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ON MARINE SCIENCES
LAS PALMAS DE GRAN CANARIA

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06-08 de julio de 2022

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FACTORS AFFECTING CATCH PER UNIT EFFORT OF RED GROUPER (*Epinephelus morio*) CAUGHT BY THE SEMI-INDUSTRIAL FLEET IN THE CAMPECHE BANK, MEXICO

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Abstract: In fisheries science, the catch per unit effort (CPUE) is assumed to be proportional to the abundance of the resource and it is used as an indicator in stock assessment. However, proportionality is rarely fulfilled (hyper-stability is the overestimation of abundance and hyper-depletion is an underestimation of abundance) (Hilborn and Walters, 1992). One way to approximate proportionality is to model nominal CPUE (raw data), to remove non-constant effects on catchability (Maunder and Punt, 2004). The red grouper is the main target species of a multi-specific fishery in the Campeche Bank (CB), this species is classified as overfished and two Mexican fleets are currently operating: small-scale fleet and semi-industrial fleet (Monroy et al., 2010). The objective of the present work was to determine the factors that affect the CPUE of the caught red grouper by the semi-industrial fleet from 1996 to 2019 in the CB. The CPUE was defined as kg of red grouper per effective fishing day. 256 Generalized Additive Models (GAM) were fitted to analyze the effect of eight variables on the CPUE of red grouper. The multi-model inference was used to determine the best GAM candidate that explains the variation of the CPUE of this species (fitted CPUE) which was the one that included as explanatory co-variables the sea surface temperature, depth, year, month, fishing area, navigation days, number of crew and fishing gear (Deviance explained = 39.53% and pseudo-R^2 = 0.39). Although, the trends between nominal CPUE and fitted CPUE by the best model were similar; the nominal CPUE was significantly higher than the predicted CPUE. This work confirmed the hypothesis of the influence of variables on the CPUE of the red grouper. The generated index could be used in the assessment of red grouper in the CB.

Key words: American grouper, CPUE, Semi-industrial fleet, Campeche Bank

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The variability of the surface CO_2 system and air-sea exchange in the Northeast Atlantic based on VOS data.

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Abstract: The seasonal and spatial variability of the CO_2 system parameters and air-sea CO_2 exchange was studied in the Northeast Atlantic through the Northwest African coastal transitional area between the Canary Islands and the Strait of Gibraltar. High spatio-temporal resolution data were collected by a Surface Ocean Observation Platform (SOOP) aboard a volunteer observing ship (VOS) from February 2019 to February 2020. The variability of the CO_2 fugacity in seawater ($fCO_{2,sw}$) was strongly driven by the seasonal pattern of the sea surface temperature (SST), which increased with latitude and was lower throughout the year in the high-intense coastal upwelling areas. The $fCO_{2,sw}$ increased from winter to summer by 11.84 ± 0.28 µatm $ºC^{-1}$ in the Canary archipelago and by 11.71 ± 0.25 µatm $ºC^{-1}$ along the northwest African continental shelf. The thermal to non-thermal effect ratio (T/B) was approximately 2, with minimum values along the African coastline explained by higher biological activity in the upwelled waters. The factors controlling the seasonality of total inorganic carbon (C_T) normalized to constant salinity of 36.7 (NC_T) were assessed. The effect of net community production on NC_T between February and October represented >90% of the reduction of inorganic carbon while air-sea CO_2 exchange described <6%. The seasonality of air-sea CO_2 fluxes was driven by SST fluctuations. The surface waters of the entire region acted as a strong CO_2 sink during the cold months and as a weak CO_2 source during the warm months. A net annual CO_2 sink behaviour was observed in both the Canary basin (-0.26 ± 0.04 mol C m^{-2} yr^{-1}) and the northwest African continental shelf (-0.48 ± 0.09 mol C m^{-2} yr^{-1}). The calculated average CO_2 flux for the entire area in the Northeast Atlantic was -2.65 ± 0.44 Tg CO_2 yr^{-1} (-0.72 ± 0.12 Tg C yr^{-1}).

Keywords: CO_2 system, air-sea CO_2 exchange, Northeast Atlantic, Surface Ocean Observation Platform, VOS line.

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EXAMINING HISTORIC AND CURRENT DIVERSITY PATTERNS OF PELAGIC CNIDARIA AND CTENOPHORA IN THE ISLAND SYSTEM OF MACARONESIA

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Abstract: Jellyfish are important components of the marine ecosystem and present a potential resource for different economic domains (*e.g.*, medicine, food, and biotechnology). We present an overview of the current state of jellyfish biodiversity in the Macaronesia region, which includes the archipelagos of the Azores, Madeira, the Canary Islands and Cape Verde, and examine possible biogeography patterns among its archipelagos. Based on a comprehensive literature survey, historical and new records, diversity and biogeographical distribution, our search included organisms belonging to Scyphozoa, Hydrozoa (strictly benthic species excluded) and Ctenophora. Our search detected 229 jellyfish species, with a dominance of holoplankton species, likely reflecting the insular and coastal morphology of the archipelagos. Differences in species richness, endemism and species affinities are found between the Azores, Madeira, Canary, and Cape Verde Island systems. The shared trend includes the dominance of holoplanktonic hydrozoans, while the second most speciose taxa (Scyphozoa and Ctenophore) vary between the archipelagos. While widespread distributed holoplankton predominates in the area, species with strict affinities suggest a pattern in the spatial distribution of jellyfish, dividing Macaronesia into two biogeographic units: (i) Azores-Madeira-Canary with temperate and subtropical and/or tropical species and (ii) Cape Verde with strictly subtropical and/or tropical species.

Keywords: Azores, Biodiversity, Canary Islands, Cape Verde, Jellyfish, Madeira

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EVIDENCES OF INTERMEDIATE DISTURBANCE HYPOTHESIS FROM ORGANISMS TO COMMUNITIES

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Abstract: The "Intermediate disturbance" hypothesis postulated by Connell (1978) for tropical forest and coral reef ecosystems considers that ecosystems are unstable, being species diversity higher when physical or biological disturbances exist at intermediate scales. Since then, there has been a debate about the validity of this across marine ecosystems. We have investigated whether the "Intermediate disturbance" hypothesis could also be applied at different levels of organizations (organisms and communities). In order to do so we have used, as our experimental framework, a naturally acidified system off La Palma Island (Gonzalez-Delgado et al. 2021) where a clear gradient of fluctuating pH can be found. We have used molecular data from a fragment of the mitochondrial gene Cytochrome c Oxidase subunit I (COI) of two sea urchin species (*Arbacia lixula* and *Paracentrotus lividus*) and from metabarcoding technique applied to the whole benthic community. The two sea urchins and the benthic community samples were collected from four sites across the pH gradient (the *Vent* site where pH fluctuates between 7.79-7.21; *Transition-1* site with pH fluctuations from 7.99 -7.59; *Transition-2* site with pH fluctuations between 8.01 -7.79; and a *Control* site with pH between 8.04 – 8.03). Using these molecular data we obtained the haplotype and nucleotide diversity of the two species, and the benthic species diversity. For *A. lixula* and *P. lividus* the highest levels of haplotype and nucleotide diversity were measured at the transition area; in parallel the results of the metabarcoding showed that the highest levels of taxonomic diversity (algal and metazoan) were also found at the transition area. Our results support the validity of the "intermediate disturbance" hypothesis (Connell 1978) in macroalgae subtropical ecosystem and across organization levels.

Key words: Intermediate disturbance hypothesis, Eucaryotic metabarcoding, genetic diversity, benthic community, sea urchins.

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EFFECTS OF THE SUBMARINE EMISSION FROM A VOLCANO ON MARINE ZOOPLANKTON REVEALED BY CARBON ISOTOPES

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Abstract: On October 10, 2011, the underwater volcano, Tagoro, erupted in the south of the island of El Hierro (Canary Islands), Atlantic Ocean. This eruption had consequences, causing physical and chemical changes (Fraile-Nuez et al., 2012; Santana-Casiano et al., 2013; 2016) in the water column resulting in alterations to the distribution of the pelagic fauna (Ariza et al., 2014) during the first stage of the volcano, and variations in the structure of the zooplankton community in the following post-eruptive stages between 2013 and 2018 (Fernández de Puelles et al., 2021). In addition, this eruption could have altered the local carbon and nitrogen cycle due to changes in nutrient concentrations, which affect phytoplankton growth, and the isotopic signatures of zooplankton. These responses were measured during the post-eruptive phase using the stable isotope $\delta^{13}C$ and $\delta^{15}N$. An increase in CO_2 alters the response of isotopic fractionation in plankton across a CO_2 gradient (Witkowski et al., 2020). A high-resolution study was conducted across 15 stations along the Tagoro volcano, separated into four zones of volcanic influence on zooplankton. We focus on the two most abundant taxonomic groups, Chaetognatha and Copepoda as predator and prey respectively in the second level of the marine food web. Significant spatial differences were found in these secondary consumers of plankton. These differences are explained mainly by an increase in the carbon isotopic signature of copepods between the Tagoro Vulcano (zone 1) to the most distant zone (zone 4) of the area studied for Copepods, and mainly in the species of the genera *Nasutus* sp. and *Sewelli* sp. This is consistent with the idea that CO_2 concentrations have an important effect on isotopic fractionation, with an $\delta^{13}C$ enrichment of ca. 2‰ from the volcano to the control area. This baseline information plays an important role in addressing gaps in the knowledge concerning the objectives to be implemented in the current Marine Strategy Framework Directive, as well as Sustainable Objective 14, Life Under Water.

Key words: Biomarker, Good environmental status, Marine Strategies, Sustainable Development Goal 14, Zooplankton

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REPRODUCTIVE STRATEGY OF LARGE-SCALED GUNARD *Lepidotrigla cavillone* (LACEPÈDE, 1801) FROM THE BALEARIC SEA (WESTERN MEDITERRANEAN)

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Abstract: This study presents the first data on the reproductive biology of the large-scaled gurnard *Lepidotrigla cavillone* (Teleostei: Triglidae) in the Western Mediterranean. Specimens were collected monthly during one year (February 2021-April 2022) from commercial trawl catches and the MEDITS bottom trawl survey carried out in the Balearic Islands. To assess the reproductive status and condition of females the gonadosomatic index (GSI), hepatosomatic index (HSI), Le Cren's condition factor (Kn), and the digestive somatic index (DSI) were calculated. We analyzed a total of 810 individuals ranging from 7.5 to 14.5 cm in total length. Females represented the 54.3% of this population. Maximum values of GSI were observed between March-April and between June-August, suggesting a protracted spawning season in spring-summer. During these periods, DSI shows its highest values, while both HSI and Kn decrease at the beginning of the spawning season. According to these results, females feed throughout the year, with reproductive expenditure being mainly at the expense of muscle and/or visceral reserves; the liver only seems to be important as a reserve at the onset of spawning when food intake is probably not sufficient to cover the lipid and protein demand associated with gonadal development. This suggest a mixed capital-income bioenergetics strategy. According to the histological analysis of ovaries (N=150), L. cavillone presents asynchronous oocyte development, pointing to indeterminate fecundity type and batch spawning strategy. Batch fecundity, estimated by the gravimetric method, was between 522 and 2249 hydrated oocytes per female, relatively low compared to most Scorpeniformes in the Mediterranean. These results are a valuable contribution to the knowledge of this poorly known bycatch species in the Mediterranean.

Key words: Somatic indices, Oocyte dynamics, Spawning season, Batch Fecundity

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UNDERSTANDING THE RISE OF CEPHALOPODS IN THE WESTERN MEDITERRANEAN USING BIODIVERSITY INDICATORS

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Abstract:
Increasing impacts of both fisheries and climate change have resulted in changes in the structure, functioning and related ecological metrics of marine communities. A recurrent observation is the rise of cephalopods as fish communities recede. The reason behind this phenomenon is most likely linked with the removal of main predators and competitors by fishing. However, the consequences of climate change (variations in primary production, changes in stratification, and sea warming, among others) may also have an influence due to the high environmental sensitivity and plasticity of cephalopods. Here we aim to unveil the effects of different drivers in the cephalopod community of the Western Mediterranean Sea as well as its differential role in space. We combine several ecological indicators offering a wide range of information about biodiversity, production, trophic structure and relative contribution of prey and predators and relate them with environmental and fisheries drivers of change. The ecological indicators are calculated using data from the MEDITS trawling survey in the region (from the Alboran Sea to the Gulf of Lion) from 2013 to 2019. Our results highlight the response of ecological indicators to several drivers of change and the spatial differences in cephalopod communities with, for instance, higher richness and proportion of predator cephalopods in areas associated to higher SST and fishing effort. Overall, the effect of the environment is greater than the effect of other variables; such results may highlight that under foreseeing scenarios of climate change cephalopods could

continue to increase due to increases in sea warming.

Key words: Ecological indicators, Mediterranean Sea, Cephalopods, ecosystem change, climate change, fisheries

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COCCOLITHOPHORE PRODUCTIVITY CHANGES DURING THE PLIO-PLEISTOCENE CLIMATE TRANSITION

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Abstract:

The global climate of the 21th century is characterized by increasing levels of atmospheric carbon dioxide (CO_2) due to anthropogenic emissions (IPCC, 2018). How this trend will impact the climate in the future is a major concern for society. In an effort to better understand the structure and functioning of the global climate in a high CO_2 world it is essential to study potential analogs in Earth´s history. The Pliocene climate is an ideal candidate for this approach as the climate during this interval was characterized by a CO_2 concentration close to today´s levels and the land-ocean configurations was similar to the current one (Bartoli et al., 2011; Pagani et al., 2010; Seki et al., 2010). In this study we use calcareous phytoplankton remains (coccolithophores) preserved in deep-sea sediments to reconstruct environmental conditions during the Plio-Pleistocene climate transition in the Southern Ocean which plays a major role in the global climate system. Coccolithophores are unicellular autotrophic organisms sensitive to environmental variations and therefore are an excellent tool to reconstruct paleoenvironmental conditions (Thierstein & Young, 2004; Winter & Siesser, 1994). Shifts in the coccolithophore assemblages identified in the sediment cores retrieved from the south Pacific and south Atlantic oceans are related to paleoceanographic and global climatic events. Our results suggest that Pliocene climate was characterized by higher sea surface temperatures and a more southward position of the Subtropical Oceanic front in the Southern Ocean. At the end of the Pliocene our data reveal a cooling trend in the Southern Ocean coinciding with the intensification of the Northern Hemisphere Glaciation (Bartoli Sarnthein M. Weinelt M., 2006) and a decrease in atmospheric CO_2 (Bartoli et al., 2011).

Key words: Coccolithophores, Southern Ocean, Pliocene

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ORGANOPHOSPHATE ESTERS IN THE WATER COLUMN AND SURFACE MICROLAYER OF THE ATLANTIC OCEAN

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Abstract: Organophosphate esters (OPEs) are synthetic organic chemicals widely used as plasticizers and flame retardants in the industry, in household consumer products and in personal care products. Their range of physicochemical properties is wide, influencing their transport and biogeochemistry in the marine environment (Xie et al., 2022). Our goal was to assess the spatial and vertical distribution of OPEs by sampling and analysing samples taken during a latitudinal transect through the Atlantic Ocean (from latitude 40 ºN to 55 ºS). Surface seawater was analyzed from 24 sampling stations, while the surface microlayer (SML) and vertical profiles (5-6 different depths from surface to 2000 m depth) were assessed at 9 and 7 stations, respectively. A total of 24 individual OPEs were targeted, among which 13 compounds were found ubiquitous in Atlantic waters (TEP, TiBP, TNBP, TCEP, 1, 2, 3-TCPP, TDCIPP, TPhP, TBEP, EHDP, TEHP, TmCP). Maximum concentrations were found in tropical waters of the SE Atlantic off-shore Brazil. At the SML, the top 0.1 mm layer at the air-water interface as sampled with a glass plate, we found higher OPE concentrations when compared to underlying waters by SML enrichment factors ranging between 1.2 to 24. Therefore, OPEs show a tendency to accumulate at the surface of the ocean, as it has been demonstrated for other organic pollutants, with implications for their potential long-range transport through sea-spray aerosol formation (Casas et al., 2021). Regarding the vertical profiles, we have found different trends depending on the locations, with maximum concentrations at surface waters, consistent with atmospheric deposition as one of the inputs. However, a second maximum was often found at deep waters, suggesting that vertical transport by settling particles may lead to the accumulation of OPEs in the deep ocean. The results will be shown in connection with other physical, chemical and biological variables explaining their transport and water column biogeochemistry.

Key words: Flame Retardants, Biogeochemistry, OPEs

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VIII INTERNATIONAL SYMPOSIUM
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POPULATION GENOMICS AND ADAPTATION IN *Marthasterias glacialis* BASED ON SINGLE NUCLEOTIDE POLYMORPHISMS

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Abstract: *Marthasterias glacialis* is a widespread sea star, across the Atlantic-Mediterranean area. Previous studies demonstrated the existence of two mitochondrial lineages within the species that presented different geographical distribution (Pérez-Portela et al., 2010; Pérez-Portela et al., 2017), one of them being Atlanto-Mediterranean and the other endemic to the Mediterranean. To date, the limited nuclear information available for this species has impeded the elucidation of this population genomic structure and patterns of local adaptation, as well as the clarification of whether these two mitochondrial lineages actually correspond to two isolated evolutionary units. To clarify these questions, we generated double digested Restriction-site Associated DNA sequencing (ddRAD-Seq) data for 161 samples collected in 17 localities from the north-east Atlantic to the east Mediterranean coasts. We identified 10,388 Single Nucleotide Polymorphisms (SNPs) suitable for population genomics and local adaptation analyses. Population genomic structure and potential mitochondrial divergence were assessed applying different statistical approaches. All analyses demonstrated significant differences among populations and three main geographical areas: the Azores, continental Atlantic and the Mediterranean. Nevertheless, no nuclear divergence between mitochondrial lineages was detected. Patterns of local adaptation were also explored based on the detection of outlier markers and redundancy analyses considering two major environmental parameters: temperature and salinity. Nuclear and mitochondrial data showed a divergent history, likely related to the isolation of lineages during a glacial period of the Pleistocene. During glacial periods, interruptions in gene flow between the Atlantic and Mediterranean basins could have promoted divergence between nuclear and mitochondrial lineages, with a posterior secondary contact that would have allowed the Atlantic newly created lineage to colonise the Mediterranean, following the main current system in this area. An incomplete lineage sorting would have allowed nuclear lineages to mix again, whereas the mitochondrial ones would have persisted over time due to the absence of recombination.

Key words: SNPs, population genomics, ddRAD-Seq, sea star, marine invertebrate, local adaptation.

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MICROALGAE PHYCOTECHNOLOGY FOR THE RECOVERY OF RESOURCES FROM MARINE FISH FARMING STREAMS

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Abstract: This work focuses on using a fish farm stream as a culture medium for the production of microalgae and the reduction of the mass flow of nutrients and the use of the biomass generated as an ingredient of fish feed.

First, two different fish production systems, the flow-through system (FTS) and the recirculation aquaculture system (RAS), were studied to produce microalgae. The results indicate that a nitrogen concentration above 8mg L^{-1} is necessary to cultivate microalgae without biomass recirculation. Therefore, the RAS system was the more suitable process for nutrient recovery. A total of six species (*Nannochloropsis gaditana, Pavlova lutheri, Isochrysis galbana, Tetraselmis chuii, Phaeodactylum tricornutum, Chaetoceros gracilis*) and a bloom were studied at laboratory scale (18 L), obtaining productivities between 7 and 71 mg L^{-1} d^{-1} and dissolved nitrogen consumption rates between 0.15 and 12.6 mg L^{-1} d^{-1}.

A raceway reactor was designed and constructed for microalgae cultivation (6000 L). They were located in a 450 t $year^{-1}$ sole production facility of Cultivos Piscícolas Marinos S.A. (CUPIMAR), using the RAS purge stream enriched with phosphorus up to 1 mg L^{-1} as a culture medium. T. chuii was cultured due to higher productivity (15 - 78 mg L^{-1} d^{-1}) and protein concentration (36 - 50 %), and both the effluent and the microalgae biomass generated at pilot scale were characterised. Two sole feeds were formulated, including 10 and 20 % algal biomass (T. chuii), reducing the fishmeal content by 25 %. No significant differences were found in the growth rate and proximal composition in juvenile sole fattening trials with both experimental feeds.

Key words: Fish farm, Marine RAS, Microalgae biotechnology, Nutrient removal, Fish feed, Sole

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MARINE MICROALGAE AND CYANOBACTERIA STRAINS FOR BIOREMEDIATION PROCESSES AND BIOSTIMULANT ACTIVITY: OUTPUTS FROM THE SABANA PROJECT

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Abstract: Marine eucaryotic microalgae and cyanobacteria from the BEA Culture Collection have been selected and assayed to evaluate bioremediation capabilities and biomass biostimulant activity under the framework of the H2020-SABANA Project. After an initial screening of 50 strains for growth performance at laboratory scale, biochemical composition and bioactivity determination, a final group of 6 strains was evaluated at an outdoor pilot scale using seawater diluted centrate (wastewaters obtained from a sludge anaerobic digestion process) as a culture medium, in two cultivation systems (tubular PBRs and open raceway ponds ORPs), during periods longer than 6-months. The simultaneous study of the biomass and biochemical productivity was performed in semi-continuous mode. Productivity, growth performance, nutrient removal capacity, biomass nutritional composition, microbiology, heavy metal content, and microalgae-bacteria consortium dynamic were studied and compared.

Selected strains were included into the bioassay work. The harvested biomass samples were freeze-dried and tested for their hormone-like activities: (1) auxin-like activities, and (2) cytokinin-like activity. The bioactivity was strain-dependent, but strongly influenced by the physiological status of the strain. Therefore, bioactivities of laboratory biomass samples were always similar to each other, while biomass samples produced in outdoor cultures either in nutrient medium or in diluted centrate showed varying, lower or higher bioactivities than the laboratory samples. One marine strain with plant biostimulating (*Chrysoreinhardia giraudii* BEA 0313B) and two with biopesticide activities (*Dolichospermun* sp. BEA 0866B and *Anabaena* sp. BEA 0912B) were selected as final candidates for application developments. Final conclusions focused on the methodologies and experimental activities carried out at the facilities of BEA in Taliarte (Gran Canaria) will be presented and discussed.

Key words: Microalgae, cyanobacteria, bioremediation, biostimulant activity, biomass production, Canary Islands

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BACTERIOPLANKTON SUCCESSION DURING THE ARCTIC OCEAN SPRING BLOOM

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Abstract: Environmental conditions change dramatically from winter to summer in the Arctic Ocean. As the sea ice melts, large amounts of algal polysaccharides are released in the water column while simultaneously the main phytoplankton bloom develops beneath the ice. These changes are reflected in the taxonomic composition of the heterotrophic bacterioplankton within the upper water column. The dominant taxonomic groups in winter are Alpha- and *Gammaproteobacteria* and *Thaumarcheota*. In contrast, *Bacteroidetes* and *Gammaproteobacteria* are instead dominant during the spring-summer bloom period. Here we present a time series from early March to late July in Dease Strait (Canadian Arctic) where metagenomes and metatranscriptomes from the planktonic bacterial size fraction were obtained over a spring ice algal bloom to investigate the causes of this transition in microbial community composition. Looking at the genes present and expressed, two main traits seemed to allow *Bacteroidetes* to dominate. First, they had a large collection of polysaccharide degradation genes. In March, on the other hand, glycosyl-hydrolases degraded a variety of compounds including fucoidan, a cell wall polysaccharide of diatoms. During the bloom, on the other hand, glycosyl-hydrolases for laminarin, a storage polysaccharide of diatoms, became extremely abundant. Thus, *Bacteroidetes* were in the optimal position to take advantage from the diatom polysaccharides and had transporters to incorporate iron siderophore complexes. However, they did not show genes for the synthesis of siderophores (Puente-Sánchez et al. 2022). This task was carried out almost exclusively by *Gammaproteobacteria*. Clearly, the ability to steal iron from other bacteria and to use algal polysaccharides are two traits favouring the dominance of this phylum in summer.

Key words: Arctic Ocean, bacterioplankton, winter to summer transition, iron, polysaccharides, metagenomics

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MAGNETIC IONIC LIQUIDS AS A REALISTIC ALTERNATIVE FOR THE GREEN AND FAST PRECONCENTRATION OF METALS IN SEAWATER

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Abstract: Interest of metals analysis in seawater is based on their role as essential nutrients for marine organisms as well as the toxicity of non-essential metals even at trace levels. Despite its interest, metal determination is limited by their low concentrations, and even more by saline sample matrix. Several liquid and solid extraction methods are used for sample preparation in analysis of metals. However, they require significant amounts of reagents, high time consumption as well as, sample handling with contamination risk. In this sense, liquid phase micro-extraction has gained increasing interest.

In particular, dispersive liquid-liquid microextraction (DLLME) is widely used. An extractant and a dispersing solvent are added to the aqueous sample. Then, a cloudy solution of fine droplets is formed, favouring a fast mass transfer of the metals from the sample to the receiving solution. Finally, this receiving solution is separated by centrifugation. Despite their potential, there are still limitations for its application to seawater samples, such as the availability of efficient chemical extractants for the extraction of the metal chlorocomplexes formed at the natural pH of marine waters, or the use of high toxicity and volatilities dispersants. Recently, the use of ionic liquids (ILs) as extraction phases has been proposed to overcome these drawbacks. ILs are molten organic salts, whose chemical structures can be easily tailored to improve selectivity towards the metal. A subclass of ILs, produced by incorporating a paramagnetic component in their structures, are the magnetic ionic liquids (MILs). MILs have a strong response to external magnetic fields, allowing rapid recovery of the extractant with the aid of a magnet. Thus, the centrifugation step is eliminated and the separation time is reduced.

In this work, the DLLME based on the MIL methyltrioctylammonium tetrachloroferrate has been developed for the efficient extraction of Ag, Cd, and Zn of seawater. The optimization of all experimental factors affecting MIL-DLLME method (i.e., ratio of anion and cation in the ionic liquid synthesis, ionic strength content in the sample, extraction time, sample pH, amount of MIL) was performed by univariate technique. Extraction efficiencies of 76.1 ± 2.6% for Ag, 98.1 ± 0.7% for Cd and 70.4 ± 3.2% for Zn were obtained when an extraction time of 30 minutes and 50 mg MIL were applied to real seawater samples.

Key words: metals, seawater**,** sample preparation, magnetic ionic liquids, liquid-phase.

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COUPLING OF POLYCYCLIC AROMATIC HYDROCARBONS AND HYDROCARBONOCLASTIC BACTERIA AT COASTAL DECEPTION AND LIVINGSTON ISLANDS (ANTARCTICA)

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Abstract: Polycyclic aromatic hydrocarbons (PAHs) and other semivolatile aromatic-like compounds (SALCs) are ubiquitous in the oceans and can substantially influence marine microbial communities at environmentally relevant concentrations (González-Gaya et al. 2016; Cerro-Gálvez et al. 2019). Microbial degradation is an important sink of PAH in the oceans (González-Gaya et al. 2019). However, the linkage between background PAH concentrations and the presence of potential PAH-degrading bacteria remains poorly characterized, especially for remote regions such as Antarctica. Here we present time-series measurements of 64 PAHs in seawater and plankton in the coastal Antarctica (Livingston and Deception Islands) during three austral summers. PAH concentrations in the dissolved phase ranged from 0.07 to 30 ng/L and in plankton from 37 to 2000 ng/g dry weight (DW). In the same set of samples, bacterial communities were characterized by 16S amplicon sequencing and relative abundances were quantified. Microbial communities were dominated by *Flavobacteriales* at Livingston and Deception Islands, with the *SAR11* clade also co-dominating in the latter.
In order to assess the potential for hydrocarbon degradation, bivariate correlations between environmental and bacterial composition variables, as well as multiparametric analysis, where done. Relative abundances of bacterial genera reported in the literature to be associated with PAH significantly correlated with dissolved PAH concentrations (both low and high molecular weight, HMW PAH) and planktonic HMW PAH concentrations. A number of evidences, such as *Sulfitobacter* correlations with PAHs, pointed to the key role of this group in PAH degradation in the maritime Antarctica. This study provides new insights on the role played by organic pollutants modulating marine microbiomes in polar environments and vice versa.

Key words: Antarctica, seawater, PAH, 16S amplicon sequencing, microbial communities, psychrophilic bacteria.

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PHYTOPLANKTON AND HETEROTROPHIC BACTERIA RESPONSE TO ATMOSPHERIC DUST DEPOSITION IN THE MAURITANIAN-SENEGALESE UPWELLING REGION

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Abstract: The eastern North Atlantic region is among the highest receivers of dust deposition in the world oceans, which is an important source of nutrients, trace metals and organic matter to the surface ocean. In this study, we assessed the response of phytoplankton and heterotrophic bacteria to intense dust deposition in the Mauritanian-Senegalese upwelling system. Four bioassays were performed, each lasting three days, along a trophic gradient extending from the eutrophic coastal upwelling to the oligotrophic open sea . On each occasion, dust concentrations above 4 mg l-1 were added to triplicate microcosms, increasing nitrate, phosphate and, to a lesser extent, silicate seawater concentrations. Even though dust deposition enhanced heterotrophic and photosynthetic activity concurrently, bacterial production rates responded faster and stronger than primary production especially as oligotrophic conditions increased. Although not always reflected in total microbial cell abundances, dust enrichment also stimulated the growth of certain planktonic groups over others according to their nutrient requirements. High silica content phytoplankton groups (such as Dinophyceae, Chrysophyceae and Filosa-Thecofilosea) thrived in dust-treated microcosms, as well as Hyphomonas type of Alphaproteobacteria and several Gammaproteobacteria orders (including Alteromonadales, OM182_clade and Ectothiorhodospirales). Yet, microbial community structure and composition were primarily shaped by the unique characteristics of each experiment (intrinsic local productivity and nutrient availability), as well as by trophic interactions across autotrophic and heterotrophic microbial communities.

Key words: Dust bioassay, primary production, bacterial production, plankton community structure, molecular diversity, subtropical Northeast Atlantic.

ASSESSMENT OF THE CONTRIBUTION OF PENGUIN´S GUANO TO THE TRACE METAL POOL IN THE ANTARCTIC WATERS

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Abstract: The Southern Ocean (SO) regions constitute the major sinks of anthropogenic carbon dioxide. Several areas of the SO are considered as High-Nutrient, Low-Chlorophyll regions (Longhurst et al., 1995), because despite the richness in fundamental nutrients such as nitrates, phosphates, or silicates, are characterized by a reduced concentration of phytoplankton biomass, resulting in a scarcity of photosynthetic biota (Shaked & Lis 2012). The lack of chlorophyll is attributed to the low availability of trace elements, especially iron (Fe). These trace metals (TM) play crucial roles in biochemical structures of the organisms, actively participating in physiological processes (Schoffman et al., 2016). In this study, we aim to perform the first multidisciplinary approach to estimate the contribution of penguins' guano-derived TM of one of the most abundant Antarctic penguin species, the chinstrap penguin (CP) (*Pygoscelis antarcticus*) to the Antarctic ecosystem. To develop an effective approach to assess its relative population status, using Deception Island as a case of study, we collected images of the northern tip of Vapour Col (VC) CP colony using unmanned aerial vehicles (UAV), data which served as an input for a deep-learning (DL) model trained to detect CP individuals. Later, to investigate the TM contents of guano, we analyzed fresh samples from VC, collected directly from the ground and from uncontaminated guano from the soil. Finally, through the combination of UAV sampling, DL-powered CP census, and guano chemical analysis, we volumetrically estimated the TM content in CV. To conclude, we present an estimate of the relative contribution of VC CP colony to the release of TM in the surrounding surface water, determining that CP are a significant source of TM and play a crucial role by releasing of up to 3×10^3 times the TM to the surrounding waters.

Key words: Trace metals, Chinstrap penguin, Guano, Deep Learning

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BEHAVIOUR OF FREE AMINO ACIDS IN *Phaeodactylum tricornutum* CELLS UNDER COPPER STRESS

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Abstract: The influence of copper (Cu) on the marine diatom *Phaeodactylum tricornutum* has been widely studied (Levy et al., 2007; Wang and Zheng, 2008). However, its biochemical response under Cu stress conditions is not fully understood. This work is focused on the behaviour of free amino acids in *P. tricornutum* cells under different Cu levels (0.31, 0.79 and 1.57 μM) and periods of culture (12, 18 and 21 days). The concentration of ten amino acids (arginine, aspartic acid, glutamic acid, histidine, lysine, methionine, proline, valine, isoleucine and phenylalanine) was analysed with Reverse Phase High Performance Liquid Chromatography with a Photodiode Array Detector.

Exposure to high concentrations of Cu strongly affects *P. tricornutum* growth, cell density and organic ligands accumulation (Rico et al., 2013). The amount of free amino acids decreased when the maximum biomass was reached (18 days) in the control cultures and at sublethal Cu level (0.31 μM). On the contrary, a dramatic increase of amino acid contents with respect to the control cultures was observed under lethal copper doses of 0.79 and 1.57 μM, reaching the maximum amino acids level after 18 and 12 days respectively. Levels of amino acids as histidine and methionine were 12.4 and 65.8 times higher under 0.79 and 1.57 μM of Cu, after 12 days of culture, and 37.4 and 24.5 times higher, respectively, after 18 days of culture. However, amino acid levels decreased dramatically after 18 and 21 days at these copper concentrations suggesting the total consumption of nitrogen.

This study provides a better understanding of the response to *P. tricornutum* cells exposed to Cu related to amino acid production and the vital role of these amino acids in the defense mechanism of the diatom during the different periods of growth.

Keywords: Amino acid, diatom, microalgae, copper toxicity, *Phaeodactylum tricornutum*

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ASSESSMENT OF ANTHROPOCENE COASTAL RESILIENCE: A CASE STUDY IN MATALASCAÑAS (SW SPAIN)

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Abstract: While there are research studies defining and analysing the concept of resilience emphasizing its importance in coastal management, there is a lack in consensus regarding the appropriate methodology to use for measuring resilience in coastal environments. This research proposes a way of measuring resilience applying the Digital Shoreline Analysis System extension (Himmelstoss et al., 2018) for ArcGIS Desktop. In this context, Engineering Resilience will be measured, understood as such where the coastline follows a stability pattern.
In order to test the proposed methodology, the results obtained were divided in 3 well known areas. The fossil dunes northwest of *Matalascañas* (eroding 0.67m/year), the urbanised front (artificially stable) and the southeast active dunes (accreting 0.51m/year). From the results obtained, it is clear that the proposed methodology could be useful in combination with previous in-depth studies concerning the settling and impacts of human infrastructures in coastal resilience. Nonetheless, the long-term goal is to develop a methodology that measures a more integrative definition of resilience where social, economic and environmental factors are properly identified. Being then crucial the support from many different fields external to the Environmental Sciences or Geography.

Key words: Anthropocene, ecological resilience, engineering resilience, GIS, Matalascañas.

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COASTAL SAND SPIT EVOLUTION AS A CONSEQUENCE OF STORM EVENTS AND LACK OF SEDIMENT SUPPLY (CAMPOSOTO BEACH, SW SPAIN)

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Abstract: Over the last years, in the context of climate change, erosive processes such as sea storms have resulted in the retreat of many coastlines damaging its dunes in a global scale. Because of the amount of socioeconomic and ecosystem services that these systems provide (i.e., the natural defense against coastal hazards), the study of such processes is of a great importance. In order to quantify the retreat registered in previous works in the dunes of Camposoto beach (Cadiz), a short-medium-term analysis of topographic surveys have been carried out of the dune foot in the southern sector between 2008 and 2018. These data, taken by GPS-RTK and UAS systems, were subjected to different treatments and analyzed focusing on four shoreline change statistical parameters. The results showed an average regression rate of -2.29 m/year, a higher value than the one registered until 2008. This suggests an acceleration of the erosion suffered by the system, which has revealed to be more intense in the northern sector of the study area due to the overwashes that are more frequent, as a consequence of the lower dune foot height. The greatest events of the dune foot erosion were registered after big storms, such as Xynthia (2010) and Emma (2018), that overpassed the natural accommodation capacity of the beach-dune system. As a result, they have led to a dune fragmentation and the initiation of a rollover process in the area, that is strongly conditioned by the lack of sediment supply and may lead to irregularities in the transversal profile of the dune system.

Key words: Coastal dunes, Erosion, Coastal hazards, Sea storms, Rollover

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ASSESSING THE TROPHIC ECOLOGY OF THE INVASIVE ATLANTIC BLUE CRAB *Callinectes sapidus* IN THE COASTAL WATERS OF THE GULF OF CADIZ

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Abstract: *Callinectes sapidus*, the invasive blue crab from the west of the Atlantic Ocean, has extended its distribution along the Atlantic coast around the Gulf of Cadiz and increased massively since 2016. Food web studies are useful for understanding changes in ecosystems caused by exotic species. Stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) were used to assess the potential carbon sources and its trophic relationships among different ecosystems (estuaries and saltmarshes), sexes (male and females) and seasons (summer vs. autumn). Significant differences were found in the $\delta^{13}C$ of blue crabs from the estuaries and salt-marshes (-21.2 ±2.6 vs -14.2 ±0.9, respectively). These differences may be explained by an increase in the ^{13}C of the blue crabs from the salt-marshes, probably due to the enrichment of this isotope in the primary producers such as the salt marsh plants (Menéndez and Sanmartí, 2007) and its preys inhabiting this ecosystem. Meanwhile,
the more depleted ^{13}C values in the estuary crabs seem to reflect a carbon source from mollusks and fish derived from decomposing detritus. Among the ecosystems analyzed, $\delta^{15}N$ was only significantly enriched in the crabs of the Guadalquivir estuary and was higher in males than females. Also, seasonal differences were found in this estuary in both sexes, by a decrease in the ^{15}N values between summer and autumn. Those differences, can be explained by the fact that the Guadalquivir estuary suffers nitrogen hyper-nitrification due to intensive agriculture and is more noticeable in the upper part of the estuary, to which the males are more associated due to their life cycle. Previous studies reported, the diet of *C. sapidus* seems to be opportunistic, dependent on the food availability in different habitats (Prado et al., 2022), with a divergence in sexes induced by different spatial distributions. Future studies analyzing the stomach content and trophic behavior should be conducted to clarify our results.

Key words: *Callinectes sapidus*, stable isotopes, trophic ecology, invasive species.

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ACTIVE RESTORATION METHODS IN SEAGRASS HABITATS: AVAILABILITY AND VIABILITY OF *Zostera marina* SEEDS

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Abstract:
Seagrasses and the valuable ecosystem services they provide are threatened worldwide by the impacts of human activity (Waycott et al., 2009). Seed-based restoration techniques hold great promise for large-scale restoration (particularly using *Zostera marina*), but there is a dependency on the availability of seeds. Seeds collection is dependent in seasonality and can be limited, so seeds conservation and seeds selection are necessary to maximize transplant actions success (Orth et al., 2020).
Generative shoots of *Z. marina* were collected in Santander Bay in two periods (October and November) and allocated in illuminated tanks with aerated seawater to promote seeds release. The biometric and viability (using tetrazolium test) of collected seeds from the two sampling periods were analysed in different sorted groups: seeds randomly selected from the whole pool; black coloured seeds and white coloured seed, since colour is an indirect indicator of maturity and viability (Xu et al., 2016). Seeds were stored at long-term (1 year) in seawater, low temperature (4ºC) and darkness in oxygenated conditions and in anoxic conditions. Seeds viability was also checked at the end of the experimental period. Biometric characteristics of the seeds were relatively constant rendering a mean wet weight of 2,71 ± 0,60 mg, a mean diameter of 1,14 ± 0,11 mg and mean length of 2,87 ± 0,29 mg. The mean density was 1,520 ± 29 kg m^{-3}. Moreover, a strong correlation was found between seed size and cuticle colour. The inicial seed viability was 100%. The 80% of the seeds kept in anoxic conditions were viable after 1 year of storage, while those kept in oxic conditions lost their viability completely. We demonstrated that a long period of storage it is possible under anoxic conditions. Intraspecific seed size variations in *Z. marina* populations from Santander Bay may have implications for seed dispersal.

Key words: *seagrass restoration, Zostera marina, seed conservation, seed biometry, seed viability, Santander Bay.*

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NATURAL RADIONUCLIDES AS TRACERS OF BEACH SEDIMENT DYNAMICS: A STUDY IN A HETEROGENEOUS ENVIRONMENT

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Abstract: Natural radionuclides have been used as tracers of sediment dynamics in coastal areas before (Thereska 2009, Dai et al, 2011) and therefore they present an interesting tool to evaluate sedimentary processes in coastal areas. To enhance the knowledge of natural radionuclides as tracers of erosion and accumulation periods in beach and coastal areas, a spato-temporal analysis of the activity concentrations of natural radionuclides in sand samples was performed in Las Canteras beach (LC), Spain, during 2016 and 2019. This beach was selected because it combines two different dynamics; one of a closed beach, and thus protected against the wave action, and that associated with a beach open to it. Moreover, the sediment dynamics of this beach has been well studied before (Alonso, 1992). Therefore, Las Canteras beach is a suitable natural laboratory to evaluate the use of natural radionuclides as tracers of beach sediment dynamics under different marine dynamics. The results of the spatial analysis showed that the activity concentration of ^{226}Ra, ^{228}Ra, ^{40}K group the samples in three clusters that agreed with three different zones related to the sediment distributions occurring due to the different sediment dynamics present in the beach. The temporal analysis seemed to prove that the activity concentrations of the radionuclides studied were influenced by erosion and accumulation agents such as significant wave height. Moreover, submarine sand samples from El Confital Bay, where LC is located, were also analysed in order to evaluate if the origin of the sediments that arrive and move along the beach are also traced by natural radionuclides.

Key words: Natural radionuclides, beach, tracers, erosion and accumulation

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LAGRANGIAN TRAJECTORIES TO ASSESS MARINE PLASTIC POLLUTION DISTRIBUTION IN THE CANARY ISLANDS

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Abstract: The increasing presence of plastics in the ocean is a harmful problem for marine ecosystems and the socio-economic sector. A recurrent type of debris gathered in waters of the Canary Islands are the identification tags employed at lobster traps deployed at the north-eastern coast of North America. In the past decade to the present, these debris have been routinely collected and classified by the EOMAR group (MICROTROFIC Project) through coastal sampling focused on the eastern part of the Canary archipelago. In order to address this problem, a further understanding of the distribution and dynamics of these debris in the ocean is demanding. In this work, a pre-existing tool in Matlab (Andrew Poje, 2008) has been adapted to produce Lagrangian trajectories based on Marine Copernicus surface current velocity data (GLORYS12V1). The main goal is to assess the trajectories that floating particles might follow in the North Atlantic subtropical gyre when released over a grid in the north-eastern coast of North America. Our results provide a quantitative basis about the link between the North American north-eastern coast and the Canary Islands, where the presence of these and other debris is of increasing concern.

Key words: Plastics, Lagrangian trajectories, Distribution, Large-scale Circulation, North Atlantic Subtropical Gyre.

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THE IMPORTANCE OF SCIENTIFIC ILLUSTRATION IN MARINE SCIENCE

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Abstract

Scientific Illustration as a dissemination tool bridges the gap between the scientific production of research institutions and society. The intrinsic interdisciplinary of this field, combining Art and Science, makes the transmitted information not only more accessible but also visually more attractive. That is why Scientific Illustration is gaining relevance today and is becoming more and more professional.

This knowledge transmission occurs through a pictorial language that serves to decode the scientific message. This language or "vocabulary of forms" is part of a universal methodological artistic expression which already began with the Paleolithic cave paintings. Nowadays, the technology evolution of the twenty first century has contributed to improve the techniques and methods used in Scientific Illustration (digital programs, 3D sculpture, animation…); however, no technological advance in photography or graphic design can replace the work of the illustrator, since he is the only one capable of representing the *archetype* of a species, which is the illustration that embody all its important diagnostic features in a holistic way, making that image representative of the entire population.

The methodology of any Scientific Illustration implies the research of the natural object and the objective interpretation of its fundamental characteristics for the creation of the *archetype*. It could be done through references (observation, photographs, databases, bibliography, fossil samples, microscopy techniques...) which allow us to find those characteristics of the species, emphasizing one attribute over another, seeking simplification over realism in order to represent the concept.

In conclusion, Scientific Illustration is an irreplaceable tool for scientific dissemination, which works as a universal language which translates complex information into accessible information for society.

Key words: illustration, scientific communication, archetype, society, education

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INTEGRATION OF DATA FROM DIFFERENT DISCIPLINES AND THEIR INTERPRETATION IN OFFSHORE PROJECTS

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Abstract: In the context of the current energy transition, the work related to studies prior to the design and subsequent implementation of any structure related to marine renewable energy is highly relevant. These works include very varied studies: social, environmental, seabed conditions and those related to soil's properties. The design of these desktop studies is also very important to ensure that the final data is as useful and reliable as possible yet at the lowest possible cost.
The integration of all the data and the interpretation from different disciplines is the most relevant final phase. For an offshore project, it must be designed from the basis of good planning, as it is essential for the coordination between the different professional profiles and companies that will intervene and collaborate for a long time.
From a geoscience point of view, data analysis is usually compiled and presented as visually as possible using graphs, GIS, profiles, etc. which provide information on the interpretation of the data obtained and the results that arise after a study. In addition, this integration sometimes takes into account previous and/or bibliographic data. The purpose of this information is to configure a coherent and useful ground model for the subsequent design and implementation of marine structures (turbines, substations, solar plants, etc.), as well as to determine the most suitable route and burial depth of export cables and electrical interconnections between different areas of the world.
The purpose of this paper is to present examples of different geotechnical and geophysical data options for a final integration report, especially focused on offshore wind farm and electrical interconnection projects. The data has been obtained from various nearshore and offshore campaigns related to marine renewable energies in Europe in recent years.

Key words:, data integration, offshore wind farms, ground model, submarine cable, marine geosciences, geotechnical, geophysical,

SKELETAL ASSEMBLAGES AND GRAIN-SIZE DISTRIBUTION OF SEAMOUNT SEDIMENTS OFF THE CANARY ISLANDS

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Abstract: Grain-size distributions and skeletal assemblages of surface sediments from the Amanay Seamount, El Banquete, and Conception Bank (Canary Islands) were combined to better understand the textural variability in carbonate microfacies of seamounts in temperate waters. Grain size was determined in half phi intervals by wet-sieving (< 63 μm) and dry-sieving (> 63 μm) and resulting fractions were stored separately in plastic bags and vials for subsequent provenance studies. Skeletal assemblages were obtained by grain counts in bulk and half phi intervals using a camera-coupled microscope (1x-600x). These compositional datasets were further analysed using multivariate methods.

In general terms, unimodal and polymodal distributions show major modes within fine sands (125-180 μm), medium sands (250-355 μm), coarse sands and fine gravels (> 1 mm). Poorly sorted sediments occur at shallow depths (< 200 m bsl) on Amanay and El Banquete, due to coarse material (e.g.: rhodolites, gastropods, serpulids, bryozoans), whereas bathyal and well sorted fine sands show peaks at 125-180 μm comprising mainly forams, pteropods and bryozoan debris. In contrast, sands of Conception Bank show an ubiquitous mode at 250-355 μm of planktic forams at bathyal depths (> 300 m bsl), whereas of mixed relict and recent grains towards the summit (< 300 m bsl) that shifts to coarse-skewed distributions due to millimetric bivalves, and subordinate bryozoan and echinoid remains.

Grain-size distribution of carbonate sediments at seamounts results of complex interactions between grain source (planktic vs. benthic), fragmentation, preservation, oceanography, and bathymetry. Hence, the analysis of grain size and skeletal assemblages combined may help constraining whether grain sources or environmental processes control the textural features of surface sediments on seamounts, and ultimately help modelling seamount carbonates and their spatial distribution using suitable prediction algorithms.

Key words: Canary Islands, Carbonates, Composition, Seamounts, Sediments

UPPER QUATERNARY SEDIMENTARY AND OCEANOGRAPHIC PROCESSES AT BIGHT FRACTURE ZONE (NORTH ATLANTIC OCEAN)

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Abstract: Charlie-Gibbs Fracture Zone (CGFZ) and Bight Fracture Zone (BFZ) are the main deep ocean passages crossing the Mid-Atlantic Ridge and connecting East and West North Atlantic basins. Iceland-Scotland Overflow Water (ISOW) travels through these narrow corridors, generating channel-related contourites. Currently, sedimentary processes linked to bottom currents, gravity flows from fault scarps, and pelagic-hemipelagic settling result in complex interactions. Upper Quaternary climate fluctuations complicate further these interactions.

Acoustic (Atlas Hydrosweep DS) and seismic parametric (Atlas Parasound P-35) records obtained during the cruise BOCATS2-BFZ21 onboard B/O Sarmiento de Gamboa were used to develop a high-resolution bathymetry and obtain the geometry of several contourite bodies and other deposits. Four gravity cores were retrieved in selected points considering the seismic information. This work presents the first multiproxy results from the westernmost core, BFZ21-GC01 (4.80 m long; 57º 7.06N; 35º 16.354W; 2746 mbsl). The study includes sedimentary and tomographic facies, grain-size (bulk and free biogenic components), and textural and compositional analyses. Besides, several AMS14C dates and specific climatic/oceanographic events enable the development of an age model.

The core spans from MIS4 to the present, recording the main North Atlantic climatic events (mainly Heinrich stadials, HS); conspicuous fluctuations in the analysed parameters and facies changes reveal millennial-scale oscillations of bottom currents activity, primary biological productivity and ice dynamics. Persistent advances and retreats of the Subarctic Front (SAF) are the most likely cause behind those high-frequency oscillations.

Key words: Bight Fracture Zone, Pleistocene, Millennial climate and oceanographic oscillations.

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CHEMOSYNTHESIS VIA COOPERATIVE BIOMINERALIZATION — THE BASIS OF UNDERWATER EMISSION-RELATED ECOSYSTEMS

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Abstract:
Underwater emission-related environments comprise cold seeps and hydrothermal systems, generally characterized by reduced conditions, low oxygen and seepage/venting of subseafloor fluids into the water column rich in CH_4, sulfur compounds (S^{2-}, S^0), CO_2 and variable quantities of reduced metals (eg., Fe^{2+}, Mn^{2+}, Ba^{2+}, Li, REE) and silica. Ecosystems at these sites are sustained by a primary production based on chemosynthesis, obtaining organic carbon and energy through chemical reactions like sulfur oxidation, sulfate reduction, methanogenesis, methane oxidation, and iron-oxidation. These primary producers are capable of living in these extreme environments and supply with nutrients the upper aerobic trophic levels, e. g. sponges, corals and fish. In fact, aerobic and non-chemosynthetic organisms are able to colonize active emission spots thanks to the consumption of the emitted (and toxic) fluids by these chemosynthetic organisms, what we call "the buffer effect" (Rincón-Tomás et al., 2019). Biomineralization processes in these environments include, among others, formation of hydrocarbon-derived carbonates, sulphides and oxy-hydroxides.
Here, we present an overview of different chemosynthetic biomineralization processes that occur in syntrophic relationships between microbial organisms or even between microorganisms and associated major fauna. In mud volcanoes from the Gulf of Cádiz we observed anaerobic oxidation of methane (AOM), and sulfur-oxidation and methane oxidation driven in symbiosis with *Bathymodiolus* mussels and Siboglinidae worms (Rincón-Tomás et al., 2019; 2020; Somoza et al., 2021). In a recently discovered shallow-water low-temperature hydrothermal system in the Tagoro Volcano (Canary Islands), we detected biogenic Fe-oxyhydroxides and sulfur-oxidizing bacterial mats (González et al., 2020).
It is important to consider symbiosis as a major motor in the development of these environments. Additionally, these biomineralization processes are of special interest since they participate in the reduction of emission of methane into the atmosphere, and in the bioaccumulation of toxic heavy metals like Fe, Mn and Hg, and compounds of industrial interest like Co, Li, Cu, Ni, and REE.

Key words: Biomineralization, Chemosynthesis, Symbiosis, vent-sites, AOM.

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IRREVERSIBLE LOSS IN MARINE ECOSYSTEM HABITABILITY (AFTER A TEMPERATURE OVERSHOOT INFORMED BY THE ECOPHYSIOLOGICAL DEMAND IN OXYGEN)

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Abstract: Anthropogenic climate change induced warming of the oceans and consequent deoxygenation is altering marine ecosystems. Previous works suggest that changes in temperature and dissolved oxygen are largely reversible within the upper layers of the ocean if atmospheric CO_2 concentrations were to decline. However, the combined effect of these stressors to marine ecosystems after a temperature overshoot is still poorly understood. Here, we explore to what extent anthropogenic climate change will drive irreversible changes in marine habitats by using a metabolic metric (φ) that captures the ecophysiological response of marine living organisms to both changes in temperature and dissolved oxygen. We track changes in φ in a suite of seven CMIP6 Earth system models under an idealized overshoot scenario in which CO_2 concentration increases from pre-industrial levels by 1% per year until peaks at four times its initial state, and then decreases at the same pace until initial conditions, at which point CO_2 is held constant for additional 60 years. Using model outputs, we decompose φ to analyse the factors driving its regional patterns. Using documented thresholds of φ for marine ecosystem habitability, where the demand in oxygen is much lower than its supply, we find that the first 1000 m depth of the world ocean has the potential to lose a volume of ~4% of habitable waters when returning back to pre-industrial atmospheric CO_2 after the overshoot. Our results suggest that the joint effect of changes in temperature and dissolved oxygen may reduce the resilience of marine ecosystems far after CO_2 levels recover.

Key words: metabolic index, hysteresis, overshoot scenario, CMIP6

ARTIFICIAL UPWELLING INTENSITY AND MODE HAVE A MAJOR IMPRINT IN DISSOLVED ORGANIC MATTER DYNAMICS

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Abstract: In the face of climate change there is a need to reduce atmospheric CO_2 concentrations. Artificial upwelling of nutrient-rich deep waters has been proposed as a method to enhance the biological carbon pump in oligotrophic oceanic regions in order to fuel carbon sequestration. However, the fate of the newly produced organic matter, and specifically of its resulting dissolved fraction, is not clearly understood. In the present work, nutrient-rich deep water was introduced to large scale (~44 m^3) mesocosms in the oligotrophic subtropical North Atlantic with the aim of studying how the intensity and mode of artificial upwelling (large single pulses vs recurring smaller pulses) affects the dissolved organic matter (DOM) pool. Artificial upwelling yielded marked increases in the concentration and shifts in the characteristics of DOM. The magnitude of the observed changes was mostly related to the upwelling intensity: more intense treatments led to higher accumulation of dissolved organic carbon (>70 μM of excess DOC over ambient waters for extreme treatments), as well as increases in the concentration and average molecular weight of chromophoric DOM (CDOM) and the intensification of humic-like fluorescent DOM, suggesting transformation of the DOM pool. The artificial upwelling mode also affected DOM, with singular treatments overall resulting in higher CDOM quantities and molecular weight than recurring treatments. Our results indicate that under artificial upwelling, large DOM pools may accumulate in the surface ocean without being remineralised in the short-term. This persistence could be associated with a combination of the molecular diversification of DOM due to microbial reworking, nutrient limitation and reduced metabolic capabilities of the prokaryotic communities inside the mesocosms. The present study highlights the importance of considering DOC when assessing the carbon sequestration potential of artificial upwelling.

Key words: dissolved organic matter, carbon sequestration, negative emission technologies, artificial upwelling, mesocosm

MARINE BIODIVERSITY EXPOSED TO PROLONGED AND INTENSE SUBSURFACE HEATWAVES

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Abstract:
The frequency and duration of marine heatwaves (MHWs) have been increasing over the past century and are anticipated to further intensify in the decades to come, driven by anthropogenic climate change. MHWs have caused substantial biological and socio-ecological impacts globally, ranging from rapid shifts in species distributions to mass mortalities, with particularly dramatic effects reported on coral reefs and kelp forests. However, our current understanding of MHWs relies heavily on sea surface temperature measurements due to data accessibility and little is known about their characteristics in the subsurface. Here, we provide the first global characterization of MHWs from the ocean surface down to 5000 m depth (from 1993 to 2019) and explore potential biodiversity exposure to their effects. Specifically, we estimated MHW metrics of maximum intensity, duration, occurrence and cumulative intensity at global and regional scales, for each depth layer and over time, following the well-established framework of Hobday et al., (2016) to allow direct comparison with previous studies. We contrasted species richness estimates with cumulative MHW intensity to pinpoint regions/depths of higher exposure. We find that MHWs are typically more intense in the subsurface ocean (50-200 m depth) than at the surface and their duration becomes longer with depth, particularly in the abyssal ocean where duration is on average 3 times longer than at the surface. The highest cumulative biodiversity exposure was detected between 75 and 150 m depth, remaining high down to

250 m. Regions of frequent and intense MHWs coincided mostly with sharp temperature gradients, such as those associated with boundary currents and fronts, extending down to 1000 m depth. Prolonged, recurrent and intense subsurface MHWs are hypothesized to produce cumulative detrimental consequences on marine biodiversity, with species expanding their distributions deeper, driving global changes in biodiversity patterns, with consequent effects on ecological interactions and ecosystem processes.

Keywords: subsurface marine heatwaves, MHW depth, extreme events, biodiversity exposure

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WESTERN BOUNDARY OF THE NORTH ATLANTIC SUBTROPICAL GYRE: DECADAL CHANGE

Daniel Santana-Toscano*, Alonso Hernández-Guerra, M. Dolores Pérez-Hernández, Verónica Caínzos, Melania Cubas Armas, Cristina Arumí-Planas, Miguel Ángel Gutiérrez-Guerra, Laura Dómenech Segú, Mara Navarro Buigues and Mae Presas Ferrer

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Abstract:
The A20 is a meridional hydrographic section located at 52ºW on the western North Atlantic Subtropical Gyre that encloses the path of the water masses of the Atlantic Meridional Overturning Circulation (AMOC). Using data from three A20 hydrographic cruises carried out in 1997, 2003 and 2012 together with LADCP-SADCP data and the velocities from an inverse box model, the circulation of the western North Atlantic Subtropical Gyre is estimated. The main poleward current of the AMOC is the Gulf Stream (GS) which carries 129.0±10.5 Sv in 2003 and 110.4±12.2 Sv in 2012. Due to the seasonality, the GS position is shifted southward in 2012 - relative to that of 2003 - as both cruises took place in different seasons. In opposite direction, the Deep Western Boundary Current (DWBC) crosses the section twice, first at 39.3-43.2ºN (-34.9±7.5 Sv in 2003 and -25.3±9.4 Sv in 2012) and then at 7.0-11.7ºN (42.0±8.0 Sv in 2003 and 48.0±8.1 Sv in 2012). Additionally, two zonal currents contribute with westward transport below 20ºN: the North Equatorial Current and the North Brazil Current; with a net value of -28.0±4.1 Sv in 2003 and -36.7±3.6 Sv in 2012.

Key words: AMOC, North Atlantic Subtropical Gyre, Climate Change.

