 1 mm. Over the years, microbeads have replaced traditional, biodegradable alternatives such as ground nut shells, and salt crystals. Where products are washed down the drain after use, microbeads pass into household waste water streams directly and are too small to be retained by the standard filters used at sewage treatment plants and therefore enter ultimately into the seas and oceans, where they contribute to the plastic soup. But microbeads not only do they enter the sea, they can also enter the food chain. Once on the aquatic environment and, because plastics are oil-based, they are particularly good at attracting waterborne pollutants from other sources. If marine animals swallow tiny plastic particles, the chemicals on their surface could be easily taken up. Ingestion of microplastics (including microbeads) by marine biota, such as mussels, worms, fish and seabirds, has been widely reported. Exposure to copepods to natural assemblages of algae with and without microbeads has shown that 7 μm significantly decreased algal feeding. All these findings clearly indicated that marine microplastic debris can negatively impact upon invertebrates function and health.

To date, little or no information is available on the potential effects of microplastics on echinodermata. Here, we studied the effect of microplastics on the fecundation rate and larval development of sea urchin (*Paracentrotus lividus*) by exposing them to a polystyrene microspheres (6 μm micrometer) t three different concentrations. The microbeads used during the exposure had fluorescence properties, allowing observation of them attached onto the membrane cells and tissues after exposure. The results obtained have contributed to the knowledge of toxicity mechanisms and potential toxic effects of microbeads on marine invertebrates and its early stages. Furthermore, the results have opened new research lines about the feasibility of use microbeads as contaminant vectors to investigated biological effects on invertebrates.

Keywords: bio-indicators, ecotoxicology, monitoring, Western Mediterranean

Distribution of current use pesticides in surface marine sediments from the Mar Menor Lagoon (SE Spain)

Moreno-González, R., Campillo, J.A., León, V.M.

¹*Instituto Español de Oceanografía, Centro Oceanográfico de Murcia, Apdo. 22, C/ Varadero 1, 30740 San Pedro del Pinatar, Murcia (Spain)*

Abstract

Coastal lagoons and surroundings are exposed to high anthropogenic pressures (industrial activities, agricultural growing, urban sewages, harbours, uncontrolled spills. . .). These activities generate a great input of pollutants in the environment, which in many cases are not treated properly or being dumped to the environment directly. Mar Menor is a hypersaline (42-47) coastal lagoon located in the Cartagena Field area at the South East of Spain, which is subjected to intensive agriculture, phreatic level rise, recreational activities and sporadic torrential rainfall regime. This intense sporadic torrential rainfall regime leading to violent flash floods in the rivers and wadis provokes the mobilization and transport of contaminants to the lagoon (Moreno-González et al., 2013) and the mobilization of the “in situ” pollutants in sediments. The seasonal input of organic pollutants through El Albuñón watercourse (the main continuous flow to the lagoon) and their distribution in seawater have been previously characterized (Moreno-González et al., 2013a,b). The distribution of PAHs and organochlorinated compounds in sediments was also described (León et al., 2013), but no information is available about the occurrence of current used pesticides in this lagoon. In this study the distribution of organophosphorus pesticides, triazines and other pesticides was semiannually characterized from spring 2009 to autumn 2010. Sampling campaigns were performed at 18 stations inside the lagoon and one, as reference, was taken in the Mediterranean Sea. Pesticides were extracted using sonication extraction or pressurized liquid extraction and were analyzed by GC-MS.

Triazines (terbuthylazine, simazine, etc), organophosphorus pesticides (chlorpyrifos, methyl-chlorpyrifos, etc) and other pollutants (tributylphosphate, propylamide, chlortal-dimethyl, etc) were detected in surface sediments in the low range of ng g^{-1} . More pesticides were detected in sediments sampled in 2010 than the corresponding ones obtained in 2009. The distribution of all the contaminant groups studied was heterogeneous, and significant seasonally differences were observed in the organic pollutants concentrations. The higher concentrations were detected close to different ports and wadis, as consequence of their input through groundwater and surface waters. Chlorpyrifos showed a preferential input to the lagoon through El Albuñón watercourse. Partition coefficients (K_d) were also calculated where chlorpyrifos showed a wide range and the highest values of K_d .

Acknowledgement. This research has been supported by the Spanish Inter-Ministerial Science and Technology Commission “DECOMAR” project (CICYT, CTM2008-01832).

References

- León VM, Moreno-González R, González E, Martínez F, García V, Campillo, JA. *Science of The. Total Environment* 2013; 463-464: 975-987.
- Moreno-González R, Campillo JA, García V, León VM. *Chemosphere* 2013a; 92: 247-257.
- Moreno-González R, Campillo JA, León VM. *Marine Pollution Bulletin* 2013b; 77: 400-411.

Bioaccumulation of pharmaceuticals in molluscs and fishes from a Mediterranean coastal lagoon (Mar Menor SE Spain)

Moreno-González, R.¹, Rodríguez-Mozaz, S.², Huerta, B.², Barceló, D.^{2,3}, León, V.M.¹

¹*Instituto Español de Oceanografía, Centro Oceanográfico de Murcia, Apdo. 22, C/ Varadero 1, 30740 San Pedro del Pinatar, Murcia, Spain*

²*Catalan Institute for Water Research (ICRA) - Parc Científic i Tecnològic de la Universitat de Girona, Edifici H2O. Emili Grahit, 101- 17003 Girona, Spain*

³*Department of Environmental Chemistry, IDAEA-CSIC, C/Jordi Girona 18-26, 08034 Barcelona, Spain*

Abstract

The use of pharmaceuticals is increasing every year for human and veterinary applications, and consequently their occurrence in the environment is being confirmed in many environmental matrices in the last decades. Not only few data are available about their presence in the marine environment but also bioaccumulation and seasonal variations on wild biota in marine ecosystems are rather sparse. In this study 20 pharmaceuticals (β -blockers, psychiatric drugs, analgesics/anti-inflammatories, antiplatelet agent, diuretic, to treat asthma and antihelmintic) were analyzed in fishes and molluscs from the Mar Menor lagoon (SE Spain). The fish species considered were golden grey mullet (*Liza aurata*) and black goby (*Gobius niger*) meanwhile the mollusc species were cockle (*Cerastodema glaucum*), noble pen shell (*Pinna nobilis*) and sea snail (*Murex trunculus*). In golden grey mullet two matrices were considered, muscle and liver, however whole body was used in the rest of species. Their spatial distribution throughout this lagoon was characterized considering 9 sampling areas and two different sampling periods, spring and autumn in 2010. The extraction of pharmaceuticals from biota was carried out by pressurised liquid extraction (PLE) step prior to gel permeation chromatography (GPC). Ultra-high-performance liquid chromatography coupled to tandem mass spectrometry (UHPLC–MS/MS) was used for their analysis (Huerta et al., 2013).

Under our knowledge this is the first study about pharmaceuticals in marine biota in Spanish seawaters. Eighteen pharmaceuticals were detected in muscle in golden grey mullet, eight ones in black goby (8 analytes) and nine ones in molluscs. However less pharmaceuticals were detected in liver than in muscle. The highest concentration detected in golden grey mullet was reached by carbamazepine. In molluscs the pharmaceuticals were detected at low ng g⁻¹ reaching the highest concentration in sea snail.

Seasonal variations were also assessed considering spring and autumn samples. Bioaccumulation factors of pharmaceuticals from water and sediments were determined, and only in the case of sea snail biomagnification factors from cockle were also estimated because cockle is the common prey of sea snail in this lagoon.

Acknowledgement. This work has been supported by the Spanish Inter-Ministerial Science and Technology Commission through 'DECOMAR' project (CICYT, CTM2008-01832) and by Seneca Foundation (Region of Murcia, Spain) through 'BIOMARO' project (15398/PI/10).

References

Huerta B, Jakimska A, Gros M, Rodriguez-Mozaz S, Barceló D. Analysis of multi-class pharmaceuticals in fish tissues by ultra-high-performance liquid chromatography tandem mass spectrometry. J Chromatogr A 2013; 1288: 63-720.

Organochlorine compounds in *Patella spp* from the Canary Islands (Spain). Distribution of DDTs. Potencial sources of exposure.

González-Quijano, A., Soriano, J.A., Ruíz, R. and Besada, V.

Instituto Español de Oceanografía, Spain.

Abstract

At present, Canary Islands archipelago is not part of the OSPAR Convention area (the Convention for the Protection of the marine Environment of the North-East Atlantic), but it is expected that EU Marine Strategy Framework Directive will recommend its inclusion soon.

Moreover, there are very few research studies on marine bioindicators of organochlorine compound contamination in this area. Therefore, in 2012 a study was carried out to determine the spatial distribution of PCBs (polychlorinated biphenyls) and DDT (dichlorodiphenyltrichloroethane) in limpets (*Patella spp*) from the seven major islands of the Canary Archipelago. Limpets were chosen since they are good indicators of pollution, are easily found on all islands and valued for human consumption.

These organochlorine compounds are characterized by their toxicity and persistence. Due to their lipophilicity, stability and persistence, they tend to accumulate up the food chain (biomagnification). Their release into the environment is mainly unintentional and related to human activity. The atmospheric transport is the main pathway for the spread of these compounds, so they can be found far from their source of emission.

Concentrations of 7 PCBs congeners (IUPAC n° 28, 52, 101, 118, 138, 153 and 180) and DDTs (p,p' DDT, p,p' DDE, p,p' DDD and o,p' DDD) were analysed by gas chromatography-electron capture detector (GC-ECD) with capillary column. The used procedures are systematically validated and controlled by the use of Certified Reference Materials (CRMs) and by participating in intercalibration exercises promoted by international institutions.

The results obtained with limpets (*Patella spp*) from the Canary Islands, present a pattern of pollution characterized by higher levels of DDTs with respect to PCBs, which have very little presence, in contrast to the northwestern Iberian Peninsula area (Galicia-Cantábrico) where PCBs are the majority.

In all the Islands, the major metabolite is the DDE, presenting the highest concentrations in Lanzarote (18 $\mu\text{g}/\text{kg}$ p.h.), Fuerteventura (10 $\mu\text{g}/\text{kg}$ p.h.) and Tenerife (8 $\mu\text{g}/\text{kg}$ p.h.). Presence of DDE in Tenerife can be attributed, among other factors, to being one of the most populated islands and to the high growth of agriculture during the last decades. The concentrations in Lanzarote and Fuerteventura, can be influenced by its proximity to the African continent, where DDTs are still in use today.

References

López Villarrubia, E., García Pérez, M.D., Peral Pérez, N., Ballester Díez, F., Iñiguez Fernández, C. and Pita Toledo, M.L., 2008: Caracterización del ambiente atmosférico en las Palmas de Gran Canaria y Santa Cruz de Tenerife. 2000 a 2004. *Rev Esp Salud Pública*, 82, 493-507.

Zumbado, M., Goethals, M., Alvarez-León, E.E., Luzardo, O.P., Cabrera, F., Serra-Majem, L. and Domínguez-Boada, L., 2005: Inadvertent exposure to organochlorine pesticides DDT and derivatives in people from the Canary Islands (Spain). *Science of the Total Environment*, 339, 49-62.

Analysis of Ni, Cr, Cu, Pb and Cd in marine sediments by using a Microwave Assisted Micellar extraction method and GFAAS

Ana M Hernández-Martínez, Carolina Padrón-Sanz

IMEDMAR-UCV San Vicente Mártir^{1,2} *C/Guillem de Castro, 94. 46003 Valencia, Spain*

Abstract

Marine sediments act as metal reservoirs and the analysis of metals in these matrices allows detecting pollution in the marine environment and provide information about the ecosystem health (Fang et al., 2011; Serrano et al., 2011; Moukhchan et al., 2013).

A new green method has been developed for the extraction of the pseudo-total content of the heavy metals: Ni, Cu, Cr, Pb, Cd from marine sediments using a mixture of biodegradable micellar media (SDS, Triton X-100) as extractants and graphite furnace atomic absorption spectrometry (GFAAS) for their determination.

This work is the first one that uses only surfactants as extractants, without the addition of chelating agents to increase the extraction efficiency of the method like other authors (Tang et al., 2005; Chen et al., 2005; Sang et al., 2008), in this kind of matrixes.

The proposed method has shown high recovery percentages for all the metals considered (>68%), good linearity and reproducibility (RSD<5.9%), as well as detection limits ranging from 0.06 to 2.78 $\mu\text{g g}^{-1}$. The method was applied to the determination of the heavy metals under study in samples with different physicochemical properties. Finally, in order to validate the optimized method, our results were compared with those obtained using MAE/GFAAS described in ISO 11047:1998, obtaining similar results.

Determination of heavy metals in the marine bioindicators *M. Galloprovincialis* and *N. Diversicolor* using a green method based on 'Microwave Assisted Micellar Extraction' and GFAAS

Ana M Hernández-Martínez, Carolina Padrón-Sanz

IMEDMAR-UCV San Vicente Mártir 1,2 C/Guillem de Castro, 94. 46003 Valencia, Spain

Abstract

Since 1975 bivalve mollusks, because their characteristics (their sessile filter-feeding lifestyle, coupled with the high bioaccumulation factor for organic and inorganic pollutants) have been used as bioindicators to assess spatial and temporal trends of metals in coastal environments (Garza-Martínez, 2009; Taleb et al., 2009; Jovic et al., 2011). On the other hand, the content of metals in polychaetes is also used as an indicator of the metal pollution in the marine environment (Harlan, 2008; Udayakumar et al., 2011).

In these sense, a new method has been developed for the extraction of the heavy metals: Ni, Cu, Cr, Pb, Cd, from the mussel (*Mytilus galloprovincialis*) and the polychaete (*Nereis diversicolor*), using a mixture of biodegradable micellar media (SDS, Triton X-100) as extractants, and GF-AAS analysis.

This work presents a methodology that uses only surfactants as extractants, without the addition of chelating agents to assist the extraction efficiency of the method, proving to be effective in the extraction of metals from this type of matrices.

The proposed method has shown satisfactory recovery percents for all the metals under study in both cases: 83%-100% for *Mytilus galloprovincialis* and 72%-100% for *Nereis diversicolor*, good linearity and reproducibility (with RSD lower than 4.6% and 3.24%, respectively), as well as detection limits ranging from 0.11 to 0.24 $\mu\text{g g}^{-1}$ for *Mytilus galloprovincialis*, and from 0.01 to 0.16 $\mu\text{g g}^{-1}$ for *Nereis diversicolor*. The method has been applied to the determination of heavy metals in other species of bivalves (*Donax trunculus* and *Cerastoderma edule*) and polychaetes (*Lumbrineris latreilli* and *Marphysa sanguinea*) with satisfactory results as well. Finally, in order to validate the optimized method, our results were compared with those obtained using MAE/GF-AAS (ISO 11047:1998).

The importance of uncontaminated sediment patches for habitat selection by snails: avoiding contamination

Cristiano V.M. Araújo^{1,2}, Mónica Martínez-Haro², Rui Ribeiro²

¹*Central Department of Research (DCI), Universidad Laica Eloy Alfaro de Manabí (ULEAM), Manta, Ecuador*

²*Instituto do Mar (IMAR), Universidade de Coimbra, Portugal*

Abstract

Environmental disturbance can be decisive for habitat selection by organisms. Although staying in a given environment might have some costs, the displacement towards less disturbed environments is expected, mainly when health status is threaten by, for instance, contamination. Using of avoidance as response to contamination has been recently explored and results indicate that many organisms are able to detect and avoid contaminants. In the present study, the gastropod *Hydrobia ulvae* was exposed to copper contaminated sediment with four different concentrations: 0, 15, 100 and 150 mg kg⁻¹. Sediment samples were patchily disposed in plates, which were divided in 25 fields, being six fields used for each sediment concentration (x four subreplicates); the central area was not filled with sediment and in this field 24 organisms were initially put in. Experiments were performed with six replicates, in dark and observations were performed at 2, 4 and 6 h (corresponding to immediate response), 8, 10 and 12 h (very short term), and 24 h (short term). A clear trend to avoid copper contaminated sediment patches was observed at immediate and very short exposure time, corroborated by a significant ($p < 0.05$) preference by control patches regarding the two highest concentrations. After 24 h, organisms exposed to the higher level of contamination seem to have lost the ability to move and, therefore, the avoidance was impaired. Since gastropods seem to be sensitive to identify patches of sediment with different levels of contamination, uncontaminated sediment patches in heterogeneous contamination scenario can offer the possibility for a rearrangement of local gastropod population with no necessity to move towards a different ecosystem.

Microbiological quality of beach sands Gran Canaria Island

J. R. Betancort Rodríguez and T. de la Cruz Martín

Dpto. Agua- Instituto Tecnológico de Canarias. Playa de pozo Izquierdo s/n, 35119, Santa Lucía, Spain

Abstract

Microbiological, bacteriological and mycological, sand content was evaluated for two recreational beaches located in Gran Canaria Island. Although beach sand monitoring for microbiological contamination is not mandatory, beach sediments can act as reservoir of potential pathogens.

Dry sands were monitored during one year, in order to evaluate the concentration of total coliforms, *E. coli* and intestinal *enterococci* (bacteriological parameters), yeast, filamentous fungi and dermatophyte (mycological parameters).

Filamentous fungi were the most frequently detected microbiological group in both beaches. Yeast presences in samples were predominated by *Candida spp*, *Rhodotorula spp*. and *Cryptococcus spp*. No dermatophyte specie was isolated during the sampling period in the monitored beaches. Bacterial content in samples were lower than fungi. Total coliforms and intestinal *enterococci* were the predominant groups.

Beach sand qualities were assessed and evaluated according to the Portuguese criteria for the sand quality monitoring in bathing areas.

Determination of heavy metals in coastal seawater of Gran Canaria Island using a matrix elimination step

V. Millán Gabet, J. R. Betancort Rodriguez and M. Rodrigo Sanz

Instituto Tecnológico de Canarias (ITC). Playa de Pozo Izquierdo, s/n, 35119 Santa Lucía. Gran Canaria. SPAIN

Abstract

The aim of this work was to study the concentration of the heavy metals Cd, Cu, Ni, Pb and Zn in eastern coastal waters of the Gran Canaria Island in order to assess its chemical quality relative to the established standards (EQS) for these pollutants in the Royal Decree 60/2011. In order to do this, a method for the elimination of matrix effect in this type of samples and subsequent analysis with ICP-OES was developed. The method agreement was tested successfully by performing a proficiency test.

In the four studied coastal areas, all metals analysed met the EQS-AA (annual average), except for Cd, in which only could ensure compliance with the EQS-MAC (maximum allowable concentration). The Zn was the only element quantified at a concentration around the tens of $\mu\text{g/L}$. This work represents a part of the results obtained within the OMARCOSt project²¹, funded by the Cross-Border Cooperation Programme POCTEFEX (Canary - Morocco).

²¹www.omarcost.org

Oceanography

Organic bases influence on total alkalinity in shallow systems of the Gulf of Cadiz

Sierra, A., Burgos, M, Ortega, T., Forja, J.M.

Dpto. Química-Física, CACYTMAR, Universidad de Cádiz, Campus Río San Pedro, s/n, Puerto Real (Cádiz), Spain

Abstract

It has been investigated the contribution of dissolved organic compounds on the value of total alkalinity (TA) and dissolved inorganic carbon (DIC) in three coastal systems surrounding Cadiz Bay: the Guadalete River, Sancti Petri tidal channel and the Rio San Pedro tidal creek. Samplings were conducted seasonally. Samples were filtered prior to the pH and total alkalinity determination through potentiometric titration. The contribution of the organic bases on the alkalinity value has been analyzed following the procedure described by Hernander-Ayon et al. (2000).

The average contribution of organic bases on the total alkalinity for the winter and spring seasons in the costal systems of the Cadiz Bay Natural Park had an average value of $236 \pm 40 \mu\text{M}$. In general, the values of this contributions increased towards the inner part of the systems, where water renewal is slower as well as where different organic matter sources are located (sewage treatment plants, marshes drainage or fish farm discharges).

Atmospheric fluxes of CO_2 have been estimated through pH and total alkalinity corrected values. The three studied systems, Guadalete River, Sancti Petri tidal channel and Rio San Pedro tidal creek, act as CO_2 sources into the atmosphere, with average fluxes of 28.3, 5.5 and $14.4 \text{ mmol m}^{-2} \text{ d}^{-1}$ of CO_2 . It is worth mentioning the high flux obtained in the Guadalete River during spring ($55.3 \text{ mmol m}^{-2} \text{ d}^{-1}$) provoking that Guadalete River emissions reached higher values than those obtained in the Sancti Petri channel although it exists important differences between areas in both systems.

Keywords: alkalinity, organic bases, CO_2 fluxes, coastal systems

References

Hernández-Ayon, A., Zirino., Dickson, A.G., Camiro-Vargas, T., and Valenzuela-Espinoza E., 2007. Estimating the contribution of organic bases from microalgae to the titration alkalinity in coastal seawaters. *Limnol. Oceanogr. Methods*, 5: 225-232.

Inter-calibration trials between the R/V Cornide de Saavedra and the R/V Miguel Oliver in bottom trawl surveys off the Spanish coast

María Soto Ruiz, Francisco Velasco Guevara, Ignacio Sobrino Yraola, Francisco Baldó, Antonio Esteban Acón, Enric Massutí

Instituto Español de Oceanografía, Spain.

Abstract

Bottom trawl surveys are conducted by the Spanish Oceanographic Institute (IEO) to provide information independent from the fisheries of commercial stocks: DEMERSALES in the northern Spanish Shelf, ARSA in the Gulf of Cadiz and MEDITS in the Mediterranean Shelf since 1983, 1993 and 1994, respectively. Surveys have been performed annually on board the R/V Cornide de Saavedra until 2013. This vessel (67 m, 1133 GRT) was built in 1972 and nowadays has been replaced by the new R/V Miguel Oliver (70 m, 2495 GRT). To guarantee the continuity between the two vessels of the abundance and biomass indices of the main target species and their length distributions, inter-calibration experiments have been performed for each of the three bottom trawl surveys. The goal of the inter-calibration between both vessels was to establish the most similar fishing conditions to detect and isolate if there was a vessel effect that caused different results in catches. And in if those differences were significant, to estimate calibration coefficients to homogenize abundance and biomass indices of the new vessel R/V Miguel Oliver with respect to the time series built with the old R/V Cornide de Saavedra.

The inter-calibration experiment consisted in performing parallel tows with both vessels, using the same gear, and carrying out hauls of the same duration and speed. The parallel surveys in the V/R Cornide de Saavedra and the R/V Miguel Oliver followed the surveys protocols of IBTS for the northern Spain and Gulf of Cadiz and MEDITS for the Mediterranean. A total of 60 paired hauls were completed in the DEMERSALES survey, 43 for the ARSA and 37 hauls in the MEDITS. Comparisons between both vessels were done in each survey addressing: gear performance, total catch, commercial species catches, length distributions of the most representative species and analyzing the faunal fish assemblages detected.

Differences between vessels were less significant for the DEMERSALES survey, with the higher catches, number of hauls and less variability; in the Gulf of Cadiz, catches of flatfish and some species of cephalopods were slightly higher in the R/V Miguel Oliver but no significant differences in the length distributions were found; for the MEDITS survey, catches by haul were lower, presenting a great diversity of species, thus complicating to separate the sources of variability due to the change of vessel from the uncertainty associated to the hauls.

In general, catches in the R/V Miguel Oliver are similar to catches in the R/V Cornide de Saavedra. To verify the continuity and congruence of the time series special attention must be paid to the new surveys in the R/V Miguel Oliver to test if inter-calibration factors are needed for some species.

Biogeochemical Processes

Phytoplankton and nutrient trends in different areas of the western Mediterranean Sea

García-Martínez, M.C.¹, Moya, F.¹, Vargas-Yáñez, M.¹, López-Jurado, J.L.², Serra, M.², Tel, E.³, Balbín, R.², Aparicio, A.², Amengual, B.²

¹*Instituto Español de Oceanografía, IEO. Puerto Pesquero, s/n.29640-Fuengirola, Spain.*

²*Instituto Español de Oceanografía, IEO. Muelle de Poniente s/n 07015.-Palma Mallorca, Spain.*

³*Instituto Español de Oceanografía, IEO. C/Corazón de María, 8. 28002-Madrid, Spain.*

Abstract

In 1992, the Spanish Institute of Oceanography (IEO) started an environmental monitoring project, Ecomalaga, where three oceanographic sections were periodically visited. Each section was made of several oceanographic stations distributed on the on-off shore direction. In 1994 a similar project called "Radial de Baleares" started in the Balearic Islands. Three oceanographic stations in the South Western continental shelf of Mallorca Island were regularly visited.

A third monitoring program was devoted to the study of Murcia shelf waters. Since 2007, these three projects and the program CIRBAL, devoted to the monitoring of Balearic channels were merged, and the sampling area was extended to the whole Spanish Mediterranean, from Cabo Pino (close to Cádiz) to Barcelona. The resulting project is the ongoing RADMED Project funded by the Spanish Institute of Oceanography (IEO). In the framework of this project certain variables are systematically studied: temperature, salinity, nutrient and chlorophyll a concentration, phytoplankton and zooplankton abundance. . . .

One of the main objectives of the project is to detect and quantify long-term changes in concentration levels of these variables. In the present work, seasonal time series of phytoplankton and nutrient concentrations from Malaga (Northwestern Alborán Sea) and Balearic Islands have been analysed in order to estimate changes and trends.

In the case of Ecomalaga stations, which are influenced by the Atlantic waters incoming through the Straits of Gibraltar, a decreasing trend in diatoms and dinoflagellata abundances is detected at all sampling depths, except at 75m where there's a strong positive trend in dinoflagellata abundance. On the contrary, the Balearic section shows an increasing trend at all depths both in diatoms and small flagellate, but a decreasing one in dinoflagellata.

Nutrient analysis revealed a strong increasing trend in integrated nutrient concentration in Balearic section, accompanied by a progressive sinking of the nutricline depth. On the other hand, in Malaga stations, no significative trend was found in nutricline depth, but a small negative one in integrated nutrient concentrations.

These results suggest a different answer to environmental forcing, depending on the study area.

Decadal analysis of apparent oxygen utilization content in upper Mediterranean Sea around Balearic Islands

Aparicio-González, A.¹, Balbín, R.¹, López-Jurado, J.L.¹, Serra-Tur, M.¹, García-Martínez, M.C.², Moya, F.², Vargas-Yáñez, M.², Santiago, R.¹

¹*Instituto Español de Oceanografía, IEO. Muelle de Poniente s/n 07015. Palma de Mallorca, Spain.*

²*Instituto Español de Oceanografía, IEO. Puerto Pesquero, s/n.29640. Fuengirola, Spain.*

Abstract

Observational data of dissolved oxygen, temperature and salinity were taken from IBAMar database to perform a decadal analysis from year 2002 to 2012. IBAMar is a quality controlled regional database that puts together all physical and biochemical data obtained by multiparametric probes (CTDs equipped with different sensors) during cruises managed by the Balearic Center of the Spanish Institute of Oceanography (COB-IEO).

Currently, one of the most important research projects feeding data to IBAMar is the RADMED Project, which is sampling the Spanish Mediterranean Sea from Cabo Pino (Cádiz) to Barcelona. We are developing this Project for collecting data in order to study trends and changes in the oceanographic parameters.

In this work we compare monthly averages of apparent oxygen utilization (AOU) in the upper ocean at 2 different zones during 11 years. These two zones, North of Balearic Islands (NBI) and South of Balearic Islands (SBI), exhibit similar behavior in AOU during the analyzed years with the exception in years 2007 and 2009. We investigate if these variations are related to the monthly averaged sea surface temperature which is driving the formation of the seasonal thermocline and the phytoplankton growing.

Evaluation of freshness of two seaweed species (*Ulva sp.* and *Codium sp.*) collected in Gulf of Cadiz

Irene Ibáñez, Josefina Sánchez, Víctor M. Palacios and Ana M. Roldán

University of Cádiz, Spain.

Abstract

Seaweed is currently one of the most important potential resources. Because of its natural properties it has many applications and uses. However, there are few studies about the freshness evolution of these species. Evaluation of freshness can be useful not only to establish the useful life of this product but to improve its conservation and get other uses.

The main objective of this work was evaluating the evolution of freshness in two species of seaweed during storage and also establishing the most suitable parameters for this evaluation. The chosen species for freshness evaluation were: *Ulva sp.*, collected in saltmarsh of Cadiz, and *Codium sp.* (*Chlorophyceae*) collected in Barbate estuary. Both species were stored in brine and refrigerated separately in bag of 250 grams for monitoring. Every two day a bag of each species was taken and evaluated by the panel of tasters.

For organoleptic analysis, an adaptation of existing sensory analysis developed for sea products (fish and seafood) was done. According to the similarities between seaweed and vegetables, some of the methodologies traditionally used for vegetables were also taking into account. Organoleptic analysis was carried out by a panel of tasters, including ten previously trained judges. Previously, were carried out some running-in experiments to select the most representative attributes and create a specific table valuation depending on intensity of perception of 1 to 10 and according to the selected descriptors for each species. An average of the valuations obtained by the judges for each attribute was considered for the monitoring and control freshness.

Results showed that the organoleptic analysis was a good way to measure the freshness of edible seaweed. To evaluate seaweed freshness was necessary to use descriptors related to marine products and vegetables adapted to each seaweed species. Notable differences in the freshness evolution of both species during storage were observed related to the collection area and the composition specie. So, symptoms of loss of freshness were characteristic of each species being *Codium sp.* the first to show such symptoms. The changes in color, decrease in the strength of flavor and taste and consistency lost were some of the changes observed during *Codium* storage.

Based on these results, it can be concluded that the freshness of seaweed shows more similarities with the marine products than vegetables although aspects such as color and texture are comparable to the latter.

2 Thursday, June 12th

General Topics

Atlantic Society of Oceanographers - Sociedad Atlántica de Oceanógrafos

Sociedad Atlántica de Oceanógrafos

Abstract

What is the Atlantic Society of Oceanographers?

The Atlantic Society of Oceanographers (SAO) was founded in 2012 and based in Las Palmas de Gran Canaria, aims to promote professionals and companies who develop their work in different fields and sub-disciplines related to the Marine Sciences, such as:

- Oceanography (Physics, Chemistry, Biology and Geology)
- Mariculture
- Fisheries
- Environmental Management, Coastal and Littoral (ICZM-LOICZM)
- Marine Technology and Structures
- Environmental Education

*What are SAO's goals?

- Develop strategies in order to preserving and protecting the oceans.
- Promote oceanic scientific research.
- Act as meeting point between professionals and companies that focus their activities on Marine Sciences.
- Identify new lines jobs, business and R&D + innovation.
- Promote sustainable development models.
- Generate programs and training activities, spread information as well as education, and environmental awareness.

*What concrete actions have aimed at developing SAO?

- Conference on environmental education and science.
- Marine Biodiversity Week, from 7th to 14th October 2013, oral communications on various topics (kelp, marine mammals, marine seaweed, sharks, fishery activities, sea algae,...) had been at the same time carried out in 5 different localities on Gran Canaria (Guía, Las Palmas de Gran Canaria, Telde, Arinaga and Mogán), bringing science and society closer together and showing "state of the art" about main Marine Sciences professionals fieldworks.
- Signature of Jointed Agreement about Protected Marine Micro Areas Project, managed by the company Oceanográfica Divulgación, Educación y Ciencia, S.L. and SAO, for a period of 5 years.
- The SAO Awards ceremony: taking place on 15th November 2013 the SAO awards, known as The Oceanos, were given in three merit categories to Dr. Francisco Rubio Royo (Category of Individual), Spanish Institute of Oceanography (IEO) (Category of Institution/ Company) and the Fishermen's Association of El Hierro (Category of Collective).
- Professional meetings.
- Dissemination and training sessions aimed at students of Marine Sciences.

Contact us and become a member at: <http://www.sociedadatlanticadeoceanografos.org/>

Ciencia Compartida

Biblioteca de la ULPGC (Ciencias Básicas). Facultad de Ciencias del Mar

Abstract

Ciencia Compartida is the name of the weekly seminars that occur every tuesday in the Sala de Grado of our Marine Science Faculty. This 30 minutes talks have a wide spectra of speakers: PhD and Master students, teachers, professors, scientific people from our university or visitors, entrepreneurs, ecologists, or management people related with the ocean environment.

The seminars are recorded and broadcasted in less than 48 hours through ACCEDA²², the University Library youtube channel²³, Pinterest²⁴ and Facebook.

How to participate? write us at cienciacompartida@ulpgc.es

We'll be willing to hear from you!!

²²acceda.ulpgc.es

²³www.youtube.com/user/BibliotecaULPGC

²⁴<http://www.pinterest.com/bulpgc/ciencia-compartida/>

Biodiversity

Sensitive Habitats and fishing footprint off Canary Islands seamounts Amanay and El Banquete

Martín-Sosa, P., González-Porto, M., Almón, B., Acosta, C., Arrese, B., González-Irusta, J.M., Barreiro, S., Jiménez, S.

Instituto Español de Oceanografía, Centro Oceanográfico de Canarias

Abstract

The main objective of the LIFE+ INDEMARES project is to contribute to the protection and sustainable use of the biodiversity in the Spanish seas through the identification of valuable areas for the Natura 2000 Network. The Spanish Institute of Oceanography (IEO) has been in charge of implementing scientific surveys to map sensitive habitats of seven of the ten INDEMARES areas, and to determine the fisheries footprint over these areas.

Sur y Oriente de Fuerteventura y Lanzarote is one of the areas chosen to be depicted in the frame of INDEMARES project, although the study about benthic habitats and fishery footprint carried by IEO has restricted to Amanay and El Banquete Seamounts. El Banquete really is the extension of southern continental shelf while Amanay seamount is located at 25 km from Jandía Lighthouse (S of Fuerteventura) and 55 km from Las Palmas de Gran Canaria, at the coordinates 28° 07' Latitude N and 14° 44' Longitude W, both volcanic buildings raise from more than 2,000 m up to their summits at 25-30 m deep, separated by a 1.500 m deep channel.

The biological richness of Amanay and El Banquete seamounts is very influenced by the deep water up-welling phenomena, which create a high productivity, attracting a multitude of pelagic species, such as cetaceans, turtles, sharks, and tunas looking for food. There is also a high influence from Saharian up-welling. Both the seamounts tops and their vicinities are often visited by a large artisanal local fishing fleet which profits of their fishery resources; also a rich invertebrate fauna cohabits in their bottoms. In general, its main impacts are related to uncontrolled fishing pressure, and maritime navigation. The available information on the anthropogenic impact of the area was scarce, and its level of research was very poor as well, before INDEMARES project.

Methodology approach complies with a multidisciplinary perspective, having described the area from geological, oceanographic, biological and fisheries points of view. Several surveys have taken place since 2009 to 2013 at Amanay and El Banquete waters. Traps, longlines, beam trawls, benthic dredges and box corers have been used to sample benthic fauna. These last two, plus EM 3002 multibeam echosounder, PS 18 parametric sub bottom profiler, EA600 monobeam sounder, Seapath 200 positioning sensor and SV Plus sound velocity calibration sensor were used to make a geophysical study which provides a range of environmental factors. CTD was used to depict physical conditions of the water column. Finally, different photogrammetric tugged sleds were used to make a great effort of visual sampling. Data from VMS (Vessel Monitoring System) were used, combined with interviews to users (fishers), landing samplings and scientific observation onboard, to describe the fishery uses in the area.

VME indicator species collected during exploratory fishing in Macaronesian seamounts

Marcos González-Porto¹, Santiago Barreiro Jueguen¹, Roberto Sarralde Vizueté¹, Luis López Abellán¹, Sebastián Jiménez Navarro¹, Juan Ramón Pedrianes², Juan Agulló García²

¹Instituto Español de Oceanografía, Centro Oceanográfico de Canarias

²Onboard Scientific observer

Abstract

During the second half of 2012, the longline vessel MARANSA completed 13 fishing trips in international waters of CECAF Area (Division FAO 34), in nine Seamounts from northeast off Madeira (Lion, Ampere, Unicorn, Seine, "Camaguay", "Cabezos", Dacia and "Fantasma") to south off the Canary Islands (Eco/Endeavour), between latitudes 19°N and 35°N, using bottom longlines.

The main target species were demersal species such as Wreckfish (*Polyprion americanus*) or Splendid-alfonsino (*Beryx splendens*).

An observer on board recorded the bycatch of Vulnerable Marine Ecosystems (VME) indicator species in order to evaluate the potential adverse impact of bottom fishing activities on VME and samples of the specimens for later identification in the laboratory were stored. The main indicator species found were cold-water corals (black corals, scleractinians and gorgonians) and sponges, species broadly associated with seamounts.

The shallower banks, Ampere and Dacia in the north and centre of the area, show the greater biodiversity and the higher percentage of presence of VME indicator species (52% and 53% of the sets respectively), followed by Endeavour (South of the Canary Islands), 36.4%. In these three banks the species distribution is strongly related to depth, finding Antipatharia (mainly *Stichopathes* sp) and Scleractinia (*Dendrophyllia cornigera* and *D. ramea*) in shallower depths and Porifera (*Neophryssospongia nolitangere*, *Leiodermatium lynceus* and *Asconema setubalense*) in deeper bottoms. Species of the Porifera group are present in all banks except of so-called "Cabezos".

Assessing sea grass meadows condition at 'El Río' Special Area of Conservation off 'La Graciosa e Islotes del Norte de Lanzarote' Marine Reserve

Jiménez, S.¹, Y. González², E.L. González², J.F. González¹, C.L. Hernández-González¹, P. Martín-Sosa¹, G. González-Lorenzo¹ and M.A.R. Fernández¹

¹*Instituto Español de Oceanografía*

²*TDC Desarrolladores de soluciones ambientales S.L.*

Abstract

Cymodosea nodosa meadows, known as 'sebadales' or 'manchones' at Canary Islands, represent EU-NIS habitat type code A5.5311, called Macaronesian Cymodocea beds. As it's described at European Union Habitats Directive (92/43/CEE) Annex 1, sea grass meadows belong to 1110 Sandbanks which are slightly covered by seawater all the time, within Natura 2000 Network.

Several 'sebadales' throughout the archipelago are included in this Network as Special Areas of Conservation. *Cymodosea nodosa* is regionally included within the Canary Islands Protected Species List (Ley 4/2010), as a species 'of interest to ecosystems of Canary Islands', is usually found at a narrow depth range (10 to 20 m of depth) and, on the whole, best structured meadows are settled at sheltered bays, away from wave and current beating, flimsier at exposed areas. Deeper meadows are also sparser, being *C. nodosa* replaced by green algae *Caulerpa prolifera* and *Caulerpa racemosa*, although mixed algae-sea grass meadows are often found at different depths.

The project Assessment of marine flora ('sebadal', maërl, 'mujo') of 'La Graciosa e Islotes del Norte de Lanzarote' Marine Reserve, funded by 'Viceconsejería de Pesca y Aguas de la Consejería de Agricultura, Ganadería, Pesca y Aguas', Canary Islands Government, has had the aim of assessing sea grass meadows condition and distribution at 'El Río' Natura 2000 Network Special Area of Conservation, the channel between La Graciosa and Lanzarote. 'LA GRACIOSA 1311' cruise was performed within the framework of the project.

First of all previous information on sea grass shallow distribution (up to a depth of 20 m) in the study area was reviewed. Afterwards, a tugged underwater video camera was used onboard of the Marine Reserve Surveillance Vessel to update cartographic info performing a grid of sampling stations, covering previously known distribution limits and verifying current presence/absence data and density.

Furthermore, population parameters were obtained in order to assess 'sebadal' condition. Fixed stations were selected in regards to this process, and methodology applied on them was as follows: five radial arranged transects were performed, identifying fragmentation (it estimates meadow continuity regarding observed cover), density (mean value of several shoots number counts with 20 x 20 cm grids placed every 2 m), height (mean value in cm of 10 independent samples by transect) and fish and macroinvertebrate species richness for each transect.

Graphic picture of sea grass density was made depending on two levels: low density level transects (≤ 10 shoots/grid (≤ 50 shoots/m²) and medium density level transects (≥ 10 shoots/grid (≥ 50 shoots/m²)).

Main study result is an estimate for the study region ('El Río') and time of year of *Cymodocea nodosa* population total distribution cover which comes to 1.640.076 m², including a higher density 'sebadal' of 178.256 m².

Mauritanian deep-water Plumularioidea (Cnidaria, Hydrozoa)

Marta Gil^{1,2}, Fran Ramil¹ and Ana Ramos²

¹*Facultade de Ciencias do Mar, Universidade de Vigo*

²*Instituto Español de Oceanografía, Centro oceanográfico de Vigo*

Abstract

Deep-waters are one of the most unknown habitats on Earth, but the displacement of fishing fleets into ever deeper waters, the emerging exploitation of mineral resources and climate change threaten to destroy these ecosystems whose functioning we just begin to understand (Levin & Sibuet, 2012).

Superfamily Plumularioidea is the most important group of deep-water Hydrozoa, both in species richness and abundance. In spite of being typical epifauna living on hard substrates, many species also colonize soft bottoms by adaptations on their hydrorhiza. The morphology of their colonies, feather shaped, often branched, and with sizes that can exceed one meter length, contributes effectively to the development of a three-dimensional habitat and provide secondary substrata for other hydrozoans (auto-epizoism sensu Millard, 1973) and for other invertebrates (see Ansín Agis et al., 2001), thus enhancing the biodiversity.

This communication deals with the results of the study of this superfamily in the continental margin of Mauritania, between 80 and 2,000 m depth. Samples were collected in 329 trawling stations during the four multidisciplinary Spanish–Mauritanian surveys (Maurit) carried out from 2007 to 2010 onboard R/V Vizconde de Eza. Most samples were collected using a commercial trawl gear (Lofoten type) following a stratified random sampling methodology program. Moreover 25 stations were also sampled along five transects perpendicular to the coastline at five bathymetric strata with an Agassiz trawl, and 26 samples with a rock dredge were carried out over the cold-water coral reef, the canyon edges and the seamount.

A total of 4,073 colonies of Plumularioidea were collected, and 20 species were identified; nine of them reported for the first time in Mauritanian waters. The greatest diversity corresponded to Plumulariidae family (8 species), followed by Aglaophenidae (6 species.), Halopterididae (4 species.) and Kirchenpaueriidae (2 species.). Most of them showed an eurybathic distribution and were collected along the continental shelf and the slope, in agreement with the results of previous studies (Calder, 1997).

The biogeographical analysis showed a clear dominance of Atlantic species (55%) over species with a wide distribution (45%). Within the Atlantic species the most representatives were those with amphioceanic (25%), Atlantic-Mediterranean (15%) and Eastern Atlantic (15%) distributions, which generally agrees with the results obtained by Ansín Agis et al. (2001). The absence of the medusa stage in the group is not a limiting factor for their geographical distribution that seems to be more dependent on their environmental tolerance than on the particularities of their life-cycle (Boero & Bouillon, 1993). Their ability to spread by rafting (Cornelius, 1992) together with ocean circulation patterns in North-eastern Atlantic waters may explain the faunal composition in Northwest Africa (Ansín Agís et al., 2001). The importance of the Atlantic-Mediterranean component and the influence of the Canary Current as a southward larval dispersal route were also emphasized by Van Soest (1993) in his study about the distribution of sponges in the continental shelf off Mauritania.

References

- Ansín Agis, J., Ramil, F. & Vervoort, W. (2001) *Zool. Verh. Leiden* 333: 1-268.
Boero, F. & J. Bouillon (1993) *Biol. J. Linn. Soc.*, 48: 239-266.
Calder, D.R. (1997). *Proc. 6th Int. Conf. Coel. Biol.* 1995: 85-90.
Levin, L.A. & Sibuet, M. (2012). *Annu. Rev. Marine. Sci.* 2012.4: 79-112.
Millard, N.A.H. (1973). *Publ. Seto Mar. Biol. Lab.*, 20: 23-34.
Van Soest, R.W.M. (1993). *Hydrobiologia* 258: 95-106.

Deep-sea Holothuroidea off Mauritania

Belén Calero^{1,2}, Fran Ramil¹ & Ana Ramos²

¹Facultade de Ciencias do Mar, Universidade de Vigo

²Instituto Español de Oceanografía, Centro oceanográfico de Vigo

Abstract

Among invertebrates, echinoderms are one of the main benthic taxa, especially in deep bottoms, where they constitute the most important group of mobile epifauna (Gage and Tyler, 1991). In addition, holothurians are one of the taxa dominating epibenthic communities in different North Atlantic basins (Billet, 1991), where they can form dense aggregations.

Despite the large literature on Atlantic echinoderms, the knowledge of this group in Northwest African waters primarily comes from the pioneering oceanographic expeditions carried out from late nineteenth century to mid twentieth century. However, the current knowledge of holothurians in Mauritanian waters is scarce, and only the works of Koehler and Vaney (1906), Hérouard (1929) and Massin (1993) were focused in this group and mainly on the fauna of the northern continental shelf.