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STRONGER TOGETHER: FISHERIES ENHANCE PRESSURE ON MEDITERRANEAN REGIONS AND PELAGIC SPECIES ALREADY IMPACTED BY CLIMATE CHANGE

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Abstract: Marine species are widely threatened by anthropogenic activities, including fishing and human-induced climate change. However, geographically broad and spatially-explicit assessments of the simultaneous impacts of these major threats at regional scales are mostly lacking due to the practical challenges of surveying vast geographical areas and obtaining adequately resolved data. Yet, these assessments are key for identifying highly and cumulatively impacted areas and species that should be prioritized for conservation through knowledge-based management strategies. Here, we analysed a 26-year (1993-2018) time series of highly-resolved remotely sensed environmental data to evaluate changes in optimal habitat availability (i.e., extent of marine areas encompassing optimal environmental conditions) for 15 species of small, medium and large pelagic fish inhabiting the Mediterranean Sea Large Marine Ecosystem. We then combined spatial and temporal data on fishing pressure and changes in optimal habitats to identify areas of high risk of cumulative impacts. Overall, results showed how most of the Mediterranean pelagic species went through a reduction of optimal habitat availability over the past decades. The few species that showed positive trends in optimal habitat availability did not expand largely and hence were unlikely to compensate for the loss of key functional roles at the group level. Habitat loss concentrated in the western and central basins. Similarly, fishing pressure was found to be the highest in both basins, thus overlapping with the areas experiencing a higher reduction of optimal habitat. Small and large pelagic fish were the most impacted groups, having a larger proportion of their distribution in highly, cumulative impacted areas. Redistributing fishing pressure and reducing it in highly impacted areas may alleviate the overall cumulative pressure on pelagic stocks, contributing to the necessary shift to sustainable and resilient fisheries that allow ensuring food security and achieving a healthy ecosystem in this “sea under siege”.

Keywords: Safe Operating Space; Mediterranean; Pelagic fish; Cumulative impact analysis; Climate change; Fisheries

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SEABIRD DISTRIBUTION IS BETTER PREDICTED BY ABUNDANCE OF PREY THAN OCEANOGRAPHY. A CASE STUDY IN THE GULF OF CADIZ (SW, IBERIAN PENINSULA)

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Abstract: Quantifying factors that influence marine predator distributions is essential to understanding current and future change in marine biodiversity. Here, we test whether marine predator distribution relates to prey, or is better predicted by other specific habitat features. We examine the correlation between spatial distribution of three seabird species and their prey, as well as environmental proxies (oceanographic characteristics) in the Gulf of Cadiz, NE Atlantic. We modeled the at-sea distribution of Cory's shearwater, Balearic shearwater and Northern gannet, based on: (1) pelagic fish abundance according to acoustic surveys, and (2) a forecast-model of remotely-sensed environmental variables (productivity, sea surface temperature, salinity).

In general, seabird distributions were better predicted by abundance of fish than by environmental variables at the habitat scale. We obtained consistent correlations between seabird presence and the abundance of medium-sized (10-20 cm) sardines, anchovies and Mediterranean horse mackerel, providing information on their preferred prey.

Additionally, oceanographic productivity variables moderately contributed to seabird distribution models, with better predictive value for the critically endangered Balearic shearwater and Northern gannet in the summer, whilst the model for Cory's shearwater's produced poorer predictions.

Predator-prey combined studies may represent essential tools for an efficient ecosystem-based management of marine environments.

Key words: Marine top predators, seabirds, predator-prey relationship, overlapping distribution, oceanographic factors, Gulf of Cadiz.

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EARLY COLONIZATION OF BIOFOULING ON ELECTROLYTIC CARBONATE STRUCTURES

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Abstract: The study of biofouling has been widely reported in different artificial substrata in order to study the succession (e.g., Anderson and Underwood, 1994; Bulleri, 2005; Chase et al., 2016). Nevertheless, studies of biofouling focused on more natural substrates, like electrolytic carbonate ones, are still unknown (Lin y Shao, 2002). Those substrates have a great potential for coral reef restoration in tropical areas (Goreau and Hilbertz, 2005; Goreau 2012, 2014) and construction of biofilters. Thus, this study was carried out to examine the colonization of sessile macrofouling in the port of Alicante (SE Spain, Western Mediterranean) on 2 types of substrata: electrolytic carbonate and iron (as control), over 3 months of immersion (October to January). The diversity of the community has been studied by means of indexes, and abundance and coverage of the assemblages, as well as the preference of organisms according to their status and functional group (filter feeders), performing univariate and multivariate analyses (PERMANOVA, SIMPER and nMDS) to examine the differences. A total of 37 taxa (25 spp.) were identified, of which 64% were native, 18% cryptogenic and 18% non-indigenous. The carbonate substrate showed higher abundances and diversity indexes than iron, as well as a more structured community; it also recruited 94.6% of the species found versus 40.5% for iron. Moreover, filter-feeders (Porifera, Bivalvia and Ascidiacea) were more abundant and most of them only have been appeared in the carbonate substrate. Hence, these results demonstrate the potential of the electrolytic carbonate substrate as a possible material for the construction of artificial reefs for restoration and/or biofilters.

Key words: Western Mediterranean, Electrolytic substrate, Macrofouling, port environment.

Acknowledgments: The authors want to thank the help of the University of Alicante (UA) for carrying out the first tests, and the Port Authority of Alicante for the facilities for the work in the harbour area. The first author has received a scholarship from the UA to carry out his master's thesis.

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MICROPLASTIC POLLUTION IN A COASTAL LAGOON: CIÉNAGA GRANDE DE SANTA MARTA, COLOMBIAN CARIBBEAN

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Abstract: Microplastics (i.e < 5 mm in size plastic objects) are emerging pollutants that have been found in all environmental matrices of marine and coastal ecosystems, where they can generate harmful ecological, and socioeconomic, impacts. This study assesses microplastic pollution in surface waters and sediments, together with microplastic ingestion by commercially important fish species from Ciénaga Grande de Santa Marta (CGSM), a less than 2 m deep fragile tropical lagoon on the Colombian Caribbean coast. We conducted sampling in March and May 2021, collecting surface water samples with a bucket and sediment samples with a grab sampler at 33 stations. Furthermore, we bought 474 specimens of the nine commercial fish species most caught and consumed locally, subsequently analysing their digestive tracts. Microplastic abundances ranged from 0.0 to 0.3 items L^{-1} in waters, and from 0.0 to 3.1 items kg^{-1} in sediments. Further, 21.1% of the analyzed fish species had microplastics in their digestive tracts, with average abundances of ingested microplastics ranging from 1 to 1.5 microplastics per fish. Microplastics in water and sediments and in the digestive tract of fishes have similar characteristics, also showing a moderate, statistically significant association. Fibers, fragments and films, colourless, white and blue, and polyethylene and polypropylene were the dominant types, colours and polymer compositions of microplastics in the three analyzed matrices. Microplastic abundance is higher near river mouths and urban areas, where a high density of fishing activities and aquaculture infrastructures occur, which are important sources of contaminants. Microplastic pollution in CGSM represents a threat to the lagoon ecosystem and to local people depending on artisanal fishing for their livelihood. Consequently, effective actions to reduce pollution and its socio-environmental impacts are urgently required.

Key words: Coastal lagoon; Microplastics; Environmental matrices; Fish ingestion; Colombian Caribbean

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LOW BUT NOT SLOW: SPERM WHALES CLICK FASTER AND LESS LOUDLY DURING BENTHIC FORAGING

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Abstract: Sperm whales produce the most powerful sounds in the animal kingdom for long-range echolocation of mesopelagic prey during long and deep dives. Occasionally, sperm whales switch from pelagic to benthic-benthopelagic foraging at or near to the highly reflective seafloor, raising the question of how the most powerful biosonar system in the world is operated in such a highly reverberant environment. Based on scarce data from small toothed whales, we hypothesized that sperm whales foraging near the seafloor echolocate faster with weaker outputs. To test that hypothesis, we used data from sound and movement recording DTAGs deployed on three Mediterranean sperm whales performing both benthic and pelagic foraging dives. The three whales reduced their click rate during benthic foraging, using 10, 23 and 31 % longer inter-click interval during pelagic dives. This was accompanied by a reduction of the apparent output levels during benthic dives. These adjustments likely serve as an adaptation to reduce backwards masking from sea floor reverberations, and to provide faster update rates for short target echo delays in a smaller auditory scene framed by the nearby sea floor. We conclude that sperm whales, like smaller toothed whales, can employ contextual adjustments of their biosonar sampling and acoustic gaze to facilitate prey target interception in different foraging habitats.

Key words: *Physeter macrocephalus, DTAG, toothed whale, inter-click interval, foraging strategies, echolocation behaviour*

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"NON- INDIGENOUS SPECIES IN MADEIRA: MPAS VERSUS ANTHROPOGENICALLY IMPACTED AREAS"

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Abstract: A key aspect of anthropogenic impacts is the introduction of non- indigenous species (NIS) to new environments. NIS arrive mostly by unintentional transportation via boats and ships, especially via touristic cruise- ships in either ballast water or as hull-fouling, like it is the case in Madeira, Portugal (Outinen et al., 2019, Castro et al., 2022). Madeira (connecting Europe with South America and Africa) is a destination of lots of cruise ships, cargo ships and leisure vessels (Canning-Clode et al., 2013). Currently 59 non- native species are recorded here, of which the majority has arrived via ships (Chainho et al., 2015). Several studies have been implemented for the monitoring of the settlement of NIS with PVC- plates, deployed in harbors, following the SERC protocol (Gestoso et al., 2017). With the proven success of this method, the present study aims to collect more data, including data about the potential spread of NIS: Structures were built containing 3 parallel PVC-plates each, connected via a central "backbone" of a metal rod, deployed at 5m depth in three different locations: Inside and outside the impacted marina of Funchal, two places inside an MPA, and inside and outside the semi-impacted marina of Quinta do Lorde. The structures were retrieved after 6 months, together with the mobile fauna attached to the plates. The settled marine organisms are now in the process to be species- identified and classified according to their status in Madeira (Non- indigenous, Native, Unknown and Cryptogenic). Furthermore, the community compositions including species cover and biodiversity will be compared among the locations. Preliminary inspection shows that species cover, and community composition differ between the harbors and the MPAs, as well as between the plates facing downwards versus upwards. NIS were found in all locations. This methodology aims to capture the current state regarding NIS in any area and could be used to test the effectiveness and monitor the health status of marine protected areas.

Key words: non- indigenous species, marine protected areas, monitoring

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AN ENHANCED RECRUITMENT OF BLUE WHITING IN THE PORCUPINE BANK (NE ATLANTIC) DURING 2020 IN RESPONSE TO FAVOURABLE ENVIRONMENTAL CONDITIONS

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Abstract: A Spanish bottom trawl research survey was conducted between 2001 and 2020 in the Porcupine Bank to retrieve recruitment data. The survey was routinely carried out in September with the objective of assessing the fisheries in the area. The 2020 data showed the largest abundance of age-0 blue whiting (*Micromesistius poutassou*), with almost twice as much than in the highest previous record (2004). Thus, this study focused on determining the environmental drivers that could explain that anomalously high abundance through their impact on the blue whiting eggs and larvae survival. For this purpose, satellite SST and chlorophyll were analyzed during the spawning season (March-April), along with reanalysis wind, salinity, and ocean currents data. Our results showed particularly low wind conditions during March and April 2020, which triggered the onset of a stable Taylor Column circulation above the Porcupine Bank, helping not only the accumulation of phytoplankton biomass, which promoted secondary productivity, but also larval retention. This was corroborated by a quantile regression fit applied on the blue whiting recruitment data (September), which showed significant positive (negative) correlations with the chlorophyll concentration (wind mixing index) during the spawning season.

Key words: Blue whiting, recruitment, 0-group, Taylor column, wind mixing index, chlorophyll

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ASSESSMENT OF ANTHROPOGENIC POLLUTION BY ORGANIC UV FILTERS USING MACROPHYTES AS BIOINDICATORS

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Abstract:

Marine environment pollution has increased in recent decades as a result of anthropogenic activities. Macrophytes can assimilate the compounds dissolved in the water and respond to changes in surround conditions, for that, they can be used as bioindicators of pollution in aquatic environments.
Currently organic ultraviolet (UV) filters have shown ever-increasing in pollution levels in marine ecosystems. The anthropogenic pollution produced by eight organic UV filters in coastal macrophytes was studied. A microwave-assisted extraction (MAE), followed by ultrahigh-performance liquid chromatography with tandem mass spectrometry (UHPLC-MS/MS) was applied to 76 macrophyte (seaweeds and seagrass) samples from three different beaches on the Gran Canaria Island (Spain), collected for 6 months. All studied UV filters were found with different detection frequencies from 16% to 100% in macrophyte samples. Octocrylene (OC) was detected in all the analysed samples throughout the sampling period. The highest concentration (19,369 $ng \cdot g^{-1}$ dry weight, dw) correspond to this compound in the seagrass Cymodocea nodosa.
The bioconcentration ratio was determined for several seaweed groups (red, brown, green). Different bioconcentration grades were obtained. Those above 1,000 indicated significant accumulation, which increases the possibility of chronic effects on seaweed and at upper tropic levels.

Key words: anthropogenic contamination, macrophytes, organic UV filters, microwave assisted extraction

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FIRST RECORD OF STRANDED MESOPELAGIC FISHES IN THE CANARY ISLANDS

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Abstract: Lanternfishes are the dominant component of mesopelagic fishes living in the ocean between 200 and 1000 m depth, playing a key role in the food web of oceanic ecosystems (Catul et al., 2011). Most mesopelagic fishes perform large diel vertical migrations from the deep-sea zone, where they stay during the day, to the surface where they feed at night, thereby transporting the ingested carbon in the upper productive waters to deep layers. Although there is a trade off between higher food availability at the upper layers and energy cost and predation risk, the incursions towards the surface also implies a transport by currents where they are exposed to stranding risk on the coast. This is especially important in the narrow shelves of oceanic islands where the shelf slope is nearshore. In the present study, we report the stranding of numerous myctophids along the shore of the southeast of Gran Canaria Island during June 2021. In previous studies (Battaglia et al., 2017), mesopelagic fishes strandings were frequently reported at the Sicilian coast (Strait of Messina, central Mediterranean Sea). However, this phenomenon has never been recorded in the Canary Islands coast (Central-East Atlantic). This study provides biological information on the species found, as well as the oceanographic conditions promoting the strandings. A subsample of the better-preserved specimens was used to identify the species, and morphometrics of the body (standard length, SL in mm) and of the *sagittae* otoliths. The remaining specimens, due to their bad conservation status, were identified through otoliths using the online AFORO web (Lombarte et al., 2006). Temperature, salinity, dissolved oxygen, and net primary production were obtained from Copernicus Marine Environment Monitoring Service (CMEMS) with the aim to understand the oceanographic conditions and discuss the causes of the stranding.

Key words: Myctophids, Central-Eastern Atlantic, Stranding, Otoliths, Remote sensing

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VARIABILITY IN PHYTOPLANKTON SIZE-ABUNDANCE SPECTRA ALONG A WIDE PRODUCTIVITY GRADIENT IN THE ATLANTIC OCEAN

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Abstract: Phytoplankton size structure is a major determinant of the functioning of pelagic food webs and plays a fundamental role in the biological pump, affecting the carbon export rate from the upper to the deep layers of the ocean. The objective of this work is to study the phytoplankton size-abundance community spectrum in the Atlantic Ocean, focusing on the differences from productive coastal waters to the oligotrophic gyres. Pooling together a large set of phytoplankton cell size and abundance data, collected along several oceanographic cruises in the Atlantic Ocean, we were able to characterize the community size structure in both the North and the South subtropical gyres, the equatorial upwelling, as well as in coastal, productive areas off Africa, South America and NW Iberia. The steepness of the size-abundance spectrum is an indicator of the size structure of the community. Oligotrophic areas are characterized by steeper slopes (from -1.5 to -1), whereas coastal areas present flatter spectra (slopes from -0.9 to -0.2), reflecting higher abundance of intermediate and large sizes Our results confirm that the phytoplankton community is progressively more dominated by intermediate and large cells as productivity increases. However, contrary to previous assumptions, we found no continuous increase in mean community cell size with productivity, but a saturating curve, suggesting that intermediate and large cells dominate in both mesotrophic and eutrophic environments. Resource availability in the water column is the main driver that defines ecosystem productivity and the steepness of the size-abundance spectrum.

Key words: Phytoplankton, Size-structure; Biomass; Atlantic Ocean

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MARINE BIOINVASIONS IN MACARONESIA: A PIONEER AND COMPREHENSIVE EVALUATION OF ITS SCALE AND RICHNESS

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Abstract: While terrestrial introductions have been well documented on many island ecosystems and continue to be the focus of extensive work in invasion biology, studies on

marine invasions on most of the world's islands remain poorly understood. The Macaronesia region comprises four volcanic archipelagos in the Atlantic Ocean - Azores, Madeira, Canary Islands, and Cabo Verde. To expand our understanding of the scale and diversity of fouling marine bioinvasions on insular systems, we examine the marine bioinvasions of Macaronesia. In this context, our study represents the first attempt to grasp the scale and richness of marine biological invasions in the Macaronesia region. We pioneered a comprehensive non-indigenous species (NIS) inventory in the region to determine their diversity patterns and native distribution origins. We also used statistical modeling to examine relationships among NIS richness, anthropogenic activities, demographic, and geographic variables across Macaronesian islands.
A total of 144 non-native marine species (NNS) were recorded for the whole Macaronesia. The highest NNS richness was registered in the Canary Islands (77 NNS), followed by Azores (66 NNS), Madeira (60 NNS), and Cabo Verde (18 NNS). Some differences amongst archipelagos were observed, as the high number of non-native macroalgae in the Azores, fishes in the Canary Islands, and tunicates in Cabo Verde. Much of the NNS present in Macaronesia were native to West Africa, Australia, New Zealand, the Caribbean and Northwest Pacific bioregions, followed by the Northwest Atlantic and the Mediterranean. Finally, Negative Binomial modeling suggested that non-native richness patterns across Macaronesia were strongly affected by minimum distance to the mainland, the total number of ports and marinas, and total marinas area (km2). This study represents pioneer baseline research in the region and will increase marine invasions awareness in Macaronesia, serve as a foundation for future research, and assist environmental decision-makers.

Key words: Non-native species (NNS), meta-analysis, modeling, anthropogenic stressors, Macaronesia

CONNECTING THE DOTS: THE USAGE OF REMOTE VIDEO FORAGING SYSTEM TO ASSESS THE EFFECT OF FORAGING ON FOULING NON-INDIGENOUS SPECIES

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Abstract:

Non-indigenous species (NIS) introduction and establishment can lead to severe environmental, socio-economic and human health impacts. Local communities and their interactions with NIS through competition and predation are crucial determinants for NIS establishment and invasiveness. However, trophic interactions, species preferences and associated biotic effects are still poorly known. Several studies have used predator exclusion trials or laboratory experiments to assess the overall effect of predation in shaping communities, but these can not discriminate predator-prey interactions or preferences. This study proposes a novel method in the marine realm that combines the deployment of settlement plates to recruit different assemblages, followed by their use as bait in remote underwater video systems. This Remote Video Foraging System (RVFS) is then used to record species (i.e. fish) foraging behaviour, including feeding choices and their impacts on fouling assemblage composition. It further allows assessing shifts in community composition due to predation by comparing bait units before and after the exposure. With the RVFS tested in a pilot study inside a marina (Quinta do Lorde, Madeira island, Portugal), we outline how it can be leveraged in marine NIS monitoring and research, and we describe a follow-up study that uses settlement plates and leverages RVFS to assess 1) differences in communities from inside and outside harbour facilities; 2) species foraging preferences of fouling communities recruited inside and outside harbour facilities, and 3) shifts in recruited

fouling communities after being exposed to predators.

Key words: Biotic resistance, Trophic Interactions, RVFS, NIS.

DETERMINATION OF EMERGING POLLUTANTS IN TISSUES OF BOTTLENOSE DOLPHINS *(TURSIOPS TRUNCATUS)* STRANDED IN CANARY ISLANDS

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Abstract: Around the 1900s, emerging pollutants (EPs) contamination has become an issue of interest to the scientific community due to its potential impact on the environment. UV filters (UVFs) and UV stabilizers (UVSs) are examples of EPs that are added to personal care products to protect skin and hair from the sunlight, and also to other products such as wax, plastic or textile to inhibit photodegradation of polymers and pigments (Gago- Ferrero et al., 2013). UVSs and UVSs have been investigated in different matrices such as sediments (Tsui et al., 2015), water (da Silva et al., 2015), algae (Pacheco-Juárez et al., 2019) and fishes (Gimeno-Monforte et al., 2020). The concentrations found are generally small, but these chemicals compounds can accumulate and biomagnify through the trophic chain (Gago-Ferrero et al., 2012). Cetaceans are top predators at highest level of trophic chain, with a worldwide distribution and they may have high concentrations of organic contaminants in their tissues. Taking into the account that cetaceans are considered as ecosystem bioindicators, a microwave assisted extraction method combined with ultra-high performance liquid chromatography and mass spectrometry detection has been performed to determine twelve UVFs and UVSs compounds in blubber samples of bottlenose dolphins *(Tursiops truncatus).* Applying the optimized method, three compounds were detected and quantified: BP-3 (1-(4-tert-butylphenyl)-3-(methoxyphenyl) propane- 1,3-dione), IMC (3-methylbutyl (E)-3-(4-methoxyphenyl) prop-2enoate) and OC (2-ethylhexyl 2-cyano-3,3-diphenylprop-2-enoate). OC was detected in all specimens analyzed with concentrations in the range of 52.61± 18.59 to 107.99 ± 11.32 ng g^{-1}. BP3 and IMC were found only in one sample, at 5.92 ± 0.04 ng g^{-1} and 8.55 ± 1.19 ng g^{-1}, respectively. To the best of our knowledge, this is the first determination of these emerging pollutants in bottlenose dolphins.

Keywords: UV filters, UV stabilizers, Bottlenose Dolphin, Blubber, MAE, UHPLC-MS/MS

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BEFORE AND AFTER A SEA URCHIN DISEASE OUTBREAK: AN HOPE FOR THE RECOVERY OF MACROALGAL HABITATS IN A BARREN DOMINATED ISLAND

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Abstract: Macroalgae play a crucial role in shallow temperate rocky reef habitats worldwide, supporting communities with high productivity and providing several ecosystem services. Sea urchin grazing greatly influences spatial and temporal variation of algae distributions, frequently causing a phase shift from macroalgae habitats to barren grounds in many temperate coastal areas. The poorly productive barren grounds are often established as alternative stable states, and only a significant reduction in sea urchin density can trigger the macroalgae habitat recovery. The long-spined sea urchin *Diadema africanum* is considered a keystone herbivore species in the northeastern Atlantic due to its control over the abundance and distribution of algae. In summer 2018, a mass mortality event off the coasts of the Madeira archipelago affected this ecologically important species, allowing us to make a deep opportunistic study on the event. A citizen-science survey for marine stakeholders was performed to understand the extent and intensity of the event. Underwater surveys recording *D. africanum* density and the diversity and abundance of benthic sessile organisms, macroinvertebrates and fishes before, during and after the event permitted to evaluate: i) the severity and magnitude of the event; ii) the *D. africanum* recovery; iii) the changes in benthic assemblages, and; iv) how these changes are related to grazer variations and herbivore densities. The event spread in the principal islands of the archipelago with population reductions of up to 90%. A clear shift from barren states to macroalgae habitats was evidenced some months after the mortality event, with *D. africanum* reduction as the major contributor. The fast recovery of *D. africanum* in the following months

suggested that its reproductive success was not compromised, putting at risk the recent increase in macroalgae dominated habitats. Follow up studies exploring *D. africanum* exclusion, removal, and population control can be the key to restoring algae dominated habitats.

Key words: *Diadema africanum*, widespread die-off, population density, alternative stable state, phase shift, Madeira Island

ENVIRONMENTAL ASPECTS OF SHALLOW WATER ECOSYSTEMS WITH ZOANTHARIANS DOMINANCE IN THE CANARY ISLANDS

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Abstract: Reports about proliferations of zoantharian populations in subtropical regions around the globe are increasing (López et al., 2019). These colonial cnidarians of tropical affinities can grow fast and dominate the benthos. Main causes for their poleward expansions are probably a combination of the increasing sea surface temperature (SST) and other anthropogenic impacts disturbing previously dominant communities (Reimer et al., 2021). In the Canary Islands several studies have observed important effects on the marine communities that lived associated to zoantharians colonies (González-Delgado et al., 2018; Moreno-Borges et al., 2022). However, little is known about the environmental conditions (temperature, pH, nutrients, primary productivity…) that characterize the specific areas where zoantharians are proliferating.

In this study we chose 6 locations (4 in Tenerife and 2 in La Palma), each one consisting of two sites, one with zoantharian dominance and the other a control area with similar environmental conditions (depth, wave exposure, type of substrate…). Two of these locations were in intertidal pools of Tenerife where *Zoanthus pulchellus* inhabited, and the other four were located at subtidal habitats dominated by *Palythoa caribaeorum*. At each site from each location we took water samples during an annual cycle, including sampling at the warm season of 2020 and at the cold season of 2021, in order to measure nutrients ($N\text{-}NO_2$, $N\text{-}NO_3$, $N\text{-}NH_4$, $P\text{-}PO_4$), chlorophyll and organic matter concentrations. Additionally, we deployed pH and temperature data loggers in order to record these variables during the whole year at each site (only for Tenerife´s locations). Records of these abiotic and biotic parameters gave us new information of the natural oscillation regimes regulating the productivity in these shallow ecosystems. Among main findings, it is to be highlighted that temperatures recorded at zoantharians dominated zones were higher than at control areas, especially during the warm season. This study provides new clues on the understanding of zoantharians outbreaks in subtropical regions.

Key words: *Palythoa caribaeorum*, *Zoanthus pulchellus*, Tropicalization, Climate Change, Anthozoa.

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SPATIO-TEMPORAL AND SEX-BASED PATTERNS OF RESIDENCY AND SPACE-USE IN ADULT ANGELSHARKS (*Squatina squatina*) IN EUROPE'S LARGEST MARINE RESERVE

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Abstract: Understanding of species distribution and space-use is an essential prerequisite for effective marine conservation and management, and with a third of all shark, ray and chimera species now threatened with extinction, a chronic lack of data on basic ecology compounds extinction risk for many species. *Squatina squatina* (hereafter Angelshark), a bottom-dwelling coastal shark, is currently listed as Critically Endangered on the IUCN Red List of Threatened Species. Despite recent conservation attention, there remains a significant lack of ecological data related to this species, and understanding of Angelshark behaviour, distribution and movement remains extremely limited. In the present study, Angel Shark Project: Canary Islands have used acoustic telemetry to collect vital detailed data on the movement, residency and sex-based space-use of adult Angelsharks within the La Graciosa Marine Reserve in the Canary Islands, with the aim of addressing key knowledge gaps and informing improved conservation policy. Between July 2018 and April 2021, 84 adult Angelsharks (61 females, 23 males) were tagged with acoustic transmitters, and 108,689 detections were recorded across nine acoustic receivers. Presence of both males and females peaked between November and January, indicative of a putative mating season. Males visited a signifcantly higher number of receivers but for shorter durations than females, possibly indicating more active, mobile behaviour. While detections were overwhelmingly concentrated in the shallow waters between La Graciosa and Lanzarote (up to 24m depth),

notable use of an offshore location (86m depth) indicated utilisation of deep-water habitat, not previously observed in this species. The present findings have implications for further research and for informing conservation of Angelsharks, particularly in relation to sex-specific space-use and use of deep waters across the study area and more widely.

Key words: Angelshark, *Squatina squatina*, space-use, residency, acoustic telemetry, conservation

Acknowledgments: This research is carried out as part of Angel Shark Project: Canary Islands and supported by Shark Conservation Fund, Oceanário de Lisboa, CanBIO Canarias, Ocean Tracking Network and Natural Environment Research Council UKRI. We thank dive centre staff who have supported and facilitated this research throughout. This includes Alexander Lehnen, and all members of staff at Buceo La Graciosa, without whom the acoustic tagging project would not have been possible.

SPATIO-TEMPORAL DISTRIBUTION OF HABs ALONG THE SOUTH SPANISH COAST

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Abstract: Harmful Algal Bloom (HAB) events have become increasingly frequent along the coast on a global scale (Hallegraeff, 2003). The aggregation of phytoplankton cells on the ocean surface may have negative impacts on both aquatic ecosystems and human health. HAB species differ locally, and their concentration and abundance might depend on physical parameters as well as biological processes. The Strait of Gibraltar is a singular – located in the southern Peninsula Iberica. It connects the Atlantic Ocean to the Alboran Sea in the Mediterranean basin. In this area, the spreading and accumulation of phytoplankton cells depend on many factors, where the physical processes of submesoscale processes circulation (Bolado-Penagos et al., 2020) that modifies temperature, salinity, dissolved oxygen, and nutrients, could also affects the ecological response of HAB species (Ravelo et al., 2022). Besides, anthropic activities are strongly developed in this area, and might influence phytoplankton concentration close to littoral urban settlements. With data obtained from Shellfish Production Areas (*Junta de Andalucía*), high values of HAB species are occasionally exhibited, as well as the presence of toxins in shellfish along the south Spanish coast. *Dinophysis acuminata*, *Dinophysis acuta* and *Gymnodinium catenatum* are the most frequent HAB dinoflagellate species during summer and autumn, and their blooms result in high levels of toxins in cultivated shellfish. *Dinophysis acuta* and *Dinophysis acuminata*, that may produce lipophilic toxins, and *Gymnodinium catenatum* and its associated toxin (saxitoxin), have been detected in the southern coast (Fernández et al., 2019). Phytoplankton in water and toxins in shellfish, have reached maximum values of 14.000 cells/L (*D.acuminata*) and 1884 µg/kg (DSP toxins) in Huelva in 2019 and 2020, and exceed the legal standards more than 450 times in this area between 2019 and 2021. This may have relevant effects to shellfish local production, specifically *Donax trunculus*, widely cultivated in the area.

Key words: Harmful Algal Bloom (HAB), submesoscale, anthropogenic impact, physical–biological interactions, community composition, shellfish production

Acknowledgments: This study has been conducted using data from the *Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible* of the Regional Government of Andalusia and E.U. Copernicus Marine Service Information. Authors acknowledge 2014–2020 ERDF Operational Programme of the Regional Government of Andalusia (FEDER-UCA18–108023).

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USE OF UNMANNED AERIAL VEHICLES (UAVS) FOR EMERGENCY ASSESSMENT DURING VOLCANIC ACTIVITIES: LA PALMA ISLAND VOLCANIC ERUPTION (2021)

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Abstract: Monitoring for assessment of volcanic eruptions presents a methodological challenge for the scientific community. These eruptions are hazardous and particularly difficult for ground-data collection or direct observations. Here, we present Unmanned Aerial Vehicles (UAVs) as a feasible, precise, rapid and safe tool for real time monitoring of the impacts and environmental processes occurring during the Cumbre Vieja eruption on La Palma Island, Spain (2021). UAV surveys with optical RGB, thermal and multispectral sensors, and a water sampling device were carried out in different areas affected by the lava flow, including the upper volcanic edifice and the lava delta formed on the coastal fringe of the island. Our results provide useful information for the monitoring of the eruption and its environmental consequences, such as the extension and volume of the lava delta entering the sea (using topographic models generated with structure from motion (SfM) photogrammetry, including Digital Elevation Models (DEMs), orthomosaics and 3D models), and the changes of seawater biogeochemical parameters in coastal surface waters using in-situ sensors and a sampling device. In addition, these devices provide real-time data and allow access to highly dangerous restricted areas, providing crucial information for scientists and managers in their assessments of the situation and facilitating the evacuation of populated areas, or the evaluation of possible impacts of eruptions.

Keywords: Volcanic eruption, drones, Unmanned Aerial Vehicles (UAVs), photogrammetry, crisis management, La Palma Island.

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AUTONOMOUS SURFACE VEHICLES NETWORK IN SUPPORT TO EOOS

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Abstract: The Ocean Observing System includes different networks, integrating their data outputs in Data Acquisition Centres (DACs) that feeds into the assimilation and forecast systems. A wide range of platforms and systems constitute the current global ocean observing infrastructure, including satellite observations, research vessels, autonomous floats, underwater gliders, fixed-point observatories, sea level stations, high frequency radar and autonomous surface vehicles. Nowadays, the ocean observing system remain largely immature and is composed of a large and diverse set of actors, such as research institutes, governmental agencies and the private sector.

The European Ocean Observing System (EOOS) is a coordinating framework designed to align and integrate Europe's Ocean observing capacity, promote a systematic and collaborative approach to collecting information on the state and variability of our seas, and underpin sustainable management of the marine environment and its resources. An overarching strategy across all measurement platforms is required to ensure that best use is made of limited resources in Member States and at European level. EOOS attempts to link the currently disparate components of the observing system in Europe and promote novel technology and infrastructure development, standardization, open access to data, and capacity building.

Within the framework of EOOS is the EU-funded EuroSea project, with an overall goal about to consolidate a more integrated interdisciplinary ocean observing system able to deliver essential information for the wellbeing, blue growth and sustainable management of the ocean, based on the implementation and coordination of the different observing networks above-mentioned, being the Autonomous Surface Vehicles (ASV) technology one of the main novelties in terms of network initiative that attempts to engage existing and forthcoming actors from public and private sectors, to set and coordinate current and upcoming efforts in order to establish and consolidate a recognized international network under Best Practices standard procedures in support to EOOS strategy.

Key words: EOOS, EuroSea, ASV, Network, Ocean Observing

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AN UNMANNED SURFACE VEHICLE FOR LARGE SCALE ACOUSTIC MONITORING

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Key words: acoustic tag, autonomous vehicle, angelshark, spiny butterfly ray.

Abstract: Unmanned systems are finding new applications in ocean data collection or marine fauna monitoring. Their utilization is not always possible, but when this approach is viable, it offers important benefits in terms of campaign duration, costs, repeatability and safety (Verfuss et al, 2019). This contribution presents a novel autonomous surface vehicle and its utilization as a relocatable acoustic receiver for detecting angelsharks and spiny butterfly ray exemplars tagged with acoustic emitters.

It is well known that elasmobranchs' populations are facing a rapid decline at a worldwide scope. Among them, the angelshark (*Squatina squatina*) is considered as critically endangered and has been included in the IUCN Red List of Threatened Species, while the spiny butterfly rays (*Gymnura altavela*) qualifies as endangered (Morey et al, 2019).

CANBIO and ACUSQUAT II projects address the study of populations of these two species using acoustic tags. The usage of acoustic tags requires not only of an important tagging effort, but also the deployment of a network of moored receivers. The classic methodology is to install a set of moored receivers that remain at fixed positions. Whilst this approach is a well-developed and proved methodology, it is not always feasible as the number of detectors required to provide an adequate level of coverage of the area under study may depend on the



Figure 1. The prototype during a sea trial in waters off Gran Canaria

range of movement of the species or the existence of geographical constraints that might be exploited (i.e. existence of passages).

This has been the situation faced during the development of ACUSQUAT II and CANBIO projects, aimed at characterizing the filopatria and residence patterns of angelsharks and spiny butterfly rays in two different areas of Canary Islands, (southwest of Gran Canaria and La Graciosa). In the scope of these projects, a network of moored receivers has been complemented with data collected by an autonomous surface vehicle, used as a rellocatable receiver.

This approach has been already tested using an autonomous sailboat (Cabrera-Gámez et al, 2020) with good results, but the utilization of a sailboat is not always possible in periods of low winds and/or strong currents in areas close to shore. To overcome these constraints, a new autonomous surface vehicle, propelled by two brushless thrusters in a differential steering configuration, has been developed from a refurbished windsurf board. Its power system integrates two photovoltaic panels (2 x 130 watts) and a rechargeable LiFePO4 battery (18 VDC, 120Ah). Using a VEMCO VR2C Mini cabled receiver, it is possible to report detections in real-time through the different radio communication links available, either via ISM radio (868 MHz), GSM/3G, or via IRIDIUM SBD.

This article provides a general description of the vehicle and its control architecture. It also presents results achieved during the field trials developed so far. In summary, this vehicle has proved to be a valuable instrument to monitor an extensive area for detections, something unaffordable with moored receivers, which can report georeferenced detections in real-time.

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TIDAL STREAM ENERGY SITE-SELECTION BASED ON ICZM

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Abstract: Tidal stream energy has shown to be a promising alternative to diversify the energy mix in many estuaries. However, in these coastal areas a large number of undergoing and potential activities coexist, which need to be considered when installing a tidal farm (Álvarez et al., 2022). The objective of this research is to define and apply a holistic methodology based on an Integrated Coastal Zone Management (ICZM) approach, leading to the identification of the best zones for installing a tidal stream facility (Lange et al., 2018). To this end, all the relevant aspects affecting its installation and operation are considered. In particular, the methodology takes into account, in the first place, the energy resource, for which the results of a high-resolution state-of-the-art numerical model are used. Then, the effects of the coastal configuration on the main installation costs are also assessed and incorporated to the analysis. Finally, the proposed methodology also considers the socioeconomic restraints along with the environmental aspects, which are analysed by using the definition of new indexes along with Geographic Information System (GIS) techniques (Vazquez and Iglesias, 2016). The methodology is applied to the Shannon Estuary (W Ireland), which has been shown to be a promising area for tidal energy conversion, and where several areas for tidal stream exploitation were proposed based on the available resource, albeit the best area is still to be identified (O'Rourke et al., 2014). The application of the proposed methodology leads to the accurate delimitation of this area.

Key words: tidal energy, site-selection, ICZM, socioeconomic aspects, high environmental value areas.

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AUTOMATIC UNDERWATER PHOTOMOSAIC SYSTEM FOR ASSESSMENT OF BENTHIC COMMUNITY USING THE CRAWLER REMOTE OPERATING VEHICLE AT OBSEA OBSERVATORY

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Abstract: The continuing need to study the oceans has led to the development of new marine technologies for the acquisition of real-time multi-parametric oceanographic, biological and biogeochemical data. So far, assessment of benthic populations and biodiversity studies have relied on the use of fixed underwater observation platforms and static cameras with a limited field of view. Because they provided a small representation of reality, new mobile platforms coupled to the fixed observatories are developed.

This work it is based on the OBSEA cabled observatory, that is part of European Multidisciplinary Seafloor and water column Observatory (EMSO), and a Remote Observation Vehicle (ROV), the underwater Crawler, which is a modified version of the "Wally" platform series. The new ROV is easily deployable for monitoring benthic communities, among other biological indices, to depths up to 50m. Here we present the Crawler components and the image processing algorithms that done for the HD camera embedded in a glass sphere on the front of the vehicle. As a context, we have a 360º camera with a 180º tilt allowing us to obtain a panoramic field of view (FOV). In this work we present the results obtained through video transects back and forth around the OBSEA platform. The control of the Crawler camera has been enhanced with an automatic underwater photomosaic system and an obstacle avoidance system, with the objective to create a mobile monitoring system and detection of species around the observatory.

Moreover, we detail the results obtained for the camera calibration tests done in air, pool and sea scenarios, with corrections due to position of the camera and problems in terms of reflectance and light scattering. In addition, we explain the selection of the area of interest and how a perspective transformation has been employed according to projection theory. We present an analysis of images through spatially heterogeneous gradients with the aim of scaling the local data to larger areas.

Keywords: benthic habitat; remote observation vehicle; underwater video; coastal ecosystems; fishes; monitoring.

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Ciencia, Innovación y Universidades; PI: JdR and JA] and JERICO S3 (Joint European Research Infrastructure of Coastal Observatories: Science, Service, Sustainability, Call: H2020-INFRAIA-2019-1, Project ID: 871153). The authors wants to thanks Jacobs University who provide the starting prototype to SARTI (UPC) and ICM (CSIC) for further upgrade, modifications and implementations.

RESULTS ON A TWO-GLIDER MISSION IN THE MESOSCALE EDDY FIELDS GENERATED SOUTH THE CANARY ISLANDS WATERS.

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Abstract: The physical and biochemical marine lagrangian dynamic generated by a mesoscale eddy field, was examined with two different physical and biochemical autonomous underwater vehicles (deep gliders, 1000m) in the framework of the FLUXES project. Deployments were hold South the Canary Islands waters between the 7th to 25th of July 2017 (435 km,). Langrangian descriptors (M function) were obtained from the 3D hourly current fields (1º/12, forecast +72h) provided by COPERNICUS IBI Regional System, and were integrated between 0 and 500m following the AUVs flying depth ranges. The hyperbolic path planning trajectories along the eddies field was then validated by both Dyna585 (physical) and Bio584 (biochemical) gliders on the ground (CTD, DVL, MR turbulence profiler, O2, Chla, and backscattering). Both AUVs were programmed allowing any bearing angle and integrating each 8 hours (gliders surfacing period), the ground true given by both glider locations each surfacing. Observations revealed the complexity of the vertical structure of the mesoscale eddy fields targeted. This study also highlights the utility of the gliders in support of the development and verification of mesoscale oceanographic features and its biochemical and physical effects in the first 1000m of the water column.

Key words: Mesoscale eddies, Autonomous Underwater Vehicles, Physical and Biochemical Dynamic, lagrangian fluxes.

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TROPHIC BIOLOGY DIFFERENCES BETWEEN RESIDENT AND MIGRATING ATLANTIC BLUEFIN TUNA IN THE STRAIT OF GIBRALTAR

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Abstract:

The Strait of Gibraltar (SoG) is crossed every year by Atlantic bluefin tuna (ABFT), *Thunnus thynnus*, which move from Atlantic Ocean foraging grounds to Mediterranean spawning grounds. Once spawning is completed, the ABFT breeders return to Atlantic waters. Apart from these "transient" individuals, there exists an unquantified contingent of ABFT that stay all year round in this area. Significant commercial catches on a regular (monthly) basis are indicative of the presence of this "resident" contingent of ABFT in the SoG. Stable isotope analysis was used to infer trophic differences between migrating and resident individuals, seasonal feeding patterns and isotopic niche width. While 298 samples were collected from tuna caught by baitboat and green stick in 2019-2021, 47 individuals were sampled in tuna traps.
δ^{15}N and δ^{13}C values showed significant differences between resident and migrating ABFT in 2019 and 2021. Likewise, we observed both seasonal and interannual isotopic differences in resident ABFT. Standard Bayesian ellipses adjusted for small sample size (SEAc) showed significant overlaps between 2019 and 2021 for muscle and liver isotopic data (58% and 50%, respectively), isotopic niche width being narrower in 2019 and 2021. Otherwise, no significant isotopic overlap was found between resident and migrating individuals in spring. Furthermore, migrating tuna showed broader isotopic niches, indicating that they had a more diverse diet. These differences suggest the presence of two different contingents of ABFT in the SoG, which show differences in feeding patterns.

Key words: *Thunnus thynnus,* trophic biology, isotopic niche width.

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THE FISHING SECTOR WILL SUPPORT A NEW "PLAN CASTELLÓN"

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Abstract:

Fisheries management plans based on co-management are the best way to govern a fishery. This type of plan optimizes the governance of the fishery due to the greater representation of those involved in the management of the fishery. A clear example of this is the "Plan Experimental de Pesca de Arrastre de Castellón" (PC), carried out between 1961 and 1966 (Dahlet and Sánchez Lizaso 2021). At that time the fishery in the PC area was overexploited and measures approved by al stakeholders were applied to reduce fishing effort and recover the fishery.

During this work, interviews were carried out with workers of the fishing sector to evaluate their knowledge of the PC, as well as their opinion regarding the elaboration of a new plan with similar characteristics to the PC. The interviews were carried out in the different ports of the province of Castellón.

To evaluate the level of knowledge of the different workers, the Chi-square statistic was used, showing that: (i) those over 50 years of age know the PC more than those under that age, (ii) skippers know the plan more than sailors, (iii) skippers are more senior than sailors, (iv) in the port of Castellón it is known more than in the rest of the ports and (v) the type of fishery has no influence on the knowledge of the PC. Most of the workers interviewed were in favor of the implementation of a new PC.

The most relevant proposed measures for the recovery of the fishing areas without reducing the fleet size are: (i) reduction of fishing time, (ii) creation of Marine Protected Areas (MPAs) and (iii) improvement in gear selectivity.

Key words: Plan Castellón ; co-management; Mediterranean fisheries

Acknowledgments: The authors acknowledge the cooperation of the sector workers from different ports studied.

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FROM FISH-FARMS TO AQUARIUMS: AMPHIPODS AS ALTERNATIVE FEED FOR ORNAMENTAL SPECIES

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Abstract: Developing an optimal feed is indispensable for the culture of many marine species, including marine ornamentals. Species such as seahorses or heterotrophic corals are kept in aquariums due to the degradation of their habitats, which threaten their conservation or to the growing demand for them in the marine ornamental trade. Satisfying the nutrient requirements of these species remains one of the major tasks in keeping and reproducing these organisms under captivity. The aim of this study is to assess the potential use of amphipods associated to marine aquaculture facilities as alternative feed for seahorses (*Hippocampus* spp.) or heterotrophic corals. For this, nutritional value and total length of amphipod species abundant in fish-farm fouling were evaluated in comparison with commonly used preys and diets. Mediterranean amphipods showed appropriate fatty acids profile for marine species, with high contents of eicosapentaenoic acid (EPA; 13.9-10.7 %) and Docosahexaenoic Acid (DHA; 16.9-13.2%) and appropriate ω3/ω6 ratio (3.08-5.68). Moreover, protein and amino acids contents are adequate and comparable to those already esteemed suitable diets for feeding seahorses and heterotrophic corals, with similar o even better composition than traditional diets (i.e. *Artemia*, rotifers or mysids). This study demonstrates that amphipods found at large densities aquaculture facilities in the Mediterranean Sea can successfully replace some traditional diets in order to offer a more natural feeding regime for ornamental species. More science-based works are required to optimize current diets and maximize results in ex situ aquaculture.

Key words: Amphipods, ornamental species, seahorses, corals, aquaculture, Mediterranean.

Acknowledgments: We would like to thank Emilio Cortes Melendreras (Aquarium University of Murcia) for his valuable comments and advice. This study is part of the project ‘Amphipods as innovation for nutrient recycling within multitrophic aquaculture. Product enhancement (AIRAM)’ developed with the collaboration of the Biodiversity Foundation (Spanish Ministry for Ecological Transition and the Demographic Challenge), through the Pleamar Program, co-financed by the European Maritime and Fisheries Fund (EMFF).

FISHING DISCARDS FROM TRAWLING IN THE GULF OF CADIZ. ANALYSIS AND CHARACTERIZATION

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Abstract: Fishing is one of the most important human activities carried out in the oceans. In 2018, of the 84 million tons of catches, 10% were discards (FAO, 2020). Discards are those specimens of different species that are returned to the sea, dead or alive, due to reasons such as not being target species or not meeting the legal size (Kelleher, 2008; Despoti et al., 2021). The objective of this work was to characterize the species discarded in the trawl fisheries of the Gulf of Cadiz, as well as, to make proposals for a better management of them. Sampling was carried out within the framework of the ECOFISH, ECOFISH 2 and ECOFISH + projects, and shipments were made with the fleet of Sanlúcar de Barrameda and El Puerto de Santa María (Cádiz) maintaining its way of fishing, from 2019 to 2021, except for the closed periods (mid-September to the end of October) for the trawl modality in the Gulf of Cádiz. To this end, 11 kg of discards were processed and identified at random for each set made, at depths ranging from 15 to 548 m. The main fishes species discarded were anchovy (*Engraulis encrasicolus*), scaldfish (*Arnoglossus* spp.), sardine (*Sardina pilchardus*) and atlantic horse mackerel (*Trachurus trachurus*) as well as invertebrates: arrow shrimp (*Plesionika heterocarpus*), sea grapes (*Molgula* sp.), spottail mantis shrimp (*Squilla mantis*) and sand sea star (*Astropecten irregularis*). These species are discarded for various reasons, either because of the low prices that some of them fetch or the lack of value of others. The involvement of the different agents involved in fisheries is very necessary to ensure effective management and reduction of discards, as well as the correct implementation of the new Common Fisheries Policy.

Key words: Discards, fisheries, professional fleet, stakeholders, trawling.

Acknowledgments: The realization of the ECOFISH, ECOFISH 2 and ECOFISH + projects have been possible thanks to the financing of the Fundación Biodiversidad, the Ministry for Ecological Transition, through the Pleamar Program, co-financed by the European Maritime and Fisheries Fund and above all by the collaboration of the fishermen who have welcomed us and allowed us to work side by side. We would like to thank all the boats that have been involved and the Cofradía de Pescadores Sanlúcar de Barrameda and El Puerto de Santa María for their willingness and support.

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CLASSICAL BREEDING IN THE DIATOM SPECIES *Seminavis robusta* FOR BIOTECHNOLOGICAL USE IN THE EUROPEAN AQUACULTURE INDUSTRY

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Abstract: Microalgae are a natural source of high-value fatty acids and could address the reduced availability of fish oil from pelagic fisheries and the increasing needs from the aquaculture sector and the ω-3 market (Chauton et al., 2015). Still, their exploitation on industrial scale is scarce, mainly due to the lack of highly performant strains.

Classical breeding constitutes a source of genetic diversification in microalgae, generating progeny strains with unique genetic heritage and bypassing the controversial issue of genetic modified organisms (GMOs). In the framework of the H2020 NewTechAqua project, our goal is to generate improved microalgae strains via classical breeding for application as aquafeed in European aquaculture. The heterothallic diatom species *Seminavis robusta* is particularly suitable for controlled breeding programs based on pedigree selection (Chepurnov et al., 2012).

Eight wild-type strains of *S. robusta* were purchased from the BCCM/DCG collection (PAE laboratory, UGENT, Belgium) and crossbred according to their sexual compatibility (De Decker et al., 2018). Single cells of 66 F1 progeny strains from eleven breeding pairs successfully developed into monoclonal cultures. All the 74 strains were cultured for twelve days under the same growth conditions in 6-well plates. Sixteen bright field and fluorescence CY5 images per well were taken every three days using the Cytation™ 3 plate reader and imager from BioTek, and processed using Gen5 and ImageJ softwares. Cell density over time was estimated using the percentage of surface showing CY5 fluorescence over the total surface.

Sixteen F1 progeny strains aroused biotechnological interest as they showed faster growth compared to their wild-type parents. Further studies will address fatty acid composition and quantification for all the strains. The most performant F1 strains will undergo crossbreeding experiments in an iterative manner, using a pedigree-based approach. Our findings will ultimately contribute to achieve a more sustainable, resilient and cost-effective European aquaculture.

Key words: Classical breeding, *Seminavis robusta*, aquaculture, w-3 PUFAs, DHA, EPA

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FISHING *Xyricthys novacula* IN THE PITYUSIC ISLANDS: STATE OF THE FISHERY AND PROTECTION MEASURES

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Abstract:
Xyrichtys novacula or pearly razorfish is a sand burrowing wrasse found in the coastal Atlantic Ocean and the Mediterranean Sea and is one of the main recreational fishing targets in the Balearic Islands. In these islands, its popularity has increased in the last years, creating a great pressure on the population. The present study is aimed at surveying the current state of this species in various areas of the islands of Ibiza and Formentera. In addition, protection measures are also assessed, in particular Marine Protected Areas (MPAs), to determine their effectivity. To address this objective, extensive experimental fishing has been carried out during 12 years, in non-protected areas of Ibiza and Formentera, and an MPA with both open and restricted areas. Captures per unit of effort, fishing and natural mortality, size and sex ratio were studied with data-limited models and statistical analysis. Despite fluctuations in size and abundance throughout the years, the trends evidence the populations are affected by area rather than year. These differences might be due to accessibility and popularity, which would drive fishing vessels to exploit one area as opposed to another. The obtained results showed that the MPA open fishing area has very high mortality rates and small sizes, due to overfishing because of a pull-effect, whilst the remaining areas are not considered overfished. The restricted MPA area presents larger sizes and healthy sex-ratios, and therefore this protection measure seems to be beneficial to the species. Altogether, the present study intends to result in information which could give the administration tools to better manage the *X. novacula* fishery, as well as insight into the populations in different areas of the island.

Key words: pearly razorfish, Pityusic islands, Marine Protected Area, fishing pressure

AGE VALIDATION IN EARLY STAGES OF *Sepia officinalis* AND ITS APPLICATION TO AGE ESTIMATION OF SEPIA SPECIES

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Abstract:

This study validates the daily deposition of beak increments in juveniles of *Sepia officinalis*. A total of 127 individuals of *Sepia officinalis* were cultured in captivity to validate the temporal deposition of increments observed in the beak rostrum surface (RS), following the methodology of Perales-Raya *et al.* (2018) in octopus paralarvae. Daily deposition in *S. officinalis* was validated up to 31 days of age, including the first increment (i.e. day-0 or hatching). The study was carried out in duplicate to standarize the methodology, and at different temperatures (21ºC as conventional rearing temperature and 18ºC as a small reduction) to assess possible variations in the temporal deposition. No differences were observed and daily deposition was confirmed at both temperatures.

This standardized validation method was used to perform age estimations in adults using the rostrum sagittal sections (RSS) of other cuttlefish, the African cuttlefish *Sepia bertheloti*. We analysed 206 beaks of adult *S. bertheloti* caught in West Africa: 78 in Morocco and 128 from Guinea-Bissau. A maximum age of 433 days was observed for individuals from Guinea-Bissau and 419 days for individuals from Morocco. The number of increments in the RSS was counted according to Perales-Raya et al. (2014). Assuming a daily deposition of growth increments in rostrum sections beaks (according with our validation in the RS of *S. officinalis* juveniles), the results show different growth patterns in both areas of NW Africa. *Sepia bertheloti* shows a slower growth rhythm in the waters of North Morocco, with smaller sizes (dorsal mantle length) at the same age than off Guinea-Bissau. Reasons of these differences are also discussed.

Key words: beaks, increments, hatching mark, culture, growth rhythm

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SUPPORT FOR THE MANAGEMENT OF THE EMERGING OFFSHORE MUSSEL AQUACULTURE SECTOR ON THE BASQUE COAST (SE BAY OF BISCAY)

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Abstract: As a result of the validation of the feasibility of installing bivalve longline systems in open waters of the Basque coast (SE Bay of Biscay), commercial farming of mussels (*Mytilus galloprovincialis*) started in 2019 in the Mollusc Production Area located between Ondarroa and Lekeitio (Bizkaia). However, the mussel culture is encountering some difficulties that compromise the economic profit of the activity, such as increased occurrence of different harmful algal blooms and insufficient monitoring of the mussel reproductive cycle. Therefore, a fortnightly or monthly survey was carried out in 2021 to determine this reproductive cycle, based on histological assessment together with analysis of mussel meat and water samples for the presence of biotoxins and toxin-producing phytoplankton, respectively. The main spawning peak occurred in late summer, but gamete release took place throughout the year, which could lead to a decrease in meat yield and quality. On the one hand, Okadaic acid, a "Diarrheic Shellfish Poisoning" (DSP) toxin, was produced by *Dinophysis acuminata* and exceeded the legal limit in spring, from March to June. On the other hand, lipophilic toxins of the yessotoxin group exceeded the legal limit during several days in June and October. The remaining regulated lipophilic toxins (dinophysistoxins, pectenotoxins or azaspiracids) were not detected. Amnesic toxin (ASP) and paralytic toxins (PSP) did not exceed the legal limit for domoic acid and saxitoxin, respectively. Thus, spring and autumn are the seasons with the highest risk of biotoxin events (DSP and PSP) and, consequently, closure of the Mollusc Production Area.

Key words: shellfish aquaculture, reproductive cycle, harmful algal blooms, Cantabrian Sea

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GRAVITY-DEPENDENT BUOYANCY OF PELAGIC FISH EGGS

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Abstract: The bathymetric distribution of pelagic eggs is determined by its buoyancy. Buoyancy depends on the interaction of biological (demersal, pelagic or bathypelagic) and physical phenomena (seawater density, viscosity, turbulence, up/down-welling phenomena and salinity) (Sundby, 1991). Egg and larvae density and their specific gravity allow eggs to reach their equilibrium buoyancy by emerging from spawning areas to the photic area where larval stages complete development (Motos *et al.,* 2000). In this study we have estimated the proportion of viable hake eggs, as assessed upon the embryonic oil drop adherence (ODA, Nande *et al.,* 2014) at each bathymetric layer upon their specific gravity. The in vitro egg buoyancy test consisted on incubating 6000 eggs distributed in experimental burettes with replicates. Eggs distributed in the water column during the incubation process and thirty eggs per layer (Ub, Sb, Mb and Bb) were collected at embryonic stage F (54 hpf), characterized under the stereomicroscope as ODA/ODNA eggs and photographed. Significant differences in the percentage of ODA eggs were observed between either ultra positive buoyancy (Ub) or negative buoyancy (Bb) layers and positive buoyancy Sb and middle buoyancy (Mb) layers. These results suggest that specific egg gravity and seawater density influence egg buoyancy and determine its bathymetric position and further viability (Iglesias *et al.,* 2013). Egg gravity is an adaptive trait strongly dependent on the local environmental with upmost relevance for the sustainability of fisheries in a challenging global climatic change.

Key words: Oil drop adhesion, *Merluccius merluccius*, Egg buoyancy, embryo development

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SHORT-TERM VARIABILITY IN PICOPLANKTON INDUCED BY A SUBMESOSCALE FRONT SOUTH OF GRAN CANARIA (CANARY ISLANDS)

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Abstract: The distribution and variability of phytoplankton in the upper layers of the ocean are highly correlated with physical processes at different time and spatial scales. Model simulations have shown that submesoscale features play a pivotal role on plankton distribution, metabolism and carbon fluxes. However, there is a lack of observational studies that provide evidence for the complexity of short-term phytoplankton distribution and variability inferred from theoretical and modelling approaches. In the present study, the development and decay of a submesoscale front south of Gran Canaria Island is tracked at scales not considered in regular oceanographic samplings in order to analyse the picoplankton response to short-term variability. Likewise, the contribution of each scale of variability to the total variance of the picophytoplankton community has been quantified. We observe statistically different picophytoplankton assemblages across stations closer than 5 km, and between time periods shorter than 24 h, which were related to high physical spatiotemporal variability. Our results suggest that both temporal and spatial variability may equally contribute to the total variance of picoplankton community in the mixed layer, while time is the principal contributor to total variance in the deep chlorophyll maximum.

Key words: picoplankton, submesoscale front, spatiotemporal variability, frontogenesis, frontolisis

SEASONAL VARIATIONS OF THE UPPER OCEAN IN THE SCOTIA SEA AND WEST OF THE ANTARCTIC PENINSULA: OBSERVATIONS FROM INSTRUMENTED SEALS

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Abstract: The Scotia Sea and Bransfield Strait represent two major exits through which water masses driven by the western boundary current system of the Weddell Sea gyre leave the basin. In the upper ocean of this study area (0-400 m), five water masses govern the hydrography: Antarctic Surface Water (AASW), Winter Water (WW), Transitional Zonal Water with Bellingshausen Sea influence (TBW), Transitional Zonal Water with Weddell Sea influence (TWW) and modified Circumpolar Deep Water (mCDW). However, due to the local hazardous weather conditions and sea-ice coverage that prevail through the fall and winter seasons, a year-round description of the regional hydrography has been traditionally hampered, especially in areas shallower than 1000 m where the standard parking depth of the freely drifting Argo floats prevent them to enter. The year-round hydrography of these shallower areas, with a greater influence in coastal scenarios, is of key interest given the role that the ocean plays as a thermal forcing to glacier retreat in polar regions.

To this aim, we use a set of historical data based on observations from instrumented seals. These seals migrate every year, during the warm seasons, from the South Orkney Islands and South Georgia Island towards the south along the west Antarctic Peninsula, performing the reverse route as the colder seasons evolve. In this study we present a series of transects of temperature and salinity down to 400 m depth, which cover the year-round variability of the regional hydrography of the shelf and open ocean of the Scotia Sea and West Antarctic Peninsula. These transects extend over distances as long as 1200 km, sampled during a period of time of nearly two months. Notably, on two occasions, the seals remained over nearly the same area in the Scotia Sea for several months, acting like a 'living mooring' and recording the time-varying temperature and salinity properties of local water masses through different seasons.

Preliminary results uncover the temperature and salinity variations governing the seasonal water mass transformation of the upper ocean in the Scotia Sea and West Antarctic Peninsula, with a special focus on the time-varying structure of thermal fronts.

Key words: Scotia Sea, West Antarctic Peninsula, Shelf Ocea, Seasonal Hydrography, Thermal Fronts, Instrumented Seals.

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ECOSYSTEM SERVICES IN THE COASTAL-MARINE ENVIRONMENT OF THE GULF OF CADIZ

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Abstract: The coastal-marine areas of the Andalusia region are characterized by a high interaction between natural ecosystems and human uses and activities. In terms of its physical-natural characteristics, the Andalusian Atlantic arc has an extensive and gently sloping continental shelf. It has some estuaries that provide fresh water to the coast, among which the Guadiana and the Guadalquivir stand out for their extension (Consejería de Medio Ambiente y Ordenación del Territorio, 2015).
On the other hand, attending to current regulations, Directive 2014/89/EU of the European Parliament and of the Council, of 23 July 2014 (Diario Oficial de la Unión Europea, 2014), establishing a framework for maritime spatial planning, stands out. This regulation promotes the sustainable development of marine spaces, taking into account the interactions between land and sea. The Directive is transposed into Spanish law through Royal Decree 363/2017, of April 8, establishing a framework for maritime spatial planning.
The present work is framed in this natural, social and regulatory context. The fundamental objective is to obtain the services offered by coastal-marine ecosystems in the Gulf of Cadiz and their impacts against the development of economic activities, in order to meet the requirements of the European Directive from an Ecosystem-Based Management. For this purpose, the intertidal and marine ecosystems of the study area are considered, mapped from the information available in Corine Land Cover (CLC, 2006) (in the case of intertidal) and European Nature Information system (Davies et al., 2004) (in the case of marine). From this information, the ecosystem services are obtained through the participation of experts and under the classification of the Common International Classification of Ecosystem Services (CICES). Obtaining the ecosystem services, as well as the human uses and activities that exert pressure on them, results in the determination of the most vulnerable areas and ecosystems or those on which to prioritize coastal-marine management processes.

Key words: Ecosystem Based Management, marine ecosystems, Andalusia, human activities

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MARINE PRIORITY HABITATS AND SUBMERGED ANTIQUITIES MAPPING THROUGH A DOWNSCALE REMOTE SENSING METHODOLOGICAL SCHEME IN THE SERVINCE OF MARINE SPATIAL PLANNING: THE CASE STUDY OF SARONIC GULF, GREECE

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Abstract: The need for an intergrated Marine Spatial Planning (MSP) map featuring areas of Marine Priority Habitats (MPH) and Submerged Antiquities (SA) is of high priority (Georgiou et al., 2021; Khakzad et al., 2015). This need is enhanced by the prolonged pressure applied upon both the MPH and SA by the ever-increasing human activities in the coastal zone (Antonioli et al., 2020; Muñoz Sevilla et al., 2019). For this reason, the following cost and time effective scheme of detecting and mapping these areas through a downscale approach was conceived. The scheme has a three level of increasing detail and their corresponding methodological approach. The first level consists of the desk-based research utilising literature research and the application of satellite image analysis. This level is used for setting the boundaries and detecting areas where the presence of MPH and SA is possible. The second level is the precise mapping and the classification of the seafloor through marine remote sensing techniques. Through this level the exact position, coverage area and morphological characteristics of these areas is achieved. The third, and final, level aim to the evaluation of the status of the MPH or SA using visual inspection and 3d imaging techniques. This scheme was tested in Saronic Gulf in Greece. The Saronic Gulf envelops the port of Peiraeus, one of the biggest ports of the Mediterranean, places of high cultural heritage value like Salamina and Aegina islands and the presence of Posidonia oceanica meadows and Coralligenous reefs. The successful application of the scheme in this area yielded great results in the form of MSP maps. These maps are the most effective tools for establishing an Integrated Coastal Zone Management plan and further highlight the need for mapping both MSP and SA areas and evaluating their status.

Key words: Marine spatial planning, Marine remote sensing, Marine priority habitats, Submerged antiquities, Downscale

Acknowledgments: This research is co-financed by Greece and the European Union (European Social Fund - ESF) through the Operational Programme «Human Resources Development, Education and Lifelong Learning 2014-2020» in the context of the project "EnAktea: Integrated Methodological Approach for the Detection & Mapping of Marine

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DIFFERENCES SHAPING MARINES COMMUNITIES RESIDING IN COASTAL MPAS

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Abstract:

Oceanic islands with limited shelves, low diversity and high endemism are particularly vulnerable to stressors and pressures. This vulnerability can be especially relevant for taxa residing in coastal habitats, where human populations are typically in higher density leading to higher pressures from pollution, fisheries, tourism, urban development and other anthropogenic related stressors. Marine Protected Areas have long been perceived as a fundamental tool for marine biodiversity conservation and to mitigate impacts from compounding pressures. Using newly acquired and historical data, we compare how MPAs in different locations of Madeira archipelago and with different restrictions promote differences in multiple biological and ecological indicators (e.g. density, cover, biomass) across different taxonomic groups (i.e. sessile organisms, macroinvertebrates and fish). We discuss pros and cons of different restrictions and propose steps to enhance protection effects and conservation of Madeira coastal habitats and biodiversity.

Key words: Marine Protected Areas, marine conservation, coastal habitats, community structure, marine spatial planning, ecosystem services

Acknowledgments: This work was supported by the project PLASMAR+ Progreso de la Planificación Sostenible de Areas Marinas en Macaronesia; project Mimar+ Seguimiento, control y mitigación de proliferaciones de organismos marinos asociadas a perturbaciones humanas y cambio climático en la Región Macaronésica; ARDITI - Agência Regional para o Desenvolvimento da Investigação Tecnologia e Inovação through the project M1420-09-5369-FSE-000002- Bolsa de Pós Doutoramento and the Marine Global Earth Observatory (MarineGEO).

SCIENTIFIC MONITORING IN SERRA D'IRTA MARINE PROTECTED AREA

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Abstract: The scientific monitoring of the marine protected areas of fishing interest it is necessary to know his ecological status and evaluate the proper operation of the protection measures. We present a two years monitoring of the marine protected area of fishing interest Serra d'Irta (Valencian Community) located in the western Mediterranean, where we evaluated the marine protected area effect in commercial species with underwater scuba visual census and data from local fishing catches; we also monitored the ecological status of the main communities and species with special interest, evaluating the structure and morphology of the *Posidonia oceanica* and *Cymodocea nodosa* meadows presents in the marine protected area, the ecological quality ratio (EQR) of organogenic formations (ex: *Dendropoma petraeum*) using CARLIT and the status of the populations of sea urchin *(Paracentrotus lividus*, *Arbacia lixula* and *Sphaerechinus granularis*) and *Patella sp*. The results shown that the marine protected area effect in fishes it is only significance for abundance and diversity, the *Cymodocea nodosa* meadows presented a moderate conservation state with high variability in density and coverage, *Posidonia oceanica* meadows are well conserved but present a limited extension with high spatial variability, the EQR of the organogenic formation was good and moderated and the sea urchin and Patella sp. populations are scarce and remain stable along the study and not affected by de anthropogenic pressure. In conclusion the marine protected area effect it is not clearly enough in all of the ecological indicators that we used, so we recommend continue monitoring the ecological status in the marine protected area to know his evolution and decrease the anthropogenic pressure in the phanerogams meadows in aims to protect that important communities.

Key words: Monitoring, marine, protected, area, effect

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EXPANDED VIEW ON ISLANDS, CLIMATE CHANGE AND NON-INDIGENOUS SPECIES TO IMPROVE MARINE MANAGEMENT

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Abstract: From the many pressures directly associated with human activities, climate change (CC) and non-indigenous species (NIS) proliferations are amongst the ones most contributing to shifts in marine species diversity and distribution (Canning-Clode & Carlton 2017). Among all the marine ecosystems, islands ecosystem are considered particularly vulnerable to the establishment and spread of NIS, and CC is expected to increase this susceptibility (Lenzer et al., 2020; Castro et al., 2021).
In this context, this study aims to capture the state of the art of works conducted to assess the effect of CC and NIS on coastal communities of oceanic islands to improve the management strategies while highlighting knowledge gaps and discussing future research pathways. To this end a systematic review was carried out using the Web of Knowledge for the period 1992-2021. To avoid biases papers addressing birds, mammals or turtles have been excluded as well as pubblications addressing research on paleoclimatology, limnology or diseases. Results of this work evidence a similar increase in research on the effects of climate change and NIS in islands starting from the year 2000. While studies aiming to relate the combined effect of CC and NIS on islands only appeared after 2002 and remained at a quite low rate of publishing until nowadays. Whitin the review we also extract information on 1) the main geographic study areas; 2) the most assessed taxonomic groups and, 3) the amount of studies suggesting management actions. Aproximately 1700 studies were assesses of which about 15% explore the intertwine effect of both CC and NIS on island marine coastal community. Of these, 25% proposed management actions. This paucity of data highlighting the need for further research on both aspects to improve the management of island marine biodiversity.

Key words: Ocean warming, Ocean acidification, Non native species, Effects, (3 to 6 key words)

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ENVIRONMENTAL RISK ANALYSIS OF WATER QUALITY IN SPANISH PORTS: A RETROSPECTIVE VIEW

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Abstract: Harbours have a crucial role for the economy of coastal countries, but sometimes an inappropriate environmental management can cause severe issues to the surrounding ecosystems. This work proposes the Environmental Risk Assessment (ERA) as a management tool, using the Pressure-State-Response (PSR) model. The assessment and integration of indicators in the different stages of this model allows carrying out a retrospective study of environmental risk over a range of years. The pressure indicators selected are linked to those logistic, management and maintenance activities which exert pressure on the quality of the port waters. In addition, a retrospective view of the evolution of the environmental state in the environment of the ports and the actions established to address these impacts is provided, considering environmental indicators. Finally, response indicators are considered to provide an insight into the measures and instruments available to port managers to mitigate and/or prevent the impacts of human activities that may affect the environment. The assessment system designed, and the databases generated, allow an environmental risk analysis of port activity for any of the 28 Port Authorities of the Spanish port system from 1962 to 2021. The implementation of the methodology developed for some of the main ports of Spain, has corroborated that the methodological procedure is sensitive to the sustained increase in port activity over the last 60 years, as well as to the detection of the most significant events occurring both on a local scale (changes in the uses and configuration of the port) and on a global scale (economic and health crises). Pressure (port activity), State (environmental status) and Response (mitigation and prevention actions) complement each other to know the environmental risk evolution of the Spanish harbour areas.

Key words: Environmental Management, Harbour, Indicators, Pressure, State, Assessment.

Acknowledgments: This work was carried out within the framework of the Educational Cooperation Agreement between the University of Cadiz (UCA) and the Coastal Observation and Forecasting System of the Balearic Islands (SOCIB). This study has been funded by SOCIB through the offer of an extracurricular internship, by the Junta de Andalucía through the PRAEM-2022, and also, by the Plan Propio-UCA 2022-2023 grants.

COLLABORATION BETWEEN FISHERMEN AND SCIENTISTS IN CALPE (ALICANTE) AS AN EXAMPLE OF A NEW MODEL FOR THE STUDY AND MANAGEMENT OF FISHERIES.

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Abstract:

Fishermen's knowledge is becoming an important tool for scientists (Gómez et al 2021). When synergistic actions are conducted, the collaboration between both sectors produces considerable improvements in the management of the local fish stock (Bjorkan et al, 2020).

To help in the management of the fishing ground 37.1.1, a collaboration between scientists and fishermen has been stablished in the fishing gild of Calpe (Alicante), where daily catch data has been provided directly by trawl fishermen to scientists. During 3 years (2018-2021), the bottom trawler CALPEMAR, has collected information on location, time and number of daily sets, as well as the depth at which they were made and the quantity (kg) of the 89 species of fishing interest within the fishing area. From these data, three representative species belonging to different groups such as fish, *Merluccius merluccius* (Linnaeus 1758), crustaceans, *Parapenaeus longirostris* (Lucas 1846) and molluscs, *Eledone cirrhosa* (Lamarck 1789), were selected. The study of the variations of their daily catches during the three years, always carried out with the same gear and in the same area, has been used to understand the state and dynamics of the fishing ground. The work will serve as a model and example of closer and more fruitful collaboration between Scientists and fishermen, for a better co-management of fishery resources for mutual economic and environmental benefit.

Key words: Fishing ground, seasonal dynamics, trawler, fishery management

Acknowledgments:

I would like to profusely thank Calp´s fishermen and the crew of the Calpemar for the data provided.

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VIII INTERNATIONAL SYMPOSIUM
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ORAL COMMUNICATIONS

CITIZEN SCIENCE AND THE SEA: CHALLENGES AND OPPORTUNITIES

ULPGC Universidad de Las Palmas de Gran Canaria
Universitat de Barcelona
Universidad Católica de Valencia San Vicente Mártir
UCA Universidad de Cádiz
Universitat d'Alacant Universidad de Alicante
Universidade de Vigo

DIVE REPORTER –MOBILE APP TO COLLECT DATA FROM RECREATIONAL SCUBA DIVERS IN MARINE BIODIVERSITY ASSESSMENT - KEY LEARNINGS AND FUTURE POSSIBILITIES

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Abstract:

Knowing the status and dynamics of marine biodiversity in a given geographic area is a crucial piece of information for marine science as well as for good decision-making about sustainable use of the ocean and marine resources. Monitoring of marine biodiversity traditionally relies on observational surveys performed by scientific divers, which is costly and laborious, and thus able to generate a limited amount of data. This is especially true in remote geographic areas or areas with limited funding and resources for scientific research or monitoring. At the same time, the rise in the use of technology and the increasing public awareness towards marine conservation offers novel opportunities to use observations of marine species by recreational divers stakeholders, acting as citizen scientists, as an additional source of biodiversity data.

This article describes a newly developed piece of software, the Dive Reporter mobile app available at http://play.google.com/store/apps/details?id=com.tigerwhale.dive, being custom designed to collect information from recreational SCUBA divers and monitor target indicator species, marine biodiversity and marine litter. We report preliminary findings from a field test and compare it with scientific surveys done within Garajau Partial Nature Reserve on the island of Madeira, NE Atlantic, Portugal. Based on the pilot test and its findings we assess usability and data quality and discuss its potential for further scaling up. Based on these learnings, we also consider the next steps in developing the Dive Reporter app for improved user experience as well as improved data quality. Taking into account the advantages and disadvantages of this new method of marine biodiversity data collection, we then proceed to discuss the possible uses of the

Dive Reporter app for scientific research and ocean governance, including monitoring threatened species frequency and abundance, the proliferation of non-indigenous species and the evaluation of ecosystem services and/or the effectiveness of conservation measures and Marine Protected Areas.

Key words: citizen science; mobile app; marine biodiversity monitoring; Madeira

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VIII International Symposium on Marine Sciences 2022 (ISMS)
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PAST, PRESENT AND FUTURE OF CITIZEN OBSERVATORIES: AN OVERVIEW FROM A SUSTAINABILITY PERSPECTIVE

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Abstract:

Citizen observatories (COs) and citizen science platforms (CSPs) have recently been positioned as a hub for the practice of citizen science in general, and particularly in the marine domain. There is a growing interest from multiple fields of knowledge about how these platforms are defined and how they operate. This research compiled the existing knowledge about COs-CPs, using peer-reviewed publications as well as gray literature, accessible through mainstreaming databases and open repositories, to characterize and analyze their conceptual evolution in order to contribute to addressing the current challenges faced by these platforms. The paper follows three steps: (a) a bibliometric analysis of COs-CSPs research using tools as KNIME (b) a content analysis of COs-CS research, and (c) development of a conceptual model and a set of main characteristics of the COs.

The research found that there is no consensus on the definitions of CO and CSP. Multiple definitions have been developed according to the area of knowledge or field that adopted the CO. To address this, an analytic model was developed that proposes looking at COs as a multifaceted concept that is evolving, which is based on a set of main characteristics linked to a set of political and social drivers. These characteristics are separate from and independent of the purpose for which the CO is used. In addition to the main characteristics, COs can adopt 'purpose-specific characteristics' depending on the topical area that they cover.

In addition to the analysis of the concept and the characteristics of COs-CPs, a compilation of impacts, benefits, best practices, challenges, questions, and future research and recommendations was made. The final goal of this talk is to give an overview of the state of knowledge of these platforms and share a set of reflections to address the current sustainability challenges that the COs-CPs are facing.

Keywords: citizen science, participatory research, civic technology, participatory technology, community-based monitoring

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EVALUATION OF THE ROLE OF CITIZEN OBSERVATORIES IN INTEGRATED OCEAN AND COASTAL OBSERVING SYSTEMS

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Abstract: Data quality is the key element in Ocean & Coastal Observing Systems to provide reliable measurements for developing evidence-based environmental policies. The H2020 MINKE project (Metrology for Integrated marine maNagement and Knowledge-transfer nEtwork) focuses on a multidimensional concept to evaluate the data quality: The project proposes a new vision in the design of marine monitoring networks, integrating two dimensions of data quality, namely accuracy and completeness, as the driving components of quality in data acquisition.

In particular MINKE will evaluate the benefits of using more conventional systems of advanced instrumentation (accuracy) with the complementary information provided by volunteers (completeness), using citizen observatories to report and validate their own observations.

The development of the participatory activities in MINKE will be promoted throughout free access to the MINKA citizen observatory, a cloud-based platform that allows creating specific projects, managed by the own communities of volunteers, to monitor marine target species or coastal areas of interest. MINKA will offer as well a virtual access to participatory monitoring networks based on low-cost sensor technologies and courses providing the communities with the use of open hardware and software solutions; and networking and consultation activities will be conducted work with citizen scientists to generate specific datasets that are of interest to the citizen science community and that are useful targets as for example marine litter monitoring methodologies.

MINKE's new vision ise framed within a quintuple helix model of innovation, incorporating the natural environmental context (ocean health), the civil society (NGO, makers community, social media and citizen science platforms), the academia, the industry and the governments as the factors involved in monitoring the network design.

Key words: Citizen science, INFRAIA, virtual access activities, metrology.

Acknowledgments: MINKE reports to INFRAIA-02-2020: Integrating Activities for Starting Communities (grant agreement n. 101008724). The consortium is made up of 22

organizations from Europe and South America and will last from April 2021 until March 2025.

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Universitat d'Alacant Universidad de Alicante
Universidade de Vigo

VIII International Symposium on Marine Sciences 2022 (ISMS)
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RESPONSE OF CALCIFYING MARINE PHYTOPLANKTON TO NATURAL AND ANTHROPOGENICALLY-INDUCED VARIATIONS OF CO_2 IN THE SUBANTARCTIC SOUTHERN OCEAN

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Abstract The Southern Ocean absorbs about one-sixth of anthropogenic emissions of CO_2, thereby playing a major role in the global climate system. This essential service, however, comes at a high cost since the enhanced dissolution of CO_2 in the ocean reduces carbonate ion concentrations and pH, a process known as ocean acidification. Model predictions indicate that the decrease in the saturation state of $CaCO_3$ will cross critical thresholds sooner in high-latitude ecosystems such as the Southern Ocean. Therefore, polar calcifying organisms are expected to experience the impacts of ocean acidification before those of mid and low latitudes. Coccolithophores are the most prolific group of marine calcifying phytoplankton and are responsible for about half of the carbonate production in the pelagic subantarctic Southern Ocean. Laboratory experiments on the most abundant coccolithophore species, *Emiliania huxleyi*, indicate that this species will be severely affected by enhanced CO_2 concentrations in the oceans in the coming decades. However, it remains unknown if Southern Ocean populations have already been altered by environmental change during the industrial era. The lack of long-term observational time series is the main reason for this gap in the knowledge. Here, we take advantage of the high preservation capacity of coccolithophores to evaluate the changes of *E. huxleyi* assemblages at different time scales. We compare the morphometric parameters in coccoliths of *E. huxleyi* registered during an annual cycle in the subantarctic waters south of New Zealand, with those from a suite of Holocene-aged sediment samples and those found in a sediment core covering the last 40,000 years. Our results allow us to reconstruct the relationship of *E. huxleyi* with environmental change in the Southern Ocean and revealed that the degree of calcification of subantarctic *E. huxleyi* assemblages is largely controlled by CO_2 concentrations in the atmosphere.

Key words: Southern Ocean, coccolithophores, ocean acidification, *Emiliania huxleyi*

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IMPLEMENTATION OF THE DELF3D HYDRODYNAMIC MODEL IN THE GUADALQUIVIR RIVER ESTUARY AND THE ADJACENT CONTINENTAL SHELF

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Abstract: The Delft3D developed by the Deltares Institute (https://oss.deltares.nl/web/delft3d), is a model suit composed of several modules. In this work the Delft3D-FLOW module was implemented in the estuary of the Guadalquivir River and part of the Gulf of Cadiz continental shelf with the aim of studying the influence of its discharges on the sea level variability. The model was calibrated and validated along the river estuary comparing the output with in-situ observations of water level and current velocities (provided by Navarro et al., 2012 and Alvarez et al. 2001) during normal (<50 $m^3 \cdot s^{-1}$) and high-discharge (<400 $m^3 \cdot s^{-1}$) events. In order to obtain the best possible adjustment, the friction coefficient and bathymetry were used as adjustment parameters. Previous works showed the advantages of including bathymetry as a calibration parameter (Khanarmuei et al., 2020). The determination coefficients attained mean values of R^2=0.9/0.8, for calibration and validation, respectively. Moreover, the model was calibrated for the continental shelf during normal discharge conditions using data from three current meters, obtaining good correlation results (rmse= 3.0 $cm \cdot s^{-1}$ and R^2=0.7, on average). The model was able to reproduce the dynamics in the estuary as well as different phenomena such as: the resonance of the semidiurnal components due to the changes in bathymetry along the estuary, the superposition of the tidal constituents, the Alcala del Rio dam reflection, the tidal damping phenomena and the low salinity plume-induced over-elevations at the mouth of the estuary and its adjacent inner shelf during periods of high river discharge. These over-elevations seem to be limited to an area close to the river mouth, as suggested by previous studies (Laiz et al, 2013; Gómez-Enri et al. 2015), and were also identified in a qualitative comparison with altimetry sea level data (provided by the GPOD service form the European Space Agency).

Key words: Delft3D model, estuary, Guadalquivir, river discharges, coastal altimetry**.**

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HABITAT SUITABILITY & COMPETITION: HOW IMPORTANT ARE THE BIOTIC INTERACTIONS AT GLOBAL SCALE?

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Abstract: Recognizing where and when the inclusion of species interactions will improve predictions on non-indigenous species (NIS) establishment would be critical to assess bio invasions and accurate prediction of geographic range shifts in the face of climate change and anthropogenic impacts on species interactions. We used different species of invasive crabs (*Callinectes sapidus*, *Charybdis hellerii*, *Cronius ruber*, *Percnon gibbesi* and *Portunus segnis*) with different invasion histories to understand in which scenarios the interaction between species could be a driver in the success of the non-indigenous species establishment even if environmental conditions are adequate, using the Mediterranean Sea as a study case. We built different correlative spatial distribution models based on Maximum Entropy and then we compared invasion histories and habitat suitability predictions. Finally, if species interactions are important in some scenarios of a species realised niche but not in others, we discuss different mechanistic approximations that could be adaptive to include these effects when formulating predictions around invasion success.

Key words: habitat suitability; invasive crabs; NIS; invasion success; ecological niche modelling; species distribution models.

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APPLICATION OF OFFLINE BIOGEOCHEMICAL MODEL WITHIN THE REGIONAL OCEAN MODELLING SYSTEM (ROMS) IN THE NORTHWESTERN MEDITERRANEAN SEA

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Abstract:
Modelling biogeochemical component distributions in the ocean is an essential step to provide a basis for further understanding climate change impacts. However, this requires robust and efficient physical-biological simulations. The Northwestern Mediterranean Sea is of particular interest, as it is one of the most productive regions of the Mediterranean (Mayot et al., 2017). In addition, it presents open-ocean upwellings and deep winter convection events (Macias et al., 2018). Biogeochemical models have proven to be invaluable tools. However, computational resources hinder large simulations of coupled ocean-ecosystem models. Because of the increased computational efficiency, the option of integrating biological tracer fields offline or separately from the online original full simulation is appealing (Thyng et al., 2020). Here, we present an assessment and implementation of an offline biogeochemical model within the Regional Ocean Modeling System (ROMS) (Shchepetkin and McWilliams, 2005): the Offline Fennel model. The methodology employs ROMS-Rutgers' (Debreu et al., 2012) physical outputs to run the Fennel model (Fennel et al., 2006) offline. This work presents the first evaluation exercise of the offline biogeochemical model. We use a variety of skill metrics to compare the simulated surface chlorophyll to an ocean colour dataset (CMEMS-Mediterranean Ocean Colour) and BIO-ARGO floats for the 2016–2019 period. The model is able to reproduce the temporal and spatial structures of the main chlorophyll fluctuation patterns in the study area, as well as the vertical distribution of chlorophyll and nitrate. The typical behaviour of the region is likewise effectively represented in the implementation, including offshore productivity, nutrient supplies from the Rhone and Ebro rivers, and mesoscale structures. This study will serve as a precedent for ROMS users who require and demand the capability to execute more biogeochemical tracer simulations independently of their more costly online simulations.

Key words: Biogeochemical model, ROMS Modelling System, Offline model, Northwestern Mediterranean Sea

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SPATIAL ASSEMBLAGES OF MICRONEKTONIC CRUSTACEANS *(Decapoda, Euphausiacea, Lophogastrida, and Mysida)* SUPPORT PELAGIC ECOREGIONS ALONG A LATITUDINAL TRANSECT IN THE ATLANTIC OCEAN.

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Abstract: The micronekton community of pelagic shrimps was studied by means of taxonomic composition, abundance and biomass analysis, across a latitudinal transect in the Atlantic Ocean from off Brazil coast (15ºS) to the south of Iceland (55ºN). Total abundance and biomass were sampled by Mesopelagos net with a mouth opening of 5 x 7 m and a total length of 58 m. Vertical variation of temperature, conductivity, pressure, dissolved oxygen and fluorescence were recorded by CTD profiler. Different depth levels were established and samples were taken during the daytime and nightly at each sampling station. A total of 132 species were identified belonging to 10 different families. Euphausiidae was the most abundant family and Acanthephyridae was the family that most contributed to the total biomass. Pelagic shrimp assemblages, related with latitudinal changes in biomass and abundance, agreed with previous delimitation of ecoregions in the Atlantic Ocean (Foxtom, 1970; Fasham and Foxton, 1979; Sutton et al., 2017). Diel vertical migrations were detected along the transect, with a maximum of biomass within the Oxygen Minimum Zone (OMZ) during the daytime, that coincides with a maximum of Chl-a (Vereshchaka et al., 2016). According to the information obtained of Euphausiacea, Decapoda and Lophogastrida biomass in both cruises, we have estimated a total of 22.9 tC in the Atlantic Ocean, that agree with previous works (Vereshchaka et al., 2019). We must point out that we only sampled the first 1700 m and 850 m of the water column in North Atlantic and Central Atlantic, respectively, that obviously suggest an underestimation of the actual total biomass. This underestimation is even higher considering that the calculations were done assuming a net efficiency of 50% (Hernández-León, et al., 2019).

Key words: Micronekton community, mesopelagic, decapod shrimps, Atlantic Ocean.

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BATHYMETRIC AND MOLECULAR DIVERSITY IN TWO MARINE CRAB SPECIES

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Abstract: *Liocarcinus depurator* and *Geryon longipes* are two crab species which widely differ with regard to the marine depths they inhabit and their associated environmental characteristics. The bathymetric distributions and molecular diversity were studied along the Atlantic-Mediterranean transition for the two species. A fragment of the *COI* (*Cytochrome Oxidase subunit I*) mitochondrial gene was studied in both species. In the case of *L. depurator*, a large number of haplotypes were detected and could be classified in two large haplogroups. One was predominant in water masses of Atlantic origin, and the other in Mediterranean waters. Three main areas were observed concerning the relative distribution of these two haplogroups: Gulf of Cadiz, Alboran Sea, and Levantine/Catalan coasts. Only eight haplotypes were detected in *G. longipes*. In this species and according to its haplotype distribution, three regions could be described: Alboran Sea, Gulf of Vera (between Cape Gata and Cape Palos), and Levantine/Catalan coasts (the species is apparently absent from the Gulf of Cadiz). In *L. depurator*, the marine currents and oceanographic fronts affecting larval dispersion could explain the pattern of haplotype distribution. A similar, but not exact pattern is shown by *G. longipes*, despite its markedly different habitat and depth they inhabit. The similarities in genetic structure may be accounted for by the epipelagic habitat of the larvae, which are the life history phase where most of the geographic dispersion takes place.

Key words: *COI*, haplotypes, oceanographic fronts, marine currents, larval dispersion, population genetics

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BIODIVERSITY PATTERNS IN RHODOLITH BOTTOMS OF THE WESTERN MEDITERRANEAN CONTINENTAL SHELF

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Abstract: Maërl beds are composed of unattached coralline red algae species that form nodules (i.e., rhodoliths) covering the seabed. The rhodoliths' accumulation provides 3D structured benthic habitats that increase the complexity of sedimentary continental shelves. Mediterranean rhodolith bottoms (also known as maërl beds) can be found in depths between 50 and 100 m, increasing the continental shelf habitat diversity, having a remarkable conservation value and being included in the Habitats Directive (92/43/EEC). However, although maërl beds are considered hotspots of biodiversity, they frequently occur within fishing grounds where bottom contact gears compromise the ecological integrity of these biogenic formations. This study aims to evaluate the diversity of species associated to rhodolith bottoms of three Mediterranean continental-shelf selected areas with the objective of finding how biophysical conditions influence the species distribution and diversity of benthic communities from rhodolith bottoms. Sampling was carried out with a non-intrusive video (ROV) providing a large-scale and continuous approach on an exposed fishing ground and two Marine Protected Areas. Each area was surveyed with a video transect covering 0.9 – 1.3 hectares in order to (i) describe the spatial patterns of the conspicuous benthic fauna and (ii) identify biophysical drivers of the species composition, richness and diversity. Multivariate analysis and Generalised Linear Models were applied to assess the effects of environmental drivers. Some factors, such as temperature, type of sediment, the location as a proxy of conservation and the number of different substrates as a proxy for small-scale heterogeneity, were identified as drivers of species relative abundance, richness and diversity. The loss of biodiversity and habitat homogenization are some of the most concerning consequences of trawling, making it imperative that we need to increase scientific knowledge.

Keywords: Coralline red algae, Maërl, Species diversity, Species richness, Video monitoring

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SEA URCHINS ASSOCIATED FAUNA IN GRAN CANARIA ISLAND COASTAL ECOSYSTEMS.

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Abstract: There are interactions between species that can help the survival of other organisms, protecting them from environmental conditions or even hiding from a predator. Some species of sea urchins made crevices creating possible refuges for small organisms, as well as in the spaces between spines of sea urchins. Association between species with coastal sea urchins in the Canary Islands has been not described until this research. The aim of our work was to describe the presence of organisms found between spines, below the shells, and inside crevices of *Arbacia lixula*, *Paracentrotus lividus*, and *Sphaerechinus granularis*. The sea urchin species were collected in 5 locations around Gran Canary Island, Spain (Bañaderos (North), San Cristóbal (East), Arguineguín (South), and Tasartico and La Aldea (West)) to identify differences between sampling areas. During a year, the associated organisms were collected within the sea urchins, preserved immediately, and identified at the lowest possible taxonomic level. Biodiversity indexes and the number of species in each area were used to compare between localities. Thirty associated species have been identified, where the mollusks were the most representative group, followed by crustaceans. The West coast (Tasartico) was the most diverse area in comparison with the other sampling areas. Even when this is a preliminary result, we found that localities with less anthropic pressure were more diverse and with a major number of associated organisms.

Keywords: species interactions, *Paracentrotus lividus*, *Sphaerechinus granularis*, *Arbacia lixula*, rocky shores, Canary Islands, biodiversity.

EXPANSION OF THE CUBOZOAN *carybdea marsupialis* (LINNAEUS, 1758) ON THE SOUTHWESTERN SPANISH COAST (NE ATLANTIC) FROM MEDITERRANEAN SEA

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Abstract: The Cubozoa cnidarian class, approximately 40-50 species divided in two orders (Carybdeida and Chirodropida), is mainly located in tropical and subtropical latitudes. In recent years they have been gaining more and more attention from the scientific community and competent administrations due to their interaction with humans, even causing death in some cases. In the Mediterranean Sea, the presence of *Carybdea marsupialis* is consolidated. The aim of this work was to show the increasing distribution of this species to the southwestern coasts of Spain. Five beaches of the Gulf of Cadiz were sampled, finding 534 individuals distributed in two periods: 2016-2017 and 2019-2020. In both periods, the highest abundances occurred around 24ºC and 21ºC, respectively. A significant relationship between abundance and sea temperature was found through a negative binomial GLM model. This expansion of the distribution of the species may be due to several factors, such as more favorable environmental and ecological conditions for its development in the southern Atlantic margin of the Peninsula. Monitoring is needed to clarify the relationship between the abundance of the species and ecological interactions.

Key words: Habitat, Jellyfish, Variability, Modelling.

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TOWARDS THE UPDATING OF KNOWLEDGE OF THE POLYCHAETES FROM THE IBERIAN PENINSULA

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Abstract: The main task of the *Fauna Ibérica* project is to elaborate a documented inventory of the animal diversity in the Iberian-Balearic area. This objective is articulated through the preparation of monographs where taxonomical, biological, and biogeographical information of the different *phyla* is collected. Five volumes have been published so far dedicated to the Class Polychaeta and one is currently in press. They address an in-depth taxonomic and bibliographic revision of each of the families covered; each chapter is dedicated to one family comprising a general introduction in which the most relevant aspects of their taxonomy, anatomy and systematics are presented, as well as identification keys for genera and species. For each species, a detailed description is presented showing the most relevant morphological characters, accompanied by line drawings and SEM micrographs, as well as a summary of current knowledge on biology and geographical distribution. The sixth volume (currently in press) focuses on the families Sabellidae, Fabriciidae and Serpulidae, including information on 121 species. The manuscripts for the seventh volume are expected to be ready by the end of this year, including several highly diverse families such as Spionidae Cirratulidae, Eunicidae and Onuphidae. A forthcoming eight volume will comprise the remaining families thus completing the definitive update of the knowledge of all Iberian-Balearic polychaete fauna.

Key words: Polychaeta, Taxonomy, Distribution, Iberian Peninsula

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MODELLING NEW PRODUCTION FROM NITRATE REDUCTASE ACTIVITY AND LIGHT IN THE PERU CURRENT UPWELLING

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Abstract: New Production (NP) is limited by NO_3^-, NH_4^+, and light (hv). Here we use a model derived from Michaelis-Menten kinetics to calculate NP from euphotic-zone phytoplankton NR activity and hv.

$$NP = -\partial[NO_3^-]/\partial t = [NR] * [hv]/(K_{lt} + [hv])$$

We calculated Peruvian upwelling NP at 15° S (C-Line) during austral fall, March-April-May 1977 from R/V WECOMA data of the Coastal Upwelling Ecosystem Analysis program. NP, at 50% hv, ranged from 1.37 µM C h^{-1} at the upwelling centre, to 0.15 µM C h^{-1} 9 km downstream, to 0.37 µM C h^{-1} 57 km further downstream over the Peru Trench. It compared well with ^{14}C carbon productivity measurements ranging from 0.29 - 2.65 µM C h^{-1} and 0.04 - 1.37 µM C h^{-1} for the 6 h (gross) and 24 h (net) productivity. Oceanographic conditions during April 1977 made the C-Line an ideal site to compare spring 1977 NP with fall 1976 NP data collected by the R/V Eastward. Those 1976 NP values ranged slightly higher (0.15 to 3.49 µM C h^{-1}) than those we found. The surface temperature background at the upwelling-centre in April 1977 reached 16.41 °C whereas in September 1976 it was 14.07 °C. For the C-Line, NO_3^- stayed above 10 µM, and NH_4^+ stayed below 0.1 µM. C-Line Chlorophyll, averaging 1.39 µg L^{-1} in April 1977, was lower than what it was for the same stations 6 months earlier (3.85 µg L^{-1}). NR, averaging 0.045 µM h^{-1} for C-Line stations in April 1977, was a fourth of what it was 6 months earlier in September 1976 (0.20 µM h^{-1}). In conclusion, overall NP for austral fall 1977, in nitrogen units, ranged from 22.6 to 206.8 nM N h^{-1}. In carbon units, median NP in austral fall was only 42% (0.76 µM C h^{-1}) of NP in austral spring (1.82 µM C h^{-1}).

Key words: primary production, nitrogen uptake, nitrate reductase, phytoplankton.

Acknowledgments: The Coastal Upwelling Ecosystem Analysis (CUEA) program was funded by the International Decade of Ocean Exploration (IDOE) office of the U.S. Nacional Science Foundation. These are results from OCE-75-23718A01 (CUEA-12 grant to T.T. Packard).

REVIEW OF THE DIVERSITY OF GENUS *Terebellides* (ANNELIDA) IN THE NORTHEAST ATLANTIC OCEAN

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Abstract: Nygren *et al.* (2018) and Lavesque *et al.* (2019) studied a large number of specimens of genus *Terebellides* Sars, 1835 in Northeast Atlantic using molecular sequencing and species delimitation techniques. Their results revealed many hidden species and several of them are currently described as new species (Parapar *et al*., 2020; Barroso *et al*., in prep.). Specimens are being studied by means of Stereomicroscope (STM) and Scanning Electron Microscope (SEM); the high-resolution images obtained with the SEM are crucial to properly assess several relevant taxonomic characters, such as the shape of the uncini. In addition, Computerized Microtomography (micro-CT) is being used to study the internal anatomy of several species from Iceland to West Africa and to reveal internal characters which can be potentially used to discriminate between taxa. The type species of the genus, *Terebellides stroemii* Sars, 1835, has been traditionally considered the only *Terebellides* species present in the Iberian Peninsula, but now it is suspected that this taxon really has a narrower geographical distribution and therefore is absent in Iberian waters, where other species are present there, either not previously reported or new to science.

Key words: *Terebellides*, diversity, taxonomy, SEM, micro-CT.

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TAXONOMY AND ANATOMY OF PECTINARIIDAE (ANNELIDA) FROM ICELAND AND THE IBERIAN PENINSULA

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Abstract: The family Pectinariidae (Annelida) comprises nowadays five genera and *ca*. 70 species. In this communication, we reviewed the pectinariids of Iceland and Galicia (NW Iberian Peninsula). Parapar *et al.* (2020) reported four species from Iceland (BIOICE project): *Amphictene auricoma* (O.F. Müller, 1776), *Cistenides granulata* (Linnaeus, 1767), *Cistenides hyperborea* Malmgren, 1865 and *Lagis koreni* Malmgren, 1866, while three species have been recorded in Galicia: *A. auricoma, L. koreni* and *Petta pusilla* Malmgren, 1866; the three latter were originally described from Norwegian waters. Specimens were studied under Stereomicroscope (STM) and Scanning Electron Microscope (SEM); taxonomic characters were reviewed, particularly those regarding the variation of neuropodial uncini shape along the body. This was done in order to assess the presence of potential hidden species under these widely distributed taxa. Furthermore, specimens from Galicia will be sequenced and molecularly analysed; this will allow to confirm whether these species are present in the Iberian Peninsula or correspond to undescribed taxa. In addition, selected specimens were subjected to histological and Computerized Microtomography (micro-CT) techniques to study internal anatomy. Preliminary results are revealing a complex internal body organization, particularly in the anterior region, that are related to bury into the sediment (paleal movement), food intake (oral tentacles), tube construction (glands) and blood supply (circulatory system).

Key words: Pectinariidae, diversity, taxonomy, SEM, micro-CT.

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FIRST STEPS TOWARDS THE KNOWLEDGE OF ROSE GORGONIAN GARDENS DISTRIBUTION AND ASSOCIATED MACROFAUNAL ASSEMBLAGES IN CENTRAL CHILE: OPENING THE DOOR TO CONSERVATION ACTIONS

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Abstract: Gorgonians are one of the most common three-dimensional organisms in circalittoral seascapes that provide key ecological services and human goods. Gorgonian gardens of a new species of the genera *Leptogorgia* sp. are found in Caleta Pichicuy, Chile. Little is known about these populations including depth distribution, colony abundance, structural attributes, and associated macrofaunal assemblages. Hierarchical sampling was conducted at 20 m depth (maximum colony abundances) in order to assess spatial variability in abundance and colony attributes at two spatial scales (among sites and rocky walls). The abundance and composition of the associated vagile and sessile macrofauna was also examined using univariant (species richness, and Shannon index (*H'e*)) and multivariant approaches and compared to that of adjacent bare rocky habitats. Our results showed a high abundance of gorgonians (ca. 28.9 to 36.5 colonies m^{-2}) compared to other gorgonian gardens in the world. For structural attributes, our results showed smaller colonies with thicker holdfasts in more exposed sites, suggesting the influence of hydrodynamic forces. Taxa richness and *H'e* of vagile fauna showed 3-fold and 2-fold, respectively, higher values in gorgonian gardens compared to bare walls, but no differences were observed for sessile fauna. In addition, PCoA and PERMANOVA evidenced a distinctive assemblages' composition between habitats for both vagile and sessile fauna. Correlation analyses and dbRDA showed, however, little association between structural attributes and associated faunal assemblages (R^2=0.06, and ca. 3 to 9.4 % of the total variation explained,

respectively). Interestingly, some overfished fish species such as *Semicossyphus darwini*, *Graus nigra*, *Loxechinus albus* and others were only observed in gorgonian habitat, highlighting the importance of this habitat. Our results constitute the first assessment of structural habitat complexity and accompanying fauna in rose gorgonian gardens and establish the baseline for understanding possible future changes associated to human activities.

Key words: biodiversity, benthic ecology, edge effect, coastal waters, cold-water gorgonian, coral

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GENOMIC HOMOGENEITY IN THE BLACK BRITTLE STAR, *Ophiocomina nigra* (Echinodermata: Ophiuroidea), ALONG THE ATLANTIC-MEDITERRANEAN COAST

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Abstract:

Ophiuroids, commonly known as brittle stars, are the most diverse echinoderm class. Species of this class play important ecological roles in marine benthic food webs and occupy a large range of ecological and trophic niches from all oceans around the world. Nevertheless, despite its biological relevance, genomic and phylogeographic studies are still limited in this animal group. In this work, we carried out a population genomic study of the black brittle star, *Ophiocomina nigra* (Echinodermata: Ophiuroidea), a common species across the Atlantic-Mediterranean area. We sequenced a fragment of the mitochondrial gene *Cytochrome c oxidase* I (*COI*) for 192 specimens collected from the North Sea to the north-western Mediterranean Sea, and produced population genomic data using double digest restriction-site associated DNA sequencing (ddRADseq) for a subset of 109 specimens, to explore: a) potential genomic divergences underpinning the morphological differences observed between morphotypes of *O. nigra* (Tortonese, 1965), b) the disruptive effect of major oceanographic fronts on the genomic structure of this species, and c) potential processes of local adaptation across its large distribution range that include a variety of divergent environmental conditions. Results, based on the COI sequences and 2,374 single nucleotide polymorphisms (SNPs), showed that both morphotypes of *O. nigra* represent a single evolutionary lineage, and morphological differences are possibly related to the phenotypic plasticity of the species. Additionally, our data demonstrated high levels of genomic diversity in this species and general genomic

homogeneity throughout its distribution range, without signals of local adaptation in the genome-wide markers analysed. Larval high dispersal capacity, together with two recent demographic expansion events might have erased signs of past historical isolation. Its large effective population size, which avoids the loss of genetic diversity due to genetic drift and populations' divergence, could additionally explain the current pattern of panmixia found in *O. nigra.*

Key words: Ophiuroids, population genomics, SNPs, Atlantic-Mediterranean, ddRADseq, phenotypic plasticity

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INTRODUCING MARINEGEO: MEASURING THE PULSE OF COASTAL ECOSYSTEMS THROUGH COORDINATED OBSERVATION AND EXPERIMENTATION

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Abstract

Most of the world's population lives within 100km of the ocean, and nearly 75% of all large cities are located on the coast. For centuries, humanity has depended on ocean and coastal ecosystems for food and livelihoods, in the process gradually modifying these ecosystems and contributing to their degradation through direct and indirect pressures. With marine habitats increasingly under peril from global, regional, and local threats (e.g. climate change, invasive species, overfishing, coastal development, pollution), it has become paramount to understand how these systems work so we can keep them working in the face of such stressors. This is the mission of the Marine Global Earth Observatory (MarineGEO), led by the Smithsonian Institution, a global network to monitor marine life and ecosystems at the changing land-sea interface, where marine life is most abundant, and where effects of human activity are most pronounced. The initiative brings together a diverse array of disciplines to empower individuals worldwide to understand local biodiversity and ecosystems in a global context. MarineGEO provides a common toolkit of standardized survey protocols, coordinated experiments, a shared data management system, and an interactive community to collaboratively assess biodiversity and ecological responses in near-shore marine ecosystems globally. Using standardized methods and emerging technology, the global MarineGEO network aims to answer big ecological questions: what is the status of marine biodiversity in coastal habitats, and how is it changing? What are the key drivers contributing to this change? And how can we use science to inform better stewardship?
Madeira joined the MarineGEO network in 2017 and represents the only site in the North Atlantic. Here we discuss the long-term monitoring activities conducted in Madeira, as well as the ambition to establish Madeira as a sentinel site for MarineGEO's mission in the North Atlantic, particularly in the Macaronesia region.

Key words: Marine Biodiversity, Climate Change, Monitoring, Madeira

ASSOCIATION BETWEEN THE ARROW CRAB *Stenorhynchus lanceolatus* (BRULLÉ, 1837) AND THE SEA ANEMONE *TELMATACTIS CRICOIDES* (DUCHASSAING, 1850) IN CANARY ISLANDS.

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Abstract: Symbiotic relationships among crustaceans and sea anemones are very common in marine environments and have been described on many occasions as very important niches for these ecosystems. This study is focused on the relationship between the decapod crustacean *Stenorhynchus lanceolatus* and the anemone *Telmatactis cricoides*, one of the largest and emblematic anemones of sublittoral bottoms off the Canary Islands. Underwater surveys were carried out in four different locations of Tenerife, in which the nature of associations among the crab and the anemone were recorded, assessing, in addition, the occurrence of other hosts, such as the sea urchin *Diadema africanum*. Furthermore, we performed laboratory host choice experiments in which the crabs were offered paired combinations of different hosts: anemones, sea urchins and rocks (in all possible combinations). Finally, another laboratory experiment focused on the specific association of the arrow crab with the anemone *T. cricoides*, and the possible intraspecific competition between symbiotic crabs was conducted. In this experiment two crabs of different sex and sizes, with all combinations, and an anemone were gathered to study their behavior. Results of surveys showed a higher degree of association of the crab with the sea anemone *T. cricoides* in the field. Despite laboratory trials exhibited no statistical preferences of the arrow crab for any particular host, when offering sea urchin, the crab displayed predilection for this host. In the absence of sea urchins, anemones were the second most chosen host. Male crabs *S. lanceolatus* in symbiosis with *T. cricoides* displayed competitive behavior with each other, but not with the opposite sex. Among juvenile crabs there were no signs of competition nor between juveniles and adults. This study adds to the understanding of the relationship stablished between the crustacean *S. lanceolatus* and the sea anemone *T. cricoides*, which is facultative and not obligate, being this crustacean a generalist symbiont. Results also showed that the different individuals of the same symbiotic species, in this case the crab *S. lanceolatus*, frequently share the same host. All these findings add new information to the characterization of poorly known symbiotic relationships in the marine environment, despite there is still a lot to study and understand about the association between these two common invertebrates of the Canary Islands.

Key words: Sea anemone, arrow crab, symbiotic relationship, host, intraspecific competition

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MICROPLASTICS INGESTION BY *Scomber colias, Mullus surmuletus* AND *Pagrus pagrus* IN THE CANARY ISLANDS COAST

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Abstract: Microplastics (plastic particles less than 5 mm in diameter) have become of great interest in the last years due to their increase in marine environment and because of their toxicity in marine organisms, including also humans. Its toxicity depends on the persistent organic pollutants (POPs) that could be adsorbed onto microplastic surfaces and therefore, result in health problems for living organisms that ingest this type of plastics. This problem could also affect the food chain as microplastics could be transferred into the food web. This study provides further evidence of microplastics ingestion in three different marine organisms from different habitats (pelagic and demersal fish) in the Canary Islands archipelago: *Scomber colias*, *Mullus surmuletus* and *Pagrus pagrus*. Results show that from the 92 specimens gastrointestinal tracts studied, a 31.52% had ingested some kinds of microplastics whereas the most predominant type of microplastics were fibres (51.3%) and the most predominant colour was blue (30.8%). *Scomber colias* was the species that had the highest amount of microplastics (37.5%), followed by *Mullus surmuletus* (33.33%) and *Pagrus pagrus* (23.33%). Further investigations are needed in order to assess whether their habitat is an important factor in determining that there are fish with more microplastics in their digestive tracts than others.

Key words: microplastics, fish, Canary Islands, plastic pollution, pelagic, demersal.

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DIVERSITY OF THE DIGENEAN FAUNA OF *Pagrus pagrus* AND *Dentex gibbosus* FROM MADEIRA ISLAND

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Abstract :

The aim of this study is to investigate the Digenean parasites of two highly exploited Sparid fishes in the Atlantic. Four parasite species have been identified in 53 specimens of *Pagrus pagrus* (Linnaeus, 1758) and one Digenean species in 59 specimens of *Dentex gibbosus* (Rafinesque, 1810). All the fish samples were caught in Madeira Island.

Seven (13.2%) out of the examined fishes of *P. pagrus* appeared to be infested by at least one Digenean species. The most commonly observed species were: *Holorchis pycnoporus* Stossich, 1901, with a prevalence of 9.4%, *Pachycreadium carnosum* (Rudolphi, 1819) Cortini & Ferretti, 1959 , *Allopodocotyle jaffensis* (Fischthal, 1980) Bray, 1987, and *Hirudinella ventricosa* (Pallas, 1774) Baird, 1853, with a prevalence of 1.9% each.

Ten (17.5%) of the fish specimens of *D. gibbosus* were infested by *Aphallus tubarium* (Rudolphi, 1819) Poche, 1926.

This work presents new host records of *H. ventricosa* in *P. pagrus* and *A. tubarium* in *D. gibbosus.* We also note the extension of the geographic distribution of *H. pycnoporus, A. jaffensis* and *A. tubarium.*

Keywords : Madeira Island, North Atlantic, Parasitism, Digenean, *Pagrus pagrus*, *Dentex gibbosus*

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ACOUSTIC ESTIMATION OF THE ABUNDANCE OF SPERM WHALES IN THE CANARY ISLANDS FROM AN ARCHIPELAGIC DISTANCE SURVEY

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Abstract: Sperm whales are classified as Vulnerable in conservation law. They inhabit the Canary Islands (Spain) year-round. Here, they suffer a high ship-strike mortality, which increased since 1999 in coincidence with the rise of speed and number of ferries in the archipelago (Carrillo & Ritter, 2010; Ritter, 2010; Rodríguez et al., 2005). It is essential to monitor the population in order to assess if this anthropogenic mortality may impact the local abundance of the species. In 2010, a team from ULL performed an acoustic survey of sperm whales summing 2668 km of transects within an area of 52933 km^2 covering the 12 nm Spanish territorial waters around the Canary Islands (Fais et al., 2016). Now, we replicated the same survey design to provide an updated and comparable abundance estimation. A line-transect acoustic *Distance* survey was performed using a stereo towed hydrophone array in autum-winter 2020-2021 (same season than the 2010 survey). A total of 23 survey blocks with 99 transects as an equidistant zig-zag transect design was used, with a random start to the zigzags within each block, and with a similar coverage rate across all blocks. Acoustic detections of sperm whale clicks were extracted and processed in *PamGuard* software to obtain perpendicular distances of the whales to the transect line. 78 transects were surveyed totalling 3561 km in length. Conventional Distance Sampling (CDS) analysis using the *Distance* package within R software will be used for abundance estimation. The results of this new survey will be discussed and compared with those of a decade ago, considering evidences for connectivity of sperm whales in Macaronesia from fotoidentification studies, as well as evidences of genetic population structuring for females in the region. This will contribute to resolve if ship strikes might be causing a population level effect in the Canary Islands, or the archipelago might be acting as an attractive sinking habitat for sperm whales.

Key words: bioacustics, abundance estimate, sperm whales

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MORPHOLOGICAL CHANGES AND ENERGETIC REQUIREMENT DURING ONTOGENETIC DEVELOPMENT OF *Chelon auratus* (RISSO, 1810)

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Abstract: Morphology is a scientific discipline analyzing the shape of organisms (Adams et al., 2004), which has been used in ecology, evolution, palaeontology, and even fisheries and aquaculture. In fishes, variation in body shape is a key factor that can influence multiple traits such as, swimming, foraging, mating, migrations, and predator avoidance (Farré et al., 2016). The present study describes the morphological changes and the growth trajectories during the transformation from 24 to 54 days after hatching (dah) in the golden grey mullet, *Chelon auratus* (Risso, 1810) using geometric morphometric analysis (GMA). The results showed a decrease of morphological disparity with the somatic growth, which indicated a higher phenotypic variability in the first phase of ontogenetic development. Given that this variability could affect to metabolism, some individuals with different morphologies and with different hatching were selected for estimating their degree of metabolic activity by means of the Electron Transport System (ETS) analysis. Differences were clearly noted depending on age group, younger individuals present higher respiration rate. Moreover, respiration rate was related with body shape individuals in way that organisms with more developed body have high metabolism rate. Therefore, these findings emphasized the relevance of the intra-specific variability for any study on larval development.

Key words: Geometric Morphometric Analysis, Electron Transport System, grow patterns, respiration rates, *Chelon auratus*

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CHARACTERIZATION AND MAIN INVERTEBRATE SPECIES, WITH SPECIAL ATTENTION TO SOLITARY ASCIDIANS, ON THE WESTERN MEDITERRANEAN SEA BOTTOMS

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Abstract: Some species of solitary ascidians stand out for their aggregation capacity, especially on soft bottoms, and their tunics provide new hard substrate and protection for other species (Monniot, 1965). It is well-known that live specimens of the mytilid bivalve *Musculus subpictus* are usually found associated with tunicates, in particular *Ascidiella aspersa* (Roberts and Breen, 1985; Bodger and Allen, 2008; Morton and Dinesen, 2011; Daan et al., 2013). The aims of this study are: i) analyze the importance of solitary ascidians on different sea beds for the creation of new hard substrates for other species; ii) verify that sea squirts increase the abundance and diversity of the associated fauna; and iii) characterize the different bottoms and their main invertebrate species. The catches obtained from the experimental trawls carried out from Cabo de Palos (Murcia) to Catalonia, from 35 to 807 meters deep, during the MEDITS surveys (Bertrand et al., 2002) of 2018 and 2019, have been examined.

In this study, *M. subpictus* has appeared inside the tunic of 10 different species, especially in *Polycarpa pomaria*, where up to 28 individuals have been found in a single tunic. Maerl bottoms host the greatest abundance of solitary ascidians by offering them hard substrate, but also infralittoral and circalittoral detrital bottoms, where *Turritella* sp. is common, representing their shells an excellent substrate where to fix themselves. The ascidians bottoms increase the abundance and diversity of the associated fauna (sessile and mobile epibenthos). Moreover, they are important as hard substrate for catshark and mollusk egg-laying.

Key words: Soft bottoms, habitat-forming species, epibionts, endobionts, invertebrates.

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*T*WO DECADES OF STUDIES ON CETACEAN DISTRIBUTION AND ECOLOGY IN THE CANARY ISLANDS: A GENERAL REVIEW.

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Key words: cetacean ecology, Canary Islands, bibliography review.

Abstract: We carry out a general review of the main studies developed in the Canary Islands during the XXI century on the ecology and distribution of free-ranging cetacean populations. The particular location and oceanographic conditions make the archipelago one of the world´s most important hotspots for cetacean diversity (Morales, 2015; Servidio, 2014). However, the 30 species reported in bibliography for these waters (Herrera et al, 2021) have been monitored with very different intensity, depending on ecological reasons, accessibility and technical issues.

We conducted a general review of previous bibliography and a later analysis of 31 selected articles. The final objective has been to identify the most important areas, time periods and environmental conditions explaining the presence of the species and populations, as well as the methods and technologies used by each of the research teams.

Up to 26 different species and 3 taxonomic groups (baleen whales, pilot whales and beaked whales) have been the targets of the studies considered. The most cited species are: *Globicephala macrorhynchus* (12 articles), *Mesoplodon densirostris* (11), *Ziphius cavirostris* (9), *Tursiops truncatus* (8), *Delphinus delphis* (6), *Stenella frontalis* (6) and *Steno bredanensis* (6). Wider taxonomic groups are targeted in 3 studies (baleen whales) or 2 studies (pilot whales, beaked whales).

A total of 35 locations have been identified, in most cases coinciding with the leeward coasts of the islands (sheltered from the trade winds and rich in prey resources) (Herrera et al, 2021). Information about the duration of the studies was extracted from 29 of the articles, showing a wide range from just several days to 22 years. Occurrence of the animals throughout the year could only be analysed in 23 studies, where presence all year round (combined with a marked spring peak) was the most frequent case.

The methods and technologies involved across the whole set of studies were also varied (18 different types). The main ones include the use of motor vessels and deployment of hydrophones (18 occasions each), photo-ID (10), D-tags (9), GIS (9) and databases (8).

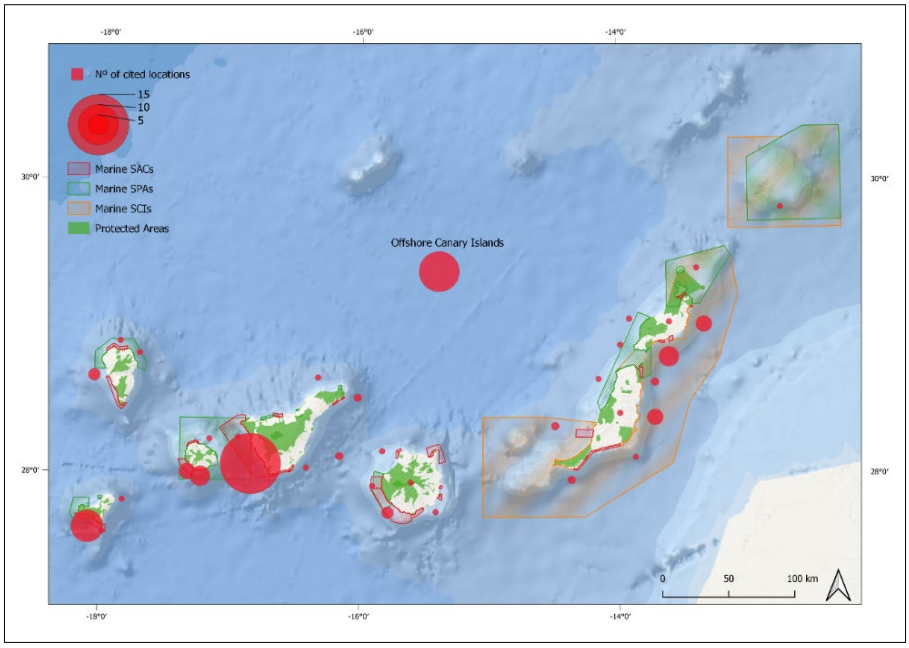


Figure 1. Number of cited locations within the 31 reviewed studies.