This is a taxonomic and ecological study of the holothurians collected during the four multidisciplinary Spanish – Mauritanian surveys (Maurit) carried out from 2007 to 2010 on board R/V Vizconde de Eza in Mauritanian EEZ waters, between Cape Blanc (21°N) and the Senegalese border (16°N). A total of 291 stations were sampled between 80 and 2000 m depth, following a stratified random sampling methodology with and using a Lofoten commercial trawl (17.7 m horizontal opening, 5.5 m vertical opening and 35 mm mesh in the cod-end).

The holothurians collected in each trawl were sorted to morphospecies level, counted and weighed to obtain quantitative data on their abundance and biomass. Each specimen was photographed and a reference collection was preserved in 70% alcohol for further identification in the laboratory. The identification methodology included the study of the external and internal morphology by dissection and the microscopic study of the endoskeletal calcareous deposits.

Quantitative data (numerical abundance and biomass) collected during Maurit-0811, were standardized to 0.1 km² and their respective matrices were calculated to enable an analysis of similarity between stations using the Bray Curtis index. Statistical treatment was performed using PRIMER software package v.6.

During the four cruises a total of 193,791 holothurians were collected in 128 of the 291 sampled stations, belonging to 15 species and 9 families. In terms of number of species, Synallactidae showed the highest specific richness (6 species), followed by Laetmogonidae (2 species). The others families were represented by only 1 species.

Eynpniastes eximia Theel, 1882, the only representative of the family Pelagothuriidae, showed the greatest occurrence (52%) and was also the dominant species, both in numbers and biomass.

Paelopatides grisea Perrier, 1898 and *Benthothuria funebris* Perrier, 1898 were collected in about 40% of the stations and, due to their big size, they significantly contributed to the total biomass despite their low numerical abundance.

The multidimensional scaling (MDS) and the dendrogram resulting from the multivariate analysis applied to biomass matrix clearly separated stations located in the deep-shell and upper slope (<300 m) from those located at greater depths along the continental slope. The dendrogram evidenced five groups, two of them corresponding to shelf and upper slope stations (80–300 m) and the others including stations beyond 1000 m depth. Holothurians were almost absent between 300 and 1000 m in Mauritanian slope, which is in agreement with the results obtained by Billet (1991) in Porcupine Seabight (North Atlantic),

where the abundance of holothurians was low in the break upper slope area (200 to 1000 m) but clearly increased beyond.

References

Billet, D.S.M. 1991. *Oceanography and Marine Biology: An Annual Review*, 29: 259-317.

Gage, J. D. & Tyler, P. A. 1991. Cambridge University Press, 504 pp.

Hérouard, E. 1902. *Résultats des Campagnes Scientifiques Prince Albert I de Monaco*, 21: 1-83.

Koehler, R. & Vaney, C. 1906. *Act. Soc. Linn. Bordeaux*, 60: 59-67.

Massin, C. 1993. *Zoologische Mededelingen*, 67:397-429.

Feeding ecology and ecological role of the Atlantic bonito *Sarda sarda* in the Northwestern Mediterranean Sea

Raquel Sáez-Liante¹, Joan Navarro¹, Marta Albo-Puigserver¹, Marta Coll^{1,2}, Isabel Palomera¹

¹*Institut de Ciències del Mar (ICM-CSIC), Passeig Marítim de la Barceloneta, 37-49, 08003 Barcelona, Spain*

²*Laboratoire Écosystèmes Marins Exploités UMR 212, IRD-IFREMER-UM2, Avenue Jean Monnet BP171, 34203 Sète Cedex, France*

Abstract

Knowing the feeding habits of marine predators is essential to understand their ecological role in the ecosystem. Moreover, this information is pivotal for an accurate management and conservation strategies of their populations. The Atlantic bonito *Sarda sarda* is an epipelagic Scombrid distributed throughout the Atlantic Ocean, Mediterranean and Black Seas. This migratory predator represents an important fishery resource along its range of distribution, as well as in the NW Mediterranean. However, despite its commercial and ecological importance, accurate information of its trophic habits in the Mediterranean is very scarce. In this study, our main aim is to examine the feeding ecology (diet composition and trophic level) of the Atlantic bonito in the NW Mediterranean Sea by combining stable isotopic and stomach content methodologies at different temporal scales. Also we compare the trophic habits of the Atlantic bonito with information from several species of the same ecosystem to determine its ecological role. Our stable isotopic and stomach content results reveal a clearly importance of small pelagic fish in the diet of this top predator without seasonal changes in diet during the year. In particular, the diet of the Atlantic bonito includes the European anchovy *Engraulis encrasicolus* as the main prey in its diet. Other pelagic species found in its diet are the European pilchard *Sardina pilchardus* and the round sardinella *Sardinella aurita*. These results indicate the position of this species as an important predator within the pelagic food web of the NW Mediterranean Sea and highlight that the Atlantic bonito feeds on pelagic species that are ecologically and commercially very important in the area. In addition, comparing the trophic position of the Atlantic bonito with other species of the study area, we observe that this species shows a similar position as other important predators such as bluefin tuna, other tunids, and Audouin's gull.

Epigenetic changes driven by ocean acidification in an intertidal marine snail

Cortés B.¹, Galindo J.¹, Diz P.², Morán P.¹, Nombela M.A.²

¹Departamento de Bioquímica, Xenética e Inmunoloxía, Facultade de Bioloxía, Universidade de Vigo, Campus Lagoas-Marcosende, Vigo, 36310, Spain

²Departamento de Xeociencias Mariñas e Ordenación do Territorio, Facultade de Ciencias do Mar, Universidade de Vigo, Campus Lagoas-Marcosende, Vigo, 36310, Spain

Abstract

Ocean acidification caused by the uptake of anthropogenic carbon dioxide represents an important threaten to marine ecosystems and biodiversity. Its impact it is believed to be more pronounced in calcifying marine organisms. Understanding the stress/adaptive response of an individual to acidified water will give us new insights about how these species will adapt to future declining pH. Epigenetic mechanisms are known to contribute to the adaptation to changes in the environment (e.g. acidification), among these, varying levels of DNA methylation. We maintained in the laboratory adult individuals of the marine snail *Littorina saxatilis* under semi-natural conditions (Control treatment, pH ~7.9) and acid conditions (Acidification treatment, pH ~7.7) for 42 days. Then we studied the differences in the methylation patterns between Control and Acidification samples using MSAP (Methylation Sensitive Amplified Polymorphism) methodology. We scored 500 MSAP loci and preliminary results show a lack of global epigenetic changes between the treatments, although certain loci show significant differences. These loci are candidates for follow up studies to identify their role in adaptation. Slight differences between Control and Acidification treatments were found at the level of shell microstructure.

These results show that epigenetic changes might not have a primary role in the stress/adaptive response to water acidification in *L. saxatilis*, or a small number of genes are responsible for such response. This is in agreement with previous studies of adaptation in this marine snail, showing that local adaptation (with a genetic basis) is predominant than phenotypic plasticity in this species and that a small percentage of the genome promotes local adaptation. Other axes of adaptation to acidification (e.g. gene expression) and other life stages should be studied to give a wider picture of the effect of ocean acidification in this species and in general.

This research was supported by the Spanish Ministry of Sciences and Innovation, co-funded by the Fondo Europeo de Desarrollo Regional 2007-2012 (FEDER) through the CATARINA Project (CTM2010-17141/MAR) and funding from Xunta de Galicia through the Competitive Research Units' Consolidation Program, co-funded by the European Regional Development Fund (ERDF) Operative Program Galicia 2007-2013.

The cetaceans and seabirds sighting net of the Canary Islands

Morales Herrera T., García Ovide B., Gil Velasco M., Monagas Manzano P., García Taveró N., Gaona Calderón M., Aguilar de Soto, N.

BIOECOMAC. Dept. Of Animal Biology, Geology and Edaphology. University of La Laguna, Tenerife, Canary Islands. Spain

Abstract

The Canary Islands are located in the subtropical region of the North Atlantic Ocean, but their waters are cooler than expected for their latitude due to: i) the influence of the Canary Current (the eastern southward branch of the Atlantic Gulf Gyre); and ii) filaments of cold and nutrient loaded water from the Sahara up-welling. These phenomena create a longitudinal temperature gradient of cooler to warmer waters from East to West. This mixing of temperatures and the geomorphological characteristics of the archipelago, with very deep waters close to the shore, result in the archipelago holding the highest diversity of cetaceans of neighbouring areas (n=30), including resident, seasonal, migratory and vagrant species. The Canary Islands are an important area for seabirds also, both for breeding and migratory species, including vagrant species from Africa and America. But the scarcity of data about the phenology, distribution and density of oceanic species in the archipelago impedes the design of management programs focused on their conservation. For example, ship collisions with cetaceans are a serious conservation concern, several species have been reported to suffer collisions and strikes may pose a population level threat to the local stock of sperm whales (*Physeter macrocephalus*). To design mitigation measures it is necessary to obtain more data on the temporal and spatial occurrence of sperm whales and other oceanic species. CetAVist aims to contribute data to the lack of knowledge on oceanic species by establishing a long-term monitoring program in the channels of the Canary Islands. For this, the University of La Laguna and the two main ferry companies in the archipelago (Fred Olsen and Armas) have organized a network of trained volunteer observers on-board the ferries gathering both abundance and behavioural data of seabirds and cetaceans. Since December 2012 to February 2014, 257 volunteers performed 171 inter-insular transects summing 188 hours of effort. Results have confirmed known areas of spatial concentration of cetaceans and identified new areas of aggregation. Sightings of more than 1000 cetaceans of at least nine species have been reported. Of these, Atlantic spotted dolphins (*Stenella frontalis*), short-finned pilot whales (*Globicephala macrorhynchus*), bottlenose dolphins (*Tursiops truncatus*) and rorquals (*Balaenoptera spp*) have been observed year-round. The presence of rorquals (Bryde's whale *B. edeni brydei*, a tropical-subtropical species) in winter has been recorded in dedicated cetacean surveys also. CetAVist has gathered a surprising number of sightings of beaked whales (*Mesoplodon densirostris*, *Ziphius cavirostris* and unidentified beaked whales including a possible *M. mirus*), showing that beaked whales occur in the channels, far from hot-spot areas previously identified off El Hierro and the eastern Canary Islands, and making the archipelago a study area of particular interest for the regular presence of these cetaceans. Here we present an analysis of the seasonality of the sightings and the habitat preferences of the species observed, and compare the results with data gathered by a similar sighting net operating from ferry lines in 1996-1998, to describe changes in cetacean occurrence, such as recent year-round occurrence of rorquals, which might be linked to climate change.

Marine Cultures

Effects of temperature in the growth and use of yolk reservoir in paralarvae of *Octopus vulgaris* (Cuvier, 1797) under starvation conditions

Rocha, Francisco., Fernández, Raquel and Peñalosa, Daniel.

Department of Ecology and Animal Biology, Faculty of Marine Sciences, University of Vigo, 36310 Vigo, Spain

Abstract

Cephalopods growth is highly influenced by different factors as the diet, age and temperature. Temperature is the external factor that has biggest influence in the growth of paralarva is. In organisms with planktonic larval period, as the common octopus, larval development and planktonic phase duration are strongly related with the temperature. Temperature is the factor that has more influence on the larval growth. If temperature regulate cephalopod growth, it is interesting to quantify its effect over larval phase duration, yolk reservoir use and weight changes.

Octopus vulgaris is the octopod species with mayor economic importance in the world. Its larval stage presents a planktonic phase that lasts between one and three months, depending on the temperature. *Octopus paralarvae* are zooplanktonic predators since hatching, even when they have an internal yolk reservoir which allows them to survive in absence of food for a few days after hatching. The yolk reserves allow the paralarvae to learn how to hunt their prey efficiently. In consequence, if paralarvae can last more yolk reserves, their will have more time to be better hunters. The digestive gland of cephalopods produces most enzymes that allow digestion as well as the nutrient and lipid storage. This gland is also the place of storage for yolk reservoir. This gland is visible in the octopus paralarvae even before hatching and through all larval phase due to its size and dark brown coloration.

The objective of this study is to quantify the temperature influence in the growth and yolk used during the first days after hatching in octopus paralarvae. It will be determined if the temperature decrease on the first culture days would allow to extend the duration of the yolk reservoir. A mayor yolk duration after hatching could be a key factor to improve the larval survival. This, because of *Octopus vulgaris* paralarvae would have more time to learn to be efficient hunters before relying exclusively on exogenous food.

Octopus eggs were maintained under culture conditions until hatching of paralarvae. These were transferred to 150 L culture tanks and maintained at two different temperatures (17 and 19°C) over a period of 4 days. In each tank a total of 120 paralarvae were placed. Culture conditions include seawater filtered (at 10 microns) with one renewal per day, natural light cycle and mild aeration. A total of 20 individuals of each tank were sampled daily. Specimens were removed and anesthetized with 10% ethanol. Total length, mantle length, digestive gland length and area of the digestive gland were measured in each specimen.

The results show that digestive gland area decreases throughout the study period, with a greatest decrease at higher temperatures. In addition, paralarval total length and dorsal length growth during the first two or three days, to show a subsequent decrease. At 17°C both parameters growth until the third day, while paralarvae at 19°C only show growth until the second day. However, no significant difference was detected in the maximum size reached, so that larvae at both temperatures have similar sizes.

Data indicates that newly hatched paralarvae have sufficient yolk reservoir to grow in size few days. However, these reserves are consumed quickly. In consequence, paralarvae have only few days to learn to be efficient hunters. Thus, culture temperature decreasing during the first few days increases the

yolk duration. This fact could enhance the survival percentage of the paralarvae., This because they would have at least one more day to develop the skills necessary to become efficient hunters. Moreover, increasing the yolk duration not seems to involve an increase in the maximum size reached by the octopus paralarvae.

A simple method to monitoring the parasite population of *Benedenia seriolae* in rearing tanks of *Seriola dumerili*

J.R. Cejas, S. Jerez, A. Doble, E. Almansa, M.V. Martín, B.C. Felipe

Instituto Español de Oceanografía. Centro Oceanográfico de Canarias. Vía Espaldón, Dársena Pesquera, Parcela nº 8, 38180 Santa Cruz de Tenerife

Abstract

Greater amberjack (*Seriola dumerili*) is a high-value and fast growing species widely spread around the world, considered a very interesting species for the future development and sustainability of aquaculture. However, infections with monogenean are a major problem that is hampering the commercial culture of this and other *Seriola spp.* that are farmed around the world (Whittington, 2012). Monogeneans flatworms are ectoparasites of fish that can proliferate rapidly due to their direct, single-host life cycle, affecting fish growth and survival. In particular, the capsalid monogenean *Benedenia seriolae* infects the skin of fish. Adult parasites attached to the host by piercing the epidermis and feeding on host epithelial cells cause skin lesions that may lead to secondary microbial infections and mortality (Ernst et al, 2005). At present there are no methods to prevent monogenean infections (Whittington, 2012). The study of oral treatments has barely begun (Militz et al., 2013) and freshwater or chemical baths used to date have low therapeutic indices. As timing is critical to attain maximum efficacy in bath treatments, monogenean infections require a regular monitoring to control parasite population.

Here we present a simple and practical method to control the parasite population of *Benedenia seriolae* in greater amberjack rearing tanks avoiding fish handling. The method consists of estimating the level of infestation based on the number of parasite eggs collected in mesh traps that are suspended in the fish tanks. *Benedenia seriolae* eggs have a tetrahedral capsule and a single long filamentous appendage which cause that eggs, laid by adult parasites infesting fish, get entangled in the mesh traps. Nylon mesh discs can be suspended in the fish tanks, removed periodically and placed in Petri dishes with filtered seawater for observation and counting the collected eggs under the stereomicroscope.

The influence of several factors on the number of eggs collected by the mesh traps have been studied, including the mesh size, the position of the mesh traps in the tank in relation to the water inlet and outlet, and the number of days that the mesh traps should be kept in the tank. All these factors showed a significant effect on the number of eggs collected. In our experimental conditions, the most practical and effective method to estimate the parasite population was the use of nylon mesh discs of 65 mm in diameter, with a mesh size of 1.5 mm, suspended near the water surface overflow of the tank, during 3 days. These values can be easily adjusted according to the needs of each culture facility.

The method described has been used to estimate the level of infestation by *Benedenia seriolae* in a 50 m³ tank containing infected greater amberjack broodstock over several months. Triplicate mesh traps have been placed in the tank each week throughout the study period to observe the evolution of the number of eggs, which reach a minimum and maximum values of 119.3 ± 26.1 and 837.7 ± 66.6 respectively.

To study the development and hatching rate of the monogenean eggs, the same mesh traps that are removed from the culture tank for the counting of eggs, can be kept for several days in Petri dishes with filtered seawater under natural light. However, if the infestation level is too high or the mesh traps accumulate excessive amounts of detritus from the tank, the observation becomes more difficult. In this case, a more practical method is the use of segments of nylon threads that are placed suspended in the culture tank, allowing eggs to be entangled as in the mesh traps. The segments of nylon threads with a significant number of eggs can be then incubated in microwell plates to determine the hatching rate. The

method described has been used to estimate the effect of 4 different incubation temperatures (19, 21, 23 and 25°C) on the hatching rate of *Benedenia seriolae*.

The method described helps to easily monitoring the parasite population of *Benedenia seriolae* in rearing tanks of *Seriola dumerili*, but could also be applied to other monogenean parasites and *Seriola* spp. The regular monitoring of the infestation level by farm staff is useful to determine the optimal time for bath treatments, which is essential to achieve maximum effectiveness against monogenean infections in farmed fish.

References

- Whittington, I.D., 2012. *Benedenia seriolae* and *Neobenedenia* species. In: Woo, P.T.K., Buchmann, K. (Eds.), Fish parasites-pathobiology and protection. CABI Publishing, London, pp. 225–244.
- Ernst, I., Whittington, I.D., Corneille, S., Talbot, C. 2005. Effects of temperature, salinity, desiccation and chemical treatments on egg embryonation and hatching success of *Benedenia seriolae* (Monogenea: Capsalidae), a parasite of farmed *Seriola* spp. *Journal of Fish Diseases*, 28: 157-164.
- Miltz, T.A., Southgate, P.C., Carton, A.G., Huston, K.S. 2013. Dietary supplementation of garlic (*Allium sativum*) to prevent monogenean infection in aquaculture. *Aquaculture*, 408-409: 95-99.

Maturation and spawning of Atlantic bluefin tuna in farm fattening cages

Silvia Gherardi, Antonio Medina, Begonya Mèlich, Manuel Lara, Guillermo Aranda

University of Cádiz, Spain

Abstract

The aquaculture of Atlantic bluefin tuna (*Thunnus thynnus*) could have a positive impact on the natural population of this species in reducing the fishing pressure on the wild stocks and hence enhancing their recovery. In recent years, the bluefin tuna aquaculture technology has experienced remarkable progress, particularly with regard to larval, fingerling and juvenile production and rearing. Nevertheless, the control of egg production is still one of the most complex challenges in bluefin tuna culture due to the difficulty of handling captive broodstocks and maintaining them in optimal conditions for spawning. Experimental specimens have spontaneously spawned in cages located inside and outside of spawning grounds. Spawners kept in cages exhibited spontaneous spawns while moving around Balearic waters during the spawning season. Far from the known spawning area, natural spawns were observed in an experimental broodstock cage located at the SE of Spain (Murcia, Spain). However, captive spawners showed several reproductive dysfunctions resulting in impaired final maturation and ovulation/spermiation, unpredictable spawning dates and frequent reproductive failures possibly related to inadequate environmental conditions. In 2012 and 2013, close observations on fattening cages (Balfegó Group tuna farm, Tarragona, Spain) revealed unexpected spontaneous spawns. The reproductive condition of these fish was assessed by qualitative and quantitative histology of the ovarian tissue. All the spawns that took place in the cages were performed by specimens that had been confined for at least one year and at temperatures exceeding 18°C. The presence of postovulatory follicles (POFs) and/or oocyte maturation follicles indicated spawning activity in 16% of the females sampled in 2012. In 2013, the proportion of females exhibiting recent spontaneous spawn was 27%. These data differ from those found in the wild population, where the proportion of active spawning females was much higher (90%). All the females sacrificed on the same year of their capture were inactive or showed gonad resorption (>50% of atretic follicles), which was most probably caused by stress. The relative batch fecundity estimated from counts of POFs in active spawners was 50 eggs per gram of body weight. This estimate is consistent with that reported for wild specimens.

Probiotics in aquaculture: Pdp11 (*Shewanella putrefaciens*) as example

Juan Miguel Miró Recio-Mensaque and Juan Miguel Mancera

Department of Biology, Faculty of Marine and Environmental Sciences, University of Cádiz, 11510 Puerto Real, Cádiz, Spain

Abstract

According to Verschuere et al. (2000) probiotics are “a live microbial adjunct which has a beneficial effect on the host by modifying the host-associated or ambient microbial community, by ensuring improved use of the feed or enhancing its nutritional value, by enhancing the host response towards disease, or by improving the quality of its ambient environment”. In recent years, several studies on nature, action and effects of probiotics in aquaculture activity have been done and have revealed the existence of several types of probiotic agents such as many Gram-positive and Gram-negative bacteria, yeasts, and microalgae. So, there is a great variety of probiotics with a number of profitable action modes. In general, these organisms have been used to improve fish health and welfare. However there are still many unsolved questions on this topic.

In this abstract we are going to describe effects of probiotic Pdp 11 on *Sparus aurata* L. (1758) and *Solea senegalensis* Kaup, (1858). Pdp 11 is a bacterium isolated from skin mucus of *S. aurata* identified as *Shewanella putrefaciens* Pdp 11.

The results showed different positive effects of this probiótico on both species: i) growth improvement; ii) reduction of stress level; iii) better digestive processes in relation with lipids absorption; iv) stimulation of immune system by increasing phagocytic activity or peroxidase content in serum; and finally v) capacity of displacing, competing and excluding certain pathogens as *Photobacterium damsela* subs. *piscida* in soles (Díaz-Rosales et al., 2006; García de la Banda et al., 2012; Sáenz de Rodríguez et al., 2009; Tapia-Paniagua et al., 2012; Varela et al., 2010).

In general, probiotic Pdp11 presents a profitable effect on *S. aurata* and *S. senegalensis*, but still it is necessary to assess its effects on other species in order to better understand action mode of Pdp11, extending their potential applications on aquaculture activity.

References

- Díaz-Rosales, P., Salinas, I., Rodríguez, A. Cuesta, A. Chabrilón, M., Balebona, M.C., Moriñigo, M.A., Esteban, M.A. and Meseguer, J. (2006). Gilthead seabream (*Sparus aurata* L.) innate immune response after dietary administration of heat-inactivated potential probiotics. *Fish & Shellfish Immunology*, 20, 482-492.
- García de la Banda, I., Lobo, C., Chabrilón, M., León-Rubio, J.M., Arijó, S., Pazos, G., Lucas, L.M. and Moriñigo, M.A. (2012). Influence of dietary administration of a probiotic strain *Shewanella putrefaciens* on senegalese sole (*Solea senegalensis*, Kaup 1858) growth, body composition and resistance to *Photobacterium damsela* subsp *piscida*. *Aquaculture Research*, 43, 6: 662-669.
- Sáenz de Rodríguez, M.A., Díaz-Rosales, P., Chabrilón, M., Smidt, H., Arijó, S., León-Rubio, J.M., Alarcón, F.J., Balebona, M.C., Moriñigo, M.A., Cara, J.B. and Moyano, F.J. (2009). Effect of dietary administration of probiotics on growth and intestine functionality of juvenile Senegalese sole (*Solea senegalensis*, Kaup 1858). *Aquaculture Nutrition*, 15, 177-185.
- Tapia-Paniagua, S.T., Díaz-Rosales, P., León-Rubio, J.M., García de La Banda, I., Lobo, C., Alarcón, F.J., Chabrilón, M., Rosas-Ledesma, P., Varela, J.L., Ruiz-Jarabo, I., Arijó, S., Esteban, M.A., Martínez-Manzanares, E., Mancera, J.M., Balebona, M.C. and Moriñigo, M.A. (2012). Use of the probiotic *Shewanella putrefaciens* Pdp11 on the culture of Senegalese sole (*Solea senegalensis*, Kaup 1858) and gilthead seabream (*Sparus aurata* L.). *Aquaculture International*, 20, 1025-1039.
- Varela, J.L., Ruiz-Jarabo, I., Vargas-Chacoff, L., Arijó, S., León-Rubio, J.M., García-Millán, I., Martín del Río, M.P., Moriñigo, M.A. and Mancera, J.M. (2010). Dietary administration of probiotic Pdp11 promotes growth and improves stress tolerance to high stocking density in gilthead seabream *Sparus auratus*. *Aquaculture*, 309, 265-271.

Verschuere, L., Rombaut, G., Sorgeloos, P. and Verstraete, W. (2000). Probiotic bacteria as biological control agents in aquaculture. *Microbiological and Molecular Biologic Reviews*, 64,655-671.

Incorporation patterns of fatty acids and carotenoids in adult *Artemia franciscana* fed with 3 enriching

Segade A.¹, Robaina L.¹, Martínez I.², & Molina L.¹

¹*Aquaculture Research Group (GIA). Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain*

²*Plankton Ecophysiology Group (EOMAR). Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain*

Abstract

Different types of live prey have been used throughout the history of aquaculture (copepods , rotifers , nematodes, amphipodos , Artemia...). Most of these organisms have been used to feed larvae and juveniles of different fish species and crustaceans. But some organisms do not accept dry food, or feed is preferable with live or frozen prey at certain stages of development. Artemia is an organism with nutritional deficiencies so it has been investigated to improve the techniques and products which can enhance their biochemical composition. In this experiment three different enrichments will be tested to observe the accumulation of different nutrients in Artemia.

In this experiment adult Artemia (8.81 ± 0.95 mm) was enriched with 3 different products: DHA Easy Selco® (INVE, Belgium) (0,6g/l); a mix of 0,6g/l of Selco® with 0,6 g/l of Superba™ (Aker BioMarine AS, Norway) and, a mix of 0,6g/l of Selco with 0,6g/l of mussel oil. Artemia initial samples were taken, and then every hour, until 8 hours from each treatment and finally one last sample at 24 hours. Total carotenoids and fatty acid methyl esters were extracted from samples.

In all three treatments both fatty acids and pigments increased in the first hour, and may be related to a rapid filling of the digestive tract of Artemia. In addition EPA / DHA ratios are higher in the SK06 and SM06 treatments, and correlation is higher in the first one ($r^2 = 0.977$) because it is more stable over time. After 8 hours the concentration of all elements decreases to approximately baseline values, which may be due to depletion in rich culture medium.

Use of Passive Integrated Transponder (PIT) system as a method to tag juveniles of greater amberjack (*Seriola dumerili*) in grow

S. Jerez, J.R. Cejas, V. Martín, E. Almansa, F.J. Santamaría.

Instituto Español de Oceanografía

Abstract

The greater amberjack (*Seriola dumerili*) is a potential species in the Mediterranean aquaculture diversification. Although the fry production at industrial scale is limited in this area, some breeding, larval culture and grow out results have been achieved.

The grow out of *Seriola dumerili*, like in other cultured species, represents the longest and more expensive production phase. Moreover, the effects of feeding strategies and management on growth patterns and size dispersal are not well known in spite of its importance in the production costs.

The use of techniques for identification of individual fish is turning out to be indispensable for obtaining precise data. Individual tagging is a very important tool because it improved the knowledge of individual growth patterns and behavior, making it an ideal system for studies in terms of getting a greater volume of information and more reliable.

Fish may be tagged with internal or external systems. External systems have the advantages of being economical, easy to apply and do not require sophisticated equipment. However, they have the potential disadvantages of affecting growth, health and survival. On the contrary, internal systems, such as the Passive Integrated Transponders (PIT), appear to have little or no effect on fish growth and survival.

Tagging systems need to be tested for each species because of differences in susceptibility to anaesthesia and manipulation, capacity for recovery, size, growth rate and morphology. Thus, several studies have been carried out on different species of salmonids, perches, tilapias and in juveniles of red snapper *Pagrus auratus* (Quartararo and Bell, 1992) and gilthead seabream *Sparus aurata* (Navarro et al., 2006).

Until present there are no reports concerning tagging of greater amberjack. Thus, this study was conducted to examine the utility of Passive Integrated Transponder (PIT) tagging system in juveniles of greater amberjack. Tag effect on growth, condition factor and mortality rate as well as PIT tag loss rate was determined in fish cultured. In the same experiments the effects of different feeding strategies (by varying frequency and ration) were tested.

The experiment was carried out in the culture facilities of the Oceanographic Center of Canary Islands (Spanish Institute of Oceanography). All fish were anaesthetized with chlorobutanol (200 mg/L) prior to tagging with Passive Integrated Transponders (PIT; Datamars, Switzerland). PIT tagging was carried out with tags of 0.096 ± 0.0007 g weight and 2.05×11 mm size, previously immersed in alcohol and introduced horizontally into the fish using a syringe. Iodine was applied after the injection. Locations of pit tag fish were introduced in dorsal muscle. PIT codes were detected by ISO MAX V reader (Datamars, Switzerland).

A total of 216 fish with an average initial weight (mean \pm SE) of 128.2 ± 38.7 g were used. 96 fish were subject to PIT tags, while the remaining 120 were untagged. Both classes were randomly assigned to twelve 1000 L tanks, with 8 PIT tag fish and 10 untagged fish per tank. Fish were kept in those tanks for 48 days and fed daily with fish pellets according to different feeding strategies by varying frequency (1, 2 or 3 times day) and ration (1.5, 2.5, 3.0 and 4.0 % biomass day). Average initial density was 2.34 ± 0.28 kg/m³ and water flow, temperature, and dissolved oxygen content along the experiment were 15 L/min, $22.3 \pm 0.5^\circ\text{C}$ and 6.48 ± 0.09 mg/L, respectively. Weight and length were measured at four sampling periods: days 0, 14, 28 and 49. Condition factor ($\text{CF} = 100 \times \text{Weight (g)} \times \text{Length (cm}^3\text{)}$) and

Specific growth rates (SGR (% day⁻¹) = 100 x (Ln Weight final (g)-Ln Weight initial (g)) x days⁻¹) were estimated at each sampling period. Mortality of each tank was recorded daily and survival and PIT loss rates were recorded at each sampling period.

There was not PIT loss in tagged fish. Mortality rates were very low being 6.25 % and 5.83 % for PIT tagged and untagged fish, respectively. Mortality took place in the last period of the experiment (28-48 days) and no differences were found between tagged and untagged fish.

Mean weights, lengths, SGR as well as condition factor of PIT tagged and untagged fish of each experimental tank were similar during experimental period (48 days), so no effect of PIT was found on growth. However, PIT tagged fish provided much more useful information. Fish feeding 3 times day showed higher growth rates (p<0.05) compared with fish feeding 1 times day in the whole rearing period (1.40±0.44 vs 0.80±0.38 %). There was no significant influences of the ration factor in the growth rate except for the period of 28-49 days being the lowest value obtain with a ration of 4% (0.24±0.56 %).

The use of PIT tag allows the acquisition of more and improved information to a better understand of the growth patterns and social interactions of fish with a reduction of the number of fish according the principles of animal experimentation and increasing the accuracy of growth parameters estimation. Moreover they can be an important tool to the study and monitoring of diseases and also for genetic breeding programs.

References

- Navarro, A., Oliva, V., Zamorano, M.J., Ginés, R., Izquierdo, M.S., Astorga, N., Afonso, J.M., 2006. Evaluation of PIT system as a method to tag fingerlings of gilthead seabream (*Sparus auratus* L.): Effects on growth, mortality and tag loss. *Aquaculture* 257, 309-315.
- Quartararo, N., Bell, J.D., 1992. Effect of intraperitoneal passive implantable transponder (PI) tags on the growth and survival of juvenile snapper, *Pagrus auratus* (Bloch and Schneider). *Aquaculture and Fisheries Management* 23, 543–548.

Coastal Management

Are the Spanish regulations appropriate for the coastal management according to the coastline trend?

Juan Montes Pérez, Laura Del Río, Juan Adolfo Chica and Javier Benavente

University of Cádiz, Spain

Abstract

The recent modification of the Spanish Coastal Law produces a risk on the management of the coastal areas. The changes introduced with the Law passed in 2013 might be a menace for the coasts, especially for those that are on a setback process and that are dominated by the erosion processes. This, along with the 'coastalisation', which consists of the migration of the population towards coastal areas, puts the Spanish coasts under a pressure coming from both the Administration and the different sectors involved in its exploitation, resulting in an unprecedented and difficult to manage phenomenon.

This paper examines the evolution of the line of the coast of the Atlantic coast of the province of Cádiz. It will also delimit the rates of the setback and the variations over the past 50 years. Furthermore, a revision of both the current and the former legislation was made in order to observe which are the changes and the consequences that it may have for the coast.

Based on the rates of erosions it was observed how most of the coast is on setback, especially on those stretches of beaches belonging to municipalities that have a large number of population or that have a major touristic importance.

The aim of this paper is to show the lack of compatibility between the current rates of coastal erosion and the modification of the public limits by comparing the limits and restrictions of the Spanish Coastal Law of 1988 and the current one. Moreover, there is also a revision of other plans such as the Plan de Protección del Corredor Litoral de Andalucía (also known as PPCLA, the Protection Plan of the Line of the Coast of Andalusia in English), the Plan Andaluz de Acción por el Clima (the Andalusian Plan of Action for the Climate) or the Programa Andaluz de Adaptación al Cambio Climático (the Andalusian Programme for the Adaptation to Climate Change). The aim of the revision of these plans is to find the tools needed in order to achieve a proper management of the coastal areas.

Effects of the anthropogenic pressures (marine litter) on the coastal ecosystems of the Marine Reserve “Isla de La Graciosa e islotes del norte de Lanzarote”

Jiménez, S.¹, E.L. González², Y. González², J.F. González¹, B. Almón¹, C.L. Hernández-González¹, P. Martín-Sosa¹, G. González-Lorenzo¹ and M.A.R. Fernández¹

¹*Instituto Español de Oceanografía*

²*TDC Desarrolladores de soluciones ambientales S.L.*

Abstract

The European Marine Strategy Framework Directive (2008/56/EC) considers marine litter as one of its environmental descriptors, requiring the development and standardization of criteria and methodologies for its use to test the good environmental status of marine conditions. The assessment of the impact caused by litter accumulation in the shoreline lacked specific monitoring planning and had not been systematically performed to date in Canary Islands.

During the project “Evaluation of the effect of the anthropogenic pressures (marine litter in beaches and alteration of shallow seabed by boats anchoring) on the coastal ecosystems of the “Marine Reserve of Isla de La Graciosa e islotes del norte de Lanzarote (MRLG)” developed with the financial help of the Canary Islands Government (Council of Agriculture, Ranching, Fishing and Waters), two surveys were carried out, “LA GRACIOSA 1310” and “LA GRACIOSA 1311”, both developed at MRLG and its vicinities. The aim has been to depict MRLG shoreline and to locate marine litter accumulation points the most, contributing with some tools to assess and manage the coastal ecosystems of the marine reserve.

Total shoreline sampled at both surveys together was 38326 m, 1834 m at Alegranza, 1366 m at Montaña Clara, 24656 m at La Graciosa Island, and the rest, 10470 m, at the Lanzarote’s shoreline portion bathed by MRLG waters. Shoreline sampling was made qualitatively sorting the sampling stations, according to litter presence and distribution, by means of a upward numerical coding related to the type of waste or garbage found. Moreover, each station was additionally depicted according to the type of substrate as well as to the prevailing type of waste, defining what we named “transects”.

To validate methodology to European standards, a more exhaustive experimental sampling was made in four transects identified as high density or high concentration of marine litter, following guidelines of a method developed for OSPAR maritime area during the first half of 2000 decade (OSPAR, 2007). It involves evaluating the possibilities and needs of adjustment of this methodology to the particular conditions of our region (González, et al., 2013 a and b).

As preliminary results, the spatial distribution of garbage coastal accumulation will be shown in a cartographic base, expressed as relative abundance by island, according to a 4 degrees scale (no litter, low, medium and high litter presence) and according to the dominant kind of garbage in each transect. An example with one of the most densely occupied with trash transects is shown to illustrate a sampling method without the requirement of trash collection. This method uses a sampling unit of 1x1 m grid, divided in 10x10 cm subgrids. This grid is set parallel to sampling direction repeatedly. Distance between grids is determined by a randomizing software. Sampling direction zigzags from sea border to beach back shore, making 45° degrees angles. Subgrids occupied by trash are counted once the grid is set. Waste is depict and identified following a guide developed for this purpose by OSPAR in 2010.

Study of the mutual interaction of submerged pipeline with the sediment dynamics of Samil beach (NW Spain)

Aimar Lersundi-Kanpistegi¹, Ana Bernabeu¹, Daniel Rey¹, Rafael Díaz²

¹GEOMA, Dpto. Xeociencias Mariñas e Ordenación do Territorio, Universidade de Vigo

²ACUAES

Abstract

The Ría de Vigo (NW Spain) is one of the most affected coastal area in Galicia due to both demographic and industrial pressure. A proper coastal management of this area requires high degree of knowledge in order to balance the diverse economic and environmental activities. An important public work to preserve the environmental conditions of the ría is the extension of the urban wastewater treatment plant of the city of Vigo (NW Spain). This infrastructure involved the construction of a new and large pipeline, discharging on the sea. The pipeline planning has been designed through Samil beach, the most important urban beach in the Vigo city. In this work, the interaction between submerged pipeline and the sediment dynamics of the beach has been studied.

Samil beach is located in the southern margin of the mid sector of the Ría de Vigo, a 30 Km length funnel shaped embayment. The beach is 3 km long, NW oriented and partially sheltered by an island located at the western side. The pipeline structure will be buried from treatment plant and will appear at the 5 m isobath in the mid-sector of the beach. The emerged pipeline will be protected by concrete and stones, and will have trapezoidal shape in the transversal plane with a 20 m width base, 4 m width crest and maximum height of 5 m.

Numerical modelling, physical characterization of the seabed and closure depth estimations were used in this study. The numerical modelling was the main tool used in the study and allowed us to get values of basic parameters in the area of interest under different conditions. The model was developed with Open Source Delft3D modelling software in which the sediment transport produced by current and waves was simulated. For the model development, bathymetry, tidal, wave and grain size data was obtained from different sources as field surveys for the local bathymetry and sediment samples, Puertos del Estado databases for wave and tidal data or nautical chart for the ría bathymetry. The wave conditions with highest impact in the area were simulated (SW and NW waves associated to winter storms with significant wave height of 2.5 m and peak period of 14 s). The model simulated the transport during 50 days under each condition with and without the structure. The seabed was physically characterized analysing the high resolution bathymetry, sediment size distribution and Side Scan Sonar (SSS) images. This allowed us to characterize the energy distribution on the bottom and identify seabed natural (i.e. outcrops, ripples) and manmade (i.e. pipes, dredge marks) structures as well as erosion-accumulation marks associated to them. Finally, the closure depth was determined using the SSS images, high resolution bathymetry, previous studies and theoretical formulae.

In the area of interest, the model results showed that the SW swell affected in higher degree than the NW swell with propagation coefficients of 0.25 and 0.20, respectively. The wave interaction with the structure produced local erosion along its flanks until the 7 m isobaths, but did not alter the global sediment dynamics of the beach. The physical characterization of the seabed revealed that the subtidal sector was a relatively low energy area dominated by fine sands. In the shallowest area (0-10 m), the existing pipelines and submerged outcrops showed clearly local erosion at the lee side and accumulation at the exposed side. In deeper (> 10 m) areas they showed the same pattern but with gradual decrease on their magnitude until disappear as the depth increased, validating the model results. The closure depth value varied depending on the method and analyzed data, but all of them were in the range of 8-12 m.

According to our threefold result, the preliminary design of the structure does not threaten the natural dynamics of Samil beach. However, the emerging point of the structure below the closure depth (< 8 m in a conservative estimation) is critical, since this part of beach is the most active, responding to the seasonal wave conditions. This would jeopardise the pipeline safety due to the erosion produced at the base. Based on these results, the final design should establish the jacking pipeline above the 8 m depth, to avoid safety problems derived from the seasonal behaviour of the beach.

Growth response of the seagrass *Cymodocea nodosa* to in situ real burial and erosion

J.M^a. Espinosa, A. Machado, J. Díaz, T. Cruz & J. A. Bermejo.

Fundación Estatal Observatorio Ambiental Granadilla, 38001 Tenerife, Spain

Abstract

The construction of a large port infrastructure such as the Port of Granadilla (Tenerife Island) carries an environmental monitoring. Part of this environmental monitoring is to study the growth and response to the new environmental conditions of the seagrass.

Environmental impact studies, especially the environmental monitoring plans of large infrastructures, are poorly studied in the Canary Islands, so we contributed to them.

The response of *Cymodocea nodosa* (Ucria) Ascherson, 1870, seedlings to in situ burial and erosion was examined to test the extent coupling between sediment depth and composition fluctuations and seagrass growth, due to the construction of a large port infrastructure.

The survivorship declined with erosion and with increasing burial depth, relative to the controls (stations distantly of port), but only between specifically ranges. In fact, under certain conditions the opposite occurs, increasing the growth and vitality of the seagrass. Seagrass growth response described by changes in leaf sheath length, the rate of appearance of new leaves, and others environmental monitoring data response to fluctuations in environmental factors.

The results show that *C. Nodosa* tolerates large burials and that burial stimulates the growth of surviving seedlings. Probably, the increased leaf sheath length is a response to this burial.

Assessment of quality of the heavily modified waters of the Port of Las Palmas.

Collado-Sánchez, C.¹, Gelado-Caballero M.D.¹, Hernández-Brito J.¹, Hernández-Artiles, M.N.², Adam-Muñoz, M.A.² and Álvarez R.³

¹*Grupo de Calidad Medioambiental, Universidad de Las Palmas de Gran Canaria*

²*Autoridad Portuaria de Las Palmas*

³*Elittoral, Estudios de Ingeniería Costera y Oceanográfica, S.L.N.E.*

Abstract

The assessment of chemical and ecological quality of the heavily modified waters of the Port of Las Palmas is performed for a period of one year. This types of water need a methodological and technical support for the integrated management of water systems port at which combines management spatial of heavily modified surface water bodies, with monitoring and assessment of ecological quality and chemical status. This feature requires that in many cases the identification of subunits establishing management more efficient evaluation to recognize its different types of environmental hazards.

The selection of indicators intended for the assessment of the chemical quality of water and the seabeds are took of the list of the Royal Decree 60/2011 on environmental quality standards on environmental quality standards in the field of water policy for those substances that may be present in the activities or pressures existing in the port or adjacent areas. Chemical quality parameters of the water masses were divided into several groups: heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and other organic compounds to each of the different water bodies. Assessment of the chemical quality in the water column is performed over the sampling cycle in response to the environmental quality standards established for the various indicators.

The assessment of the ecological quality is performed with a biological and physico-chemical indicators set representative of the main pollution processes in port environments, which define its ecological potential. Biological quality is performed with phytoplankton, chlorophyll "a". The indicators used in the assessment of physico-chemical sediment quality include total organic carbon, total Kjeldahl nitrogen and total phosphorus. The environmental quality of heavily modified waters is evaluated from the hierarchical integration of the previous quality elements.

Biological Oceanography

Vulnerability and Acclimation to climate change factors of vermetid reefs: physiological effects in the associated algae *N.brassica-florida* to increased irradiances and temperature.

Hermoso, M., Figueroa, F. L.

Departamento de Ecología. Facultad de Ciencias Universidad de Málaga

Abstract

One of the most important bioconstructors in the Southern Mediterranean Sea are the vermetid reefs. It is a biotic structure formed by the association between the endemic gastropod *Dendropoma petraeum* and red calcareous algae *Neogoniolithon brassica-florida*. They play an important ecological role because they favored the biodiversity of the associated biota due to the vermetid reef offers protection of many organisms against predation, wave forcing and high solar irradiance.

The vermetid distribution depends on the environmental variables such as temperature i.e. they are presented just in warm temperate areas (Chemello & Silenzi 2011). Most of the studies on vermetid reefs have been focused on the gastropod (Calvo et al. 1998; Schiaparelli & Cattaneo-vietti 1999) or the entire community (Di Franco et al. 2011). However the expected equilibrium between the two biological components of the reefs could be affected by the external factors (Bulleri et al. 2011). In that context, it is important to evaluate how the environmental variables affect the physiology of the associated algae to understand the impact on stress factor on the equilibrium of the relation alga-gastropod and its resilience.

In the present work we have analyzed the bio-optic properties and photosynthetic activity of the red algae *N. brassica-florida* in association with *D. petraeum* of vermetids collected Cabo de Gata (Almería, Spain) and incubated in experimental tanks for six months (February to August, 2013) at ambient temperature and +2°C increase. The daily integrated irradiance and maximal and evening irradiances of PAR (400-700 nm) and UVA (320-400 nm) had positive effects on photosynthetic production and influenced the bio-optical characteristics whereas UVB irradiances provoked negative effects. The photosynthetic pattern of *N. brassica-florida* in association with vermetid reefs was like “sun type algae” (high maximal photosynthetic activity and saturated irradiances and low photosynthetic efficiencies). The increase of 2°C of water temperature water also increased the algal production and its capacity of acclimation to changes of radiation. This work encourage to study how the increase of algal production could affect community and disequilibrium point between algae –gastropod to test and the capacity of acclimation and resilience of vermetids to increased irradiances and temperature.

References

- Bulleri, F. et al., 2011. Crossing gradients of consumer pressure and physical stress on shallow rocky reefs: a test of the stress-gradient hypothesis. *Journal of Ecology* 2011., 99, pp.335–344.
- Calvo, M., Templado, J. & Penchaszadeh, P.E., 1998. Reproductive biology of the gregarious mediterranean vermetid gastropod *Dendropoma petraeum*. *Journal of Marine Biological Association of the United Kingdom*, 78, pp.525–549.
- Chemello, R. & Silenzi, S., 2011. Vermetid reefs in the Mediterranean Sea as archives of sea-level and surface temperature changes., 27(2), pp.121–127.
- Di Franco, A. et al., 2011. Do small marinas drive habitat specific impacts? A case study from Mediterranean Sea. *Marine Pollution Bulletin*, 62, pp.926–933. Available at: <http://dx.doi.org/10.1016/j.marpolbul.2011.02.053>.
- Schiaparelli, S. & Cattaneo-vietti, R., 1999. Functional morphology of vermetid feeding-tubes. *Lethaia*, 32, pp.41–46.

Response of scavengers to food subsidies in Galician exposed sandy beaches

Juez, A., Gayraud, G., Lastra, M.

Facultad de Ciencias del Mar de la Universidad de Vigo

Abstract

Scavenging is one of the main components of the trophic webs in the marine ecosystems worldwide. Scavenging in exposed sandy beaches is based on the consumption of animal cast and/or carrion drifted by waves and current and stranded along the intertidal beach face. In these subsidized environments, scavenging behavior has relevant consequences for the structure and stability of the macrofaunal community, as well as in the transferring of food supplies toward higher trophic levels.

This study is focused on scavengers inhabiting the swash zone of exposed sandy beaches, trying to establish which factors can affect its abundance and distribution. Special adaptations are required to live in the harsh environment of the swash zone of exposed beaches, due to its high hydrodynamic stress and sediment instability. Furthermore, crucial adaptations are also needed to capture occasional and unpredictable allochthonous food supplies that reach the beach.

The dominant scavenger in the European sandy beaches is the crab *Portumnus latipes* (Pennant 1777), an omnivorous Decapod that lives buried in the lower intertidal and shallows subtidal sandy sediment. *P. latipes* also behave as an opportunistic predator that has different diets depending on the season and prey availability.

We sampled the presence of *P. latipes* in the swash zone of six exposed sandy beaches along the Galician coast. We use bait as sampling protocol to capture carrion feeders; three baited sites 5 m spaced were located along each of three transects 30 m separated in the mean swash level. After 10 and 20 minutes, a 15 cm diameter corer was extracted right over each bait site. Corer content was then sieved with a 1 mm mesh and the residual sent to the laboratory where all the individuals were sorted and measured. We took nine corers at each of the transects as control samples to check for the natural density.

Burrowing behavior was tested to evaluate the performance of the target species to cope with the harsh environment of the swash zone. Assays consist of measuring burrowing time on a range of sandy sediments, from fine to coarse granulometries. 30 individuals of *P. latipes* sizing from 10 to 30 mm carapace length were used in the trials. Results indicate that fine to medium sands are adequate sediment sizes to increase burrowing velocity, compare to those in coarse and gravel sediments.

References

- Chartosia, N, M.-S. Kitsos, Th. Tzomos., 2010: Diet Composition of Five Species of Crabs (Decapoda, Brachyura) that Show a Gradual Transition from Marine to Terrestrial Life .Crustaceana.,83, 1181-97.
- F. Joel Fodrie, Michelle C. Brodeur, Benjamin J. Toscano, Sean P. Powers., 2012: or foe: Conflicting demands and conditional risk taking by opportunistic scavengers. Journal of Experimental Marine Biology and Ecology. Volumes 422-423, 114-121.
- James C. Beasley, Z. H. Olson and T. L. DeVault., 2012: Carrion cycling in food webs: comparisons among terrestrial and marine Ecosystems.Oikos. 121, 1021-1026.

New data on feeding and breathing of the fan mussel *Pinna Nobilis*

Trigos, S.¹, García-March, J.R.¹, Vicente, N.², Tena, J.¹ and Torres, J.¹

¹Institute of Environment and Marine Science Research (IMEDMAR). Universidad Católica de Valencia, Alicante, Spain

²Institut Océanographique Paul Ricard, Ile des Embiez, 83140 Six Fours les Plages (France) and Institut Méditerranéen de la Biodiversité et de l'Ecologie marine et continentale (IMBE). Aix-Marseille Université, France

Abstract

In this work new feeding and breathing studies of *Pinna nobilis* Linnaeus, 1758 have been carried out in order to constrain the ecophysiological information of this endangered species for future development of manipulative experiments. Firstly we tested the acceptance of several food sources (detritus, phytoplankton, *Spirulina*, nauplii and adult artemia and mysidaceans) and the retention of OM from detritus and phytoplankton. Then we studied the breathing activity of *P. nobilis* in respiration chambers. The tests were carried out in a total of 30 individuals, though sample size was different among experiments. Individuals were collected at Embiez archipelago, north-western Mediterranean (France) between July and September 2012 in two areas (43°04'25" N; 5°46'7" E and 43°04'34" N; 5°47'32" E) and kept in the facilities of the Oceanographic Institute Paul Ricard. Once experimental activity was finished, fan mussels were reintroduced into their original habitat.

Both adults of *Artemia* sp. and mysidaceans were barely captured due to their greater ability of movement whereas, high acceptance of *Artemia* sp. nauplii was observed. Constant rejection of undigested *Spirulina* sp. indicates a poor level of acceptance of this cyanobacteria by *P. nobilis*. The greatest levels of acceptance were observed with phytoplankton and detritus. Two feeding experiments were performed with these food sources to determine the degree of acceptance and the utilisation of their organic matter (OM) by *P. nobilis*. Doses of 20 g (dry weight) of muddy detritus with known proportions of OM were given to isolated individuals (22 individuals total, 30.3 to 60.8 cm of Ht). After 8 hours of experiment, the biodeposits produced (feces and pseudofeces) were recovered and its content of OM determined. Our studies show that *P. nobilis* retains on average high quantities of OM from muddy detritus: 0.5 ± 0.2 g ($48.01 \pm 13.69\%$ of filtered OM) irrespectively of shell size. Smaller individuals, however, actively filter more detritus than large ones. Furthermore, six individuals (34.6 to 57.2 cm of Ht) were exposed individually to a 1.8 L (25 g dry weight) of microalgae mixture (*Pavlova lutheri*, *Isochrysis galbana* and *Chaetoceros calcitrans*) at 20°C. *P. nobilis* retained on average 0.8 ± 0.1 g of OM ($84.4 \pm 6.2\%$ of total OM added) from phytoplankton.

The breathing activity was studied at three different temperatures on 30 fan mussels between 34.0 to 64.9 cm shell length: estimated optimum living temperature (20 °C) and minimum and maximum conformability temperatures (16 °C and 25 °C respectively). We registered great respiration rates in *P. nobilis* which are reduced at the conformability limits of temperature in comparison to the estimated optimum living temperature (T=16°C, 3.1 ± 1.2 mgO₂ h⁻¹, N = 18; T=20°C, 12.0 ± 3.9 mgO₂ h⁻¹, N = 18 and T=25°C, 8.5 ± 3.8 mgO₂ h⁻¹, N = 18).

Our results indicate that *P. nobilis* is as a large oxygen consumer with great acceptance for the OM from muddy detritus. In these terms, our values of retained OM, together with previous studies on stomach contents, suggest that muddy detritus may be a more important OM source than phytoplankton for this species. Our data will be useful for the maintenance of individuals in captivity in order to develop further manipulative experiments and will be also of great value for evaluating the adaptability of *P. nobilis* to variable environments.

Impact generated by accumulation of marine debris on the shoreline of Canary Islands. Preliminary results of the Project OMARCOST

S. Gonzalez-Gil, J.F. González, J. Rodríguez, C. Boza, A. Bartolomé, S. Jiménez, C. Hernández, M.T.G. Santamaría & G. González-Lorenzo

Instituto Español de Oceanografía

Abstract

The impact generated by accumulation of marine debris on the Canarian coastline had no specific monitoring plans that addressed this issue systematically. The need to address these information gaps is obvious, just to determine the status of coastal conservation but also to implement environmental monitoring plans at a regional level. In addition, the European Marine strategy Framework Directive considers marine litter as one of its environmental descriptors (Descriptor 10), requiring the development and standardization of criteria to be used in the evaluation of the good environmental status of marine waters.

The Project OMARCOST (Strategy for the Environmental Sustainability of the Litoral Border), funded by the European Operational Program "Spain-External Borders Cross-Border Cooperation Program" (POCTEFEX) in the context of the objective of European territorial cooperation between Spain and Morocco, has as first objective the characterization of the shorelines of the islands of Fuerteventura and El Hierro as well as the location of the places where marine litter accumulates more. Thus, coastline were initially sampled and stations defined based on estimated ranges of the number of items per meter of coast analyzed and their distribution (no litter, low presence of litter, medium and high litter presence). Each station was additionally characterized according to the type of substrate (sand, rock, lava, etc) as well as to the dominant type of waste (plastic, rope, etc).

Marine debris is a problem in oceans, coasts, and watersheds throughout the World, therefore standardization of methods is important. According to OSPAR directives, additional samplings were accomplished in certain coastal areas of 100 m length to measured and classify in detail the accumulated litter. These stations would be considered as fixed stations in future monitoring programs. However, the original method has several handicaps that may condition their implementation. This type of work is based on the collection, processing and subsequent disposal of waste, so they demand a high participation of staff at the time of its collection and sorting, solved mostly by voluntary participation. Another important issue is the accessibility of the stations to study in order to remove the garbage to dumps.

OMARCOST design and apply a new sampling method that does not require garbage picking. It consists in a 1x1 meter grid sampling unit subdivided into 10x10 cm sub grids. The unit is placed in the sampling position by using a computer application that generates random numbers. These numbers are used as distance in meters between one grid and the next, following a "road" of oblique transects from the edge of the ocean line to the head and/or end of the beach. Once located in place, the number of sub grids occupied by trash is counted and the debris type characterized following OSPAR criteria.

Preliminary results shows for the first time the spatial distribution of litter in the islands of Fuerteventura and El Hierro. Analysis of the nature and composition of waste according to OSPAR is still in progress but up to now plastic is the more abundant source of debris for all studied stations.

Growth of the endangered bivalve *Pinna nobilis* in the western Mediterranean Sea .

Martínez-Martí, A.¹, Del Toro, M.², Trigos, S.¹, García-March, J.R.¹, Tena, J.¹, Deudero, S.², Vázquez-Luis, M.², Torres, J.¹

Abstract

We present here the preliminary results of a comparative study of growth of *Pinna nobilis* in the western Mediterranean Sea in a depth range between 5 and 10 m. For this aim we have studied the inner record of the posterior adductor muscle scar (PAMS) of a total of 140 empty shells collected from dead specimens found during different field surveys in 7 different populations (20 shells from each population): Mar Menor in Murcia, Tabarca, Serra Gelada, Calpe and Moraira in Alicante and Freus and Gandulf in the Balearic Islands. Shells were processed according to the new methodology by García-March et al (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 doi 10.1016/j.jembe.2011.07.016", which uses sclerochronological methods based on the annual deposition of the inner record of the PAMS. To estimate the growth parameters, we measured the positions of the inner record of the PAMS to the anterior end of the shell, then back-calculated total sizes (Ht) from these positions for each year and estimated the missing records measuring calcite width. With these data we could fit a Von Bertalanffy equation for each population using non linear mixed effects, considering the parameters t_0 and k as fixed and L_{∞} as random. Results have revealed significant differences between the growth models of the populations, either in maximum age or size. This information will help identifying the best environmental conditions for the growth and development of this species, and the influence of environmental factors such as hydrodynamics on shell growth. This work will be useful to define better conservation strategies of those marine coastal areas where *P. nobilis* inhabits.

Horizontal distribution of Copepoda *Cyclopoida Sapphirinidae* in the Canary Islands

José María Espinosa Gutiérrez and Fernando Lozano Soldevilla

Departamento de Biología Animal, Edafología y Geología (Unidad Departamental de Ciencias Marinas), Universidad de La Laguna. 38206 Tenerife, Spain

Abstract

The Canary Islands present obstacles to the trade winds and to the Canary Current flowing equatorward past them. Cyclonic and anticyclonic eddies were alternatively observed from the northwestern area to the central area of the Canary Islands. Copepoda *Cyclopoida Sapphirinidae* abundance were analysed to study the influence of the disturbance of the Canary Current flow by the Canary Islands archipelago on the variability of copepods distribution. Two transects and two fixed stations located at the north (non-perturbed zone) and the south (perturbed zone) of the Canary Islands were sampled. Oceanographic data showed high stratified water column and uniform salinity and temperature sections, in the non-perturbed zone while leeward of the islands an eddy field was observed. *Sapphirinidae* copepods abundance were lower for the most species studied in the non-perturbed zone and at the north fixed station. Significant differences of *Sapphirinidae* copepods abundance and sizes between both sampled zones were found. Stations located in eddy structures presented the highest values of copepods densities and sizes. Our results suggest that eddies, mainly anticyclonic eddies, act as copepods retention zones southward of the islands and there is an important differential size retention between North and South.

Geological Oceanography

Multiproxy evidences of the environmental and climatic shifts in the Alboran Sea during the last 25 ka.

Bernárdez, P., Gutiérrez-Arnillas, E., Francés, G., Sánchez-Pellicer, R., Pérez-Arlucea, M. González-Álvarez, R., Alejo, I.

Departamento de Xeociencias Mariñas e Ordenación do Territorio, Facultade de Ciencias do Mar, Universidade de Vigo, Campus Lagoas-Marcosende, Vigo, 36310, Spain

Abstract

Environmental and climate shifts in the western Mediterranean Sea were reconstructed for the last 25 ka on the basis of lithological, sedimentological, biogeochemical, micropaleontological and AMS 14C analyses conducted in high-resolution marine sediment record piston core (Ceuta-8, depth 928 m below sea level, 628 cm-long, latitude: 36.0231°N, longitude: 4.8669°W) retrieved from the eastern Alboran Sea during the Leg-1 Contouriber cruise onboard R/V Sarmiento de Gamboa in 2010. The chronology of the core was established using 17 AMS 14C dates in monospecific samples of *G. bulloides*. Mean sedimentation rate is about 30 cm ka⁻¹, allowing for a temporal resolution of ca. 100 years between samples. We observe that fluctuations in planktic foraminiferal assemblages, foraminiferal stable oxygen isotope compositions ($\delta^{18}\text{O}$), MAT-derived SST temperatures, geochemical composition of the sediment, as well as grain size distribution, are linked to variations in the circulation and characteristics of the water masses, marine productivity, detrital supply, redox conditions, and bottom currents intensity. In this way, this set proxies allowed us to the reconstruction of the oceanographic and climatic processes affecting the paleorecord over the depositional period.

Planktic foraminiferal assemblages, $\delta^{18}\text{O}$ variations in *G. bulloides* and SST oscillations indicate that the HE1 and HE2 and also the 8.2 ka. event are well represented in our record. Increases in *G. bulloides* abundance, Ba/Al ratios and TOC concentrations indicate that during these cold periods marine productivity is enhanced. These changes in productivity could be accompanied by changes in the bottom-water redox conditions being reflected in the sediment record. Applying redox proxies we describe changes in deep-water oxygenation and we infer the evolution of deep-water conditions during millennial-scale and the influence of the climate/oceanographic events in the area. We propose that these changes in the water masses circulation affected bottom-water oxygenation in the Alboran Sea region, which together with increased productivity promoted reducing conditions and enhanced organic-matter preservation. On the other hand, the detrital input proxies group, that include those supplied via eolian dust or fluvial runoff, show that during HE1 and HE2 dryer conditions occurred, whereas the B/A could be wetter.

Inputs of detrital material to the core site together with changes in the oceanographical and climatic setting affected the grain size distribution of the record, together with periods of reinforcing of the bottom-water circulation. In this way, faster bottom currents and more energetic hydrodynamic conditions are evidenced by current speed proxies during cold periods. Additionally, better oxygenated bottom waters were detected. In contrast, several periods of lower deep currents and reduced circulation can also be assessed. Summarizing, deep-water redox conditions at site Ceuta-8 are interpreted by combining paleoproductivity and bottom-water ventilation to reconstruct a balance between oxygen consumption due to enhanced export productivity and decreased bottom-water circulation.

A review of all available palaeoclimate studies in the western Mediterranean sea reveals a consistency on the oceanographic and climatic fluctuations in the records during the last 25 ka., showing that the interpretations that are available are reliable. The main driving mechanisms behind this environmental

variability over millennial time-scales are related to changes fluctuations in the atmosphere-hydrosphere systems, revealing a close terrestrial-ocean-atmosphere coupling in the western Mediterranean region. Variations in the solar irradiance, NAO variability and the African monsoon system could also have a considerable importance.

Acknowledgements: The research leading to these results are funded by projects CONTOURIBER (CTM2008-06399—0401/MAR), and MOWER (CTM2012-39599-C03) under the research program of the Spanish MICINN. P.B. acknowledges the funding from the Juan de la Cierva postdoctoral program.

A preliminary approach to the definition of the oil burial depth on sandy beaches

Sandra Fernández-Fernández, Ana M. Bernabeu, Daniel Rey, Belén Rubio, Federico Vilas

GEOMA, Grupo de Geología Marina y Ambiental, Departamento de Geociencias Marinas, Universidad de Vigo, 36310 Vigo, Spain.

Abstract

The fuel that remains buried up to several meters is one of the main challenges in the assessment and cleanup of an oil spill at present. The current oil spill protocols design cleanup strategies to a maximum depth of 1 m, clearly insufficient after recent finds in the Prestige oil spill (Bernabeu et al., 2009). As a result, the coastal managers need new tools to fill the gap in the estimation of the affected area as well as in the fate of the stranded oil.

The previous studies on sandy beaches affected by Prestige oil spill highlighted the importance of the beach morphodynamic for deep burial in the intertidal area. The oil tanker accidents frequently coincide with storm events. When oil reaches the coast, beaches are at their morphodynamic erosive extreme. The arrival of fair-weather conditions activates the depositional sequence on the beach and favors the burial of oil (Bernabeu et al., 2006). Nevertheless, the quantification of the oil buried depth is still an open question. The present work tackles the oil burial depth considering the beach morphodynamic changes.

Beach profiles data were gathered from the bibliography, which had been measured under different oceanographic conditions around the world. These data allowed estimating the movement of advance (accretion) or retreatment (erosion) of shoreline. The equilibrium beach profile proposed by Bernabeu et al. (2003) was used to compute beach profiles under different oceanographic and sedimentary conditions, simulating seasonal changes. The modeled conditions comprised morphodynamic states from reflective ($\Omega=1.12$) to dissipative ($\Omega=6.87$).

The results allowed distinguishing two kinds of beach profiles behavior: A: under the seasonal changes, the beach profiles ran parallel each other and B: the beach profiles change the mean slope and cross themselves in a point within the intertidal area. In the case A, the accretion and the erosion on beach profiles were linked with the wave height. On one hand, when moves to higher wave conditions, sand accretion occurs, entailing the oil burial. On the other hand, when moves to lower wave conditions, erosion prevails, favoring the oil exhumation. In the case B, both processes, accretion and erosion, occur concurrently. Beach profile accumulates sand in the shallower zone and loses sediment in the lower part of the profile.

This behavior has a consequence in the definition of the oil burial depth as the thickness between the initial and the final beach profiles at the mean sea level. When the cross point was located between the high tide level and the mean sea level, the accretion was observed and the oil burial would be expected. When the cross point was located between the mean sea level and the low tide level, the erosion was reported and that would involve the oil exhumation.

Based on our results, a formulation of burial depth of oil on sandy beaches is proposed for those beaches where seasonal behavior entails an accretion during high energetic conditions. This formulation will be part of a sandy beach cleanup protocol that is developing at present.

Acknowledgements: This work was financially supported by MICINN of Spain (CTM 2008-02699E) in the framework of the EU AMPERA. S. F.-F. is awarded a FPU grant by Ministry of Spanish Education.

References

Bernabeu, A.M., Medina, R., Vidal, C. 2003. A morphological model of the beach profile integrating wave and tidal influences. *Marine Geology*, 197 (1-4), 95-116.

Bernabeu, A. M., Nuez de la Fuente, M., Rey, D., Rubio, B., Vilas, F., Medina, R., González, M. E. 2006. Beach morphodynamics forcements in oiled shorelines: coupled physical and chemical processes during and after fuel burial. *Marine Pollution Bulletin*, 52, 1156–1168.

Bernabeu, A. M., Rey, D., Rubio, B., Vilas, F., Dominguez, C., Bayona, J. M., Albaigés, J. 2009. Assessment of cleanup needs of oiled sandy beaches: Lessons from the prestige oil spill . *Environmental Science and Technology*, 43 (7), 2470-2475.

Sea-surface changes in the Galicia Interior Basin during the past 60 ka.

Anxo Mena, Raquel González-Álvarez and Guillermo Francés

Dpto. Xeociencias Mariñas e Ordenación do Territorio. Facultade de Ciencias do Mar. Universidade de Vigo, Spain

Abstract

The Galicia Interior Basin (GIB) is a narrow area located at in the NW of the Iberian Peninsula between the Galicia Bank and the Galicia continental slope. Nowadays a complex interplay between different surface and subsurface currents can be identified. These currents involve the two modes of the Eastern North Atlantic Central Water (subpolar and subtropical). During the most part of the year surface circulation is dominated by the Portugal Current (PC) and its eastern branch, the Portugal Coastal Current (PCC). Both currents flow southward as a slow branch of the North Atlantic Current (NAC) carrying to the region the relative cold and less saline waters of the ENACWsp. During winters the circulation over the continental slope is dominated by the Iberian Poleward Current (IPC) that carries the warmer and saltier waters of the ENACWst. The IPC is originated by the latitudinal density gradient, strongly dependent of the Polar Front position. The rest of the year the IPC is weaker and it is restricted to deeper and offshore parts of the water column. The coastal areas of the Galicia Margin are under the influence of a seasonal upwelling. Upwelling does not affect directly to the GIB, but its filaments could reach the GIB, increasing the productivity of the water column.

The described oceanographic setting changed drastically during the Last Glaciation in response to millennial and submillennial climatic fluctuations. This work aims to reconstruct these changes using planktonic foraminifera assemblages recorded in three cores from an East-West transect at the GIB. Analyses are completed with SST reconstruction using the Modern Analogue Technique (MAT) and the measurements of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ monospecific *Globigerina bulloides*. The SST reconstruction based on MAT allows the identification of three SST ranges (A: 1-3.5°C; B: 5-9.5°C; C: 11.5-16°C) which corresponds with particular planktonic foraminifera assemblages dominated by: *A-Neogloboquadrina pachyderma* (sin), *C-N. pachyderma* (dex), *G. bulloides* and *Globorotalia inflata*. This proxy combination reveals specific oceanographic conditions for each range. SST range A corresponds with Heinrich Events conditions (HE, very cold and relatively less saline waters). SST range C represents the NAC assemblage (modern conditions). SST range B corresponds with the glacial conditions between HE.

HE surface water status is characterized by the presence of polar water masses where the iceberg melting and the southward position of the Polar Front allowed the invasion of cold and less saline water into the GIB. The NAC assemblage, similar to the present conditions can be detailed in two sub-assemblages attending to the relative abundances of the species for each extreme of the SST range C, higher percentages of *G. bulloides* and *G. inflata* for the colder and the warmer extremes respectively.. Higher percentages of *G. inflata* are related to more intense stratification than *G. bulloides*) and prevalence of the ENACWst due to the IPC action. Higher percentages of *G. bulloides* are linked to vertical mixing and preponderance of the ENACWsp due to the PC action.

All these proxies obtained from the three cores recorded in the centre, the westernmost and easternmost extremes of the GIB allow the reconstruction of the sea surface configuration at different sectors of the GIB during the past 60 ka. The planktonic foraminifera and the SST evolution can be broadly described as an alternation between the HE and the NAC stages conditions. The small size of the basin reveals a common oceanographic evolution, although significant E-W differences can be distinguished. These differences show significant variations of the surface currents system especially between 20–30 ka. During this period, both water masses, ENACWst and ENACWsp, corresponding with IPC in the

continental slope and PC in the centre of the basin are active at the same time. This fact could even act as a barrier to the iceberg arrival, avoiding the achievement of the HE in the record of the lower continental slope.

Acknowledgements: This work has been possible thanks to the projects CATARINA (CTM2010-17141/MAR), and GRACCIE (Consolider-Ingenio, CDS 2007-00067), Spanish MICINN and FEDER 2007-2012).

A pocket beach that reaches equilibrium after becoming disconnected from a large system of beaches. Playa Barca (Fuerteventura)

Eduardo Bru, Ignacio Alonso

Instituto de Oceanografía y Cambio Global, Univ. Las Palmas de Gran Canaria, 35017-Las Palmas, Spain.

Abstract

Playa Barca is a 370 m long beach located within the system of the Leeward beaches on the Jandía peninsula, Fuerteventura. This system of beaches represents one of the major sources of economic income to the island, both because of its natural landscape that attract a specific type of tourism, and because of its particular climate conditions that make these beaches ideal for practicing wind-water sports. Nevertheless, in the past decades, this area has suffered from a significant and worrying coastline retreat.

In order to look for an explanation to this retreat, five topographic surveys were carried out in October 1999, February 2001, February 2002, February 2003 and February 2013 to track the beach behavior in the last 15 years. A total station Topcon GTS-303D was used for this purpose. Surveys were carried out during low spring tides, so that the outer limit was the furthest possible depending on wave conditions. The inner limit covered part of the dunes in the backshore. From these topographic data both coastline changes and the sedimentary balance have been obtained.

To determine the causes responsible of the measured coastal retreat climatological data were used. Wave data were provided by Puertos del Estado (www.puertos.es) corresponding to WANA 1024012 point, the closest to the study area. The data set included Hs, Tp and approaching wave direction, covering a 5 years period from January 1999 to December 2003, with one data every 3 hours.

The most outstanding results are shown between consecutive topographic data:

- Between October 1999 and February 2001 the beach suffered a very important erosion in the outer part of the beach, while the inner one showed accretion. The net balance was an erosion of 6.700 m³, which represents a coastline retreat of 13.6 m/year.

- Between February 2001 and February 2002, the shoreline retreat increased to 32.5 m/year, resulting from a net erosion that reached 25.000 m³ just in one year. Once more, most of the erosion took place along the outer part of the beach.

- From February 2002 to February 2003, the loss of material measured was 6.600 m³. At this stage the beach had lost so much material that it became a pocket beach bounded by two rocky outcrops, the erosion rate become constant and virtually nil reaching 0.25 m/year, which indicates that the shoreline remained virtually unchanged, except at the north and south ends of the beach.

- Finally, from February 2003 to February 2013 there was a net accumulation of 15.200 m³, which mostly took place along the inner limit of the area. Due to the lack of intermediate data between 2003 and 2013 it is not possible to know if this accumulation was regular during the 10 year interval, or associated to a punctual phenomenon that added this new material. Nevertheless, the shoreline remained virtually unchanged, except at the north and south ends of the beach. The coastal retreat rate was only 0.25 m/year.

Considering the whole period, the beach has shown a total loss of 23.100 m³ of sediment, and an average coastal retreat of 51 m. These numbers represents the total disappearance of the sandy barrier and the inner lagoon, which were the main geomorphological feature along this area.

There are two main reasons to explain this erosion: First one is related to the general southward longshore drift that characterized the Leeward beaches system. According to Alonso et al (2006), who studied

the long term evolution of the whole system, it becomes clear that the measured erosion is related to longshore transport processes, so that the sediment outputs are not being replaced by new inputs, due to the depletion of sediments in the source area and the construction of physical barriers such as roads.

This general erosive pattern was accelerated by several unusual stormy events that took place at the beginning of 2002. These events were characterized by easterly and southerly high waves, to which, due to its orientation, Playa Barca is completely exposed:

The first and most aggressive event took place between the 6 of January at 3:00 and the 8 of January at 21:00. In this particular event, Hs of 3.2m were reached with Tp values up to 7s.

The second outstanding event, took place between the 11 of January at 00:00 up to the 12 of January at 18:00. In this particular event the maximum Hs measured was 2.3m and Tp of 13.5s. Lastly, the third event, took place between the 18 of February at 00:00 to the 22 of February at 6:00. In this case Hs reached values of 2.6m and Tp of 10.2s.

The resulting situation is that nowadays the beach is bounded between two rocky outcrops that completely interrupts the long-shore drift. This is the reason to explain that the present retreat rate remains constant at 0.25 m/year, suggesting it has reached some sedimentary stability.

References

Alonso, I., Jiménez, J.A., and Valdemoro, H.I. 2006. CorJan Vol II, Technical report, Dirección General de Costas, Ministerio de Medio Ambiente.

Millennial environmental changes from geophysical and palynological analyses in San Simón Bay (Ría de Vigo).

García-García, P.¹, García-Moreiras, I.², Martínez Carreño, N.¹, Muñoz-Sobrino, C.², García-Gil, S.¹

¹*Departamento de Geociencias Marinas y Ordenación del Territorio, Facultad de Ciencias, Universidad de Vigo, Spain.*

²*Departamento de Biología Vegetal e Ciencias do Solo, Facultade de Ciencias, Universidade de Vigo, Spain.*

Abstract

The Ría de Vigo is the most southerly of the Rías Baixas of Galicia (Fig. 1). Its physiography shows a distinctive funnel shape, its major axis is orientated N45°E and it covers an area of 176 km². In its inner part there is a small basin of approximately 19.4 km² called San Simón Bay, which is connected to the rest of the ría by a long (1.5 km), narrow (600 m) channel, the Rande Strait. At the entrance to the ría the Cíes Islands provide natural protection against Atlantic storms.

The Ría de Vigo has a NE–SW central channel with a maximum depth of 55 m (Fig. 1a). Towards the inner part of the ría the water depth decreases, with the lowest values in San Simón Bay (average depth = 7 m). The average salinity of the outer part of the Ría de Vigo is 36 psu, decreasing to 31–32 psu at the entrance to San Simón Bay. Lower salinity values are found in the river estuaries in the bay. Superficial water temperatures of the ría vary from 11 to 12°C in winter and 19 to 20°C in summer.

The sedimentary infill of the Ría de Vigo (García-Gil et al., 1999; García-García et al., 2005) is constituted by three sedimentary sequences. The oldest sedimentary sequence (S1) only occurs in the lowest areas of the ría. García-Gil et al. (1999) propose a fluvial origin for this sequence in the Ría de Pontevedra. The stratigraphic discontinuity between lower and middle sequences is very erosive and irregular, with channel incisions. This discontinuity was correlated to the erosion caused by the fall in sea level (-120 m below the present seabed, Dias et al., 2000; García-García et al., 2005) during the Last Glacial Maximum (LGM), 18 ky BP. The middle sequence (S2) would be of Late Pleistocene age (García-Gil et al., 2011) and was deposited during the sea-level rise after the LGM. The discontinuity between the middle (S2) and upper sequence (S3) was identified as an erosive surface caused by the sea-level fall during the cooler Younger Dryas event. The youngest (and most extensive) sequence identified in the rías of Holocene age (García-García et al., 2005) deposited during the sea-level rise that took place after the Younger Dryas event. Martínez-Carreño and García-Gil (2013) identified three new seismic units (Uh1 to Uh3) that compose the Holocene sequence (S3) in the Ría de Vigo. The units are bounded by erosive surfaces. Core sediment retrieval at positions selected on the basis of high-resolution seismic profiles (Fig. 1a) provided insights into the sedimentary characteristics of these individual seismic units. Unit Uh3 retrieved in vibro-core B-1, located in San Simón Bay, is composed by facies: 1) coarse to very coarse grain bioclastic sand, with shell sizes ranging from several millimeters to several centimeters and 2) muds that are characteristic of sub-units Uh3.1 and Uh3.2, respectively.

A preliminary palynological study of vibro-core B-1 is presented in this study. It includes (1) terrestrial pollen percentages and concentrations calculated on the basis of the sum of terrestrial pollen; (2) non-pollen palynomorphs (NPPs) including microforaminiferal linings and fungal and fresh/brackish-water algae remains; and (3) dinocyst percentages and concentrations, and (4) the changes in the pollen/dinocyst rates along the sequence.

The core was subsampled at regular 10 cm intervals and spiked with *Lycopodium* spores for absolute pollen analysis, but only a number of them are being presented in this work. Pollen samples of 2.5 cm³ fresh sediment were prepared using HCl+HF treatment (Moore et al., 1991). Coarse (>250 µm) and fine

fraction ($<10\ \mu\text{m}$) were eliminated by sieving. The mounting medium was glycerol liquid and the slides were analysed using a light microscope at 400 and 600x magnifications.

More than 250 palynomorphs per sample were analysed at each of the levels studied. Terrestrial pollen percentages were calculated on the basis of the sum of terrestrial pollen. NPPs percentages are based on total pollen + NPPs. The minimum number of dinocysts counted per sample was 250. The percentages of the different types of dinocysts (identified groups follow Marret and Zonneveld, 2003 and Sprangers et al., 2004) were calculated in relation to the total dinocyst count. Pollen/dinocyst accumulation rates (respectively PAR/DAR, expressed as number of grains [or cysts] $\text{cm}^{-2}\ \text{yr}^{-1}$) were also calculated. Finally, the ratio of dinocysts to pollen+spores+dinocyst count (the D/P ratio, ranging between 0 and 1) was calculated for each sample, to show their temporal variation.

Glacial-interglacial sedimentary processes in the Northeast Atlantic Ocean as reveal grain-size analyses.

Alejo, I.¹, Nombela, M.A.¹, Francés, G.¹, Pérez-Arlucea, M.¹, Mena, A.¹, Diz, P.¹, Caínzos, V.¹, Estrada, F.²

¹*Departamento de Xeociencias Mariñas e Ordenación do Territorio, Universidade de Vigo, Campus Vigo, 36310, Spain*

²*Grupo de Márgenes Continentales ICM-CSIC, Paseo Marítimo de la Barceloneta, 37-49, 08003 Barcelona, Spain*

Abstract

High resolution grain-size results of core KTA-GC-05 are presented in order to infer millennial and submillennial changes of open ocean transport processes. The core was collected using a gravity corer on board the B/O Sarmiento de Gamboa during PALEOACID cruise of CATARINA project in August 2012. It is located in the eastern basin of the North Atlantic Ocean at 46° 11.157'N and 18° 18.837'W, at a depth of 3939 meters. The core length reaches 337 cm and an expected age of around 120 ka.

Grain-size analyses were performed on both the total fraction (organic matter removed with 10% H₂O₂) and the non-carbonate fraction (both organic matter and carbonate were removed with H₂O₂ and HCl, respectively). Grain-size distributions were measured with a Beckman Coulter LS 13 320 laser particle size analyser (CLS), which determines particle grain-sizes between 0.04 and 2000 μm as volume percentages based on diffraction laws (McCave et al., 1986; Agrawal et al., 1991).

Results for every sample include the median (D50), the mean and the first mode. Also percentages of sand, silt and clay fractions are shown. In addition, the UP10 size (i.e. particles coarser than 10 μm) is considered, which adds the fine sand subpopulation to the sortable silt size fraction (SS, 10–63 μm). The sortable silt size (SS) has been broadly used as a proxy to infer the intensity of deep water currents (McCave et al., 1995). However, since strong currents are also able to rework particles coarser than 63 μm, the UP10 fraction has been also considered for the study of paleocurrent intensity (Frigola et al., 2008).

Median and mean values of bulk and non-carbonated sediment fractions show different features thus pointing to different processes controlling the deposition of both fractions. Nevertheless, the non-carbonate fraction better represents the intensity of bottom currents (McCave et al., 1995) or the influence of iceberg discharge.

Clear differences of sedimentological data between the Last Glaciation (MIS 2-4) and the Last Interglacial (MIS 5) are observed, suggesting much contrasted sedimentation patterns during both periods. During glacial times sedimentation is controlled by iceberg input, thus grain-size data does not reflect bottom current intensity. Besides, Atlantic Meridional Overturning Circulation (AMOC) was reduced during glaciations or even stopped during extreme cold events. Precisely, stronger sedimentological signals are recorded coinciding with these events (Heinrich Events, HE). This pattern is corroborated by other geochemical and micropaleontological proxies analysed in the same core. HEs are in general characterized by sharp increases of sand, D50, UP10 and silt/clay ratio of non-carbonate fraction as well as slight decrease of SS. Nevertheless, several differences between the younger HEs (HE1, HE2 and HE3) and the earlier HEs (HE4, HE5 and HE6) can be observed.

On the other hand, during the Last Interglacial (MIS 5), with active AMOC observed fluctuations in the grain-size data are an accurate proxy for reconstructing bottom currents intensity. Variations in silt/clay ratio, UP10 and SS are in agreement with climate changes associated with MIS 5 substages. Warmer substages 5a, 5c and 5e are characterized by higher values of the above mentioned markers, pointing to

more vigorous bottom circulation. In fact, lower percentages of clay fraction are recorded during these warmer intervals and coarse and very coarse silt are the dominant size from the non-carbonate fraction. The opposite trend occurs during relatively colder substages 5b and 5d, when percentages of clay and finer silt fractions increase, as well as SS and UP10 values decrease. These facts suggest sluggish bottom current.

Acknowledgements: This research was supported by the CATARINA Project (CTM2010-17141/MAR), Spanish MICINN and FEDER 2007-2012.

References

- Agrawal, Y.C., McCave, I.N., Riley, J.B., 1991. Laser diffraction size analysis. In: Syvitski, J.P.M. (Ed.), *Principles, Methods, and Application of Particle Size Analysis*. Cambridge University Press, Cambridge, pp. 119–129.
- Frigola, J., Moreno, A., Cacho, I., Canals, M., Sierro, F.J., Flores, J.A., Grimalt, J.O., 2008. Evidence of abrupt changes in Western Mediterranean Deep Water circulation during the last 50 kyr: A high-resolution marine record from the Balearic Sea. *Quaternary International* 181, 88-104.
- McCave, I.N., Bryant, R.J., Cook, H.F., Coughanowr, C.A., 1986. Evaluation of a laser-diffraction-size analyzer for use with natural sediments. *Journal of Sedimentary Research* 56, 561–564.
- McCave, I.N., Manighetti, B., Robinson, S.G., 1995. Sortable silt and fine sediment size/composition slicing: parameters for palaeocurrent speed and palaeoceanography. *Paleoceanography* 10, 593–610.

Analysis and characterization of modern tectonic structures of Gulf of Cádiz continental shelf (SW Iberian Peninsula)

Sánchez-Guillamón, Olga.¹, Vázquez, J.Tomas.¹, Fernández-Puga, M.Carmen.², Fernández-Salas, L.Miguel.³, Díaz del Rio, Victor.¹

¹*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga. Puerto pesquero s/n, 29640 Fuengirola, Málaga. (Spain)*

²*Facultad de Ciencias del Mar y Ambientales. Universidad de Cádiz, Puerto Real (Spain)*

³*Instituto Español de Oceanografía, Centro Oceanográfico de Cádiz.(Spain)*

Abstract

Morphostructural interpretation based on high and very high resolution reflection seismic profiles and a bathymetric mosaic acquired along several oceanographic cruises have allowed the neotectonic characterization of a sector of the Gulf of Cádiz continental shelf, which is extended from the Guadalquivir river mouth to the Bay of Cádiz. High resolution acoustic data acquisition was carried out during the oceanographic cruises INDEMARES-CHICA 0610 and 1011 in the context of the Project LIFE+ INDEMARES (LIFE07/NAT/E/000732) using the parametric echosounder TOPAS PS18 in the middle and outer part of the continental shelf; and high resolution seismic data was obtained during several prospecting projects realized to MOPTMA (now MAGRAMA) with Geopulse and Uniboom systems in the inner continental shelf since 1991 to 1996 used in the context of the CADHYS project (P08-RNM-03581).

It has been identified a serie of tectonic structures, fault and folds, on the continental shelf of Cadiz, that deform postglacial deposits highlighting the recent tectonic activity of this region. Age characterization of these structures is based, mainly on Upper Pleistocene-Holocene (last 18 ka) stratigraphy. The relative dating of each tectonic structural activity has been determined using a stratigraphical model for the Highstand systems tract (HST) and Transgressive systems tract (TST) units (Fernández-Salas et al.,2008), which has been compared with the architecture stratigraphy in this continental shelf sector. We have identified 4 discontinuities as chronological markers that have used to date the tectonic activity by determination the structural displacement of these discontinuities in seismic reflection profiles. The discontinuities surfaces, from oldest to most recent, are the following:

- Postglacial transgressive surface(18.000 years BP):TS
- Maximum flooding surface(6500 yearsBP): MFS
- Mid highstand deposits surface (3500 years BP): MHS
- Seafloor surface(nowadays)

The tectonic structures located at the inner continental shelf are normal faults and folds with NW-SE and NE-SW respectively. The faults present an average length of 1 to 5 kilometers, and the folds between 1 to 2.5 kilometers, extending 2 to 6 kilometers wide. Faults present several fracture zones that affect the Upper Pleistocene sedimentary units and displaced clearly the TS and MFS mainly, but not reach MHS to seafloor surface. In some cases, seafloor surface show bathymetric expressions escarp-like due to recent activity of the faults. Folds show syncline and anticline geometries and affect the Pleistocene deposits but not deform transgressive and Holocene units. In some cases the folds were erosionated by the TS due to sea level changes. In the inner and middle continental shelf a shallow acoustic masking has been mapped and interpreted (Fernández-Puga et al.,2009), between 10 and 50 m depth, that could be related to the biogenic gas formation and its accumulation from the Holocene Guadalquivir prodelta, avoiding possible structural tectonic identification.

At the outer continental shelf, it has been located normal faults, folds and diapiric structures. All these structures deform the transgressive and Holocene deposits and could be considered currently actives.

They should be the surface expression of deeper and more significant faults. It has been mapped normal faults, both planar and listric, which follow W-E to NW-SE trends. These shallower faults have been related to WNW-ESE deeper listric faults, and show similar geometry with the faults located in the adjacent southward sector between San Fernando and Conil de la Frontera (Vázquez et al., 2010). The diapiric bodies deform mainly the Last Glacial sedimentary units, and affect postglacial sedimentary units and all discontinuities (TS to seafloor surface) generating a bathymetric dome-like expressions associate with postglacial units uplift, which are bounded by crestral faults.

Neotectonic activity has been quantified through the relative rates of displacement during the postglacial period. The maximum vertical displacement values of these faults (8.25 to 6.60 m) in all stratigraphic surfaces are located in areas which are influenced by the diapiric activity, where postglacial sedimentary units are faulted and uplifted. Meanwhile medium vertical displacement values (5.78 to 4.95 m) are associated with the reactivation of deeper faults and previous folded structures. In this sense modern displacement of neotectonics structures are possible related to the reactivation of diapiric uplift as a result of the convergent stress between the Eurasian and African plates. The average deformation rate of entire postglacial deposits in this sector is 0,37 mm/year, presenting upper deformation rates in individual structures affected by diapirism (1.192 mm/y). Transgressive deposits present an average deformation rate of 0.227 mm/year whilst Highstand deposits show the highest deformation rate, in order to 0.547 mm/year.

Keywords: continental shelf, high resolution seismic, normal faults, tectonic offsets, Gulf of Cádiz

References

- Fernández- Puga, M.C., Vázquez, J.T., Mata, M.P., Medialdea, T., Somoza, L., León, R.(2009). Caracterización de un campo de gas somero en la plataforma continental del Golfo de Cádiz. 6º Simposio sobre el Margen Ibérico Atlántico.2009. (89-92)
- Fernández-Salas, L.M., Lobo, F.J., Hernández-Molina, F.J., Díaz del Río, V., L., Díaz del Río y Somoza, L. (2008). Modelo estratigráfico secuencial de muy alta resolución de los depósitos del alto nivel del mar del Holoceno Superior en el sur de la Península Ibérica. *GeoTemas*, 10: 523-526.
- Vázquez, J.T., Fernández-Puga, M.C., Medialdea, T., Díaz del Río, V., Fernández-Salas, L.M., Llave,E. Lobo, F.J., López, F.C., Maldonado, A., Somoza, L., Palomino, D. (2010). Fracturación normal durante el Cuaternario Superior en la Plataforma Continental Septentrional del Golfo de Cádiz (SO de Iberia). En: J.M. Insua y F. Martín-González (eds.): *Contribución de la Geología al Análisis de la Peligrosidad Sísmica*, pp. 183-186, Sigüenza, España.