The reviewed articles include 27 different topics, the most recurrent being behaviour and distribution (17 cases for both), echolocation and social communication (10 cases each), as well as habitat use and foraging strategies (8 for both). Secondary information primarily includes oceanographic data, maritime traffic and presence of boats.

Despite the variety of contexts and objectives covered by this set of studies, some patterns and trends have been identified. As a closing recommendation to avoid unbalanced monitoring of species and areas, we propose to prioritize the acquisition of time series data through strategic transects in offshore waters. This could be addressed either with sets of moored or drifting hydrophones or, ideally, with autonomous vehicles equipped with passive acoustic monitoring (PAM) systems, capable of covering wider areas.

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RELEVANCE OF THE FEEDING ECOLOGY IN INVASIVE SPECIES MANAGEMENT: PREY VARIABILITY IN A NOVEL INVASIVE CRAB.

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Abstract: The diet composition of invasive species provides essential information to recognize potential impacts on an ecosystem. This study examined the feeding ecology of the novel invasive crab *Cronius ruber* from a demographic and seasonal perspectives. We identified 52 prey items in the gastric contents of the crabs (n=278), including more than 18% of the studied specimens that possessed empty guts. Preys with high frequency belonged to Brachyuran (51.54%) and Polychaete (34.36%), followed by Echinidea (22.47%), Gastropoda (21.15%) and Perciformes (20.70%). Additionally, observations during night sampling enriched the diet diversity of prey with missing stomach contents. Daily ingestion rates based on polychaeta indicate further prey consumption by juveniles and adults crabs than old adults. This was consistent with the number of prey retained per individual, changing seasonally and within ontogenic groups. Moreover, visual observation during night scientific-diving informs of native predators foraging on the invasive crab. These predators were groupers, octopus and elasmobranchs. Seasonally and ontogenically differences observed in diet through stomach content analysis and daily ingestion ratio may indicate that *C. ruber* has a generalist diet and dissimilarity analysis suggest a possible resource partitioning within ontogenic groups. The present results could represent the baseline for future studies on the possible impact sof this invasive NIS as well as part of the arguments to include *C. ruber* in the list of invasive alien species of European Union (EU) concern..

Key words: invasive crab; mesopredator; management; diet; NIS; daily ingestion rate.

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STUDY OF THE ZOOPLANKTON COMMUNITY IN SAGUNTO PORT, VALENCIA (SPAIN)

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Abstract: The purpose of this study is to characterize seasonally throughout an annual cycle the zooplankton community of Puerto de Sagunto, Valencia (Spain). For the fulfilment and execution of the analysis, samples were collected using a Juday-Bogorov zooplankton net with a mouth diameter of 50 cm and mesh size of 150 µm, and they were fixed in 4% formaldehyde.

Specifically, the zoological group that presented the greatest abundance throughout the annual cycle were the copepods, with a great difference compared to the rest of the groups, specifically there were abundant specimens of the order Calanoida. These were followed by the cladocerans, to a noticeable lesser extent, with species such as *Penilia avirostris* or the genus *Evadne sp.*, which contrary to copepods, were not present in all campaigns. Occasionally, groups such as chaetognaths and some ichthyofauna larvae appeared.

Finally, the sample that presented the greatest abundance was the one of the July month, with a total of 131,575 specimens, independently of the zoological group to which they belonged, which was associated with the fact that it was due to the increase in water temperature in the summer season. This confirms the importance of temperature fluctuations throughout the annual cycle of the zooplankton community.

Key words: zooplankton, copepod, Juday-Bogorov.

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SEASONAL AND INTERANNUAL VARIABILITY OF THE ABUNDANCE AND SPECIES ASSEMBLAGE OF ICHTHYOPLANKTON DURING 2015–2017 IN CABO PULMO NATIONAL PARK, MEXICO

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Abstract: A weekly zooplankton time series (2015–2017) was done at Cabo Pulmo National Park (PNCP, located on the southwestern coast of the Gulf of California, Mexico) to investigate seasonal and interannual changes in fish larvae species assemblage under the influence of the strong El Niño 2015–2016 event. MEIv.2 values >0.5 with anomalous high SST (+1.5-2.9 °C) occurred during May 2015-May 2016 and with a relaxation during Jun 2016-Nov 2017. Fish larval species assemblage was analyzed in function of 13 satellite climatological and oceanographic (Copernicus website) variables using multivariate statistical methods. We tested the hypothesis that species composition and abundance of fish larvae in this tropical ecosystem show greater changes related to seasonal (cold periods Dec-May; warm Jul-Oct, Jun and Nov transition) than the interannual time scales associated with El Niño 2015–2016 expecting a larger proportion of tropical affinity species during El Niño period. A total of 187 taxa of fish larvae (60 families, 93 genera and 180 spp.) was observed during 2015-2017, being more diverse than in diversity recorded in 2014 in a previous study in the same zooplankton time series (157 taxa). Multi-Response-Permutation Analysis showed moderate significant difference in fish larvae assemblage between seasonal cold (Dec-Jun) and warm (Jul-Nov) seasons and highly significant differences between El Niño period and the rest of the time series. Bray-Curtis cluster analysis and Canonical Correspondance Analysis showed three sampling units groups of fish assemblages, one with most of the 2016 sampling units and two more with mostly a mix of 2015 and 2017 zooplankton samples. Four fish larvae species were indicator of El Niño 2015–2016 with significant value of Species Indicator Analysis (*Syacium* spp., Lutjanidae spp., *Bathospilus filifer* and *Auxis* spp.). We conclude that El Niño 2015–2016 caused larger changes in fish larvae than seasonal variability in this tropical ecosystem.

Key words: ichthyoplankton, National Park Cabo Pulmo, cluster analysis, species indicator analysis

BONAIRE (SOUTHERN CARIBBEAN) CORAL RESTORATION PROJECT: *Acropora cervicornis* (LAMARCK, 1816) GENOTYPE PERFORMANCE ASSESSMENT IN THE NURSERY PHASE

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Abstract: Coral reefs are some of the most diverse and valuable ecosystems worldwide. Since the 1970's the coral populations of Acropora spp. around the island of Bonaire have been declining due to White Band Disease (WBD) and due to heavy storms and hurricanes (i.e., hurricane Lenny in 1999) (Bries, 2004; Summer, 2011). *Acropora cervicornis* is one of the species selected as restoration target because of its critically endangered status according to the IUCN red list and its ecological value as reef builder. Promoting genetic diversity is key to aid the recovery of degraded populations and gives this species higher chances of survival in the long-term (Drury, 2017). In this study, we measure growth and healing (Shopmeyer, 2017), as phenotypic traits of propagated corals to assess the different genotypes performances in the nursery phase (Calle-Triviño,2020). Linear length and tissue regeneration have been monitored for 8 weeks for 10 different genotypes (n=5), respectively with in situ measurement and image analysis (Kiel, 2012). The preliminary results suggest that some individual fragments can grow up to one centimeter per week and achieve complete tissue regeneration from cutting and handling damage in 15 days. Being able to determinate the differences in performance from various coral genotypes can help nursery based coral restoration to be more performant (Hollarsmith, 2012). Indeed, selecting coral genotypes that can grow and regenerate faster is a considerable advantage for coral restoration practitioners that could therefore optimize their outplanting efforts (Meesters, 2015).

Key words: *Acropora cervicornis*, Staghorn coral, genotype, growth, healing, nursery.

Acknowledgments: To the Universidad Católica de Valencia for the opportunity, they have given me by being able to go abroad to develop this project. To Reef Renewal Foundation Bonaire for the welcome, letting me carry out my own research and helping me grow. Especially to Francesca for her trust, to Nina for her support in everything she could, and to Julie for being my tireless diving partner. To Buddy Dive for helping me with all the diving logistics and for the great work environment.

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APPROXIMATION TO THE STATE OF THE *Xanthio poressa* STOCK IN THE COAST OF GRAN CANARIA

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Abstract: The jaguar round crab *Xantho poressa* is the most important species in shellfishing in the Canary Islands (Noguera & Riera, 2011) used as bait to fish different bentodemersal species as the parrotfish *Sparisoma cretense*. In this study we analyse the populations of *Xantho poressa* caught in 3 rocky areas of Gran Canaria with a high gatherer presence between July 2020 and December 2021. 1208 individuals were analysed, where the males showed a great predominance in all the areas, while the females were the ones that showed the largest sizes. *Xantho poressa* showed two well-defined reproductive periods, one in winter and the other during the summer, which do not coincide with the closed season for the Canary Islands.

In order to evaluate this fishery resource and propose correct closure periods for this species, the size distributions, the condition factor, a modal progression analysis and other biological parameters were analysed. The analysis of these biological parameters will provide information for a correct management of the fishing resource.

Key words: jaguar round crab, gathering, Canary Islands, Modal Progression analysis.

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REVIEW AN UPDATE OF CETACEAN SHIP STRIKES IN THE CANARY ISLANDS

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Abstract: The Canary Islands is an archipelago composed of seven main volcanic islands, located in the northwest of Africa. It is one of the richest areas for cetacean biodiversity in the Northeast Atlantic, with 30 species identified. Strikes between vessels and cetaceans have become an issue of concern in the last decades due to an increase of the number and speed of ships. Areas with high cetacean diversity and high maritime traffic overlap have been identified as hot spots as ship strikes may compromise the population status of some cetacean species in those areas. In Europe, these areas include the Ligurian Sea, the Helenic Trench and the Balearic Islands in the Mediterranean Sea, the Strait of Gibraltar, and the Canary Islands. International but mainly inter-island ferry traffic in the Canarian waters has increased considerably in the last years including normal ferries, fast ferries, and high-speed ferries. The review and update of the Canary Islands Cetacean Stranding Network data, shows that ship collisions have affected a total of 81 cetaceans belonging to 12 species in the last 24 years (8 mysticetes: 3 fin whales, 3 Bryde´s whales, 1 sei whales and 1 humpback whale; and 73 odontocetes: 5 short-finned pilot whales, 9 pigmy sperm whales, 10 beaked whales, 47 sperm whales and 2 small delphinids), 38 of these cases were confirmed by forensic studies. The average per year of ship strikes in this period (1999-2022) is 3.48 for all the species, and 2,02 for sperm whales. These data and the increasing numbers of high-speed ferries and routes, raises concern about the impact of ship strikes in the conservation of cetaceans, mainly sperm whales in the Canary Islands.

Key words: cetaceans, ship strikes, sperm whales.

Acknowledgments: The Canary Islands Government funded the cetacean stranding network. This study involved Ph.D. and postdoctoral fellowships supported by the University of Las Palmas de Gran Canaria, the Canary Agency of Research, Innovation and Information Society, the Ministry of Science, Innovation, and Universities of Spain, and the

European Commission. The authors would like to thank all the members of the Cetacean Stranding Network and especially to the Society for the Study of Cetaceans in the Canarian Archipelago (SECAC), to Marisa Tejedor, and to the Canary Islands Conservation Association.

INVESTIGATION OF JUVENILE ANGELSHARK (*squatina squatina)* HABITAT IN THE CANARY ISLANDS TO INFORM PROTECTION OF THIS CRITICALLY ENDANGERED SPECIES

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A unique stronghold for the Critically Endangered Angelshark (*Squatina squatina*) is found in the Canary Islands, where the species is still frequently encountered. This provides a great opportunity to conduct research into Angelshark ecology, as limited understanding of Angelshark habitat use, movement and site fidelity is a major factor preventing effective species protection and conservation.

A key focus for Angel Shark Project: Canary Islands (ASP:CI) is the investigation of juvenile Angelshark habitat in the region and identification of Angelshark nursery areas. The definition of shark nursery areas varies greatly in scientific literature, but ASP:CI have developed a multidisciplinary approach (using citizen science sightings, satellite imagery, focal surveys and mark-recapture techniques) to test the three nursery area criteria outlined in Heupel *et al.* 2007 and has later refined this criteria with gathered data to match to specific characteristics of the species.

Research over the last seven years has identified that juvenile Angelsharks are present across a number of shallow, sheltered areas in the Canary Islands. Survey data in each site was analysed and the results of each analysis were given a point score to allow comparison of different sites across the Canary Islands. The team has identified 7 confirmed nursery areas, 6 potential nursery areas, and 21 beaches where juvenile Angelsharks are observed (high) and 21 beaches where Angelsharks are observed (low). Mark-recapture work at the largest confirmed nursery area, Playa de Las Teresitas in Tenerife, confirms that juvenile Angelsharks remain present for up to 15 months.

Data was used to develop a Guidance Document on the identification and protection of juvenile Angelshark habitat in the Canary Islands, which identifies eight key recommendations to improve protection of these areas.

Key words: juvenile, Angelshark, nursery areas, Canary Islands

Acknowledgments: This research is carried out as part of Angel Shark Project: Canary Islands, a collaboration between Universidad de Las Palmas de Gran Canaria, Zoological Research Museum Alexander Koenig and Zoological Society of London. The nursery area surveys have been funded by the Shark Conservation Fund, Disney Conservation Fund, Save Our Seas Foundation, Oceanario de Lisboa, The Biodiversity Consultancy, German Elasmobranch Association, BIAZA and WWF Netherlands. We would also like to thank all the volunteers and collaborators who have contributed to this study.

HOOK INGESTION IN CETACEANS 2000-2021 IN CANARY ISLANDS

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Abstract: Estimating cetacean interactions with fishery activities is challenging (Kuiken, 1996; Moore et al., 2013). Bycatch is responsible for thousands of cetacean deaths per year globally (Young & Iudicello, 2007; Dolman & Moore, 2017). This study updates the data on fishery interaction in stranded cetaceans in the Canary Islands, from the last review (Puig-Lozano et al. 2020), focusing on the cases of ingested hooks. Between January 2000 and December 2021, 741 cetaceans have been necropsied. During this period, a total of 8 cetaceans died due to the severity of the lesions caused by an ingested hook. Additionally, 3 cetaceans have been counted with ingested hooks during this year 2022. The most affected species was the Atlantic spotted dolphin (*Stenella frontalis*) [88% (7/8)]. This species is very frequent in the canary waters all year round. All the cases (8/8) were found stranded or floating dead, in different decomposition codes (3/8 fresh, 3/8 moderate autolytic, and 2/8 very autolytic). The hooks were identified during the external examination (3/8), being lodged in the oral cavity, or observed during the dissection of the carcass (5/8), perforating the oesophagus (2/8), and the trachea (2/8), and producing haemothorax (3/8). The majority of the cases were mature animals [48% (6/8)] in a good or moderate body condition [88% (7/8)]. The most common gross finding was the hemoabdomen [75% (6/8)]. The most frequently described histological finding in these cases was alveolar oedema [40% (5/8)]. Histological examination confirms the gross lesions and excludes other possible causes of death. Hooks founded are of different types and can measure up to 7cm long and 4cm wide. This study updates the data about the presence of interaction with hooks in cetaceans and the importance of marine conservation policies in the Canary Islands.

Keywords: Cetaceans, bycatch, hook, ingestion, fisheries.

Acknowledgments: The authors would like to thank our laboratory technicians, all the members of the Cetacean Stranding Network of the Canary Islands, especially Marisa

Tejedor, Vidal Martín (Society for the Study of Cetaceans in the Canarian Archipelago), and Manuel Carrillo (Canary Islands Conservation).

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THE ROLE OF SCIENTIFIC DIVING AND UNDERWATER SURVEYS IN ECOLOGY STUDIES AND MONITORING IN MADEIRA

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Abstract:

Studying subtidal communities structure, dynamics and habitats can be challenging. Having access to the underwater environment for sampling requires specific skills. Scientific diving has come to change this paradigm. Marine biologists and ecologists worldwide use SCUBA diving activities as a tool for underwater sampling. The collected data can be widely varied, it depends on the research topic. In the last decade, the interest, the opportunity, and the available resources allowed MARE-Madeira to focus on *in situ* sampling efforts for coastal communities and habitat characteristics on Madeira Island. A long-term monitoring program, started in 2016, was created to have a robust database for studying the coastal community structure using UVC (Underwater Visual Census) and photoquadrats and led to multiple discoveries and case studies such as witnessing a mass mortality event of a keystone species and the arrival of tropical fish and crustaceans. The use of DPV (Diver Propulsion Vehicle) with a high resolution attached camera enables the chance to record the coastal (hard and soft) bottoms to characterize them and create a habitat mapping of regions of interest. The interaction between individuals of the same and different species (using acoustic loggers) is crucial for knowledge about species behavior and climate change issues (using continuous temperature loggers) is essential to study how climate change may affect populations. Scientific diving can be considered a determinant tool for doctoral programs during the experimental work, allowing the students to assemble their laboratory in a natural and realistic environment. Underwater sampling and the monitoring program are becoming an essential research tool in the MARE-Madeira workgroup, increasing the local knowledge of ecological characteristics and coastal community structure features, and supporting restrictive decisions when needed (e.g., conservation measures).

Key words: Scientific diving, Monitoring, Community Structure, Marine Ecology

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Progreso de la Planificación Sostenible de Areas Marinas en Macaronesia(PLASMAR+), INTERREG-MAC

MarineGEO: Marine Global Earth Observatory

Mimar+ Seguimiento, control y mitigación de proligeraciones de organismos marinos asociadas a perturbaciones humanas y cambio climático en la Región Macaronésica

OTOLITH FLUCTUATING ASYMMETRY FOR BATCHES DIFFERENTIATION IN ATLANTIC BLUEFIN TUNA (*Thunnus thynnus*)

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Abstract:

The developmental stability refers to the capacity of an organism to withstand disturbances during its development and is the cause of symmetry development in bilateral structures in a homogeneous environment. However, environmental perturbations can deviate the developmental pathway from the expected trajectory. In fish, the otoliths are bony-like bilateral structures with species-specific morphology, which are theoretically symmetric, but sometimes they can grow. The asymmetry of otoliths has been studied in several fish species, but still is not clear in Atlantic Bluefin tuna (ABFT, *Thunnus thynnus*), a species of great commercial interest with its aquaculture still being developed. In this study, 101 otoliths of ABFT juveniles were analysed to evaluate the possible development of differences in three groups: tunas captured from wild, tunas farmed fed with rotifers as their first prey and tunas farmed fed at the beginning with copepods. From the morphological data, a fluctuating asymmetry index (FAI) to analyse all the taken morphometrics as one was created. To create it, a Principal Component Analysis was performed for both left and right otoliths' standardised morphometrics and shape indices measures. Afterwards, the Bartlett Score Factors (BFS) from the Principal Axis of morphometric characters were considered. Finally, right and left otolith's BFS from the same individual were subtracted (R – L) to perform each individual FAI. To compare the FAI from different groups, the Akaike Information Criterion was used, and it determined if the FAI distribution in the samples were sufficiently different between batches. According to the FAI results, rotifer fed tunas was the group with higher otolith asymmetry, followed by copepod fed and finally by wild, having them the least asymmetry between sides. The distribution of the asymmetry was much wider in rotifer fed tunas, raising critical values. These critical values are considered above 0.2 (Jawad et al., 2020), due to the appearance of functional disability. These results show that wild specimens have fewer tendency to otolith asymmetry, and that the asymmetry measurement could be taken into account in future traceability studies to separate ABFT batches.

Key words: otoliths, Atlantic Bluefin tuna, asymmetry, Principal Component Analysis

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CADMIUM AND LEAD TISSUE DISTRIBUTION IN ATLANTIC BLUEFIN TUNA (*Thunnus thynnus*)

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Abstract: In recent decades, the increase in the consumption of bluefin tuna (ABFT, *Thunnus thynnus*) has caused concern about their conservation status. As migratory species, their possibility of exposure to different environmental pollutants increases considerably. Additionally, given its ichthyophagous condition, the possibility of tissue accumulation of heavy metals increases with respect to other species of commercial interest. Cadmium (Cd) and lead (Pb) accumulate in the environment from natural and anthropogenic activities, and its adverse impact in living organisms is well known. The Mediterranean Sea is an important place for ABFT breeding, and although it is a migratory species, tuna can remain in this region for years. Thus, the main aim of this work was the study of accumulation and distribution of Pb and Cd in blood and six tissues (gill, liver, kidney, brain, muscle and bone) of ABFT caught in the Mediterranean Sea and fattened in aquaculture facilities in the coast of Murcia (Spain). For this proposal, samples of 43 specimens (206-360 kg) were obtained and analysed by inductively coupled plasma optical emission spectrometry. The order of tissue concentration was liver>kidney>gill>brain>blood>muscle>bone (Cd) and kidney>liver>brain>muscle>blood>bone=gill (Pb). The highest concentration was found for Cd, and a low and negative relationship between tuna weigh and Cd concentration in muscle was found. A positive relationship was found between weight and Pb concentration in brain and muscle. In conclusion, no risk for consumer for these pollutants were found (low muscle concentrations), but accumulation of Cd in liver should be taken into account for tuna health.

Key words: Accumulation, Atlantic Bluefin tuna, cadmium, distribution, lead, tissues

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INORGANIC ELEMENTS IN CRAB TISSUES: DO THEY SERVE TO DISCRIMINATE THEIR ORIGIN?

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Abstract: The blue crab (*Callinectes sapidus*) is an invasive species in the Mediterranean Sea. The sedentary and voracious behaviour of this species, as well as its presence on coasts and rivers, make it of interest in environmental pollution biomonitoring and bioassay studies of. In the present study, we have used this species to analyse the effect of the diet in the tissular composition, and thus, discriminating its provenance. For this proposal, two diet were considered: natural *vs.* controlled feeding. For both natural and control feeding, the crabs were caught from the mouth of Segura river (Guardamar, Spain), and specimens for the natural feeding study were directly euthanized. For controlled feeding, crabs were fed during a week with wild mussels (*Mytilus galloprovincialis*) from two locations (San Pedro del Pinatar and Portmán Bay, Spain). The tissues (hepatopancreas, muscle and gills) were analysed by inductively coupled plasma optical emission spectrometry and data of twenty (hepatopancreas and gill) and nineteen (muscle) elements were obtained. Then, a discriminant correspondence analysis (DCA) was performed. The crabs from natural feeding were discriminated at 100% through the three tissues, while crabs with controlled feeding were only discriminated so successfully through the muscle. Discrimination through hepatopancreas needed only two elements (K and Zn), for gill, three elements were necessary (Ca, Mg and P), and five for muscle (Bi, B, P, Rb and Zn). Essential and other inorganic elements not routinely used in biomonitoring studies could be useful in identifying the blue crab specimen's provenance.
Key words: blue crab, discrimination, inorganic elements, provenance, tissues

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OTOLITH CHEMICAL COMPOSITION OF ATLANTIC BLUEFIN TUNA (*Thunnus thynnus*)

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Abstract:

In fish, otoliths play an important role for balance and hearing. They are bony structures in which daily depositions of mineral and proteins remain unaltered through the passage of time. Therefore, they constitute permanent recorders of the natural history of the specimen. Their mineral composition can report physiological and environmental conditions, such as temperature, presence of pollutants, habitat use, etc. Thus, the aim of this study was to investigate the use of inorganic elements composition of otoliths to discriminate juveniles of Atlantic bluefin tuna (ABFT, *Thunnus thynnus*) according their life conditions: wild (n=35) and captive-reared specimens (n=66). Elements like as Ca, Na, Mg, P, S, Sr, Al, Fe, Rb, Ti and Zn were detected in 100% of otoliths, and their concentration was used to discriminate the batches thought a simple (Kruskal-Wallis) and a multivariant statistical test (Discriminant Canonical Analysis, DCA). The mean comparison showed statistical differences between batches only for Ca, Fe, Mg, P and Zn. For DCA, Ca, Mg, P and Sr were considered in discrimination (86.1% of differentiation success), so the elements ratios were also studied. Then, Sr:Mg, Ca:Mg and Rb:P ratios allowed also a 85.1% of accuracy batches' discrimination, with better separation for farmed tuna (>90.0%). Future studies on this topic may provide more information to identify batches of this species.

Key words: Atlantic Bluefin tuna, otolith, composition, discriminant analysis, origin

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OTOLITH MORPHOLOGY IN ATLANTIC BLUEFIN TUNA (*Thunnus thynnus)*

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Abstract:

Atlantic bluefin tunas (ABFT, *Thunnus thynnus*) culture started in Europe in the 90's with the 'wild tuna fattening' (Mylonas et al., 2010; Benetti et al., 2016). And recently, the biological cycle of the ABFT in captivity has been closed. Therefore, the aquaculture future of this species its promising and due to the high economic impact of the species worldwide, it is necessary to find new traceability methods to distinguish between wild and reared individuals. For this purpose, the morphology of otoliths outstands as a useful tool. In this study, otoliths of 35 wild and 66 farmed ABFT juveniles weighing between 100 and 1499 grams were analysed. For the morphological analysis, both otoliths from each individual were placed in a dark background and photographed. On each otolith, thirteen different size parameters using an image software analysis (Otolab, 2019) were measured: area, perimeter, length, width, circularity, eccentricity, compactness, 4 Moments of Boundaries (F1, F2, F3 and F13) and a Fourier Descriptor (FF). In order to classify the provenance of the fish using the morphological traits, two multivariate techniques were used: a principal component analysis (PCA) and a discriminant canonical analysis (DCA). Differences were found in the otolith morphology between farmed and wild specimens. Globally, farmed tunas had smaller otoliths, showing lower otolith weight, area, perimeter, length and width. In conclusion, reared tunas' otoliths appeared to have smaller otoliths with higher shape variance than wild. This is constant with the idea that otolith shape descriptors plus multivariate analysis can be used to discriminate ABFT groups (Megalofonou, 2006; Brophy et al., 2016).

Key words: Atlantic bluefin tuna, otolith, morphology, provenance

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VATERITIC OTOLITHS IN ATLANTIC BLUEFIN TUNA (*Thunnus thynnus)*

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Abstract:

Fish otoliths are composed of calcium carbonate ($CaCO_3$), organic matter and inorganic constituents. In biological systems, $CaCO_3$ can have three iso-morphologies with identical chemical formulas but different crystalline structures: aragonite, calcite and vaterite (Carlstrom, 1963; Falini et al., 2005). *Sagitta* otoliths are normally composed of $CaCO_3$ crystals arranged as aragonite. However, in aberrant *sagitta*, vaterite and calcite forms can be found in some species like salmon (Reimer et al., 2016; Austad et al., 2021), trout (Vignon & Aymes, 2020) and herring (Long et al., 2021) among others. Atlantic bluefin tuna (ABFT, T*hunnus thynnus*) is an oceanic marine species with an expansion in aquaculture. This issue will allow the future commercialization of captive-reared tunas. In this context, any system that differentiates wild specimens from those captive-raised could be interesting. In recent years, the use of the otoliths for this purpose has emerged, with special emphasis on composition and morphology. To date, no study has ever been carried out about vaterite deposition and/or prevalence in any tuna species. Meanwhile, in other species, captive-reared fish are known to have 10 times higher vaterite incidence. For this purpose, 46 ABFT juveniles (474.7 ± 210.9 grams, 23 captive-reared and 23 wild) otoliths were sampled. Otoliths were photographed, thirteen morphological characteristics were measurement, and an X-Ray diffraction analysis was conducted. Visual and analytical vaterite was studied, and the percentage of aragonite, vaterite and calcite was quantified. Morphological differences were observed according to the rate of vaterite: Those otoliths with a greater rate of aragonite had higher size parameters, but otoliths with greater vaterite were more irregular. In addition, a differing vaterite presence by origin we found: 28.9% in reared and 4.4% in wild tunas. Therefore, the use of vaterite deposition and incidence as natural marker to differentiate groups could be possible.

Key words: otolith, Atlantic bluefin tuna, vaterite, X-Ray diffraction

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VIII International Symposium on Marine Sciences 2022 (ISMS)
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DISTRIBUTION AND DIVERGENCE OF SHALLOW AND UPPER MESOPHOTIC COLD-WATER GORGONIANS (OCTOCORALLIA: GORGONIIDAE) IN CHILEAN COASTS, WITH THE DESCRIPTION OF A NEW SPECIES

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Abstract: The Eastern Pacific Ocean can be considered a gorgonian biodiversity hotspot. However, most biodiversity studies in this group of organisms have focused on tropical shallow waters from Mexico to Ecuador, neglecting the faunistic component of southern regions from Ecuador to Chile. The first description of a Chilean octocoral dates back to the H.M.S Challenger expedition in 1873-1876. Since then, only few descriptions of new soft coral species from this region have been documented. In addition, the taxonomic status of most gorgonian taxa reported from the temperate Pacific coast of South America is dubious due to the loss of the original type material. Here, we present new taxonomical information

on recently reevaluated Chilean gorgonian species *Phycogorgia fucata* and *Leptogorgia chilensis*, with the description of new *Leptogorgia* species, using an integrative taxonomic approach considering genetic (nuclear and mitochondrial genes), and morphological analyses (colony structure and coloration, and sclerite evaluation). Also, we present the first description of their latitudinal distribution patterns. Our results support the monophyly of the Chilean gorgoniids investigated, and the assignment of *P. fucata* within the Genus *Leptogorgia*. Our distribution analyses revealed a clear biogeographic break congruent with the Chile Central and Araucanian marine ecoregions. Overall, our study provides the first integrative taxonomic study of Southern Eastern Pacific cold-water gorgonians suggesting a higher number of species than expected for this underexplored region.

Key words: biodiversity, benthic ecology, evolution, phylogeography, coral, Eastern Pacific

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CONTRIBUTION TO THE KNOWLEDGE OF THE BIOLOGY OF *DIAPHUS DUMERILII* (BLEEKER 1856) OF GRAN CANARIA (CANARY ISLAND, CENTAL-EAST ATLANTIC)

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Abstract

Diaphus dumerilii is one of the most abundant and poorly known mesopelagic species belonging to myctophids family, they are also known as lanternfishes. The individuals of *Diaphus dumerilii* were obtained from pelagic trawling surveys carried out by the vessel B/E 'La Bocaina' in the Canary Islands. The 1706 individuals of this species analysed in this work were measured and weighed, with a length of 17-87 mm and a weight varying from 0.028-4.12 respectively. Also, a subsample of 260 individuals was taken for morphological analysis. This study will also examine the sex-ratio (Chi-square) indicates an abundance of females 1:1,47, this species plays a fundamental role in the food chain and in energy transfer, as well, this species performs vertical migrations towards the surface (0-100m) during the night and remains hidden in the depths during the day below 500m depth, other parameters such as the condition index (KN), gonadosomatic index (GSI) are calculated to know what could be the reproductive seasons. This study also includes the Modal Progression Analysis and total mortality estimation.

Key words: *Diaphus dumerilii*, Canary Islands, growth, length distribution analysis

Acknowledgments: To D. Fernando Bordes, for the collection of samples, including Diaphus dumerilii, throughout his campaigns that has allowed to increase the knowledge of this species.

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DISTRIBUTION AND BIOLOGICAL FEATURES OF *Munida perarmata* A. MILNE-EDWARDS & BOUVIER, 1894 IN THE WESTERN MEDITERRANEAN

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Abstract: *Munida perarmata* is a decapod crustacean that dwells on mud bottoms from the intermediate continental slope to the bathyal depths (near 2000 m). It shares habitat with other species such as the red shrimp *Aristeus antennatus*, an important trawling objective (Abelló et al., 2002) (Macpherson & García, 2008). Due to its limited abundance and habitat conditions, it is a species whose population characteristics are relatively unknown. It is for this reason that this study intends to acquire a greater knowledge about the geographical and bathymetric distribution, and the interannual variability of its populations by means of data obtained in pluriannual sampling executed during 25 years in the western Mediterranean (MEDITS Program) (Spedicato et al., 2019; Bertrand et al., 2002), and present the main biological characteristics by means of additional sampling from other campaigns. The obtained results have allowed to detect a population decline, specially pronounced in the last decade. The species is scarce in the Alborán Sea, while in the Catalan-Balear basin is abundant but smaller in size. Females perform an ontogenetic migration as they mature sexually towards shallower depths, to spawn near 500 m. The CL (carapace length) average is 16.7 mm, and there are no differences between sexes. The estimated sexual maturity size calculated by means of the relation between RCL (Right Cheliped Length) and CL, is 14 mm of CL. Bigger individuals dwell between 400 – 500 m and near 1200 m, while juveniles live between 800 and 1000 m. Males and females follow the same bathymetric distribution. This type of distribution might indicate that the recruitment occurs on the inferior limit of the twilight zone (near 1000 m), and that the individuals perform an ontogenetic migration towards shallower or greater depths depending on differences in its coloration, caused by the differences in depredation pressures above and below the twilight zone (Aguzzi et al., 2013). All the information collected in this study will bring the opportunity to know better the biology of continental slope and bathyal depth species.

Key words: CL (carapace length), RCL (Right Cheliped Length), abundance, distribution, twilight zone.

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TEMPORAL TRENDS OF VIRAL ABUNDANCE AND COMMUNITY IN AN OLIGOTROPHIC COASTAL SYSTEM

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Abstract: Marine viruses, considered the smallest and most abundant (10^{30}) biological entities in the sea, play key roles in controlling microbial communities and modifying global biogeochemical cycles (Lara et al., 2014). Yet, although nowadays their dynamics and distribution are being increasingly explored, little is known about temporal patterns of viral abundance, diversity and community structure (Gasol et al., 2012). In fact, the growing concern about climate change and its impacts make it fundamental to study these trends and their effects in marine ecosystems (Sotomayor et al., 2020). *Blanes Bay Microbial Observatory (BBMO)* monthly monitored the viral abundance (2005) and community structure (2010) of an oligotrophic coastal system, as well as other environmental and biological factors that could modulate them (Gasol et al., 2012; Lara et al., 2014). To perform this study, several molecular and statistical techniques were used, being RAPD-PCR (*Random Amplified Polymorphic DNA*) the main one. The time – series results from the last 12 years (2010 – 2021) showed that temperature had a significant tendency to increase, while viral abundance tended to decrease; nevertheless, the latter did not follow any clear seasonal pattern. Furthermore, these results showed that viral communities were mainly correlated with salinity (-), chlorophyll (+), turbidity (-) and photosynthetic protists (+). However, the community structure, represented with a *NMDS (Non-Metric Multidimensional Scaling)*, seemed to cluster the populations according to the season. The analyzed data not only contributed to a better understanding of viral communities and their trends in marine oligotrophic systems, but also demonstrated the complexity of their dynamics and structure.

Key words: viral abundance, viral community, environmental variables, time – series, RAPD.

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DESCRIPTION OF THE POLYCHAETE TAXOCOENOSIS IN THE ARTIFICIAL SUBSTRATE OF THE COMMERCIAL PORT OF SAGUNTO: FAMILIES AND NEREIDIDAE (BLAINVILLE, 1818) SPECIES.

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Abstract:

The commercial port of Sagunto is one of the strategic sites for maritime trade in the Western Mediterranean Sea supporting high maritime traffic. Port installations and maritime activities induce important changes in benthic communities, even though soft bottoms communities have received mayor attention, little is known about hard substrates in portuary communities. In the present study a description of the artificial hard bottom benthic communities and associated polychaete taxocoenosis is made with special attention in species belonging to the Nereididae family. *In situ* observations by divers identified three different communities: Photophilic Algae, Hemiphotophilic Algae and Cave Communities. A total of 60 samples were taken using the scraping technique with 0,25 m^2 quadrats and macrofaunal organisms were isolated using a 500 µm sieve. A total of 1354 polychaetes were identified to family level, 21 families were present, being Nereididae the most abundant with 573 individuals followed by Cirratulidae, Syllidae and Opheliidae. Among Nereididae family, 13 different species were identified, *Platynereis dumerilii* and *Neanthes agulhana* were the most abundant, being respectively a eutrophication bioindicator and a cryptogenic specie first cited for the Valencian Community.

Key words: Polychaeta, Nereididae, Port communities, Sagunto, Modified habitat.

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BIO-GUIDED ISOLATION OF ANTIPROLIFERATIVE MICROALGAE CULTURES

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Abstract: The search for new therapeutic agents for the treatment of diseases such as cancer is a topic of special interest as alternative to fight the increasing resistance to antiproliferative drugs (De Vera et al., 2018). That is why attention is focused on the study of the marine ecosystem as a potential source of new compounds. The exceptional diversity of chemical components of microalgae and their high unused biomass may represent a main step in the development of anticancer drugs (El-Hacka et al., 2019).

The present study shows the bio-guided isolation of two extracts of the species *Chrysoreinhardia giraudii* cultured in two different nutrient medium (F/2 and seawater diluted centrate-SDC) (Arashiro et al., 2020) in 80-400 L photobioreactors under outdoor natural conditions. Both extracts showed antiproliferative activity when tested against 6 cancer cell lines. Different chromatographic techniques allowed to separate the active compounds and their molecular structures analyzed by application of spectroscopic and spectrometric methods.

The results show that most of the active compounds isolated from the F/2 extract fit a characteristic pattern of triglycerides and fatty acids, and also an active sterol was isolated. Additionally, the SDC extract yielded a halogenated polyphenolic nature compound. This work demonstrate the importance of culture medium as a key factor in the production of secondary metabolites, and constitutes the first chemical study of the species *C. giraudii*.

Key words: Marine natural products, triglycerides, sterols, polyphenols, antiproliferative activity, marine microalgae.

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STUDY OF THE ANTIMICROBIAL AND LIGNOCELLULYTIC CAPACITIES OF MICROORGANISMS ASSOCIATED WITH *Posidonia oceanica* BANQUETTES

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Abstract: *Posidonia oceanica* (Linnaeus) Delile, is a marine seagrass endemic to the Mediterranean Sea forming meadows that constitute one of the most biodiverse ecosystems in the Mediterranean. The organic material produced by this phanerogam (rhizomes, leaves, etc.) is deposited and accumulate on beaches during storms, forming structures what are commonly known as banquettes. Numerous studies have shown that *P. oceanica* extracts may have antioxidant, anti-diabetic and vasoprotective properties (Gokce and Haznedaroglu, 2008). In addition, metagenomic studies to investigate the microbial community associated with these banquettes have detected a great diversity of secondary metabolites, which may have antimicrobial activities as well as enzymes capable of degrading lignocellulosic biomass (Rubio-Portillo et al, 2021). These kind of enzymes may be of great interest to produce biofuels. (Tsegaye et al, 2019)
The aim of the present work is to isolate microorganisms present in these banquettes and to study their antimicrobial or lignocellulosytic capacities. For this purpose, a total of 36 microorganisms have been isolated from the banquettes at different stages of decomposition (different times) with the aim of isolating the highest diversity of microorganisms present in the banquettes. These microorganisms that were isolated on Luria-Bertani medium with 3.5% NaCl will be tested against laboratory strains potentially pathogenic to humans to detect antimicrobial activities. On the other hand, a total of 6 microorganisms were isolated on culture media in which the only carbon source was the *P. oceanica* leaves. The growth of these microorganisms in this culture medium means that they have *P. oceanica* organic material hydrolyse activity, which may be correlated with the presence of lignocellulolytic enzymes. Strains selected for their inhibitory character or lignocellulolytic activity will be characterised phenotypically and by 16S rRNA gene sequencing.

Key words: *Posidonia oceanica*, banquettes, antimicrobial activity, lignocellulosic enzymes.

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SEASONAL AND DIEL DYNAMICS OF MARINE VIRUSES IN SUBTROPICAL COASTAL WATERS OF THE SOUTH CHINA SEA

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Abstract: Marine viruses are dominant biological entities in the oceans (1). They play a major role in the global biogeochemical cycle, as they strongly influence the activity, longevity and therefore the recycling of many microorganisms. Marine viruses have been shown to follow diel cycling patterns as well as longer temporal dynamics (2, 3, 4), and yet the precise patterns and the relationship between viral and microbial populations are still poorly understood, as the study of most populations in most of the oceans is scarce, and the scale so large.
Here, I make use of viromics data to observe the changes in the populations of viruses in the coastal South China Sea. The timeframe studied is both seasonal (winter and summer) and diel (every 6h for two days each season) and should allow the comparison of populations at different times, linked to oscillating factors such as temperature and nutrient availability. I will share some preliminary results on virus population dynamics, aiming to link these to patterns in microbial and viral metagenomics and metatranscriptomics, sampled at the same time.

Key words: marine virus, viromics, diel, seasonal, metagenomics, metatranscriptomics

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POLYSACCHARIDE ANALYSIS OF THE MUCUS OF THE PHOTOSYNTHETIC SEA SLUG *Elysia crispata*

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Abstract: Sacoglossa is a group of sap-sucking sea slugs from the phylum Mollusca and class Gastropoda that feed on macroalgae. The most striking feature of some of these sea slugs is their capacity to digest the macroalgal cellular content while retaining functional chloroplasts (kleptoplasts) in their digestive gland cells (Cruz, 2013). The stolen chloroplasts translocate photosynthates to the sea slugs cells, including kleptoplast-free reproductive tissues (Cartaxana, 2021). Trench (1972) also observed the incorporation of photosynthesis-derived metabolites in the mucus secreted by these animals. We collected mucus samples from *Elysia crispata*, a species found in coastal and tropical reef areas, grown and maintained under controlled laboratory conditions. Mucus samples were collected from a pull of up to 7 animals and afterwards dialyzed to remove all salts and small molecules present. The samples were then analysed by GC-FID for monosaccharide composition and by GC-MS for glycosidic linkages. With the results obtained from both techniques, we were able to characterize the sugar composition of polysaccharides present in *E. crispata* mucus. These polysaccharides were mainly composed of galactose (Gal, 72 mol%), glucose (Glc, 8 mol%), fucose (Fuc, 7 mol%) and xylose (Xyl, 6 mol%). The most abundant identified glycosidic linkage was (1→4)-Gal (44 mol%), followed by (1→3,6)-Glc (10 mol%), terminally linked Gal (9 mol%), (1→4)-Xyl (9 mol%), and (1→3,4)-Glc (5 mol%). In future experiments, using ^{13}C, we expect to determine the amount of polysaccharides present in the mucus of *E. crispata* deriving from photosynthetic activity at the kleptoplasts.

Key words: kleptoplasty, polysaccharides, photosynthesis, sacoglossa

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EMERGING CHALLENGES: MACROALGAE ¿WASTE OR HEALTHY FOOD?

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Abstract: Macroalgal mass occurrences on the Canary Islands coasts, and the unpleasant odour originated during algal decomposition, affect coastal tourism and fishing. Besides, a great effort in terms of time and money is yearly required for removing thousands of tons of algae to local landfills (Canarias 7, 2022). The nutritional and pharmaceutical value of this renewable marine resource could be used to develop local and sustainable industrial activity. Therefore, extracts derived from macroalgae mix biomass and isolated pure strain of *Lobophora variegate* (*L. variegate*) were subjected to colorimetric determinations of carbohydrates and antioxidant activities (expressed as 1,1-diphenyl-2-picrylhydrazyl radical inhibition percentage). Contents of ash, fibre and fats were also evaluated (James, 1995). Seaweed polysaccharides present several bioactive properties (Islam et al., 2002) and antioxidants prevent oxidative damage and inhibit chronic diseases (Nestel et al., 2019). Ash content refers to minerals, dietary fibre reduces the levels of cholesterol, the risk of hyperglycemia and prevents cardiovascular diseases (Anderson et al., 2009) and, fats help to regulate blood pressure (Bauer et al. 2021).

The results were as follows:

i. Mix biomass: Ash (%): 33.3±0.3; Fibre (%): 14.86±0.67; Fat (%): 2.122±0.001; Carbohydrates (mg of glucose g^{-1} of dry biomass): 21.83±0.02 (aqueous extraction for 1h); 21.99±0.02 (extraction with HCl 3M at 100ºC for 5h); and 21.4±0.05 (extraction with HCl 3M at 121ºC for 1h);
ii. *L. variegate*: Ash (%): 47.9±0.4; Fibre (%): 13.1±0.3; Fat (%): 1.1±0.1; Carbohydrates (mg of glucose g^{-1} of dry biomass): 22.16±0.04 (aqueous extraction), 21.658±0.003 (extraction with HCl 3M at 100ºC for 5h), and 21.00±0.06 (extraction with HCl 3M at 121ºC for 1h). Radical scavenging activities were 60.8±4.0 for mix biomass and 70.9±3.5 for *L. variegate*. All values are means of triplicate determinations ± standard deviation.

These results confirm the potential feasibility of using macroalgae biomass in the healthy food and pharmaceutical industries.

Key words: Macroalgae, Nutritional and Pharmaceutical Value, Sustainable Economy.

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FOUR ALGAE STRAINS COLLECTED FROM LAS CANTERAS BEACH AS SOURCES OF ANTIOXIDANTS

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Abstract: The massive influx of algae affects the entire coastal ecosystem. These algae could become a source of natural products with several applications in the food, feed, cosmetic and pharmaceutical industries. Four algae strains (*Dictyota dycotoma, Dictyota fasciola, Hypnea spinella and Sargassum vulgare*) were isolated from samples collected from Las Canteras beach (Las Palmas de Gran Canaria, Gran Canaria), freeze-dried and kept in darkness until analysis.

Despite synthetic compounds butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are classified as cancer promoters (Saito et al., 2003), they are widely used antioxidant food additives. Therefore, their replacement by safer antioxidants has been extensively studied (Jerez-Martel et al., 2017). Algae extracts were screened for their capacity to scavenge 1,1-diphenyl-2-picrylhydrazyl radical (Bondet et al., 1997). All algae samples showed higher radical scavenging activity than BHT (12.75%), and *S vulgare* exhibited higher activity than BHA (75.1 and 62.47% respectively). Their reducing ability was also estimated using the ferric reducing antioxidant power assay and ranged from 37.8 to 154.2 µmol of reduced Fe^{+2} g^{-1} of dry biomass (Benzie and Strain, 1996).

Seaweed polysaccharides show several bioactive properties (Amna Kashif et al., 2018; Bauer et al., 2021). Freeze-dried algae were subjected to: (i) acid hydrolysis (3M HCl) at 121ºC for 1h; (ii) aqueous extraction. Carbohydrates were determined with the anthrone colorimetric method using a glucose standard curve ($y=0.0103x+0.1459$; $R^2=0.9982$). Contents (expressed as mg of glucose g^{-1} of dry biomass) ranged from 0.75 to 6.40 in aqueous extracts, and from 4.52 to 8.63 in acid hydrolysates of dry biomass.

This study confirms the potential possibilities of these algae collected from Las Canteras as sources of antioxidants. The massive influx of algae on the coasts could become a revulsive for the local economy by developing new commercial and industrial activity using these algae as raw material.

Key words: Algae, Las Canteras, Carbohydrates, Radical scavenging activity

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STRUCTURAL DIVERSITY AND ANTI-INFLAMMATORY POTENTIAL OF NATURAL PRODUCTS FROM THE ALGA *Rugulopteryx okamurae*

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Abstract

The marine environment possesses great potential for the discovery of new natural products with pharmacological properties (Dayanidhi et al. 2020, Mayer et al. 2017). In particular, during the last decades a renewed interest has emerged for marine macroalgae as source of compounds with application in cosmetics, nutraceuticals, and pharmaceuticals (Leandro et al. 2020). Recent studies of our group have shown the presence of bioactive natural products in the brown alga *Rugulopteryx okamurae*, that has invaded the coasts of the Strait of Gibraltar (Cuevas et al. 2021, Casal et al. 2021). This work was aimed to isolate natural products of different structural classes from *R. okamurae* and to assess their biomedical potential in the anti-inflammatory area. In the first part of this research, the extract of *R. okamurae* was subjected to exhaustive chemical study by using chromatographic techniques and the structures of the isolated compounds were characterized by spectroscopic means, mainly nuclear magnetic resonance (NMR) and high resolution mass spectrometry (HRMS). These studies led to obtain an array of natural products of the diterpene class which belong to three different structural types: secospatanes, spatanes, and prenylcubebanes. In the second part of this work, compounds of each structural type were tested in anti-inflammatory assays. In particular, the inhibition of the production of the inflammatory mediator nitric oxide (NO) in LPS-stimulated microglial cells Bv.2 was measured. Significant NO-inhibitory activity was observed for compounds of the different structural types, suggesting that some diterpenoids from *R. okamurae* could be interesting lead compounds for further anti-inflammatory studies.

Key words: *Rugulopteryx okamurae*, diterpenoids, anti-inflammatory activity

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STUDY OF THE POTENTIAL OF TWO RED ALGAE EXTRACTS AGAINST OXIDATIVE STRESS. OPTIMISATION AND QUANTIFICATION OF ANTIOXIDANT COMPOUNDS

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Abstract:
Oxidative stress occurs when there is an imbalance between the action of free radicals (ROS) and endogenous enzymatic antioxidants, causing oxidative damage at cellular level (Grande *et al*., 2006). Therefore, in these situations, it is necessary to apply exogenous antioxidants (Machu *et al*., 2015). Seaweeds are a natural source of these compounds, their antioxidant capacity is mainly due to the presence of active biomolecules, which could be beneficial in the treatment of cellular damage caused by oxidative stress (Sánchez-Bonet *et al*., 2021; Yalçın *et al*., 2021). The objective of this study was therefore to obtain crude extracts from the red algae: *Palmaria palmata* and *Porphyra sp*, and characterize their composition by means of chromatographic techniques.

To obtain extracts with the highest antioxidant activity, UAE extraction was used and the variables optimised were: quantity of algae, type, volume and concentration of solvent, time-power and temperature. Optimal extraction conditions were: 8 g of algae, 20 mL of ethanol-water (40:60), 10 min-300 W and 65 °C for *P. palmata* and 35 °C for *Porphyra sp*.

Antioxidant activity was determined by the DPPH method, obtaining better results for *Porphyra sp.* than *Palmaria palmata* (87.64% *vs*. 78.70%, respectively). These results were confirmed by ORAC and FRAP assays. In addition, the total content of polyphenols (Folin-Ciocalteu) and polysaccharides (Dubois) of the optimised extract were determined. Lastly, by means of HPLC-DAD, the polyphenol content was determined by quantifying 11 polyphenols in *Palmaria palmata* and 10 in *Porphyra sp.* And, by means of HPLC-Fl, the the pigments: fucoxanthin, violaxanthin, lutein and chlorophyll a' in *Palmaria palmata,* and lutein and chlorophyll a' in *Porphyra sp*. were identified and quantified.

The results obtained confirm the high potential of *Palmaria* and *Porphyra* algae in the possible treatment of oxidative stress.

Key words: Oxidative stress, natural antioxidants, *Palmaria palmata*, *Porphyra sp*, liquid chromatography

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STUDY OF THE INFECTIVE CAPACITY OF fusarium oxysporum ON musa acuminata

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Abstract: The pathogen *Fusarium oxysporum* f.sp. cubense is the main cause of the *Musa acuminate* wilt, making its cultivation harder. In this project, different treatments will be applied with chitosan, a biodegradable marine compound with antimicrobial, antifungal and antioxidant properties (Dodane and Vilivalam, 1998); and the biological control agent fungus *Pochonia chlamydosporia* (Aranda-Martínez *et al*., 2016). The aim is to characterize the effect produced by the combination of chitosan and *P. chlamydosporia* over the infective capacity of *F. oxysporum* in a hydroponic system. A seeding of root fragments will be performed to observe qualitatively if there are differences between the different treatments. The colonization of *F. oxysporum* will be also analysed by PCRs and the amount of pathogen will be molecularly quantified with the qPCR technique. Fragment seeding has shown that it seems to be a negative trend in terms of pathogen presence in roots exposed to the treatments compared to the control (untreated plants). PCRs resulted in amplification of *F. oxysporum* DNA in all treatments in which the fungus was inoculated, although it should be noted that amplification was lower in treatments with chitosan. The results seem to indicate that the combined action of chitosan with *P. chlamydosporia* could be an effective treatment to prevent *F. oxysporum* infection in *Musa acuminata*. Moreover, as it is a compound obtained from marine debris, the circular blue economy is put in value by avoiding the accumulation of debris on the seafloor.

Key words: Pathogen, treatments, Chitosan, biological control agent, colonization, marine debris

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ANALYSIS OF ANTIOXIDANT COMPOUNDS EXTRACTED FROM *Eisenia bicyclis* AND *Sargassum fusiforme* AS A POTENTIAL SOURCE AGAINST ISCHEMIA/REPERFUSION INJURY

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Abstract: Ischemia/reperfusion (I/R) injury is manifested by blood flow deprived and consequent deprivation of oxygen to the organs followed by restoration of blood flow and tissue oxygenation, resulting in excess production of reactive oxygen species (ROS) (Granger *et al*., 2015)). Studies carried out with antioxidants show protective effects against cell damage caused by ROS (Delgado-Roche *et al*., 2010). In this sense, algae are a natural source of antioxidants with possible beneficial effects in the treatment of cellular damage caused by oxidative stress (Sánchez-Bonet *et al*., 2021). Therefore, the objective of this study was to optimise the extraction conditions of two brown algae: *Eisenia bicyclis* and *Sargassum fusiforme*, in order to obtain crude extracts with the highest possible antioxidant activity. And subsequent characterisation of the antioxidant substances using chromatographic techniques.

For this purpose, Ultrasound Assisted Extraction was employed and the variables optimised were: quantity of algae, type, volume and concentration of solvent, time-power and temperature. The conditions established as optimal were set at 9 g of seaweed, 10 mL of acetone-water (40:60), 2.5 min-150 W and 25 °C for *Sargassum fusiforme* and 1 g, 30 mL of ethanol-water (60:40), 2.5 min-75 W and 25 °C for *Eisenia bicyclis*.

The antioxidant activity (AA) was determined by DPPH and confirmed by ORAC and FRAP. The total content of polyphenols (Folin-Ciocalteu) of the extracts and polysaccharides (Dubois) of the optimised extracts were determined. The characterization of the extracted polyphenols was carried out by HPLC-DAD and the pigment content by means of HPLC-Fl.

The results corroborated the high AA of the optimised extracts of *Eisenia bicyclis* and

Sargassum fusiforme (87.42% and 86.97%, respectively), confirming their high potential for the treatment of ischemia/reperfusion injury.

Key words: Oxidative stress, natural antioxidants, *Eisenia bicyclis*, *Sargassum fusiforme*, liquid chromatography

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OPTIMISATION OF AN ULTRASOUND-ASSISTED EXTRACTION METHOD AND HPLC-DAD DETERMINATION OF POLYPHENOLS FROM *Arthrospira platensis.*

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Abstract: The growing interest in obtaining antioxidants from natural sources has positioned microalgae, including the cyanobacteria Spirulina (*Arthrospira sp*.), as a potential source of antioxidant compounds (Blagojević *et al.,* 2018). Phenolic compounds, such as polyphenols, have shown high antioxidant activity (Santiago-Díaz *et al.,* 2022). Traditional methods used for the extraction of these compounds are inefficient in terms of time and energy requirements (Azmir *et al.,* 2013). Therefore, the optimisation of an ultrasound-assisted extraction method is proposed to obtain a crude extract of *Arthrospira platensis* with the highest possible antioxidant activity. For this purpose, the following parameters were optimised: amount of algae, solvent volume, solvent type and concentration, ultrasound extraction time and power, as well as temperature. For each condition studied, the total phenolic content (using the Folin-Ciocalteu method) and the antioxidant activity (using the DPPH method) were analysed. The optimised method provided a hydroalcoholic extract with high antioxidant activity (>85%) in only 1 minute at 75W. In addition, the highperformance liquid chromatography technique (HPLC-DAD) was used for the identification and quantification of each polyphenol.
The optimised method allowed us to obtain crude extracts with high antioxidant activity under very convenient experimental conditions.

Key words: *Arthrospira sp.,* Antioxidants, Ultrasound Assisted Extraction, Optimization, Polyphenols.

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PHENOLIC NATURAL PRODUCTS PROFILE IN CULTURED *Zostera noltei* PLANTS: IMPORTANCE FOR RESTAURATION ACTIONS

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Abstract: Seagrasses are rooted, flowering plants adapted to marine environments, that grow both at inter and subtidal soft sediment areas along the coasts of most continents (Short et al., 2007). Within coastal vegetated habitats, seagrasses are the basis of one of the most efficient ecosystems storing carbon (Macreadie et al. 2019), but also one of the most threatened (Short. et al. 2011). This makes the restoration of such coastal vegetated communities by transplantation to be considered a priority within mitigation actions (Macreadie et al. 2021). In this regard, an important factor to analyse in transplanted shoots is the concentration of natural products, which are likely involved in the chemical defense of the plants (Sieg and Kubanek, 2013), thus affecting to their survival probability. We selected the seagrass *Zostera noltei* as a model species, since it contains phenolic natural products and can grow and survive on various culture media for at least sixty days under artificial light, exhibiting high survival rates (Cabaço et al. 2006). This makes *Zostera noltei* a suitable species for restoration actions after field collection and laboratory preparation. This study was aimed to evaluate the effects of laboratory plants processing on their natural product content before transplantation actions. Plants were collected in the Bay of Cadiz and planted in aquaria with natural sediment and seawater, under controlled light and temperature conditions. Samples of the leaves were collected, extracted weekly and the extracts were analysed by ultra-high performance liquid chromatography coupled to mass spectrometry (UPLC-MS). The phenolic natural profile established for the leaves of cultured plants did not differ significantly from that of wild plants and only small changes in the natural product content were observed along the experimental period (3 months), which makes suitable using collected plants for transplanting issues.

Key words: Restauration, *Zostera noltei*, Phenolic natural products, Cultured seagrasses

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CHARACTERISATION OF COMMON SKATE SPECIES DIPTURUS SPP THROUGH MOLECULAR AND MORPHOLOGICAL IDENTIFICATION

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Abstract: Elasmobranchs are marine vertebrates with a global decline in catches due to overfishing (2). Skates and rays have particular biological characteristics including large sizes, slow growth, late reproduction and low fecundity, which increase vulnerability to fisheries (4). They present a high morphological variability during their growth, which makes a correct identification difficult; there is scientific evidence of misidentifications and mixtures of species, which prevents a proper fisheries management. In fisheries management it is very useful to combine morphological and molecular techniques for the unequivocal identification of species. The EU has established a landing ban on the common skate, *Dipturus batis*, which inhabits the Northeast Atlantic, and it is currently listed as "critically endangered" by the IUCN (1) due to overfishing (6). In addition, there is currently a great controversy surrounding the taxonomic confusion of this skate, since this species was considered in the literature as a single species, being in fact a complex of species formed by the provisionally named *Dipturus batis* and *Dipturus intermedia* (3, 5, 6). The aim of this study is to combine morphometric and molecular analyses for the correct identification. For the analyses, samples of *Dipturus batis*, *Dipturus oxyrinchus* and *Dipturus nidarosiensis* were taken. Type entire specimens were storage for morphometric analysis, and muscle samples preserved in absolute alcohol for genetic analysis. Twenty-nine morphometric measurements were taken from each type specimen and DNA extraction on muscle and amplification of two mitochondrial, genes were performed, a Cytochrome Oxidase I (COI) fragment (aprox. 600pb) and a 16S fragment (aprox. 500pb). Identification was made through the Basic Local Alignment Search Tool of GenBank. According to the preliminary results obtained from the analysis of the sequences, this would correspond mainly to *D. batis*.

Key words: Common skate, Elasmobranchs, Molecular analyses, DNA, Endangered species, Fisheries

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SHEDDING LIGHT ON THE HOLOCEPHALI TAXONOMY, THE MITOGENOME OF CHIMAERA OPALESCENS

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Abstract: Cartilaginous fish (Chondrichthyes), i.e. sharks, rays, and chimaeras, are extremely interesting from a biological perspective as they represent one of the oldest and most ecologically diverse groups of jawed vertebrates. Their K-selective reproductive traits, make them vulnerable to overfishing. Chimaerid are also a frequent by-catch of deep-water fisheries. Holocephalans comprise a single surviving order, the Chimaeriformes, and are allocated into three different families: Callorhinchidae, Rhinochimaeridae and Chimaeridae (Weigmann 2016). Furthermore, the family Chimaeridae only includes two genera: Chimera and Hydrolagus. Recently, several new species have been described (Iglesias et al., 2022), including Chimera opalescens from deep-sea assemblages (Luchetti et al., 2011).
However, previous records of *C. opalescens* were erroneously classified as *Chimera monstrosa* (Luchetti et al., 2011; Catarino et al., 2020), due to the similar morphology (Luchetti et al., 2011), which highlights the critical importance of molecular approaches to support species identification. Mitogenomes have been a powerful tool used to elucidate

phylogenetic relationships, both at deep and at shallow evolutionary nodes.
The development of long-read sequencing technologies a precise and reliable assembly of complete mtDNA genomes. The sequencing and characterization of the complete mitogenome of the opal chimera *Chimera opalescens* (Luchetti, Iglesias et al., 2011) was carried out, using the long-read technique PacBio HiFi. The entire mitogenome was 23,411 bp long and shows the same overall content, i.e. 13 protein-coding genes, 22 transfer RNA and 2 ribosomal RNA genes, as all other examined Chondrichthyan mitogenomes. Phylogenetic reconstructions using all available Chondrichthyan mitogenomes, including 11 Holocephali (chimeras and ratfishes), places *C. opalescens* within the Chimaeridae family. Furthermore, the results reinforce previous findings, showing the genus Chimera as paraphyletic and thus highlighting the need to expand molecular approaches in this group of cartilaginous fishes.

Key words: Chondrichthyes; Chimaeridae; Short-nosed chimeras; PacBio

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NOCARDIOSIS IN FREE-RANGING CETACEANS FROM THE CENTRAL-EASTERN ATLANTIC OCEAN AND CONTIGUOUS MEDITERRANEAN SEA

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Abstract: Characterization, description, and geographical location of harmful bacterial agents in cetaceans are important for population surveillance and health monitoring around the world. This research compiles the pathologic features of nocardiosis in five free-ranging delphinids from the Canary Islands and Andalusia. All examined animals showed a disseminated pattern of infection with characteristic suppurative to pyogranulomatous lesions with thromboembolism in two or more organs. The obtained results provide the first record of *N. otitidiscaviarum* in cetaceans, the first account of *N. farcinica* in free-ranging dolphins, and confirmation of nocardiosis in central eastern Atlantic Ocean.

Key words: Cetacean; nocardiosis; striped dolphin; bottlenose dolphin; Canary Islands; Andalusia; Spain

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NEW POTENTIAL INSIGHT FOR CETACEAN WELFARE ASSESSMENTS: MOLECULAR DETECTION OF CETACEAN POXVIRUS THROUGH A NON-INVASIVE SKIN SAMPLING DEVICE

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Abstract: Animal welfare can be understood as animals' adaptation to their environment, resulting in a balance of positive and negative stimuli affecting physical and physiological health as well as emotional state and behaviour. Thus, health is an important aspect of welfare, being especially relevant in welfare assessments. In last decades, characteristic poxvirus-like lesions have been reported as a potential general health indicator in both free-ranging and under human care odontocetes (CePV-1) and mysticetes (CePV-2). There is an overall agreement that these distinguishable lesions are caused due to chronic environmental disturbances leading into immunosuppression and, therefore, more susceptibility to disease. Most studies have related the presence of these lesions with tattoo-skin-disease through visual assessments, depriving of diagnostic methods to correctly corroborate CePV infection. On the other hand, some authors have used biopsy as a skin sampling procedure to further either histologically or molecularly determine viral infection. Nevertheless, extrapolate this sampling technique on cetaceans under human care might be invasive, adding to this that it implies long-term handling which can negatively affect animals' well-being. Accordingly, aiming to address skin biopsies intrusiveness, we developed a model study validating cytology cell samplers (CCS) as a non-invasive skin sampling device to detect CePV-1 in twelve tattoo-like-lesions from two stranded cetaceans on Canary coasts. To sustain the results, two different genomic extraction protocols to compare both skin sampling procedures were performed, using DNA Tissue Kit S™ (QuickGene, Kurabo, Japan) and DNeasy™ Blood and Tissue Kit (Qiagen, Inc., Valencia, CA). Our findings show that, through the first extraction kit, a percentage of positivity of 83.3% with CCS was obtained compared to 91.7% with biopsies. However, better results were obtained with

second extraction kit with 100% of positivity using CCS. Confirming poxvirus lesions in cetaceans under human care through CCS could be a potential health measure to welfare evaluation.

Key words: Cetacean poxvirus; Skin lesions; DNA extraction; Health indicator; Welfare.

TRANSATLANTIC CONNECTIVITY PATTERN OF THE WRECKFISH *Polyprion americanus*

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Abstract: The wreckfish *Polyprion americanus* is a long-living grouper distributed antitropically in the Atlantic Ocean and in the southern Indo-Pacific Ocean (Sedberry *et al.,* 1999). Population studies have shown a lack of genetic structuring in the whole Atlantic North, which is congruent with its pelagic drift from western Atlantic North towards eastern Atlantic North Archipelagos and its return to Blake Plateau for spawning (Ball *et al.,* 2000). However, a more conspicuous characterization of intensity, periodicity and direction of migration are needed to properly understand the dynamics of the wreckfish connectivity pattern in the Atlantic. This study addresses the connectivity pattern highlighted above using nuclear DNA microsatellite markers on a sample collection from the Atlantic. Application of Bayesian inference on microsatellite variation shows a pan-Atlantic North connectivity defined by longitudinal bi-directional migration rates between Northwest and Northeast Atlantic facades. Such result comes to strengthen the life-cycle stage-dependent migratory hypothesis of this species and the need to develop joint transatlantic efforts for the proper management of this fishery (Matusse *et al.,* 2016).

Key words: Genetic markers, Migration ecology, *Polyprion americanus*, Trans-Atlantic connectivity, Wreckfish

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A NEW GENETIC TOOL TO DEPICT A MAJOR PHYLOGEOGRAPHIC BREAK IN THE SOUTH EAST PACIFIC

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Abstract: Knowing and understanding the mechanisms that maintain the patterns of distribution and connectivity of marine organisms is essential to designing sustainable resource management. Various studies showed the existence of two phylogeographic groups within the species *Perumytilus purpuratus* (Bivalvia: Mytilidae) of uncertain origin (Briones *et al.,* 2012, 2013). This work seeks to provide new evidence to clarify the taxonomic status of *P. purpuratus* and the origin of its distribution, through the experimental application of a PCR-RFLPs tool that should allow the genetic distinction of geographic subspecies in the Southern Cone. For this purpose, a fragment of the nuclear DNA 18S ribosomal gene subunit was selected as the molecular marker submitted for RFLP analyses. The results show that the geographic pattern of the nucleotide variation detected with endo-restrictase M*sp*_I on a whole coastline coverage allows the recognition of two gene pools flanking the 32ºS biogeographical breakpoint (Gabasa-Ulfe, 2020). The complete coverage of the sampling effort along Chilean and Argentinean coast allows to make inferences on the recent or historical origin of such northern and southern clades (Trovant *et al.,* 2015). This research is relevant not only for basic evolutionary inference on southern cone evolution of biota but also for a proper differential management of each subspecies (Guiñez *et al.*, 2016).

Key words: Connectivity pattern, PCR-RFLP, *Perumytilus purpuratus*, Phylogeography, Post-LGM speciation, South-East Pacific.

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INTERACTION BETWEEN MARINE SYMBIOTIC MICROORGANISMS AND *Zoanthus pulchellus*.

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The genus *Zoanthus* has been studied over the years, due to novel additions of bioactive compounds with pharmacological potential, such as zoanthamine. As a result of competition for survival, this secondary metabolite is responsible for controlling the ecological relationships of numerous marine invertebrates due to, among other things, defensive effects (Paul, 1992). Although almost 40 years have passed since it was discovered, literature on its complex biosynthesis is scarce due to the peculiar relationship that the coral establishes with numerous microorganisms, especially with the dinoflagellate of genus *Symbiodinium sp*. These symbiotic organisms may, very often, be involved in the metabolic complementation/handoffs of small molecules that may become building blocks for the resulting metabolites, that likely leads to an enhanced natural product diversity (Van Oppen and Medina, 2020). This study aims to contribute to the investigation of an unsolved debate: the involvement of symbiotic organisms, in particular those isolated from the colonial zoanthid *Z. pulchellus*, in the production of natural products, and thus, shed light on the origin of zoanthamine alkaloids.

Keywords: *Zoanthus*, zoanthamine, *Symbiodinium*, symbionts, dinoflagellate, marine natural products

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SANITARY SURVEILLANCE OF THE MARINE ECOSYSTEM OF THE CANARY ISLANDS

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Abstract: During the last ten years, the IUSA Molecular Pathology Laboratory has set up and/or optimized numerous molecular diagnostic techniques using the polymerase chain reaction (PCR) technique for the accurate detection of marine wildlife pathogens in the Canary Islands, constituting the first systematic Sanitary Surveillance of our marine ecosystem. The presence of microorganisms including bacteria (*Brucella* spp., *Photobacterium damsela* subspecies *damsela*, *Bartonella henselae*, *Listeria monocytogenes* and *Erysipelothrix rhusiopathiae*), virus (herpesvirus, morbillivirus, poxvirus, polyomavirus, Flaviviruses including the two main lineages of West Nile Virus, Sars-CoV-2 and other compatible coronaviruses and Influenza virus (N1H1, H5, H7)), and parasites (*Nasitrema delphini* and *N. globicephalae*, *Crassicauda* spp. and *Toxoplasma gondii*) were detected, quantified, and typed by different and specific PCRs (conventional, nested, quantitative, retrotranscriptase, multiplex, SYBR Green and TaqMan, etc.). Different DNA/RNA extraction techniques are also carried out; an automated robot for these extractions has recently been incorporated into the laboratory, which greatly optimizes laboratory work. 260 cetaceans from 17 different species (*Balaenoptera acutorostrata*, *B. physalus*, *Delphinus delphis*, *Globicephala macrorhynchus*, *Grampus griseus*, *Kogia breviceps*, *Lagenodelphis hosei*, *Mesoplodon bidens*, *M. densirostris*, *M. europaeus*, *M. mirus*, *Physeter macrocephalus*, *Stenella coeruleoalba*, *S. frontalis*, *Steno bredanensis*, *Tursiops truncatus* and *Ziphius cavirostris*) and 72 seabirds of 14 different species (*Ardea cinerea*, *Bubulcus ibis*, *Bulweria bulwerii*, *Calonectris diomedea borealis*, *Charadrius alexandrinus*, *Ciconia ciconia*, *Fratercula arctica*, *Larus michahellis Atlantis*, *Morus bassanus*, *Nycticorax nycticorax*, *Oceanodroma leucorhoa*, *Pandion haliaetus*, *Puffinus puffinus canariensis*, and *Sterna sandvicensis*) have been analyzed to date. As a result, we have described the first detection of *Brucella* sp. in a cetacean stranded in the Canary Islands [1], a region with no reported cases of brucellosis for this taxon, the first detection of herpesvirus infection in Gervais' and Sowerby's beaked whales [2], and the

first molecular confirmation of a Dolphin Morbillivirus infection in a Cuvier's beaked whale [3], among others.

Key words: Sanitary Surveillance, Marine, Wildlife, PCR, Ecosystem.

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MOLECULAR AND CELLULAR CHARACTERIZATION OF THE EFFECT OF CHITOSAN ON THE FUNGUS, *Zymoseptoria tritici* CAUSAL AGENT OF WHEAT BLIGHT

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Abstract: Leaf spot caused by *Zymoseptoria tritici* is a disease that causes significant economic losses in wheat growing areas of the world. Changes in cultural practices such as minimum tillage, coupled with the irrational use of fungicides and the great genetic plasticity and reproductive capacity of the fungus are responsible, in part, for the development of new pathologies caused by this disease. Recently, sustainable strategies are being developed for its control based on the application of chitosan, a by-product of the shellfish industry with antimicrobial activity. In this study we will address the effect of chitosan on *Zymoseptoria tritici* at a physiological and cellular level. In this work we intend to study the capacity of chitosan as an antimicrobial compound on the viability, development, and pathogenicity of *Zymoseptoria tritici*. We will evaluate through bioassays the effectiveness of chitosan as an antimicrobial on *Zymoseptoria tritici*.

Key words: Zymoseptoria, chitosan, wheat, pathologies.

MOLECULAR DIAGNOSIS OF HERPESVIRUS AND *CETACEAN MORBILLIVIRUS* IN BEAKED WHALES STRANDED IN THE CANARY ISLANDS (1999-2017)

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Abstract: Beaked whales (BWs), *Ziphiidae* family, have oceanic and deep diving habitat patterns[1], with records of six different species in the Canary Islands. The aim of this study was developed a retrospective survey for detecting herpesvirus (HV) and *cetacean morbillivirus* (CeMV) in 55 BWs (35 *Ziphius cavirostris* and 20 animals belonging to the *Mesoplodon* genus) stranded in the Canary Islands between 1999 to 2017. Between 294-319 tissue samples were subjected to molecular analysis. For detection of HV, a conventional nested polymerase chain reaction (PCR) based on the DNA polymerase gene, was performed[2], while CeMV identification was carried out by one or more of three PCRs[3–5] amplifying a fragment of the fusion protein (F) and/or phosphoprotein (P) genes. HV was detected in 14.45% (8/55) of the analyzed BWs. A positive percentage of 8.57% (3/8) was found within the Cuvier's BW group, whereas the positivity rose to 25% (5/8) within the *Mesoplodon* genus group (three *M. densirostris*, one *M. europaeus*, and one *M. bidens*). All the obtained sequences belonged to the *Alphaherpesvirinae* subfamily, from which three are considered novel sequences, all of them within the *Mesoplodon* genus group. In addition, to the best of our knowledge, this is the first description of HV infection in Gervais' and Sowerby's BWs[6]. On the other hand, Dolphin morbillivirus (DMV) was detected in one subadult male Cuvier's BW (1.82%; 1/55), stranded in 2002. This result supposes the earliest confirmed occurrence of DMV in the Cuvier's BW species. The obtained partial P gene sequence showed the closest relationship with other DMV sequence detected in a striped dolphin stranded in the Canary Islands in the same year[7]. Furthermore, the obtained DMV result supports a previous hypothesis of a cross-species infection and the existence of the circulation of endemic DMV strains in the Atlantic Ocean[8].

Key words: Herpesvirus, *cetacean morbillivirus*, Beaked whales, *Mesoplodon*, *Ziphius cavirostris*, PCR.

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GROWTH AND FATTY ACID PRODUCTION OF THREE NATIVE CANARIAN STRAINS OF *Nitzchia palea* IN BATCH CULTURES

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Abstract: Assessment of growth and production of metabolites of interest from a given microalgae on a laboratory scale is crucial to evaluate its potential applicability on larger scales into the biotechnology sector. Our work within the H2020 NewTechAqua project focuses on fatty acid production for use of microalgae as aquafeed in the aquaculture industry.

Growth studies of microalgae comprise the estimation of cell density over time, for which several methods have been described in the literature. While indirect methods are undoubtedly less time-consuming, their relevance needs to be evaluated case by case for the species and the experimental conditions used.

Our study focused on the benthic diatom *Nitzschia palea*, a species of interest for biotechnology (Abdel-Hamid et al., 2013). Three native strains of *N. palea* from the Canaries were cultured for 26 days in triplicate flasks under the same culture conditions. Growth was monitored using cell counting as direct method, and optical density (OD) and basal fluorescence (F_o) as indirect methods. The three strains showed their maximum growth rates between days 4 and 7 (0.21 – 0.29 day^{-1}), and entered the stationary phase at day 17. The relevance of OD and F_o was demonstrated during the exponential phase only (days 4 – 17), as they both positively correlated with cell density in a linear regression model ($R^2 > 0.89$, n = 45).

Preliminary results on the fatty acid (FA) composition indicated that the major FAs produced by *N. palea* were palmitic acid (18 – 41 %) and palmitoleic acid (12 – 25 %), in accordance with a previous study (Touliabah et al., 2020). As for the ω-3 FAs, DHA was poorly produced (≤ 3%), while EPA constituted a major FA for two of the strains (21% and 13%).

This study showed that OD and F_o were suitable alternatives to cell counting for cell density estimation, at least during the exponential phase of growth, allowing faster execution of the daily laboratory work.

More accurate studies on the fatty acid production should be developed in the future to have a more comprehensive view of the biotechnological value of these strains.

Key words: *Nitzschia palea*, fatty acids, growth, basal fluorescence, optical density, aquaculture.

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MUSSEL-PROCESSING WASTEWATER AS CULTURE MEDIA TO PRODUCE MICROBIAL BIOMASS BY MIXED CULTURES

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Abstract: Spain is one of the largest mussels' producer in Europe. Despite the benefits of this production, there is a negative impact caused by the high amounts of wastewater that are produced and continuously released to the environment provoking harmful efects such as eutrophication events. These effluents contain high amounts of organic matter and thus, they have been proposed as culture media for microorganisms and for the production of cell wall biomass (CW/B). Previously, it was selected the most suitable species for CW/B production (Prieto et al., 2015). However, the possibility of using mixed cultures for the enhancement of the CW/B production is a valid alternative still unknown. In this study, the growth kinetics of five species (*Saccharomyces fibuligera*, *Aspergillus niger*, *Aspergillus oryzae*, *Saccharomyces cerevisae* and *Rodotulora rubra*) in pure and mixed cultures was assessed. The microbial growth was evaluated under different conditions of temperature (22ºC and 30ºC) and supplemented with $NaNO_3$ or NH_4Cl at different proportions. Responses were measured in terms of reducing sugars, total sugars, total nitrogen and biomass production. The best results were obtained when *S. cerevisae* and *A. oryzae* were combined obtaining biomass yields up to 20 g/L. This study proposes a combined approach of using mixed cultures to valorize mussel processing wastewater as culture media, integrating a sustainable solution from the economic and the environmental point of view towards the achievement of industrial processes based on the principles of circular economy.

Key words: mussel wastewater, mixed culture, biomass production, circular economy.

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BENEFITS AND DRAWBACKS OF PRESSURIZED EXTRACTION FOR THE RECOVERY OF BIOACTIVE COMPOUNDS FROM MARINE ALGAE

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Abstract: Algae are little used as food in the western world but commonly consumed in Asia. In recent years, the food industry has increased its interes in macroalgae due to its composition, which includes polysaccharides, lipids, proteins, dietary fiber and different bioactive compounds such as vitamins, essential minerals, phenols and carotenoids. However, to obtain these active molecules, it is necessary to apply an extraction technique and high pressure liquid extraction has been highlighted as a suitable alternative. High pressure liquid extraction (PLE) is considered a green technique in which high temperatures and pressures are used in combination with a solvent to extract the components from a solid matrix. It is important to note that the critical points of pressure and temperature are not reached. To increase the efficiency of this technique, the optimization of different parameters such as solvent, temperature, pressure, extraction time or the number of cycles have a considerable influence. It is important to underline that the operating conditions of the PLE allow the extraction of the target analyte using short periods of time and reduced amounts of solvent but maintaining a optimum yield. This review is aimed at compiling the advantages and disadvantages of PLE for the recovery of bioactive compounds in seaweeds.

Key words: Pressurized liquid extraction, macroalgae, green extraction technique, bioactive compounds, optimization.

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MACROALGAE-BASED NANOTECHNOLOGY IN THE FOOD INDUSTRY: CURRENT STATUS AND POTENTIALLY EMERGING APPLICATIONS

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Abstract: Nanotechnology has opened a new frontier in recent years, capable of providing new ways of controlling and structuring products with greater market value and also offering important opportunities for the development of innovative products and applications in food processing, preservation and packaging. It is also of interest for the development of productive and sustainable activities. On the other hand, algae are the largest photoautotrophic group of microorganisms as a potential source of secondary metabolites, pigments and proteins, which can serve as nanobiofactories for nanoparticles. The main focus of using algae for nanoparticle synthesis is based on the high potential to take over from chemical counterparts, the low cost of cultivation, the reduction of production time and the eco-friendly and commercially viable synthesis of competent compounds. Consequently, the aim of this review will be to summarize the available information on the use of algae for the development and synthesis of nanomaterials focused on the food industry, as well as possible and innovative applications such as the development of active packaging based on the bioactive properties attributed to algal nanoparticles (antioxidant, antimicrobial, oxygen absorption capacity, UV impermeability, ...), which means that this new technology applied to the food industry and correctly regulated can continue to expand in a promising and profitable way for consumers, industry and research.

Key words: Nanoparticles, Algae, Food, Synthesis.

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NOBEL PEN SHELL PARASITE *Haplosporidium pinnae*: PARASITE DETECTION IN ENVIRONMENTAL SAMPLES

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Abstract:

Pinna nobilis Linnaeus, 1758, is an endemic marine mussel of the Mediterranean Sea. Since 2016, the population of *P. nobilis* has decreased between 80-100% due to a Mass Mortality Event mainly associated to the parasite *Haplosporidium pinnae* (Vázquez-Luis *et al* 2017; Catanese *et al.* 2018; Grau et al. 2022). This new pathogen *H. pinnae* induces the death of the pen shell obstructing its digestive gland. Since 2018, *P. nobilis* is listed as in critical situation and priority preference by the Spanish government (Orden TEC/1708/2018) and critically endangered in IUCN (2019), due to the outbreaks of the pathogen that spread rapidly and widely in the north and east of the Mediterranean Sea (Cabanellas-Reboredo *et al.,* 2019; García March *et al.,* 2020). The aim of this study was to contribute to create a protocol for parasite detection in seawater and planktonic samples, which have been collected in different locations of the Mediterranean Sea, in any of its life stages: free-living, spores, intermediate host to increase the knowledge about its life cycle and intermediate hosts, essential to enhance the early detection and improve survival possibilities of *P. nobilis*. The detection of the parasite has been made through a molecular biology approach of the seawater and planktonic samples, using the well-known PCR technique and specific primers designed in previous studies based on the 18S rDNA (SSU rDNA) gene sequence of the parasite (López-Sanmartín *et al.* 2019). *H. pinnae* was finally detected on planktonic samples being this the first study providing this parasite detection outside its main host.

Key words: *Haplosporidium pinnae*, *Pinna nobilis*, parasite, PCR, detection, intermediate host

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MONITORING FLOATING MICROPLASTICS IN THE NEARSHORE OF BARCELONA CITY

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Abstract: It has been recently documented that the abundance of floating microplastics in the nearshore can be orders of magnitude greater than offshore or in the subtropical gyres. In addition, plastic production is constantly increasing, so investigating microplastic abundances in this transition area between land and sea is of high importance. I'm going to present the results of my Final Degree Project, in which we investigated the abundances and characteristics of floating microplastics in the Sant Sebastià beach in Barcelona, from September 2021 to April 2022. We carry out this project with citizen volunteers, who helped during the sampling process by towing a trawl from a SUP board twice a month. Then, samples were analyzed at the laboratory where each microplastic was picked and classified according to its size, shape, color and polymer type. The results present dramatic levels of microplastic concentration in Barcelona waters, with a mean of 3.86 items m^{-2} and a maximum of 45.92 items m^{-2} dated in October 2021, which is among the highest concentrations reported in the Mediterranean Sea. This is also the highest abundance recorded in a 3-year long time series within the study area (Camins et al., 2020; de Haan et al., 2022), which suggests that microplastic concentrations are increasing exponentially. Among the possible causes, meteorology parameters have no significant correlation, population may be the reason of increasing values, though. The formation of litter hot-spots during calmed conditions seems to be one of the causes.

Key words: microplastic, citizen science, hot-spot, nearshore, coastal waters

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PRODUCTION OPTIMIZATION OF CANARIAN NATIVE MICROALGAE STRAINS FOR FOOD, FEED AND FUTURE EXTRACTION OF METABOLITES OF COMMERCIAL INTEREST

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Abstract: *Arthrospira platensis* and *Chlorella vulgaris* are the only two microalgae species allowed for human consumption in Europe in unprocessed form[1,2]. Their valuable biomass have multiple market applications, such as the incorporation in conventional food and feed to improve their nutritional characteristics, as well as the extraction of target natural metabolites with high demand[1,3]. Gran Canaria (Spain) is a strategic site for microalgae production due to ideal climatological conditions and large seawater availability. The main bottlenecks for the cultivation of freshwater strains are the environmental and economic costs associated with the use of freshwater, fertilizers supplying and biomass harvesting process[4]. The objective of this study was to optimize the cultivation of the native Canarian strains *A. platensis* BEA 1257B and *C. vulgaris* BEA 0441B by acclimation to seawater, reduction in nitrogen addition, improvement in biomass harvesting process and more efficient CO_2 supply, while maintaining high-valuable compound contents in the biomass. Cultures productivity and biochemical composition of the biomass cultivated with 10% seawater were similar to those obtained in the control (freshwater) medium for both strains. Nitrogen reduction under a quarter of the concentration in the control mediums did not affect culture productivities nor phycocianin content, and only partially affected protein content. The use of a plexiglass hood located at the CO_2 supply site in open raceway cultures of *C. vulgaris* increased productivity of 17% at low CO_2 supply flow rates. Rinsing of *A. platensis* fresh biomass with freshwater and pressing had a relevant effect in ash content reduction (18.7±3.6%, 25.2±3.2% and 32.2±2.6% for rinsing, pressing and both processes together, respectively), leading to a higher relative contribution of valuable compounds in the biomass. Preliminary results suggest that seawater amount in *A. platensis* medium can be further increased up to 50% while maintaining similar productivities.

Key words: *Arthrospira* (Spirulina), biocompounds maximization, *Chlorella*, seawater acclimation, nitrogen reduction

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CHARACTERIZATION OF *Rugulopteryx okamurae* (*R. OKAMURAE*) FOR ITS POTENTIAL ASSESSMENT

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R. okamurae is an invasive seaweed that is gaining importance due to its quick expansion in the Strait of Gibraltar and the Mediterranean Sea. Its economic and ecological impact highlights the need to evaluate and study this specie in order to prevent it from spreading and to assess the biomass that the local governments are removing from the beaches. The characterization of *R. okamurae* was carried out to establish which compounds of interest it presents, emphasizing mostly on the study of lipids, proteins and carbohydrates, due to the bioactive potential of these macromolecules. Subsequently, different biofilms prototypes were developed and characterized in order to verify whether the biomass could be used as raw material for the production of bioactive packaging. The present study shows the huge potential of *R. okamurae* on the industry because of its high lipid content, polyphenols and antioxidant capacity when compared to other brown macroalgae. In addition, it presents a similar alginate content to those of the *Laminaria* and *Ascophyllum* genders, which are being currently used for the alginate extraction. Regarding the bioplastic manufacturing, its mechanical properties show that it could be useful to for low added value applications such as mulching.

Key words: *Rugulopteryx okamurae*, Seaweeds, Invasive, Assessment, Biofilms.

THE IMPORTANCE OF RESTRICTION ENZYME SELECTION FOR GENOME REDUCTION IN NON-MODEL ORGANISMS.

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Abstract: Genome-wide studies in non-model organisms generally rely on genome reduction techniques using restriction enzymes and in bioinformatic tools to process the data. These reduced libraries ensure a high density of SNP markers and a high coverage for accurate genotyping even when multiplexing samples. Despite the fraction of the genome that is sequenced is expected to be randomly located, the reduction of the genome depends on the recognition site of the restriction enzyme. Here, we evaluate if the distribution of markers and their functional composition differ between restriction enzymes. In particular, we evaluated the total and candidate loci markers obtained by Genotyping-by-sequencing (GBS) in two fish species (*Symphodus tinca* and *Symphodus ocellatus* [2]) obtained using the EcoT221 enzyme and those of two sea urchins (*Paracentrotus lividus* [1] and *Arbacia lixula* [3]) obtained using the ApeKI enzyme. To do so, we mapped them to the phylogenetically closest reference genome available (*Labrus bergylta* for fish and *Strongylocentrotus purpuratus* for sea urchins) and we classified them as exonic, intronic, intergenic. Furthermore, we studied the functionality of the markers by using GO terms. Surprisingly, in sea urchins, most markers were in exons [1] while in fish most were in intergenic regions [2], and no differences between total and candidate markers were detected. The GO terms analysis also showed differences between sea urchins and fish, since most abundant GO terms were not shared between species. We discuss the frequency of mapped markers according to the species divergence to the used reference genome and the distribution of markers in intergenic, intronic and exonic regions, along with the different functions related to biological process they present. Our results highlight the importance of the restriction enzyme selection. Adaptation studies will benefit from using exonic enrichment enzymes such as ApeKI where the targets of selection might be identified more directly.

Key words: genome reduction, GBS, SNPs, genome populations, adaptation, functional annotation

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TEMPORAL TRENDS OF VIRAL ABUNDANCE AND COMMUNITY IN AN OLIGOTROPHIC COASTAL SYSTEM

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Abstract: Marine viruses, considered the smallest and most abundant (10^{30}) biological entities in the sea, play key roles in controlling microbial communities and modifying global biogeochemical cycles. Yet, although nowadays their dynamics and distribution are being increasingly explored, little is known about temporal patterns of viral abundance, diversity and community structure. In fact, the growing concern about climate change and its impacts make it fundamental to study these trends and their effects in marine ecosystems. *Blanes Bay Microbial Observatory (BBMO)* monthly monitored the viral abundance (2005) and community structure (2010) of an oligotrophic coastal system, as well as other environmental and biological factors that could modulate them. To perform this study, several molecular and statistical techniques were used, being RAPD-PCR (*Random Amplified Polymorphic DNA*) the main one. The time – series results from the last 12 years (2010 – 2021) showed that temperature had a significant tendency to increase, while viral abundance tended to decrease; nevertheless, the latter did not follow any clear seasonal pattern. Furthermore, these results showed that viral communities were mainly correlated with salinity (-), chlorophyll (+), turbidity (-) and photosynthetic protists (+). However, the community structure, represented with a *NMDS (Non-Metric Multidimensional Scaling)*, seemed to cluster the populations according to the season. The analyzed data not only contributed to a better understanding of viral communities and their trends in marine oligotrophic systems, but also demonstrated the complexity of their dynamics and structure.

Key words: viral abundance, viral community, environmental variables, time – series, RAPD.

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SEASONAL VARIABILITY OF THE PHENOLIC PROFILES OF ALGAE *Cymopolia barbata AND Lobophora variegata*

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Abstract: Phenolic profiles of *Cymopolia barbata* (*C. barbata*) *and Lobophora variegate* (*L. variegate*) strains collected from Las Canteras beach (Gran Canaria) in different seasons (January, April, August and November 2021) were studied. Algae were washed, cleaned and freeze-dried. Chromatographic analysis was performed with a Jasco LC-4000 HPLC and a Varian C18 column according to a previously reported method (Rico et al., 2013; Santiago-Díaz et al., 2021). Simultaneous monitoring for quantification was set at 270 nm (gallic acid (GA), protocatechuic acid, catechin, vanillic acid, rutin, epicatechin, and syringic acid).

GA was the only compound detected in *C. barbata* methanolic extracts, ranging from 10.1 µg g^{-1} of dry biomass in samples collected in April to 4.39 µg g^{-1} of dry biomass in samples collected in November. GA was also identified in all samples of *L. variegate* (18.7, 7.95, 5.66 and 4.50 µg g^{-1} of dry biomass collected in August, April, January and November, respectively) (López et al., 2011). Relevant amounts of epicatechin and syringic acid were also quantified in *L variegata* strains collected in January (29.6 and 5.66 Antioxidant activities of *C. barbata* extracts were determined using 1,1-diphenyl-2-picrylhydrazyl free radical (Bondet et al., 1997). Samples collected in August and January exhibited the highest radical scavenging activities (79.6 and 75.5% respectively). All the extracts gave higher activity than that shown by the food preservative butylhydroxyanisole (62.5%). The extracts were also subjected to the ferric reducing ability of plasma assay and showed similar results: samples of *C. barbata* colleted in August and January exhibited the highest activities (0.169 and 0.146 µmol of Fe^{3+} reduced to Fe^{2+} equivalents g^{-1} of dry biomass respectively).

The amounts of phenolic compounds found in both strains and the antioxidant activities of samples collected in different seasons might be linked to climatic, other ecologic, and/or genetic factors.

Key words: C*ymopolia barbata*, *Lobophora variegate*, phenolic profile, Reversed-phase high performance liquid chromatography

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EVALUATION OF THE U/MN RATIO AS AN OXYGEN PROXY FOR PALEOCEANOGRAPHIC RECONSTRUCTIONS

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Abstract:
Deciphering past deep water oxygen conditions is crucial to understand changes in water masses properties and also to investigate oscillations in the global thermohaline circulation. Different proxies have been traditionally applied to infer ventilation changes, as is the case of carbon isotopes or benthic foraminifera assemblages. Nevertheless, several factors can complicate these signals and often, the scarcity of benthic foraminifera compromises their suitability to obtain continuous or globally distributed oxygen records.
Some elements present in sediments are sensitive to the presence or absence of oxygen, and consequently, by measuring their concentration we can infer oxygen conditions. In this study, we focus on two redox-sensitive elements that have opposite behavior depending on the oxygen content: uranium, which precipitates under reductive conditions; and manganese, which precipitates in oxidative conditions.
The aim of this research is to evaluate the application of U/Mn ratios on foraminiferal authigenic coatings as a proxy of bottom water oxygen content, and explore how this signal is fixed on the sediments throughout the redox front. This proxy is tested on two sediment cores, recovered one at 564 m in the Gulf of Cadiz, and the other at 1805 m in the SW Portuguese continental margin 5. The U/Mn ratio was measured on authigenic coatings of three planktonic foraminiferal species, *Globigerina inflata, Globigerinoides ruber,* and *Globigerina bulloides*, to assess potential controls from their test morphology and texture. The proxy value is also tested by measuring the U/Mn ratios in a set of core-tops covering a range of oxygen water content. The obtained results indicate that the U/Mn ratios are affected by the oxygen boundary zone in the sediment, with a clear depletion associated with Mn enrichment that marks this level. Nevertheless, U/Mn ratios above and below this band are comparable and present coherent values with the oxygen content of the current deep-water masses encouraging the application of this ratio as an indicator of oxygen content.

Key words: U/Mn ratio, authigenic coatings, oxygen content, sediment record, paleoceanographic reconstructions.

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COMPARISON OF BIODEGRADATION OF BIOPLASTICS BY MARINE BACTERIA IN SEAWATER

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Abstract: Plastic in the ocean is posing threat to marine ecosystems. Therefore, the demand for innovative biopolymers such as PLA and PHAs as a replacement for fossil-based plastics is increasing[1]. Removal of these bioplastics require some treatment that reach an efficiency of 90% while the rest will reach microscopic size once discharged in the environment[2]. Those biomicroplastics (bioMPLs) could persist in the environment if their optimum biodegradation conditions are not reached (temperature, pH, bacteria, etc.). Therefore, these bioMPLs could behave like conventional plastics with the added drawback of a future decomposition in (bio)monomers faster than fuel-based plastics. The main objective of this work has been to investigate the biodegradation of two selected bioplastics (PLA and PHB) and two commonly used consumer products made of these polymers (PHB - plastic bags and PLA-single use knives) and to characterize the associated microbial communities. All the materials have been exposed in marine microcosms for two months emulating controlled Mediterranean conditions. Samples for chemical characterization and bacterial abundances were taken weekly. Extracts for chemical analyses were purified and concentrated by a solid-phase extraction procedure, and analyzed by means of liquid chromatography coupled to high resolution mass spectrometry equipped with an electrospray[3]. Bacterial abundance was quantified by flow cytometry. Results showed the lixiviation of bioplastic additives such as phthalates and adipates. The ratio of lixiviation decreased while the presence of bioplastics monomers (i.e., polylactic acid) increased. Comparing consumer products, plastic bags made of PHB degraded faster than PLA knives. Bacterial abundances followed divergent patterns in each treatment. These results agree with the chemical results, where additives were found more frequently in PHB microcosms than in PLA ones. These findings support the need to further investigate the effects of bioplastics, their degradation products and their additives, not only in biota but also in the whole water column.

Key words: bioplastics, biodegradation in marine microcosms, non-target screening by LC-ESI-QExactive

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ANNUAL STUDY OF MICRO AND MESOPLASTICS IN 5 BEACHES ON FUERTEVENTURA, CANARY ISLANDS

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Abstract: Islands are presented as model laboratories in the oceans for marine pollution studies. Several studies detail areas of accumulation of macro and microplastic in the Canary archipelago, however, information on the island of Fuerteventura is scarce (Álvarez-Hernández, C. *et al*., 2019; Baztan, J. *et al*., 2014; Edo, C. *et al*., 2019; Herrera, A. *et al*., 2018; Reinold, S. *et al*., 2020). Here we present data from a meso and microplastic abundance, number of items and morphology composition study in 5 beaches in Fuerteventura (Canary Islands) during one year (December 2020 to December 2021).

Quantification analysis (CEDEX, 2016) showed, in the specific case of Caletillas beach (Puerto del Rosario), the highest microplastic abundance data in the study were recorded, with average abundances of 121.08 g/m2 and 6741.33 items/m2.

Morphology analysis showed in general, the FRA morphology (hard plastic fragments) predominated in all the beaches and seasons of the year, reaching, in some cases, for up to 93% of the composition of the sample (Caletillas, winter 2021), and representing more than 50% of the composition of most of the analyzed samples.

Morphology analysis showed differences at local level. In Viejo Rey (La Pared), the FOA morphology (corks, foams and polystyrene) predominated in part of the year (winter, spring, autumn), which represented between the 34% and 77% of the composition of the samples. Differences were also observed on Caleta del Marrajo (El Cotillo). Although hard plastic fragments (FRA) representation varied between 41% and 87% of the composition of the samples depending on the time of year, the morphology LINES (lines, ropes and fishing nets) was especially relevant in the summer season, representing the 41%. In a preliminary way we can establish the beach of Caletillas, in the municipality of Puerto del Rosario, as a point of special attention in the accumulation of marine debris, especially meso and microplastics.

Key words: Microplastics, Marine debris, Abundance, Plastic pollution, Fuerteventura, Canary islands.

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VIII INTERNATIONAL SYMPOSIUM
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POSTER COMMUNICATIONS

COASTAL AND ESTUARINE SYSTEMS

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A SUDDEN BEACHES FORMATION ON THE COASTAL LAVA-DELTAS OF THE 2021 VOLCANIC ERUPTION ON LA PALMA

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Abstract: On September 19, 2021, a new monogenetic volcano erupted on the island of La Palma (Canary Islands, Spain), in the northwestern sector of the Cumbre Vieja volcanic rift, at an altitude of approximately 1,050 meters. As a result of approximately 12 weeks of volcanic emissions, a pyroclastic cone about 200 meters high was formed, as well as successive lava flows that descended the western slopes of Cumbre Vieja until reaching the sea for the first time on September 29, 2021. As they descended the coastal cliffs and entered the sea, the lava flows formed two lava delta of 75 and 5 ha on the insular shelf. This work explores the coastal transformations associated with this process through the analysis of high-resolution orthophotos from September 29 to December 27, 2021, with an average frequency of 2 weekly drone images. The observations show a sudden accumulation of fine-grained particles in the shoreline in short periods of only 24 to 72 hours, and their subsequent apparently stability. This process was verified in two similar events of lava delta progradation. The first lasted from September 29, when the first lava flows entered the sea; until October 8, when the lava front stabilizes. Just after, a total of 10 small beaches of fine volcanic material appeared in following the 24-72 hours. The second episode took place between November 10, with a new lava front affecting the southern half of the lava delta, and the formation of a new, smaller one, to the north; until November 24, when both lava fronts stabilize. Once again, 16 small beaches of fine volcanic grains appeared in the following 24-72 hours. This research discusses the processes that may have given rise to the sudden formation of these new beaches, as well as their possible short- and mid-term stability and evolution.

Key words: detrital volcanic beaches, lava delta, volcanic eruption, La Palma, Canary Islands

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THE IMPACT OF BEACH KIOSKS ON ARID FOREDUNES

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Abstract: Beach-dune systems are some of the most visited touristic destinations. Infrastructure is often built to service visitors, which tends to occupy the public domain and puts pressure on beach-dune environments. Among other impacts, kiosks and other beach equipment can interfere with aeolian processes and modify sand flux patterns towards the dunes. In arid coastal dune systems, the presence of naturally discontinuous foredunes and the relative fragility of nebkha vegetation can lead to further complexities.

We investigate some of the environmental impacts associated with the presence of beach kiosks in *El Inglés* (Gran Canaria, Spain), a beach of specific interest because of the high levels of human pressure throughout the year. *El Inglés* is the main sediment supply to the Maspalomas transgressive dune field. The number and size of beach kiosks here have varied over time from their first installation in the 1970s, as the need to adapt to new environmental regulations came into place. However, and although *El Inglés* is an Area of Ecological Sensitivity since 1994, recommendations for designing more 'aerodynamic' kiosks have been so far ignored. In 2019, new rectangular-shaped kiosks of 20 m^2 were installed and still operate in the area.

This research investigates how the installation of kiosks leads to the development of deflation surfaces, foredune fragmentation, and changes to airflow dynamics. We present results from a field experiment at *El Inglés* beach-dune system specifically designed to measure near-surface (0.5 m above the ground) wind speeds and directions around a beach kiosk. A digital elevation model of the kiosk was created from topographic data collected in the field, which helped analyze interactions between this artificial landscape element, aeolian processes, and the development of deflation surfaces downwind. Implications for the design and location of kiosks and other beach equipment are discussed.

Key words: Maspalomas, beach equipment, beach-dune management, airflow patterns

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METAL AND METALLOIDS CONCENTRATION IN GALAPAGOS FISH LIVER AND GONAD TISSUES

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Abstract: The Galapagos Islands are one of the best-preserved archipelagos in the world. However, previous studies have shown that metals are present in fish muscle. Here, we explore metal concentration in fish liver and gonads to evaluate its toxicity in the studied fish species. Between February and May 2019, we sampled individuals of six demersal (*Caulolatilus princeps*, *Caulolatilus affinis*, *Mycteroperca olfax*, *Pontinus clemensi*, *Hyporthodus mystacinus* and *Paralabrax albomaculatus*) and three pelagic species (*Thunnus albacares*, *Seriolella violacea*, and *Acanthocybium solandri*). The metal concentrations were analyzed by Inductively Coupled Plasma Optical Spectrometry (ICP-OES). *A. solandri* showed the highest concentrations of Zn and Cu in liver of all the species (118.9 and 20.0 mg/kg wet weight, respectively), which could be due to a metallothionein's lower degree of activity. An antagonism between Zn and Cd was observed in *S. violacea*, since Cd competes for the active site of Zn. *S. violacea* and *P. clemensi* Zn levels were lower in liver (31.1 and 17.1 mg/kg wet weight, respectively) than in gonads (51.6 and 27.0 mg/kg wet weight, respectively), indicating that these species could be in their reproduction period. High concentrations of Cd were found in the liver of *C. princeps* (23.1 mg/kg wet weight), *C. affinis* (10.6 mg/kg wet weight) and *P. albomaculatus* (18.5 mg/kg wet weight). *H. mystacinus* showed the lowest metallic concentrations, so we consider that this species is the least susceptible to toxicity due to the metals studied. *H. mystacinus* is considered a top predator in the demersal habitat, but its metallic concentrations do not respond to the predicted bioaccumulation process and should be further investigated. We conclude that the high metal concentrations found in the demersal species could be originated by the volcanism of the islands, since no major sources of anthropogenic metal contamination can be found in Galapagos.

Key words: Galapagos Marine Reserve, Metals, Demersal fishes, Pelagic fishes, Liver and gonads.

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METALLIC CHARACTERIZATION IN TUNA FROM THE CANARY ARCHIPELAGO, SPAIN

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Abstract: Biological assimilability and amplification through marine food webs is regulated by many abiotic and biotic factors (Kuijper et al., 2003; Pringle and Hutchinson, 2020). The objective of this study is to know the contamination present in tuna species of the Canary Islands, and to be able to know the relationship between the patterns of metal content of tuna by trophic level with ecological characteristics. For this study, a total of 75 specimens of tuna present in the Canary archipelago have been sampled and analysed: *Acanthocybium solandri, Katsuwonus pelamis, Thunnus albacares, Thunnus obesus and Thunnus thynnus*. Ten grams of muscle were taken from each specimen and the metals Al, Cd, Cr, Cu, Fe, Li, Ni, Pb and Zn were determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). The results obtained showed that *T. thynnus* was the species that had the highest concentrations in the analyzed metals, reaching up to 100 times more in Fe with 137.8 ± 100.9 mg/Kg, this may be due to the fact that it is the larger species reaching ages of more than 15 years (Mourente et al., 2015). Metals cross the trophic network bioaccumulating, which is why species at a high trophic level and older are the ones with the highest concentrations of metals, such as larger tuna or cetaceans (Cappello et al., 2018; Lozano-Bilbao et al., 2019). Whereas *A. solandri* is the species of Tuna with lower

concentration of metals. The study of contaminants in these species is of great importance to know the state of the ecosystem and provide information on consumption, since they are species of great fishing interest and the risks of consumption for human beings must be evaluated.

Key words: Metal, Tuna, Trophic level, ICP-OES, Bioaccumulation

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A PRELIMINARY STUDY ABOUT CHANGES ON AEOLIAN SEDIMENTARY DYNAMICS IN BEACH-DUNE SYSTEMS THROUGH LONG-TERM MONITORING OF VEHICLE TRACKS AND HEAVY DUTY MACHINERY IN EL INGLÉS BEACH (GRAN CANARIA, SPAIN)

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Abstract: Beach-dune systems are coastal ecosystems highly susceptible to changes, especially those associated to human activities. This study is located in El Inglés beach (Canary Islands, Spain), which is the sediment input to the Maspalomas transgressive dunefield and where vehicles, especially beach cleaning machinery, circulate daily. The aim of this study is to take a first approach into long-term analysis of the topographic and geomorphological effects of vehicles and heavy duty machinery of the beach cleaning service and how it may affect aeolian sedimentary dynamics in beach-dune systems.
The methodology was divided into three sections: i) a spatiotemporal study of vehicle tracks on the beach through orthophotos (2002-2018); ii) a field campaign to observe and compile beach cleaning activities information to discriminate heavy duty machinery tracks; and iii) long-term analysis of the variables associated to topography and geomorphology.
The variation in vehicle track density was found to be related with the management actions through the years, depending on the number of tourists. Thus, different track densities (not homogeneous throughout the beach) could be related to the number of users and hence the intensity of beach use. The vehicle track densities showed a high correlation with the heavy duty machinery track densities obtained in the field campaign, which could explain the importance of this activity on the presence of tracks on the beach.

Significant differences were observed in the topographic profiles' behaviour along the beach, according to the vehicle track density obtained. However, an artificially-maintained steady beach with insignificant slope variation in the topographic profile was observed, contrary to the documented sedimentary deficit in the Maspalomas dune system. Therefore, mechanical cleaning does not have a sole and direct impact on sediment loss in the system but rather contributes to maintain the erosive areas responsible for sediment loss in the Maspalomas beach-dune system.

Key words: Arid coastal dune system, Maspalomas, vehicle tracks, mechanical cleaning, beach-dune management

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IMPACT OF MUSSEL RAFT ON THE ORGANIC CARBON BIOGEOCHEMISTRY IN AN UPWELLING-DRIVEN BAY

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Abstract: The main goal of the study is to find out whether suspended mussel culture affects the organic carbon biogeochemistry on seasonal time scales in the Ria de Vigo (NW Iberian Peninsula). From spring to autumn, prevailing northerly winds over the NW Iberian Peninsula, cause upwelling events of nutrient-rich subsurface waters that promote phytoplanktonic blooms. The massive primary productivity during upwelling events enables the ria to support the highest mussel production in Europe. Mussels are filter feeders, thereby diverting primary production and energy flow from planktonic to benthic food webs and altering the carbon biogeochemical routes of the ecosystem. For the study, we'll use data from 6 oceanographic cruises covering two seasonal periods, summer and winter, between 2007 and 2008. Water samples were taken at 5 depths at two stations: a reference station, located in the central channel of the ria and a mussel raft station. At each depth, temperature, salinity, nutrients, oxygen, pH and chlorophyll a were measured, as well as dissolved and particulate organic carbon (DOC and POC). Our results indicate differences in organic matter concentration. In summer, upwelling process increase the concentration of nutrients in surface waters of the ria, promoting high levels in primary production and thereby in POC. During winter, POC concentration was low in response to low light-limited primary production. Likewise, we found differences in POC concentration between the two studied sites. POC concentration was lower under the raft due to intense mussel filtration activity. In contrast, DOC concentrations were very similar at both sites, pointing to different biogeochemical routes for the particulate and dissolved organic carbon forms under the raft. Mussel farming activity modulates the organic carbon biogeochemistry of the ria´s water column.

Key words: organic carbon, mussel farming, upwelling, NW Iberian.

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TURBIDITY PATTERNS IN A TIDAL SOUTH ATLANTIC ESTUARY: A REMOTE SENSING APPROACH

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Abstract: The distribution of Suspended Particulate Matter (SPM) in coastal areas often responds to the interaction of several agents that create a large spatiotemporal heterogeneity in turbidity. This work combines single-point measurements with a time series of satellite turbidity derived from Landsat8-OLI images to provide a first synoptic overview of the main hydrometeorological drivers of turbidity patterns in the Bahía Blanca Estuary (Argentina). The atmospheric correction algorithm based on the black-pixel assumption, using the two OLI-SWIR bands (Vanhellemonth&Ruddick, 2014) and the semi-empirical single band turbidity retrieval algorithm proposed by Dogliotti *et al*., (2015) were validated using field values of turbidity and applied to all the available Landsat 8-OLI scenes (2013-2021) to produce a time series of satellite turbidity maps. Then, the effects of tides, winds, and rainfall on satellite turbidity were evaluated through Generalized Linear Models built for the outermost zone of the estuary. Cumulative rainfall had negligible effects on turbidity. Around the mouth of the estuary, turbidity responds entirely to winds and were not affected by tidal current speeds or tidal phase. Strong winds within 24 hours before image acquisition time had the greatest influence on turbidity. Winds from all directions except E/NE/N were associated with higher turbidity values, and the effect was significant for winds blowing from the NW. Surface currents produced by winds blowing from the NW, aligned with the azimuth of the channel, aid to the export of estuarine sediments to the shelf and reduce the residence time of the estuary. Therefore, while tides might control erosional processes in the inner section, wind-induced sediment resuspension and export would be critical for the sedimentary budget of the estuary. This work reveal the potential of time series of ocean color products derived from high spatial resolution sensors to resolve turbidity patterns over narrow coastal areas.

Key words: Turbidity, Landsat 8-OLI, Bahía Blanca Estuary, Sediment Transport,

hydrometeorological forces.

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MICROPALAEONTOLOGICAL ANALYSIS FOR RECONSTRUCTING THE ENVIRONMENT OF S'ALBUFERA DES GRAUS (MENORCA, SPAIN) DURING THE HOLOCENE

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Abstract:

The main objective of this study is to determine the different palaeoenvironmental episodes during the Holocene in the S'Albufera des Graus lagoon (Menorca, Spain). To this end, a core 10 m thick was obtained, and the benthic foraminifera contained there then underwent micropalaeontological analysis and 14C dating. These organisms are very sensitive to environmental changes and their study has made it possible to record two phases of evolution of this lagoon. The first, dated between 8000 and 2000 cal yr BP, contains a mixed association of foraminifera made up, on the one hand, of euryhaline species characteristic of restricted environments and, on the other, of stenohaline species that come from the adjacent marine environment. The second phase of evolution dates from after 2000 BP and represents a deposit with a restricted environment without marine communication, which has been stable from the first phases of development until the present day. Between 7200 and 5000 cal yr BP, the marine advance associated with the maximum of the Holocene transgression is recorded. The cause of the change in palaeoenvironment seems to have been the closure of the barrier due to coastal progradation processes caused in turn by the greater sedimentary availability in Roman times, which is confirmed in various areas of the Mediterranean (Fumanal & Ferrer, 1998; Ejarque et al., 2016; Sabatier et al., 2010). The foraminifera characteristic of restricted environments found in S'Albufera des Graus are *Ammonia beccarii tepida, Haynesina germanica, Elphidium excavatum and Miliolinella eburnea*. Among the abundant allochthonous foraminifera found, the species associated with the genera *Quinqueloculina* and *Triloculina* stand out, in addition to the species *Adelosina laevigata*; the predominance of these species may indicate the existence of seagrass meadows on the continental shelf adjacent to the study area, at least since the Upper Holocene.

Key words: Palaeoenvironmental, Foraminifera, S'Albufera des Graus, Menorca, Spain.

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SEDIMENTARY CHARACTERISTICS OF THE BARRIER ISLAND OF THE MORO MARSH (VALENCIA, SPAIN)

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Abstract: The Moro marsh is a wetland located south of the city of Sagunto, in the province of Valencia (Spain). From the morphogenetic point of view, it is a marsh that has been filled by natural and anthropic processes and isolated from the open sea through a barrier-island (Sanchis and Ferri, 1997). The main objective of the study is to carry out a sedimentary characterization of this barrier from the beginning of its formation, that is, after the stabilization of the marine rise of the Holocene, around 6000-5000 cal yr BP (Blázquez *et al*., 2017; Rodríguez-Pérez *et al*., 2018). For this purpose, a 14.4 m-thick core (0.79 m asl), was obtained 350 m from the current coastline, and sampled each 10 cm (a total of 102 samples). The samples then underwent sedimentary and chronological study (the latter using 14C dating).

The results indicate the dominance of sandy textures in most of the borehole, with abundant levels of pebbles and flattened gravel. From the bottom to -9.3 m b.s.l., silt-clay textures predominate, reaching 91% in the base samples, where the ferric oxide content is very abundant. Between -9.3 m b.s.l. and -5.2 m b.s.l., sand dominates with abundant flattened pebbles, which in some cases account for more than 80% of the total sample. Finally, from -5.2 m b.s.l. to the top sands predominate, although localized levels of pebbles are also observed. 14C dating indicates ages around 5200 cal yr BP at -2.35 m b.s.l. The morphoscopic characteristics of the sediment allow the interpretation of the silt-clay level of the base as an alluvial environment, while the upper levels, rich in sand and pebbles, are related to a sedimentary sub-environment linked to the barrier island; they are probably foreshore or shoreface facies and, towards the top, backshore facies.

Key words: Barrier-island, Moro Marsh, Sediment, Valencia, Spain

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POTENTIAL MICROBIAL CONNECTIVITY IN THE RÍA DE VIGO THROUGH SUBMARINE GROUNDWATER DISCHARGE

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Abstract: Submarine groundwater discharge (SGD) refers to any flux of water originated from the seafloor. This includes the discharge of continental groundwater that often occurs through a subsurface mixing zone called subterranean estuary (STE). Previous research has identified significant volumetric SGD in the Ría de Vigo, a highly productive coastal system in the NW of the Iberian Peninsula. (Ibánhez et al., 2021). Yet, the impact of SGD over the biogeochemistry and microbial ecology of the embayment is still unknown. Thus, this study focuses on evaluating the potential, SGD-driven microbial and biogeochemical connectivity in the embayment in order to assess the ecological impact that SGD can produce in the coastal zone.Samples were taken from different water bodies within the ria and its surrounding basin, including surface and deep pore-water samples from two contrasting STEs, surface seawater, riverine water and groundwater samples.

Samples were used to determine a complete set of microbial and biogeochemical variables, such as taxonomic composition, salinity, temperature, inorganic and organic nutrients, carbonate system, radioisotopes, biogases and dissolver organic matter. We have found very diverse microbial communities, with higher diversity in the STEs compared to land and sea endmembers, likely related to the variety of niches in this transitional ecosystems. Most operational taxonomic units (OTUs) (ca. 87%) were exclusive of a single environment (river, groundwater, seawater or STEs), revealing a poor microbial connection between land and sea. Overall STEs shared a significantly higher proportion of OTUs with seawater than with freshwater endmembers.

Despite that a biogeochemical connectivity can be observed, the contrasting biogeochemical conditions found in the different environments may explain the low level of common microbial species, in contrast to what was expected from ^{222}Rn and salinity-based estimates of water flow between the local groundwaters and the sea.

Key words: submarine groundwater discharge, microbial diversity, subterranean estuary, marine environment

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RELATIONSHIP BETWEEN SEDIMENTS TEXTURAL CHARACTERISTICS OF AN INTERTIDAL SANDBANK AND ITS TOPOGRAPHICAL VARIATIONS (RÍA DE CEDEIRA, GALICIA, NW SPAIN)

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Abstract: In this contribution we combine textural and topographical information from an intertidal shellfish sandbank located in the inner part of the Ría de Cedeira (Galicia, NW Spain). The aim of this study is to explore the relationship between both variables over time. We used the data set of 43 sediment stations sampled during 16 seasonal campaigns since September 2016 to October 2020, that means about 690 samples. At the same time, a detailed topographical survey was carried out with DGPS (Trimble, DGPS R7) to produce a digital terrain model (MDT) for each campaign. We compared the variation of D50 and sorting of all the samples with variations in the topographic heights over time using linear correlations. The sandbank (1.5 km long, 800 m wide and E-W oriented) is part of a beach and dune complex and showed an important topographical variation over time. It is composed by a very dynamical intertidal swash bar system associated to river inlet at both side.
The spatial distribution of the sediments shows a persistent pattern over time with the grain size being slightly coarser towards the eastern part of the sandbank.
The results allow us that the sediments are well sorted fine sands (Nombela *et a*l., 2017) with D50 between 188 and 215 microns, and Sorting between 1,30 and 1,42. However, significant variations in topographic height have been recorded along the surveys for each sampling point, with height values ranging from 0.20 to 1.8 m. This fact is related to the high morphodynamic behaviour observed.
The statistical analysis shows a positive correlation between grain size and heights, this means that de grain size of the sediments increases with topographic height. Similarly the sorting increases too.

Key words: Sediments, Textural Characteristics, Intertidal Sandbank, Topography

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MECHANISMS OF AMMONIUM UPTAKE IN SEAGRASSES FROM CADIZ BAY (SPAIN)

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Abstract: Seagrasses are marine plants capable of completing their life cycle in the sea and able to take up nutrients both, throughroots and leaves (den Hartog, 1970; Pérez-Lloréns *et al.,* 1993). Although they occupy a very low percentage of the ocean surface, they fulfill very important ecosystem functions in coastal areas (Duarte *et al*., 2005). However, seagrass ecosystems are declining worldwide, being eutrophication one of the main causes. The main negative effects of this phenomenon are related to the exacerbated growth of phytoplankton, ephemeral macroalgae and epiphytes reducing light received by the plants (Vergara *et al.,* 1997); as well as a direct toxicity of ammonium (Brun *et al.,* 2003). The objective of this study was to compare ammonium uptake kinetics in two seagrass species thriving in Cadiz Bay (Spain), *Zostera noltei* and *Cymodocea nodosa*, which seem to have different sensitivity to ammonium toxicity (López-Pulido, 2013; Villazán *et al.,* 2013). Both species were cultured in the absence or presence of this nutrient, and the kinetics of foliar ammonium uptake was performed using compartmentalized incubation chambers with isolation of the aboveground tissued from the belowground ones. The ammonium concentrations tested ranged between 0 and 100 µM, and samples for ammonium analyses in seawater were taken at different intervals from 15 minutes to 2 hours.
The results showed differences in ammonium uptake rates between species and treatments. While *Z. noltei* plants showed linear kinetics indicating an unregulated ammonium influx through aquaporins is the predominant process. Conversely, *C. nodosa* followed a saturation model, compatible with the possible presence of ammonium transport (AMT, "Ammonium Transporter Genes") proteins, indicating a more regulated ammonium transport. The different mechanisms involved in these two species are in accordance with previous results of the research group, where *Z. noltei* was much more sensible to ammonium toxicity than *C. nodosa*.