Fisheries

Reproductive aspects of *Octopus vulgaris*, Cuvier 1797, caught by the industrial Spanish fleet off Mauritania (NW Africa)

Alba Jurado-Ruzafa, Verónica Duque, M. Nazaret Carrasco, Gustavo González-Lorenzo

Instituto Español de Oceanografía (Centro Oceanográfico de Canarias), Spain

Abstract

From January 2010 to September 2011 2011 (excluding the biological shutdowns established in May-June and October-November), a total of 4044 *Octopus vulgaris* (2554 males and 1490 females) from Mauritania were analyzed. They were provided by the Spanish freezing trawlers fleet that operated in these waters till July 2012, when the new Fisheries partnership agreement between the EU and the Islamic Republic of Mauritania ended up with this activity.

Dorsal Mantle Length (DML) and Body Weight (BW) relationships was obtained ($BW=0.36 \cdot DML^{3.05}$; $R^2=0.86$) and the reproductive cycle was studied. Males outnumbered females in the overall sex-ratio (1.71:1) and in almost all months of the period. Although mature individuals were found throughout the year and males reached maturity at small sizes (the smallest weighted 128.6 g), two spawning peaks were identified in winter-spring and autumn among females, overlapping the shutdown periods (when the recruitment seasons occur (Hatanaka, 1979; Jouffre et al., 2000)).

The exploited population of *O. vulgaris* was composed by two main groups (Inejih, 2000): individuals hatched in winter-spring (corresponding to the autumn spawning) and specimens hatched in autumn (corresponding to winter-spring spawning).

Sizes at maturity were calculated using individuals caught round the year. The DML₅₀ was 6.0 cm for males and 16.8 cm for females, while BW₅₀ was 59.4 g and 2103.1 g for males and females, respectively.

References

- Hatanaka, H. 1979. Appendix 11. Spawning season of common octopus, *Octopus vulgaris* CUVIER, off the northwestern coast of Africa: 135–146. Rapport du Groupe de Travail Ad Hoc sur l'Evaluation des Stocks de Céphalopodes. Santa-Cruz de Ténériffe, Espagne. 18 - 23 septembre 1978. COPACE/PACE SERIES 78/11. Rome. FAO.
- Inejih, C.A. 2000. Dynamique spatio-temporelle et biologie du poulpe (*Octopus vulgaris*) dans les eaux mauritaniennes: modélisation de l'abondance et aménagement des pêcheries. Doctoral Thesis. Université de Bretagne Occidentale. 253 pp.
- Jouffre, D., C.A. Inejih and M. Simier. 2000. Cycle biologique du poulpe (*Octopus vulgaris*) au large du Cap-Blanc (Mauritanie): 243-267. In: Gascuel, D., P. Chavance, N. Bez and A. Biseau (eds.). Les espaces de l'halieutique. Paris. Éditions IRD.

Submarine Eruption at El Hierro

The submarine volcano eruption at the island of El Hierro: more than 2 years registering physical-chemical anomalies

E. Fraile-Nuez¹, J.M. Santana-Casiano², M. González-Dávila², C. Presas-Navarro¹, A. Rodríguez-Santana², D. de Armas¹

¹*Instituto Español de Oceanografía. Centro Oceanográfico de Canarias. Santa Cruz de Tenerife. Spain*

²*Universidad de Las Palmas de Gran Canaria. 35017 Las Palmas de Gran Canaria. Spain*

Abstract

On October 10 2011 an underwater eruption gave rise to a novel shallow submarine volcano south of the island of El Hierro, Canary Islands, Spain. During the eruption large quantities of mantle-derived gases, solutes and heat were released into the surrounding waters. In order to monitor the impact of the eruption on the marine ecosystem, periodic multidisciplinary cruises were carried out with different projects: Bimbache, Raprocan, Cetobaph and Vulcano.

The extreme physical-chemical perturbations caused by this event during the first six months, comprising thermal changes, water acidification and deoxygenation, resulted in significant alterations to the activity and composition of local plankton communities. Our findings highlight the potential role of this eruptive process as a natural ecosystem-scale experiment for the study of extreme effects of global change stressors on marine environments.

On the other hand, and due to the fact that the degasification phase is still active, a post-eruptive monitoring were necessary in order to have a completely view of the system variability. In this way, in January 2013, the Spanish Government together with FEDER funded approved VULCANO project (CTM2012-36317) with three multidisciplinary cruises (March, October 2013 and March 2014), which have already proved and quantified that the physical-chemical anomalies are still present in an area of 200 meters radio around the main crater of the submarine volcano.

References

Fraile-Nuez et al., 2013. The submarine volcano eruption at the island of El Hierro: physical-chemical perturbation and biological response. *Scientific Reports* 2:486.

Santana-Casiano et al., 2014. The natural Ocean acidification and fertilization event caused by the submarine eruption of El Hierro. *Scientific Reports* 3:1140.

The natural ocean acidification and fertilization event caused by the submarine eruption of El Hierro

J. M. Santana-Casiano¹, M. González-Dávila¹, E. Fraile-Nuez², D. de Armas²

¹IOCAG-Grupo QUIMA. Universidad de Las Palmas de Gran Canaria. 35017 Las Palmas de Gran Canaria. Spain

²Instituto Español de Oceanografía. Centro Oceanográfico de Canarias. Santa Cruz de Tenerife. Spain

Abstract

The shallow submarine eruption which took place in October 10th 2011, 1.8 km south of the island of El Hierro (Canary Islands) allowed the study of the abrupt changes in the physical-chemical properties of seawater caused by volcanic discharges. In order to monitor the evolution of these changes, seven oceanographic surveys were carried out over six months (November 2011-April 2012) from the beginning of the eruptive stage to the post-eruptive phase. The pH in total scale at 25°C (pH_T), total dissolved inorganic carbon (C_T), and total alkalinity (A_T), were measured together with temperature, salinity, dissolved oxygen and total sulfur reduced species. Nutrients, ferrous iron and pCO_2 were also analysed on most of the cruises.

Important changes in the water column chemistry including large decreases in pH, striking effects on the carbonate system, decreases in the oxygen concentrations and enrichment of Fe(II) and nutrients were produced. As a result of the ongoing magmatic activity, the submarine eruption produced an unprecedented episode of severe acidification and fertilization.

The findings highlight that the same volcano which was responsible for the creation of a highly corrosive environment, affecting marine biota, has also provided the nutrients required for the rapid recuperation of the marine ecosystem.

In January 2013, the Spanish Government approved the project VULCANO in order to study the post-eruptive phase in the submarine volcano of El Hierro. Three cruises were planned (March and October 2013 and March 2014). Physical-chemical anomalies are still being observed close to the volcano area.

Acknowledgements. This work was supported by the Instituto Español de Oceanografía, by the European Project CARBOCHANGE-264879 and by the Spanish Ministerio de Economía y Competitividad, through the ECOFEMA CTM2010-19517 and the VULCANO CTM2012-36317 projects.

References

Fraile-Nuez et al., 2013. The submarine volcano eruption at the island of El Hierro: physical-chemical perturbation and biological response. *Scientific Reports* 2:486. Santana-Casiano et al., 2014. The natural Ocean acidification and fertilization event caused by the submarine eruption of El Hierro. *Scientific Reports* 3:1140.

Benthic and demersal communities after the submarine eruption of El Hierro: Spatial patterns of survival and colonization of fauna

Rueda, J.L.¹, Gallardo, H.², Luque, V.², López, F. J.³, López-González, N.¹, Fernández-Salas, L.M.⁴, Díaz del Río, V.¹, Santana-Casiano, J.M.⁵, Fraile-Nuez, E.⁶ & Vázquez, J.T.¹

¹Centro Oceanográfico de Málaga, Instituto Español de Oceanografía, Fuengirola (Spain)

²Facultad de Ciencias del Mar, Universidad de Cádiz, Puerto Real (Spain)

³E.T.S. Ingeniería Industrial, Universidad de Málaga, Málaga (Spain)

⁴Centro Oceanográfico de Cádiz, Instituto Español de Oceanografía, Cádiz (Spain)

⁵Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria (Spain)

⁶Centro Oceanográfico de Canarias, Instituto Español de Oceanografía, Santa Cruz de Tenerife (Spain)

Abstract

In October 2011, the shallow submarine eruption of the southern part of El Hierro (Canary Islands) caused severe effects in the seafloor morphology and substrate composition (e.g. lava extrusion and construction of the volcanic edifice), the water column (e.g. acidification, deoxygenation and fertilization) and the biological communities (e.g. changes in the composition and functioning of communities) (Fraile-Nuez et al. 2012; Santana-Casiano et al. 2013). Due to this natural event, habitats and associated biota have experienced changes at different levels and in different parts of this new seafloor volcanic structure. Underwater images obtained with VOR Aphia 2012 (October 2013) and ROV Liropus 2000 (March 2014) as well as samples collected with a benthic dredge in March and October 2013 have made possible the study of the benthic and demersal organisms that persisted after this acute natural event as well as those that are recolonizing the recently formed volcanic bottoms.

During the eruption, material of variable size and texture buried previous existing habitats and associated biota, except in certain bathyal bottoms close to the base of this new seafloor structure (200 - 500 m depth) where slow-growing suspension-feeders such as antipatharians (e.g. *Stichopathes cf. gracilis*, *Antipathes furcata*), small gorgonians (e.g. *Acanthogorgia*, *Bebryce*) and lithistid sponges still increase the bottom complexity when compared to those buried bottoms. Among them, small colonies of cold-water corals (probably *Dendrophyllia cornigera* and *Cladocora debilis*) also occur, but mostly represented by dead specimens. In both March and October 2013, benthic dredge samples collected lava rocks and gravels that were poorly colonized by invertebrates, together with remains of antipatharians and dead cold-water corals. In shallower parts of the flanks of the volcano (ca. 200m depth), most previously existing habitats formed by antipatharians have been buried after the eruptive processes and the recent lava rocks are starting to be colonized by small and scarce colonies of hydrozoans, serpulids and small size echinoids (e.g. *Coelopleurus floridianus*), among other species. Nevertheless, the gravel bottoms at this bathymetric level display a higher degree of colonization, with higher abundances of polychaetes (e.g. *Glyceridae*, *Polynoidae*), decapods (e.g. *Alpheus spp.*, *Heterocrypta maltzami*) and some molluscs (e.g. *Nassaridae*), probably linked to previous successful recruitment events or horizontal movements from adjacent unimpacted bottoms. The fish *Anthias anthias* and the decapod *P. narval* are two of the top dominant demersal organisms that have recolonized this area after the eruption.

Close to the summit, one of the top-dominant sessile macroinvertebrates is the oyster *Neopycnodonte cochlear*, which occurs at densities of more than 100 indiv. m⁻² in some of the large lava rocks and represent one of the first sessile colonizers of the lava erupted by the volcano. This filter feeder is also very abundant on black-corals and undisturbed hard substrates located nearby at similar depths and may have benefited from the new micro-habitats available in the hard bottoms formed and the fertilization process after the eruptive event.

In general, a pattern of decreasing species richness of benthic-demersal organisms has been found from close to the summit to the base of the volcano, where the low colonization rate is a result of the lower number of potential species that are able to recolonize these substrates, the specific biological features of these species (e.g. slow growth rates, small reproductive outputs) and the oligotrophic character of the water masses when compared to the summit. The findings highlight that the volcanic eruption firstly buried most previously existing habitats and later on created a highly unstable and corrosive environment that affected some slow-growing organisms (e.g. cold-water corals) but not others (e.g. antipatharians). Nevertheless, the eruption provided nutrients that are important for primary pelagic production that may have also promoted the establishment of dense populations of some sessile suspension feeders (e.g. *N. cochlear*, hydrozoans) in the newly formed hard substrates.

This study has been funded by the project VULCANO (CTM2012-36317) and MONTERA (CTM2009-14157-C02) and we deeply appreciate the help of the Captains and all the crews of R/V Ángeles Alvariño and R/V Ramón Margalef as well as other colleagues during the sampling expeditions. FEDER funding assigned to construction of R/V Ramón Margalef (FICTS-2011-03-01) and R/V Ángeles Alvariño (FICTS-2011-03-02) is also acknowledged.

References

- Fraile-Nuez, E., González-Dávila, M., Santana-Casiano, J.M., Arístegui, J., Alonso-González, I.J., Hernández-León, S., Blanco, M.J., Rodríguez-Santana, A., Hernández-Guerra, A., Gelado-Caballero, M.D., Eugenio, F., Marcello, J., De Armas, D., Domínguez-Yanes, J.F., Montero, M.F., Laetsch, D.R., Vélez-Belchí, P., Ramos, A., Ariza, A.V., Comas-Rodríguez, I., Benítez-Barrios, V.M. 2012. The submarine volcano eruption at the island of El Hierro: physical-chemical perturbation and biological response. *Scientific Reports*, 2: 486.
- Santana-Casiano, J.M., González-Dávila, M., Fraile-Nuez, E., de Armas, D., González, A.G., Domínguez-Yanes, J.F. and Escánez, J. 2013. The natural ocean acidification and fertilization event caused by the submarine eruption of El Hierro. *Scientific Reports*, 3: 1140

Oceanic cephalopods from western Canary Islands collected during CETOBAPH mesopelagic survey: distribution and biodiversity.

A. Escáñez^{1,2}, F. Rocha¹, Á.F. González³ & Á. Guerra³

¹*Departamento de Ecología y Biología Animal, Facultad de Ciencias del Mar, Universidad de Vigo, Spain*

²*BIECOMAC, Departamento de Biología Animal, Edafología y Geología, Facultad de Biología, Universidad de La Laguna, Spain*

³*ECOBIMAR, Instituto de Investigaciones Marinas de Vigo, Consejo Superior de Investigaciones Científicas, Vigo, Spain*

Abstract

The diversity and distribution of the mesopelagic cephalopods fauna in three Canary Islands (El Hierro, La Palma and Tenerife) was investigated during April 2012. Samples were obtained using a commercial pelagic trawl between 30 and 900 meters depth. A total of thirty trawl stations were made directed on Deep Scattering Layer (DSL) and migrant Sound Scattering Layer (SSL) during diurnal and nocturnal period. A total of 3717 specimens belonging to seventeen families including two octopods, one sepiolid, one spirulid and thirty four squid's species were caught. Diurnal DSL and nocturnal SSL were characterized by 28 species respectively, while nocturnal DSL was characterized by 34 species. The same four dominant species were found in all sampled layers. These were represented by actively diel vertical migratory species (DVM) as *Pyroteuthis margaritifera*, *Abraliopsis moriisi*, *Onychoteuthis banksii* and *Pterygioteuthis giardi* that comprised the 91% of the total number of cephalopods caught. The remaining 9% was composed by the remaining semi-migrant or ontogenetic migratory species found in this study. Data of poorly known species and vertical distribution patterns of the squid community in Canary Islands will be presented here. Also, new species records for the region, including a new species of *Octopoteuthis* for the Atlantic, will be discussed.

Mesozooplankton biomass distribution in the waters of the El Hierro Island, (Canary Islands, Spain) during March and October 2013

Espinosa, J. M^a.¹, F. Lozano Soldevilla¹, A. Escanez¹, M^a. L. Fernández de Puellas², F. Hernández³, A. de Vera³ & E. Fraile-Nuez⁴

¹*Departamento de Biología Animal, Edafología y Geología (Unidad Departamental de Ciencias Marinas), Universidad de La Laguna. 38206 Tenerife, Spain*

²*Centro Oceanográfico de Baleares del Instituto Español de Oceanografía (IEO). 07015 Palma de Mallorca, Spain*

³*Departamento de Biología Marina del Museo de la Naturaleza y el Hombre (Cabildo de Tenerife). 38003 Santa Cruz de Tenerife, Spain*

⁴*Centro Oceanográfico de Canarias del Instituto Español de Oceanografía (IEO). 38180 Santa Cruz de Tenerife, Spain*

Abstract

VULCANO project (Volcanic eruption at El Hierro island. Sensitivity and recovery of the marine ecosystem, CTM 2012-36317), funded by Feder and The Ministry of Economy and Competitiveness carried out two multidisciplinary oceanographic cruises on board R/V Ramón Margalef and R/V Ángeles Alvariño during March and October 2013 (VULCANO0313 and VULCANO1013).

Here, we present an initial report of the results of the mesozooplankton biomass in epipelagic waters (0-200 m depth) south of the island of El Hierro (Canary Islands, Spain) and marine influence zone of the shallow submarine eruption which took place in October 2011.

The results, expressed like wet weight, dry weight, ashes, organic matter and %C (in mg/m³), shown for the first cruise, Vulcano3013, that the higher values were found in the South of El Hierro instead of the rest of the whole island. A size speciation ultra resolution study was carried out around the volcano. In this area, located between the stations 50 - 61, high values were also found. Around the volcanic crater, the values obtained were 4.32 mg/m³ (dry weight), 2.85 mg/m³ (organic matter) and 1.73 mg/m³ (%C) at station 58; and 13.56 mg/m³ (dry weight), 8.72 mg/m³ (organic matter) and 5.43 mg/m³ (%C) at station 56; where the submit of the volcano is located.

During the second cruise of the year, Vulcano1013, the distribution of the general biomass was quite similar. However, the volcanic area observed an important decreases of the biomass, with values around 2.04 mg/m³ (dry weight) 1.91 mg/m³ (organic matter) and 0.81 mg/m³ (%C) at station 50 and 4.36 mg/m³ (dry weight) 4.11 mg/m³ (organic matter) and 1.70 mg/m³ (%C) at station 56 (volcanic submit).

The results obtained during the last cruise of the project, March 2013, will be essential in order to see how important is the time factor in the differences found between the stations located in the size speciation ultra resolution study during the two oceanographic cruises carried out at the moment.

Analysis in pre and post eruptive periods of zooplankton from La Restinga (SW-El Hierro, Canary Islands). VULCANO project.

Fátima Hernández Martín¹, Alejandro de Vera Hernández¹, Eugenio Fraile Nuez², Fernando Lozano Soldevilla³, María Luz Fernández de Puelles⁴, José María Espinosa Gutierrez³, Francisco García-Talavera Fariña¹, María José Peñalver Puerta¹ & Blanca Muñoz Ortín¹

¹Museo de Ciencias Naturales de Tenerife. Museo de la Naturaleza y el Hombre. C/Fuente Morales, 1.38003 Santa Cruz de Tenerife, SPAIN

²Centro Oceanográfico de Canarias del Instituto Español de Oceanografía (IEO). 38180 Santa Cruz de Tenerife, SPAIN

³Departamento de Biología Animal, Edafología y Geología (Unidad Departamental de Ciencias Marinas), Universidad de La Laguna. 38206 Tenerife, SPAIN

⁴Centro Oceanográfico de Baleares del Instituto Español de Oceanografía (IEO). 07015 Palma de Mallorca, SPAIN

Abstract

The “Museo de Ciencias Naturales de Tenerife” carried out some studies at La Restinga (SW of El Hierro Island), previous to the submarine volcanic eruption in October, 2011 (Hernández, 1985a; Hernández & Jiménez, 1992 and Hernández & de Vera, 2001). Zooplanktonic data groups were obtained, especially chaetognaths collected in the area where the source of material from magmatic emission was subsequently placed. These studies revealed the richness of zooplanktonic zone. Hernández recorded in his work (Hernández, 1985b) as dominant species, *Sagitta serratodentata* and *Sagitta minima* present in the current study with high values of abundance, especially the second one. Later, Hernández & Jiménez (1992) relate *Sagitta decipiens*, *Sagitta inflata* and *Sagitta lyra* as predominant in the samples, although with very similar percentages. *Sagitta minima*, prominent species in terms of percentage of presence in the samples from the campaign of Vulcano project (March, 2013), is founded in every state of sexual maturity (I, II and III in the latter case in stations closer to the coast). Therefore, it is confirmed that it is a species well represented, not only in El Hierro (West area). In the present study 1,855 mature individuals were analyzed (stages of maturity I, II and II) and 702 juvenile chaetognaths. Eleven species have been identified, belonging to the genera *Sagitta*, *Krohnitta* and *Pterosagitta*, nine of the genus *Sagitta*: *Pterosagitta draco*, *Krohnitta pacifica*, *Krohnitta subtilis*, *Sagitta sibogae*, *Sagitta decipiens*, *Sagitta planctonis*, *Sagitta hexaptera*, *Sagitta inflata*, *Sagitta serratodentata*, *Sagitta lyra* and *Sagitta minima*. The most abundant species was *Sagitta minima*, followed by *Sagitta inflata* and *Sagitta serratodentata*. *Sagitta decipiens* and *Sagitta sibogae*, which are not very frequent in Canary Islands coastal plankton, are present on the island of El Hierro, where are relatively abundant in the species list of previous work of the authors (pre-eruptive) and in recent samplings post-eruptive. The mollusc *Atlanta meteori* is present at several stations located at different sides of the island, having recently recorded for the first time to the Atlantic Ocean (De Vera et al., 2006). Some common epipelagic species typical from undisturbed communities of this surface layer (*Creseis clava*, *C. virgula*) were abundantly collected. There is also a high abundance of benthic molluscs protoconchs at stations near the coast and in normally distributed values along sub-grid samples surrounding the volcano. The presence of these veliger larvae suggests that there is a recolonization of benthic gastropods in the vicinity of the eruption.

Zooplankton abundance and structure during the submarine post-eruptive process in waters of the Hierro Island: March 2013

M.L. Fernandez de Puellas¹, M. Gazá¹, F. Hernandez², F. Lozano³, J.M. Espinosa³ and E- Fraile-Nuez⁴

¹*Centro Oceanográfico de Baleares del Instituto Español de Oceanografía (IEO). 07015 Palma de Mallorca, Spain.*

²*Departamento de Biología Marina del Museo de la Naturaleza y el Hombre (Cabildo de Tenerife). 38003 Santa Cruz de Tenerife, Spain.*

³*Departamento de Biología Animal, Edafología y Geología (Unidad Departamental de Ciencias Marinas), Universidad de La Laguna. 38206 Tenerife, Spain.*

⁴*Centro Oceanográfico de Canarias del Instituto Español de Oceanografía (IEO). 38180 Santa Cruz de Tenerife, Spain.*

Abstract

During spring 2013²⁵ and after 15 months of the eruptive process, the zooplankton community, has been sampled in the upper waters (0-200m depth) of the Hierro island, with a higher frequency of resolution in the submarine volcano area. A mean value of 470 mesozooplankters m⁻³ (SD=112) was found, being the copepods the most abundant group (75%). They were followed by the appendicularians (15%) and the ostracods (3%). Although in lower abundance, chaetognaths, pteropods, siphonophores and euphausiids were present and 10 taxonomic identified groups. High similarity (89%) was observed among regions, with no significant differences, even between light and dark samples. Nevertheless, it is relevant to mention that the highest zooplankton abundance was found over the submarine volcano where the proportion of the groups slightly changed.

High diversity was the main characteristic and more than 126 spp of identified Copepods, where “no calanoids” had greater importance (Cyclopoids: 45%). *Oncaea media* and *Oithona plumifera* were the most abundant species, followed by the small *Clausocalanus* (16%) and *Paracalanus* (9%) group. They together with 7 ocean species of Calanoids (*N. minor*, *M. tenuicornis*, *M. clausi*, *C. vanus*, *L. flavicornis*, *C. styliremis* and *A. danae*) and their juveniles contributed on 70% of the copepod community. Moreover, from east to west of the island, an increasing gradient in oceanic species was observed, which were more abundant in the nord-occidental side meanwhile more neritic organisms and meroplankton larvae with the Gastropods and Bivalve had a higher presence in the east of the Hierro Island.

²⁵These data were obtained during the VULCANO0313 survey in the R/V A. Alvariño and the “Volcanic Eruption at El Hierro Island. Sensitivity and Recovery of the Marine Ecosystem” project (VULCANO) supported by the Ministry of Economy and Competitively and FEDER funds (Ref: CTM 2012-36317)

Remote Sensing of the El Hierro submarine volcanic eruption plume

Josep Coca¹, Thomas Ohde², Alexandre Redondo¹, Luís García-Weil³, Antonio G. Ramos¹

¹*División de Robótica y Oceanografía Computacional, IUSIANI, ULPGC*

²*Leibniz Institute for Baltic Sea Research, Seestraße 15, D 18119 Warnemünde, Germany*

³*Departamento de Física, ULPGC*

Abstract

Between October 2011 and March 2012 submarine volcanic eruptions took place at El Hierro, the westernmost of the Canary Islands. The event produced plumes of discoloured waters due to the discharge of volcanic matter, magmatic gases and hydrothermal fluids, which induced changes in physical and chemical properties affecting the local marine wildlife. The expelled materials discoloured surrounding waters depending on their composition behaving like oceanic tracers, and thus detected from the site of the volcano to the open sea by remote sensing techniques using different level-2 (L2) products of the Moderate-resolution Imaging Spectroradiometer (MODIS) sensor, supported by field samples of chlorophyll a (Chl-a) and sulphur reduced species collected by oceanographic cruises organized by the Instituto Español de Oceanografía (IEO).

The satellite derived product of Kd490, considered as an indicator of the turbidity of the water column, was used as a measure of plume intensity in comparison with other submarine volcanic eruptions. The MODIS derived Kd490 values verified that the intensity of the El Hierro plume was moderate since only in some specific situations did the values barely exceed 0.4 m^{-1} . Besides, field data from oceanographic surveys verified the high concentration of sulphur compounds in affected waters and confirmed the overestimation by the MODIS algorithm of Chl-a concentrations in the volcanic plume.

In order to assess the effect of the anomalous ocean turbidity on the remote sensing data retrieval caused by the volcanic eruption releasing inorganic materials, three atmospheric correction schemes for satellite imagery were evaluated: SeaDAS (SeaWiFS Data Analysis System) standard, NIR-SWIR (near-infrared – shortwave-infrared) and MUMM (Management Unit of the North Sea Mathematical Models). The comparison between them verified that the SeaDAS standard atmospheric correction was the most suitable.

The spatial and temporal distribution of the volcanic material expelled during the eruption was described by means of 5-day syntheses MODIS Sea Surface Temperature (SST) images and RGB images created using MODIS remote sensing reflectances (Rrs). Geostrophic velocities derived from altimeter data (Jason 1, Jason 2 and Envisat) were superimposed over RGB and 5-day syntheses SST images to study the relationship between prominent mesoscale oceanographic features identified in the region and the spatio-temporal evolution of the discoloured volcanic waters. The spreading and transport of volcanic material observed at the ocean surface was caused by the predominant surface currents coupled with different mesoscale eddies. Discoloured waters were identified more than 200 km away from the eruption site.

Furthermore, the Rrs spectra were used to characterize types of discoloured water plumes of volcanic origin and to perform a comparison with other water types. Thus, the spectra were divided into three levels depending on Kd490: level 1 ($\text{Kd490} \geq 0.15$), level 2 ($0.13 \leq \text{Kd490} < 0.15$) and level 3 ($\text{Kd490} < 0.13$) allowing a comparison with other volcanic and sulphide events reported in previous studies. Thus, similarities were found, both with submarine volcanic eruptions in the southwestern Pacific (Mantas et al. 2011) and with sulphide events at the Namibian coast (Ohde and Mohrholz 2011), in composition and properties of optically active water constituents.

In the same way, the Rrs product was used for the characterization of the affected waters leading to the development of a classification schema based on apparent optical properties such as Kd490 values

and Rrs ratios (Rrs 667 nm to Rrs 678 nm) so as to track and to characterise the event separating the different kind of waters. The number of areas classified as productive water increased throughout the spatio-temporal evolution of the plume.

References

- Mantas, V. M., A. J. S. C. Pereira, and P. V. Morais. 2011. "Plumes of discolored water of volcanic origin and possible implications for algal communities. The case of the Home Reef eruption of 2006 (Tonga, South-west Pacific Ocean)." *Remote sensing of Environment* 115: 1341-1352.
- Ohde, T., and V. Mohrholz. 2011. "Interannual variability of sulphur plumes off the Namibian coast." *International Journal of Remote Sensing* 32 (24): 9327-9342. doi:10.1080/01431161.2011.554455.

Ocean and Climate Change

Quantifying anthropogenic and natural contributions to thermosteric sea level rise

Marta Marcos¹, Ángel Amores¹, Damià Gomis²

¹*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain*

²*Departamento de Física, Universidad de las Islas Baleares*

Abstract

Changes in thermosteric sea level at decadal and longer time scales respond to anthropogenic forcing and natural variability of the climate system. Disentangling these contributions is essential to quantify the impact of human activity in the past and to anticipate thermosteric sea level rise under global warming. Climate models, fed with radiative forcing, display a large spread of outputs with limited correspondence with the observationally based estimates of thermosteric sea level during the last decades of the 20th century. Here we extract the common signal of climate models from CMIP5 using a signal-to-noise maximizing EOF technique for the period 1950-2005. Our results match the observed trends, improving the widely used approach of multi-model ensemble averaging. We then compute the fraction of the observed thermosteric sea level rise of anthropogenic origin and conclude that 87% of the observed trend in the upper 700 m since 1970 is induced by human activity.

Ocean bottom pressure variability in the Mediterranean Sea and its relationship with sea level

Marta Marcos

Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.

Abstract

The spatial and temporal scales of variability of ocean bottom pressure (Pb) in the Mediterranean Sea are characterized and their relationship with sea level assessed using a high resolution eddy-permitting regional ocean model spanning the period 1999-2011. It was found that rapid (periods of a few days) bottom pressure fluctuations are decoupled between the eastern and western basins as a result of topographic constraints. In the longer periods, baroclinic processes gained relevance away from the coast and partially broke the coherence between sea level and Pb, especially on the western basin. In spite of this, results confirm that sea level changes are predominantly barotropic everywhere in the basin at all time scales, except for the annual cycle. Along the coasts sea level fluctuations partly captured baroclinic processes taking place in their vicinity. This effect was stronger on the western basin, while the coasts of the Eastern Mediterranean arise as the most suitable proxies for basin wide mean sea level (or ocean bottom pressure) changes.

Numerical Study of the Mediterranean Outflow with a Simplified Topography

Sergio Ramírez Garrido, Jordi Solé Ollé, Antonio García Olivares Rodríguez, Josep Lluís Pelegrí Llopart

Institut de Ciències del Mar, CSIC, Barcelona

Abstract

A 3D numerical model is used to setup a simplified scenario on the Atlantic side of the Strait of Gibraltar. This scenario simulates an Atlantic Water (AW) flowing into Mediterranean basin along the surface and a Mediterranean Outflow Water (MOW) escaping to the Atlantic near the sea bottom. The MOW has two different main paths: northwards, along the Iberian slope, reaching as far as the Scandinavian Peninsula, thereby influencing the formation of North Atlantic Deep Water (NADW), and southwestwards, propagating into the Atlantic Ocean. In this simplified scenario we want to study the way a gravity current, like the MOW, behaves for different outflow conditions. The emphasis is on understanding how distinct outflow conditions lead to different propagating depths and mixing that may affect NADW formation under predicted global change future scenarios. The numerical model used is Regional Ocean Model System, ROMS, (<http://www.myroms.org/>). ROMS is a free surface, terrain-following, primitive equations ocean model widely used by the scientific community for a diverse range of applications. The model domain is centered in the area of Gulf of Cadis with the northern and southern boundaries delimited by the Iberian Peninsula and the Moroccan coast, the eastern boundary is at 6°W, near to Camarinal Sill, and the western boundary is open, reaching as far as Cape San Vicente. The imposed boundary conditions consist in two layers of different density, the upper one simulating the AW and the lower simulating the MOW. The grid has 96 X 64 grid points with a resolution of about 3 km and 36 sigma levels. The complex topography of the area is simplified through a slope with two different zonal dependences: the initial (1/3 of the domain) decay of the bathymetry at the east is adjusted by a hyperbolic tangent function, followed by a constant slope. Initial conditions are setup as follows. The western part of the basin is filled with AW, and the eastern part of the domain is filled with AW from the surface to 150 m and with MOW from 150 m to the sea bottom. The open boundary conditions for temperature, salinity and velocity are specified using climatological vertical profiles. In particular, the velocity profiles have been adjusted and calculated with a positive velocity for the inflow and negative one for the outflow, such that mass is conserved within the model domain. Forcing conditions are setup with winds and atmospheric pressure fields.

Uncertain uncertainties in climate projections

Josep Llasses, Gabriel Jordà, Damià Gomis

¹*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.*

Abstract

For decision makers it is essential to comprehend and narrow as much as possible the uncertainties associated with climate projections, in order to enhance their confidence on the value of adaptation strategies. The quantification of uncertainties from ensembles of model runs is state of the art for climate projections as it is commonly related to the spread of the ensemble. The relative contribution of each uncertainty source (e.g. natural variability, model limitations or the scenario choice) to the total uncertainty has also been considered in several studies. Conversely, less attention has been paid to analyze the reliability of the estimated uncertainties. The spread of the ensemble can be an accurate measure only if a sufficient number of simulations are included in the ensemble. When only a few simulations are available, which is usually the case for regional projections, a study of the number of simulations needed to estimate the confidence of the quantified uncertainties is of great importance. In this work we investigate the impact of the ensemble size on the quantification of each uncertainty source in climate projections. We intend to produce error-bars for the uncertainties, but also to guide the optimization of future simulation ensembles, since knowing the relative importance of the different sources of uncertainty and the potential benefit of reducing them is very important for the design of the ensembles.

When only a few simulations with several uncertainty sources are available, an oriented-ensemble approach is needed to quantify the relative importance of each source of uncertainty. The oriented-ensemble approach bases on combining sub-sets of simulations where all the uncertainty sources but one are fixed. This means that, by quantifying the uncertainty of each of those sub-sets, we are quantifying just one of the uncertainty sources. For example, in the case of defining three sources of uncertainty: the Global Climate Model (GCM), the Regional Climate Model (RCM) and the scenario choice, by quantifying the uncertainty of a sub-set of simulations where the GCM and the scenario are fixed, we are directly measuring the uncertainty associated with the RCM. This can be very helpful in the case of having a poor ensemble but with the possibility of re-distributing the simulations in different sub-sets. Moreover, in some cases we may have estimations of the uncertainty sources that are not compatible with the total set, e.g. a set of future climate projections on the one hand, and a set of hindcast simulations on the other hand. These simulations cannot be combined in a single ensemble, but they can be used in the form of sub-sets to quantify the relative importance of each uncertainty source.

The first result of this work is the development of a generic methodology that quantifies the relative importance of sampling each uncertainty source. This methodology is first applied to simplified ensembles where the sources of uncertainty are perfectly determined a-priori and the number of simulations are unlimited. The results show that it is worth increasing the number of simulations that allow us to explore the dominant uncertainty source. However, the results also show that secondary sources of uncertainty cannot be neglected and should also be included in the ensemble. Therefore, we quantify the number of simulations in each sub-set that is required to significantly reduce the total uncertainty. This number is a complex function that depends on the relative importance of the different sources of uncertainty

We also explore whether it is more convenient to use oriented-ensembles or ensembles of opportunity in order to optimize the uncertainty estimations. Results indicate that, when the total uncertainty is calculated from an oriented-ensemble, it is less reliable than when it is quantified from the complete ensemble.

Finally, the methodology will be applied to real ensembles. The uncertainties associated to wind waves and storm surge projections in the Mediterranean will be quantified and their reliability assessed.

Monitoring the Oceanic Waters of the Canary Islands: the deep hydrographic section of the Canaries.

Pedro Vélez-Belchi¹, Alonso Hernández-Guerra², Carlos Barrera³, Eugenio Fraile-Nuez¹, Anna Barrera³, Octavio Llinas³, Verónica Benítez Barrios^{1,4}, Francisco Domínguez^{1,5}, Iván Alonso-González^{1,4}, Melchor González Dávila², Magdalena Santana Casiano², Joaquín Hernández Brito³, Carmen Presas Navarro¹, Javier Arístegui Ruiz², Isis Comas Rodríguez², Juan Carlos Garijo Lopez², Santiago Hernández León², María Dolores Pérez Hernández², Ángel Rodríguez Santana², David Sosa Trejo²

¹*Centro Oceanográfico de Canarias, Instituto Español de Oceanografía, Spain.*

²*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Spain.*

³*Plataforma Oceánica de Canarias, Spain.*

⁴*Oceomic, Marine BIO and Technology S.L., Spain.*

⁵*DC Servicios Ambientales S.L., Spain.*

Abstract

Due to the high density and heat capacity of water, the ocean modulates climate in scales much larger than the atmosphere, both spatially and temporally. In order to understand the mechanisms governing this internal variability of the ocean, and therefore climate, it is necessary to have long systematic observations. The Atlantic Meridional Overturning Circulation (AMOC), which is composed by the south-north circulation, transports 18Sv (1Sv=10⁶ m³/s) of water that carries more than 1.5PW (1PW=10¹⁵W) of heat to the North Atlantic, and therefore plays a determining role in regulating the climate in Europe. An important component of the AMOC is the subtropical gyre, the largest oceanic structure of the North Atlantic. The Canary Islands are immersed in the eastern margin of the subtropical gyre, in the coastal transition zone of the Canary Current Upwelling System and therefore they are an ideal place for the study of the subtropical gyre variability.

With this background, in 2006 the Spanish Institute of Oceanography began (IEO) the program deep hydrographic section around the Canary Islands (Raprocán), in order to establish the scales of variability in the range decadal/subdecadal in the subtropical gyre, specifically in its eastern margin. Based on previous results the observational strategy of Raprocán consists in hydrographic cruises in two seasons, with 50 hydrographic stations around the Canary archipelago. In each one of the stations velocity, temperature, salinity, pressure, oxygen, turbidity and fluorescence is continuously measured (CTD). In each station 24 samples are taken for calibration of the above variables as well as for determination of alkalinity, carbon content and chlorophyll. This program is carried out in collaboration with the University of Las Palmas de Gran Canaria (ULPGC) and with the Oceanic Platform of the Canary Islands (PLOCAN) that provides glider data since 2013.

The warming of the upper 600 m continues at a rate of 0.14°C/decade in the oceanic waters and 0.32°C/decade in the waters between Lanzarote and Africa under influence of upwelling off the African coast. At intermittent levels the warming continues at rate of 0.04°C/decade in the oceanic waters and 0.08°C/decade in the waters between Lanzarote and Africa. At deeper levels, since 1997 there is not statistical significant trend. Regarding the oceanic circulation, the Canary Current presents a seasonal cycle, with the minimum transport occurring during fall, when only carries 3 Sv. During this season the transport is concentrated between the islands of Tenerife and Lanzarote and in the first 400 meters.

Operational Oceanography

The OPERA project: An operative HF radar network in the Spanish coast

Javier Soto Navarro, Pablo Lorente Jiménez, M. Isabel Ruíz Gil de la Serna and Enrique Álvarez Fanjul

Puertos del Estado, Spain

Abstract

The OPERA (OPERational RADars for research in marine sciences) project, funded by the Spanish Ministerio de Economía y Competitividad, is a two-year project (2014-2016) which main objective is to perform the necessary technical developments in order to transform the set of already active HF radar systems along the Iberian coast in a measuring network fully integrated in the Puertos del Estado system. This network will complement and improve the observation system and the operational waves and currents prediction models currently on service at Puertos del Estado. Once fully operative, the HF radar network will constitute a unique tool, as it will provide real time measured surface current data at key points of the Spanish coast such as the Strait of Gibraltar, the Gulf of Cadiz, the Galician coast and the Delta of the Ebro river area. This invaluable data set has direct operative applications on coastal and harbors management, search and rescue operations or pollution episodes investigation, but also suppose a new wide frame of research applications.

The specific objectives of the project are:

- Development of an operative validation methodology for the information provided by the HF radar network of Puertos del Estado.
- Validation of the operational waves and currents prediction models of Puertos del Estado using the previously validated HF radar data.
- Development of an operative system merging both model and HF radar data.
- Use of this new system information for backtracking estimation in collaboration with Salvamento Marítimo.

In this work we present the first steps on the project development: the network structure and the preliminary current validation results. Satisfactory agreements have been found in the comparison between the HF current data and direct measurements from point-wise current meter and ADCP data at the Strait of Gibraltar, Galicia and the Delta of the Ebro systems. The comparison with regional circulation models show also good results at the Strait area, although deeper analysis have to be performed.

The IBI-MFC Validation Tool: Application to the MyOcean IBI model upgrades and its transition into operations.

Lorente P.¹, Amo-Baladrón A.¹, Levier B.², Aznar R.¹, Cailleau S.² and García-Sotillo M.¹

¹*Puertos del Estado, Madrid, Spain*

²*Mercator-Ocean, Toulouse, France*

Abstract

The MyOcean IBI Monitoring & Forecasting Center (MFC) researches, designs, develops, implements and makes operational transitions of numerical model applications and re-analysis systems used to generate MyOcean IBI ocean products that are later disseminated to the ocean community.

Specific activities within the framework of MyOcean and MyOcean-2 projects in support of the mission include: development of regional forecast model systems, based on the NEMO ocean model code, for accurately predicting sea level, currents, salinity, temperature and other oceanographic parameters, mainly focused on the IBI (Iberian-Biscay-Ireland) area; the application of hydrodynamic models and data assimilation schemes to research problems aimed at better understanding the physical phenomena affecting coastal waters as well as the development of tailored downstream services for end-users, who employ IBI model outputs in a wide range of practical applications.

Before a new IBI forecast system is transitioned into operational status, the updated system is tested, fully evaluated and deemed to meet standards established by the IBI-MFC and the MyOcean community. The calibration/validation phase of each IBI upgrade is made through the employment of NARVAL (Numerical Assessment for Regional VALidation) Tool. This comprehensive web toolbox (developed by Puertos del Estado and presented in a very preliminary stage in the EOF-2012) was initially implemented to monitor routinely MyOcean IBI products quality on daily basis by means of comparisons with available observations and to generate updated metrics and objective quality indicators.

After a 2-year period of steady development, NARVAL has evolved towards a much more comprehensive and sophisticated tool. Among others, broadened functions are the computation of product quality metrics over longer time periods (on monthly, quarterly and annual basis) and a model-model comparing framework with regional and local ocean model products (provided by other MyOcean MFCs or by other MyO-external systems) in overlapping areas.

In addition, new observational sources have been introduced. IBI products are currently validated against L3 and L4 SST satellite-derived products, observations from High-Frequency radars (for surface currents) and ARGO-floats (for salinity and temperature profiles), providing a three dimensional perspective of IBI performance and accuracy.

Special attention has been focused on regionalization, being the IBI domain (26°N-56°N, 19°W-5°E) split into specific sub-regions of particular concern in the Iberian context like Strait of Gibraltar, Gulf of Cadiz, Western Mediterranean Sea, Gulf of Biscay and Western and Northern Iberian shelves. This methodology gives the chance to evaluate uncertainty levels and delimits areas where discrepancies are mainly located, providing useful information to the IBI-MFC team in order to improve the IBI model performance. Furthermore, an assessment of IBI products quality attending to its different forecast horizons has been also achieved.

In this context, PdE has implemented a standardized framework, named IBI-test, which is an attempt to streamline the entire process of taking any new NEMO model application from research environment and transitioning it to IBI operational phase. This new IBI-Test environment includes the essential operational management of required inputs (i.e.: observations and model data for ocean, atmosphere and riverine inputs) as well as the operational quality control of outputs by means of NARVAL. The coupled-action of both IBI-test and NARVAL constitutes a solid and encouraging approach to make the required

continuous evolution of the IBI-MFC systems and services complying with well-defined protocols and standards.

Use of AUVs to validate coastal HF Radar

D. Roque, R. Mañanes, P. Rodriguez, A. vazquez Lopez-Escobar, A. Izquierdo, M. Bruno

University of Cádiz, Spain.

Abstract

Surface currents are identified as a high priority product for coastal ocean observing systems. Shore-based high-frequency (HF) radars that broadcast and then observe back-scattered radio signals from the oceans surface are now a mature technology that has been implemented and is routinely operating in numerous locations worldwide.

In Spain this type of surface measurements has been being implemented along the last ten years. One of the most important tasks to get confidence from the recorded velocities is the validation of HF Radar Measurements.

When evaluating the accuracy of a new instrument, the typical procedure is to compare side-by-side measurements made with both the new instrument or and other measurement system of proven accuracy (current profilers, drifters, etc..).

In the present work, we tested a new methodology for the HF radar measurements, in the frame of the project "TRANSREGIONAL RADARS FOR ENVIRONMENTAL APPLICATIONS" (TRADE).

Past October 2013 had been a campaign to validate data from HF Radar with measurements taken with conventional systems; drifters, bottom-mounted Acoustic Doppler Current Profiler (ADCP) and an Autonomous Underwater Vehicle (AUV).

AUV is a robot which travels underwater without requiring input from an operator. These vehicles allow scientist to conduct other experiments from a surface ship while the vehicle is off collecting data elsewhere on the surface or in the deep ocean.

Use of AUV to compare data with the HF Radar has several advantages: (i) operations are possible in storms when surface ships may not be able to operate; (ii) is an independent platform, you can do it other measurements; (iii) You can move with vehicle in an area not a single point, and (iv) can be develop a comparative map at a relative low cost.