Key words: Ammonium toxicity, ammonium uptake, AMT proteins, aquaporins, *Cymodocea nodosa, Zostera noltei*.

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MATURE BENTHIC COMMUNITIES ARE LESS DIVERSE IN CONCRETE THAN BASALT AT ARTIFICIAL COASTAL DEFENCES IN MADEIRA ISLAND (NE ATLANTIC, PORTUGAL)

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Abstract: Coastal sprawl is one of the main drivers of global degradation of shallow ecosystems. These impacts can be mitigated through ecological engineering, which includes the manipulation of the material used for construction. Among artificial substrata, quarry rock can have a faster initial recruitment of benthic organisms than traditional concrete, which is, in turn, more versatile for construction. To increase knowledge of the factors involved in these differences, this study compares the sessile and epibenthic communities of concrete and basalt units of breakwaters >5 years of age at intertidal and subtidal levels in six locations of Madeira Island (East Atlantic, Portugal). The extension of artificial coastlines in the south of the island was quantified using satellite images, resulting in more than 34% of the south coast of Madeira being artificial. In these structures, benthic assemblages differ between sites (scale of meters) and locations (km) and although the role of substratum type was secondary to location, the mineral biomass and species diversity was lower in concrete than in basalt across all the spatial scales studied. These differences could be explained by the higher rates of detachment of calcareous biocrusts from concrete, as cement experiences a surface abrasion (weathering) than basalt. Additionally, concrete can leach heavy metals, which can reduce community abundance and diversity, although more research is needed on the factors that cause these differences. In general, the results of this study will help inform ecological criteria for coastal protection.

Key words: Shoreline Hardening; Coastal Urbanization; Artificial Reefs; Sessile Benthos; Epibenthic Communities

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SHORELINE EVOLUTION IN LAS CANTERAS URBAN BEACH (GRAN CANARIA, SPAIN)

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Abstract: Coastal ecosystems are places where converge biophysical and social processes. In this sense, natural and anthropogenic processes can have long-lasting impacts on coastal environments and fundamentally alter the evolution of the shoreline. The study of the shoreline and its evolution shows the habitats responses as it could be the surface behaviour of the beaches associated to natural or anthropogenic actions. This research analyses the shoreline evolution of a currently urban beach such as Las Canteras beach located in Las Palmas de Gran Canaria (Canary Islands, Spain), to know which areas are experiencing progradation or retrogradation. The Digital Shoreline Analysis System (DSAS) tool has been used as an extension to the ArcMap GIS program, which enables to calculate rate of change statistics from multiple historical shoreline positions. Results through this metrology shows that the beach does not behave in a homogeneous way since from the area of La Puntilla (north of the beach) to Playa Chica (central area of the beach) it has been able to recover certain meters of sandy coastline (progradation) while the rest of the beach, in La Cícer (south of the beach), suffers severe losses of coastline (retrogradation). On the one hand, it is discussed what natural and anthropogenic variables could be affecting the positive or negative evolution of the beach, and on the other hand, where shoreline progradation is obtained, if they would be potential areas for beach transgression towards the land (a process that would occur naturally) as a response to sea level if the urban density allows it.

Key words: urban beach, coastal processes, shoreline, DSAS, sea level rise, beach response.

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POSITION OF THE COASTLINE AT THE MAXIMUM OF THE HOLOCENE TRANSGRESSION ON THE VALENCIAN COAST

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Abstract

The aim of this work is to evaluate the position and extent of the Holocene transgression on the coast of the Gulf of Valencia. To achieve this goal, a sedimentological and micropaleontological (fossil benthic foraminifera) analysis of samples from cores from five borehole drilled at three different wetlands (Almenara marsh, del Moro marsh and Valencia lagoon) has been carried out. The cores were sampled at 10-cm intervals. Grain size distribution and geochemistry chemical (carbonate and organic matter) of each sample were analyzed.

In order to assess the extent of sea level change, at least three factors (linked to three different time and space scales) must be taken into account: 1) eustatic rise, derived from the ice melt due to global warming during the Holocene; 2) coastal subsidence rate at regional scale, neotectonics and, finally, 3) the sedimentary factor, linked to more local processes resulting in shoreline progradation or retrogradation following positive or negative changes in the sediment input. Regarding the first factor, some authors (Goy et al., 2003; Brisset et al., 2018) have remarked that the Holocene transgression reached +1 m above the current sea level in this area. As for the second factor, whereas the Valencia lagoon is located on a subsiding coast, the northernmost Valencian marshes (like the Almenara or the Moro marshes) are located on a tectonically stable coast (Rey and Fumanal,1996). Finally, sedimentation rates are highly variable depending on the area, but as a general rule, whereas in the Valencia lagoon the shoreline shifts seawards (progradation) as a result of sediment accumulation, in the northernmost areas the coast is retrograding at present; nevertheless, the anthropic factor clearly interferes with this pattern. The main conclusions indicate that in the Valencian coast the Holocene maximum sea level did not exceed the current one, except in the case of the subsiding area of the Valencia lagoon. Radiocarbon analysis allowed us to date the maximum extent of the Holocene transgression on the Valencian coast at around 5500 cal yr BP in all cases.

Key words: Marine Isotopic Stage 1, Holocene, Valencia, Lagoons, Coast

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DISTRIBUTION AND DENSITY OF INTERTIDAL OYSTER (*Crassostrea SPP*) REEFS IN RIO PIEDRAS ESTUARY (HUELVA, SW SPAIN)

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Abstract: Oyster populations play an important role on estuaries health. In one hand, the oysters are filter-feeders removing phytoplankton and suspended matter from the water column, improving the water transparency. In the other hand, the life cycle of oysters includes a settlement phase on a hard substrate and the most suitable substrate for oyster larvae is usually the oyster shells. This behaviour results in clusters of oysters that grow in height and surface in sub- and intertidal areas in the creeks of the estuaries. These groups of oysters form large extensions and offer habitat heterogeneity, improving the species biodiversity. Therefore, the surface and density of these oyster reefs are important to estimate the ecosystems services provided by these oyster populations.
In order to evaluate the population of oyster (*Crassostrea spp*) along the Rio Piedras estuary (Huelva, SW Spain) different sampling methods were used. First of all, the intertidal oyster reefs were delimited using a boat and recording the location of the limits of the oyster beds by a portable GPS. In those areas accessible from land or by boat, the oyster beds were sampled by transects and 35x35 cm quadrats. Oysters in the quadrats were collected and lately counted, measured and weighted. In the areas where was not possible to access mainly because the substrate was mud too soft for sampling, a drone (UAV) was used taking serial pictures with 2-3 cm/pixel resolution. The images were later analysed by an image analysis software, counting the number and surface occupied by each oyster groups.
In intertidal areas 17 oyster beds were found. The surface occupied by oyster groups summarize 1.511,45 m^2 in a total intertidal potential area of 67,05 Ha. The density of oyster beds along the Rio Piedras estuary showed important variations, ranging between 2,1 and 26,9 uds.m^{-2}.

Key words: Oyster reefs, density, sampling methods, intertidal, UAV,

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EVOLUTION OF PANTÍN COASTAL DUNE BARRIER, NW IBERIA

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Abstract: Coastal dunes can be used as geological archives to discern the global changes since their formation. This paper analyzes the evolution of the Pantín dune barrier located on the Galician Atlantic coast, NW of the Iberian Peninsula. Twelve transects were obtained by ground-penetrating radar (GPR) with a 200MHz antenna and ten sedimentary corers were obtained with a suction logger (TESS-1). The interpretation of the radargrams was carried out with the Kingdom Suite software, crossing it with the available sedimentary record information. The ages of the main stratigraphic units identified were established through a total of ten optical thermoluminescence (OSL) datings and one radiocarbon (14C) dating, obtaining age ranges that oscillate between 3029BC and 1862AD (middle and upper Holocene). These data allow us to reconstruct the processes and driving agents in the evolution of the Pantín dune barrier, as well as establish a correlation between climatic events and sea level in the context of the Holocene transition.

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FRESHWATER INPUTS AND METEOROLOGICAL PROCESSES MEDIATE FISH LANDINGS IN THE EBRO RIVER AREA

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Abstract: The lower Ebro River (NE Iberian Peninsula) has suffered several changes in the last decades (*e.g.* Alcaraz et al., 2011; Ibáñez et al., 2012; Rovira et al., 2012); consequently, present river flow (425 m^3/s) is *ca*. 30 % lower than originally, and environmental variability is modulated by the presence of about 200 large dams. Furthermore, both the intensification of human activities and sediment retention into the reservoirs led to an increase of nutrients until the 90s, but, during the last 30 years, the significant decrease in dissolved phosphorus caused an ecosystem shift from phytoplankton to a macrophyte-dominated system. The Ebro River (*i.e.* nutrient inputs) supports a high diversity of ecosystems and socio-economic activities such as agriculture, tourism, aquaculture, and fisheries. The aim of this study is to analyse the effect of the Ebro River (*e.g.* nutrients concentration and flow) and meteorological processes (e.g. rainfall, storms, temperature) on fish landings from waters surrounding the Ebro River. Hydrological, water quality, and meteorological data were obtained from the Ebro Water Authority (CHE) and the Tortosa meteorological station; and fish landings were collected from the Catalan Government. We collected information of fish landings from the five main ports of the surrounding waters of the Ebro River and differentiated by fishing methods (small-scale, towed gears and encircling nets). Our analysis showed a clear evidence of the influence of riverine nutrient enrichment and meteorological process on total fish landings, for the three fishing gears considered. River effects on fish landings are important in oligotrophic seas such as the Mediterranean (Lloret et al., 2004), while meteorological processes such as wind and storms promote the productivity of surface layers by mixing and upwelling. Our results constitute a contribution to better understanding of key aspects of Mediterranean fisheries, and to develop management strategies for preserving fish stocks.

Key words: Nutrients, Phosphorous, Flow, Mediterranean Fisheries, GLM

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ADVANCING COASTAL HABITAT MAPPING: INTEGRATING AERIAL, SURFACE AND UNDERWATER REMOTE VEHICLES

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Abstract:
With marine ecosystems across the globe in peril, there is a growing urgent need to better understand spatial patterns and possible factors shaping and conditioning habitat distribution. Similarly, spatially explicit data on biodiversity and habitats is crucial for marine spatial planning (MSP), marine conservation and marine resources management. Towards this goal, coastal monitoring programs and studies must deliver information on a range of variables and factors, from taxonomic/functional diversity and spatial distribution of habitats to anthropogenic stress indicators such as land use, coastal development, fisheries use, and pollution. Effective monitoring programs must therefore integrate observations from different sources and spatial scales to provide a comprehensive view to managers. Here we explore integrating aerial, surface and underwater remote vehicles to enhance data collected by scientific divers and sampling to enhance habitat and biotope mapping in coastal areas. Leveraging commercial off the shelf and open-source technologies, these integrated approaches enable to combine physiographic habitat assessments and biological data and observations to: i) classify habitats; ii) identify distinct organism assemblages; and iii) predict their distribution, produce maps and other spatial data. We then further discuss the applications of the spatially explicit data produced and included on GIS systems, ranging from management and MSP to detecting underlying ecological mechanisms shaping taxa distribution to predicting responses to climate change.

Key words: Marine Technology, remote sensing, habitat mapping, marine spatial planning, oceanic islands, distribution modeling

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A NEW THEORETICAL ENGAGEMENT MODEL FOR CITIZEN SCIENCE PROJECTS: USING ENABLERS TO OVERCOME LONG TERM PUBLIC ENGAGEMENT CHALLENGES

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Abstract: To date, despite the global acceptance of the need for effective citizen engagement as one of the most important steps for the success of citizen science programs, there is a lack of a common theoretical framework for recruitment and most projects rely on intuition or trial and error to develop their engagement strategies. Effective citizen science engagement needs theoretical models of participation and the concurrent action of different actors to implement the model. Besides, citizen observatories are evolving towards infrastructures with technical but also social components to ensure long-term engagement. We have developed and tested an engagement model for citizen science projects using a novel approach that combines different strategies and theoretical models that have been proven efficient in other disciplines such as human behaviour change and persuasion. Our model is based on four pillars that are interconnected and feed each other: theoretical engagement frameworks for behavioural change (Khan et al, Fogg B., Eyal, Yardley et al, Crall et al); social design for citizen observatories (Yamakami); strategies for maintaining volunteer motivation (Ryan and Deci, Stukas et al); and strategies to increment the ability of volunteers (Cigliano et al). The proposed model integrates all the actors of the Quintuple Helix framework of Innovation (Salmon et al, Carayannis et al): the academic community (that provides the data curation and a technological support though a citizen observatory), an enabling community formed by the government and the industry (that facilitate access to a local community and provide field support to overcome participatory barriers), the citizens providing the data, and the natural and social environment. Specifically, we have implemented and tested this model and we provide a case study of a marine citizen science project that monitors urban beaches since 2018: UrbamarBIO. Furthermore, together with the proposed model, we provide specific tools that will help managers to design tailored strategies to overcome the specific engagement challenges of their citizen science project.

Key words: Volunteers' recruitment, citizen science engagement, citizen engagement model, Participatory engagement models

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SEDIMENTARY FACIES AND STRATIGRAPHY OF A SUBMARINE MINE TAILINGS DEPOSIT IN PORTMÁN BAY, MURCIA, SPAIN

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Abstract: Industrial-scale mining produces large amounts of waste often containing potentially toxic components such as heavy metals. Portmán Bay, in Murcia, SE of Spain, was used since 1957 to 1990 as mine tailings disposal site from open pit sulphide exploitation in Sierra Minera de Cartagena, located at short distance from shore. It is estimated that during this period about 60 million tons of Pb-Zn mining waste accumulated, filling the bay while leading to a major environmental impact, including sealing of the natural seabed. A multiproxy analysis of 28 sediment gravity cores up to 4.3 m long — totalling more than 60 m of record — by means of innovative non-destructive techniques allowed characterizing the physicochemical properties of the submarine extension of the dumped materials. Our main objective was to identify the internal variability of the deposit in terms of properties from where to establish sedimentary facies. As a result, the combined assessment of physical properties and geochemical proxies, including the distinction of geogenic and anthropogenic elements, led to the recognition of eight sedimentary facies, which have been grouped in four stratigraphic units defining the internal configuration of the tailings deposit. From bottom to top these are: Unit 1 formed by Facies 1 corresponding to pre-dumping natural sediments; Unit 2 formed by Facies 2, which is of transitional character as it marks the onset of tailings disposal; Unit 3 encompassing facies 3 to 6 that represent the bulk of the tailings deposit with high concentrations of heavy metals; and Unit 4 including facies 7 and 8 made of reworked tailings and post-dumping deposits, which are indicative of the establishment of a new sedimentation states.

Key words: Mine tailings, Physicochemical properties, Sedimentary facies, Stratigraphy, Portmán Bay

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THE TRANSFORMATION OF PORTMÁN BAY AND NEARBY CONTINENTAL SHELF IN JUST THREE DECADES BY THE ACCUMULATION OF MINE WASTES

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Abstract: Ore extraction and treatment produce wastes that most often are disposed in natural depressions or artificial land-fills close to mining sites inland (Dold, 2014). Seafloor disposal has been viewed as a cheap option with barely visible impacts. However, countless cases of severe environmental impacts are known (Koski, 2012). In Murcia's Sierra Minera de Cartagena, SE of Spain, large scale mining of Pb-Zn ores from 1957 to 1990 resulted in about 60 million tons of wastes that were dumped into Portmán Bay and spread over the nearby continental shelf. The infilling bay experienced a 600 m seaward shoreline shift and the natural seabed was sealed over a large area. Here we reconstruct the succession of events and involved processes in the Portmán Bay area from pre-dumping to present times. Such a reconstruction relies on: (i) a set of historical aerial photographs from 1956 to 2019; (ii) the current subaerial and submarine morphology of the area; and (iii) the characteristics and distribution of sedimentary facies and stratigraphic units in the submarine extension of the mine tailings deposit, including pre-, syn- and post-dumping materials. The reconstruction also brings light on the suffocation process leading to the local extinction of *Posidonia oceanica*, previously forming healthy and extensive meadows, as testified by widespread leave and fiber remnants in the investigated records. This research exemplifies the benefits of multidisciplinarity in the study of coastal areas subject to severe anthropogenic impacts.

Key words: Mine waste, Historical reconstruction, Environmental impact, Suffocation, *Posidonia oceanica*, Portmán Bay

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LA ESFINGE PALEONTOLOGICAL SITE (GRAN CANARIA). NEW CONTRIBUTIONS FOR A BETTER KNOWLEDGE OF THE EASTERN CANARIES PALEOCLIMATIC HISTORY

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Abstract: Pliocene marine deposits are widely represented in the Eastern Canary Islands. They are present at varied elevations in Gran Canaria, Fuerteventura and Lanzarote Islands, with characteristic sedimentary facies and a number of fossil species, standing out among them: *Grypahea virleti (Deshayes, 1832), Nerita emiliana* (Mayer, 1872), *Persististrombus coronatus* (Defrance, 1827), *Siderastraea miocenica* (Osasco, 1897), *Isognomon soldanii* (Deshyes, 1836), *Clypeaster altus* (Lamark, 1816) and *Otodus megalodon* (Agassiz, 1843).

The La Esfinge site, at La Isleta, NE Gran Canaria, shows a complex geological succession with, bottom to top: Pliocene submarine lavas in the form of pillow lavas and hyaloclastite, dated ca. 4.2 Myr (Meco et al., 2015); Pliocene sandy sedimentary beds bearing abundant marine fossil fauna; and Pleistocene lava flows and pyroclasts (Figure1). A new stratigraphic section has been done, 6 strata has been drawn and 42 different taxa has been classified. It is specially outstanding the presence of a sedimentary bed with a huge number of *Lutraria oblonga* (Gmelin, 1791) which are in life position and a sedimentary bed bearing (Bronn, 1860), a planktonic gastropod (Meco et al., 2016; Almenara Perera, 2021).

Key words: Pliocene, marine sediments, Gran Canaria, *Lutraria lutraria, Janthina typica*

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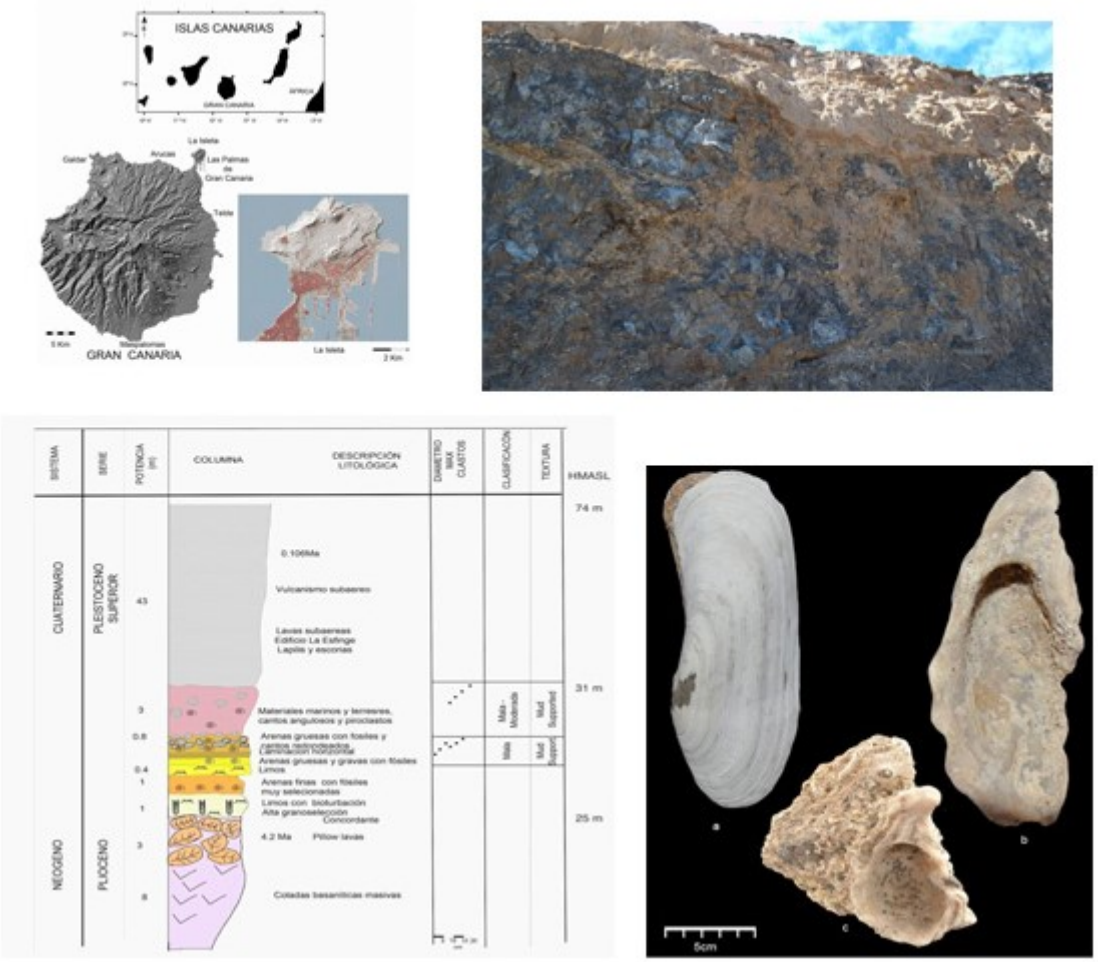


Figure 1. Location, view and stratigraphic section of La Esfinge, La Isleta, Gran Canaria. a.- *Lutraria oblonga* (Gmelin, 1791), b.- *Gryphaea virleti* (Deshayes, 1832).

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GEOLOGICAL MATERIALS, MORPHOLOGIES AND STRUCTURES IN THE COAST OF GÁLDAR (NW OF GRAN CANARIA): COASTAL GEOROUTE, INCORPORATING AN INCLUSIVE ONE IN SARDINA DEL NORTE

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Abstract: The coastline of Gáldar municipality, NW of Gran Canaria Island, is about 24 km in length, comprising a volcanic and rocky littoral characterised by cliffs tens of meters high, coastal platforms, caves, erosive remains, and occasional pebble and sand beaches (Balcells et al., 1990). These materials, geoforms and structures are mainly related to both strombolian volcanic eruptions from the plio-quaternary Post-Roque Nublo magmatic cycle (e.g.: mafic and ultramafic lava flows, pyroclastic cones, fall pyroclastic deposits, dikes) and to erosive features from sea abrasion and nearby ravines. The proposed coastal georoute is divided into 3 stages of about 8 km each, along trails and dirt tracks, with more than 20 viewpoints and sites of geological relevance: (i) Juncal beach - Sardina bay, (ii) Sardina bay - Bocabarranco beach, and (iii) Bocabarranco beach - Caleta de Arriba. This georoute offers geoscientific, didactic, and cultural interest for research community, different teaching cycles, geotourism and public in general, since its location has hardly been studied. Likewise, an inclusive route for people with physical disabilities (i.e.: visual impairment and reduced mobility) has been proposed in the bay of Sardina del Norte, due to its great accessibility and variety of natural and cultural heritage. This work is basic for future strategies of geoconservation, scientific diffusion and coastal management. Aside from several geoheritage investigations carried out on Gran Canaria Island, yet this is the first work on the subject for this municipality.

Key words: Geoheritage, Georoute, Inclusive route, Plio-quaternary strombolian vulcanism, NW of Gran Canaria

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COMPARATIVE STUDY THROUGH MATHEMATICAL MORPHOLOGY OF TECTONIC DEFORMATION IN THE SOUTH OF THE IBERIAN PENINSULA: CABONERAS OFFSHORE FAULT

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The use of the fractal dimension (Hausdorff, 1919) as a method for classifying geological faults began in the 1980s with the work of Okubo, Paul G., Aki, & Keiiti, (1987). Since then, this method has been widely used in Geology and Seismology, making it possible to establish fractal dimension limits for each level of seismic hazard. Some examples are the works of: Silva, (1996); Toro Salas, Murcia Duran, & Domínguez Cajeli, (2007).
Starting from this basis, a new methodology based on the application of Mathematical Morphology tools is proposed that allows cleaning the data set of those unwanted before calculating the Fractal Dimension. With this, it is possible to isolate the structures of interest and not confuse them with other types of deformations. To apply this methodology, topo-bathymetric data from the Alboran Sea obtained from the bathymetry portal of European Marine Observation and Data Network (EMODnet, 2020) have been used.
With the data obtained, a comparative study of the tectonic deformation to the south of the Iberian Peninsula on the Carboneras Offshore fault has been carried out, taking as a reference the data provided by Moreno, et al., (2016) and the National Geographic Institute, (2015).
After analyzing the results, it has been concluded that the extraction of the fault skeletons obtained from the bathymetric data fits adequately with the reference data. On the other hand, obtaining the fractal dimension of faults and their segments has been useful in relating said fault to the seismic hazard of its zone of influence.

Key words: Fractal dimension, Mathematical Morphology, Tectonic deformation

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VIII International Symposium on Marine Sciences 2022 (ISMS)
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ANTHROPOGENIC IMPACTS STUDIES BASED ON SPATIAL TOOLS ON THE COAST OF SMALL ISLANDS

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Abstract: Over the last 50 years, global environmental issues have been getting more attention from governments and the public in general. Human activities have altered the coastal ecosystems services, such as carbon capture and storage, water and energy exchange or biodiversity, leading the modification of environmental balance of the planet and damaging the livelihoods and economic activity of local communities. Those problems have been exacerbated in territories with fragile ecosystems or closed systems, such as small islands marine-terrestrial ecosystems, where the intrusion of entropies generates serious damage to the ecosystemic stability, affecting directly to the maritime and terrestrial coastal environments and their inhabitants. This systematic review analyses studies focused on anthropogenic impacts on small island coastal environments at a global level. Based on keywords, 507 peer reviewed articles related to anthropogenic impacts on small islands for the period between 1985 and 2021 were found and classified. This review have paid special attention to the use of geographic information systems and remote sensing for obtaining and processing coastal management tools. Exclusively, the 32 % of the studies have used spatial tools, showing a generalised deficit at a regional level. Furthermore, the use of stochastic, predictive or simulation models associated with studies focused on the characterization of impacts was analysed. The use of spatial tools helps to evaluate the socioeconomics and environmental impacts of different environmental problems, being an accurate and low-cost tool. Nevertheless, the study of coastal environmental problems on small islands may need to deep the use of those tools for improving their diagnosis and remediation actions.

Key words: Small Island, Coastal environment, geographical information system, remote sensing.

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CHANGES IN THE SUBMERGED DELTA OF THE RIVER TURIA (VALENCIA, SPAIN) FROM THE NINETEENTH CENTURY TO THE PRESENT

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Abstract:
The submerged delta of the River Turia constitutes a detrital sedimentary formation created by the deposits of the river during the Holocene, on an inner shelf subjected to subsidence processes and superposition of levels (Carmona, 1990). Today, it is a river with a moderate flow, mainly due to its use for crop irrigation; in previous centuries it was characterized by occasional flooding in response to intense rainfall events (Carmona and Ruiz, 2000). In 1957 an episode of overflow caused serious economic losses and loss of life that led to the diversion of the river south of the city (Portugués, 2017). This, together with the expansion of the harbour of Valencia, produced a major disturbance in the sedimentary dynamics in the area. Hence, the main objective of this study is to analyse the impact of the 1957 flood in the submerged Turia delta. To this end, three nautical charts from the years 1878, 1961 and 1988 of the Hydrographic Institute of la Marina were georeferenced, with Mean Square Errors of 13.34, 9.98 and 4.5, respectively which were reduced using RGB orthophotos of the years 1956 and 2000, obtained from the Institut Cartogràfic Valencià. In addition, a present-day map of the harbour of Valencia was georeferenced and a present-day bathymetry was obtained. As a result, four bathymetries are available for use in order to carry out comparisons between centuries. This process is achieved through the generation of a Digital Elevation Model (DEM) for each chart and its raster analytics through ArcGIS desktop 10.7. The results indicate that the new Turia channel has generated a displacement of the fluvial sedimentation, and that the expansion of the harbour of Valencia has substantially modified the position and sediment thickness of the submerged delta.

Key words: Submerged delta, Bathymetry, Turia River, Digital Elevation Model (DEM), Geographic Information System (GIS)

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FIRST DIRECT HYDROTHERMAL HEAT FLUX MEASUREMENTS AT TAGORO SUBMARINE VOLCANO, EL HIERRO ISLAND: PRELIMINARY RESULTS

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Abstract: Tagoro is one of the few worldwide submarine volcanoes that satisfies the following features: i) is an intraplate and shallow-water volcano; ii) comprises diffuse low-temperature hydrothermal fields; and iii) its physical-chemical and biological characteristics that have been monitored since its first eruption in 2011 (Fraile-Nuez et al., 2018). Despite a decade of widespread investigation, there is still a gap of knowledge on Tagoro volcano hydrothermal system. Hence, this preliminary research aims to report a precise estimation on the amount and distribution of hydrothermal vents, as well as an estimative quantification of the heat fluxes associated therein.

The hydrothermal vents distribution was determined through video imagery recorded by the Remote Operated Vehicle (ROV) Liropus-2000 during oceanographic expeditions in March and November of 2018 on board the *R/V Ángeles Alvariño*. Moreover, fluid flow velocities were estimated using a previously proposed sampling technique involving a custom-built particle-tracker device, designed to be manipulated by ROV Liropus-2000 on the hydrothermal areas (Sarrazin et al., 2009; Germanovich et al., 2015). This device was deployed during oceanographic cruises in October of 2021 and February of 2022 on board the *R/V Ángeles Alvariño*.

Preliminary results highlight the remarkably vast richness and complexity of the Tagoro hydrothermal system, which is mainly distributed in the main crater and secondary cone. Covering an area of more than 3000 m^2, the system is composed of over 3000 vents of various morphologies including diffuse-discharge fields, crevices and very fragile chimney-like vents. Additionally, hydrothermal fluid velocities at substratum level were estimated to be, on average, approximately 1 mms^{-1} with a heat flux exceeding 150 MWs^{-1}. This comprehensive study contributes to the broadening knowledge of the magnitude of hydrothermal activity at Tagoro submarine volcano and builds a reference for further studies.

Key words: heat flux, hydrothermal vents, particle-tracker device, Tagoro submarine volcano, El Hierro island.

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SEAFLOOR CHANGES RELATED TO THE DELTA LAVA FRONTS GROWTH OF LA PALMA ISLAND (ERUPTION OF 2021)

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Abstract: On September 19th, 2021, a volcanic eruption began on the island of La Palma. The lava flows reached the western shores of this island on September 28th at 23:00 UTC and formed a southern lava delta attached to the northern part of the lava delta generated during the 1949´s eruption and a second delta located to the south of Tazacorte port. To control the changes caused on the seabed by the lava flows, it has carried out four oceanographic cruises, three during the eruption and one when it was finished, VULCANA-III-LP- 0921 on board the RV Ramón Margalef and VULCANA-III-EH-LP-1021, VULCANA-III-LP-1221 and VULCANA-III-0222 on board the RV Angeles Alvariño, during which high resolution multibeam bathymetric data were acquired with EM710 echosounders. First, a bathymetric survey was carried out in the probable arrival zone to the sea of lava flows to establish the pre-eruption characteristics of the seafloor. This first study has served as the base for determining the changes caused by the arrival of lava flows on the seabed. Mainly, the deep part of the lava flows emplacement on the shelf and slope of the island has been studied. It was observed that these materials advanced along the seabed both as block flows (aa) and as pillow lavas flows (pahoehoe), preferentially occupying the insular shelf and filling in a series of previous submarine gullies on the slope. The southern and northern subaerial surface of the lava deltas extend along 43 ha and 5.4 ha, respectively. On the seafloor, new volcanic materials have been located at least to a depth of 300 m at 1.2 km far from the initial shoreline, occupying an estimated area of 30 ha. A thickness of up to 40 m has been measured inside the gullies.

Key words: seafloor geomorphology, lava delta,

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VIII International Symposium on Marine Sciences 2022 (ISMS)
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CARBONATE AVAILABILITY FOR BIOGENIC CALCIFICATION IN THE STRAIT OF GIBRALTAR IN A FUTURE HIGH CO_2 OCEAN

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Abstract:

The oceanic uptake of atmospheric CO_2 is driving changes in seawater chemistry that result in the decrease of pH and the concentration of the carbonate ion, which is essential for marine calcifiers. This reduction lowers the saturation state (Ω) for calcium carbonate minerals (aragonite and calcite) in the ocean. When the concentration of these minerals changes from over saturation ($\Omega>1$) to undersaturation ($\Omega<1$), biogenic calcification is not supported, with severe impacts on marine biodiversity and ecosystem functioning. This study examines temporal trends of $\Omega_{Aragonite}$ and $\Omega_{Calcite}$ in three water masses that exchange in the Strait of Gibraltar: North Atlantic Central Water (NACW), Levantine Intermediate Water (LIW) and Western Mediterranean Deep Water (WMDW) using accurate measurements of carbon system parameters collected from 2005-2021. Our analysis shows a gradual temporal decline in Ω in all water masses, with decreasing trends being more and less pronounced in the NACW and LIW, respectively. Estimated long-term changes of Ω for future increases in atmospheric CO_2 under the business-as-usual scenario indicate that critical conditions for calcifiers will be reached in the region before 2100, with a corrosive environment (undersaturation of carbonate) expected within the next 200 years.

Keywords:

- Aragonite
- Calcite
- Ocean acidification
- Saturation state
- Strait of Gibraltar

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METALLIC STUDY OF THE INVASIVE SPECIES *Cronius ruber*. ASSESSMENT OF TOXIC RISK.

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Abstract:

Three types of toxic heavy metals (Cd, Pb and Hg) were analyzed in the new invasive species present in the Canary Islands, *Cronius ruber*. The high growth rate it presents and its wide variety in terms of its diet is a problem for the canarian marine ecosystem. The study was carried out by Electrothermal Vaporization Atomic Absorption Spectrometry (GF-AAS) and Cold Vapor Atomic Absorption Spectrophotometry (CV-AAS). Significant differences were found regarding the factors of location and gender. In the case of Cd in muscle tissue, depending on the location and sex of the specimens, The females present in El Pajar presented significant differences (0.008±0.006 mg/kg), having a higher concentration of this metal in their tissue, compared to males from the same locality (0.002±0.001 mg/kg) with males (0.001 ±0.001 mg/kg) and females (0.004±0.003 mg/kg) of Agaete. On the other hand, it determined that the intake of this animal does not pose any toxic risk to public health. Also, the levels obtained in the muscle tissue of this species do not exceed the established metal limits. In such a way, that its consumption together with other activities that can be carried out by an outpost can help control the proliferation of this species on the canary coasts.

Key words: Heavy metals, Cronius ruber, Invasive species, GF-AAS, CV-AAS

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IDENTIFICATION OF PHENOLIC COMPOUNDS EXUDED BY *Emiliania huxleyi* UNDER ACIDIFICATION CONDITIONS

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Abstract: Extracellular phenolic compounds released by *Emiliania huxleyi* cultured under four different pH (8.25, 8.1; 7.9 and 7.75) were identified (Samperio-Ramos et al., 2017). Therefore, samples of seawater enriched with exudates (700 mL) were passed through cartridges Chromabon Easy (Macherey-Nagel, 500 mg). The retained analytes were eluted with MeOH (5 mL), which was evaporated to dryness, and dissolved in MeOH (300 µL) (Rico et al., 2013). Chromatographic analysis was performed with a Jasco LC-4000 HPLC, a Varian C18 column (250 mm × 4.6 mm, 5 µm), and eluents Milli-Q water with 0.1% formic acid (A) and methanol (B). The elution conditions were: 0–5 min, 80% A isocratic; 5–30 min, linear gradient from 80% to 40% A. Simultaneous monitoring for quantification was set at 270 nm (gallic acid, protocatechuic acid, catechin, vanillic acid, rutin, epicatechin, and syringic acid) and 324 nm (gentisic acid, coumaric acid, and ferulic acid) (Santiago-Díaz et al., 2021). Gallic, protocatechuic, vanillic and syringic acids were detected over the limits of quantification. Syringic acid was identified in all samples and vanillic acid was only detected in cells cultured at pH 8.25 and 8.1. Protocatechuic acid was the most abundant compound at pH 7.75 and 8.25 (6.75 and 4.65 µg mL^{-1} respectively), and syringic acid at pH 8.1 and 7.9 (2.08 and 1.85 µg mL^{-1} respectively). The total content of these four compounds was higher at pH 7.75, followed by pH 8.25, 8.1 and 7.9 (8.73, 8.09, 3.15 and 2.99 µg mL^{-1} respectively). The highest productivity per cell was attained at pH 7.75, followed by pH 8.25 (1.43×10^{-8} and 1.22×10^{-8} µg $cell^{-1}$ respectively).

The exudates reducing power, expressed as neutralization percentage of 1,1-diphenyl-2-picrylhydrazyl radical (Bondet et al., 1997), were 18.2, 18.7, 23.2, and 40.2% at pH 7.75, 8.25, 8.10, and 7.9 respectively.

Acidification conditions affect the amount, composition and antioxidant activity of *Emiliania huxleyi* exudate.

Key words: Seawater, *Emiliania huxleyi* exudate, phenolic compounds, reducing power, solid phase extraction, HPLC

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AN R PACKAGE IMPLEMENTING KNOWN-BIOMASS PRODUCTION MODELS CONSIDERING ENVIRONMENTAL EFFECTS

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Abstract: Living marine resources inhabit complex ecosystems, influenced by multiple physical, environmental, anthropogenic and biotic drivers that operate and interact at multiple scales that can result in non-linear or abrupt responses to disturbances. Different assessment models can be used to assess the state of marine resources and how the complexity of the ecosystem affects their dynamics. However, most of them ignore it by focusing on assessing the stocks of individual species and not considering the different environmental effects and biological interactions. As an alternative to traditional models is the so called known-biomass production models (KBPMs, MacCall, 2002), which provide a useful and simple tool to consider that the overall productivity responds nonlinearly to multiple drivers related to climatic, anthropogenic factors, and ecological influences. In particular, KBPMs can detect whether or not there have been regime shifts in a stock and if they are related to environmental factors. Moreover, they can assess a species community dynamic by aggregating biomass and catch of all species together.
In spite of the useful applications of KBPMs, very few studies implemented this approach in practice, probably due to the unavailability of a software implementing this methodology. For this reason, we have development a package (called KBPM) in the R software implementing KBPMs and including their practical utilities as the possibility to include environmental effects in the stock dynamics. The R package is available on https://github.com/IMPRESSPROJECT.
The package allows different utilities such as: (1) estimating the surplus production function, (2) performing retrospective analysis to identify possible regime shifts, (3) evaluating relationships between productivity and environmental variables, and (4) fit a multispecies KBPM. The use of these functions is illustrated by the example of the European hake (*Merluccius merluccius*) and its two stocks in the ICES (International Council for the Exploration of the Sea) divisions.
Our R package allows the scientific community to discover the possibilities offered by KBPMs.

Key words: Stock assessment model, Regime shifts, Ecosystem.

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CALCIFYING STRUCTURE OF THE SEA URCHIN *Arbacia lixula* LIVING AT CO_2 VENTS

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Abstract: Ocean acidification (OA) has important repercussions on the physiological and ecological functions of marine animals, especially calcifying species such as sea urchins, and is therefore considered one of the major threat to marine life (Byrne & Hernández, 2020). This study aims to determine the effects of OA on the black sea urchin *Arbacia lixula* using a long-term natural experiment, the CO_2 vent system off the coast of Fuencaliente on the island of La Palma (Canary Islands). In this area, there is a large tide-dependent pH fluctuation, with the pH dropping to 7.2 units at the point of emission (González-Delgado et al., 2021). In addition, these emissions generate a natural pH gradient in the surroundings, comparable to the scenarios predicted by the IPCC in the future due to climate change (IPCC, 2021). A total of 108 individuals of *A. lixula* were collected by snorkelling between 2 and 5 m depth to study the external morphometry of its skeleton and the Aristotle's lantern, the fracture force and its mineralogy following this pH gradient. It was observed that in the pH zone with the highest fluctuation, sea urchins had a smaller body size and Aristotle's lantern, but showed a more fracture resistant skeleton. Also, they have a slightly higher percentage of Mg in the calcite of the skeleton and lantern. These results have shown how these natural laboratories, analogues of future oceans, are essential to understand the real consequences of acidification on calcareous organisms.

Key words: Ocean Acidification, *Arbacia lixula*, calcified structures, CO_2 vent.

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PALEOGEOGRAPHIC RECONSTRUCTION OF THE CANARY ISLANDS DURING THE LAST GLACIAL MAXIMUM

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Abstract: The aim of this study, based on a dissemination paper by Lomoschitz (2022, in press), is to show the paleogeography of the Canary Islands when the Last Glacial Maximum (LGM) occurred, 21,000 years ago. At this time, Europe, North America and North Africa reached the coolest temperatures ever recorded.
Nevertheless, the last glacial period ranges between 70,000 and 12,000 BP (BP: before present) and it was the longest glaciation period in the Quaternary. Moreover, the oldest prehistoric paintings in European caves also coincide with this period. But, what type of consequences had this period on the Canaries? And what type of evidence could we get?
A number of geologic evidence indicate that each glacial period was followed by a significant sea level drop, due to the freezing of a huge volume of water from the hydrosphere. More specifically, during the LGM a mean sea level drop of -120 m occurred. This drop is evidenced at the submarine volcanic tube of Corona volcano, NE Lanzarote, dated 21+/- 0.6 kyr (Carracedo et al., 2003).
On a DTM (Digital Terrain Model) of the Canarian archipelago topography we have drawn the -120 m contour on each island. We could then measure the emerged areas at that time (i.e. 21,000 years ago) in the form of Surface increase (ΔS), area (km^2) and percentage increase (Δ%).
The last glacial period produced a significant increase of the emerged surfaces on the coast areas of the Canaries, in the form of erosion platforms. They reached a percentage increase of 45% on average, with an extension of 11,154 km^2 instead of the 7,447 km^2 of the current islands. According to previous studies on Gran Canaria Island (Sánchez et al., 2017, Montoya et al., 2017) we suggest that such island platforms could be covered by sediments, conforming extensive sandy beaches with some gravel accumulations.

Key words: Last Glacial Maximum, Paleogeography, Canary Islands, erosive platform.

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ANALYSIS OF THE EFFECTS OF CLIMATE CHANGE ON THE ECOSYSTEM SERVICES IN LOS LANCES NATURAL PLACE, TARIFA.

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ABSTRACT

Ecosystem Services are assets that the society obtains as benefits and products from nature. Climate change is one of the main impacts ecosystems will face in the coming decades, modifying their capacities to generate services.

In this project, an analysis of the ecosystem services in Los Lances Beach Natural place in the municipality of Tarifa (Spain) has been carried out in relation to the effects of climate change. Therefore, the ecosystems present in that area have been studied, namely forest, wetlands, beaches and dunes, and the specific services (providing, regulating and cultural services) that these ecosystems offer have also been identified applying the Common International Classification of Ecosystem Services (CICES). An assessment of the ecosystem services state to determine which ones are the most exposed and which the most vulnerable to the climate change effects and its possible trends through a coastal risk detection tool from the *Climate Central* organization.

The results showed that beaches and wetlands are the most affected of the ecosystems identified in the area. Most of the ecosystem services showed a negative trend, answering with floodings to the mean sea level rise trend predicted for the year 2050. The most affected are the cultural and regulating services, which are the most associated with the climate change phenomenon. However, the opposite situation occurs in provisioning services, which depending on the service and ecosystem do not record such a pronounced negative trend due to the protection of the study area.

The effects of climate change, especially the rise in mean sea level, are related to the loss and degradation of marine ecosystems and the services they provide.

Key words: Playa de Los Lances, Ecosystem Services, Climate Change, Evaluation of Ecosystems, Human Well-being.

EFFECT OF SALINITY AND TEMPERATURE ON THE GROWTH OF MARINE MICROALGAE

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Abstract: Global Climate Change (GCC) constitutes a complex challenge posing a serious threat to biodiversity and ecosystems in the next decades. There are currently numerous studies dealing with the potential effect of increased temperature, shifts in salinity, and cascading events of GCC and their impact on human-environment systems. Microalgae, as primary producers, are an example of marine ecosystems which are highly suitable biological indicators of such changes. Thus, in this study, we investigated the effects related to the combination of potential future changes in temperature and salinity on microalgae. A laboratory experiment was performed using a marine diatom (*Chaetoceros gacilis*), a cyanobacteria (*Synechococcus* sp.) and a cryptophyte (*Rhodomonas baltica*), in single and mixed cultures. Populations of this species were exposed during 96 h to a two-factor experimental design (3 × 3) tree levels of temperature (20, 23 and 26°C), and tree levels of salinity (33, 36 and 39 psu). Effects on growth were studied using flow cytometry (cell density and changes in cell size). Maximum photochemical efficiency (Fv/Fm), chlorophyll content and ROS production were also determined. The results indicated that in mixed culture all these species examined exhibited different growth responses in the salinities used. Maximal photochemical efficiency of PSII (F_v/F_m) decreased significantly at high temperatures and salinities stresses. Total chlorophyll content of the algal species increases as the temperature decreased.

Key words: Microalgae, Flow cytometry, growth, temperature, Salinity. Climate change

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WAVE ENERGY CLASSIFICATION IN THE BAY OF BISCAY IN A CLIMATE CHANGE CONTEXT

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Abstract: Marine renewable energies are a key asset to fight global warming. Among these, the study of wave energy is of major interest in order to be able to exploit it in a close future. When it comes about determining where to install Wave Energy Converters (WECs), it would be reductive to only consider areas of high wave power. There are more aspects to examine like variability of this wave power, risk, and economic cost of these WECs. Thus, following the work of Ribeiro et al. (2021), it has been applied a Delphi method using seven indexes: mean wave power, temporal and monthly variability, downtime (percentage of time the WEC does not operate due to too small or too high waves), risk (annual higher wave), water depth and distance to coast. These seven indexes are given a weight and mixed into a unique index which permits to easily classify the wave energy resource of any area. Since waves are generated by wind, wind data are needed to provide wave power data. Thus, historical and future (simulated under the RCP8.5 scenario) wind data have been converted to wave power data through the SWAN model of WAVEWATCH III simulations. The mean wave power in the Bay of Biscay is expected to decline by the end of the century. Also, this decrease would be less important in winter than for other seasons and thus would increase the variability. Nevertheless, for the 2026-2045 period, the main part of the Bay of Biscay would be characterized as "excellent", with some areas even characterized "outstanding", according to the wave energy classification that has been made.

Keywords: wave energy, Delphi method, resource classification, global warming, Bay of Biscay.

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SHORT-TERM MACROALGAL COMMUNITY SHIFT TRENDS IN SOUTHERN BAY OF BISCAY

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Abstract: Global climate change and the numerous ecological consequences of human development are shifting biological communities worldwide. Thousands of species are on the move, and predictions suggest many more will do so under the multiple IPCC scenarios. Although evidence is overwhelming, there is a missing link between species distribution models' changes and expected global environmental changes to predict specific community shifts at more local scales. Using algal abundance data collected in 2015 along the southern Bay of Biscay, two reference locations from the western Mediterranean, and IPCC environmental projections, Muguerza et al. (2022) predicted canopy-forming macroalgal communities in this area would become turf-forming Mediterranean-like algal communities following an east-to-west gradient. The coldest, most western section of the Bay of Biscay could be a temporary refuge for those once dominating kelp forest communities. Here, we sampled those very same communities after four years and tested the capacity of their model to forecast short-term trends. Four years later, we found a good correlation between the observed spatial distribution and the one predicted by the model (R^2=0.548). As expected from the model, algal communities in the southern Bay of Biscay in 2019 looked more like Mediterranean algal communities in 2015. Communities in the central section of the southern Bay of Biscay showed a higher resemblance to communities in the eastern section, supporting the east-to-west gradient of "Meridionalization". The most western section remained distinct from the other locations in the southern Bay of Biscay, supporting the refuge function forecasted by the model. Our study showed evidence that a community-based model used to predict long-term changes in algal composition and abundance can produce accurate short-term responses. It also proved that benthic communities in the Bay of Biscay are losing their identity, exposing the hidden biodiversity shifts occurring in our oceans.

Key words: Climate change, Spatial model, Canopy-forming, Meridionalization

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SEASONAL VARIABILITY OF CO_2 SYSTEM AND AIR-SEA FLUXES ON THE EAST COAST OF GRAN CANARIA

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Abstract: This study describes the annual pattern, from March 2020 to April 2021, of different parameters of the CO_2 system and ocean acidification in the eastern coast of Gran Canaria Island (Gando Bay) via the monitoring of pH_T, total dissolved inorganic carbon (C_T), total alkalinity (A_T) and CO_2 fugacity (fCO_2), as well as other parameters such as sea surface salinity and temperature (SSS and SST), dissolved oxygen (O_2), chlorophyll (chl-*a*) and wind. In addition, the flux of CO_2 (FCO_2) between the atmosphere and the sea surface has been computed.

The results show a clear seasonal fCO_2 variation in seawater from 380 µatm (in winter) to 430 µatm (in summer), where the opposite behaviour was observed in pH_T with a range of variation of 8.072 to 8.032 and C_T between 2123.2 and 2101.5 µmol kg^{-1}. The thermal/non-thermal processes (ratio T/NT) affect the seasonal fCO_2 in seawater with a value of 1.38. The temperature mainly controls the variability of fCO_2 in the region, but the non-thermal factors have a higher contribution than other studies in the open ocean. Results indicate a higher role of the primary production in the area, which reduces C_T and the fCO_2. In addition, the rise of a water mass with low salinity (36.4) and temperature (22 ºC) due to the effect of high and constant Trade Winds (July and August), contribute to the physical and chemical seasonal variability in the Bay. This water mass had also higher concentrations of C_T due to the remineralization of organic matter that takes place at depth and out of the Bay.

The calculated flux of CO_2 at the buoy location was 0.27 ± 0.22 mmol m^{-2} d^{-1}, showing a mean behaviour as a slight source of CO_2. Assuming this value for all Gando Bay, it was found that the area emits 4.58 ± 3.68 Tons yr^{-1} of CO_2 each year.

This coastal time-series in the Canary Islands is contributing to improve our knowledge about the impacts of climate change in the CO_2 system and ocean acidification in coastal systems, also, incrementing the data set for the global carbon budget.

Key words: CO_2 system, CO_2 fluxes, coastal acidification, coastal time-series

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THERMAL PERFORMANCE AND VULNERABILITY TO OCEAN WARMING OF THE KEY STONE SPECIES *Paracentrotus lividus*

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Abstract

Global rising temperatures and associated extreme heat events are impacting biodiversity, currently threatening the persistence of many species. The European purple sea urchin *Paracentrotus lividus*, a key stone species vital to the structure and function of benthic marine ecosystems, has been suggested as a vulnerable species to current ocean warming in the Mediterranean. Here we experimentally quantified the thermal optimum and the critical thermal limit (CTL) of a population of *Paracentrotus lividus* in the western Mediterranean (Mallorca, Spain). We identified an optimum temperature between 24 and 27 ºC for behaviour (righting response) and metabolism (respiration), respectively. The critical thermal limit of the western Mediterranean urchin population (Spain) was 4 ºC higher than that reported previously in the eastern Mediterranean (Israel). These results suggest that the sensitivity of the sea urchin *Paracentrotus lividus* to ocean warming might be higher than previously stated.

Key words: Climate change, Ocean warming, *Paracentrotus lividus,* Thermal limit, Urchin

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THE RUBISCO-ALGARDEN PROJECT: ASSAY AND EVALUATION OF THE PRODUCTION OF NATIVE SEAWEEDS FOR CARBON SEQUESTRATION IN THE PORT OF LA LUZ - LAS PALMAS

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Abstract: In the actual scenario of Global Change, there is an increased interest in seaweeds as an efficient sink of anthropogenic carbon. The CO_2 fixation and O_2 emission through photosynthesis by algae growing in coastal ecosystems and cultivation systems, both in-land or at the open-sea, represent a significant carbon reduction of CO_2 emissions, particularly generated by industrial and port areas activities. Primary marine producers (microalgae, macroalgae and seagrasses) contribute roughly at 50% of the world's carbon fixation and can account for 71% of all carbon storage. In addition, the use of the final biomass obtained from the cultured species in the production of biofuels, biomaterials, food and/or other products, preventing the use of fossil fuels, further contribute to the carbon sink potential of these aquaculture practices.

The Canarian Strategy of Blue Economy 2021-2030 highlights the maritime port sector, which is immersed in a transformation phase marked by the reduction of greenhouse gas emissions. This requires the adoption of energy-efficient actions, the development of alternative green tech solutions such as the Cold Ironing, and the compensation of the Carbon Footprint through innovative projects acting as "carbon sinks". In this framework, the Spanish Bank of Algae (BEA) of the University of Las Palmas de Gran Canaria (ULPGC) and the Las Palmas Port Authority (APLP) are developing the RuBisCO-Algarden Project: a 15-month study to evaluate the reduction of the carbon footprint within the port area by assessing a pilot production unit of the native green seaweed *Ulva rigida* in a classical ropes cultivation system that is situated at the sea.

The RuBisCO-Algarden Project is a novel experience in the Macaronesian Region that aims to evaluate the possibilities of seaweed culture methodologies, the quantification of carbon sequestration based on the accumulation of carbon stocks in the produced biomass, and its valorisation for biofuels and agriculture applications.

Key words: Carbon sequestration, Biological productivity, Open-sea cultivation, Seaweed

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OBSERVATION NETWORK OF THE CARBON DIOXIDE SYSTEM AND OCEAN ACIDIFICATION IN THE CANARY ISLANDS

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Abstract: The observation network of the CO_2 and ocean acidification system of the Canary Islands consists of three oceanographic buoys and two VOS lines. The buoys are located in the coastal areas of Gran Canaria (Gando Bay), El Hierro (Marine Reserve) and La Graciosa (Marine Reserve). The observation lines connect Tenerife-La Gomera-La Palma on one side and Gran Canaria-Tenerife-Lanzarote-Valencia-Barcelona on the other. The buoys are included in the Global Ocean Acidification Observing Network (GOA-ON). The VOS line from Gran Canaria to Barcelona is included in the Integrated Carbon Observation System (ICOS).

The first year's data of this observation network is revealing that the coastal processes are very important in defining the coastal characterization of the CO_2 system. In this sense, the Trade Winds are contributing to the physical and chemical variability in the coastal areas. An example is that Gando Bay (Gran Canaria) is acting as a slight source of CO_2 (0.27 ± 0.22 mmol m^{-2} d^{-1}). On the other hand, the VOS line's data showed that the net annual CO_2 sink (-0.26 ± 0.04 mol C m^{-2} yr^{-1}) increased in the northwest African continental shelf (-0.48 ± 0.09 mol C m^{-2} yr^{-1}).

This observation network is producing a highly valuable CO_2 system and ocean acidification dataset. These data are necessary to understand the impact of climate change in the region, the answer of the ocean, and open new windows to the governance of the blue economy.

Keywords: CARBOCAN, Time-Series, CO2 system, Ocean Acidification

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FEEDING STUDY OF THE PORTUNID CRAB *Cronius ruber* IN THE NATURAL ENVIRONMENT THROUGH MANIPULATIVE FIELD EXPERIMENTS AND THE USE OF LIPIDIC BIOMARKERS

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Abstract: The main objective of the present study was to contribute to the knowledge of food preferences of *Cronius ruber* species, through multiple choice experiments in the natural environment in which factors such as the type of prey, size and sex of *C.ruber* were included and time and locality of experimentation. In parallel, complementary studies were carried out analyzing the profiles of lipid classes and fatty acids of specimens of this portunid crab (male and female) and of the potential prey studied *Arbacia lixula,Paracentrotus lividus*, *Taonia atomaria*, *Hermodice carunculata* and *Percnon gibbesi*, in order to understand the trophic ecology of this species in a broader way and with the help of lipid biomarkers. A preference on *P. gibbesi*, *T. atomaria* and to a lesser extent *H. carunculata* preys was observed, but no consumption was recorded on *A.lixula* and *P.lividus* species. Furthermore, differences were found between consumption rates of male and female individuals, and highest consumption rates were recorded after 24 hours of experimentation. The study of the profile of fatty acids and lipid classes of the portunid crab *C. ruber*, shows a greater correlation with the lipid composition of the prey *P.gibbesi*, *A.lixula* and to a lesser extent, *of H. carunculata* finding some essential fatty acids LC - PUFAs such as ARA, EPA and DHA, which could be considered as useful trophic bioindicators.

Key words*: Cronius ruber,* consumption rates, multiple choice, fatty acids, lipid classes, trophic biomarkers.

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STUDY OF NATURAL PREDATORS OF CRONIUS RUBER IN THE NATURAL ENVIRONMENT, AN APPROACH THROUGH MANIPULATIVE EXPERIMENTS INTHE FIELD

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Abstract: The occurrence of the portunido crab Cronius ruber in the Island of Tenerife is a phenomenon that is being appreciated since the beginning of 2016, increasing its presence and abundance gradually. This is thought to have been a result of the combination of anthropogenic activity, such as increased shipping and climate change. This study has sought to develop an effective tagging method for the development of predation studies on C. ruber in the natural environment, as well as to evaluate predation rates to which this crustacean is subjected on the coast Tenerife Island through manipulative experiments. A new tagging technique adapted to this portunid is described and successfully applied to the development of predation experiments that showed the low rate of predation that this species of crab has on the coasts off Tenerife.

Key words*: Cronius ruber*, portunid, invasive species, climatic change, and predation.

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FIRST EXPERIENCE IN GROWING *Arthrospira platensis* USING LOW ENTHALPY WATERS IN THE CANARY ISLANDS

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Abstract: The potential use of the low enthalpy geothermal water from La Florida volcanic gallery, situated in the South Tenerife (Canary Islands), were evaluated for the cultivation of *Arthrospira (Spirulina) platensis*.

La Florida gallery conditions, such as the mineral composition and constant mild temperature range (20-30ºC) of the water, as well as the possibility of using the CO_2 emissions of the gallery, support the photosynthetic performance and productivity of the cultures in a cost-effective culture system compared to conventional.

Growth of five different strains of *Spirulina*, including a native strain from Fuerteventura Island, were assayed in a new formulated culture medium to enrich the chemical composition of the geothermal water (Reduced Low Cost medium: RLC) The growth rates of the different strains cultivated in this media range from 2.3 to 3.4 d^{-1}, higher than the obtained for *Spirulina* cultivated in the ordinary growth medium (Aiba & Ogawa, 1977) modified by Schlösser (1994). Proximal analysis, pigment concentration and antioxidant activity of the biomass obtained presented promising values to be considered at the nutritional level (e.g. 71.8% of proteins). Moreover, microbiology and heavy metals analyses showed that *Spirulina* dry biomass complies with the food quality and safety regulations standards. These results demonstrate the feasibility of using the local geothermal resources for the cultivation of Spirulina to produce competitive products in an environmentally friendly system, favoring the diversification of the rural economy.