Remote Sensing Oceanography

Measuring surface salinity in the N. Atlantic subtropical gyre. The SPURS-MIDAS cruise, spring 2013

J. Font¹, B. Ward², M. Emelianov¹, S. Morisset³, J. Salvador¹, J. Busecke⁴, and the SPURS-MIDAS Team

¹*Institut de Ciències del Mar CSIC, Barcelona, Spain*

²*National University of Ireland, Galway, Ireland*

³*LOCEAN, U. Pierre et Marie Curie, Paris, France*

⁴*Lamont-Doherty Earth Observatory, U. Columbia, Palisades NY, USA*

Abstract

SPURS-MIDAS (March–April 2013) on board the Spanish R/V Sarmiento de Gamboa was a contribution to SPURS (Salinity Processes in the Upper ocean Regional Study) focused on the processes responsible for the formation and maintenance of the salinity maximum associated to the North Atlantic subtropical gyre. Scientists from Spain, Ireland, France and US sampled the mesoscale and submesoscale structures in the surface layer (fixed points and towed undulating CTD, underway near surface TSG) and deployed operational and experimental drifters and vertical profilers, plus additional ocean and atmospheric data collection. Validation of salinity maps obtained from the SMOS satellite was one of the objectives of the cruise. The cruise included a joint workplan and coordinated sampling with the US R/V Endeavor, with contribution from SPURS teams on land in real time data and analysis exchange. We present here an overview of the different kinds of measurements made during the cruise, as well as a first comparison between SMOS-derived sea surface salinity products and salinity maps obtained from near-surface sampling in the SPURS-MIDAS area and from surface drifters released during the cruise.

The SPURS-MIDAS Team: D. Alcoverro, A. Castellon, L. Centurioni, E. Flo, A. Giraldez, L. Gonzalez, S. Guimbard, O. Hernandez, A. Martinez, M. Maso, B. Moli, J. Olive, M. Pastor, S. Quintana, G. Reverdin, M. Rosell, G. Sutherland, A. ten Doeschate, M. Umbert, X. Vidal, K. Walesby, N. Yarovenko

Towards a North Atlantic SMOS SSS product using a numerical model of the North Atlantic Ocean

Nina Hoareau, Laura Gómez, Joaquim Ballabrera, Marcos Portabella, Antonio Turiel

Institut de Ciències del Mar, CSIC, Barcelona, Spain.

Abstract

In a recently published work (Hoareau et al., 2013), we have shown that the salinity field resulting from assimilating SMOS Level 3 data (i.e. binned maps) into an ocean model has less noise than the input data. Moreover, by using the ocean model as a dynamical interpolator, the resulting fields have no data-voids and increased geophysical coherence. The region of study had been the Macaronesian Region (the Northeast subtropical Atlantic Gyre), where SMOS data is prone to large errors (about 0.50 in the practical salinity scale) due to the vicinity of the large continental masses and the presence of artificial Radio Frequency Interferences (RFI). Our work proved that a technique as simple as the Newtonian Relaxation (nudging) is able to assimilate SMOS in such a challenging region, provided that the spatial structure of the SMOS data is taken into account.

To further investigate the ability of data assimilation to produce a basin-wide salinity product, we plan to assimilate SMOS data in a numerical simulation of the North Atlantic Ocean. The NATL025 DRAKKAR configuration is an eddy permitting simulation ranging from 20°S to 80°N. It has a sea-ice climatology in the Northern boundary to help maintaining a realistic Meridional Overturning Circulation. It has a free surface with z-coordinates on the vertical. The ocean model is coupled with the Louvain La Neuve Ice Model (LIM2.0). The horizontal grid is a Mercator grid with resolution of 1/4°. The bathymetry is the ORCA025-G70, and the vertical structure of the simulation is given by 45 geopotential levels, with a vertical thickness of 6 m at the surface and 250 m at the bottom.

In a first phase towards the data assimilation of SMOS, the variability of the salinity and temperature fields provided by the model is characterized via first and second order statistics, empirical orthogonal functions and power spectra. The time period of our simulation covers the years 2001 to 2012. Comparison against Argo data is also done to estimate the spatial structure of the model error. Finally, the spatial structure of the error of SMOS data in the North Atlantic region is estimated in order to ensure the proper application of the nudging algorithm.

Interannual Variability in the South Shetland Island system

C. Salinas-Núñez, A. Marrero-Díaz, P. Sangrà

University of Las Palmas de Gran Canaria, Spain.

Abstract

The objective is make a analisis of both spatial and temporal of sea superficial temperature (SST) variability on area between 61-64°S and 55-64°W. Region around South Shetland Island, covering the Drake Passage to north and Bransfield Straits to Routh. From satellite data of SST obtained from remote sensing system calls Advanced Microwave Scanning Radiometer (AMRS-E).

This system is a combined product between both infrared sensor (high spatial resolutions, but can not see through clouds) and microwave sensor (capability to see through clouds, but have low spatial resolution). With this system the work is based in a 0.25x0.25 degree grid, with this resolution the mesoescalar structures can be analyzed and this spatial resolution is similar with our Project (CLOUPLING Project).

The data base is from 2006 to 2010 and with this data we make SST distributions in both whole region and different temporal periods (Days, months, annuals and years stations) allowing us a caracterization of series temporal SST in all year not only southern summer, because the remote sensing system not limited for the formation of the winter ice how happen with the oceanographic cruises

From this study are obtained the most high SST records in south summer ($>2.5^{\circ}\text{C}$) and the largest seasonal variations, while the lowest records are located in the south winter ($<-1^{\circ}\text{C}$) and homogeneous distribution of SST. demonstrating a variability in temperature at 3°C .

On the other hand, summer (December-April) its the best period for study the superficial mesoescalar structures, because in this time period the principal structures are visible in superficie, whereas in winter, rise to the surface homogeneity not presents any superficial structure visible

Despite the above, the frontal structures surrounding the South Shetland Islands are dominant structures in the system. this is shown in the graphic representation of the average total of superficial sea temperature, where surface structures are both dominant and are located parallel to the archipelago of the South Shetland Islands.

This spatial variation can be explained by the dynamics that exist around the South Shetland Islands:

- the north of archipelago (Drake Passage) has features circumpolar because the system is dominated by the Antarctic Circumpolar Current.
- the south of the archipelago (Bransfield Strait) is influenced by the presence of two water mass: Transicional Zonal water with Bellinghausen influence (TBW) and Transicional Zonal water with Weddell Sea influence (TWW)

This set determines the characteristics of the different hydrographic fronts in the area, its extent and intensity, and justifies the observed spatial variability.

From 2006, when I make my profesional practice in the antarctic chilean institut, I start my antarctic adventure, participated in several Antarctic latinoamerican Congress, I did my master research in spain and actually I'm PhD(c) in Oceanography physical in the south shetland island, through the project called Physical-biological coupling around South Shetland Islands (Antarctica) at the mesoscale range (COUPLING), awarded by the Ministry of Research of the Spanish government. Our research line is make a model exchange heat between atmosphere-ocean, but first we need make a good description about the system around the south shetland island both time and spacing

Determination of Coastal Management Parameters with High Resolution Remote Sensing Imagery

Javier Marcello¹, Francisco Eugenio¹, Javier Martín¹, Juan A. Bermejo²

¹*Instituto Oceanografía y Cambio Global, Universidad de Las Palmas de G.C., Spain*

²*Fundación Observatorio Ambiental Granadilla, Edificio Puerto-Ciudad 1B, 38001 Santa Cruz de Tenerife, Spain*

Abstract

Remote spectral imaging of coastal areas can provide valuable information for characterizing and monitoring coastal waters. The use of multispectral imagery from satellite sensors such as MODIS (Moderate Resolution Imaging Spectroradiometer), SeaWiFS (Sea-viewing Wide Field-of-view Sensor), and others has been established for many applications, including the estimation of chlorophyll concentrations, suspended matter, etc., but mainly in open waters. With the advent of very high resolution multispectral imaging sensors such as the WorldView 2 (WV2), there is the potential to retrieve much more information and, in particular, for coastal areas. Applications include water quality monitoring, benthic habitat mapping or bathymetry estimation in littoral shallow zones. However, achieving these goals requires overcoming a number of challenges.

Water-leaving radiance is very difficult to determine accurately, as it is often small compared to reflected radiance from sources such as atmospheric and water surface scattering, and it is subject to uncertainties in the sensor's radiometric calibration. Thus, the atmospheric correction has proven to be a crucial aspect in the processing of high resolution images that can affect subsequent steps in remote sensing applications of satellite data. In order to make reliable estimates of water quality parameters, bathymetry and benthic mapping in coastal areas, accurate retrievals of water leaving reflectances are required. In this context, the present operational atmospheric correction algorithms work reasonably well over clear ocean areas ('Case 1' waters), but give inaccurate results over brighter coastal waters ('Case 2' waters). So, we have implemented a multi-channel atmospheric correction algorithm, specifically, the 6S (Second Simulation of a Satellite Signal in the Solar Spectrum) atmospheric correction method adapted to high resolution WorldView-2 multispectral satellite imagery.

On the other hand, specular reflection of solar radiation on non-flat water surfaces is a serious confounding factor for water quality remote sensing, bathymetry and, specially, for benthic remote sensing mapping in shallow-water environments. Therefore, the accurate estimation of these indicators can be seriously impeded by the state of the water. To overcome this challenge, experts could refer to previous methods and models designed to take advantage of the glint to compute surface characteristics (e.g., wave height) or to remove glint contamination prior to estimating water column constituents and optical properties (e.g., mapping shallow-water benthos). However, these methods have been conceived for the open ocean, not for nearshore shallow environments. Because of nearshore topography, the assumption of monodirectionality of waves is generally not valid. Moreover, open ocean algorithms are designed for low-resolution data (1 km), where glint effects occur at a scale much smaller than pixel dimensions. In this work, we propose a method based on combining physical principles, using the near IR channels, and image processing techniques for removal of the sun-glint effects from high-resolution imagery in coastal environments.

Finally, after performing atmospheric and glinting corrections of WorldView-2 multispectral imagery, remote water quality parameters, bathymetry and benthic mapping of shallow-water environments can be obtained with high resolution and precision. To address the water quality monitoring, two essential parameters have been estimated. The photosynthetic pigment chlorophyll-a (Chl-a), that is a key indicator of phytoplankton biomass, commonly used to assess the eutrophic status of water bodies; and the diffuse attenuation coefficient (K_d), that is an important water property related to light penetration

and availability in aquatic systems. A novel algorithm applied to WV2 multispectral imagery to extract the diffuse attenuation from the original bands has been proposed and validated. On the other hand, for bathymetry, an efficient multichannel physics-based algorithm has been implemented, capable of solving the radiative transfer physical model equation of seawater. Finally, we have combined efficient physics-based methods and advanced remote sensing image processing techniques to obtain the mapping of benthic species (seagrass or algae) in coastal shallow waters.

The previous methodology for the determination of coastal management parameters using Worldview-2 imagery has been applied to selected pilot regions around the Canary Island (Spain). In particular, the main study area has been the southern part of Tenerife Island, near Granadilla City, because an Environmental Monitoring Programme for the Port of Granadilla was established in order to ensure sustained environmental quality across the wide range of natural and artificially created habitats outside of the Port.

References

- Eugenio, F., J. Martín, J. Marcello and J.A. Bermejo, 2012: Atmospheric correction models for high resolution WorldView-2 multispectral imagery: A case study in Canary Islands, Spain. *Proceedings SPIE Remote Sensing*. Edinburgh.
- Eugenio, F., J. Martín, J. Marcello and E. Fraile-Nuez., 2014: Environmental monitoring of El Hierro Island submarine volcano, by combining low and high resolution satellite imagery. *International Journal of Applied Earth Observation and Geoinformation*. 29, 53–66.
- Kay, S., J. Hedley and S. Lavender, 2009: Sun Glint Correction of High and Low Spatial Resolution Images of Aquatic Scenes: a Review of Methods for Visible and Near-Infrared Wavelengths. *Remote Sensing*, 1, 697-730.
- Lyzenga, D.R., N.P. Malinas, and F.J. Tanis, 2006: "Multispectral bathymetry using a simple physically based algorithm," *IEEE Transactions on Geoscience and Remote Sensing*, 44(8), 2251-2259.
- Maritorena, S., A. Morel and B. Gentili, 1994: Diffuse Reflectance of Oceanic Shallow Waters: Influence of the Water Depth and Bottom Albedo. *Limnology and Oceanography*, 39(7), 1689-1703.

Large-scale Processes

Pathways of oxygen supply into the Eastern South Pacific Oxygen Minimum Zone

P.J. Llanillo¹, J.L. Pelegrí¹, J. Peña-Izquierdo¹ and S. A. Navarrete²

¹*Instituto de Ciencias del Mar, CSIC, Passeig Maritim de la Barceloneta 37–49, 08003 Barcelona, Spain*

²*Estación Costera de Investigaciones Marinas, Las Cruces, and Center for Advanced Studies in Ecology and Biodiversity, Pontificia Universidad Católica de Chile, Casilla 114-D, Santiago, Chile*

Abstract

We use climatological and Argo program data to look at the ventilation patterns of the Tropical Eastern South Pacific (TESP) Oxygen Minimum Zone (OMZ). Streamlines of volume transport and contours of accumulated oxygen transport (through advection and epipycnal turbulent diffusion) are computed for the whole TESP. In particular, we provide a novel description of the southern/subtropical pathway and compare its relevance with the recently described (Stramma et al. 2010) equatorial pathway of oxygen supply. In addition, we analyse the annual oxygen budget for the ESP OMZ core. The importance of each term (advection, epipycnal and diapycnal turbulent diffusion, and biological consumption) is examined for several isoneutral layers. The slight imbalances obtained when computing the oxygen budget within each isoneutral layer cast light on the expected mean oxygen changes at different depth regimes of the TESP OMZ.

Water mass exchange between the North Atlantic Tropical and Subtropical gyres.

Peña-Izquierdo J., Pelegrí JL., Llanillo P.J., García-Olivares A.

Instituto de Ciencias del Mar, ICM-CSIC, Barcelona, Spain, Spain

Abstract

The basic pathway for the return flow of the Atlantic Meridional Overturning Circulation (AMOC), across the tropics from the South to the North Atlantic Ocean, is usually sketched along the western margin via the North Brazil Current and directly entering into the Caribbean Sea. However, only about half of the AMOC flow follows this straightforward pathway. Just north of the equator, the other half retroflects eastwards successively, feeding a complex system of zonal jets. This southern origin water recirculates within the tropics during relative long times scales while slowly upwelling into the surface layer and gaining heat content. It is mostly via Ekman-driven dynamics that this half of the AMOC flow enters into the northern Atlantic subtropics across the ocean interior. This tropical component of the AMOC therefore plays a key role in its heat budget. In this study we use a numerical ocean circulation model to compute the water mass fluxes and the heat budget across the tropics. Both Eulerian and Lagrangians descriptions will be used, with especial attention to the seasonal variability.

Transport Variability of the Canary Current

Teresa M. Carmo-Costa, A. Hernández-Guerra, I. Comas-Rodríguez, M. D. Pérez-Hernández, P. Vélez-Belchí & E. Fraile-Nuez

Instituto Universitario de Oceanografía y Cambio Global, University of Las Palmas de Gran Canaria, Spain

Abstract

Referencing geostrophic velocities through LADCP data is a valuable technique to study ocean dynamics. This was applied to study the seasonal and interannual variability of the water mass transport of the Canary Current. This work processed CTD and LADCP data of various RAPROCAN cruises, from February 2006 to December 2012. The 18 CTD stations go from 18.5°-15.5°W at latitude 29°20'N and from that point on until [30°20'N, 13°W], through the Fuerteventura-Lanzarote strait. The water mass characteristics were derived from the CTD data, as well as the geostrophic velocities computed through the thermal wind equation. These velocities were then adjusted to the LADCP drawn reference velocities in order to obtain temporal variability of the mass transport of the Canary Current.

Meridional Overturning Transports at 7.5N and 24.5N in the Atlantic Ocean during 1992-93 and 2010-11

Alonso Hernández-Guerra, José Luis Pelegrí, Eugenio Fraile-Nuez, Verónica Benítez-Barrios, Mikhail Emelianov, María Dolores Pérez Hernández

Instituto Universitario de Oceanografía y Cambio Global, University of Las Palmas de Gran Canaria, Spain

Abstract

Transatlantic hydrographic sections along latitudes 7.5°N and 24.5°N have been repeated with about 20 years difference, at the beginning of the 1990s and 2010s. For each period, an inverse model is applied to the box bound by both sections. The model imposes mass conservation for individual layers, defined by isoneutral surfaces, and the whole water column, using surface Ekman transport and several transport constraints for specific ranges of longitudes and depths. As a result, the velocities at the reference layer for each station pair and the dianeutral velocities between layers are estimated, and the horizontal velocity fields and the water, heat and freshwater transports are calculated. The dianeutral velocities show downwelling from the Upper North Atlantic Deep Water (UNADW) stratum to the Lower North Atlantic Deep Water (LNADW) stratum, resulting that the two lobes at 24.5°N merge at 7.5°N with a larger vertical extension. At 24.5°N, the 1992 to 2011 increase in southward UNADW transport is compensated with a decrease of southward LNADW transport. The Atlantic Meridional Overturning Circulation (AMOC) at 24.5°N is larger in 1992 (24.7 ± 1.7 Sv) than in 2011 (20.1 ± 1.4 Sv). Much of the observed AMOC variability arises because of a changing northward flow of Antarctic Intermediate Water (AAIW), which was much more intense in 1992/93 than in 2010/11. In contrast, heat transport at 24.5°N is not significantly different in 1992 (1.4 ± 0.1 PW) and 2011 (1.2 ± 0.1 PW).

Riding the Canary deep Poleward Undercurrent (CdPU)

Pedro Vélez-Belchí¹, Alonso Hernández-Guerra², Cesar González-Pola¹, Francisco Machín², and Curtis Collins³

¹*Instituto Español de Oceanografía, Spain.*

²*Universidad de Las Palmas de Gran Canaria, Spain.*

³*Naval Postgraduate School*

Abstract

Poleward undercurrents are well known features in Eastern Boundary systems. In the California upwelling system (CalCEBS), the poleward flow has been observed along the entire outer continental shelf and upper-slope, (<500m depth) using indirect methods based on geostrophic estimates and also using direct current measurements. The importance of the poleward undercurrents in the CalCEBS, among others, is to maintain its high productivity by means of the transport of equatorial Pacific waters all the way northward to Vancouver Island and the subpolar gyre but there is also concern about the low oxygen concentration of these waters. However, in the case of the Canary Current Eastern Boundary upwelling system (CanCEBS), there are very few observations of the poleward undercurrent. Most of these observations are short-term mooring records, or drifter trajectories of the upper-slope flow. Hence, the importance of the subsurface poleward flow in the CanCEBS has been only hypothesized. Moreover, due to the large differences between the shape of the coastline and topography between the California and the Canary Current system, the results obtained for the CalCEBS are not completely applicable to the CanCEBS. In this study we report the first direct observations of the continuity of the deep poleward flow of the Canary Deep Poleward undercurrent (CdPU) in the North-Africa sector of the CanCEBS, and one of the few direct observations in the North-Africa sector of the Canary Current eastern boundary. The results indicate that the Canary Island archipelago disrupts the deep poleward undercurrent even at depths where the flow is not blocked by the bathymetry. The deep poleward undercurrent flows west around the eastern-most islands and north east of the Conception Bank to rejoin the intermittent branch that follows the African slope in the Lanzarote Passage. This hypothesis is consistent with the AAIW found west of Lanzarote, as far as 17 W. But also, this hypothesis would be coherent with a cyclonic circulation associated with the Savage Islands, the Conception bank and the Canary Islands sub basin that would redistribute the AAIW northeast of the Canaries. The poleward flow in the CanCEBS is deeper (>1000m) than the poleward flow in the CalCEBS (<500m). The differences are explored based on the hypothesis that the gradient between the Mediterranean Outflow Waters and the Antarctic Intermediate Waters contribute to force the deep flow in the CalCEBS.

Small-scale Processes

Small-scale mixing in the subsurface salinity maximum in the subtropical North Atlantic

Mikhail Emelianov, Jordi Font

Instituto de Ciencias del Mar, CSIC, Pg. Marítim de la Barceloneta, 37-39, 08003 Barcelona, Spain

Abstract

Continuous measurements of the thermohaline fields were carried out between March 22nd and April 8th on the Spanish research vessel B/O Sarmiento de Gamboa in the framework of the SPURS (Salinity Processes in the Upper ocean Regional Study) project focused on the processes responsible for the formation and maintenance of the salinity maximum associated to the North Atlantic subtropical gyre.

The high spatio-temporal resolution scanning of the first 300 meters of the water column was performed with a towed undulating platform SeaSoar, equipped with two CTDs, and sensors of dissolved oxygen, fluorescence and turbidity.

The obtained data allowed determining the 3D temperature and salinity fields characterized by high inhomogeneity. Various relatively fresh and warm, and salty and relatively cold waters were observed to intruded into the Surface Maximum Salinity water mass.

The 3D distribution of Turner Angle values allows to detect the areas of small-scale mixing activity and helps to better understanding the interrelation between differently transformed water masses inside the sampled area.

Vertical mixing and vertical velocities in an anticyclonic eddy south of Gran Canaria Island. A first approach.

Sheila N. Estrada-Allis¹, Ángel Rodríguez-Santana¹, Pablo Sangrà¹ Evan Mason²

¹Universidad de Las Palmas de Gran Canaria. Grupo OFYGA. Departamento de Física. Spain

²Mediterranean Institute for Advanced Studies (IMEDEA), Spain.

Abstract

During February of 2007 an anticyclonic eddy has been localized and cross-measured in two transects; from 6 to 7 and from 26 to 27 of February south of the Gran Canaria Island in the framework of RODA-II project. Hydrographic measurements such as CTD profiles and altimeter derived data from AVISO were used to determine the structure of such mesoscalar structure. In order to obtain a contextual vision of the diapycnal mixing of this eddy, potential density profiles were used to compute Thorpe scales through the displacements of each overturn. Moreover, ADCP measurements were used to establish the critical Richardson gradient number as a parameter to determinate the presence of mixing below the mixed layer in stable stratified fluid. The results show that, the highest level of vertical active mixing is concentrated on the surface layers, over the mixed layer, which can lead to a diapycnal transport between the upper mixed layer and the stratified layer below favoring then the turbulent vertical entrainment. Moreover, high Thorpe length scales are found at the periphery of the first transect which match with critical gradient Richardson numbers below the mixed layer and high vertical shear levels. The second transect has shown higher Thorpe scales at the core of the eddy and critical gradient Richardson numbers were found in some stations that not necessarily match to those enhancement of Thorpe scales. An additional meteorological-related quantity, the Monin-Obukhov length scale, was determined for each cast through surface buoyancy and heat fluxes as well as the friction velocity calculations, using empirical formulations and the bulk flux of TOGA/COARE for surface heat flux and wind stress. Across the eddy we find Monin-Obukhov scales less than zero which could indicate that the wind-generated turbulence can be overwhelmed by an stable stratification. On the other hand, absolutes depths of Monin-Obukhov were lower than mixed layer depths indicating that the wind-induced mixing could not be enough to explain the total turbulence over the mixed layer.

In order to determine in a first approach the relevance of vertical mixing in the vertical velocities and the magnitude of this vertical velocities a regional ocean model solution is used which is part of the PUMP project. Although terms of vertical mixing are small compared to other components of vertical velocity, first results indicates a downwelling on the dense side of the periphery and upwelling on the light side at the core of the eddy when a simple vertical velocity scaling is used. This agrees with theoretical and observational studies of mesoscalar structures. In addition, further analysis related to the structure of the vertical velocities inside an anticyclonic eddy using realistic model solutions will also be addressed.

Turbulence associated with volcanic activity: the submarine volcano at the island of El Hierro

Rodríguez-Santana, A.¹, E. Fraile-Nuez², S. Estrada-Allis¹, J.M. Santana-Casiano¹, M. González-Dávila¹, C. Presas-Navarro²

¹*Universidad de Las Palmas de Gran Canarias. 35017 Las Palmas de Gran Canaria. Spain*

²*Instituto Español de Oceanografía. Centro Oceanográfico de Canarias. Santa Cruz de Tenerife. Spain*

Abstract

Three multidisciplinary cruises (March, October 2013 and March 2014) have been carried out (VULCANO project) to study physical-chemical anomalies, among other objectives, due to the degasification phase that is still active in the submarine Hierro volcano. In the last two cruises, we could deploy a microstructure profiler (turboMAP-L) to study the turbulence effects of this volcanic activity.

The preliminary results show for the October 2013 cruise temperature inversions with high instabilities on the secondary cones. The dissipation rates of turbulent kinetic energy, ϵ , observed by microstructure profiler reached values above $10^{-7} \text{ m}^2 \text{ s}^{-3}$ along the water column enough away from the surface layers. These regions of high turbulence induced by thermal instabilities must play an important role in the mixing of the different chemical substances whose effects would be assessed in the future.

However, ϵ observed on March 2014 cruise show high values near the bottom on the main crater of the submarine volcano. Comparisons were performed to distinguish between the turbulence of the bottom boundary layer and the induced by thermal instabilities. This turbulence in the main cone would help the mixing of chemicals substances along the water column.

The study of submarine volcanic activity in the generation of turbulence will help us understand the role that submarine volcanoes play on the vertical flux of chemicals substances and their possible effects on different marine ecosystems.

Acknowledgements. This research has been funded by the Spanish Government together with FEDER through VULCANO project (CTM2012-36317).

References

Fraile-Nuez et al., 2013. The submarine volcano eruption at the island of El Hierro: physical-chemical perturbation and biological response. *Scientific Reports* 2:486.

Santana-Casiano et al., 2014. The natural Ocean acidification and fertilization event caused by the submarine eruption of El Hierro. *Scientific Reports* 3:1140.

Coastal Processes

Analysis of ADCP data in the Bay of Setúbal

Daniel Bondyale Juez, Maite Báez Hernández, Rubén González Gérboles, Laura Gómez Navarro, Pol Carbó Mestre, Airam Sarmiento Lezcano

Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, Spain.

Abstract

Current data from an acoustic Doppler current profiler (ADCP) deployed in the Bay of Setúbal at 100 meters depth are used with the aim of analysing the observed current oscillations. The deployment recorded vertical profiles of horizontal velocity with a broadband of 300 kHz and 24 bins of 4 meters size for the period 4-14 April 2004. In this work, spectral analysis and empirical orthogonal functions (EOF) decomposition are used to interpret the diurnal and semidiurnal oscillations and evaluating their relative importance. The EOF shows that the 90 % of the variance is explained by the combination of three modes: a diurnal near-inertial mode, a barotropic tidal mode and a baroclinic tidal mode. The results reveal that the strong near inertial oscillations, characterized by a 180°-phase difference between the upper and lower layers, and the added effect of the baroclinic tides, induce the strong vertical shears previously studied by Aguiar-González et al. (2011).

References

Aguiar-González, B., A. Rodríguez-Santana, J. Cisneros-Aguirre, A. Martínez-Marrero, (2011), Diurnal-inertial motions and diapycnal mixing on the Portuguese shelf, *Continental Shelf Research*, 31 (11), 1193–1201

Temperature and salinity sub-surface variability on the Southern Coast of Galicia

E. Tel¹, J. M. Cabanas², G. Gonzalez-Nuevo² and A. Cabrero²

¹*Instituto Español de Oceanografía, IEO. C/Corazón de María, 8. 28002-Madrid*

²*Instituto Español de Oceanografía, IEO. Subida Radio Faro, 50, 36390-Vigo*

Abstract

In 2008, the Instituto Español de Oceanografía (IEO) has installed a thermosalinometer (TSG) on board of R/V J.M. Navaz that operates on Galician coastal waters. Weekly, it covers the area between Vigo and Muros according to the ship works. The TSG continuously measures the sea subsurface salinity and temperature along the ships tracks and some results are systematically disseminated thorough the web www.vi.ieo.es. Permanent archive is made at IEO DataCenter after a detailed quality check putting also a special effort in filling correct metadata information that will allow a future reuse of data. As the delayed mode quality check as the metadata give added value to the original TSG measures.

Data-Interpolating Variational Analysis (DIVA) allows the spatial interpolation of data in an optimal way, taking into account oceanographic features as coastlines and inlets (Troupin et al, 2012). Calculations are optimized and rely on a finite element resolution and the software allows optimizing the analysis parameters, checking for duplicates and performing quality controls.

Current paper shows the results of performing DIVA on the whole historical TSG dataset. Monthly variability has been calculated as well as seasonal and annual ones. Differences can be appreciated between the inner part of the inlets and the open sea areas. These climatological results, that will be updated systematically, can be useful not only for scientific research but also for coastal management activities.

References

Troupin, C. Barth, A. Sirjacobs, D. Ouberdous, M. Brankart, J.-M. Brasseur, P. Rixen, M. Alvera-Azcárate, A. Belounis, M. Capet, A. Lenartz, F. Toussaint, M.-E. Beckers, J.-M. . Generation of analysis and consistent error fields using the Data Interpolating Variational Analysis (Diva). *Ocean Modelling*, 2012, vol 52-53, 90-101, doi 10.1016/j.ocemod.2012.05.002

HF Radar-derived surface circulation in the Ría de Vigo. Lateral variability and coastal wind relationship

S.Piedracoba¹, J.L. Herrera¹, R.Graña¹, J.González¹, M.Gilcolto², R.Varela¹, G. Rosón¹

¹Dpto. de Física Aplicada - Facultade de Ciencias - Universidade de Vigo, Pontevedra

²Instituto de Investigaciones Mariñas, CSIC, Vigo

Abstract

Coastal ocean current mapping using High-Frequency (HF) Radar has entailed an important advance in the knowledge of the ocean surface circulation, improving the socioeconomic management capabilities of the coastal regions.

The main advantage of the HF Radar system consists in obtaining high spatial and temporal-resolution surface currents that none other technology can measure. Conventional in-situ current measuring instruments like ADCPs or other mechanic current meters, although they measure continuous current observations they are not capable of measuring the most superficial section of the water column because of sidelobe contamination or mooring deployments. Other methods such as surface drifters can measure surface/sub-surface currents but with the disadvantage of shorter temporal records are normally obtained. Besides, HF radar is a land based oceanographic tool that allows obtaining surface currents in nearly real time while most of the current meters are deployed without a cable system to send real-time data.

The upwelling system of the Ría de Vigo combines an important economic activity coming from fisheries and harbour activities with highly valuable ecological areas like Cíes Islands. This makes the Ría de Vigo a place of special interest for surface circulation studies both scientific and coastal management applications. The position of Cíes Islands has influence on the shelf-ría water exchange processes through the North and South Mouths of the ría.

Surface currents of the outer third of the Ría de Vigo have been observed using HF-radar data derived from two short range CODAR radar antennas installed at Toralla island (TORA) and Point Subrido (SUBR). The radars, operating at a frequency of 46.2 and 46.8 MHz, respectively, provide continuous radial vectors with a maximum horizontal range of 10 km and a radar coverage area of approximately 60 Km². Combining radial currents from both stations nearly 450 total vectors are obtained on the order of 375 m and 5° azimuthal resolutions each 30 minutes. The HF Radar System of the Ría de Vigo has been working since March 2010.

Surface current maps (daily and monthly) have been created from HF radar currents and remote wind data to describe the surface circulation of the Ría de Vigo during different seasons (upwelling, relaxation and winter seasons) for the period 2010-2013. The series length has allowed studying the interannual variability of the typical upwelling and downwelling periods of this upwelling system.

Furthermore, correlation and regression analyses between surface current and remote wind as a function of the time lag, as well as time series of the along and across components of surface current at sections of oceanographic interest (North Mouth, South Mouths and Central Section), has been calculated during different seasons, concluding: i) remote wind is the main forcing of the residual circulation obtained from HF Radar System in the Ría de Vigo; ii) along and across surface currents through the mouths and central section are constant with the distance most of the time, excepting some periods when lateral variability is detected due to the gradient of along or/and across components; iii) this surface lateral variability could be associated with lateral gradient at deeper waters and it should be considered for balance calculation of exchange residual fluxes in the Ría de Vigo.

Mesoscale Processes

Reversals of vertical flows between layers by meteorological forcing in Gibraltar: linking with the hydraulics of the exchange

A.Sánchez-Román, G. Sannino, G. Jordà and D. Gomis

Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.

Abstract

The Strait of Gibraltar is the scenario of a very energetic baroclinic exchange between Atlantic and Mediterranean waters: fresh and warm Atlantic waters enter into the basin while salty and cold Mediterranean waters outflow to the Atlantic. This mean flow fluctuates at different timescales showing seasonal and inter-annual variability, sub-inertial changes driven by winds and atmospheric pressure differences between the Atlantic Ocean and the Mediterranean; and diurnal and semidiurnal variations due to strong tidal currents. Moreover, the magnitude and hydrological properties of the exchange strongly depend on the physical configuration of the Strait, which submits the water exchange to hydraulic control. Those facts promote vertical transfers of heat, salt and mass between the Mediterranean and Atlantic waters during their passage through the Strait, which modify their TS properties having impact on the net heat and salt exchanges of the Mediterranean Sea with the global ocean.

In this work we investigate the meteorologically induced subinertial reversals of the mass vertical transfers between the Atlantic and Mediterranean waters along the Strait and their connections with the hydraulics of the exchange. To do that we analyse the outputs of a numerical simulation covering the entire Mediterranean basin ($1/6^\circ$ of spatial resolution) with enhanced resolution in the area of the Strait ($1/200^\circ$). Thanks to its very high spatial resolution in the area of Gibraltar this model properly solves, for the first time, the hydraulics of the Strait. Another special feature of this model is that it was only forced through the specification of both the atmospheric pressure and heat & water fluxes at the sea surface so, it does not include the forcing exerted by tides. Tides were excluded from the experiment to further investigate the effects of a realistic atmospheric forcing over the mean flow.

The vertical fluxes between the upper and lower layer exhibit temporal variability with enhanced fluctuations between late autumn and wintertime due to the sensitivity of the exchange to the passage of atmospheric systems over the Mediterranean basin. These enhanced fluctuations can be strong enough to occasionally reverse those vertical fluxes, thus promoting water conveying from the fast-flowing layers to the slow-flowing ones. Those episodes are associated to intense wind regimes, which are able to modify the long-term transfers between layers in detriment of the atmospheric pressure that plays here a secondary role. On the other hand, and in order to check if these inversions are coupled to the hydraulic regime of the Strait, we compute the composite Froude number at the control sections of Espartel Sill, Camarinal Sill and Tarifa Narrows during the reversal episodes. We found a quasi-permanent supercritical region over the main sill of Camarinal (97%) and Tarifa Narrows (79%) with a subcritical region in between. As a result, the Strait would be isolated from the adjacent basins during the inversion events being both the vertical transfers between layers and the water exchange between the Atlantic and the Mediterranean basins determined by processes occurring in the region in between the two controls.

Direct temperature and salinity acoustic full waveform inversion

Guillermo Bornstein, Berta Biescas, Valentí Sallarès, Jhon Fredy Mojica

Institut de Ciències del Mar (CSIC), Spain.

Abstract

Acoustic reflectivity provides insight into the fine structure of the ocean by using the multichannel seismic reflection method. Retrieving physical properties of the ocean from acoustic reflectivity has been one of the main topics of this subject. Until now, the main inversion strategy has been to invert sound speed from reflectivity. Afterwards, a combination of equations of state and a local T-S relationship is required to derive subsequently the rest of parameters (temperature, salinity and density). We have developed an alternative approach based on the direct inversion of temperature and salinity from the reflected waveform. We have implemented a time domain, multi scale, acoustic FWI algorithm with a gradient-based optimization scheme that solves for T and S. The sensitivity kernels of those parameters are calculated via the adjoint method, and we use the iterative non-linear conjugate gradients (NL-CG) search method to minimize a misfit function. We present in this work the T and S inversions obtained from acoustic synthetic data propagated through the thermohaline finestructure of the Gulf of Cadiz, North Atlantic Ocean.

Combined use of glider, radar and altimetry data to study a coastal current in the western Mediterranean Sea

C. Troupin¹, A. Pascual², A. Lana², G. Valladeau³, I. Pujol³ and J. Tintoré^{1,2}

¹Balearic Islands Coastal Observing and Forecasting System (SOCIB), Palma de Mallorca, Spain

²IMEDEA (UIB-CSIC), TMOOS, Esporles, Spain

³Collecte Localisation Satellites (CLS), Space Oceanography Division, Ramonville St-Agne, France

Abstract

The Mediterranean Sea is characterized by a small Rossby radius of deformation, hence small structures and eddies. The Ibiza Channel, located in the Balearic Sea, is of particular importance since it controls the exchanges in the western Mediterranean Sea.

In order to understand and describe the upper ocean dynamics, a multi-sensor/integrated approach was applied in the Ibiza Channel in the first days of August 2013 during the G-AltiKa mission. This approach combines:

- Sea-level anomaly (SLA) measurements from Saral-AltiKa track no. 16, which passed west of Ibiza island. 1-Hz and 40-Hz data were considered.
- Glider data obtained along the satellite track a few hours after its passage. The horizontal resolution ranges from 5 km offshore to about 1 km in the coastal area.
- HF radar hourly velocities on a 3 km-resolution grid that partially covers the study region (range up to 74 km offshore).

Dynamic height (DH) was derived from the glider temperature and salinity profiles, while Absolute Dynamic Topography (ADT) was obtained by combining SLA and the new Mean Dynamic Topography (MDT) jointly produced by CLS and SOCIB. From DH and SLA, the cross-track velocities were derived using geostrophy relations.

Different filters were applied on SLA data and different reference levels were tested for the DH computation. DH and ADT both displayed very weak variations, on the order of 2-3 cm, along the glider trajectory. The glider- and the altimetry-derived velocities exhibit the signal of a meander centered at 38.65° N and a narrow coastal current flowing northward a few kilometers off Ibiza. These computed velocities are on the order of 20 cm/s, as confirmed by the HF radar. The time separation between the passage of the satellite and the glider can explain the discrepancies observed between the two platforms.

Our results highlight the promising measurements offered by SARAL/AltiKa in the coastal band. In particular, the satellite was able to capture the northern edge of the meander which lied on a shallow bathymetry, less than 10 km from the coast. They also constitute the first experiment where satellite altimetry and glider measurements were obtained almost simultaneously on the same track, in a region covered by a HF radar. Such an approach allows us to process, validate and inter-calibrate multi-platform datasets dedicated to coastal ocean.

First look at a new interannual ROMS solution for the Canary Basin

Evan Mason¹, Ananda Pascual¹, James C. McWilliams²

¹*Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain*

²*UCLA, Los Angeles, USA*

Abstract

A new multidecadal oceanic model configuration has been developed for the Canary Basin in the north-east Atlantic Ocean. The model is based on the Regional Oceanic Modelling System (ROMS) and has moderate horizontal and vertical resolutions. Initial conditions corresponding to January 1985 are taken from a Simple Ocean Data Assimilation (SODA) global model solution (version 2.2.8). The model has been integrated to 2011, with monthly mean SODA data applied at the lateral boundaries, and 6-hourly Climate Forecast System Reanalysis (CFSR) wind, heat and freshwater fluxes applied at the surface. An initial validation with in situ and satellite observations shows the model performs well in terms of interannual and seasonal cycles. Projected applications of the solution include investigation of Canary Current variability; support to observational studies of island-generated mesoscale eddies (project PUMP); and interdisciplinary work on larval exchange across the Canary-African transition zone.

Multiscale variability in the Balearic Sea: an altimetric perspective

Evan Mason, Ananda Pascual

Mediterranean Institute for Advanced Studies, IMEDEA (CSIC-UIB), Miguel Marqués 21, 07190 Esporles, Balearic Island, Spain.

Abstract

The present day availability of an eighteen year record of $1/8^\circ$ merged Mediterranean Sea sea level anomaly (SLA) data enables a contemporary description of long-term mesoscale variability in the Balearic Sea. SLA data from satellite altimetry are used to study the variability of sea level and surface geostrophic circulation at different spatial and temporal scales within this complex and relatively understudied region in the western Mediterranean (WMED). We find that the mean Northern Current along the Iberian slope is strongest in autumn, although higher variability in winter leads to stronger peaks in temporal variability of kinetic energy. The Balearic Current, which flows along the northern slopes of the Balearic islands, also has its maximum expression in autumn. Across the two Balearic channels (Ibiza and Mallorca), key locations that partly regulate meridional exchange in the WMED, observed seasonal variability in geostrophic velocity anomalies conforms rather well to prior descriptions, suggesting cautious confidence in the use of the Mediterranean merged altimeter product in nearshore regions.

Circulation through the channels is maximum in winter. The channel data support the hypothesis that the channel circulation may be hindered by the intermittent presence of the Western Intermediate Water mass, which sometimes forms in winter in the Gulf of Lions. This is the first time that an analysis of variability in the Balearic channels has been performed using altimetric data.

Observations of the interaction between near-inertial waves and mesoscale eddies

A. Martínez-Marrero¹, P. Sangrà¹, R. Caldeira², B. Aguiar-González³ and A. Rodríguez-Santana¹

¹*IOCAG, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain*

²*CIIMAR Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Portugal*

³*NIOZ Royal Netherlands Institute for Sea Research, Den Burg, Netherlands*

Abstract

Trajectories of drifters dragged at 50-100 meters depth and current meter data from a mooring are used to analyse the interaction between near-inertial waves and mesoscale eddies. Drifters were deployed within eddies generated downstream of Canary and Madeira islands between 1998 and 2011 (Sangra et al., 2005; Caldeira et al., 2014). The mooring was installed in the passage of cyclonic eddies induced by Gran Canaria island during 2006 (Piedeleu et al., 2009). Rotatory wavelet analysis of Lagrangian velocities shows a clear relationship between the near-inertial waves' intrinsic frequencies and the eddy angular velocities. The results reveal that near-inertial waves reach a minimum frequency of half the planetary vorticity ($f/2$) in anticyclonic eddies rotating with its maximum absolute angular speed. The highest amplitudes of the observed inertial motions are found in the inner core of young anticyclonic eddies evidencing strong trapping of inertial waves. Finally, the analysis of the current meter series show frequency fluctuations of the near-inertial currents in the upper 500 meters that are related to the passage of cyclonic eddies. These fluctuations appear to be consistent with the variation of the background vorticity produced by the eddies.

References

- Caldeira, R. M. A., A. Stegner, X. Couvelard, I. B. Araújo, P. Testor, and A. Lorenzo (2014), Evolution of an oceanic anticyclone in the lee of Madeira Island: In situ and remote sensing survey, *J. Geophys. Res. Oceans*, 119, 1195–1216, doi:10.1002/2013JC009493.
- Piedeleu, M., P. Sangrà, A. Sánchez-Vidal, J. Fabrès, C. Gordo and A. Calafat, (2009), observational study of oceanic eddy generation mechanisms by tall deep-water islands (Gran Canaria) DOI: 10.1029/2008GL037010
- Sangrà, P., J. L. Pelegrí, A. Hernández-Guerra, Igor Arregui, J. M. Martín, A. Marrero-Díaz, A. Martínez, A. W. Ratsimandresy and A. Rodríguez-Santana (2005) Life history of an anticyclonic Eddy, DOI: 10.1029/2004JC002526

Technologies for the environment

Oceanographic moorings: behavioral study of EBC4

Jonathan Anger, Eugenio Fraile-Nuez, Pedro Velez-Belchi, Demetrio de Armas, J. Francisco Dominguez-Yanes

Instituto Español de Oceanografía, Spain

Abstract

Mooring EBC4 (Easter Boundary Current) is located between the Canary Islands and the African coast. This mooring gathers observations of the eastern boundary current of the North Atlantic subtropical gyre, also known as the Canary Current System (Grill et al., 2002; Knoll et al., 2002; Hernández-Guerra et al., 2003; Fraile-Nuez et al., 2010). In 2011, the Canary Oceanographic Centre, belonging to the Spanish Institute of Oceanography, employed new materials supplied by DC Servicios Ambientales for building this mooring, improving its security. As a result of this collaboration, a model to study the mooring behaviour in the environment has been developed. To assess the evaluation of tensions in the mooring, a software under Matlab (Richard K. Dewey, 1999) was used, addressing the different forces acting on the mooring and comparing the results from the former and current settings.

3 Friday, June 13th

General Topics

Atlantic Society of Oceanographers - Sociedad Atlántica de Oceanógrafos

Sociedad Atlántica de Oceanógrafos

Abstract

What is the Atlantic Society of Oceanographers?

The Atlantic Society of Oceanographers (SAO) was founded in 2012 and based in Las Palmas de Gran Canaria, aims to promote professionals and companies who develop their work in different fields and sub-disciplines related to the Marine Sciences, such as:

- Oceanography (Physics, Chemistry, Biology and Geology)
- Mariculture
- Fisheries
- Environmental Management, Coastal and Littoral (ICZM-LOICZM)
- Marine Technology and Structures
- Environmental Education

*What are SAO's goals?

- Develop strategies in order to preserving and protecting the oceans.
- Promote oceanic scientific research.
- Act as meeting point between professionals and companies that focus their activities on Marine Sciences.
- Identify new lines jobs, business and R&D + innovation.
- Promote sustainable development models.
- Generate programs and training activities, spread information as well as education, and environmental awareness.

*What concrete actions have aimed at developing SAO?

- Conference on environmental education and science.
- Marine Biodiversity Week, from 7th to 14th October 2013, oral communications on various topics (kelp, marine mammals, marine seaweed, sharks, fishery activities, sea algae,...) had been at the same time carried out in 5 different localities on Gran Canaria (Guía, Las Palmas de Gran Canaria, Telde, Arinaga and Mogán), bringing science and society closer together and showing "state of the art" about main Marine Sciences professionals fieldworks.
- Signature of Jointed Agreement about Protected Marine Micro Areas Project, managed by the company Oceanográfica Divulgación, Educación y Ciencia, S.L. and SAO, for a period of 5 years.
- The SAO Awards ceremony: taking place on 15th November 2013 the SAO awards, known as The Oceanos, were given in three merit categories to Dr. Francisco Rubio Royo (Category of Individual), Spanish Institute of Oceanography (IEO) (Category of Institution/ Company) and the Fishermen's Association of El Hierro (Category of Collective).
- Professional meetings.
- Dissemination and training sessions aimed at students of Marine Sciences.

Contact us and become a member at: <http://www.sociedadatlanticadeoceanografos.org/>

Ciencia Compartida

Biblioteca de la ULPGC (Ciencias Básicas). Facultad de Ciencias del Mar

Abstract

Ciencia Compartida is the name of the weekly seminars that occur every tuesday in the Sala de Grado of our Marine Science Faculty. This 30 minutes talks have a wide spectra of speakers: PhD and Master students, teachers, professors, scientific people from our university or visitors, entrepreneurs, ecologists, or management people related with the ocean environment.

The seminars are recorded and broadcasted in less than 48 hours through ACCEDA²⁶, the University Library youtube channel²⁷, Pinterest²⁸ and Facebook.

How to participate? write us at cienciacompartida@ulpgc.es

We'll be willing to hear from you!!

²⁶acceda.ulpgc.es

²⁷www.youtube.com/user/BibliotecaULPGC

²⁸<http://www.pinterest.com/bulpgc/ciencia-compartida/>

Biodiversity

Preliminary results of the craniometric characteristics of the Mediterranean Monk Seal population at Cabo Blanco Peninsula (western Sahara-Mauritania)

Aguilera-Rodà, M.^{1,2}, Azumendi-Esquibel, J.¹, López, O.^{1,2} & López-Jurado, LF¹

¹Biology Department, University of La Palmas de Gran Canaria (ULPGC), Spain (a Biodiversity and Conservation Research Group)

²NGO Asociación para el Desarrollo Sostenible y Conservación de la Biodiversidad (ADS Biodiversidad), Spain

Abstract

The Mediterranean Monk Seal (*Monachus monachus*), classified by the International Union for Conservation of Nature (IUCN) as critically endangered, is one of the world's most endangered marine mammals, with an estimated total population size of 350-450 animals around the world (mainly located on the eastern Mediterranean, Cabo Blanco area, and Desertas Island in Madeira). In the 1990's there were around 300-400 individuals in Cabo Blanco (Western Sahara-Mauritania), but on 1997 a mass mortality killed two thirds of the population. Currently, about 130 individuals inhabit the Cabo Blanco Peninsula. Only a few studies have been made on the osteometry of the Mediterranean Monk Seal, mostly in the Mediterranean population, where a sexual dimorphism on the adult skull was described. We carried out craniometric measurements of 46 individuals died on that mass mortality event. For each individual, we took 31 measurements, founding that the mean length of the cranium, condilobasal length, was 28.62 cm, and the mean length of the mandible, from condylar process to cranial part of alveolar (infradental) arch, was 17.26 cm. The goal of the study was to develop a first approach of the craniometric characteristics of the Cabo Blanco population, in order to provide key information for the management of the actual population.

Cape Verde loggerhead colony: research and conservation activities

Liria-Loza, A.^{1,2,3}, Medina-Suárez M.^{2,3}, Jiménez-Bordón S.², Varo-Cruz, N.^{1,3}, Monzón-Argüello C.^{1,2}, López O.^{1,2}, Eiroa, A.², Aguilera-Rodà M.^{1,2} & López-Jurado, L.F.^{1,2,3}

¹Biology Department, University of La Palmas de Gran Canaria (ULPGC), Spain (a Biodiversity and Conservation Research Group)

²NGO Asociación para el Desarrollo Sostenible y Conservación de la Biodiversidad (ADS Biodiversidad), Spain ³NGO Cabo Verde Natura 2000

Abstract

Cape Verde harbours the largest loggerhead colony of Africa and the second most important of the Atlantic Ocean, after the South Florida rookery. Adult males and females of this population have been subjected to poaching since many years ago, reaching to place as one of the 11 most endangered sea turtle populations in the world.

This loggerhead population was discovered to the scientific world in 1998 by a research group of University of Las Palmas de Gran Canaria (ULPGC), who has led important scientific and conservation programs until now, in collaboration with Cape Verde and Canary Islands Institutions and a large number of volunteers who have participated over the years. These programs focused in the southeastern coast of Boa Vista Island (currently the Protected Area: “Reserva Natural das Tartarugas – RNT”) that houses the 80% of the nests of the Cape Verde Archipelago, making it the hotspot of this loggerhead population.

Nesting beach surveys are the most widely implemented monitoring tool in use by the global sea turtle community and are an important component of a comprehensive program to assess and monitor the status of sea turtle populations. From 1998 to present, the ULPGC's marine turtles research group, through two non-profit organizations (NGO Cabo Verde Natura 2000 and ADS Biodiversidad) and national and international projects, has conducted daily surveys (e.g. nest survey and monitoring, females protection and rescue, nest relocation to hatchery) as well as activities for sustainable development (e.g. national and international environmental training, local people awareness and involvement).

Furthermore, all along these years several scientific studies have allowed to gain insights into the characterization of this important colony (e.g.: genetic population structure, satellite tracking, nest ecology, reproductive biology, toxicology, females and hatchlings morphometric).

The long-term efforts carried out in the area provide an excellent opportunity to evaluate the success of loggerhead conservation strategies and policies in the area.

Ex-situ marine turtles conservation strategies: loggerhead reintroduction program in Canary Islands

Liria-Loza A.^{1,2,3}, Jiménez-Bordón S.², Medina-Suárez M.^{2,3}, Aguilera-Roda M.^{1,2}, López O.^{1,2}, Eiroa-Suárez A.², & López-Jurado L.F.^{1,2,3}

¹Biology Department, University of La Palmas de Gran Canaria (ULPGC), Spain (a Biodiversity and Conservation Research Group)

²NGO Asociación para el Desarrollo Sostenible y Conservación de la Biodiversidad (ADS Biodiversidad), Spain ³NGO Cabo Verde Natura 2000

Abstract

All along the eastern Atlantic Ocean there is only one loggerhead (*Caretta caretta*) breeding colony, housed in the Cape Verde archipelago. There are evidences of sporadic nesting activities of the specie in the African coast, but no accurate data.

Cape Verde beaches harbors the third largest loggerhead nesting population in the world, and the second one of the Atlantic, after the eastern U.S. colonies. The most important area all around the Archipelago is the Protected area “Reserva Natural das Tartarugas (RNT)”, southeastern Boa Vista Island, which houses the 80% of Cape Verde loggerhead nests. This high density of nests in such a small stretch of beaches (RNT, 20km of beaches) turns it in a very vulnerable colony whose conservation and protection are crucial for the specie. Two NGOs (Cabo Verde Natura 2000 and ADS- Biodiversidad) have been carrying out conservation and protection activities since 1998 in the area, but increasing the number of loggerhead breeding colonies in eastern Atlantic could give an important step in the global conservations efforts on loggerhead turtle.

Cape Verde and Canary Islands are oceanic archipelagos of the Macaronesian region, which share several characteristics: volcanic origins, climate and oceanographic conditions, flora and fauna endemism etc. Cape Verde has the only loggerhead nesting colony in the area, and Canary Island has evidences of marine turtle nesting activities in their oriental islands in the past. The similarities between both archipelagos, the evidence of marine turtle nesting activity in the Canary Islands, and the dangerous conservation status of the marine turtles around the world, had resulted in the development of a huge Experimental and Conservation Program to re-establish the loggerhead nesting colony in the oriental islands of Canary Islands.

This Reintroduction Program is based on three key goals: 1. Support conservation and protection activities on the origin population: the Capeverdean breeding colony; 2. Research in long-distance egg translocation and incubation experiments; 3. Head-starting programs to increase survival rates and decrease the number of eggs removed from the origin population (Cape Verde).

In 2006, a viability study started with a low number of eggs (3 nests) collected from Boa Vista Island, Cape Verde, to experiment the incubation conditions of the Canarian beaches (Cofete beach, Fuerteventura). Also laboratory experiments (200 eggs) were carried out. The 85.4% of the eggs disposed in the canarian beaches hatched successfully and the hatchlings showed very good conditions. From 2007 to 2010, 800 - 1000 eggs per year (8-14 nests) were removed from the Cape Verde beaches to the Canary Island (200 eggs/year to laboratory experiments, and 500-800 eggs/year to beach incubation). Canarian beaches showed good incubation conditions to loggerhead eggs (hatching success ranged from 65.3% to 86.6%).

Head-starting programs were carried out with all neonates hatched in Canary Islands, and they have been a very important tool to study the little-known first years of life of these animals.

Burrowing behavior in the sand crab *Portumnus latipes* (Pennant 1777) in sandy beaches of Galicia, NW Spain

Gayraud, G., Juez, A., Lastra M., López, J., Troncoso, J.

Marine Sciences Faculty, Univ. of Vigo, SPAIN

Abstract

The sand crab *Portumnus latipes* (Decapoda, Portunidae) is commonly distributed in exposed sandy beaches of European and Mediterranean sandy beaches. It lives buried in the swash zone, where special adaptations to high hydrodynamic stress and sediment instability are required. During April 2014, Playa América beach, and intermediate open ocean sandy beach in Galicia, was sampled. Individuals of *P. latipes* were collected by pushing a 15 cm Ø corer down till 15cm depth on baited sticks deployed in the mean swash zone. The burrowing velocity at different sediment grain sizes (125-250 μ , 250-500 μ , 500-1000 μ , 1000-2000 μ and natural sediment) of a wide range of body size of individuals, was tested. The response to physical stress was analysed by counting burrowing time when individuals were forced to bury 1, 5 and 10 times in natural sediment. Our results show the following trends, a) burrowing time increases with the increasing body size of the individuals b) the fatigue caused by the increase number of burrowing events, provoke a decrease in the burrowing velocity; c) the burrowing velocity is fastest on medium sand (grain size 500-1000 μ), d) tiredness effect is higher in coarse grain size.

As a conclusion, the risk of the individuals to be drifted away by beach hydrodynamics, increase when burrowing time became longer than swash period. Repeated uprooting by sediment instability also reduces the probabilities of the individuals to endure with the harsh physical environment of exposed sandy beaches.

Keywords: *Portumnus latipes*, grain size, burrowing, sandy beaches, Galicia.

Biotechnology

The cyanobacterium *Nostoc sp.* and an intertidal cyanobacterial mat community as a source of scytonemin and dihydroscytonemin

Ferriol Buñola P.¹, Toledo Marante F.J.¹, Estevez Reyes F.J.¹, Brouard Martin I.², Leon Oyola J.F.²

¹Universidad de Las Palmas de Gran Canaria

²Instituto de Productos Naturales y Agrobiología

Abstract

The cyanobacterium *Nostoc sp.* Strain BEA1032B was isolated by the Banco Español de Algas (BEA) from a biofilm on the road to El Hornillo (Gran Canaria) and it attracted our attention in the project Desarrollo Industrial de Canarias (DISCan-2007) as a potential source of high added value products. The antecedents pointed out the presence of a high content of oxidized scytonemin (Scy) and reduced scytonemin (H2Scy) in the organic extracts of *Nostoc spp.* The oxidized compound (Scy) is an inhibitor of kinases key in hyperproliferative inflammatory diseases. The reduced compound (H2Scy) induces autophagic cell death in human T-lymphoid cell line Jurkat cells. With these precedents, in this study we have decided to deepen into the chemical, biochemical and pharmacological knowledge of some cyanobacteria from the coast of Canary Islands.

The cyanobacterium *Nostoc sp.* Strain BEA1032B was cultivated at 20 °C in a growth chamber under a photon irradiance of 100 $\mu\text{mol m}^{-2} \text{s}^{-1}$. The cyanobacterial mats were collected from an intertidal flat in Las Palmas de Gran Canaria (Canary Islands). The cyanobacterium *Nostoc sp.* Strain BEA1032B and the cyanobacterial mats were extracted in a Soxhlet apparatus with acetone followed by rotary evaporation concentration, a brown extract was obtained. This extract was fractionated by silica gel column chromatography eluted with n-hexane/ethyl acetate mixtures of increasing polarity, and successive fractions were analyzed by thin-layer chromatography (TLC) eluting chloroform-methanol (9:1). The cytotoxic activity assays were performed by Bioquímica Farmacológica group of the ULPGC.

Study of less polar product.- When eluted with chloroform-methanol (9:1) on TLC (silica gel) it shows a green spot at $R_f = 0.40$. It was identified as scytonemin (Scy) by ¹H-NMR spectra, both in one and two dimensions.

Study of the more polar product.- When eluted with chloroform-methanol (9:1) on TLC (silica gel) it shows a red spot at $R_f = 0.35$. It was identified as dihydroscytonemin (H2Scy) by ¹H-NMR spectrum.

HPLC analysis.- Both metabolites were separated by HPLC using a column Waters μ Bondapak C18, according to the following elution program: 80% H₂O/ 20% MeOH for 2 min; then 13 min to reach 100% of MeOH by linear gradient. Flow rate was 1 ml min⁻¹. UV detection was set at 386 nm and with these conditions scytonemin (Scy) and dihydroscytonemin (H2Scy) were eluted at 14.48 and 15.55 minutes, respectively.

Cytotoxic activity.- Both products showed a cytotoxic activity against the human leukemia cell line HL-60 IC₅₀ (Scy) = 4.6 μM ; IC₅₀ (H2Scy) = 1.9 μM . Similar results were found against the human leukemia cell line U937.

As conclusion, *Nostoc sp.* Strain BEA1032B and the intertidal cyanobacterial mat community are good raw materials to obtain scytonemin (Scy) and dihydroscytonemin (H2Scy). Both products showed cytotoxic activity against human leukemia cell lines, HL-60 and U937.

Monitoring the water quality through molecular techniques

Carrasco-Acosta M.¹, Herrera-Melián J.A.², Robaina RR.¹, García-Jiménez P.¹

¹Departamento de Biología. Facultad de Ciencias del Mar. Universidad de Las Palmas de Gran Canaria

²Departamento de Química. Facultad de Ciencias del Mar. Universidad de Las Palmas de Gran Canaria

Abstract

Monitoring of the quality of water is mainly carried out through biochemical techniques with a consuming-time cost. The development of molecular techniques and specific probes to determine microorganisms has allowed a breakthrough in the validation of water quality not only for the technique sensitivity but also for its precision. In this work two attempts were carried out i) Identification of microorganisms through specific molecular probes and ii) Molecular characterization of structure of the bacterial communities.

The main bacterial groups which are included in the current legislation (*Escherichia coli*, *Enterococcus intestinalis*, *Salmonella spp.* and *Legionella spp.*) were analyzed in beaches and a wetland wastewater, through the design of specific probes from the 16S rRNA region. Potentially pathogenic filamentous fungi, belonging to genera *Cladosporium spp.*, *Aspergillus spp.* and *Penicillium spp.*, were also identified using primers from the Internal Transcribed Spacer region (ITS).

Specific probes for the identification of these microorganisms were designed and tested, from cultures in microbiological media, for both groups and their corresponding genera. DNA isolation was performed with lithium acetate, and fragments amplified were sequenced and further analyzed in the BLAST database. Phylogenetic analysis was confirmed with MEGA v 5.05 software in order to generate the corresponding phylogeny trees. Results revealed the specificity of the probes for each one of the microorganisms tested.

To continue, the molecular method of Amplified Ribosomal DNA Restriction Analysis (ARDRA) was performed with well-characterized molecularly strains. This would allow further the characterization of the structure of the bacterial community and the validation of the effectiveness of different wastewater treatments. This fingerprint method is based on the amplification of the 16S rRNA region for the family Enterobacteriaceae, the genus *Enterococcus* and specifically *E.coli*, digestion by restriction enzymes namely AluI, TaqI, MspI, HaeIII, HhaI and MseI, and followed by electrophoresis detection.

The different sized-band profiles from ARDRA revealed a characteristic pattern for different bacterial strains. Moreover an exhaustive molecular method, such as Terminal-Restriction Fragment Length Polymorphism (T-RFLP) will be used to qualify and quantify bacterial or fungal communities.

Results highlight the value of molecular techniques for the improvement and optimization of water quality monitoring for these microorganisms.

References

Chakravorty, S., Helb, D., Burday, M., Connell, N., and Alland, D., 2007: A detailed analysis of 16S ribosomal RNA gene segments for the diagnosis of pathogenic bacteria. *J. Microbiol. Methods*, 69, 330-339.

Herrera-Melián J.A., González-Bordón A., Martín-González M.A., García-Jiménez P., Carrasco M. and J. Araña J., 2014: Palm tree mulch as substrate for primary treatment wetlands processing high strength urban wastewater. *J. Environ. Manage.* (in press, JEMA-D-13-01609R2).

Malik, S., Beer, M., Megharaj, M., and Naidu, R. 2008: The use of molecular techniques to characterize the microbial communities in contaminated soil and water. *Environ. Inter.*, 34, 265-276.

Determination of scytonemin by UHPLC-MS/MS in extracts of an intertidal cyanobacterial mat community and in *Nostoc sp.*

R. Guedes-Alonso, J.J. Santana-Rodríguez, P. Ferriol-Buñola, F.J. Toledo-Marante

Departamento de Química, Universidad de Las Palmas de Gran Canaria, 35017, Las Palmas de Gran Canaria, Spain

Abstract

There is a variety of cyanobacteria located in Canary Islands in the intertidal flat of the coast that presents a photoprotective molecule called scytonemin. Scytonemin is a yellow-brown pigment of the sheath of many cyanobacteria that protect them from the UV-A radiations, making easier the colonization of areas with big radiation [1]. This compound is capable of absorb up to 90% of the radiation and is accumulated in the extracellular region of the organism. Scytonemin could be more than 5% of the dry weight of the cyanobacteria [2]. Oxidized scytonemin could be reduced to dihydroscytonemin using hydrogen sulfide or sodium sulfite. Both compounds have been determined in this study

The cyanobacteria *Nostoc sp.* Strain BEA1032B was isolated by the Banco Español de Algas (BEA) and was cultivated at 20°C in a growth chamber under a photon irradiance of 100 $\mu\text{mol m}^{-2} \text{s}^{-1}$. A brown extract was obtained after a Soxhlet extraction with acetone followed by rotary evaporation. This extract was redissolved with dimethylsulfoxide (DMSO) and acetonitrile (20:80 v/v) to determine the presence of oxidized and reduced scytonemin using an ultra-high performance liquid chromatography system coupled to a mass spectrometer of triple quadrupole (UHPLC-MS/MS).

In this study, all parameters involved in the detection of both compounds such as cone voltage, capillary voltage, source temperature or desolvation gas flow were optimized. At the optimum detection conditions, parent and daughter ions of both compounds were determined by direct injection of the diluted extract and after that, they were separated by UHPLC using a C18 column. After the chromatographic separation, the relative concentrations of both metabolites were calculated.

References

1. E.P. Balskus, R.J. Case, C.T. Walsh. The biosynthesis of cyanobacterial sunscreen scytonemin in intertidal microbial mat communities. *FEMS Microbiol. Ecol.* (2011) 77,322-332.
2. U. Karsten, J. Maier, F. Garcia-Pichel. Seasonality in UV-absorbing compounds of cyanobacterial mat communities from an intertidal mangrove flat. *Aquat. Microbiol. Ecol.* (1998) 16, 37-44.

Extraction and determination of polyphenols from *Caulerpa prolifera* using orbital shaking and HPLC

Samanta García Oms, Estefanía Sánchez Chicharro, Carolina Padrón Sanz, Dolores Cejalvo Lapeña, José Miguel Lloris Carsí

Facultad de Veterinaria y Ciencias Experimentales, Universidad Católica de Valencia "San Vicente Mártir". Valencia

Abstract

Reperfusion injury is the tissue damage caused when blood supply returns to the tissue after a period of ischemia or lack of oxygen. The absence of oxygen and nutrients from blood during the ischemic period creates a condition in which the restoration of circulation results in inflammation and oxidative damage through the induction of oxidative stress rather than restoration of normal function (Ramirez et al., 2000). This cellular damage can be treated with antioxidants. Seaweeds are one of the richest natural sources of antioxidants due to their content of sulfated polysaccharides and polyphenols, among others (Ye et al, 2009; Duan et al, 2006). The phenolic compounds are the most abundant antioxidants in algae (Garrido et al, 2008; Zhao et al 2006). This study focuses on the extraction of phenolic compounds and the determination of the antioxidant activity on a Mediterranean algae: *Caulerpa prolifera*.

In order to optimize the extraction of polyphenols, the effect of the following variables: type of organic solvent, extraction temperature and extraction time to be applied, have been studied.

The concentration of the total polyphenols in the extracts obtained has been determined by Folin-Ciocalteu method. The antioxidant activity has also been determined by the scavenging DPPH assay. Finally, the polyphenols extracted have been determined by HPLC –DAD.

References

- Duan X, Zhang W, Li X, Wang B. Evaluation of antioxidant property of extract and fractions obtained from a red alga, *Polysiphonia urceolata*. Food Chem 2006; 95(1):37-43.
- Garrido Ferrari DP, Ortiz Viedma J, Parada Valenzuela RA. Propiedades antioxidantes y funcionales de cinco algas chilenas sobre la calidad de pasta de salmón. 2008.
- Ramírez P, Marín J, Piñero A, Chávez-Cartaya R, Parrilla P. Investigación experimental aplicada a la clínica: isquemia-reperusión hepática. Cir Esp 2000;67:281-291.
- Ye H, Zhou C, Sun Y, Zhang X, Liu J, Hu Q, et al. Antioxidant activities in vitro of ethanol extract from brown seaweed *Sargassum pallidum*. European Food Research and Technology 2009;230(1):101-109.
- Zhao M.; Yang B.; Wang J.; Li B.; Jiang Y. Identification of the major flavonoids from pericarp tissues of lychee fruit in relation to their antioxidant activities. Food Chemistry. 2006; 98: 539-544.

New developments in *Gambierdiscus Australes* (VGO1046) toxin profile

C.R. de Vera^{1,2}, G. D. Crespín^{1,2}, M.L. Souto^{1,2}, José M. Franco³, Pilar Riobó³, J. Fernández^{1,2}, M. Norte^{1,2}

¹Instituto Universitario de Bio-Organica "Antonio González", CIBICAN. Universidad de La Laguna, Avda. Astrofísico Francisco Sánchez 2, 38206 La Laguna, Tenerife, Spain

²Departamento de Química Orgánica, Universidad de La Laguna, Campus de Anchieta, Avda. Astrofísico Francisco Sánchez s/n, 38206 La Laguna, Tenerife, Spain

³UA Fitoplancton tóxico (CSIC-IEO). Instituto de Investigaciones Marinas, CSIC, Eduardo Cabello,6, 36208 Vigo, Spain

Abstract

Harmful Algal Blooms (HAB'S or red tides), are massive proliferations of toxic algal species that occur under appropriate conditions. It can exert adverse impacts both on the environment and in living organisms through the production of marine biotoxins.[1]

Gambierdiscus genera is one of the known benthic toxigenic microalgae that presents high threats to human and environmental health.[2] Moreover, scientist have been fascinated by its ability to produce unique and complex molecules like gambierol and ciguatoxins which possess specific bioactivities.[3]

First approaches of the LC-MS profiles and bioactivity data are reported, in order to extend knowledge in the metabolomics and the discovering of new therapeutic applications of *Gambierdiscus austales* (VGO1046) strain.

Acknowledgements: To MINECO SAF2011-28883-C03-01, FP7-KBBE-2009-3-245137 (MAREX EU) and FP7-REGPOT-2012-CT2012-316137-IMBRAIM projects. C.R. de Vera to MINECO FPU program and G.D. Crespín to MAE (AECID) program and University of El Salvador for the financial support. To Santiago Fraga, IEO Vigo, for donating the strain.

References

1. Patrizia Ciminesiello, Carmela Dell'Aversano, Martino Forino and Luciana Tartaglione; Marine toxins in Italy: The more you look, the more you find; European Journal of Organic Chemistry (2014),7, 1357-1369.
2. Michael L. Parsons, Katerina Aligizaki, Marie-Yasmine Dechraoui Bottein, Santiago Fraga, Steve L. Morton; Antonella Penna, Lesley Rhodes; Gambierdiscus and Ostreopsis: Reassessment of the state of knowledge of the taxonomy, geography, ecophysiology and toxicology; Harmful Algae (2012), 14, 107-129.
3. Antonio H. Daranas, Manuel Norte, José J. Fernández; Toxic marine microalgae; Toxicon (2001), 29, 1101-1132.

Interaction DNA-DNA between the endophyte *Microspongium tenuissimum* and his host the marine alga *Grateloupia imbricata*

Navarro-Ponce M.A.¹, Afonso J.M.² and Robaina R.R.¹

¹Department of Biology, University of de Las Palmas de Gran Canaria, Las Palmas, Spain

²Department of Animal Production, University of Las Palmas de Gran Canaria, Las Palmas, Spain

Abstract

Macroalgae form habitat for a variety of other organisms from virus and bacteria to other algae that live as a passive epiphytes and endophytes, or causing infection. Structural intimate association among the participating algae is quite common. *Grateloupia imbricata* (Holmes) is a red alga that grown along the northeast coast of Gran Canaria, Canary Island (Spain). *Grateloupia imbricata* is infected by a microscopic endophyte identified as *Microspongium tenuissimum* (Hauck) via phylogenetic analysis inferred from ITS-5.8S rDNA. In Vitro culture showed high rate of infection, up 90 %. The infection by *Microspongium tenuissimum* was revealed by PCR, occurring in all thalli of *Grateloupia imbricata*. This process is repeated for three different populations in the coast of Gran Canaria. The strong structural interaction between host and its endophytes has been reported, however it has not been investigated at the molecular level. We performed a Southern blot analysis with a specific dioxigening-labeled DNA probes for *Microspongium tenuissimum* which revealed an relevant interaction at DNA level between of the endophyte *Microspongium tenuissimum* and its host *Grateloupia imbricata*. In addition, these results did not figure out the role of the interaction. However, this interaction improve the knowledge about the relationship between hosts and endophytes, especially for biotechnology such as algal transformation.

Marine Cultures

Macroalgal biomass intensive tank production as affected by co-culture and nutrient dynamic

Y. García Fernández¹, J. de Vera Soto¹, R. Haroun², F.L. Figueroa³, J.L. Gómez Pinchetti¹

¹Banco Español de Algas, Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de G.C., Muelle de Taliarte s/n, 35214 Telde, Canary Islands, Spain

²Centro de Investigación en Biodiversidad y Gestión Ambiental, Universidad de Las Palmas de G.C., Campus Universitario de Tafira, 35017 Las Palmas de G.C.

³Grupo de Fotobiología y Biotecnología de Organismos Acuáticos, Dpto. Ecología, Facultad de Ciencias, Universidad de Málaga, Campus Univ. de Teatinos s/n, 29071 Málaga, Spain

Abstract

Red and green macroalgae with biotechnological potential were intensively co-cultivated in 90 L tanks to test, as a new experimental approach, if biomass production and biofiltering capacities in nutrient enriched effluents were positive or negatively affected by different species growing in the same tank at the same time (co-culture), when compared to standard monoalgal cultures.

Tank co-cultures of *Jania adhaerens* with *Halopithys incurva*, *Grateloupia turuturu* with *Ulva rigida*, *Grateloupia imbricata* with *Hypnea musciformis* and *Hydropuntia cornea*, were assayed and data compared to monoalgal cultures of *H. cornea*, *Hypnea spinella* and *U. rigida*.

Nutrients, N-NH⁴⁺ and P-PO₄³⁻, were continuously provided during 4 weeks previous to a 2 weeks period with running seawater (nutrients deprivation). Under the combined effects of light, temperature and nutrients flow dynamic, algal yields and growth rates, ammonium and phosphate biofiltration capacities, pigments content and chlorophyll fluorescence parameters, as physiological stress indicators, were determined. Biomass obtained from the different treatments was mainly evaluated for acid polysaccharides content and antioxidant activity.

Results on the combined effect of the different assayed conditions reveal how algae species co-cultivation might be an interesting approach for nutrients removal in integrated multi-trophic aquaculture units (IMTA), as well as the biomass produced might be treated to obtain high-value metabolites under the biorefinery concept.

Incorporation of probiotic bacteria and microalgae in the rotifer *Brachionus rotundiformis* as vector in live food in fish larvae

Franchesca Muñoz, Yanett Leyton, Cristian Mejias, Carlos Riquelme

Laboratorio Mesocosmos Marino. Centro de Bioinnovación Antofagasta (CBIA). Universidad de Antofagasta

Abstract

Aquaculture is one of the most exploited areas nationally and internationally. Crops of commercially important organisms show critical points in their life cycle that affect mortality, such as the presence of pathogens bacterial in the early stages of the crop. The fish in the larval stage are fed with rotifers (*Brachionus plicatilis* or *B. rotundiformis*), these micro-crustaceans do not select their food and have low nutritional quality. However are good candidates for use as vectors of bacteria with antagonistic activity against pathogenic bacteria.

The aim of this study was to evaluate *B. rotundiformis* as food vector of probiotic bacteria and microalgae *Nannochloropsis gaditana*. To meet this objective, bacteria were selected that showed inhibitory activity against fish pathogenic bacteria by the technique of Dopazo and was evaluated growth of these bacteria in exudates of microalga *N. gaditana*. Then was evaluated the optimal concentration of the bacterial for inoculate in the rotifer cultures. Finally, was evaluated the incorporation of potential probiotic bacteria in the microbiota of the rotifer.

The results showed that the bacteria tested exhibited inhibition against fish pathogenic bacteria. Of the total bacteria, three had good growth with exudates of the microalga *N. gaditana*. Rotifers fed with specific bacteria and microalgae showed a significantly higher growth compared to control. Molecular analysis showed that the microbiota in the presence of rotifers probiotic bacteria was detected.

Finally the results obtained in this work indicate that the rotifer *B. rotundiformis* are a good candidate for use as a vector of a consortium Bacteria-microalga and using this food can improve the nutritional quality of larval fish.

Spawning quality obtained in greater amberjack (*Seriola dumerili*) through GnRHa inductions by injections or implants

Antonino La Barbera, Samira Sarih, Hipólito Fernández-Palacios Barber, Javier Roo, Dominique Schuchardt, María Soledad Izquierdo

Grupo de investigación en Acuicultura, Universidad de Las Palmas de Gran Canaria, Telde, Spain.

Abstract

Aquaculture development in marine fish is mainly based on a few species, therefore diversification is a priority. The aim of the present study was to obtain spawns of great amberjack (*Seriola dumerili*) by induction with gonadotropin releasing hormone analogue (GnRHa) injection or implant and determine their effects on eggs quality and economic performance. Wild sub-adult were captured and tagged individually, and kept in 40 m³ tanks during 2 years. A total of 6 mature fish (sex ratio 50%) per treatment were induced with 20 µg kg⁻¹ and 40 µg kg⁻¹ of GnRHa through injection and implants respectively. The spawn quality showed significant differences (P<0,05) between injection and implant treatments, in terms of viable eggs (%), hatched larvae (%), and larvae survival (% 3dph). The injection treatment showed better economic performance in all evaluated parameters, but significant differences were displayed only in price of 1000 eggs/Kg/spawn.

On the presence of potential pathogen bacteria in moribund seahorse juveniles

Ofelio Claudia, Pintado Jose, Planas Miquel

Instituto de Investigaciones Marinas IIM-CSIC, Vigo, Galicia, Spain

Abstract

Sharp declines in survivals of seahorse juveniles *H. guttulatus* Cuvier, 1829 and one batch of *H. reidi* Ginsburg, 1933 were observed coinciding with epizootic events of dermatitis. Clinical symptoms included dark body pigmentation, milky white cape covering skin surface and eyes, epithelial ulceration with protruding white cottony masses and complete liquefaction of the intestine. In addition, the faeces were reduced to a white thread. Microscopical observation of epithelial ulcerations showed the presence of septate fungal hyphae which appeared to course freely through tissues. Four moribund seahorse *H. guttulatus* juveniles (240 mg in weight) from the same batch were anesthetized then exposed to a lethal dose of MS-222. The samples were homogenized and then 50 μ l were resuspended in 450 μ l of steril seawater. Serial dilutions on Marine Agar and TCBS Agar were made for total bacteria and *Vibrio* quantification, respectively. Unidentified green-black colonies were observed in TCBS Agar plates, counted and isolated, and the genomic DNA extracted. The universal primers 27-F and 1492-R were used to amplify and sequence a fragment of 16S ribosomal RNA gene. The obtained sequences were similar to *Shewanella sp.* and *Vibrio splendidus* (GenBank). *Shewanella* bacteria are a common component of the skin microflora in fish, whereas several strains of *Vibrio splendidus* have related with mortalities of fish and invertebrates. Further studies will be necessary to determine whether the outbreaks of juvenile reared seahorses were due to infections caused by the identified bacteria strains or a consequence of unhealthy seahorse status.

Coastal Management

La Laja beach (Gran Canaria, Spain): An example of an effective coastal engineering project

Melián-Ramírez, A.¹, Suárez-González, E.¹, Santos-Bethencourt, R.¹, Santiago-Villalba, J.¹, Masdeu-Navarro, M.¹, Hernández-Acosta, C.N.¹, Echevarrieta-Legrand, L.¹, Castro-Rodríguez, M.A.¹, Sanchez-García, M.J.², Alonso, I.²

¹*Facultad de Ciencias del Mar, Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas (Spain)*

²*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas (Spain)*

Abstract

Engineering changes environment in an irrevocable way, using techniques that require an extensive knowledge of the natural environment and its constituents, to reach the onset goals with a minimum possible cost (Montoya and Galofré, 1997). There have been many interventions in the coastline for both beach stabilization structures and nourishment projects. The resulting construction is not always the expected one and quite often it needs to be repaired (in the case of stabilization structures) or repeated (in case of periodic fills) (Serra et al, 1991; Flor-Blanco & Flor, 2011).

Dirección General de Costas was responsible for the "Regeneration of La Laja beach", a coastal engineering project carried out between 1991-1993, consisting on three main actuations: the regeneration of the beach by means of filling 400000 m³ of sand, the construction of a detached breakwater 140 m long in the middle of the beach, and the construction of a groin in the southern end of the beach. First structure was designed to reduce wave energy in its lee and thus to reduce the sediment carrying capacity of the waves, while the groin was designed to prevent sediment losses by longshore drift.

The purpose of this regeneration project was to expand the original beach in order to promote a new recreational area in the southern part of the town of Las Palmas de Gran Canaria (MOPTMA, 1993). The used sand was extracted from Malpaso sandbank, in the eastern coast of Gran Canaria island (MOPTMA, 1993).

The main goal of this study is to determine the goodness of this coastal engineering project carried out more than 20 years ago. With this purpose, the evolution of the beach in the last 50 years has been established, as well as and its variation in volume of sediments between 2012 and 2014.

La Laja beach is located in the island of Gran Canaria and it is 1200 m long. The prevailing winds are NNE-NE, with average Hs of 1.19 m. During storms the wind direction is E-SE (Ministerio de Medio Ambiente, 2002). The beach contains volcanic sand with an average diameter of 0.4 mm (MOPTMA, 1989).

A number of aerial photographs covering several decades before and after the project was carried out were selected for the coastline evolution. Aerial photographs available at www.grafcan.es of 1966, 1975, 1987, 1998, 2005 and 2011 were chosen based on three criteria: tide setting; time span between them and spacial resolution. All them were georeferenced and the shorelines were obtained considering the water lever marks of previous high tide. Two topographic surveys were made with DGPS in April 2012 and February 2014 during low tide conditions.

No significant shoreline changes were observed between 1966 and 1987. Between 1987 and 1998, as a result of the regeneration project, the beach completely changed, since it become much larger and wider. Particularly along the southern zone, the beach amplitude increased by some 30 m, and a salient was naturally formed in the central part of the beach facing the breakwater. Since 1998 the coastline is again very stable.

High resolution topographic data from the foreshore al the backshore shows a small increase in sand volume of 287 m³ between 2012 and 2014. This value is so small that it indicates sedimentary stability along the beach. Nevertheless, some movement of sediment has been detected, so that there is a certain erosion along the foreshore and in the southern part of the beach, while the accumulation mostly takes place in the upper beach.

La Laja beach has a shoreline that remains stable both before and after the regeneration. This result from the aerial photographs analysis in the long term is supported by the DGPS measurements in the short term. This sedimentary stability is normal in closed systems with no sediment inputs nor outputs. This is due to its location between one protruding rock in the north and the groin located in the southern end preventing the sediment loss from the beach. The current state of equilibrium is based on the properly designed structures (the detached breakwater and the south groin) that prevent sediment losses.

References

- Anfuso, G., Nachite, D., Benavente, J., Meklach, Y., Bello, E., Macías, A. 2004. Caracterización morfodinámica de las playas del tramo costero marroquí entre Ceuta y Cabo Negro. *Geogaceta*, 35.
- Flor-Blanco, G., Flor, G. 2011. Alteraciones antrópicas por dragados en el estuario de Avilés y la playa/dunas de "Salinas-El Espartal" (Asturias). *Actas de las VI Jornadas de Geomorfología Litoral*, Tarragona.
- Ministerio de Medio Ambiente. 2002. Estudio ecocartográfico de la zona norte del litoral de la isla de Gran Canaria.
- Ministerio de Obras Públicas, Transporte y Medio Ambiente. 1993. Regeneración de la playa de La Laja.
- Ministerio de Obras Públicas, Transporte y Medio Ambiente. 1989. Proyecto de regeneración de la playa de La Laja.
- Montoya, F., Galofré J. 1997. La particularidad sobre la actuación física en la costa: Caso del delta del Ebro. *Revista de obras públicas* N°3368.
- Serra, J., Bautista, R., Maia, L.P., Montori, C. 1999. Sistemas de protección de costas (i): Regeneración de playas, el ejemplo del Maresme (1987-1998). *Geogaceta*, 25, 187-190.

Implementation environmental management system ROM 5.1 in Las Palmas Port

Fernández Sánchez, S.¹ Arto Cuesta, N.¹, Álvarez Vazquez, R.¹, Collado-Sánchez, C.², Hernández-Artiles, M.N.³ Adam-Muñoz, M.A.³

¹*elitoral, Estudios de Ingeniería Costera y Oceanográfica, S.L.N.E.*

²*Environmental Quality Department, University of Las Palmas de Gran Canaria*

³*Port Authority of Las Palmas*

Abstract

As a planning framework and river basin management plans, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, also known as Water Framework Directive, considers the inland waters of ports as heavily modified masses of water (with the significant pressure to which they are subjected). Because of this, it is essential to introduce a management system which allows minimizing the risk of breaching the environmental targets set by this directive. This is accomplished by deploying an operating control program designed to evaluate the magnitude and impact of pressures directing, in addition, the proceedings, to which all the surface water bodies reach a "good ecological status". Ports of the State suggested this management system through the Program of Recommendations for Maritime Works (Program ROM) 5.1. "Coastal Water Quality in port areas".

Last year we began the implementation process of ROM 5.1 in by the port managed by the Port Authority of Las Palmas. As of today we have developed, in the port of Las Palmas, the of Delimitation of Uses Programme and Characterization Masses of Water as a basic tool of management which allows to establish methods and procedures for the delineation and characterization of the different Unidades de Gestión Acuáticas Portuarias (UGAP) (Units of aquatic port management) that make up the port environment and the Plan of systematic monitoring allows to learn about the evolution in time of the chemical quality and ecological condition (or the potential ecological, in your case) of the masses of water port.

The Delimitation of Uses Programme and Characterization Masses of Water was developed thanks to field visits which allowed inventory and classifying the polluting emissions complementing the collection and analysis studies and previously existing reports on the water quality and the port environment. Due to the results we proceeded to the management port of the aquatic environment to allow an estimation of the risk to which the masses of water are subjected, together with the simulations with the hydrodynamic model MIKE 3 fruit of which has been able to define the rates of renewal of the masses of water port. We have been able to identify the different Units of aquatic port management that include the port of Las Palmas and set a systematic process of sampling for environmental monitoring. Currently this phase is waiting for validation by the Port Authority.

On the other side, we are developing a Systematic Surveillance Process on port waters through monitoring and a regular, systematic and standard evaluation of masses of port waters (including water and sediments). It is also an important control network of quality port waters. For that purpose we carry out samples each quarter for pelagic samples (water columns) and annual samples for benthic (sediments). We measure physic-chemical parameters, chemical, and biological and microbiological that allows assessing its quality and its chemical state and ecological potential. To date there have been 4 pelagic campaigns and a benthic campaign, still in the final evaluation process of the results obtained related to the biological indicators of water, chemical quality of water quality and sediment and physical-chemistry quality of the sediment.

Even though it still needs to be confirmed through this final assessment where a metric has been fixed which ranges from "very good condition or ecological potential" and "poor condition or ecological potential", everything seems to indicate that the masses of water from the port of Las Palmas, noting

the conditions of the sampling campaign carried out, the masses of water are a very good trend towards Good Environmental Quality good in the final annual valuation.

The National Park of the Atlantic Islands of Galicia: morphodynamics of the beach systems more emblematic.

Sanz, V.¹, Alejo, I.², Pérez-Estévez, C.²

¹Master student. Master in Oceanography, Marine Sciences Faculty, University of Vigo, Campus Vigo, 36310 Vigo, Spain

²Marine Geosciences Dept., Marine Sciences Faculty, University of Vigo, Campus Vigo, 36310, Spain

Abstract

The Maritime-Terrestrial National Park of the Atlantic Islands of Galicia, is conform by four archipelagos: Cíes, Ons, Sálvora and Cortegada, located at the NW of Spain Península at the area known as "Rías Baixas". The total area of the National Park is 8.480 ha, of which 7285.2 ha are marine.

Its geographical location makes these islands behave as barriers facing the Atlantic Ocean, leading to the Rías a quieter environment. West side of the island is dominated by energy processes and characterizes by erosive environments, while the East side, much more protected, is characterizes by sedimentary environments where beaches and dunes are model by currents and winds processes.

In this study, we focus on the larger beaches of the three waves exposed archipelagos: Cíes (Rodas beach at the north and San Martiño beach from the southern island), Ons (Melide beach) and Sálvora (De Bois beach). Cortegada island is excluded from this study as it is located at the head of Ria de Arosa; it is dominated by estuarine processes and their beaches has very little development.

The aim of this study is the characterization of these beaches, according their morphology, orientation, modeling processes, sediment characteristics, evolution and morphodynamics attending the control processes. To achieve this objective we have analyzed data from 2009, summer/winter periods, until nowadays. Phenomena occurred in 2014 stand out as it is one year with unusual high number of high-energy storms (from December 2013 until March 2014), with few periods of calm in between, therefore National Park beaches have changed significantly.

Maritime climate data was taken from the point WANA 1044069, which is the closest to the study area (historical database from Puertos del Estado). Beach profiles were achieved by DGPS (Trimble r8/R7), following predetermined beach transect; each point of the profile were georeferenced with heights relative to MSLA (Mean Sea Level at Alicante, topographic zero for Spain). Comparison of beach profiles shapes, volume and tang variation was performed. Wright & Short (1984) model was used for morphodynamic classification. Also, a comparative cartography was done using aerial photographs from 1956 and 2014, in GIS base, in order to evaluate the evolution along this time.

The results show that all beaches have common characteristics of protected beaches (reflective type according Masselin & Short classification) as they are located in the protected islands margin. However, each one has an own morphodynamics peculiarities depending the accommodation space available (local boundary setting) and wave and prevailing winds exposure. They all have are associated to a dune system, which degree of development is depending on the above factors as well as sediment available. So, on the beach dos Bois (Sálvora Island) there is wide aeolian platform (7m average height) associated with the low relief featuring this island. Melide beach (Ons Island) and San Martino beach (South Cíes Island) have a developed dune system, with heights reaching 12m, nowadays fixed by vegetation. Rodas Beach (northern Cíes Islands) is part of a sand barrier (6.5m average height) which encloses a lagoon.