Key words: Arthrospira, low enthalpy water, CO_2, temperature

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THE EFFECT OF THE EXTRATROPICAL STORM "OPHELIA" ON THE SMALL PLANKTON DYNAMICS IN THE RÍA DE VIGO (NW SPAIN)

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Abstract: The storm "Ophelia" was an extratropical cyclone that affected Spain's far north-western region of Galicia in October 2017 with gale force winds of up to 100 km/h. The approach of such storms to the Iberian Atlantic coast is quite exceptional but some evidence points to an increase of these events in recent years. We investigated the effects of strong wind forcing on the pico- (0.2-2 µm) and nanoplankton (2-20 µm) dynamics in a semi-enclosed bay during downwelling season. For 3 weeks and every 2/3 days, environmental data (upwelling index, temperature, salinity, nitrate and chlorophyll *a*), primary production (PP) rates using the ^{14}C technique and pico- and nanoplankton biomass by flow cytometry and epifluorescence microscopy were collected. During the first half of the month, when upwelling conditions prevailed and water column was stratified, microbial plankton community was dominated by large phytoplankton (> 20 µm). From 14th of October onwards the study area was under "Ophelia" influence with persistent downwelling-favourable winds. These southerly winds triggered a downward movement of surface waters, lowering large phytoplankton biomass and PP, but also that of pico- and nanoplankton overall. Nevertheless, small plankton gained relevance during this downwelling event at expenses of the largest counterpart. Within picoplankton there was a permanent dominance of heterotrophic components (mostly bacteria) compared with autotrophic ones. By contrast, the bulk of nanoplankton biomass was autotrophic at surface but heterotrophic in slightly deeper waters. Interestingly, coinciding with Ophelia's downwelling, there was an upward trend in the biomass of heterotrophic nanoplankton at surface. Sources of this variability may be the advection of oceanic water into the ría, but also trophic interactions within the microbial community. In the context of global change, extreme events such as "Ophelia" storm could profoundly affect upwelling ecosystems productivity.

Key words: picoplankton, nanoplankton, upwelling-downwelling, NW Iberian Peninsula, Global Change.

Acknowledgments: This research was financially supported by the Spanish National Project i-SMALL (CTM2014-56119-R, MCIN).

EFFECTS OF CLIMATE CHANGE ON CARBON METABOLISM AND DISSOLVED ORGANIC CARBON FLUXES (DOC) IN *Cymodocea nodosa* COMMUNITIES FROM CADIZ BAY

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Seagrass meadows are considered one of the most valuable ecosystems on the planet in the fight against climate change, thanks to their ability to capture and store "blue carbon" (Trumper et al., 2009). They are also important producers of dissolved organic carbon (DOC), which form the second largest carbon pool in the ocean, essential for the exchange of matter and energy between organisms and ecosystems (Romera-Castillo et al., 2011; Hansell et al., 2013; Egea et al., 2019). Although the effects of climate change on these ecosystems have been well documented (Jiang et al., 2010; Doney et al., 2012; Egea et al., 2018; Trevathan-Tackett et al., 2020), its effect on the DOC release has been largely overlooked. This study aims to analyse how temperature increase and ocean acidification (OA) affect to the carbon metabolism and DOC fluxes on these important ecosystems. A factorial mesocosm experiment was performed, in which *Cymodocea nodosa* communities from Cadiz Bay were acclimated for 45 days at two levels of temperature and pH. The results showed significant differences in biomass and morphological variables, especially in treatments subjected to OA, where leaf length and photosynthetic surface area increased by 76% and 72%, respectively. The combined treatment (i.e., temperature increase and OA) showed a significant tendency to rise the carbon metabolism (gross primary production and net community production), turning more autotrophic, while DOC fluxes decreased up to 40%, respect to control treatment. Moreover, a reduction in the sediment inorganic carbon (i.e., carbonates) content was found, which could be related to the dissolution caused by OA. Therefore, in this work we have shown for the first time how climate change can alter the productivity and the DOC release in seagrass meadows, which may ultimately affect to their role as blue carbon ecosystem under future climate change conditions.

Key words: seagrass meadows, carbonates, ocean acidification, warming, blue carbon, net community production

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EFFECTS OF CLIMATE CHANGE ON THE LIPID COMPOSITION AND FATTY ACID PROFILE OF *Millepora alcicornis*, LINNAEUS, 1758.

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Abstract: Climate change has a major impact on marine ecosystems, which has implied the increase in acidification and water surface temperature in recent years. A variety of studies can be found on the effect of these climate change parameters on the physiology and dynamics of different species. However, little is known about the effects of climate change on lipid classes and fatty acid profiles of organisms. Changes in lipid composition are known as an important adaptive mechanism, as well as being a tool for understanding the trophic ecology of an ecosystem. The present study evaluated the combined effects of rising sea temperature and ocean acidification predicted for the end of the century (+5 ˚C and pH 7.5) on the fatty acid and lipid class composition of colonies of *Millepora alcicornis* from Tenerife Island. *M. alcicornis* is a tropical hydrocoral recently established in the Canary Islands. Diverse colonies were subjected to 4 treatments: control pH and temperature; low pH and high temperature; high temperature and control pH and low pH and control temperature. The results showed significant differences in fatty acid composition highlighted mainly by docosahexaenoic acid (DHA, 22:6n-3) in the interaction effect of both factors (T x pH) as well as significant differences between temperature levels in lipid class. Therefore, this study reveals that future climate change scenarios will affect *Millepora alcicornis* populations in their lipid composition, finding variation even in the biologically active long-chain (C20-24) polyunsaturated fatty acids (LC-PUFA) such as DHA, considered as a useful and physiologically relevant trophic biomarker.

Key words: Climate change**,** *Millepora alcicornis*, Fatty acids, Lipid classes, Hydrocorals

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CHANGES IN THE LIPID AND FATTY ACIDS COMPOSITION OF *Cymodocea nodosa* (UCRIA) ASCHERSON UNDER A GLOBAL CHANGE SCENARIO

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Abstract: Global warming, and, therefore, ocean warming and acidification, are emerging as some of the most critical threats to marine species worldwide. The importance of studying the combined effects of two or more stressors that can alter the performance of a particular species or community lies in its capacity to better replicate real-life conditions and offer us information that, without this approach, would have been ignored. This study analyzed the combined effects of increased temperature (+5ºC) and ocean acidification (pH 7.5) on the lipid and fatty acids composition of *Cymodocea nodosa* (Ucria) Ascherson from the Canary Islands. Four different treatments were applied for one month: control pH and temperature; low pH and high temperature; high temperature and control pH and low pH and control temperature. Total lipid extracts were obtained from 500 mg of seagrass following a modification of the methodology designed by Folch et al. (1957). Fatty acids and lipid classes analysis were carried out using a gas chromatograph equipped with a flame ionization detector (GC-FID) and a high-performance thin layer chromatography (HPTLC), respectively. Results showed significant differences between treatments and highlight the importance of pH and temperature on *C.nodosa*'s lipid metabolism. Considering the habitat-forming nature of *C. nodosa* and its major role in the food chain as a primary producer, this change in the content of some physiologically important fatty acids could have serious consequences in the future of the entire ecosystem when faced global change scenarios.

Key words: *Cymodocea nodosa*, Canary Islands, lipids, fatty acids, climate change, ocean acidification.

Acknowledgments: This study has benefited from the development of the MIMAR MAC/ 4.6. d/066 project (INTERREG MAC 2014–2020).

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FIRST CASE OF BREVETOXICOSIS LINKED TO ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*) MASS-MORTALITY EVENT IN EASTERN CENTRAL ATLANTIC OCEAN: A CLIMATE CHANGE EFFECT?

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Abstract: Climate change is influencing marine systems to a global scale, with alterations ranging from the strictly oceanographic perspective to the loss of biodiversity. As an example of these increasing disturbances, a rise of reports of Harmful algal blooms (HABs) have been notified in the last decade. These events occur when algae grow rapidly leading to a rise in production of a series of toxins that can be harmful for many species, that go from fish, shellfish, or birds to marine mammals and even humans, compromising ecosystem viability and public health as a transdisciplinary concept. Many multispecies mass-mortality events due to these toxins have been notified in the central eastern Atlantic Ocean, but no cetacean species were reportedly affected until date. During the course of one week in the spring of 2008, twelve rough-toothed dolphins (*Steno bredanensis*) appeared dead stranded or floating in the southwestern coast of Gran Canaria, in the Canary Islands, Spain. Concurrent necropsy findings were multisystemic hemorrhage and undigested material in the gastric compartments. The state of decomposition of the carcasses difficulted the pathologic examinations, but further toxicologic analysis of the gastric contents identified PbTx2 and PbTx2 brevetoxins. These results show powerful toxicopathologic proof of fatal brevetoxicosis in a group of rough-toothed dolphins. The work hereby presented documents for the first time the epidemiologic, pathologic, microbiologic and toxicologic occurrence of cetacean mass-mortalities due to brevetoxins in European waters, consistent with the global situation regarding HABs and stressing the need for further investigation and monitorization of these greatly damaging events and addressing once again the ongoing universal climate crisis.

Key words: Biotoxin, *Karenia brevis*, Harmful algal bloom, climate change, PbTx.

VULNERABILITY OF LITTORAL CULTURAL HERITAGE TO ENVIRONMENTAL AGENTS: IMPACT OF CLIMATE CHANGE (VOLICHE)

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Abstract:. the coastal zone is a system in dynamic equilibrium under the action of atmospheric and marine forcing with a high density of Cultural Heritage sites (CH). The preservation of the emerged CH (ECH) and the underwater CH (UCH) located in the littoral area must be addressed considering the particularities of the littoral environment. The natural variability of environmental conditions (physical, chemical, geochemical, biological and sedimentary), along with anthropogenic pressure could increase the degradation rates of ECH and UCH. This is especially relevant in a context of global warming due to CC, considering the severity of its effects in the littoral. VOLICHE project aims to evaluate the vulnerability of ECH and UCH to current environmental conditions and to assess the impact of CC on the in situ preservation of littoral CH evaluating the changes in the average and extreme condition of the key oceanographic variables for the UCH preservation (salinity, temperature, pH, oxygen, waves and current); and coastal hazard indicator (extreme waves sea level and extreme winds) for the ECH. Theses objectives will be achieved establishing innovative methodologies applied under a holistic perspective including the expertise of the different stakeholders and end-user. These methodologies will include the characterization of the environmental agents during the baseline period and under the climate projections (RCP4.5, RCP8.5), and the analysis of the impact of CC in the processes of degradation of CH materials. The obtained information will be integrated to generate predictive models and vulnerability indicators of UCH and ECH to quantify the effect of marine and atmospheric

agents. The results obtained will help to design a Decision Support System for CH managers, identifying higher risk areas for the littoral CH preservation, forecast its evolution and to prioritize those sites were measures must be adopted to mitigate the impact of CC in the littoral CH.

Key words: cultural heritage, climate change, numerical modeling, coastal hazards, littoral dynamics

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STORM SURGE FEATURES ASSOCIATED WITH THE SEPTEMBER 2019 ATMOSPHERIC EXTREME EVENT IN THE SPANISH MEDITERRANEAN COAST

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Abstract:
Extreme precipitation events are usually combined with storm surges over coastal areas, causing drastic destruction and losses and disable human activities both in and out of the sea. Between September 10th and 14th 2019, a heavy rain event took place in eastern Spain. The intense storm displaced from north to the south of the Spanish Mediterranean coast, affecting and damaging the south-east coast of Spain, where the highest accumulations of precipitation were reached. The present study aims to investigate the maritime conditions generated by this storm on the Mediterranean coast of Spain. For this purpose, a wave characterisation is carried out using the parameters of the wave spectrum, such as the significant height, the peak period, the mean period, and the mean wave direction from, all of them associated with the surface wind. The parameters mapping was performed using data from numerical models from CMEMS and ECMWF to recreate the storm surge. The visual description is accompanied by a validation of those wave models with in-situ data provided by oceanographic buoys of Spanish's entity *Puertos del Estado*. Numerical model by this entity, SIMAR, was added for validation. The results show a great agreement for the significant wave height variable in the different models, obtaining mostly a correlation coefficient above 0.800 and an Index of Agreement above 0.850 for most of the locations studied. Peak period and mean period data from models have a good concordance with the observation depending on the location, with similar values such as the significant wave height. The lowest agreement results are shown for the mean wave direction.

Key words: Heavy rain, storm surge, surge characterization, model verification, Western Mediterranean Sea

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SUBLETHAL EFFECTS OF MARINE HEATWAVES ON THE REPRODUCTION OF THE MEDITERRANEAN OCTOCORAL *Eunicella singularis*

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Abstract: In the last decades, marine heatwaves (MHWs) have caused massive mortalities of several sessile invertebrates in the Mediterranean Sea [1]. Since their recovery largely depends on their reproductive success [3], acquiring a better understanding of the impacts of MHWs on their reproduction remains fundamental. The white gorgonian *Eunicella singularis* (Esper, 1791), a common octocoral in the western Mediterranean [4], has been one of the most affected species by MHWs. Our study evaluates the impact of different MHWs observed in the last years over the North Catalan coast on its reproduction. The proportion of fertile polyps, the number, diameter, and gonadal volume of sexual products per polyp were estimated from samples obtained in 2021 in four localities placed at Cap de Creus and Medes Islands and were also compared to similar results obtained in 2003 [2]. Here, we show no significant differences in sex ratio and gonadal volume per polyp among localities. However, the percentage of undetermined colonies was very high, reaching more than 15% of the colonies. Fertility in male colonies was reaching 100% among localities, but in female colonies was lower and more variable between 66-86%. No significant differences in diameter and number of sexual products per polyp have been observed between males and females. However, we found a clear negative correlation between both parameters. Comparing with 2003, only significant differences were found in the number of sexual products, with a higher production observed in males while females produced less oocytes. These results suggest that: i) there are many colonies that either do not reproduce or have decreased reproductive effort, and ii) females invest more energy on producing larger oocytes while males are investing on producing more spermatocytes per polyp. These effects of climate change on the reproduction of this species may have implications for the recovery of affected populations in the long-term.

Keywords: gorgonians, Mediterranean Sea, sexual reproduction, marine heatwaves, climate change

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SEAGRASS RESTORATION (*Posidonia oceanica* (L.) Delile): EARLY SIGNS OF FISH COMMUNITY RECOVERY

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Abstract: Seagrass meadows have been identified as an essential habitat for the life cycle maintenance of many coastal fish species in the Mediterranean, through the provision of food and shelter for various life stages. Seagrass restoration actions are also aimed at recuperating these functions. This study evaluates the changes in fish community composition and nursery function within a 2 hectares area of restored *Posidonia oceanica* meadow in Pollença Bay, Majorca (Spain). Regular visual census data collection by Diver-Operated Stereo-Video (DOV) and Towed Stereo-Video (TSV) systems was performed during a 4-year period in the study area, including the restored *P. oceanica* meadow, an adjacent undisturbed meadow, and an area of a dead meadow now colonized by *Cymodocea nodosa* and *Caulerpa prolifera*. GPS data from the surface shadowing DOV and TSV position was used to be able to attain a more precise geo-location measure of each fish. We evaluate fish richness, abundance, density, and biomass by using SeaGISs EventMeasure software. Preliminary results show a significant difference in juvenile and adult fish species richness, abundance, density, and biomass of most species, between the natural *P. oceanica* meadow and the dead meadow and restored area, indicating fish prefer mature and undisturbed *P. oceanica* meadows. Differences between the dead meadow and the restored habitat are only found for some species (e.g., *Symphodus tinca* juveniles, present in the restored meadow but not in the dead meadow). However, results suggest that the time since restoration is still too short to observe any significant differences that may indicate a recovery in the fish community and the nursery function between the restored and adjacent areas. In conclusion, long-term monitoring is necessary for evaluating possible changes in habitat structure, and therefore, a recovery in the ecosystem functions for the fish community.

Key words: Seagrass meadow, Stereo-Video, Fish populations, Nursery, Restoration, Habitat structure

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ENVIRONMENTAL CONDITIONS DRIVING RHODOLITH ABUNDANCE ALONG THE WESTERN MEDITERRANEAN SEA FROM ROV OBSERVATIONS.

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Abstract: Maërl beds are ecosystem engineers occurring worldwide. They are composed by species of calcified red seaweed, coralline algae, which are found alive or dead as unattached nodules on the seabed and identified as rhodoliths. These habitats harbour a very high diversity of organisms and provide a wide variety of ecosystem services. The occurrence of the species forming rhodoliths beds is driven by environmental conditions. In this study we examine which environmental factors shape the variation in abundance of rhodoliths in four study areas along the Western Mediterranean Sea. These areas were recorded with a remoted operated vehicle (ROV) getting georeferenced video data from the seafloor. Rhodolith abundance was modelled by means of boosted-regression trees (BRT) in order to estimate the relative importance of each environmental parameter in explaining the abundance of rhodoliths. Three main factors were shared for the four stations: temperature, depth and slope. Each variable showed similar patterns across stations. Maërl habitats are very sensitive and vulnerable, threatened by a range of disturbance from anthropogenic activities to climate-driven fluctuations. Therefore, they are considered habitats with a remarkable conservation value, included in the Habitats Directive (92/43/EEC). Nevertheless, maërl habitats have received a concerning scarce attention in relation to their abundance and spatial distribution, especially in the Mediterranean Sea. In historically fished seafloors and in a climate change context, it is imperative to define the distribution and abundance of rodoliths in order to be possible to develop and implement management initiatives properly.

Key words: maërl beds, key habitat, biophysical factors, species distribution models, video monitoring

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EVALUATING DISPERSAL POTENTIAL OF *Cymodocea nodosa* PROPAGULES IN THE CONTEXT OF SEAGRASS RESTORATION

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Abstract:
The dispersal is a basic component of seagrass life cycle. It is essential in determining population connectivity as a function of the spatial scale of fragmentation. Quantifying the potential for dispersal can allow parametrization of dispersal models and offer valuable information on community ecology for management and conservation. Here we studied the dispersal potential of four types of propagules of the seagrass *Cymodocea nodosa*. An experimental evaluation of buoyancy and dispersal of seeds, seedlings, vegetative fragments and reproductive shoots was done in mesocosm facilities, in still water and under different currents. Further field experiments were conducted to test if selected propagule types are indeed relevant for species' dispersal due to their successful establishment after the dispersal phase.
Measured sedimentation rates in still water for seeds were in average 6.6 cm/s; critical resuspension current velocity (at which seeds on the sediment started moving) was 16.6 cm/s; average distance travelled by seeds in along-bottom transport was 8.31 cm, in accordance with that calculated using formula by Orth (1994). Average cotyledon length of the tested seedlings was 33 mm; the critical current velocity for along-bottom transport was 6.4 cm/s. Vegetative fragments showed extended viability in mesocosm (over 4 weeks), after which period they continued growing planted in sediment, with growth rates comparable to the fragments which were not exposed to floating. Both reproductive (N=60) and vegetative fragments (N=135) were tested in the flume tanks, exposed to current velocities from 22 to 60 cm/s. Damage observed after the exposure to current grew with increasing current velocity, but was overall maintained on lower level than has been reported for some other seagrass species, such as *Z. noltei* and *Z. marina*.
Obtained results show potential for long distance dispersal in *Cymodocea nodosa*, mostly via fragments dispersal, and their subsequent establishment.

Key words: seagrass, dispersal, *Cymodocea nodosa*, restoration.

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THE MEDITERRANEAN SEA, ONE OF THE WORLD AREAS AT HIGHEST RISK FROM CLIMATE CHANGE

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Abstract: Understanding the vulnerability of marine communities to climate change is critical should we aim to halt current biodiversity loss. As defined by the IPCC (Parry et al. 2007), the three components that determine species climate change vulnerability are a) the capacity of a species to survive environmental shifts (sensitivity), b) the actual magnitude of climate-driven change that species face (exposure), and c) the species capacity to adapt to or avoid climate change (adaptive capacity). This theoretical background allowed Foden et al. (2013) to develop a framework to identify the species most prone to extinction due to climate change. Using a modified version of this framework, we calculated a vulnerability score and presented a global snapshot of the climate change vulnerability of shallow reef communities worldwide. We used the Reef Life Survey database containing quantitative information gathered with standardized methods on thousands of rocky and coral reef species worldwide (Edgar et al. 2020). Over seven percent of the species quantified in our study (204 out of 2583) were highly vulnerable to climate change. Less than five percent of these species were on the IUCN red list of threatened species. The current network of marine protected areas failed to provide vulnerable species with the same level of protection as non-vulnerable species. Geographically, we found areas of the Mediterranean basin and northern Europe seriously threatened by climate change as they hold high concentrations of vulnerable species. Foden et al. (2013) found that sensitive and low-adaptive species do not necessarily populate the most exposed sites to climate change. Our study confirmed this hypothesis with reef communities, highlighting the role of species traits, and not just exposure, in assessing vulnerability. Our results can help lay the foundations to minimize the adverse effects of climate change in our oceans.

Keywords: Climate change, Marine Protected Areas, Vulnerability

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THE EFFECTIVENESS OF UNDERWATER VIDEO IMAGES FROM ROV FOR ASSESSING THE ECOLOGICAL INTEGRITY OF COMPLEX CALCAREOUS RED ALGAE HABITATS

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ABSTRACT

The study demonstrates the value of the video images to identify the coralligenous assemblages of calcareous red algae habitats. The non-intrusive methodology by the use of a Remoted Operated Vehicle (ROV) following the transects designed on the seabed facilitates the possibility to identify the complex communities structure without the use of damaging methods. The video images covered a total area of 13,8 km^2 at depth from 42m to 111m in the continental shelf of the Catalan coast (NW Mediterranean) in adjacent waters of the Blanes port. The studied area suffers trawl fishing activity during 6 month of the year. For the reconstruction of the video transects observed to habitat mapping a PostGIS database was designed and built with all obtained data during the cruise of the CriMa Project. Its visualization and data analysis was made using the QGIS software. Maërl beds habitats are composed of calcareous red algae species that can live free rolling by the seabed and forming nodules the so-called rhodoliths. Other calcareous red algae species produced accumulation of encrusting algae and live attached or incrusted and forming the so-called coralline rock habitats. The work aims to describe and characterise these vulnerable calcareous red algae habitats to estimate their Good Environment Status. From the video images it was feasible to define levels of abundance of both maërl and incrusted red algae habitats, identify the relief features and characterize the different sediments. In addition, the species and communities that inhabit it were identified and abundance estimated. The main results obtained from the analyses highlight that maërl habitat is associated to ripples beds and encrusting calcareous algae to rocky relief. The fragmentation or continuity of these two type of red algae associations has also been possible to estimate.

Key words: calcareous red algae**,** maërl beds, coraligenous rock, vulnerable habitat, underwater video analysis, GIS.

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ANTHROPOGENIC PRESSURE ON THE ZOOPLANKTON COMMUNITY OF THE GULF OF CÁDIZ ESTUARIES (SW IBERIAN PENINSULA)

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Abstract: Estuaries are one of the most productive ecosystems in the world and provide important ecosystems services (Elliot et al., 2019). Coastal ecosystems are subjected to intense stressors, derived mainly from the increasing human activities that are threatening these natural systems worldwide (Halpern et al., 2008). Zooplankton community plays a pivotal role in estuaries and marine ecosystems food webs, acting as vector that transfers energy from primary producers to higher trophic levels. Zooplankton has close links with the environmental features throughout their life cycle and could change their natural distributions and structure community when disturbance occurs (Uriarte et al., 2004). Therefore, they are considered as potential bioindicators of ecosystem integrity.
This study focuses on temporal and spatial variations in the mesozooplankton community of two estuaries from Gulf of Cádiz with different degree of anthropic perturbation: Guadalquivir and Guadiana. The Guadalquivir estuary is an example of a highly impacted environment while Guadiana has been catalogued as one of the least polluted European estuaries.

The sampling campaign was carried out in 2017 and 2018 during the dry-warm season (June–July). For each estuary, samples were collected at five sampling stations, three located in the inner zone and two in the nearshore of the river mouth.

Preliminary results showed that richness and abundance were higher in Guadalquivir while Pielou's evenness and Shannon diversity index were higher in Guadiana estuary. Mesozooplankton community structure also differed among estuaries. The copepod *Acartia tonsa* was the most dominant taxa, reaching 98% of total abundance in Guadalquivir. This estuary, characterized by higher anthropogenic pressures, had the highest turbidity and suspended organic matter concentrations and the lowest Chlorophyll a concentration. These features were identified as the main environmental variables in structuring zooplankton community and could be responsible for the success of *A. tonsa* in Guadalquivir estuary, due to the opportunistic feeding behavior of this species.

Key words: Estuary, mesozooplankton, anthropic perturbation, Gulf of Cádiz

Acknowledgments: We thank to Autoridad Portuaria de Sevilla for financial support.

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REPRODUCTIVE CYCLE CHARACTERIZATION OF *Arbacia lixula, Paracentrotus lividus,* AND *Sphaerechinus granularis* IN GRAN CANARY ISLAND, SPAIN.

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Abstract: Sea urchins are key species in marine ecosystems because play controlling algae covering rocky shores. In addition, for some populations around the world, their gonads have a great value to the gastronomy industry, which plays a great fishery pressure at coastal ecosystems, which in some cases are not regulated. The aim of this research was to describe the reproductive cycle of the most important sea urchins in rocky shore ecosystems on Gran Canaria Island, Spain. This research was made between June 2020 to May 2021, in 5 locations around Gran Canary Island: Bañaderos (North), San Cristóbal (East), Arguineguin (South), and Tasartico and La Aldea (West). In each area sea urchins were collected (*Paracentrotus lividus* N=359, *Arbacia lixula* N=252, and *Sphaerechinus granularis* N=66). The gonadosomatic index reveals that reproduction varies between localities, seasons, and species. *P. lividus* show two reproductive seasons (summer and winter), while *A. lixula* and *S. granularis* just show one reproductive season by the year (in summer). Histological analysis corresponds with the quantitative analysis. We conclude that, even when all the species cohabitate in all the localities, environmental variables affect in different ways the reproductive cycles of each species.

Keywords: rocky shores, sea urchins, Canary Islands, Macaronesia

A REVIEW ON METAL CONTENT IN *Tursiops truncatus* IN DIFFERENTS SEAS AND OCEANS AROUND THE WORLD

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Abstract: In this bibliographic review, different scientific publications have been collected that presented data on metal concentrations in the muscle of *Tursiops truncatus* (Montagu, 1821). A total of 12 scientific articles were included, those found in a period of 15 years (2006-2021) and data were obtained from the following heavy metals and trace elements: Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Me-Hg, Mg, Mn, Mo, Na, Ni, Pb, Se, Sr, THg, Tl, V and Zn. Low concentrations of Cd and Pb have been found in this dolphin species. However, the same result has not been obtained for Total Hg. In addition, with the data collected it has been possible to observe that among the seas and oceans included in the studies it is the Mediterranean Sea that presents a greater metallic pollution. Conversely, according to the data collected, the one with the least metallic pollution is the Atlantic Ocean. This difference may be due to the closed nature of the Mediterranean Sea. Furthermore, it is a highly populated and industrialized area.

Key words: Heavy metals, Trace elements, Cetaceans, Dolphins, *Tursiops truncatus*.

CAN BACTERIAL PRESENCE MODIFY POLYUNSATURATED ALDEHYDES PRODUCTION BY *Cycloatella cryptica* UNDER PHOSPHATE LIMITATION?

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Abstract: Polyunsaturated aldehydes (PUAs) are bioactive molecules produced and released into the marine environment by some phytoplankton species, especially diatoms (Miralto et al., 1999). The production of PUAs has been demonstrated to be very plastic depending on diatom stress condition. Different ecological functions have been attributed to them, such as chemical defense against predators and competitors (Ianora and Miralto, 2010) or cell to cell infochemical signal during ending blooms when resources are limited (Vardi et al., 2006). Nevertheless, the bacterial-diatom interaction in PUAs producers has been less studied. The aim of the present study was exploring such interaction by comparing the type and quantity of PUAs produced by axenic versus non-axenic unialgal cultures of *Cyclotella cryptica* (a PUAs producer diatom). Additionally, the effect of bacterial presence in PUAs production under less beneficial conditions for diatom of phosphate availability would be also compared. Preliminary results showed that phosphate limited non-axenic cultures produced higher levels of PUAss. This could be indicative of any role in bacterial-diatom interaction under stress nutrient conditions. Qualitative and quantitative results will be presented.

Key words: polyunsaturated aldehydes, diatoms, *Cyclotella cryptica*, bacterial.

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PREDICTED FUNDAMENTAL NICHE EXPANSION OF *Agarophyton vermiculophyllum* UNDER PRESENT AND FUTURE CLIMATE SCENARIOS

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Abstract: The introduction of new species in marine ecosystems is a phenomenon that has grown in recent years due to anthropogenic activities and climate change effects (Rilov and Crooks 2009; Hu and Juan 2013). *Agarophyton vermiculophyllum*, a red seaweed native from the north-eastern Pacific, has successfully colonised large regions in the Northern Hemisphere (Terada and Yamamoto 2002; Kim et al. 2010; Krueger-Hadfield et al. 2017); however, there are no studies to date investigating how future climate conditions will affect its potential biogeographical range. In this investigation, we implemented species distribution models (SDMs) based on sea surface temperature (SST) and salinity to determine the potential current, and future distribution of *A. vermiculophyllum* based on two climate scenarios (Representative Concentration Pathways [RCP 2.6 and RCP 8.5]) (Tyberghein et al. 2012). The model built for *A. vermiculophyllum* showed a high discriminatory ability and marked sensitivity. The SDM for present climate settings showed a potential wider distribution than is recorded to date. In addition, a subtle habitat expansion of 2.9º into higher latitudes was reported under the RCP 2.6 scenario by the end of this century. The high carbon emission scenario (RCP 8.5) delivered a potential large habitat expansion (6.0º), even reaching arctic latitudes. Under this climate scenario, it was also observed a remarkable habitat loss of 11° in its southern distribution range. SMDs also forecasted suitable areas for this species in the Southern Hemisphere, pointing toward a potential global expansion in the coming decades. The information reported in this study is relevant to developing management plans to effectively implement contingency actions addressing invasion events, thereby fostering adequate habitat conservation policies.

Key words: Species Distribution Models (SDMs), climate change, habitat expansion, macroalgae, colonization

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CHORUSES AT DUSK IN DEEP WATERS OF THE CANARY ISLANDS (SPAIN) ARE ASSOCIATED WITH MESOPELAGIC LARGE-SCALE DIEL VERTICAL MIGRATIONS

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Abstract:

Passive acoustics are used to study marine soundscapes and biodiversity (Erbe et al. 2015; Picciulin et al. 2016). Correlations between received levels of specific sounds and species abundance could be useful to estimate potential fishing stocks that otherwise are difficult to monitor. Here, we investigate marine soundscapes in pelagic waters of two volcanic islands in the subtropical NE Atlantic combining passive and active acoustics. We conducted a concurrent sampling of the soundscape using two SoundTrap hydrophones located at 50 and 600m depth (passive acoustics) while scanning the water column using a portable SIMRAD-EK80 echosounder emitting pulses centred at 38 and 200kHz (active acoustics). The surveys were performed in SW Tenerife and El Hierro and covered the sunset to record the diel vertical migration of mesopelagic organisms to shallow waters previously reported for these waters (Ariza et al. 2016). We report for the first time in deep waters of the Atlantic a chorus centred at 2.5kHz that occurs concurrently with the upwards migration of the Deep Scattering Layer (DSL) at dusk and is like the ones reported in the Pacific and Indian Oceans (McCauley and Cato 2016; Lin and Tsao 2018). Maximum received sound levels of this chorus are positively correlated with acoustic backscatter of DSL organisms migrating to shallow waters. We propose that mesopelagic fish are most likely responsible for the chorus because these are the most abundant taxa involved in the DSL migration. Calibrated measures of chorus sound levels might thus be applicable to provide estimates of migrating DSL biomass. We believe it is important to continue monitoring these habitats using the novel combination of passive and active acoustic techniques used here to assess the origin of the chorus to improve monitoring of deep-water ecosystems and contribute information to base conservation management measures in areas impacted by anthropogenic noise.

Key words: deep waters, chorus, bioacoustics, deep scattering layer, diel vertical migration

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NON-INDIGENOUS FISH ON THE RUN: ASSESS THE DISPERSAL AND INVASION RISK OF SEABREAM IN MADEIRA ISLAND

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Abstract: Gilthead seabream (*Sparus aurata*) is an important commercial species, and one of the most used fishes in aquaculture (1). This fish was introduced in Madeira coastal waters at the beginning of the 1990s when fish farms were implemented in the island. Starting from 2000, studies have reported sporadic *S.aurata* sightings (2;3) or catches by recreational fishers (4;5). Considered a non-indigenous species in Madeira, this fish represents a unique opportunity to evaluate the dispersal ability of offshore farm escapees, a challenging task in its native range where it must first be distinguished from wild conspecifics. In addition, assessing *S. aurata* potential invasion risk is of paramount importance to evaluate possible impacts on local habitats and native communities and to highlight the urgency of future monitoring programs. This study was designed to assess the dispersal ability of *S. aurata* escapee and evaluate the potential invasion risk at Madeira Island. Occurrences of *S. aurata*

in the coastal waters of Madeira Island were assessed with GIS participatory mapping survey. Complementary data from recreational fishing contests were used to supply evidence of the presence of this species in different locations. The invasiveness of the species was screened using the Aquatic Species Invasiveness Screening Kit (AS-ISK, 6). A total of 108 markers were obtained reporting the presence of *S. aurata* also far from offshore farms. A GLM analysis revealed that the presence of adult fish around the island is not dependent on the proximity of aquaculture facilities, suggesting that *S. aurata* has already spread and successfully established in the coastal waters of Madeira Island. Seven assessments revealed a high invasion risk for this species at Madeira Island. Overall, based on our findings, we recommend the implementation of monitoring programs to confirm and follow the establishment of sexually mature individuals at Madeira and to address a possible competition for food sources with native species.

Key words: Non-indigenous species, Aquaculture escapee, Risk Assessment, Citizen Science, Participatory Mapping

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ZOOPLANKTON BIOMASS, ETS ACTIVITY, AND RESPIRATORY FLUX AROUND THE CANARY ISLANDS

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Abstract: The ocean sinks approximately one-third of greenhouse gas emissions out of the atmosphere, including carbon dioxide. An important part of this downward carbon flux is driven actively by large zooplankton and micronekton during their downward diel vertical migration (DVM) and their residence at depth. However, there is a considerable gap in the role that zooplankton and micronekton play in the biological carbon pump (BCP) as only a few studies are addressing this downward transport (Ariza et al., 2015), (Boyd et al., 2019), (Hernández-León et al., 2019). Here, we show the results of migrant biomass and respiratory flux of these organisms and their relationship to primary productivity around the Canary Islands. We measured zooplankton biomass from 200 meters depth up to the surface day and night during March 2022, following an E-W transect around 29˚N, from the more productive waters near the African coastal upwelling to the oligotrophic gyre west of the Canary Islands. Mesozooplankton biomass and abundance were estimated from day and night hauls using a WP-2 net. We estimated biomass from protein converting to dry weight and carbon using published relationships. Respiration was estimated by measuring the enzymatic activity of the electron transfer system (ETS) of the organisms (King & Packard, 1975). Migrant biomass was assessed by the difference between day and night samples in the upper 200 m layer. Respiratory flux and carbon export through zooplankton DVM were estimated converting ETS activity in the upper layers to oxygen consumption at depth. The results showed differences about the different physical scenarios observed and agree with previous estimations in the area. We also compared our results with an earlier sampling carried out in November 2021 during much more stratified conditions.

Keywords: Carbon pump, Zooplankton, Diel vertical migration, Active flux, Respiratory flux, Migrant biomass, Canary current.

Acknowledgments: The authors wish to acknowledge Carmen Presas (cruise leader) and the crew of the R.V. Ángeles Alvariño for their help and involvement in sampling during the cruise.

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ZOOPLANKTON RESPONSE TO VOLCANIC ASH DEPOSITION AFTER THE ERUPTION OF LA PALMA VOLCANO

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Abstract:

The zooplankton community has been extensively analysed around the Canary Islands, including the coastal submarine eruption occurred in "El Hierro" island, where the zooplankton changed due to the physical disturbances caused by the strong effect upon the physical and chemical scenarios in the water column. The ridge of "Cumbre Vieja" is the most recent active volcanic region around the Canary Islands. The eruption led to ash deposition around La Palma Island. The ash deposited on the ocean generates changes in the physical and biological variables affecting phytoplankton and zooplankton communities. This study provides information about the zooplankton composition before, during, and after the volcanic eruption occurred in September 19th 2021. Sampling was carried out on board the RVs *Ramón Margalef* and *Ángeles Alvariño* in the context of the VULCANA project from IEO-CSIC institutions in September 26th(Vulcana-III-0921) and October 26th during 2021 (Vulcana-III-1021), and February 2nd (Vulcana-III-0222) during 2022. We compared the results of the biological stations performed near the island with the northwest station of the RAPROCAN monitoring cruise as a farfield reference. We also show the previous oceanographic conditions throughout the eruptive process. Sea surface temperature, salinity, mixed layer depth, chlorophyll a, dissolved oxygen, and depth of the euphotic zone were obtained from the Copernicus Marine Environment Service. Zooplankton was sampled using a WP2 net in vertical hauls from 200 m depth to the surface. These samples were processed with ZooScan through EcoTaxa. Environmental variables such as temperature and chlorophyll changed near the volcano in comparison to the distant oceanographic station. We discuss those changes in relation to the effect of ashes released by the volcano.

Key words: Zooplankton, chlorophyll, volcano, La Palma, Canary Islands.

Acknowledgments: We thanks the crew of RV Ángeles Alvariño as well as graduate students and researchers from the Instituto Español de Oceanografía (IEO-CSIC) and Biological Oceanography and Global Change Group (GOBCAG) for their assistance with sampling. Zooplankton samples and CTD data were obtained through the VULCANA project funded by the IEO-CSIC institutions. CTD farfield stations were carried out in the context of the RAPROCAN project also funded by IEO-CSIC.

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LONG-TERM VARIABILITY AND TRENDS OF SATELLITE-OBSERVED CHLOROPHYLL IN THE PATAGONIAN CONTINENTAL SHELF

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Abstract:
The Patagonian Continental Shelf (PCS), is considered as one of the most productive areas of the world, with high abundance of economically important fish species. The ecological responses of this oceanographically complex region to climate variability are still uncertain. Here, based on 24 years (1998-2021) of ocean color data, we investigate the long-term variability and trends of phytoplankton biomass (using Chl-a, as proxy) in the PCS. Based on Self-Organizing Maps (SOM) analysis in the temporal domain, we first defined 9 topologically ordered biogeographical regions, associated with the oceanographic patterns prevailing in the PCS. Marked differences in chlorophyll patterns were observed, between the highly productive areas, characterized by marine fronts of different origins (*e.g.* upwelling, estuarine, thermal; 1.4-2.3 ± 0.9-1.7 mg m^{-3}) and the oligotrophic Atlantic oceanic waters, with relatively low Chl-a concentration and variability (0.41 ± 0.18 mg m^{-3}). In 7 of the classified regions significative positive monotonic trends were observed revealing a tendency of increase in the productivity (biomass enhancement) of the PCS. Phytoplankton biomass in the highly productive areas of the northern shelf break outstandingly increase at a rate of 0.42 mg m^{-3} $decade^{-1}$. Somewhat lower values, yet significant, were observed in the southern shelf-break (Malvinas Current; 0.16 mg m^{-3} $decade^{-1}$), and in the southern Patagonian tidal fronts (0.13 mg m^{-3} $decade^{-1}$). In addition to this, also a clear shift in the blooms' seasonality has been identified, with an increase in the amplitude of the seasonal signal in the northern shelf break and, conversely a weakening of the signal in the oligotrophic Atlantic waters. Our results are consistent with previous descriptions of the response of these waters to climate change and builds the basis of the future scenarios that PCS and beyond will face in a climate changing reality.

Key words: Phytoplankton, Remote sensing, Self-organizing maps, Southern Atlantic Ocean, Trends, Climate variability.

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HOLO- AND MEROPLANKTON COMMUNITIES IN SURF ZONE WATERS OF A SOUTHWESTERN ATLANTIC SANDY BEACH (MONTE HERMOSO, ARGENTINA)

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Abstract: In this study, we aimed to answer the following questions: (*i*) which taxa makeup and can be considered as descriptors within surf zone holo- and meroplankton in Monte Hermoso sandy beach, Argentina?, (*ii*) what environmental factors control their seasonal variations?, and (*iii*) is it possible to define a typical surf zooplankton community for this coastal ecosystem?. Zooplankton samples were collected at one fixed station twice per season during two annual cycles (2009-10, 2015-16), using a 300 µm mesh size conical net. A set of environmental variables were measured *in situ* and water samples were collected to determine chlorophyll and suspended sediments concentrations. Holoplankton was very abundant (13.52-11070.4 ind. m^{-3}) and showed a strong seasonality, mainly related to the specific pattern of the two most abundant species: the copepods *Acartia tonsa* (>late summer-spring) and *Paracalanus parvus* (>winter). This community was affected not only by changes in water temperature and salinity but also by variations in the velocity of littoral currents, which evidenced that hydrodynamic forces were more significant in a short-term time scale than seasonal. Meroplankton abundances (1.3-48.05 ind. m^{-3}) were significantly lower than those registered for the holoplankton. Medusae and larvae of Bivalvia and Grapsidae mainly dominated this community. This fraction also exhibited a seasonal pattern (>abundances in summer), mainly guided by the temporal changes in water temperature. The present results showed that in the surf waters, estuarine and neritic species coexists, evidencing the connection between near coastal ecosystems. These species can be recognized as *residents* or *non-residents species*, according to the description proposed by McLachlan and Defeo (2018). The abundances of the main surf zone zooplanktonic taxa were high and constant, emphasizing not only the importance of these waters as regular habitats (well-established communities) rather than transient ones but also the ecological role of coastal waters in planktonic life.

Key words: zooplankton, surf zone, sandy beaches, Southwestern Atlantic.

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PHYTOPLANKTON PHENOLOGY PATTERNS DERIVED FROM MODIS-AQUA CHLOROPHYLL-A PRODUCTS IN THE ARGENTINE SHELF FROM 38° S TO 43° S

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Phytoplankton phenology is of critical importance in ocean dynamics as higher trophic levels are sustained by primary producers. In the Argentine Continental Shelf, (Southwestern Atlantic Ocean), the combined origin and varying properties of water masses generates a heterogeneous distribution of phytoplankton productivity. Based on water properties, 3 broad areas have been described: the inner-shelf (El Rincón, ER), the mid-shelf (MS), and the outer-shelf – shelf-break area (OS-SB) between 38° and 43° S. In this work, the areas were further divided by means of unsupervised classification using a time series (2003-2016) of monthly mean Chlorophyll-a values derived from 4-km 8-days composites of MODIS-Aqua Chlorophyll-a products, and phytoplankton phenology patterns were characterized in terms of bloom maximum (mg m^{-3}), bloom duration (days), bloom integral (mg m^{-3} per season) and bloom start date. Values are presented as mean ± standard deviation. Within ER, 2 areas were identified: the central ER, where season started in March and bloom duration was 192±47 days; and the ER-MS transition, where bloom started later (July) and showed a shorter season (131±40 days). Over the MS, 3 areas were identified. The inner- central MS, showing an intermediate maximum and low integral values (9±2 mg m^{-3} and 58±16 mg m^{-3} respectively); the MS front, with higher maximum and integral values (13±2 mg m^{-3} and 93±18 mg m^{-3} respectively); and the outer MS, where the main difference was the longer bloom duration compared to the inner-central MS and MS front (105±29, 73±20 and 75±10 days respectively). Finally, the OS-SB zone was divided into the inner OS-SB, with higher maximum (13±2 mg m^{-3}) and integral (119±28 mg m^{-3}) values, and the outer OS-SB where values were lower (7±4 mg m^{-3} and 63±38 mg m^{-3} respectively). This study provides a finer regionalization for the study area, based on phytoplankton patterns, setting the basis for future assessments of phytoplankton phenology drivers.

Key words: phytoplankton phenology, Chlorophyll-a, remote sensing.

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MAJOR RESTRUCTURING OF MARINE FORESTS' DIVERSITY UNDER PROJECTED CLIMATE CHANGE

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Abstract:
Future climate change poses a major threat to global marine biodiversity. For marine forests that structure essential habitats for coastal species worldwide, climate change effects can be magnified into losses of ecosystem functioning, with direct consequences for the numerous ecological and economic services provided (Assis et al., 2022; 2017). To date, the direction and intensity of future net changes in the global patterns of marine forests' biodiversity remain unknown, precluding well-informed IPCC impact assessments, conservation and management strategies (Fragkopoulou et al., 2022). Here, we use machine learning species distribution modelling to forecast global changes in richness and community composition (i.e., persistence, extinction and turnover) of 115 kelp species (orders Desmarestiales, Laminariales and Tilopteridales) under contrasting Shared Socioeconomic Pathway (SSP) scenarios of climate change (decade 2090–2100): one aligned with the Paris Agreement climate forcing (SSP1-1.9) and another of substantially higher emissions (SSP5-8.5). Models anticipate a generalized trend of poleward shifts at the species level, particularly pronounced with SSP5-8.5, which translated into significant net changes in the global patterns of biodiversity. Maximum community composition changes (i.e., turnover) were projected in the Arctic and Northern Pacific Ocean due to an overall increase in species richness (average gains of 10.96 ± 9.47 species with SSP5-8.5), and in the temperate regions

of the North Atlantic Ocean and Northwest Pacific, as well as the Mediterranean Sea, Australia and New Zealand, due to major losses of suitable habitats (average losses of 3.59 ± 4.04 species with SSP5-8.5). Overall, we show that climate change can strongly restructure the global patterns of marine forests' biodiversity, however, broad compliance with the Paris Agreement may minimize potential knock-on effects on the productivity and functioning of temperate coastal environments. The projected patterns also pinpoint refugial areas for conservation that serve as baselines for well-informed management strategies in the face of future climate change.

Keywords: Marine biodiversity; Marine forests; Climate change; Distribution range shifts; Paris Agreement.

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EFFECTS OF THE PROLIFERATION OF *Zoanthus pulchellus* (CNIDARIA: ANTHOZOA) ON MACROALGAE COMMUNITIES: IMPLICATIONS FOR BENTHIC PRODUCTIVITY OF INTERTIDAL HABITATS OF TENERIFE ISLAND.

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Abstract:
In recent years, an increase in populations of organisms with tropical affinities in marine ecosystems of the Canary Islands has been recorded, due to the rise in ocean temperatures related to climate change (López et al., 2020). Specifically, in intertidal habitats of Tenerife, the zoantharian *Zoanthus pulchellus* has shown its capacity to proliferate, occupying extensive areas of substrate of intertidal pools (González-Delgado et al., 2018). In the present study we analysed the effects of these population expansions over macroalgae communities at two intertidal locations of Tenerife (Punta Hidalgo and Los Silos) during two seasons (autumn and spring), as well as its effect on the benthic productivity of the system. To this end, we gathered data on substrate coverage and biomass of species recorded in habitats dominated by zoanthids and they were compared to nearby habitats dominated by erect macroalgae. In order to estimate benthic productivity in both habitats, analyses of the chlorophyll content of the most representative species in the field were carried out and referred to the biomass recorded in the substrate (Betancor et al., 2015; Osório et al., 2020). In general terms, we found significant reductions of biomass and coverage of macroalgae at *Z. pulchellus* dominated habitats compared to macroalgae stands. Furthermore, macroalgae communities showed differences in coverage and species composition between studied habitats depending on the locality and the season. In terms of biomass, differences in macroalgae communities between localities and season were also found. Despite these structural changes, benthic productivity was maintained in similar values seasonally for both habitats, but it showed marginally significant differences between studied habitats in autumn. This study demonstrates that increasing populations of *Z. pulchellus* in the intertidal of Tenerife modifies macroalgae communities in terms of species composition and abundance, but does not influence the productive potential of the ecosystem.

Key words: Zoantharian, ocean warming, benthic primary productivity, zooxanthella, macroalgae

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ROLE OF ARTIFICIAL REEFS IN RESTORING MARINE ECOSYSTEMS IN HARBOR ENVIRONMENTS

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Abstract: The introduction of harbor infrastructures in natural marine environments causes serious ecological damages and environmental problems, including biodiversity losses, destruction, fragmentation and modification of natural habitats, in addition to the disruption of the ecosystem functioning (Bishop *et al.*, 2017; Hall *et al.*, 2019).

Artificial reefs (ARs) could reduce and mitigate these ecological effects by increasing the spatial complexity and surface availability, thus facilitating the presence of benthic organisms. By providing food and shelter, ARs could attract commercial species such as coastal fishes and crustaceans, hence behaving as nurseries areas and improving productivity and the quality of the altered ecosystems (Evans *et al.*, 2019; Perkol-Finkel *et al.*, 2018).

The objective of this study was to evaluate the effect of three types of ARs (hanging plates, fixed wall plates and moored cubes) on an altered benthic ecosystem in the port of Vigo (NW Spain). Following a biomimetic design, the ARs surfaces imitating the shape of the coralline algae *Lithothamnion corallioides* (P. Crouan & H. Crouan) P. Crouan & H. Crouan, 1867, which forms one of the most diverse marine ecosystems worldwide, the Maërl bottoms. Futhermore, two types of surfaces with the shape of *L. corallioides* were used: surface out and surface in. Four biotic variables were tested: species richness, abundance, biomass and CO_2 sequestration

The results suggest that the species richness and abundance were significantly higher in ARs than in the dock wall, having a biological succession during the study. In the case of biomass and CO_2 sequestration more time span is needed to observe differences between the compared assemblages. Anyway, ARs have similar species richness, biomass and CO_2 sequestration than the dock wall, so their use supports the restoration of the ecological conditions in harbour areas.

Key words: infrastructure, artificial reef, marine habitat, shelter, ecosystem

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NEW TOOLS FOR DEEP-SEA CAMERA IMAGE ANALYSIS APPLIED TO MESOPELAGIC COMMUNITY STUDIES

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Abstract: The steep bathymetry of the volcanic archipelago of the Canary Islands favours finding an exceptional deep-water fauna near the coast. Here, there are year-round populations of at least five species of deep-diving cetaceans; also, there are regular surface findings of mesopelagic large cephalopods, including giant and diamond squids, as well as large mesopelagic sharks and teleost fishes. Many deep marine megafauna exploits the deep scattering layer (DSL) (Aguilar et al., 2008; Arranz et al., 2011), which is one of the largest biomasses on the planet (Bordes et al., 2009; Sutton, 2013; Ariza et al., 2016). The objective of this study is to apply novel technologies to investigate abundance and composition of the DSL, which affects the distribution of mid- and top predators. Mesopelagic communities were sampled at two sites with different cetacean communities (south of Tenerife and El Hierro) with acoustic monitoring and deep-water cameras with an illumination system launched at different depths to record the Diel Vertical Migration. A software for automatic analysis of underwater images has been developed within Matlab and tested to detect the presence of small organisms, record their position in the frame and size (Joshi, 2016) and provide temporal output data that can be analysed using statistical methods. Although the software is already operational, the process of improvement is on-going. In parallel, an analysis of larger organisms was carried out using Motion Meerkat software (Weinstein, 2015), with the aim of estimating diversity of species groups by manual identification. A total of 971 organisms were detected, of which 29.15% could be taxonomically identified. This study is relevant to contribute data towards understanding the functioning of the DSL community with a low-cost monitoring system, in the context of potential future exploitation of mesopelagic resources and the foraging requirements of non-human top predators.

Key words: Deep scattering layer, cetaceans, marine biodiversity, underwater camera, artificial intelligence

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NUTRIENT REGIMES DETERMINE THE STRENGTH OF HERBIVORE-MEDIATED STABILIZING FEEDBACKS IN BARRENS.

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Abstract: The last few decades have seen a rapid spread of barrens on temperate rocky reefs as sea urchin overgrazing of marine forests causes habitats to shift to more depauperate stable states. Reversing these trends requires a proper understanding of the novel ecological feedbacks that maintain rocky barrens and the conditions under which they operate. In this study, we explored the role of a secondary herbivore (a grazing limpet) in reinforcing the stability of barrens formed under different nutrient conditions. Combining comparative and field experimental studies in two Mediterranean regions characterized by contrasting nutrient regimes, we assessed: (i) if the creation of barren areas by sea urchins enhances limpet abundance, (ii) the grazing impact by limpets through foraging marks (halos), and (iii) the ability of limpets to maintain barrens in the absence of sea urchins. Our results show that sea urchin overgrazing of erect macroalgae enhanced limpet abundance in both nutrient regimes. The effects of limpet grazing on macroalgal assemblages varied with nutrient regimes being up to six times more intense under oligotrophic conditions. Finally, we found that limpets were able to maintain barrens in the absence of the sea urchins only under low

nutrient regimes. Our results suggest greater vulnerability of subtidal forests to overgrazing in oligotrophic regions and demonstrate the importance of environmental settings in regulating ecosystem feedbacks mediated by plant-herbivore interactions.

Keywords: alternative stable states, environmental conditions, feedbacks, herbivory, limpets

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PATHOLOGICAL STUDY OF ANGEL SHARKS (*Squatina Squatina)* FOUND DEAD IN THE CANARY ISLANDS

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Abstract: The angel shark is listed as critically endangered species. The Canary Islands are considered a unique stronghold for these animals (Barker et al., 2016), but unfortunately some have been found stranded or dead in the recent years. The IUSA-ULPGC together with the Government of the Canary Islands and, in collaboration with researchers of the "Angel Shark Project: Canary Islands", have performed the necropsies of angel sharks found dead from 2021 to 2022. 10 angel sharks (4 females and 6 males) were studied during this period: 6 in Lanzarote, 2 in Tenerife, 1 in Gran Canaria, and 1 in Fuerteventura. 1 of these animals was in a severe autolytic status, 4 presented advance decomposition and in 3, it was moderated. Only 2 specimens well preserved. The weights ranged: female (10.6-13.8kg) and male (9.6-13kg). According to reproductive status (Osaer et al., 2015), all females were mature with large developing follicles in the ovaries and distended, vascularised uterus. One female was pregnant, with a fetus inside the left uterine horn. The males were mature, with dilated ductus deferent that contained abundant seminal fluid. Other findings were cestodal intestinal infestation and congestion in the stomach mucosa. The necropsy and histopathological analysis resulted inconclusive to determinate the cause of death in eight of the animals. However, two individuals were found entangled with fishing nets and with associated skin lesions. This preliminary research shows new data of potential death causes in angel sharks in the Canary Islands and for future conservation management plans.

Key words: elasmobranch, dead, reproductive status, fishing interaction, histopathology.

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MONITORING THE MARINE INVASIVE ALIEN MACROPHYTE *Rugulopterix okamurae* USING REMOTE SENSING IN TARIFA (SPAIN)

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Abstract: *Rugulopteryx okamurae* is a brown macroalgae belonging to the *Dictyotaceae* family and native to the northwestern Pacific. As an invasive species, it was first detected in the Strait of Gibraltar in 2015 (Altamirano *et al*., 2016). Since then, *R. okamurae* has spread rapidly through the submerged euphotic zone, colonizing from 0 to 40 m deep and generating substantial economic and environmental impacts on the Andalusian coasts (Altamirano *et al*., 2017). More than 40% of marine invasive species in the European Union are macroalgae, representing one of the main threats to biodiversity and ecosystem functioning in coastal habitats (Schaffelke *et al*., 2006). This work shows a pilot monitoring study of *R. okamurae* upwellings in Tarifa (Cadiz, Spain), using multispectral remote sensing techniques on-board drones and satellites for mapping. We have used a flight carried out at Bolonia beach on 1st July 2021 and Sentinel-2 (S2) and Landsat-8 (L8) images captured close to the drone flight date. *In-situ* data was used to train the Super Vector Machine (SVM) supervised classification method based on the spectral information obtained for each substrates (Vapnick, 1995). The results obtained show how multispectral images allow the classification of *R. okamurae* upwellings on the coast, mapping performance depended on their spatial resolution (8.3 cm/pixel for drone flight, 10 m/pixel for S2 and 30 m/pixel for L8). However, although the drone images delimit the extension of this macroalgae more precisely, the satellites are capable of detecting its presence, being able to generate early-warning systems. This study demonstrates the usefulness of multispectral remote sensing to monitor the marine invasive alien species *R. okamurae*, as well as the implications of this approach for supporting regional, national and European policies to monitor marine ecosystems.

Key words: Invasive marine macroalgae, Multispectral sensor, UAV, Earth Observation, Machine Learning.

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INTERANNUAL WAVE CLIMATE VARIABILITY EXPLAINS MASSIVE MORTALITY EVENTS OF POLITITAPES RHOMBOIDES CLAMS IN A GALICIAN RIA

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Abstract: Subtidal natural beds of *Polititapes rhomboides* in the Ría de Vigo (NW Iberia) suffered massive mortality events in June 2010 (Darriba et al., 2019). Abnormal high-intensity infections of intracellular prokaryotic colonies (Rickettsiales-like) in the gills observed in the histopathological study could explain the clam's mortality and the drop in this wild population. An atypical long period (7 months) of continuous and strong wave storms entailed high bottom boundary layer dynamics with intense sediment mobilization and resuspension. Immediately after this energetic period, warm water (17ºC) conditions near the seabed prevailed, and these could promote prokaryote colonies proliferation. Stress produced by the continuous wave impact on the seabed could have weakened the clam's ecophysiology inhibiting an efficient immune response. This physiological status would coincide with the expansion and infection of Rickettsial colonies in the gills, probably boosted by the warmer temperatures. This synergetic effect would have produced massive clam mortality events.

The analysis of wave climate winter variability shows an evident interannual variability related to the NAO (North Atlantic Oscillation) and WEPA (West Europe Pressure Anomaly) climate indices (Villacieros-Robineau et al., 2021). Winters with the highest waves occur during the coincidence of negative NAO and positive WEPA phases. Warmer temperatures and low salinity conditions (downwelling scenarios) are more frequent during these severe winters. Collapses of banded carpet shell populations, with a critical reduction in the abundance and a production decline, occurred after these energetic winters (2000/2001, 2009/2010). During intermediate recovery periods (years with low energy conditions, e.g., 2006-2009), clam populations grow until the subsequent collapse.

This multidisciplinary approach, including histopathological, oceanographic, and population ecology studies, shows that monitoring environmental stressors related to the climate indices can be used as an ecological indicator of the clam's health population status and evolution with potential applications for managing this and other marine resources.

Key words: Clam mortality events, intracellular prokaryotic colonies, wave climate, climate indices, population collapse, ecosystem services.

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INTERACTIONS BETWEEN ZOANTHARIANS AND MACROALGAE OF THE CANARY ISLANDS UNDER LABORATORY CONDITIONS: EFFECTS OF SEA URCHIN GRAZING

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Abstract: The effects of ocean warming in the Canary Islands are favouring the expansion of certain thermophilic organisms like zoantharians, which are able to modify shallow benthic habitats due to their mat-forming growth. In the present study, a 3,5-month experiment under laboratory conditions was conducted to assess the influence of the type of algal community on the growth of two species of zoantharians, *Palythoa caribaeorum* and *Zoanthus pulchellus*. Three types of macroalgae, representative of the region and studied habitats: turf algae, *Lobophora* spp. and crustose coralline algae, were chosen to interact with both species of zoantharian. In addition, the grazing effect of the echinoids *Diadema africanum* and *Paracentrotus lividus*, as facilitators of substrate colonization by controlling macroalgae cover, was evaluated. Colony and algal coverages were measured at the beginning and end of the experiment with ImageJ software and their increments were calculated. A general decrease in zoanthid coverage of both species was recorded for samples in contact with the different types of algae in the absence of sea urchins. However, a trend of increasing *P. caribaeorum* colonies areas in the presence of the sea urchin *D. africanum* was observed. On the contrary, no effect of substrate release on *Z. pulchellus* growth was observed in the presence of *Paracentrotus lividus*. This study shows a higher competitive efficiency of *P. caribaeorum* to expand on substrates under conditions of grazing pressure compared to conditions of interaction with well-established macroalgal communities of different kinds. Therefore, we highlight the ecological role of sea urchins in the proliferation of zoantharian populations and the subsequent modification of the associated communities.

Key words: Interspecific competition, *Palythoa caribaeorum*, *Zoanthus pulchellus, Diadema africanum, Paracentrotus lividus*

Acknowledgments: We would like to thank the service of “Mantenimiento” from University of La Laguna for providing weekly sea water supplies for the experimental tanks. This study is part of the first author's doctoral thesis, beneficiary of a predoctoral contract for the training of PhDs of the Spanish Ministry of Science and Innovation and has been supported by the Government of Spain under the program "Proyectos de I + D + i Retos Investigación 2018" (RTI2018-093943-A-I00).

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INFLUENCE OF THE EUTROPHICATION OF THE MAR MENOR ON THE EXPLOITED FISH POPULATIONS

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Abstract: The Mar Menor is a coastal lagoon in the Spanish Mediterranean Sea subjected to numerous anthropic pressures, among which it is worth highlighting the surrounding agriculture and urban pressure, that has discharged tons of nutrients into the lagoon for years, finally causing an ecological imbalance with eutrophic episodes. This eutrophication process has had a direct impact on all the components of the ecosystem (massive death of fish, crustaceans, algae, etc.). The objective of this work is to determine the impact of eutrophication on the exploited fish population in Mar Menor lagoon. For this, taxonomic diversity indices were calculated as well as the CPUE (as kg/day/boat) of the main exploited fish species from 2016 to 2020, to study the influence of the eutrophication process on the taxonomic and functional composition of the exploited fish community. ANOVA was used to test if there were significant differences between years in CPUE and taxonomic diversity indices. Also we used a CPUE dataset of fish species, biological traits, and environmental conditions to investigate the role of biological traits and environmental trait filtering in species responses to change. We combined a three-table ordination method, RLQ, with the fourth-corner approach to quantify and test relationships between environmental variables and biological traits in two different periods with massive mortality (2016-2017 and 2018-2019). CPUE of 2019 was the lowest during the eutrophication. Species Richness and relative richness were different among years, but the diversity and equality of the species were not. No functional change was observed in the structure of the fish population, although a change was detected in the dominant environmental variables between period 1 and 2. In period 1, a significant positive relationship was observed between nitrates, nitrites and oxygen with axis 1 of the functional traits, while in period 2 only oxygen maintained that relationship.

Key words: Mar Menor, eutrophication, traits, environment, structure of the population

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We would like to express our gratitude to Jesús Gómez-Escudero, senior skipper, of the San Pedro del Pinatar fish market for their valuable help in obtaining eels. The contributions of DMEMEN Project of Centro Nacional Instituto Español de Oceanografía has been essential for the understanding of the Eutrophication process in the Mar Menor lagoon.

SEAGRASS FINE-SCALE DISTRIBUTION LINKED TO WAVE ENERGY AND HYDRODYNAMICS IN A SHALLOW MEDITERRANEAN MARINE PROTECTED AREA

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Abstract: Seagrasses are flowering plants that are highly diverse, adapted to marine environments and provide a variety of ecosystem services. It is widely accepted that light availability sets the lower limit of seagrass bathymetric distribution, while the upper limit depends on the level of bottom disturbance by currents and waves (Infantes et.al., 2009). In contrast to light requirements, the influence of energy levels on the establishment, growth, and maintenance of seagrasses has received low attention. The aim of this work is to provide a fine-scale case-study correlating seagrass distribution as a response to wave and current energies dissipated on the seafloor. Detailed distribution of seagrass, obtained through geo-acoustic habitat mapping and optical ground-truthing (Fakiris et.al., 2019), has been correlated to the modelled wave and current energies in the Marine Protected Area of Laganas Bay, Zakynthos Island, Greece, where the seagrass *Posidonia oceanica* forms an extensive meadow. Mean wave and current conditions were propagated/ modelled in the bay using a two-dimensional model (DHI-MIKE 2) over the detailed bathymetry. The resulting energies were correlated with fine-scale bottom types and the distribution of P. oceanica. Results showed a predicted near-bottom orbital velocity level and oscillatory flow (Dimas and Leftheriotis, 2019) as a determinant of the upper depth limit of P. oceanica as well as of geometrical patterns, such as sand gaps and corridors, of the meadow and the level of seagrass fragmentation. This work is a steppingstone towards achieving more holistic habitat suitability models of seagrass distribution, by incorporating hydrodynamic predictive variables in the relevant data assimilation processes.

Key words: Posidonia oceanica, habitat suitability, wave energy, hydrodynamics

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Fertilization of the coastal waters of the Canary Islands by the diazotrophic cyanobacterium *Trichodesmium.*

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Trichodesmium is a filamentous diazotrophic cyanobacterium commonly found in tropical and subtropical oceans. During the last decade, the unabated increase in water temperature, together with periods of intense dust events and decrease in wind intensity, have resulted into recurrent *Trichodesmium* blooms around the Canary Islands. Soon after the colonies of *Trichodesmium* aggregate at convergence surface fronts, cells collapse and die liberating high concentrations of inorganic and organic nutrients to the water column. This could favor the growth of other planktonic organisms, thus acting as a fertilizer in the marine food web. In order to test this hypothesis, we carried out a monitoring program in coastal waters south of Gran Canaria with a biweekly to monthly sampling to track *Trichodesmium* blooms and their impact on the planktonic food web. We observed that patches of *Trichodesmium* were more frequent during summer in the lee of the island, coinciding with higher temperatures and stratified conditions. Waters below the patches showed increases in inorganic nutrient concentrations up to 10 fold for NO_x, 4 fold for NH_4 and 40 fold for PO_4, with respect to ambient concentrations. Likewise, dissolved organic carbon and nitrogen increased up to 45 and 60 fold, respectively, over average concentrations. We also found that chlorophyll *a* increased several fold, as result of enhancements in the abundances of small and large eukaryotes. Moreover, it was observed higher abundances of dinoflagellates (some potentially toxic), probably benefiting from high dissolved organic matter available. Our results suggest that under a future warmer and more stratified subtropical ocean that would reduce water mixing and hence nutrient inputs, *Trichodesmium* may thrive and alleviate the reduction in productivity by fertilizing the surface waters after dying, through nutrients' leaching. But also, our results point out to a future potential enhancement of toxic dinoflagellate blooms associated with these patches.

Acknowledgements: This study was funded by the cooperative agreement between the ULPGC and the Canary Regional Government to monitor *Trichodesmium*. Additional support was provided through the "Observatorio Canario de Algas Nocivas (OCHABS)" funded by the Gobierno de Canarias and ULPGC, and from projects TRIATLAS (AMD-817578-5) from the European Union's Horizon 2020, FONIAC

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SEABIRDS AND OFFSHORE AQUACULUTE CAGES INTERACTIONS IN GRAN CANARIA

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Abstract:

Concerns about the environmental effects of aquaculture have raised during last decades due to the global expansion of the industry (FAO Fisheries and Aquaculture, 2021). Currently, the gilt-head bream (*Sparus aurata*) and the European bass (*Dicentrarchus labrax*) are the two species farmed industrially in Gran Canaria. While offshore aquaculture may affect wildlife distribution, there is a lack of information on birds presence and abundance in association with these industrial facilities. The aim of this study was to investigate interactions between offshore sea cages and the seabird community, using simultaneous scan-sampling of two aquaculture and two adjacent control sites in the east coast of Gran Canaria from March to May 2022. While species diversity did not differ between the cages and control sites, the yellow-legged gull (*Larus michahellis*) was more abundant in aquaculture than in control sites. More specifically, evidence for gulls aggregation is clear in Tufia, the southern study site. In line with this result, a previous study reported the dominance of Laridae in mussel suspension culture in the Ireland coast (Roycroft et al., 2004). The use of cages as perching platforms plus increased food availability in aquaculture sites seem to increase abundance of seabirds, particularly gulls. However, detrimental effects in seabirds survival and reproduction rates caused by aquaculture activity are not studied in this work. Further investigation would be useful to test the influence of this industry on wildlife health.

Key words: Aquaculture, Gran Canaria coast, seabirds, *Larus michahellis*

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PHYTO-TREATMENT OF AQUACULTURE EFFLUENTS USING MICROALGAE-BACTERIAL TECHNOLOGY.

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Abstract:
Marine aquaculture has considerably increased its production growth in recent decades. Intensive aquaculture farms generate currents of concentrated solids corresponding to uneaten feed remains and fish feces [1]. These residues contain big amounts of organic matter and nutrients; species of nitrogen and phosphorus, which worsen water quality and produce eutrophication, facilitating the appearance of bacteria that endanger aquatic plants and animals, even the risk to public health [2].

In the present study, a purification treatment for the concentrated current of solids in an aquaculture farm dedicated to the cultivation of soles (*Solea Senegalensis*) with recirculation aquaculture systems (RAS) were studied [3]. The current was treated by a consortium of microalgae-bacterial. This consortium was cultivated in 8-liter reactors and operated in a discontinuous and semi-continuous mode to determine the kinetic modeling of the biological process (organic matter, nutrients removal, and production of biomass). Concerning the nutrient removal rate, a yield of 87% for N and 98% for P was achieved and 52% in the case of C.

The algal biomass was harvested by coagulation-flocculation and the final separation of biomass from the water was tasted by two techniques: flotation and decantation. The decantation was the best harvesting technique, using a concentration of 60 mg/L of coagulant and obtaining a greater biomass recovery efficiency of 93%. Furthermore, the biomass obtained was dehydrated by centrifugation, and the water obtained in this process was filtered through a sand filter to obtain a quality effluent.

The composition of algal biomass will be analyzed to use as a biofertilizer in agriculture.
In this way, the life cycle impacts of microalgae systems will be able to get environmental and economic benefits.

Key words: renewable resources, wastewater treatment, nutrient removal, photobioreactor.

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CAN PLANKTON BE COUNTED AUTOMATICALLY? LOPC MAY BE THE SOLUTION.

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Abstract:

In recent years, new automatic methodologies for plankton analysis have been developed with the main goal of finding a way to carry out *in situ* studies. Among them is the Laser Optical Plankton Counter (LOPC), equipment that allows the analysis of particles present in water and their size distribution thanks to their laser optics technology (Herman *et al*., 2004).

This work has been based on the execution of the necessary tests to put into operation a LOPC machine and know it is functioning, in order to use it in future works. First, it has been calibrated by comparing its measurements with other plankton analysis methodologies, image analysis and manual analysis. The repeatability of the equipment has been evaluated using plankton samples from the Bay of Cadiz. The main variables of the analysis process have also been studied: the dilution factor of the sample and if it is stained or non-stained. Finally, two practical cases of LOPC use have been developed: a case of use in laboratory, comparing the data obtained with the image analysis methodology, and an *in situ* test in which the variability of particle concentration in the water during the process of tide rising was studied. In laboratory studies, LOPC's resolution is significantly greater than ordinary methods' resolution but does not allow individual particle analysis like taxonomy studies. *In situ* results show that the LOPC has a temporal resolution sufficiently high for detecting particle distribution variations in periods of minutes with a great accuracy.

The results obtained show the great potential of this technology, either by taking measurements directly in the water, or by analyzing samples in the laboratory and combining them with other methodologies to achieve more complete works. Furthermore, in case of *in situ* measurements, nowadays no equipment with such attractive ability for plankton investigations exist.

Key words: LOPC, plankton, particles, oceanography, zooplankton, marine sciences

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DESIGNING UNMANNED AERIAL SURVEY MONITORING PROGRAMS TO ASSESS FLOATING LITTER CONTAMINATION

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Abstract: Monitoring marine contamination by floating litter can be particularly challenging since surface debris are moving objects covering a large spatial extent. Floating litter data collection has mostly relied on opportunistic surveys from vessels, modelling and, more recently, remote sensing and spectral analysis. Low-cost and commercial-out-of-the-shelf (COTS) equipment for science and monitoring processes are becoming a common practice, due to their availability and quality of the information they can collect. In this case study, a low-cost commercial Unmanned Aircraft System (UAS) equipped with a high-resolution RGB camera was used to collect images from the ocean surface where dummy litter items had been deployed for an experimental trial. The study explores and discusses different strategies for image data processing that can be applied for detecting floating litter items from aerial image surveys. It also outlines how low-cost UAS remote sensing can be used in floating marine litter monitoring programs. The images collected were submitted at three different approaches of imagery analysis: i) visual inspection and manual count; ii) colour and pixel-based analysis, and; iii) machine learning (ML) for automated object detection using state-of-the-art Convolutional Neural Network (CNN). Data inquiry included: i) average time required to inspect and process each image; ii) ability to adequately assess floating litter contamination, and; iii) skills and logistical requirements for implementing a monitoring program using each method. A discussion on strengths and

limitations of the different analytical methods is summarised and used to outline guidelines for integrating UAS remote sensing in floating litter monitoring.

Keywords: Unmanned Aircraft Systems (UAS - Drones); Deep Learning (DL); Artificial Intelligence (AI); Machine Learning (ML); Convolutional Neural Networks (CNNs); Marine Floating Litter (MFL).

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THE METADATA CATALOGUE OF THE SPANISH INSTITUTE OF OCEANOGRAPHY: A TOOL TO IMPLEMENT THE EU MARINE STRATEGY FRAMEWORK DIRECTIVE (MSFD)

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Abstract: The Spanish Institute of Oceanography (IEO-CSIC) is responsible, among other aspects, for scientific and technical advice for the Government's fisheries policy as well as for the protection and sustainability of the marine environment. Thus, the IEO-CSIC plays a key role in the implementation of the *Marine Strategy Framework Directive* (MSFD), an EU legislative act that seeks to achieve a good environmental status of European marine waters and protect the resource base on which sustain economic and social activities related to the sea. Under this commission, the IEO-CSIC generates a large amount of marine data characterized by its spatial dispersion during acquisition as well as by its different typology. One of the main tasks is to safeguard data and to disclose what data exists and where, how and when it has been acquired and, in addition, to provide access to that data through the collaboration with different national and international organizations. To this end, the data and metadata are subjected to quality control and formatted for integration into a nationa l Spatial Data Infrastructure (SDI). This SDI has a GeoNetwork catalogue (http://datos.ieo.es) with ~ 2800 oceanographic campaigns. The metadata of the campaigns known as Cruise Summary Report (CSR) follow the ISO 19139, and although similar to those reported to the pan European SeaDataNet infrastructure, here they have been adapted following an XSL transformation to facilitate the data discovery to the Spanish community. CSRs constitute the parent metadata for ~ 250 layers associated with the implementation of the MSFD. Thus, the INSPIRE-compliant layers with biological, geological and physical resource data can be found through the catalogue and are linked to the corresponding map services. Finally, relevant metadata for the implementation of the MSFD are harvested in other nationa l infrastructures, as the InfoMar catalogue (http://www.infomar.miteco.es/), promoted by the Ministry for the Ecological Transition and the Demographic Challenge and maintained by the CEDEX.

Key words: marine data, metadata, GeoNetwork, SDI, MSFD

Acknowledgments: Authors wish to thank to all the researchers and technicians who contribute with metadata to the catalogue.

HYDROKINETIC ENERGY RESOURCE ASSESSMENT IN THE SHANNON ESTUARY

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Abstract: The Shannon Estuary (Ireland) has a large hydrokinetic energy resource, resulting from the combination of tidal-induced currents and large river inputs. In the present work, its hydrokinetic energy potential is analysed through numerical modelling techniques and in situ data. To this end, a state-of-the-art shallow water numerical model is applied and calibrated by comparing the numerical results with instrumental measurements of currents velocity. After calibration and validation of the numerical model, and to accurately determine the spatiotemporal distribution of the energy resource, a simulation covering a complete year is conducted considering the main forcing factors and their intra-annual variability (e.g., river discharges) (Fouz et al., 2019; Sánchez et al., 2014). It is shown that despite the large river inputs to this estuary, their contribution to the total available resource is limited, resulting in a significant stability in the available resource throughout the year. Based on these results, several areas are delimited as appropriate for the hydrokinetic energy exploitation. The final selection of the most suitable area and conversion technology should be based on further socioeconomic and environmental analyses (Areán et al., 2017).

Key words: hydrokinetic energy, resource assessment, estuarine areas, numerical modelling, Ireland.

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SATELLITE MONITORING OF FORCASTED OCEANIC VARIABLES THROUGH THE MARINE OBSERVATORY OF ANDALUSIA

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Abstract: The ocean plays major environmental and socioeconomic roles. At local scales, like the Andalusian coast, aquaculture and fishing industries account for a large economical relevance, being dependent of the water quality where these activities are taking place. Variations in water indicators, such as surface and water column temperature, chlorophyll biomass, zonal hydrodynamics among others can significantly conditionate the development of these local industries. It becomes necessary therefore to incorporate platforms that will enable the continuous monitoring of the physical and biological water quality indicators. This monitorization is fundamental for the creation and organization of sustainable development plans, as well as the management of natural resources, where the usage of great temporal range data helps establishing fluctuating patterns (Tanhua et al., 2019). For such purposes, the Marine Observatory of Andalusia (MOA) implemented physicochemical and biological products from Copernicus program satellite observations, providing a synoptic vision of its historical and near real-time (NRT) trends. However, NRT products allow only to visualize a past event, which only provide an insight of how an extreme marine event should have been managed after this had occurred. The present work addresses this issue and sets an important update for the MOA, implementing forecast products to obtain a holistic past, present and future view of the ocean state. In this way, products such as the potential temperature (thethao) across several depths or chlorophyll concentration are used to offer a better overview of the future water inherent characteristics, and which integrated with NRT observations help to analyze local and regional impacts of ocean variability (Juza y Tintoré, 2021). By providing a forecast for variables like thethao, the visualization of upcoming extreme marine events like marine heat waves, which can cause a massive impact on local marine industries (Frölicher & Laufkötter, 2018), will be easily accessible for the users.

Key words: Marine Observatory, Forecasted monitoring, Near real-time monitoring, Extreme events

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LOW-COST BIOTELEMETRY TRACKER FOR MARINE MEGAFAUNA MONITORING

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Abstract: Biologging and biotelemetry are of great importance in animal movement and behavioural ecology studies. While current biologging equipment for assessing marine megafauna remain at a significant high cost, ubiquitous computing, Internet of Things (IoT) and open radio communication protocols such as Long-Range (LoRa) provide opportunities for creation of robust, low-cost sensors to study behavioral patterns in marine megafauna. In this work, we present preliminary results with an implemented low-cost device, designed for monitoring marine megafauna. We provide threefold contribution to: (i) discuss constraints of current biotelemetry and biologging systems; (ii) design a novel tag and telecommunication system using IoT and LoRa, detailing its setup and steps to prototype it; and (iii) develop a location estimation pipeline, allowing to interpret raw satellite signals for decoding the position of marine mammals at the sea surface. We showcase obtained results from experiments conducted in controlled land-based settings.

Key words: Marine Megafauna Monitoring; Ubiquitous Computing; Internet of Things (IoT); Biologger; Remote Sensing; LoRa; Fastloc; Snapshot Receivers.

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SELECTIVITY OF TRAWL MODIFICATION WITH T90 PANEL IN A MEDITERRANEAN SEA NEPHROPS FISHERY

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Abstract: Current European Union fisheries policy encourages member states to improve fishing selectivity in order to minimize fisheries discards. Trawling on the Mediterranean upper slope often generates over 30% of discards of the total catch, including, among other, *Nephrops norvegicus* juveniles. Improvements in trawl selectivity, using T90 net panels, have successfully been trialled for other Mediterranean target species such as hake or horse mackerel, but the selectivity of T90 was not previously been tested for the Mediterranean Nephrops trawl fishery. Experimental and control paired trawl hauls (N=7 pairs) on board a commercial trawler based on the port of Blanes (N.E. Catalonia) were carried out in Summer 2019. For the control hauls we used a standard net currently used by the Mediterranean trawling fleet, where the extension piece was built entirely with diamond mesh 50 mm (nominal) and 206 meshes around the extension circumference. For the T90 experimental hauls the standard net was modified with a T90 panel in the extension piece made with 90º turned mesh before the codend. The T90 net had a mesh of 50 mm (nominal), 140 meshes around the extension circumference and 100 meshes length. The results of the field tests were analysed statistically with catch analysis methods, considering that the individuals in the population have equal probability (0.5) of being captured by the test trawl net or the standard trawl net, but retention in each net codend may differ due to the different properties of the modified and standard extension pieces. The results showed a significant decrease in the capture of juvenile Nephrops (below 27 mm of carapace length) by using T90. The study showed that relatively simple modifications in the current trawl gear design used can significantly reduce the catches of juvenile Nephrops in the Mediterranean otter bottom trawl fishery.

Key words: *Nephrops norvegicus*, T90, selectivity, trawl fisheries, Mediterranean sea.

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GROWTH VARIABILITY AND DEMOGRAPHIC STRUCTURE OF NORTHEAST ATLANTIC CHUB MACKEREL (*Scomber colias*) IN SOUTHERN EUROPEAN ATLANTIC WATERS

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Abstract: The Atlantic chub mackerel (*Scomber colias*) is one of the main fishing resources for the fisheries targeting small pelagics in NW African waters. This species is expanding its geographical distribution through higher latitudes in southern European Atlantic waters, and it has become an important fishing resource in Iberian Atlantic waters during the last decades. The present study addresses the growth variability of *S. colias* in the Iberian waters, from southern Bay of Biscay up to Gulf of Cadiz. Age estimates based on otoliths and growth parameters were obtained from specimens collected within the study area during one decade (from both commercial landings and scientific-acoustic surveys), and sexual growth variation was analysed. A common pattern of abundant cohorts was observed in various areas. However, differences in the demographic structure of the catches were observed among the different areas, with the southernmost area studied (Portuguese and Spanish waters off Gulf of Cadiz) standing out with younger individuals. These new findings are of interest for the stock assessment of *S. colias*, which has not been addressed in ICES waters so far.

Key words: Age estimation, Growth, *Scomber colias*, chub mackerel, Atlantic Ocean, Iberian waters

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data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy, by the Instituto Español de Oceanografía (BIOPEL, PELASSES, PELCOSAT and ERDEM projects) and by the Instituto Português do Mar e da Atmosfera (PNAB and SARDINHA2020 projects).

PERCEPTIONS OF THE FISHERY'S SECTOR OF CURRENT MEDITERRANEAN MANAGEMENT MEASURES

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Abstract:

At present, most of the Mediterranean fisheries are overexploited and management measures are needed to improve their situation (Coll et al., 2014).

During this work, interviews were carried out with workers of the fishing sector to evaluate their perception in front of the actual state of the fisheries, as well as on the application of some of the current management measures. The interviews were carried out in the different ports of the province of Castellón.

In this work the fleets were separated between trawlers, purse seiners and artisanal fleets. Main questions relate to the current state of the fishery and to current management measures.

The majority of the workers in the sector interviewed consider that catches have decreased over the last few years. Measures considered important in actual management of the fishery are: i) the time and space closures, ii) the minimum catch depths and iii) minimum sizes of catches.

Key words: overexploitation; fishermen perceptions; Mediterranean fishery management

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BIOTECHNOLOGICAL TREATMENT OF MICROALGAE ENHANCES GROWTH PERFORMANCE, HEPATIC CARBOHYDRATE METABOLISM AND INTESTINAL PHYSIOLOGY IN GILTHEAD SEABREAM (*Sparus aurata*) JUVENILES CLOSE TO COMMERCIAL SIZE

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Abstract

The aim of this work was to evaluate the effects on growth performance, intermediary metabolism and welfare of the inclusion of two commercial microalgae-based ingredients called LB-ChromaBream (LB-CB) and LB-ChromaBream-plus (LB-CBplus) in the diet of gilthead seabream (*Sparus aurata*) close to commercial size. For this purpose, fish of ~182 g of initial body mass were fed to satiety (*ad libitum*) for 41 days with three different diets: i) CONTROL diet (CTRL), with a commercial-like formulation; ii) LB-CB diet, with a 10% inclusion of microalgal product; iii) LB-CBplus diet, with a 10% inclusion of the same product but enzymatically hydrolysed to increase the bioavailability of the nutrients. The results obtained show that the use of these microalgal products leads an overall improvement in productive parameters in terms of growth (15% in SGR) and feed efficiency (11%), as well as a significant reduction in circulating cortisol with the LB-CBplus diet. Observations on plasma and liver metabolites, and particularly on hepatic metabolic enzymes, collectively indicate that microalgae supplementation of feed lead to a better use of carbohydrates as a source of energy in the liver, some sparing of triglycerides within this tissue, and a channelling of hepatic triglycerides to fuels growth. Finally, the specimens fed the supplemented diets experienced a substantial improvement in intestinal health achieved by longer intestines, a higher transepithelial resistance and better apparent permeability measured by electrophysiological methods, especially those fed LB-CBplus, which could lead to an increase in productive performance by improving nutrient assimilation. In conclusion, this study shows that the experimental feeds, especially the one

containing biotechnologically treated microalgae, are suitable for improving some important indicators of growth performance and physiological condition of gilthead seabream, thus revealing the potential for their inclusion in new functional feeds for this species at an advanced stage of the production cycle.

Key words: aquafeeds; enzymatic pre-treatment; gilthead seabream; microalgae.

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LIFE CYCLE ASSESSEMENT OF THE PHOTOSYNTHETIC SEA SLUG *Elysia crispata*

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Abstract: *Elysia crispata* is a sacoglossan sea slug that retains intracellular functional chloroplasts acquired from their macroalgal food sources. This photosynthetic sea slug has lecitotrophic development and stolen chloroplasts (kleptoplasts) are not transmitted vertically (i.e., are absent in eggs and larvae). In this study, sixteen egg masses were monitored during development and a photographic record was made of the most relevant stages: i) fertilized eggs; ii) veliger larvae; iii) post-hatching juveniles; iv) 3-5 days post-feeding juveniles; v) >10 days post-feeding juveniles; and vi) adults. The time span between egg deposition and juvenile hatching was about 14 days. Veliger larvae formed 4 days post-spawning (dps), while stomach and statocysts were visible within 6-7 dps. Metamorphosis was intracapsular. Post-hatching juveniles of *E. crispata* began feeding on *Bryopsis plumosa* within 3-5 days, digesting the macroalgal tissue while incorporating functional chloroplasts. Five months after hatching, when the slugs reached sexual maturity, they started laying egg masses. Identification and control of the different development stages of *E. crispata* and the timing of chloroplast acquisition will contribute allow analysing sea slugs at these different stages, leading to the elucidation of kleptoplasty in sacoglossan sea slugs. Furthermore, the optimization of culturing protocols significantly reduce the number of wild specimens needed for laboratorial experimentation and mitigate the impact of sampling on natural populations.

Key words: *Bryopsis plumosa*, kleptoplasty, larval development, photosynthesis, Sacoglossa.

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ICHTHYOPLANKTON ABUNDANCE AND DISTRIBUTION DURING LATE WINTER BLOOM AROUND THE CANARY ISLANDS IN RELATION TO MESOSCALE STRUCTURES

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Abstract: The study of early life stages (eggs and larvae) of marine fishes is of paramount importance to estimate the fate of marine fish populations, their management, and to estimate their biomass (Moyano et al., 2014). Small pelagic fishes were the objective of most studies carried out in coastal and shelf systems (Brochier et al., 2011). However, the distribution of oceanic ichthyoplankton and their adult populations are less known (Moyano et al., 2014), and their evaluation is of importance to assess their role in the biological carbon pump. The Canary Archipelago disrupts the main flow of the Canary Current (CC), leading to large mesoscale variability such as warm wakes and cyclonic and anticyclonic eddies downstream of the islands. Besides, the African costal upwelling promotes filaments reaching the archipelago and transporting fish larvae (Arístegui et al., 1994; Barton et al., 1998, 2004; Sangrà et al., 2005; Rodriguez et al., 2009). All these physical mechanisms influence the composition and distribution of these organisms (Rodriguez et al., 2009). During March 2022, ichthyoplankton was sampled on board the research vessel Ángeles Alvariño during the scientific expedition RAPROCAN 2203 around the Canary Islands and the African upwelling. Samples were collected by day and night using a Bongo 40 net fitted with nets of 200 μm mesh size and a flowmeter. Hauls were oblique and attempted to sample the surface layer down to 200 m. Our results showed (i) a higher abundance of fish larvae in the upwelling region, especially at nighttime, as expected, (ii) Clupeidae was the most abundant family in the area, and (iii) the abundance of fish eggs did not show any clear distribution pattern.

Key words: fish larvae, eggs, Clupeid, upwelling, eddies, filaments.

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GROWTH AND FEEDING IN THE SURF ZONES OF THREE SANDY BEACHES OF THE GULF OF CADIZ OF THE SPOTTED SEABASS, *Dicentrarchus punctatus* (BLOCH, 1792) AND THE EUROPEAN SEABASS, *Dicentrachus labrax* (LINNEAUS, 1758)

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Abstract: Sandy beaches are used as nursery grounds by juvenile fish due to the availability of food and better shelter conditions. The aim of this study was to analyse in three beaches of the coast of Cádiz the growth and feeding habits in the surf zone of two species of commercial interest: the spotted seabass (*Dicentrarchus punctatus*) and the european seabass (*Dicentrarchus labrax*). Monthly samplings were conducted with a beach seine net during dawn and dusk tides, taking environmental data at each of them. Growth and feeding habits were analyzed using otoliths and stomach contents, respectively. The size range of the individuals was between 3.8-31.5 cm for spotted seabass and 14.4-37.9 cm for european seabass, with age 0+ being the most frequent in both species. Length-weight relationship analysis determined negative allometric growth for spotted seabass (b=2.9383) and positive allometric growth for european seabass (b=3.1161) with an R^2=0.99 for both species. Von Bertalanffy parameters were L_∞=82.202, k=0.072, t_0=-2.696 and L_∞=91.519, k=0.093, t_0=-2.287 for spotted seabass and european seabass, respectively. The length-weight relationship as well as the Von Bertalanffy model obtained for both species were similar to those reported by other authors, although there are some fluctuations conditioned by latitudinal differences. Regarding food habits, crustaceans and fish were the resources with the highest relative importance in both species. Differences in feeding habits were observed according to the time of the year and age class, but not according to the sex of the individuals.

Key words: *D. punctatus*, *D. labrax*, diet, feeding habits, Moronidae, otoliths.

Acknowledgments: We would like to thank the Territorial Delegation of Agriculture, Fisheries and Rural Development of Cádiz for its fast disposition to provide us with the permits for the samplings on beaches.

GROWTH AND REPRODUCTION OF FIVE SPECIES OF THE FAMILY MUGILIDAE PRESENT ON THE BEACHES OF THE CADIZ COAST

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Abstract: Mugilids represent one of the most important commercial resources for estuarine and coastal fisheries in temperate, tropical and subtropical seas. They are also considered as potential fish in aquaculture. The aim of the project is to study the distribution, growth and reproduction of five species of the family Mugilidae: golden grey mullet (*Chelon auratus*), thinlip mullet (*Chelon ramada*), leaping mullet (*Chelon salilens*), thicklip grey mullet (*Chelon labrosus*) and flathead mullet (*Mugil cephalus*). Fish were caught monthly with a beach seine, coinciding with low tide (day and night). For fish growth, otoliths were analysed and growth rings were counted. Regarding fecundity, the volumetric method was used and eggs were counted and measured. Preliminary results show that the size range was between 15-48 cm for golden grey mullet, 20-33 cm for thinlip mullet, 18-22 cm for leaping mullet, 20-50 cm for thicklip grey mullet and 44-52 cm for flathead mullet. These size variations are related to ages from 1 to 6 years for golden grey mullet, between 2 and 4+ years for thinlip mullet, from 2 to 4 years for leaping mullet, thicklip grey mullet is between 2 and 7 years old and flathead mullet from 4 to 6+ years old. In terms of reproduction, egg diameters were generally between 0.2 and 0.8 mm, which varied according to the gonadal stage of the female. Moreover, in the same gonad, different stages can be found, characterised by the way in which the yolk is arranged and the variation in colour.

Key words: Mugilidae, fecundity, growth, coast, eggs, age

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HOW TO APPROACH THE IDENTIFICATION AND ASSESSMENT OF THE CONSERVATION STATUS OF ELASMOBRANCHS CAUGHT IN A DEVELOPING COUNTRY? CASE STUDY OF THE ARTISANAL FISHERY OF MUCURIPE (BRAZIL)

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Abstract:

Global statistics point to a deficiency in the reporting of elasmobranch catch data, with the number of species caught far exceeding those reported to official agencies (Cashion, 2019). Many developing countries, such as Brazil, continue to fail to collect and report fisheries data on catches of elasmobranchs caught as bycatch. The lack of knowledge of the current conservation status of these species puts their populations at risk making them susceptible to decline. In north-eastern Brazil (western equatorial Atlantic), artisanal fisheries have traditionally caught elasmobranchs. Specifically, in Mucuripe (state of Ceará), elasmobranchs have been landed periodically for more than 30 years. During this time, this port has been the object of study for students and researchers, showing the weekly landing of large volumes of rays and sharks that are sold on the beach without any control of the landings. The objective of the present work was to evaluate and describe the capture and trade of elasmobranchs in the port of Mucuripe in order to determine the conservation status of the species that are landed. Data were obtained through observation and photographic collection of beach-side landings (2018-2020), as well as through informal interviews with fishermen. Of the elasmobranchs identified so far: the shark, *Ginglymostoma cirratum* and the stingray, *Hypanus berthalutzae* have been the most landed species, both listed as Data Deficient according to IUCN conservation status.

Key words: Elasmobranch; Conservation; Reporting; Bycatch; Artisanal fishing

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Study of the diet and growth of sand sole (*Pegusa lascaris*) and brill (*Scophthalmus rhombus*) on the beaches of the Cadiz coast.

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Abstract: Sand sole (*Pegusa lascaris*) and brill (*Scophthalmus rhom*bus) are two flatfish species whose fisheries are of great commercial interest, although little information is available on aspects of the biology of both species. The main objective of this work, still in a preliminary phase, is to study the diet and growth of these species from the specimens captured by beach seine netting during sampling on five beaches along the coast of Cádiz. A total of 149 individuals of juvenile sand sole and 107 individuals of brill were analyzed. Stomach contents were studied to identify preferences of prey consumed and otolith growth rings were studied to determine age classes. Both species presented a varied diet where it was observed that sand sole fed mainly on cumaceans (52.09 %), bivalves (33.29 %) and crabs (6.24 %) while in brill digestives, mysidaceans (90.06 %), teleosts (4.52 %) and amphipods (3.28 %) were identified. The growth equation parameters of the Von Bertalanffy model for sand sole were L∞= 36.29 cm, k= 0.24 years-1, t0= -0.91 years and for juvenile brill, L∞= 80.06 cm, k= 0.14 years-1, t0= -0.09 years. With this type of study it is expected to increase the knowledge about the biology of both species in the area.

Key words: *Pegusa lascaris, Scophthalmus rhombus*, Cádiz coastline, diet, growth.

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FISH PATHOLOGY ASSOCIATED TO THE RECENT VOLCANIC ERUPTIONS IN THE CANARY ISLANDS

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Abstract: This work reports the results of pathological studies of fish specimens found dead during the recent volcano eruptions in the Canary Islands. These include: the submarine eruption on the island of El Hierro in 2011, and the terrestrial eruption of La Palma, in 2021, with the impact on marine fauna after the arrival of lava flows to the sea. Fish necropsies were performed at the Fish Pathology Unit of the Institute of Animal Health and Food Safety (IUSA) of the ULPGC.

During El Hierro's underwater volcanic eruption, lasted 145 days, 70 fish specimens of different species were analysed. In most of them, generalized congestion in the gills, liver, heart and rete mirabile of the swim bladder was observed. Some specimens also presented exophthalmia and gastric eversion. In addition, this study allowed us to describe a less frequent pathological condition, affecting only to deep-sea fish species, characterized by the severe formation of gas bubbles detected mainly on the skin and cornea.

The recent eruption of La Palma volcano was terrestrial and with the longest duration registered on the island with 85 days. It was characterized by the deposit of large amounts of pyroclastic material both, on land and the sea. Lava flowed initially on land and, eventually, arrived the sea water creating volcanic lava deltas in different coastal locations. 14 fish specimens of different species, coming from these locations, were analysed. The results showed the presence of ash particles in the opercular/oral cavities, in the gills and, even in several fishes, an intense intestinal impaction was observed, composed of volcanic material including ashes and hyaloclastites fragments.

Key words: gas bubbles, intestinal impactation, ash, lava flows, volcano, El Hierro, La Palma

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SEDIMENT MOBILIZATION AND SEAWATER WARMING AFFECT ECOPHYSIOLOGY OF THE CLAM POLITITAPES RHOMBOIDES

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Abstract: High-energy hydrodynamic events associated to currents and waves may disturb bivalve mollusks ecophysiology, especially those buried in the the sea bed where the bottom boundary layer dynamics may mobilize and resuspend the surface sediments. Evidences of massive mortality for the clam *Polititapes rhomboides* (banded carpet shell clam) in Galicia (NW Spain) have been associated to warm water temperatures and high wave magnitudes above climatic averages and the presence of rickettsias (intracellular prokaryotic colonies) in gills (Villalba et al. 1999; Darriba et al. 2019; Villacieros-Robineau et al. 2021).
Behavioural, ecophysiological and immune system responses of the clams subjected to sediment high mobilization and seawater warming, by increasing the seawater temperature in 3ºC (15ºC *vs* 18ºC), were monitored in the laboratory.
Valve opening of clams was negatively affected by sediment remobilization. Recovery after such disturbance supposed comparable valve opening values than non-disturbed scenario. Seawater warming and sediment mobilization presented additive synergistic effects causing the lowest opening amplitude. Sediment remobilization and warming caused abrupt decrease and increase in clearance rates (CR) of clams, respectively. Reduced valve opening during high sediment mobilization may have altered filtration processes of phytoplankton uptake whereas temperature increase may have not overpassed the optimal range for maintaining filtration activities. Metabolic rate as oxygen consumption (VO_2) showed an increase (greater metabolism) with both seawater warming and sediment mobilization. Both abiotic factors of stress simultaneously gave the greatest metabolism.
Nitric oxide (NO) production increased synergistically with seawater warming and sediment remobilization. The most striking effect was the increased NO response after a second stimulation, suggesting that clams achieve a kind of alertness the first time they are exposed to a stimulus through a mechanism possibly related to "trained immunity".
According to these ecophysiological aspects, energetic requirements and potential effects on tissue growth of *P. rhomb*oides were discussed for these stressors.

Key words: clam, banded carpet shell, ecophysiology, sediment mobilization, seawater warming

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ORIGIN SEARCH OF HARMFUL ALGAL BLOOMS WITH COASTAL MODELS AND SATELLITE IMAGERY

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Abstract:
In 2016, the Basque Government legally declared the Ondarroa-Lekeitio coastal section as a "Bivalve Mollusc Production Area" (BMPA), where production of mussels (*Mytilus galloprovincialis*) is taking place on offshore longlines. An Integrated Marine Observing System (IMOS) was established in 2019 to monitor the presence of biotoxins due to Harmful Algal Blooms (HABs) and to study its possible relation with the environmental conditions during the toxic episodes.
This system includes shellfish biotoxin analysis, phytoplankton identification in water samples, in-situ hydrographic measurements with CTD, a fluorescence sensor measuring continuously, a 3D coastal hydrodynamic model (CROCO) and a Lagrangian particle tracking model (SOFT), high- and mid-resolution satellite imagery (MODIS-AQUA, MODIS-TERRA, VIIRS, Sentinel-2 and Sentinel-3), and ancillary meteorological (wind, precipitation and irradiance) and river input observations (flow and nutrients) from nearby meteorological and hydrographic stations. From January 2019 to December 2021, the concentration of biotoxins in mussels exceeded the regulatory limits several times, mostly due to the okadaic acid, a "Diarrheic Shellfish Poisoning" toxin produced by the dinoflagellate *Dinophysis acuminata* in this area. Also, yessotoxins and "Paralytic Shellfish Poisoning" toxins produced by other dinoflagellates caused the banning of the production on some occasions. However, the "Amnesic Shellfish Poisoning" toxin, which is produced by some *Pseudo-nitzschia* species, was rarely detected.
In this work, we will show how model simulations together with satellite images and in-situ observations obtained during some toxic episodes, can be used to identify the most probable origins of these episodes in the surrounding area. The simulated water circulation was locally validated with the release of a large number of Identified Floating Objects (IFOs).

Key words: satellite imagery, drift, shellfish aquaculture, Harmful Algal Blooms, Cantabrian Sea

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MICROENCAPSULATED DIETS USING THRAUSTOCHYTRIDS AND MACROALGAE SIDE STREAMS FOR *Mytilus galloprovincialis* SPAT

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Abstract: Global expansion of bivalve aquaculture can drive sustainable protein production. Inland culture of mussel spat can play an important role in supporting extensive mussel farming. Nursery culture of bivalves is, however, dependent on nutritious, cost-efficient and more reliable diets for spat. The aim of this study was to assess the impact of dietary alternatives to commercial algal feeds (Shellfish Diet 1800) on the survival and growth of *Mytilus galloprovincialis* spat, widely farmed in Europe. Spat (6.8 ± 1.1 mm) were supplied with different diets for six weeks: commercial microalgal diet (A), microencapsulated feeds containing a 1:1 blend of the macroalga *Undaria pinnatifida* and the microalga *Schizochytrium* (BioBullets; BB), or commercial microalgae and BioBullets combined (ABB). Unsupplemented spat showed no growth and little change in body condition (CI). Spat fed microcapsules grew at comparable rates and body condition rose at higher levels (shell growth rates: 8.5 ± 3.7 μm day^{-1}; ΔCI: 6.1 ± 1.1 %) relative to those fed commercial microalgae (8.5 ± 5.7 μm day^{-1}; ΔCI: 3.3 ± 0.8 %). Supplementing microencapsulated feeds with the commercial microalgal diet did not significantly improve growth performances (9.3 ± 2.3 μm day^{-1}; ΔCI: 4.7 ± 1.4 %) relative to mussels fed microcapsules alone. Microencapsulated feeds for *M. galloprovincialis* spat production can significantly reduce nursery costs compared to commercial feeds or cultured microalgae. By sourcing encapsulated algae from aquaculture side streams, microencapsulated feeds can further promote circular economies.

Keywords: microcapsules, *Mytilus galloprovincialis,* shellfish aquaculture, spat, sustainable aquaculture, sustainable feeds

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ACUSQUAT II:" ACOUSTIC MONITORING OF ANGELSHARK (*Squatina squatina*) BEHAVIOUR IN CRITICAL CONSERVATION AREAS".

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Abstract: The Angelshark, *Squatina squatina*, is a benthic shark that can be found throughout the coastal zone of the Canary Islands. The species is classified by the IUCN Red List as critically endangered, mainly due to overfishing. Increasing the existing knowledge about its habits and distribution will help to ensure the correct management and conservation of the species. It is due to this lack of information on the species that the Acusquat-II project has been carried out. This main objective of the project is to study the circadian rhythms of this species during the breeding season and the seasonal movements of this shark within the areas they use for breeding and mating, many of them of high touristic interest and which could endanger the survival of this species. The study also provide information on the sharks' movements towards deeper waters after reproduce, thus increasing our knowledge of their movements to deeper waters thanks to acoustic tags, a fixed acoustic received net, and an autonomous surface vehicle integrating a mobile receiver onboard, which will allow us to learn more about their ecology and behaviour.

Key words: Elasmobranch, shark, distribution, management, critically endangered

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TELEMETRY AND VISUAL TAG AS TECHNIQUES TO IDENTIFY RAYS DISTRIBUTION AND BEHAVIOUR.

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Abstract: Marine ecosystems are one of the most difficult environments to study, if you add to this the need to increase the knowledge of decimated species like elasmobranch, whose biology, ecology and even more distribution are, in large part, unknown, it is necessary to look forward for new techniques to improve their knowledge.
In the Canary Island, Spiny butterfly ray, *Gymnura altavela*, is a benthonic ray that occasional visit coastal areas during the summer, but after, its distribution and behaviour are already unknown. Tagging techniques have been used, though acoustic tag implanted in the pectoral cavity and T-tag inserted in the dorsal, to increase the information about displacements of this species between coastal breeding areas and deeper waters, and the circadian rhythms in shallow water areas. But we have also used citizen science data provided by coastal users as diver and anglers. With the aim to collect all this ecological and behavioural data, it has been created a network of fixed acoustic receivers along the southern and eastern coasts of Gran Canaria, but also it has been used an autonomous surface vehicle with an integrating mobile acoustic receiver on board.

Key words: acoustic tag, ray, elasmobranch, surgery.

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ECOLOGY AND BEHAVIOR OF THE SPINY BUTTERFLY RAY (*Gymnura altavela*) IN COASTAL WATERS OF GRAN CANARIA, CANARY ISLANDS.

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Abstract: The spiny butterfly ray, *Gymnura altavela*, also known as Mantelina in the Canary Islands, is an occasional benthic species that migrate to very shallow waters of some beaches of the Canary Islands during the summer months. In order to record ecology and behavioural data of this species in these areas, monthly sampling campaigns were carried out between May 2017 and March 2020 in four sandy beaches: Sardina del Norte, Salinetas, El Cabrón and Pasito Blanco, located respectively in the northwest, east, southeast, and south of the island of Gran Canaria. Visual censuses were carried out and were counting the number of specimens present on the beach, identifying sex, and behaviour, but also the water temperature and salinity. The spiny butterfly rays show a preference for shallow water, decreasing their abundance with depth. Displacements of this ray to shallow waters seem to follow a temperature gradient between 19 and 24 Cº, remaining on the coast from June to October. Pasito Blanco beach shows the highest aggregations of individuals per square metre, and the largest individuals were recorded there, while those from Salinetas were the smaller ones. The estimated sex ratio was 1:18.9, with a predominance of females, larger than males.

Key words: abundance, visual census, Mantelina, beaches, campaign.

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OPTIMIZATION OF WATER, ENERGY AND NUTRIENT CONSUMPTION IN THE INDUSTRIAL CULTIVATION OF THE NATIVE CANARIAN STRAIN *Tetraselmis striata*: A CASE STUDY IN POZO IZQUIERDO

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Abstract: Gran Canaria is a strategic site for microalgae production due to its ideal climatological conditions and focal geographic location. The main bottlenecks for microalgae cultivation are energy, freshwater and fertilizer consumption, and management of effluents, all of which represent a relevant cost for the companies and the environment. Fast-growing chlorophytes belonging to the genus *Tetraselmis* are largely cultivated worldwide for industrial purposes such as aquaculture feeding and nutritional supplements. This study addresses the optimization of the cultivation of a *T. striata* native strain at pilot scale (up to 10 m^3) in an operational environment, focusing on the valorization of locally available hydric, energetic and nutrient resources. In order to assess the optimization of water and energy use strategies, *T. striata* was scaled up to 10 m^3 open raceways (RWs) and operated semicontinuously. The used culture medium resulting from the biomass separation by centrifuge (supernatant) was recirculated during 77 days, and a total of 10 harvests were performed. No significant difference in terms of biomass productivity, biochemical profile and microbiological quality between the treatment using recirculated supernatant and the control were observed, pointing out that medium recirculation is a viable strategy to provide a relevant reduction of both the effluent volume and energy associated to new seawater pumping. Additionally, to optimize nutrient use in the cultivation process, cultures in 250-L RWs where gradually induced to nitrogen limitation, in order to identify the minimal concentration of N in the culture medium that does not significantly affect the biomass productivity. There was no significant difference in terms of biomass productivity between the N-limited cultures and the controls. *T. striata* stands out as a promising candidate for large-scale cultivation in the Canary Island. These results pave the way for the development of new cultivation processes based on low resource consumption and minimal environmental impact.

Keywords: *Culture medium recycling, native Canarian microalgae, nitrogen limitation, Tetraselmis striata, water efficiency*

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PILOT-SCALE PRE-CONCENTRATION OF NATIVE CANARIAN MICROALGAE BY THE APPLICATION OF SELECTED FLOCCULANTS

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Abstract: One of the main bottlenecks in microalgae production is the high cost and energy consumption harvesting process which can be up to 30%. This cost can be significantly reduced by the pre-concentration of the culture using flocculants. This study investigated the efficiency of flocculation as a pre-concentration step prior to centrifugation by the application of three different flocculants at pilot scale cultures of three microalgae species native to the Canary Islands (Spain). Natural polymer chitosan and two chemical flocculants $FeCl_3$ and $AlCl_3$ were tested on freshwater *Chlorella sorokiniana* and two marine microalgae: *Dunaliella tertiolecta* and *Tetraselmis striata*. After a preliminary screening at laboratory scale to find the most promising doses of flocculants for each experimental system (i.e., those determining a biomass recovery ≥ 85%), pilot scale cultures were tested in an operational environment to confirm the effectiveness of flocculants. The results of this study shows that chitosan and $AlCl_3$ were efficient in doses of 0.1 g/L where $FeCl_3$ was efficient in doses of 0.2 g/L for *D. tertiolecta* and *C. sorokiniana*. In case of *T. striata*, flocculants were more effective in lower doses: chitosan at 0.04 g/L, $AlCl_3$ at 0.08 g/L and $FeCl_3$ at 0.1 g/L. The composition of the biomass obtained by harvesting the most concentrated fraction after flocculation was determined, and its possible application in food and feed industry. An energy reduction of 10 times was obtained with the use of flocculants as a pre-concentration step compared to a one-step harvesting process by centrifugation only.

Key words: Chemical flocculants, chitosan, down-streaming, native microalgae, pre-concentration

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AREAS OF THE DEUTOCEREBRUM INVOLVED IN THE DETERMINATION OF POTENTIAL PAIN IN THE NORWAY LOBSTER *Nephrops norvegicus* (LINNAEUS, 1758)

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Abstract: *Nephrops norvegicus* is the most fished commercial species of crustaceans in Europe. Currently there are no legislation guaranteeing the welfare of crustaceans. Several studies support the hypothesis that crustaceans are sentient animals and can feel pain, suffering and distress, and that they not only respond to purely reflective stimuli (Birch et al. 2021). However, some authors reported that the evidence attributing sentience-pain-suffering to crustaceans is weak (Browman et al. 2019) since the structural organization and operational capacity of the central nervous system (CNS), is small and simple. The CNS of *N. norvegicus* was recently demonstrate to be complex (Montemar 2021). Moreover, previous studies have indicated that the neurons in the deutocerebrum of decapods are formed throughout the individual's life in neuronal groups 9 and 10. Our project aims to confirm the mitosis in the neuronal groups 9 and 10 of *N. norvegicus*, comparing it in turn with group 11 in which it does not occur. Specimens were collected in trawling boats where three size classes of lobsters were selected, the deutocerebrum was dissected in the laboratory, tissues fixed in formaldehyde (10%) in phosphate buffer, blocks prepared in paraffin and 5 mμ sections stained in methylene blue. For the analysis of the histological sections, we used a digital scanner, then the neurons of the different neuronal groups were identified and counted for each group. We have developed and implemented a method to be able to count neurons in a significant way, which has allowed us to obtain some results such as the density of neurons found by m^2: in group 9 we found 0.023 neurons per m^2. The results from this study will increase the knowledge of the nervous system, to support *N. norvegicus* well-being.

Key words*:* Animal welfare, *Nephrops norvegicus*, Brain, Mitosis, Neurons, Neuronal groups.

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VIII INTERNATIONAL SYMPOSIUM
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MANAGEMENT OF THE MARINE ENVIRONMENT

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STUDY OF THE GROWTH OF *Enteromorpha compressa* (LINNAEUS) NEES 1820 ON DIFFERENT MATERIALS (CONVENTIONAL VS SUSTAINABLE CONCRETE)

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Abstract: The present study aims to compare the growth of the macroalga *Enteromorpha compressa* in different materials. For this purpose, three types of concrete were used: one with conventional composition (control) and two others with different amounts of recycled glass in their composition (low glass concentration (V2) and high glass concentration (V3)). These three materials, in turn, presented three types of roughness (smooth, intermediate and rough) to evaluate the influence of the surface on macroalgae growth. To achieve algae attachment to the different materials, 9.5 x 5 x 5.5 cm rectangular blocks with the different combinations of material and roughness were arranged in a closed-loop aquarium system. Subsequently, *E. compressa* reproduction was induced by three methods: fragmentation, dehydration and "thermal shock". The combination of the dehydration treatment with the "thermal shock" treatment at 4º for 30' proved to be the most effective method to induce the reproduction of this macroalgae. After a period of five months the concrete blocks were extracted and the algal content fixed in each block was evaluated by photographic analysis, dry weight determination and analysis of the amount of total organic carbon (TOC) by means of a carbon analyzer (CHN628 Elemental Analyzer with additional LecoTM S module). The results showed that the material with the highest glass content (V3) and the highest roughness shown the highest *E. compressa* growth and TOC content, and was able to fix 50% more C than conventional concrete. Therefore, this material could be a more sustainable alternative to conventional concrete with a greater capacity to promote the growth of marine flora and fauna on its surface.

Key words: *Enteromorpha compressa*, reproduction, Total Organic Carbon (TOC), concrete.

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EVALUATION OF THE MANAGEMENT OF MARINE PROTECTED AREAS. COMPARATIVE STUDY IN COSTA RICA.

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Abstract:

Costa Rica is one of the most biodiverse countries in the world, and stands out for its commitment to conservation. Along its two coasts, it presents a great heterogeneity of ecosystems and social realities. This paper analyzes the management of three marine protected areas: Santa Rosa National Park, Marino Ballena National Park and Cahuita National Park. The methodology proposed by Maestro et al (2020) was used to analyze four factors: management body, planning subprocess, public participation, and implementation subprocess. The methodology proposes 5 possible scenarios in which priority is given to one or other factors, each of which has consequences on the biophysical and socioeconomic systems that are influenced by the MPA. These scenarios have been termed (from the ideal situation to the least favourable): proactive (1), learning (2), interactive (3), centralized (4) and formal (5) management. The results show that both Santa Rosa and Cahuita present a proactive scenario (1), with high citizen participation, although in practice the way the two MPAs are managed is very different. Marino Ballena, on the other hand, is in scenario 5 (formal), and a series of measures are presented that can move it towards scenario 2 (learning).

Key words: Assessment, Costa Rica, management, marine protected area, socio-ecosystem

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PROBABILISTIC SCHOOL CLASSIFICATION OF MULTIPLE SPECIES IN ACOUSTIC ECHOGRAMS BASED ON MACHINE LEARNING

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Abstract: Multifrequency trawl-acoustic surveys are used worldwide for continuous monitoring of pelagic ecosystems (Horne, 2000). Acoustic backscattering energy partitioning in different species is typically done by visual scrutiny of the echograms with the aid of trawl species composition, which may be subjective and time-consuming (Korneliussen, 2018). Alternatively, machine learning techniques may provide well-stablished, objective, and reproducible methods for automatic school classification in acoustic echograms. The pelagic ecosystem is a diverse one, where many species co-occur in space and time, being mixed catches very common during scientific surveys (Petitgas *et al.*, 2003; Fablet *et al*., 2009). However, most of the school classification models are built using single species composition trawls due to difficulties to assign a class to each school in multispecific trawls. The present study has the aim of developing and comparing different probabilistic multivariate models to identify pelagic species in mixed scenarios based on trawl catch proportions. In addition to the standard predictors, a novel variable, collective mean TS per nautical mile measured on the periphery of the schools, has shown to play an important role in species discrimination. The methods were applied on data from 7 consecutive years of an acoustic survey in the Bay of Biscay. Preliminary results yielded classification performances near 95 % in classifying 10 different pelagic species.

Key words: Machine learning, classification, multivariate, pelagic species, mixed scenario

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POINT PATTERN ANALYSIS AS A CONSERVATION TOOL FOR ASSESSING DISEASE SPREAD AND POPULATION FEATURES IN REMAINING SANCTUARIES OF *Pinna nobilis*

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Abstract: An emergent disease has brought the endemic Mediterranean pen shell, *Pinna nobilis* L., to the brink of extinction, and last remaining populations are currently relegated to coastal lagoons and bays featuring salinities outside the 36.5 to 39 range (Cabanellas-Reboredo et al., 2019; Prado et al., 2021). Point pattern analysis was used in three areas of the Alfacs Bay (Ebro Delta) still hosting live pen shells to assess the possible undergoing of disease spread by comparing the spatial distribution of live individuals vs. empty shells across spatial scales. We also evaluated the importance of other ecological aspects of relevance for conservation such as the size distribution of individuals, and the possible association to seagrass habitats. The population assessment showed no recent mortality and a clear dominance of large adults among empty shells (97.3%) pointing to no disease spread during the study period. At the low spatial scale Nearest Neighbor (NN) analyses evidenced significant clustering (NN Ratios of 0.4-0.8), but in one of the zones NN distances were closer in empty shells than in live individuals, suggesting a former localized outbreak. At the larger spatial scale, MDSCA confirmed clustering patterns up to distances of 115 to 190 m, with higher aggregation of empty shells at the same study zone. The bay also featured low juvenile availability (3.2%), which risks the continuity of the population. No evidence for habitat or conspecific selection could be observed from abundance patterns and variation

in NN across study regions. Our research provides a tool for assessing population condition in paralic environments, where salinity conditions tend to slow down disease spread, thus allowing a time gap for undertaking conservation decisions.

Key words: Pen shell; spatial clustering; GIS; size class structure; population condition assessment; Mass Mortality Events; habitat type

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MARINE SPATIAL PLANNING IN THE MACARONESIAN REGION. IMPLEMENTING EUROPEAN DIRECTIVE THROUGH TRANSBOUNDARY COOPERATION

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Abstract: The Marine Spatial Planning Directive specifies that member states must cooperate and ensure that their marine plans are coherent for the entire marine region in which they are located. The research presented here aims to articulate, in a participatory way, a pilot cross-border cooperation programme for marine planning in the European Macaronesia region (Canary Islands, Madeira and Azores). The work was carried out within the framework of the European MarSP project (www.marsp.eu).
The research is based on an integrated analysis of the marine socio-ecological system for the Macaronesian region. It identifies jointly and for the three archipelagos the pressures and impacts on the main marine ecosystems. In addition, a diagnosis is made of the governance system in the region, from the sub-national level, through the national level, to the European level. In this way, the institutional and legal keys are obtained to address the MSP jointly, based on cross-border cooperation. On the other hand, a participatory process is elaborated and developed in the region in order to highlight the main problems, as well as possible options for improvement in the management of the marine environment. The result is to provide a cross-border programme from