In general all these beaches shows very little seasonal variability along the time, where changes are related to energetic events. The period of SW storms this past winter has been particularly relevant in the beaches of the Cíes Islands, San Martiño and more markedly in Rodas, causing beach erosion and general beach and dune retreat with the disappearance of the foredune.

Acknowledgements: Pojects: 046/2007 Ministerio de Medio Ambiente and Xunta de Galicia-Parque Nacional Illas Atlánticas de Galicia and FEDER 2010-11.

A methodological proposal for the definition of management units by hierarchical analysis of the territory (Canary Islands), as a part of an ICZM process

A. Bilbao Sieyro¹, Y. Pérez González¹, MV. Cedeño Rodríguez², M. González Hernández² and N. Pavón Salas¹

¹*Gestión del Medio Rural de Canarias S.A.U. C/Subida al Mayorazgo nº 26, portal B, 2º planta. Polig. Ind. El Mayorazgo. 38108 Santa Cruz de Tenerife. Islas Canarias*

²*Departamento de Análisis Económico Aplicado. Universidad de Las Palmas de Gran Canaria. Tafira, Gran Canaria. Islas Canarias*

Abstract

INTRODUCTION

In the context of sustainable development the management of coastal areas is a complex process due difficulty of establishing a balance between socioeconomic development and coastal conservation (Brenner et al. 2006). In Spain the coastal zone is defined by the Coastal Law at least 500 m inland. In this narrow fringe converge different administrative units: national (Government of Spain), regional (Government of Canary Islands) and local (municipalities) levels (Balaguer et al. 2008). So it, there is another administrative entity: the inter-islands council of Canary Islands that are responsible for the preparation of the Island Territory Management Plans (ITMP), where land uses are established (and also sea uses to some marine bathymetric, except the fishing activity). All these elements form a poorly defined area in terms of planning and management (Brenner et al. 2006, Sanabria & García 2011). Thus, the conservation status of coastal zone is considered delicate and occasionally critical (Gesplan 2012). In Canary Islands the ICZM process has hardly been developed (Sanabria & García 2011) and always in a theoretical context. In any case, one of the first steps to establish an ICZM process requires the definition of management units and that is the purpose of this communication.

METHODS

The study area was the island of Gran Canaria (Canary Islands), but the necessary data are available on all the islands of the archipelago. After the analysis of specialized literature we have followed and adapted the methodologies developed by Balaguer et al. 2008, Brenner et al. 2006 and Sardá et al. 2005. The proposal uses tools provided by GIS (Geographical System Information) software.

RESULTS AND DISCUSSION

In the Canary Islands the main driving forces that impact on the littoral are of terrestrial origin (Gesplan 2012). Therefore, the need for proper definition of these units analysis focuses on the coastal land area. We opted for an arrangement of management units considering a hierarchical structure because it clarifies the territorial vision and adapts to the processes that are required to be implemented according IZCM (Doménech & Sanz 2010).

Insular scale (Gran Canaria): The insular condition of the study area means that practically all the territory may have a direct or indirect impact on the marine environment (Balaguer et al. 2008)

Territorial scale (regions or comarcas): The spatial heterogeneity of the coastal zone can be tackled by choosing territorial units with similar characteristics or attributes, from an environmental and economic standpoint, to be considered under the criteria of evaluation and planning (Brenner et al. 2006, Balaguer et al. 2008). In Gran Canaria there are 5 comarcas bordering the coast.

Council scale: The municipalities are the smallest geographical unit management official, and in turn, provide the highest level of administrative implementation and therefore the most effective planning unit for ICZM (Brenner 2006; Sarda et al. 2005). In Gran Canaria there are 14 councils bordering the coast.

Shoreline Units-functional area (SU-functional areas): The SU-functional areas are those that have to be taken into account when implementing ICZM processes. To define the SU vector information layers were created and then were raster with a cell size of 50x50 m. On these layers an overlay analysis was performed in the range of 500 m. These were the layers of information considered:

- Land cover: "Information System Land Cover of Spain" (SIOSE 2011; provisionally) and the natural protected zones from (e.g. Natura 2000).
- Existing beaches or related: more than 200 beaches, ponds and natural pools
- Population sites: more than 80 localities within or intersecting with fringe of 500 m (49% of the population of the island in 2013)
- Elevation levels: to differentiate locations, above or below 200 m, linked to shield growth, e.g. high cliffs)

Finally and to determine the spatial area defined by SU-functional areas, we must consider the Analysis Units.

Analysis Units (AU): Represent the minimum areas for which data must be obtained, e.g. through indicators. These AU are the beaches, canyons, cliffs, harbors, protected areas, characteristic habitats, etc.

The appropriate territory for a project that has as main purpose the implementation of ICZM, is a key task that must be approached from a multidisciplinary approach and applying multi-criteria analysis. However, determining the scales, make the availability of data, ecosystems, jurisdictional boundaries, etc., remains one of the main challenges of coastal managers and scientists (Brenner et al. 2006). The way to reduce the space complexity presented here is a method to link the decisions of the managers with the biophysical and socioeconomic properties of the littoral (Balaguer et al. 2008). All information is presented in a plane considering the different scales and SU obtained.

FINANCE

This work has been carried out within the framework of the OMARCOST Project, with the support of the European Union (EU) and co-funded by European Regional Development Fund (ERDF) and POCTEFEX Programme.

Ocean Modelling

Geospatial analysis of loggerhead turtles in Canary Islands

Antonio Machado and Juan Antonio Bermejo

Observatorio Ambiental Granadilla

Abstract

We have developed an geospatial analysis based on ARGOS data positioning radio system, from the SEATURTLE platform. Data are from 3 projects which have provided information of 39 turtles (*Caretta caretta*) from 1998 to 2012.

We studied 35.000 raw signals, that produce 14.000 quality filtered signals , which has allowed us to analyze in detail the behavior and spatial distribution. Among geoprocesses used we have worked with geoprocessing , Kernel density analysis, geospatial correlation and other geostatistical processes. The project also has a geoportal²⁹, where you can see each and every one of the tagged turtles and their details (including signals), and that allows you to overlay layers of interesting information such as bathymetry , the seabeds or Special Areas of Conservation etc,

²⁹<http://www.redmic.es/flexviewers/tortuga/>

Moving towards an Ecosystem Based Management in the Gulf of Cadiz

Fdez-Palacios JM, Torres MA, Llope M

Instituto Español de Oceanografía, CO de Cádiz, Spain

Abstract

The concentration of the world's population in coastal regions, in addition to the direct human use, is leading to an accelerated process of change and deterioration of the marine ecosystems worldwide. In the case of the Gulf of Cadiz (GoC), intense fishing throughout history has resulted in the overexploitation of its major commercial stocks.

The Ecosystem Based Management (EBM) is the framework currently used for restoration of marine ecosystems. Unlike conventional strategies which only focus on individual components, this new paradigm in ecosystem management implies the consideration of the entire system as a whole.

Following the steps of other European seas, this work presents an Integrated Ecosystem Assessment (IEA) for the Gulf of Cadiz as first stone towards an eventual operational EBM. The IEA of the GoC is developed by combining a customized implementation of Levin's cycle with other complementary approaches, commonly used in other European seas.

In particular we made use of a traffic light plot to describe the state and trends of the most important descriptors and an Ecopath model to depict the main trophic interactions in this specific ecosystem. From these analyses, we finally come up with candidate indicators suitable to be used within Levin's cycle framework.

Numerical modeling of floating plastic pollutants on the Galician region (NW Spain)

Diego Pereiro Rodríguez, Carlos Souto Torres, Jesús Gago

University of Vigo, Spain

Abstract

Uncontrolled plastic spills represent one of the main causes of coastal pollution on the Galician region. Recent researches show that the majority of litter affecting Galician beaches is made of plastic, which mostly comes from such important economic activities in the region as fishing, aquaculture or shipping. The Fisterra maritime corridor records intense traffic all year long and it is a continuous source of pollutants with a high probability of reaching the shore.

In this work, we apply the ROMS model (Regional Oceanic Modeling System) (Debreu, L. et al., 2011) in order to simulate the Lagrangian drift of virtual particles in northwest Iberia (39 °N 11.5 °W to 45 °N 6°W). The module for particle tracking was enabled by means of the modification of the model code. Each particle represents a plastic spill released into the maritime corridor at a constant rate in time. Our aims are to investigate how plastic spills from maritime activities threaten the coastline and to detect which are the most exposed areas. Future researches will enable us to compare the results of the model with available data from rubbish collection on Galician beaches.

Preliminary results show that approximately 15% of objects released into the maritime corridor reach the coast of the region included in the grid and that the coast of northwest Galicia suffers the highest levels of pollution produced by plastic spills.

Marine GIS applications: GIS Spanish Institute of Oceanography (IEO)

Tello, M. O., Hermida, N., Pastor, E., Sanz, J.L.

Instituto Español de Oceanografía, Spain.

Abstract

The knowledge about which human activities take place, where, when and how often, in addition to the information on the distribution of marine resources and marine ecosystems and their conditions, is essential for successful sustainable management of marine environment and its resources.

Geographic Information Systems (GIS) technology plays an important role in geospatial data representation, analysis and mapping. It is an advanced technology that allows the storage and integration of all information about marine environment, marine resources and human activities. GIS allows scientists to organize and analyze complex marine data through time and space. Therefore GIS technology provides the tools that facilitate and optimize the knowledge of marine environment.

The GIS is used in the study of living marine resources, species, habitats, ecosystems, and natural resources as oil, gas, sand extractions, geology, study of physical and chemical variables of water column and the study of human activities and their impacts on the marine environment.

Since 1998 in the IEO is developing a MARINE GIS with the objective of organize, harmonize, standardize, integrated the geo-information of IEO. GIS tools are used in several projects carried out in the IEO related to study of living resources, natural resources, studies of evolution of natural phenomena, collecting data, marine spatial planning, etc.

Biological Oceanography

Are tetrazolium salts a reliable proxy to assess in vivo respiratory activity in natural marine communities?

Isabel Baños Cerón and Javier Arístegui Ruiz.

Instituto Universitario de Oceanografía y Cambio Global, University of Las Palmas de Gran Canaria, Spain.

Abstract

Recently, the in vivo enzymatic ETS assay, which measures the reduction of INT to INT-formazan in living organisms, has been proposed as a more reliable, proxy of in situ respiration in aquatic ecosystems than the in vitro ETS assay, which requires measuring the reduction of INT in homogenizes, saturated with natural substrates (NADH, NADPH and succinate). Although at first sight the in vivo assay seems to be faster, simpler and more reliable in addressing actual respiration rates, there are some methodological issues that question its usefulness. Here we test the toxicity of INT at three different concentrations (0.1, 0.2 and 0.4mM), during a typical in vivo ETS assay with natural planktonic communities collected in coastal waters of Gran Canaria. Our preliminary results reveal a significant toxic effect of INT over autotrophic and heterotrophic microorganisms. *Synechococcus*-like cyanobacteria and Picoeukaryotes showed a marked effect in the reduction of the chlorophyll fluorescence, matching the progressive assimilation of INT during the first 6 h of incubation. On the other hand, bacterial viability tests indicated that, just after 10 minutes of incubation, a loss in the cellular membrane integrity occurred in all samples inoculated with INT, regardless of the concentration employed. Although the in vivo enzymatic ETS assay has been presented as a reliable alternative to estimate “actual” respiration, the damaging effect observed over the cellular physiological state due to INT suggests that this method may yield misleading results.

Effect of patch size on metabolic activity of stranded macroalgae

Lucia Palacios, Jesús López, Mariano Lastra & Cristina Louzan

Departamento de Ecoloxía e Bioloxía Animal, Facultade de Ciencias do Mar, Universidade de Vigo, Spain

Abstract

Stranded algae in sandy intertidal beaches are a frequent event around the world. These deposits usually have a large spatial variation in patches of very different size and biomass. Most of the ecological processes that occur in these ecosystems depend on the amount of accumulated algae. Studies addressed to analyze this phenomenon are of relevance, especially if we consider the thousands of kilometres of sandy beaches that exist in our geography and the impact that the metabolism of the algal deposit can have on the global change (especially climate change). Algal deposits on the intertidal zone are considered by many authors as "hot spots" from the biogeochemical point of view, i.e. places that show a disproportionate metabolic activity in comparison with the surrounding environment.

In this work, the effect of algal wrack accumulation on the metabolic activity, rate of degradation and CO₂ fluxes was studied in algal patches of different size. To fulfil with this, samples were taken in patches of natural algae of different sizes located in the supra-littoral zone of beaches in Galicia, NW Spain. At the same time, algae patches of different sizes (100, 250, 500 and 1000 g), with 20 cm diameter in size, were deployed in the limit of the supralittoral zone. During a tidal cycle, triplicated patches from each size were chosen at random. At each patch, metabolism through CO₂ flow was measured with a breathing chamber with a temperature probe (LI-8150-103) 20 cm diameter placed directly over the patch of algae and sediment. Breath chamber was connected to an automatic system to measure flow of CO₂, LI-8100 control unit, in which the infrared Analyzer is located (IRGA) (0 to 3000 μmol/mol measurement).

The results clearly showed that there is a close relationship between the size of the patch and the flow of CO₂. When the size of the patch increases, the metabolic rate measured as CO₂ flow raises, but with a negative allometric growth. Therefore smaller patches have a higher metabolism per unit of weight, than large patches. As a result, larger patches had a slower degradation rate, thus depleting subsequent processes such as leaching of nutrients to the coastal zone.

Allometric growth and effect of size on the metabolism of *Echiichthys vipera* (Cuvier, 1829)

Lucia Palacios¹, Cristina Louzan¹, Jesús López¹, Luiz R. Gaelzer², Fernando Aneiros¹ & Jesús S. Troncoso¹

¹*Departamento de Ecoloxía e Bioloxía Animal, Facultade de Ciencias do Mar, Universidade de Vigo, Spain*

²*Instituto de Estudos do Mar Alte. Paulo Moreira, Brasil*

Abstract

There is a close relationship between body size and metabolism of organisms. At large scale, metabolic rate is proportional to body mass raised to a power 0.75. When body biomass increases, metabolic rate per unit of weight decreases. Also within each taxonomic group, smaller individuals have a faster metabolism and need more energy per unit of weight than larger individuals. Allometric relations on the growth of many organisms also affect both their physical and physiological properties and are essential for their survival.

This paper discusses the allometric relations on growth, both physical and physiological, of the lesser weever *Echiichthys vipera*. For these analyses, 62 individuals were collected in four beaches of Ría de Vigo, two on the North coast and two on the South. The collection was made with a beach seine type network 20 meters long and with a 5 mm mesh. At each beach, the network was crept over 9 transects, 30 meters long each. Collected individuals were transported to the laboratory alive in drums, where their metabolic activity was analyzed through measures of O₂ consumption. After that, their biometric characteristics were studied.

The results showed clear allometric relations in the growth of different parts of the body. Special attention must be paid to the allometric relation between body biomass and dorsal fin rays length. These rays, used in defense, are well developed in juveniles and hardly change with growth. There are also clear difference between beaches, like the allometric growth of length and height of individuals. These differences are probably due to adaptations in the burial capacity of this species in sediments with different grain sizes.

Metabolic rate is very high in these animals, probably due to the aggressive habitat they inhabit in the surf zone of beaches. In addition, the relationship between metabolic rate (measured as O₂ consumption) and body biomass presents a clear negative allometric growth. When body biomass increases, metabolic rate increases with a power of 0.74, very similar to that found in the majority of the ectothermic organisms. As a result, individuals of small size have a higher metabolism per unit weight (around 2.5 times more) than larger individuals.

Biovolume variability in natural populations of picoplankton and nanoplankton from the Canary Current region

María F. Montero¹, Javier Arístegui¹, Valeria Anabalón², Santiago Hernández-León¹, Juan L. Gómez-Pinchetti¹

¹*Instituto de Oceanografía y Cambio Global (IOCAG), Universidad de Las Palmas de Gran Canaria*

²*Facultad de Ciencias Naturales y Oceanográficas, Universidad de Concepción, Chile*

Abstract

Picoplankton (0,2-2 μm) and nanoplankton (2-20 μm) populations contribute greatly to total living biomass of planktonic food webs in the oceans. However, quantifying the biomass size-distribution variability across the different autotrophic and heterotrophic groups is a tedious, time-consuming effort that barely is done in oceanographic studies. For this reason, most authors estimate carbon biomass of natural populations from measured cells counts, using fixed biovolumes obtained from the literature. These are mostly derived from laboratory cultures or field studies from a particular site and time of the year, leading to significant inaccuracies. Here, we present data from two field studies where the variability in biovolume of different picoplanktonic (*Prochlorococcus*, *Synechococcus*, picoeukaryotes, high NA and low NA bacteria) and nanoplanktonic (autotrophic and heterotrophic flagellates) groups were estimated. Water samples for picoplankton biovolumes were collected from 1 coastal and 3 oceanic stations around the Island of Gran Canaria (Canary Islands) at different depth layers (surface, mixed layer, and depth of chlorophyll maximum), during 2011. More than 40 sequential filtration experiments were carried out, filtering through 7 polycarbonate filters (ranging from 0.2 to 3 μm), to obtain the average cell diameter. Cell counts were measured by flow cytometry, using a FACScalibur system (Beckton & Dickinson). Samples for nanoplankton biovolumes were collected during four seasonal oceanographic cruises at seven stations and five depths near Cape Guir (NW Africa), during 2009.

Cells were counted and measured by epifluorescence microscopy, before being clustered into 3 size classes (2-6, 6-11 and 11-20 μm) and 2 different morphologies (oval and pear-shaped). Biovolumes were calculated from mathematical equations according to the shape of the cell, and biomasses were derived from carbon conversion factors. Our results show that picoplankton biovolumes are very constant in time and depth, and similar to published studies in the NE Atlantic; except for picoeukaryotes, which may range up to 6 fold in the average biovolume (from 0.3 to 1.9 μm^3). Average nanoplankton range in biovolume from 14 to 697 μm^3 across the whole community, and up to 2-fold across a same size cluster. Our study is the first one that estimates the biovolume variability in the smaller but most abundant size classes of planktonic communities in the Canary Current. This work will allow better estimations of planktonic biomass to address future studies of food webs dynamics in this eastern boundary region.

Analysis of the problems of Sea Urchin *Diadema Antillarum* in Canary Islands

Yurena A. Hernández-Marrero¹ and Remedios Cabrera²

¹Student of Postgraduate Aquaculture and Fisheries (ACUIPESCA). University of Cadiz

²Department of Biology. Faculty of Marine and Environmental Sciences. University of Cadiz

Abstract

In the Canary Islands populations of a hitherto, sea urchin *D. antillarum*, are increasing partly due to the existence of overfishing of their natural predators. This, together with a good reproductive strategy of this urchin, favors the multiplication and widespread, extension of their populations worsening the situation of the ecosystem by forming barren grounds. The aim of this study is collecting and analyzing the information about this species. With the idea of develop proposals to help reduce the negative effects on the ecosystem and restore balance in the future thereof. For this purpose, we conducted an extensive literature review (over 100 papers) and concept maps on this issue and many proposals for action were made. A review of one of these articles reveals a new stage and a possible change in management strategy taken so far by the administration. Genetic studies comparing populations of the eastern Atlantic Western with Atlantic populations, allowed us to distinguish between these species, and *D. antillarum*, an invasive species is actually *D. africanum*, a endemic one of the Macaronesian region (Rodriguez et al., 2013). This highlights the importance of in-depth studies before undertaking any management measures on a particular species that can impact on the ecosystem as a whole.

Keywords: barren grounds, Canary Island, *Diadema africanum*, *Diadema antillarum*, protected area, sea urchin, urchin barrens.

Estimating age 1-2 bluefin tuna diet by isotope mixing model

B Orúe, N Goñi, JM Sorell, H Arrizabalaga, A Medina, JL Varela

University of Cádiz, Spain

Abstract

The Atlantic bluefin tuna (ABFT) (*Thunnus thynnus*) is a top predator located at high trophic levels of the pelagic food webs. In the last decades, ABFT populations have undergone an important depletion because of overfishing. A better understanding of their feeding ecology is essential to promote management strategies in order to achieve the sustainable exploitation of the resource. Traditionally, trophic studies have relied on stomach content analyses, which provide information at a short time scale. In contrast, modern stable isotope analyses of different tissues coupled to isotope mixing models have become a useful tool to estimate fish diets because the tissue isotopic compositions integrate information on the consumed prey at longer time scales.

With the aim to reconstruct the diet of 1-2 age bluefin tuna in the Bay of Biscay, stable isotope analysis was performed in 43 muscle samples of juvenile tuna captured by baitboat in July-August, 2013. All samples were frozen at -20°C until analysis. After thawing, the samples were rinsed with distilled water and freeze-dried for 48h. Afterwards, they were ground to powder by pestle and mortar. Then, each sample was split into two subsamples, one of which was directly prepared for $\delta^{15}\text{N}$ analysis, whereas the other was subjected to lipid extraction prior to $\delta^{13}\text{C}$ analysis. The relative abundances of ^{13}C and ^{15}N (respectively, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) were measured by continuous gas flow system using a Thermo Finnigan Elementary Analyzer Flash EA 1112 coupled to a Finnigan MAT Delta Plus mass spectrometer. The dietary contribution of prey was estimated by the stable isotope mixing model of Parnell et al (2010) using tissue-specific discrimination factors previously determined for juvenile bluefin tuna. In addition, isotopic data of the preys were taken from a previous work carried out in the study area.

Mixing-model estimates showed the highest contribution of anchovy (*Engraulis encrasicolus*) to the bluefin diet, whereas horse mackerel (*Trachurus trachurus*), bogue (*Boops Boops*) and swimming crabs (*Polybus sp.*) were prey of secondary importance. Our results suggest that juvenile bluefin tuna prey on a wide variety of species, and therefore may be regarded as opportunistic feeders.

Inter-island movements of Blainville's and Cuvier's beaked whales the Canary Islands

A.Schiavi¹, N.Aguilar de Soto¹, C.Reyes¹, and V.Martín²

¹BIOECOMAC, Depto. de Biología Animal, Geología y Edafología, Facultad de Biología, Universidad de La Laguna, Tenerife

²Sociedad para el Estudio de Cetáceos en el Archipiélago Canario (SECAC), Lanzarote

Abstract

The eastern Canary Islands are one of the places in the world where more mass mortalities of beaked whales have been associated with naval maneuvers. The potential population-level of these mortalities will depend on the size of the local populations and the level of replacement of impacted individuals with animals from other areas. But the lack of data on population structure and connectivity of beaked whales in the archipelago impedes assessment of the population effects of stranding mortalities.

Cuvier's and Blainville beaked whales have been recorded in the waters of all the Canary Islands, and there are long-time series of photoID data from the two longitudinal extremes of the archipelago: the most western island of El Hierro and the eastern islands of Lanzarote and Fuerteventura. These data enable studies of site fidelity and connectivity of beaked whales in the archipelago. It is important to coordinate the analysis of photoID catalogues in order to determine if populations of beaked whales in the Canary Islands are: i) a metapopulation in the archipelago, with individuals moving between different areas of concentration but forming a single reproductive stock; or ii) local populations with site-fidelity to the different islands and little genetic interchange. Each option has different demographic and conservation implications. In the first case the total archipelagic population would be smaller than the estimates obtained by summing the abundance in the local areas of concentration, as animals with a wide distribution would be counted in several areas, but populations would be resilient to local impacts as impacted animals can be replaced by individuals from other areas. In contrast, if there is little or no connectivity among local areas, the population of each island would be more vulnerable to impacts, such as mass mortalities recorded in the Canary Islands until a moratorium to the use of naval sonar in 2004 put an end to these events in the archipelago. Here we show that out of 69 and 61 well marked Cuvier's and Blainville beaked whales, respectively, catalogued in El Hierro, and 28 and 50 individuals of these species in Fuerteventura-Lanzarote, none of these animals are recorded in both areas. In contrast, re-sightings of individual beaked whales are common within each area and can be recorded several years apart. Although our sample size is relatively small (208 individuals), a previous study showing that 20% of 313 common bottlenose dolphins travel among different Canary Islands suggests that we would have observed movements among islands for beaked whales if these occur. The lack of connectivity among islands within the same archipelago has been observed for Cuvier's and Blainville's beaked whales in Bahamas also, in spite of satellite data from Hawaii showing that these species are able of travelling large distances. We expect that some of the beaked whales observed only once in El Hierro will travel to other areas, but it is still unknown where. Our results suggest that an important part of the beaked whale population in the Canary Islands has strong site-fidelity for specific preferred areas around the slope of different islands, and thus these sub-populations should be managed as separated units for their conservation.

Long-term sightings of elasmobranchs by recreational divers in the island of Gran Canaria (central-east atlantic)

Krupskaya Narváez^{1,2}, Filip Osaer^{1,2}, Brian Goldthorpe³ and Eduardo Vera González³

¹*ELASMOCAN, Asociación Canaria para la Investigación y Conservación de los Elasmobranchios, Las Palmas de Gran Canaria, Spain*

²*Fundación Colombiana para la Investigación y Conservación de Tiburones y Rayas SQUALUS, Cali, Colombia*

³*Davy Jones Diving Centre Calle Luis Velasco 39, Playa de Arinaga 35118, Gran Canaria, Spain*

Abstract

The potential of data collection by recreational divers for coastal elasmobranchs is illustrated with trends of long-term sightings data in the island of Gran Canaria (Central-East Atlantic). Observations and experiences of the wide public are frequently used to attempt to describe and estimate the population aspects of wild animals. Elasmobranchs are highly valued as attraction in tourism and their important role in the marine ecosystems. This aspect becomes more important when the studied species have difficult access and are vulnerable to extinction. Additionally, the study of elasmobranchs requires a high effort due to their low abundance. Therefore it is important to explore this type of data and to contrast it with findings of systematic research.

Effects of the submarine volcanic eruption of El Hierro (Canary Islands) on the bacterioplankton communities of the surrounding

Isabel Ferrera¹, Josep M. Gasol¹, Jose M. González², María F. Montero³, Eugenio Fraile-Nuez⁴ and Javier Arístegui³

¹*Departament de Biologia Marina i Oceanografia, Institut de Ciències del Mar, CSIC, Barcelona, Spain*

²*Departamento de Microbiología, Universidad de la Laguna, La Laguna, Spain*

³*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria. Las Palmas, Spain*

⁴*Instituto Español de Oceanografía, Centro Oceanográfico de Canarias. Santa Cruz de Tenerife, Spain*

Abstract

Direct observations of submarine eruptions are scarce because they usually occur unexpectedly in remote locations. The submarine volcano eruption of El Hierro (Canary Islands) occurring in October 2011 provided a unique opportunity to determine the effects of volcanic eruptions on the microbial populations of the surrounding waters. The birth of a new underwater volcano 1.8 km south of El Hierro produced a large plume of vent material detectable from satellite that led to abrupt changes in the physico-chemical properties of the water column. In order to test whether these changes resulted in changes in bacterioplankton communities, we combined flow cytometry and 454-pyrosequencing of 16S rRNA gene amplicons to monitor the area around the volcano through the eruptive and post-eruptive phases (November 2011 to April 2012). Flow cytometric analyses revealed the presence of large amounts of inorganic particles likely associated to the discharge of vent material. Likewise, a population of cells attached to these particles and an increase in the proportion of cells with high DNA content was detected during the eruptive phase. Changes observed in populations detectable by flow-cytometry were more evident at the depths closer to the volcano (75-125 m) coinciding also with oxygen-depleted areas. Alpha-diversity analyses unveiled that species richness (Chao1 index) decreased during the eruptive phase. However, no dramatic changes in community composition were observed. The most abundant taxa during the eruptive phase were similar to those in the post-eruptive stages and to those typically prevalent in oceanic bacterioplankton communities (i.e., the alphaproteobacterial SAR11 group, the Flavobacteria class of the Bacteroidetes, and certain groups of Gammaproteobacteria). Yet, we also detected the presence of taxa not typically found in bacterioplankton communities such as the Epsilon- and Zetaproteobacteria and members of the candidate division ZB3, particularly apparent in the eruptive stage. These groups are often associated with deep-sea hydrothermal vents, seamounts or sulfur-rich springs. Both cytometric and sequence analyses showed that once the eruption ceased, bacterial populations returned to typical patterns and no evidences of a volcano-induced fertilization could be observed.

Potential grazing, respiration and growth of *Euphausia distinguenda* in relation to the oxygen minimum zone at the Eastern Tropic

Inma Herrera¹, Tarsicio Antezana², Alan Giraldo³, Emilio Beier⁴, Lidia Yebra⁵, Santiago Hernández-León¹ and Jaime Färber-Lorda⁶

¹*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas de Gran Canaria, Spain*

²*Department of Oceanography, University of Concepción, Chile*

³*Universidad del Valle, Departamento de Biología. Grupo de Investigación en Ecología Animal, A.A. 25360, Cali, Colombia*

⁴*Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Unidad La Paz, Miraflores No. 334 e/Mulegé y La Paz, La Paz CP 23050, Baja California Sur, México*

⁵*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero s/n, 29640, Fuengirola, Málaga, Spain*

⁶*Centro de Investigación Científica y de Educación Superior de Ensenada División de Oceanología. Departamento de Ecología. Carretera Tijuana-Ensenada 3918 Zona Playitas. Ensenada 22860, Baja California, México*

Abstract

Euphausiids play an important role in the carbon cycling of pelagic ecosystems. They perform diel vertical migrations promoting a transport of organic matter from the euphotic zone to deep layers. The oxygen minimum zone (OMZ) in tropical oceans affects to the diversity, distribution and physiological processes of marine organisms. In order to study the relationship between the physiological processes of *Euphausia distinguenda* and the OMZ, we collected samples of euphausiids in the Eastern Tropical Pacific off Mexico (ETPM) during November 2009. We assessed the indices of potential grazing (specific gut fluorescence, GF), respiration (specific electron transport system activity, ETS) and growth (specific aminoacyl-tRNA synthetases activity, AARS) and the individual protein content. *E. distinguenda* behavior was characterized a diel vertical migration descending during the day and ascending to the surface at night. Specific ETS and AARS activities showed the same daily pattern; where high metabolic activities were found during the night in superficial highly oxygenated waters. Both growth and respiration rates were significantly reduced within the OMZ. However, specific GF had not daily variations and it is suggested that *E. distinguenda* migratory behavior into the OMZ is not a feeding response but a strategy to avoid predation.

Investigating *Sardinella aurita* seasonal migratory pattern off North-West Africa with a biophysical model

Timothée Brochier¹, Pierre-Amaël Auger², Laure Pecquerie³, Eric Machu², Baye Cheikh Mbaye⁴, Modou Thiaw⁵, Patrice Brehmer¹

¹IRD UMR195, ISRA-CRODT, BP 1386, Hann, Dakar Sénégal

²Laboratoire de Physique des Océans (LPO), UMR 6523 CNRS/IFREMER/IRD/UBO, Technopole Brest Iroise, 29280 Plouzané, France

³Laboratoire des sciences de l'Environnement MARin (LEMAR), UMR 6539 CNRS/UBO/IRD/IFREMER, IRD, Technopole Brest-Iroise, rue Dumont d'Urville, 29280 Plouzané, France

⁴Laboratoire de Physique de l'Atmosphère et de l'Océan Siméon Fongang (LPAO-SF), BP 5085 Dakar-Fann, Senegal

⁵ISRA-CRODT, BP 1386, Hann, Dakar Sénégal

Abstract

Sardinella aurita, or round sardinella, has been the main small pelagic fish species harvested off Senegal and Mauritania coasts over the last 4 decades and plays a central role for sub-regional food security and economic incomes. The landings of this species have strongly declined recently. Intense exploitation and climate change are acting together but population's dynamics are too poorly understood to disentangle the different drivers and to clearly evaluate the current state of *S. aurita*'s population. In the present study, we developed a bio-physical, individual based model for *S. aurita* population off North-West Africa. The hydrodynamic environment was simulated by a regional model ("ROMS") configuration covering the area 5°-40°N and 5°-30°W, with a 8km resolution and 32 sigma-levels in our area of interest. The biogeochemical compartments were simulated using the PISCES model coupled with ROMS. Fish schools of *S. aurita* were represented by active lagrangian markers affected with ad hoc larval, juvenile and adult fish swimming behavior. Individual's physiology was described following the local temperature and food availability by the Dynamic Energy Budget model "DEB". The extended kinesis algorithm ruled the horizontal fish movement and depends on food research, individual temperature preference and spawning migration, whereas fish vertical position in the water column was set for each stage according to scientific knowledge. We investigate the predicted seasonal migrations pattern of *S. aurita* off West Africa over the period 1980-2006. Then we also evaluate the fluctuations of fish biomass available for coastal fisheries (h<200m) in 4 distinct areas from the western Saharan bank (24°N) down to the Bijagos islands (11°N) and compare with the available fish landings data on this period. Finally, we calculate seasonal connectivity indices between the populations in the 4 areas selected as the percentage of fish present in an area that was born in another area.

Physical Oceanography

The source of the Canary Current in fall 2009

M.D. Pérez-Hernández¹, A. Hernández-Guerra¹, E. Fraile-Nuez², I. Comas-Rodríguez¹, V.M. Benítez-Barrios², J.F. Domínguez-Yanes², P. Vélez-Belchí², Demetrio De Armas²

¹*Instituto de Oceanografía y Cambio Global, Universidad de Las Palmas de Gran Canaria, Las Palmas, Spain*

²*Centro Oceanográfico de Canarias, Instituto Español de Oceanografía, Santa Cruz de Tenerife, Spain*

Abstract

The source of the Canary Current has been inferred from an inverse box model applied to the hydrographic data of a survey carried out in 2009 in the northeast subtropical gyre (29–37°N, 9–24°W). The Portugal Current is observed between 13.5 and 14.8°W at 37°N carrying 1.8 ± 0.4 Sv southward. This current presumably merges with the eastward transport of the Azores Current System and partly contributes to the Mediterranean inflow and partly to the northward recirculation of the Azores Current through the Gulf of Cadiz. The Azores Current System is located in the meridional range 33.50–36.25°N at 24.50°W. This System transports eastward 7.2 ± 0.5 Sv in the thermocline layers and 1.1 ± 0.8 Sv at intermediate layers. The Azores Current intermediate water mass has the highest portion of Sub-Arctic intermediate water (SAIW) in the region, while the Azores Countercurrent intermediate waters mass is mainly Mediterranean water. The Canary Current extends from 22.25° to 18.50°W at 29°N, the westernmost position ever observed. This current transports southward -6.2 ± 0.6 Sv in the thermocline layers and -2.0 ± 0.8 Sv in the intermediate layers. This intermediate flow shows a relative maximum of oxygen and a relative minimum in nutrient concentration, indicating the presence of SAIW. The study concludes that, at least in fall 2009, the Canary Current extends to the intermediate waters (σ_{θ} 27.9220 approximately 1600 dbar) and that Azores Current feeds the Canary Current at surface and intermediate layers.

Non-isostatic sea level response to barometric pressure within the Gulf of Cadiz

Irene Laiz, Begoña Tejedor, Alazne Aboitiz, Jesús Gómez-Enri, J. Coca, Pilar Villares

Dept. of Applied Physics, Univ. of Cadiz, Campus Rio San Pedro, 11510; Puerto Real, Cadiz, Spain

Abstract

Time series of in situ daily mean sea level, total pressure and atmospheric pressure were analysed for the period October 2006 to November 2007 with the aim of studying the sea level response to atmospheric pressure within the Gulf of Cadiz. Daily mean sea level data were retrieved from tide gauge stations placed in different ports around the GoC. More specifically, data were obtained for the stations of Bonanza and Huelva, both of them belonging to the Red de Mareógrafos (REDMAR) network of Puertos del Estado (Spain). Total pressure was measured with two absolute pressure transducers deployed near the coast (Sancti Petri, and Rota).

Atmospheric pressure at sea level was retrieved from the Royal Navy Observatory (ROA) as well as from Puertos del Estado (Spain). The total pressure time series were highly correlated to atmospheric pressure only during certain periods with linear correlation values of up to 0.8 showing a non-isostatic sea level response to atmospheric pressure. More specifically, this anomalous behaviour was observed between October 2006 and January 2007 with an inverted barometer factor of -2 cm/hPa.

The Huelva and Bonanza tide gauge records also corroborated these results, suggesting a dynamic response of the sea level to the movement of the atmospheric pressure field. Following these results, the aim of the present study is to analyse the spatial variability of the non-isostatic daily sea level response to atmospheric pressure within the Gulf of Cadiz continental shelf. To do this, sea level anomalies time series from radar altimetry have been retrieved for the period October 2006 to January 2007 with the aim of determining spatial variability of the inverted barometer factor.

Energy of marine currents in the Strait of Gibraltar and its potential as a renewable energy resource.

María Concepción Calero Quesada, Jesús García Lafuente, José Carlos Sánchez Garrido, Simone Sammartino, Javier Delgado.

Physical Oceanographic Group of the University of Malaga (Spain)

Abstract

A non-hydrostatic hydrodynamic model of the Strait of Gibraltar with high spatial and temporal resolution has been used to assess suitable areas for energy extraction from marine currents. The model shows great spatial variability of the available energy flux, ranging from 200 Wm^{-2} to more than 1800 Wm^{-2} . In addition to the mean energy flux, other properties and characteristics of the flow such as permanence and direction of the currents, vertical shear or occurrence of unwanted high frequency internal waves have been merged into an index that is used in this work as a proxy for the suitability of a given place to install a power plant. This index highlights two zones gathering the required conditions: the subsurface layer of the eastern half of the strait and the near-bottom layer off Espartel sill at the westernmost gateway of the strait.

Geological Oceanography

Geomorphological characteristics of Pipoca mud volcano linked to recent geological processes in the Gulf of Cadiz continental margin

Palomino, D.¹, Vázquez, J.T.¹, Fernández-Salas, L.M.², López-González, N.¹, Rueda, J.L.¹, Díaz del Río, V.¹

¹*Instituto Español de Oceanografía, Centro Oceanográfico de Málaga. Puerto Pesquero S/N. 29640 Fuengirola*

²*Instituto Español de Oceanografía, Centro Oceanográfico de Cádiz. Muelle Pesquero S/N. 11006 Cádiz*

Abstract

Mud volcanoes are conical edifices formed by the vertical migration of muddy sediments and fluids (hydrocarbons and brines) that are extruded by successive emissions. Mud breccia is the distinctive material of these volcanoes which is composed by clasts of varied lithologies embedded in a clayey matrix. This material is pushed out by the central diatrema of the cone and gives rise to mud flows that slide down the flanks of the edifice. These volcanoes are very common in the middle and upper slope of the Gulf of Cadiz. They are placed over buried diapiric structures and are associated to faults that facilitate the fluid escape (Fernández-Puga et al. 2007). The aim of this communication is to study the seafloor morphology and the sub-superficial characteristics of the Pipoca mud volcano, its interaction with the water masses hydrodynamic and the recent geological processes (tectonics, sedimentary, diapirism) that have occurred in the zone. This work has been developed in the framework of the LIFE+ INDEMARES/CHICA Project.

It has been analyzed data obtained during the oceanographic cruise INDEMARES/CHICA0412 onboard R/V "Ramón Margalef" that was carried out in the area named Shallow Field of Fluids Expulsion (SFFE) in the middle slope of the continental margin of the Gulf of Cadiz. The acquired information comprised: bathymetric data from a Kongsberg Simrad EM-710 multibeam echosounder (70 to 100kHz); and a very high-resolution seismic system TOPAS PS018, working with a primary frequency from 16 to 20kHz and a secondary frequency ranging from 0,5 to 4 kHz.

The Pipoca mud volcano is situated in the SFFE, to the west of the Guadalquivir diapiric ridge and to the north of Huelva channel (Hernández-Molina et al. 2006). It shows a sub-conical shape with an elliptic base as an ENE-WSW direction. The major semiaxis has a length of 2.89 km and the minor semiaxis of 1.1 km. The summit is dome shaped and is located at 503m water depth. A large mud flow is observed from the summit to 762 m water depth crossing the volcano southwestward and interrupting the Huelva channel. On the mud flow surface, six superimposed lobes have been mapped indicating that the venting processes and the formation of mud flows have took place in different stages. To the SE, it is characterized by a plastered contouritic deposits that ascend the volcano flank. Very high-resolution seismic profiles reveal chaotic-to-transparent units with faults that break the contouritic deposits and are interpreted as slides. Some slide scars can be seen in the contourite-volcano limit. The slides have been occurred in different episodes and the deposits are buried between sediment layers of sub-parallel reflectors. Two large depressions, with areas of 2 and 5 km² respectively, are located to the north and northwest of the volcano. They have a sub-circular plan view shape and their edges show approximately vertical walls that end on a low-gradient flat bottom surfaces. The bottom of the depressions is slightly tilted to the NNE, where both reach the maximum depth, and parallel reflectors are observed which appear abruptly truncated in the very high-resolution seismic profiles.

In this sector of the Gulf of Cadiz, the Mediterranean Outflow Water (MOW) flows with the same direction SE-NW as the Huelva channel (Hernández-Molina, et al., 2006) reaching current velocities that

range between 0,20 and 0,40 m/s at the southeastern flank of the Pipoca mud volcano and between 0,10 and 0,20 m/s in the northwestern depression zone (Fernández-Salas et al. 2012). The interaction of the current with the volcanic edifice generates an increase of the erosion in the southeastern zone of its base. It could be the trigger mechanism of mass transport processes observed in this zone. These mass transport deposits appear buried and intercalated with units of subparallel reflectors of contouritic deposits. Plastered contouritic deposits, possibly generated by the currents, are therefore emplaced over old mass transport deposits giving rise to a low slope surface. Whereas in the NW zone, there is a countercurrent generating eddies and vortex with minor speed intensity. In this zone, the two main depressions are generated by the non-consistency of the sediments related to the lack of interstitial fluids and the presence of normal faults which drive the fluid migration could produce also the collapse of the surface. The elongated shape of the eastward depression could be also explained by a major influence of the erosion by currents that are favored by eddies and vortex of the MOW. Besides, slide generated deposits have been observed along the walls of the depressions that would be also a consequence of this current effect. In the southeastern flank of Pipoca dense crinoid beds of mediterranean affinity (*Leptometra phalangium*) occur due to the nature of the water mass (MOW) and also the stronger currents that favour the availability of particles for these suspension feeders that are indicative of productive waters.

References

- Fernández Salas, L.M., R. Sánchez Leal, J.L. Rueda, N. López González, V. Díaz del Río, F.J. López Rodríguez, G. Bruque, J.T. Vázquez, 2012. Interacción entre las masas de agua, los relieves submarinos y la distribución de especies bentónicas en el talud continental del Golfo de Cádiz Geo-Temas 13: 198.
- Fernández-Puga, M.C., Vázquez, J.T., Somoza, L., Díaz del Río, V., Medialdea, T., Mata, M.P., León, R. 2007. Gas related morphologies and diapirism in the Gulf of Cadiz. *Geo-Marine Letters*, 27: 213-221.
- Hernández-Molina, F. J.; Llave, E.; Stow, D.A.V.; García, M.; Somoza, L.; Vázquez, J.T.; Lobo, F.; Maestro, A.; Díaz del Río, V.; León, R. ; Medialdea, T. and Gardner, J. 2006. The Contourite Depositional System of the Gulf of Cadiz: a sedimentary model related to the bottom current activity of the Mediterranean Outflow Water and the continental margin characteristics. *Deep Sea Research II*, 53: 1420-1463.

Magnetic Properties Of Sediments. What They Tell Us About Natural And Anthropogenic Changes In Coastal Marine Sediments

K.J. Mohamed, D. Rey, B. Rubio, A. Bernabeu

GEOMA. Dept. of Marine Geosciences. University of Vigo, 36310, Vigo. Spain.

Abstract

The magnetic properties of organic-rich marine sediments are a sensitive tool to detect and assess the occurrence of redoxomorphic early diagenesis. This phenomenon has been extensively studied in the Rias Baixas of Galicia, in the NW Iberian Margin. In these settings, enviromagnetic analyses have shown that the onset of reductive early diagenesis occurs within a few mm or cm from the sediment surface. Observed rates of dissolution of magnetic iron oxides vary within the typical range of reductive environments, with magnetite half-lives varying between a few decades to nearly 1,000 years.

Down-core profiles of magnetic properties along transects from the inner to the outer areas of the rias has also revealed the occurrence of a consistent magnetic pattern. Sediments from the inner ria areas are rapidly depleted in iron oxides. The depth of total depletion deepens towards the outer areas, with the development of an intermediate layer characterized by rapid changes in magnetic properties and the occurrence of the ferrimagnetic iron sulphide greigite. This intermediate layer also becomes progressively more important towards the outer ria areas.

The implications of reductive diagenesis and the ability to rapidly detect these changes analysing the magnetic properties of sediments include the mobility of trace metals. Trace metal pollution is of high societal concern in the Ria de Vigo, given its high population density and the concentration of industrial activities (shipyards, car manufacturing and port activities) in its coastal areas. In addition, shellfish harvesting and aquaculture are two important economic sectors especially sensitive to the degree of pollution and bioavailability of trace metals, given their intimate relationships with the sediments. The redox state is instrumental in the mobility and transformations of these pollutants, and therefore it is important to understand its effects.

Heavy metals tend to be adsorbed on the surface of magnetic Fe oxides, thus lowering their bioavailability. However, their dissolution during early diagenesis releases these metals into the pore waters, making them available to being absorbed by organisms. Trace metals bioavailability can also be reduced by their co-precipitation and adsorption to the iron sulphide pyrite, which is a major sink of pollutants in anoxic sediments. Fe sulphides are ubiquitous in sediments affected by reductive diagenesis below the level of sulphate reduction. The proximity of this level to the surface in inner areas of the rias increases the likelihood of these sediments being reoxygenated by bioturbation, by resuspension caused by waves and/or anthropogenic processes (trawling). Reoxygenation of sulphidic sediments releases trace metals to the pore waters, increasing the potential of inner areas of the rias as a potential source of trace metals.

The study of magnetic properties in the sediments of the Ria de Vigo has also shown its potential to detect anthropogenic alterations of sediments caused by land reclamation and/or heavy shipping activities. This alteration is observed as a disruption of the natural down-core magnetic pattern, with higher magnetic susceptibilities than expected according to the organic matter content of the sediments, and repeated low amplitude peaks down-core suggesting periodic reoxidation of the sediments. Scanning Electron Microscopic (SEM) analysis showed that iron sulphides are ubiquitous, but heavily altered. Typical alterations include an outer rim of deoxidized material, with secondary epitaxial growth of a new generation of iron sulphides. In addition, SEM images showed that grain size is very heterometric,

with a high proportion of non grain-supported detrital sand grains in a muddy matrix. This grain size heterogeneity is inconsistent with the low-energy hydrodynamics typical of the muddy central channel of the Ria de Vigo. Our findings are interpreted as the result of land reclamation building in different stages, with dumping of material causing strong remobilization and sedimentation of iron oxides. In addition, the turbulence caused by large car-carrier ships in the area may resuspend and reoxidize the sediments, exacerbating the departure from the natural down-core pattern of magnetic properties. This periodic reoxidation of iron-sulphides may increase the mobility of trace metals, which are especially concentrated in industrialized harbour areas, thus increasing their potential bioavailability and risk.

Our results provide an example of the application of magnetic properties of sediments with an environmental focus. Their non-destructive nature, low cost and rapid measurement provide an interesting tool for detecting natural changes in the composition of marine sediments and anthropogenic alterations, which may have important implications for the mobility of trace metals and their bioavailability.

Morphological features of the Portimao Bank Seamount (NW Gulf of Cadiz Margin) related to Pliocene-Quaternary activity.

M.C. Fernández-Puga¹, J.T. Vázquez², C. Roque³, B. Alonso⁴, T. Medialdea⁵, D. Palomino², G. Ercilla¹, V. Diaz del Río², L. Somoza⁵

¹*Departamento de Ciencias de la Tierra, Facultad de Ciencias del Mar y Ambientales, Universidad de Cádiz, Campus de Puerto Real, 11510, Puerto Real (Spain)*

²*Instituto Español de Oceanografía. Centro Oceanográfico de Málaga, Puerto Pesquero s/n, 29640, Fuengirola (Spain)*

³*Instituto Português do Mar e da Atmosfera, 1749-077, Lisboa (Portugal)*

⁴*Institut de Ciències del Mar, CSIC. Passeig Marítim de la Barceloneta, 37-49. 08003, Barcelona (Spain)*

⁵*Instituto Geológico y Minero de España. C/Ríos Rosas, 23. 28003 Madrid*

Abstract

The main aim of this work is the knowledge of the detailed morphology of the Portimao Bank which is an E-W structural seamount located in the distal sector of the South Portuguese margin, northeastern area of the Gulf of Cadiz, and it is bordered to the north by the Don Carlos Valley and to the south by the Cádiz Valley. This seamount has been described like a morphostructural high related to a Variscan basement high, strongly deformed by the NW convergence of Africa respect to Eurasia during the Pliocene-Quaternary as a pop-up structure (Terrinha et al., 2009). Current uplift has been related to thrust faults characterized by successive reactivations (Medialdea et al., 2004) during the Pliocene and Quaternary (Vázquez et al., 2003). This Bank exhibit a complex morphology result of tectonics, halokinetic and oceanographic processes mainly since Upper Miocene times to now.

This seamount has an elongated and asymmetric W-E shape of 93 km long and 15-28 km wide, and its summit is located at 1500 m water depth. The total surface is around 1800 km². The top is flat (approximately 0.2°) in the eastern sector, while in the central and western part higher gradients are found (2°-4°). The slope gradient increases on the flanks (4-15°); the southern flank is the steepest (12°-15°) and presents escarpment morphology, while the north-eastern flank is less steep (4-5°).

Along the surface of this high, in terms of morphological features and deposits, ridges, depressions, domes, mass movement deposits and escarpments have been identified on the Portimao Bank. A central circular depression of radius 6 km bounded between the western and eastern structural styles of the bank. The highlight in halokinetic processes is the presence of two domes in the central sector of the Bank that exhibit conical shapes. The diapirs uplift the recent sedimentary cover but they do not outcrop. The main dome is related to the Don Carlos Diapir uplift that are not outcrop in the seafloor. This is a circular dome-shaped area (47 km²) rising around 320 m above the high and surrounded by a circular depression. The other bulge, located 4 km towards the northwest of the Don Carlos diapir, is cone-shaped, occupies a smaller area (2.5 km²) and is 100 m high. Related to diapir activity, a 32 km-long ridge feature oriented W-E has been mapped on the top towards the north of the bank, which has been related to recent diapiric activity. Escarpments are found in the north-eastern part of the Portimao Bank which are 28 km long and rising 170 m above the seafloor.

Along the northern and southern flanks of the Portimao Bank it is possible to identify several slide scars with different features. In the southwestern one, it has been possible to identify five scar slides developed in a quasi radial manner from the D. Carlos Diapir in SW direction between 18 to 12 km long and 3 to 5 km wide. These slide scars seem to originate from the Don Carlos diapir uplift, and they extend downslope on the southern flank. Along the southeastern flank, it has been identified a slide scar 8 km long and 9 km wide with smaller slide scars inside. In the north western sector flank, the dimension of slide scars increase from the D. Carlos Diapir towards east, from 3 to 5 km long, and 2 km wide. In the

northeastern sector, three slide scars with sizes that decrease from west to east have been identified. The largest is 8,6 km long and 11 km wide and the smallest measure is 2 km long and 2,5 km wide.

In the northern sector has been observed the most recent and active deformation feature, which correspond to a ridge delimited at the seafloor surface by an anticline fold related to a blind thrust or diapirism, which causes marked deformation of the current sedimentary units.

Acknowledgements: This work was funded by the Seamounts of the southern Iberia: tectonics and sedimentation project (MONTERA-CTM2009-14157-C02-01-02) of the Spanish R & D Plan (MINECO).

References

- Medialdea, T., Vegas, R., Somoza, T., Vázquez, J.T., Maldonado, A., Díaz-del Río, V., Maestro, A., Córdoba, D. and Fernández-Puga, M.C. 2004. Structure and evolution of the "Olistostrome" complex of the Gibraltar Arc in the Gulf of Cadiz (Eastern Central Atlantic): evidence from two long seismic cross-sections. *Marine Geology*, 209 (1-4), 173-198.
- Terrinha, P., Matias, L., Vicente, J., Duarte, J., Luís, J., Pinheiro, L., Lourenco, N., Diez, S., Rosas, F., Magalhaes, V., Valadares, V., Zitellini, N., Roque, C., Mendes Víctor, L. and MATESPRO Team. 2009. Morphotectonics and strain partitioning at the Iberia-Africa plate boundary from multibeam and seismic reflection data. 2009. *Marine Geology*, 267, 156-174.
- Vázquez, J.T., Medialdea, T., Fernández-Puga, M.C., Llave, E., Hernández-Molina, F.J., Somoza, L., Vegas, R., Díaz-del Río, V., Maestro, A. and Terrinha, P. 2003. Terminación de las Unidades Alóctonas de Cádiz sobre el Banco del Guadalquivir. Deformaciones asociadas. *Thalassas*, 19 (2 a), 77-78.

Recent sedimentation in the Galician Internal Basin: Sediment Provenance, transport time and hydrodynamics over the last 60 Ky

M. Plaza Morlote¹, A. M. Bernabeu¹, O. Benazzouz², Virginia Martins², K.J. Mohamed¹, L. Pinheiro², D. Rey¹, S. Ribeiro³, B. Rubio¹, J. F. Santos³.

¹GEOMA, Department of Marine Geosciences and Territorial Planning, University of de Vigo, Spain

²CESAM & Department of Geosciences, University of Aveiro, 3810-193 Aveiro, Portugal

³GeoBioTec, Research Unit, Department of Geosciences, University of Aveiro, 3810-193 Aveiro, Portugal

Abstract

The sediments of the Galician Interior Basin are influenced by the Atlantic Meridional Overturn Circulation (AMOC) and by their proximity to the Western Iberia continental landmass, and thus provide an adequate archive to study the peculiarities of the last glacial-interglacial dynamics and the transition into present day conditions.

The aim of this study has been to analyse the sedimentary expression of climatic processes and forcings derived from the relation between the last North Atlantic glacial cycle and the local regional components -including abrupt climate changes and local events- since the end of the last glacial period in this area. We have attempted to establish the rates and magnitudes of change of this system to understand its climate dynamics, processes and feedbacks, and hence its role on a local to sub-regional scale from a palaeoclimatic proxies perspective. The inference of these climatic mechanisms encrypted in the deep-sea sedimentary record needs to constrain the spatial and temporal scales of the sedimentary processes involved, in particular the identification of source areas, pathways and transport, storage times and hydrodynamic conditions. In order to achieve these goals we have used a twofold approach; an initial effort to constrain the current sedimentary conditions to their associated local hydrography conditions by means of a mooring, which will be used to later infer the palaeoenvironmental conditions from sediment cores. The location of the mooring and the 5 coring locations has been based on the acquisition of new geophysical data: a precise 20 x 20 m bathymetry covering an area of 9860 km² and 690 km of high-resolution seismic profiles distributed in 10 transects that allow to investigate the main sedimentary units in the region. The mooring comprised 2 sediment traps located at 500 and 1400 m below the sea surface. These depths are under the influence of the Eastern North Atlantic Central Water (ENACW) and Mediterranean Water (MW). The sediment traps also target sediments from the shelf and the upper slope. Sediments were collected monthly for a 9 month period, whilst hydrographic conditions such as current speed, salinity, oxygen and turbidity were continuously recorded in associated instruments at the same depths. Finally, a multidisciplinary study combining resolution scans, including geochemistry (ITRAX), physical properties (GEOTEK) and enviromagnetic properties (2G cryogenic magnetometer), has been constrained using a very robust geochronology framework. Further analyses comprised grain size distributions, SEM, XRD, stable and high-precision radioactive isotopes.

The area consists mostly of generally autochthonous hemipelagic and terrigenous muds and sandy to silty muds with high clay content, showing abundant bioturbation and early diagenesis.

Allochthonous material of different provenances (characterized by ¹⁴³Nd/¹⁴⁴Nd and ⁸⁷Sr/⁸⁶Sr isotopic ratios) occurs interbedded within the hemipelagic sediments associated to Heinrich Stadials HS1 to HS6. The sediments also show significant changes in the vigour of bottom-currents (based on the \overline{SS} proxy) both within and between the HS.

The combination of these sedimentological, geochemical and geophysical data has provided a new insight into the role of current strength, circulation and sediment provenance changes in the area, and

allowed to establish across vs. along margin transport balances in the sedimentary record of the Galician Internal basin over the last 60 Ky.

Mapping the Spain's exclusive economic zone in the Galician margin

Gómez Ballesteros, M.¹, González-Aller, J-D.², Martín Dávila, J.³, Carbó, A.⁴, Somoza, L.⁵, Druet, M.¹, Martínez-Espinosa, S.², Catalán, M.³, Muñoz, A.⁴, León, R.⁵

¹*Instituto Español de Oceanografía, Madrid, Spain.*

²*Instituto Hidrográfico de la Marina, Cádiz, Spain.*

³*Real Observatorio de la Armada, Cádiz, Spain.*

⁴*Universidad Complutense de Madrid, Madrid, Spain.*

⁵*Instituto Geológico y Minero de España, Madrid, Spain.*

Abstract

In the context of the Hydrographic and Oceanographic Research of the Spain's Exclusive Economic program (ZEEE), operated jointly by Instituto Hidrográfico de la Marina (IHM) and Real Observatorio de la Armada (ROA) working in close collaboration with the Instituto Español de Oceanografía (IEO), Universidad Complutense de Madrid (UCM) and Instituto Geológico y Minero de España (IGME) have conducted seven oceanographic cruises in Galician waters (EEZ -01 -02 ZEE , ZEE -03, ZEE -06 -07 ZEE , ZEE- ZEE- 08 and 09). The main objective of the Spain's Exclusive Economic Zone project is mapping the seafloor, carrying out a systematic bathymetric survey of the 200 miles that comprise this area. In addition, as secondary objectives were performed acquiring that complement other geophysical parameters characterizing the seafloor and seabed from the knowledge of other variables such as the Terrestrial Magnetic Field , Terrestrial Gravity field, sound velocity and seabed internal structure.

For the acquisition of detailed and accurate information during these cruises, carried on board the BIO Hespérides, high-resolution geophysical techniques were used to compile the data and the bathymetry of the region was mapped using a multibeam system during which 100 per cent coverage was obtained. At the same time high-resolution parametric seismic reflection profiles, as well as gravity and magnetic, were also recorded in the survey areas. These systems provide data on bathymetry, quality seafloor, acoustics backscatter , gravimetry, magnetometry and subsurface structure and require the use of precise positioning techniques, so were used in conjunction with GPSD and inertial navigation systems.

As a result of these oceanographic researches and post-processing, analysis and interpretation of the whole acquired data, a synthesis of 6 maps were published with 1:500.000 scale and corresponding to Bathymetric map, Geomorphology map, Geomagnetic Anomaly map, Bouguer and Free Air Anomaly maps and backscatter map.

References

J. Martín Davila, M. Catalán, M. Larrán, Sección de Hidrografía del IHM, A. Carbó, A. Muñoz-Martín, JL Granja, P. Llanes, L. Somoza, R. León, F.J. Gonzalez, M. Gómez-Ballesteros, M. Druet, and J. Acosta, 2014: Zona Económica Exclusiva Española (ZEEE): Margen Continental Gallego. Mapas Generales de batimetría, de anomalías Geomagnéticas, Gravimétricas de Aire Libre y Bpouguer, Geomorfológico y Mosaico de Imágenes de Reflectividad (E. 1:500.000). Ministerio de Defensa. Secretaria General Técnica, NIPO: 083-12-230-3, DL: M-39518-2012

Morphological feature analyses of the Avilés Canyon System

Gómez Ballesteros, M.¹, Druet, M.¹, González-Pola, C.², Sánchez, F.³, García-Alegre, A.³, Arrese, B.¹, and Acosta, A.¹

¹*Instituto Español de Oceanografía. C/ Corazón de María 8, 28002 Madrid (Spain)*

²*Instituto Español de Oceanografía, C.O. de Gijón, Av. Príncipe de Asturias 70 bis, 33212 Gijón (Spain)*

³*Instituto Español de Oceanografía, C.O. de Santander, Promontorio San Martín s/n, 39080 Santander (Spain)*

Abstract

Morphological analysis was carried out on the north margin of Iberian Peninsula, in the Avilés Canyon System (ACS) a complex, structurally-controlled canyon and valley system (Gómez Ballesteros et al., 2014). Crossing the Cantabrian continental margin, from the shelf to the abyssal plain, is excavated the ACS between 6 ° 50' W - 5 ° 20' W and 43 ° 40' -44 ° 20' N. This region is part of the north compressive continental margin of the Iberian Peninsula (Boillot et al., 1979; Thinon et al., 2001; Gallastegui et al., 2002) and its morphology, especially the trace of the canyons that goes through the margin, is strongly influenced by the structural processes indicating a tectonic-controlled drainage pattern of the canyons. The ACS is constituted by three main canyons of different morphostructural character. They are, from east to west: La Gaviera Canyon, El Corbiro Canyon and Avilés Canyon. In addition to this ACS, a new canyon has been surveyed: Navia Canyon. Courses of submarine canyons converge at the foot of slope, where the transition to the abyssal plain occur very smoothly.

In this work, the great diversity of morphological, tectonic, sedimentary and oceanographic features, which define the complex geomorphology of the region of ACS have been analyzed.

The main tectonic morphological feature are the NW-SE, NNE-SSW and E-W structures imprint marked in the area and the tectonized rock outcrops located at the continental shelf. The main erosive features are: gullies, slide scars, erosive scarps and moats. Dominant depositional morphologies comprise: sedimentary wedges and lobes, patches, and sediment waves as megaripples and barchand-type dunes. Characterization, classification and distribution of these features and the relationship between them have been studied in order to establish the systems and sedimentary processes.

The method of study is based on detailed geomorphological analysis from multibeam echosounder bathymetric data and high resolution seismic TOPAS profiles recorded during different cruises carried out in the area under the LIFE-INDEMARES project, focused in the study of marine ecosystems biodiversity to de designed as Marine Protected Area.

References

- Boillot, G., Dupeuble, P.A., Malod, J., 1979. Subduction and tectonics on the continental margin off northern Spain. *Mar. Geol.* 32, 53–70.
- Gallastegui, J., Pulgar, J.A., Gallart, J., 2002. Initiation of an active margin at North Iberian continent-ocean transition. *Tectonics*, 21 (4), 15-1/15-13.
- Gómez-Ballesteros, M., Druet, M., Muñoz, A., Arrese, B., Rivera, J., Sánchez, F., Cristobo, J., Parra, S., García-Alegre, A., González-Pola, C., Gallastegui, J., and Acosta, J., 2014. Geomorphology of the Avilés Canyon System, Cantabrian Sea (Bay of Biscay). *Deep Sea Research II*, in press.
- Thinon, I., Fidalgo-González, L., Réhault, J.P., Oliver, J.L., 2001. Déformations pyrénées dans le golfe de Gascogne. *C. R. Acad. Sci. Paris, Sciences de la Terre et des planètes / Earth and Planetary Sciences* 332, 561-568.

Chemical Oceanography

Carbon chemistry in high-density cultures of marine microalgae

A. García-Fuentes¹, J. Forja², L.M. Lubián¹

¹Instituto de Ciencias Marinas de Andalucía (CSIC), Spain

²Universidad de Cádiz, Spain

Abstract

In previous studies, we established the carbon fractionation in a closed photobioreactor system for different microalgae species. Between a 5.40 and 13.05% of total carbon outputs in the system was the contribution of dissolved inorganic carbon, depending on the strain and culture conditions. Due to the importance of this fraction on the total carbon pool, we considered important to evaluate the effect on the carbon system of high-density cultures of different marine microalgae species: *Picochlorum atomus*, *Nannochloropsis gaditana*, *Tetraselmis chuii* and *Synechococcus sp.*, cultured in a closed photobioreactor.

Microalgae were cultured in a photobioreactor BIOSTAT®PBRs - 2S with steady temperature. CO₂ injection was modulated with a pH controller, maintaining a constant pH. Samples were taken daily for measurement of biomass, dissolved organic carbon (DOC), and simultaneous determination of dissolved inorganic carbon (DIC) and total alkalinity (AT). Organic bases (OB) are defined as the difference between measured AT and AT calculated from pH and the total DIC content.

Our cultures experimented an exponential growth ($R^2 > 0.94$), with final densities of 12.57, 855, 1167 and 1282×10^6 cell mL⁻¹ for *T. chuii*, *N. gaditana*, *P. atomus* and *Synechococcus sp.* respectively. In the same way, DOC, DIC, AT, HCO₃²⁻ and CO₃²⁻ showed an exponential increase ($R^2 > 0.90$) in their concentrations. Hence, DOC and these inorganic carbon species were directly related to cellular density in cultures ($R^2 > 0.91$) in all cases, except for CO₃²⁻ for *T. chuii* ($R^2 = 0.68$). The same pattern was found between DIC, AT, HCO₃²⁻ and CO₃²⁻ with DOC.

OB in these high-density cultures had a contribution up to 22% to AT depending on the cultured specie. These OB not only had an influence to the quantification of DIC, but also affected the intensity of the inflection points and shape of peaks in derivative titration curves. For the four cultures, the intensity of inflection points decreased when DOC and cellular densities increased.

The results of this study indicate that the culture of high densities of microalgae strongly affect the carbon chemistry of seawater. Furthermore, the evaluation of such organic bases in AT, provides a best quantification of inorganic carbon outputs applied to carbon balances in photobioreactors.

Iron solubility in mineral dust and aerosols generated from soil samples

Jerez Sarmiento, Vanesa P., Gelado – Caballero, María D., López García, Patricia

University of Las Palmas de Gran Canaria, Spain.

Abstract

Studies of Fe solubility are vital to improve knowledge of Fe speciation in the mineral aerosols and its bioavailability to marine organisms. During atmospheric transport, mineral aerosol particles undergo various processes that may increase its solubility. Most important are changes in pH, which occur during cloud formation.

In this work we have simulated the cycle of condensation and evaporation of clouds in samples of sieved African soils samples and compared the Fe solubility with natural mineral aerosols dry deposition (DD) samples collected on the island of Gran Canaria. The percentage of soluble Fe in the “precursor” aerosol increased from 0.19% to 0.67%, which was in agreement with values for the DD samples (0.23-0.68%). Our results show the effectiveness of the cloud simulation process, since there was a fivefold increase in the solubility of Fe, resulting in aerosol solubility comparable to that found in natural aerosol samples. Comparing the Fe speciation in soil and aerosol precursor samples with aerosol samples collected in Gran Canaria, a connection between chemical properties of aerosols and their soil origins can be demonstrated. Moreover, the high variability in Fe speciation in dry deposition samples suggests that atmospheric transport may be an important factor controlling aerosol solubility.

A study of alkalinity in aerosols collected in Gran Canaria, Spain during 2011

Desire Santana-Castellano¹, María Dolores Gelado-Caballero¹, Patricia López-García¹ and Jose Joaquín Hernández-Brito²

¹University of Las Palmas de Gran Canaria, Spain

²PLOCAN

Abstract

The solubility and bioavailability of aerosol elements that play an important role in the biogeochemistry in the ocean may be influenced by atmospheric process during transport and the presence of acidic and basic components. In this work, we studied the chemical characterization of particulate aerosols collected at Pico de La Gorra station, (1930 m altitude and located in Gran Canaria, Spain) during 2011, focusing primarily in the acid and basic components (pH, total alkalinity, and soluble NO_3^- , SO_4^{2-} , Ca and Mg). In addition, other major ion concentrations (like F^- , Cl^-) and soluble and total trace metal concentrations (Al, Fe, Ca, Na, K, Mg, Zn, Co, Cu, Cr, Ni, Cd, Pb, V) were determined. Total suspended particles (TSP) were collected on cellulose filters (WH 41) using high volume samplers and were subdivided into 8 equal parts for analysis.

Using soluble Ca and Mg as indicators of carbonate concentrations (CaCO_3 and MgCO_3), some variations in total alkalinity were detected between anthropogenic and African aerosols. In African dust outbreaks with TSP concentrations higher than $26 \mu\text{g m}^{-3}$ ($2 \mu\text{g Al m}^{-3}$), the relative concentration of these elements were lower compared with values for less dust load. In the anthropogenic aerosol group, despite high concentrations of acidic species (such as NO_3^- and SO_4^{2-}), relatively high carbonate concentrations appear to be acting to reduce the acidity of these aerosols.

Inputs of soluble aerosol-derived trace metals and nutrients to the Canary Basin. A study of factors that may influence bioavailability

P. López-García¹, M.D. Patey¹, M.D. Gelado-Caballero¹, J.J. Hernández-Brito²

¹*Chemistry Department, University of las Palmas de Gran Canaria, Spain*

²*PLOCAN, Spain*

Abstract

African dust inputs have important effects on climate and the marine biogeochemistry of the subtropical North Atlantic Ocean. The impact of dust inputs on oceanic carbon uptake and climate is dependent on total dust deposition fluxes as well as the bioavailability of nutrients and metals in the dust. There are very few sets of long-term measurements of aerosol concentrations over the North Atlantic Ocean, yet such data is invaluable in quantifying atmospheric dust inputs to this important ocean region and critical for constraining biogeochemical models.

In this work, we collected filters to calculate total suspended particle (TSP) concentrations continuously since 2002 and wet and dry deposition samples since 2004 in the island of Gran Canaria, Spain. Using soluble fractions of trace elements measured in this work, atmospheric deposition fluxes of soluble metals and nutrients are estimated. The influences in metal solubility due to the presence of acid components (like NO_3^- and SO_4^{2-}) or ligands (like oxalate) as well as the dust load were also studied.

Using the average of deposition flux at Tafira during 2004-2014 and considering that wet deposition is only 10% of the total flux, we were able to estimate the increase in dissolved trace metals and nutrients in the mixed layer during 1 year. These inputs of trace metals and nutrients seem to be significant relative to ambient concentrations in this area found in the literature, especially during the summer months when the water column is more stratified and nutrients inputs from deeper water are more limited.

Fisheries

Notes on the biology and bathymetric distribution of the family *Stomiidae* in Canary waters

S. Lugo, R. Ginés, A. D. Mathisen, C. Peña, C. R. Andrade, A. Sarmiento, A. Cruz, E. Caudet, J. J. Castro, F. Bordes, A. Barrera

University of Las Palmas de Gran Canaria, Spain.

Abstract

Biological data and distribution of the family *Stomiidae*; genres *Stomiinae* and *Bathophilus* of the Canary Islands (Central-East Atlantic) are given. Are provided the morphometric relationships of *Stomias boa*, *S. longibarbat*, *S. brevibarbat*, *Bathophilus vaillanti*, *B. pawnee*, *B. longininnis* and their respective bathymetric distribution. All specimens were captured in the surveys conducted by the R/V Bocaina between 1997 and 2002.

Notes on the biology and bathymetric distribution of *Lamppanyctus pusillus* in Canary waters

A. D. Mathisen, R. Ginés, S. Lugo, C. R. Andrade, C. Peña, A. Sarmiento, A. Cruz, E. Caudet, J. J. Castro, A. Barrera, F. Bordes

University of Las Palmas de Gran Canaria, Spain.

Abstract

The objective of this work is the distribution of *Lamppanyctus pusillus* in the vicinity of the Canary Islands (Central-east Atlantic). The length-weight relationship and different morphometric relationships are also described. Data on geographical and bathymetric distribution of the species in waters of the Archipelago are reported. All specimens were captured in the surveys conducted by the R/V Bocaina between 1997 and 2002.

Notes on the biology and bathymetric distribution of *Sternoptyx diaphana* in Canary waters

C. Peña, C. R. Andrade, S. Lugo, A. D. Mathisen, R. Ginés, A. Sarmiento, A. Cruz, E. Caudet, J. J. Castro, A. Barrera, F. Bordes

University of Las Palmas de Gran Canaria, Spain.

Abstract

The objective of this work is the distribution of *Sternoptyx diaphana* in the vicinity of the Canary Islands (Central-east Atlantic). The length-weight relationship and different morphometric relationships are also described. Data on geographical and bathymetric distribution of the species in waters of the Archipelago are reported. All specimens were captured in the surveys conducted by the R/V Bocaina between 1997 and 2002.

Fisheries Research in the European Union Framework Programmes

Rodríguez-Alfaro, S. & Castro, J.J.

Bioges, Departamento de Biología, Universidad de Las Palmas de Gran Canaria, Spain

Abstract

The Framework Programmes (FPs) for research have been the European Union's main instruments for funding research. This paper presents an overview of fisheries research projects funded by the European Union FPs over the last two decades, from the beginning of fisheries research at European Community level in 1988 until 2013 the last year of the 7th FP for Research and Technological Development.

It gives a brief introduction to the main structural changes to the different FPs. Additional details are provided on fisheries research, linking the funding allocation within each FP with the development of fish catches.

In total, 359 research projects on fisheries have been financed under EU research FPs since 1989. In the last 25 years, more than €361 million have been allocated to fisheries research under EU FPs. A structured view of fisheries research budget allocation within the EU Framework Programmes, shows the following distribution: Fisheries management (38.56%), interaction with the environment (16.01%), fish biology (16.25%), socio-economy and fisheries policy (12.55%), fisheries technology (8.17%) and research infrastructures (8.44%).

Surprisingly, there is no link between the investment in EU fisheries research and the amount of fish caught. Furthermore, this paper highlights the fact that within the EU research FPs, fisheries research as a research area, is becoming less and less important as the budget allocated to it has been drastically reduced in the last years.

A review of cooperative research on fisheries within the EU Framework Programmes is also provided showing the low participation of fishers in only a mere 3.89% of the EU Framework Programmes fisheries research projects.

The paper underlines the strategic importance of fisheries research for the competitiveness and sustainable development of the fishing industry, and for the proper implementation of the new Common Fisheries Policy.

By-catch composition of the striped soldier shrimp *Plesionika edwardsii* (Crustacea: Decapoda: Pandalidae) experimental fishery in the Cape Verde Islands

Triay-Portella, R.¹, V. García-Martín¹, A. Martins², N. Almeida³, C. Monteiro², S. Correia², G. González-Lorenzo⁴, S. Jiménez⁴, J.I. Santana¹, J.G. Pajuelo¹, J.M. Lorenzo¹ & J.A. González¹

¹*Grupo de Ecología Marina Aplicada y Pesquerías, Universidad de Las Palmas de Gran Canaria, Spain.*

²*Instituto Nacional de Desenvolvimento das Pescas de Cabo Verde*

³*Departamento de Engenharia e Ciências do Mar, Universidade de Cabo Verde*

⁴*Centro Oceanográfico de Canarias, Instituto Español de Oceanografía, Spain.*

Abstract

This work focuses on the by-catch composition of *Plesionika edwardsii* experimental fishery in the Cape Verde Islands. Obtaining information on abundance, composition and lifecycle of species involved in this potential fishery is useful, in order to ensure its sustainable development under an ecosystem approach. The first step towards this goal is the description of catches.

Four 15-day research surveys were conducted on board the R/V Prof. Ignacio Lozano: April 2010 (São Vicente and Santa Luzia islands), November 2011 (Santiago island), March 2012 (Boa Vista island,) and July 2012 (Sal and São Nicolau islands). The working depths were between 66 and 458 m depth. A standardized innovative fishing gear was used, so-called multiple semi-floating shrimp traps. Each fishing line was composed by 40-65 traps operating around 2.4 m above the seafloor, using *Decapterus macarellus* (*Carangidae*) as unique bait of the traps.

Multiple semi-floating shrimp traps is a passive fishing system that allows catch and release sea significant part of the unwanted catches, as in the case of *Chondrichthyes* or *Anguilliformes*, reducing the fishing impact on non-target species.

The main by-catch was composed of 53 species belonging to three groups including *Chondrichthyes* (three families and three species), *Crustacea* (11 families and 19 species) and *Osteichthyes* (15 families and 29 species). *Plesionika edwardsii*, the target species of this fishery, represented 97.8% of the catch in terms of abundance and 40.1% in biomass. By-catch represented 59.9% of total catch in terms of biomass. *Osteichthyes* (87.5%) were the dominant group and was represented by the following main families; *Sparidae* (33.9%), *Moridae* (32.5%), *Muraenidae* (32.5%), *Scorpaenidae* (9.9%) and *Tetraodontidae* (9.8%). *Chondrichthyes* (11.6%) were composed by *Centrophoridae* (65.3%) and *Triakidae* (34.1%). Finally, *Crustacea* (1.9%) were chiefly composed by *Pandalidae* (79.1%). However, different families represented by specific species were found to be dominant around each island. *Sparidae* were the dominant family represented by *Pagellus acarne* (46.2% of total by-catch) at São Vicente, and by *Dentex macrophthalmus* (42.6%) at Boa Vista. *Tetraodontidae* with *Sphoeroides pachygaster* (25.9%) and *Sparidae* with *P. acarne* (25.1%) were the co-dominant families in the by-catch around Santa Luzia. *Muraenidae* were the dominant family represented by *Gymnothorax polygonius* (69.4%) at Sal, and by *Muraena helena* (63.4%) at São Nicolau. Finally, *Scorpaenidae* with *Pontinus kuhlii* (22.3%) and *Moridae* with *Physiculus cyanostrophus* (22.1%) were the co-dominant families of the by-catch around Santiago.

Acknowledgements: This study is part of the PROACTIVA 1-2 (2009-2012) and MARPROF-CV (2010-2014) projects, in the framework of the Canary Islands Government and UE PCT MAC 2007-2013 programmes respectively.

Genetic Stock identification of The African Hind *Cephalopholis taeniops* in the Cape Verde archipelago

Santos K, Manent P, Lopes E, Quinteiro J, Almeida C, González N

University of Las Palmas de Gran Canaria, Spain

Abstract

The African Hind *Cephalopholis taeniops* is one of the most important commercial demersal species in the Cape Verde archipelago. The consequences of population reductions on genetic diversity due to an intensive fishing effort and the geographic distribution of the stocks are the main concerns towards its fishery's sustainability. For this reason, island genetic diversity estimates and genetic stock identification method have been combined in order to develop a more effective management in the region. To achieve those objectives DNA was extracted from fish samples of 5 islands and target regions of the mitochondrial DNA were amplified through PCR reaction. Then, nucleotide sequences were aligned to perform population genetic analyses such as population diversity indices, AMOVA, phylogenetic Neighbour-Joining Tree and haplotype Median Joining Network. Those analyses were used to relate genetic diversity with island fishing effort as well as to delimit discrete genetic units (stocks) of *C. taeniops* considering the geographical distribution of haplotypes across the archipelago.

Genetic traceability of canned fish products manufactured in Cape Verde

Nilson Brás, Isilda Fortes, Javier Quinteiro, Manuel Rey-Méndez, Corrine Almeida, Pablo Mament, Nieves González

University of Las Palmas de Gran Canaria, Spain

Abstract

Genetic traceability has been defined as the ability to identify the geographic origin and/or the essence of ingredients used in the elaboration of a food product or ingredient. The production of canned fish in the Cape Verde archipelago is supported by the local captures of the mackerel scad, *Decapterus macarellus* (Cuvier, 1833), and a number of scombrid species, including *Thunnus albacares* (Bonnaterre, 1788), *Auxis thazard* (Lacepède, 1800) and *Katsuwonus pelamis* (Linnaeus, 1758).

In canned food, morphological features that allow the identification of taxa used in the elaboration process are removed. In this context, the genetic identification of tissues is a tool useful within the industry traceability standards, to verify the authenticity of seafood, and to resolve questions about fraud or accidental substitution with less valuable raw material. The characterization of mitochondrial sequences (Cytochrome b, COX1 and control region) for the involved species was the first step to obtain a methodology of canned fish identification. This work was particularly relevant for *D. macarellus*, with limited available data for this species in Genbank. For the scombrid species the obtained mitochondrial DNA sequences was greatly complemented with abundant sequence information available in the Genbank data repository. The short (<500pb) sequences obtained by PCR from canned products were used for comparative analysis and phylogenetic inference allowing the unambiguously identification of samples. In addition, a protocol for rapid identification involving PCR amplification and RFLP analysis (PCR-RFLP), was designed and evaluated which allows the identification of a sample without the requirement of DNA sequencing methodology.

The importance of size frequency samplings and growth models for Atlantic Bluefin tuna, *Thunnus thynnus* (L.), stock assess

José Luis Cort

Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Spain.

Abstract

In the process of assessing ABFT resources, size samplings play an important role. The analytical model used (Cohort analysis) is based on the demographic structure of the population, which means that a growth model must be available in order to convert fish lengths sampled to ages.

The growth model used in the assessment of the eastern stock, $L_t = 318.85 [1 - e^{-0.093(t+0.97)}]$, equation 1 (Cort, 1991), is based on combined modal progression data and fin spine section readings.

During the 2010 meeting of the ABFT assessment group, for the first time two very similar growth equations were applied to the two stocks, to the western stock, $L_t = 314.90 [1 - e^{-0.089(t+1.13)}]$, equation 2 (Restrepo et al., 2010), based on combined modal progression data and otholiths readings, and equation 1 to the eastern stock. This use of similar equations represented a great step forward with respect to previous ABFT stocks assessments, as up until then two very different equations had been used: $L_t = 382 [1 - e^{-0.707(t+0.079)}]$ by Turner and Restrepo (1994), based on marked and recaptured ABFTs, for the western stock, and equation 1 for the eastern stock. The effects on the estimation of the Spawning Stock Biomass (SSB) for the use of different models of growth may be significant, as has been found in other tuna species (Wells et al., 2013).

However, two documents were presented to the SCRS ABFT group in 2011 (Luque et al., 2011; Landa et al., 2011) that put forward alternative relationships for the eastern ABFT stock. These authors argued that, based on reported ABFT catch lengths, the estimated $L_t = 382.7$ cm and $L_t = 341-348$ cm were more reliable than the currently used L_t for this stock. Indeed, ICCAT's ABFT database contains 412 records of fishes of over 330 cm (outliers), which indicates that there are countries that fail to submit their data to quality controls before sending them to ICCAT. Moreover, in ICCAT's ABFT manual, L_{max} is considered to be 427 cm.

In order to clarify the situation with respect to L_t and L_{max} , in 2012 the ABFT assessment group was presented with a document in which the value of L_{max} was determined based on a meta-analysis of published and available biometric data. In this document 224 scientific publications were consulted, from which almost 2.2 million values of ABFT L_s data were available. An additional 273,050 L_s measurements from the unpublished sampling data of various scientific institutions and private companies were also used in the analysis. The total available dataset comprised 2,458,028 ABFT. The result obtained was: $L_{max} = 319.93 \pm 11.3$ cm for $P_{max} = 725$ kg.

In order to remove L_s and W_s outliers from the various datasets available, Fulton's condition factor, K (Ricker, 1975), was calculated for each and every fish. Tukey's outlier method, based on the distribution quartiles (Tukey, 1977; Hoaglin et al., 1983), was then used considering two samples that are different in nature: one of wild tuna and another of tuna from fattening farms.

The paper concludes that the growth equation now used by the ABFT assessment group for the eastern stock (equation 1) adapts to the biology of the growth of this species throughout its lifecycle, the value of L_t (318.85 cm) being within the confidence limits (95%) of L_{max} obtained in the present study, $L_{max} = 319.93 \pm 11.3$ cm. These conclusions are also valid for the equation of the western Atlantic (equation 2). Therefore, the value of L_{max} for ABFT should be established at 331 cm and all records of fish of greater L_s should be removed from the ICCAT bluefin tuna database. This paper was published by *Reviews in Fisheries Science* in 2013 (Cort et al., 2013).

In the light of all these considerations we can conclude that appropriately conducted size frequency samplings and growth models are of fundamental importance for ABFT stock assessment.

References

- Cort, J. L. Age and growth of the bluefin tuna, *Thunnus thynnus* (L.) of the Northeast Atlantic. Col. Vol. Sci. Pap. ICCAT 35: 213-230 (1991).
- Cort, J. L., S. Deguara, T. Galaz, B. Mèlich, I. Artetxe, I. Arregi, J. Neilson, I. Andrushchenko, A. Hanke, M. N. Dos Santos, V. Estruch, M. Lutcavage, J. Knapp, G. Compeán-Jiménez, R. Solana-Sansores, A. Belmonte, D. Martínez, C. Piccinetti, A. Kimoto, P. Addis, M. Velasco, J. M. De la Serna, D. Godoy, T. Ceyhan, I. Oray, S. Karakulak, L. Nøttestad, A. López, O. Ribalta, N. Abid, and M. Idrissi. Determination of Lmax for Atlantic Bluefin Tuna, *Thunnus thynnus* (L.), from Meta-Analysis of Published and Available Biometric Data, *Reviews in Fisheries Science*, 21:2, 181-212 (2013).
- Hoaglin, D. C., F. Mosteller, and J.W. Tukey (Eds.). *Understanding Robust and Exploratory Data Analysis*. New York: John Wiley & Sons (1983).
- Landa, J., E. Rodríguez-Marín, P. L. Luque, M. Ruíz, and P. Quelle. Growth of bluefin tuna (*Thunnus thynnus*) in the North-eastern Atlantic and Mediterranean based on back-calculation of dorsal spine annuli. ICCAT, SCRS/2011/178, 12 p. (2011).
- Luque, P., E. Rodríguez-Marín, M. Ruíz, P. Quelle, J. Landa, and D. Macías. A review of direct ageing methodology using dorsal fin spine from Atlantic bluefin tuna (*Thunnus thynnus*). ICCAT, SCRS/2011/176, 22 p. (2011).
- Restrepo, V. R., G. A. Díaz, J. F. Walter, J. Neilson, S. E. Campana, D. Secor, and R. L. Wingate. Updated estimate of the growth curve of western Atlantic bluefin tuna. *Aquat. Living Resour.* 23: 335-342 (2010).
- Ricker, W. E. Computation and interpretation of biological statistics of fish populations. *Bull. Fish. Board Canada*, 191: 1–382 (1975).
- Tukey, J. W. *Exploratory Data Analysis*. Reading, MA: Addison-Wesley Publishing Co., 44 pp. (1977).
- Turner, S. C., and V. R. Restrepo. A review of the growth rate of west Atlantic bluefin tuna, *Thunnus thynnus*, estimated from marked and recaptured fish. Col. Vol. Sci. Pap. ICCAT 42: 170-172 (1994).
- Wells, D., S. Kohin, S. Teo, O. E. Snodgrass, and K. Uosaki. Age and growth of North Pacific albacore (*Thunnus alalunga*): Implications for stock assessment. *Fisheries Research* 147, 55– 62 (2013).

Climate Change

Seagrasses: the Fighter of the Coastal Ecosystems. Is the Climate Change their Achilles heel?

Carmen Henares Gómez

Máster en Oceanografía, Facultad de Ciencias del Mar y Ambientales, Universidad de Cádiz, 11510 Puerto Real, Cádiz, Spain

Abstract

Climate change is caused by the rising greenhouse gases from anthropogenic activity and changes in land-use, especially deforestation, as well which release a large amount of organic carbon (Corg) stored. While the role of terrestrial forests as a Corg stored (C sink) is well known, new evidence indicates that 55% of Corg captured by biosphere is due to marine organism called "blue carbon". Vegetated coastal areas, despite their small marine area occupied and their high rates of global losses ($0.7-2\% \text{ y}^{-1}$) are known to be an important Corg store. Within these areas, blue carbon from seagrass is important for the magnitude and it is composed of both autochthonous and allochthonous Corg which can be sustained over millennia in their sediments unlike other ecosystems. Thus, seagrass beds act as authentic hot spots in carbon burial and beginning to consider initiatives for protection because of its importance in the fight against climate change. Seagrasses cover about 0.1–0.2% of the global ocean, and develop highly productive ecosystems which fulfil a key role in the coastal ecosystem. Widespread seagrass loss results from direct and indirect human impacts, including negative effects of climate change (erosion by rising sea level, increased storms, increased ultraviolet irradiance, eutrophication, etc.). United Nations advances the importance of reducing this source of GEI mitigating climate change through the conservation of forests, which act as stores of organic carbon (Corg), called Green Carbon by "Reduced Emissions from Deforestation and program degradation (REDD +) that uses financial incentives for conservation. Three key actions are needed to ensure the effective conservation of seagrass ecosystems: (1) the development of a coherent worldwide monitoring network, (2) the development of quantitative models predicting the responses of seagrasses to disturbance, and (3) the education of the public on the functions of seagrass meadows and the impacts of human activity.

KEY WORDS: Climate change · Blue Carbon · Carbon sink · Seagrass beds · Carbon burial · Conservation.

Blue Carbon & the Oceans

María del Rosario Martín-Hervás Santos

Máster en Oceanografía, Facultad de Ciencias del Mar y Ambientales, Universidad de Cádiz, 11510 Puerto Real, Cádiz, Spain

Abstract

Knowledge of the role of natural ecosystems in capturing CO₂ is an increasingly important component in developing strategies to mitigate climate change. Of all the Green carbon captured annually in the world, over half (55%) is captured by marine living organisms and sequestered in vegetated coastal ecosystems, specifically mangrove forests, seagrass beds, and salt marshes and it has been termed “blue carbon”. Although their global area is one to two orders of magnitude smaller than that of terrestrial forests, the contribution of vegetated coastal habitats per unit area to long-term C sequestration is much greater. However, while increasing efforts are being made to slow degradation on land, these systems are being lost at critical rates and the loss of blue carbon sinks represents, in addition to the impacts on biodiversity and coastal protection involved, the loss of a natural carbon sink, eroding the capacity of the biosphere to remove anthropogenic CO₂ emissions. While overall emissions from the burning of fossil fuels needs to be severely reduced, mitigating climate change can also be achieved by protecting and restoring natural ecosystems.

KEYWORDS: Climate change, blue carbon, anthropogenic CO₂ emissions

We appreciate the support from the following institutions:

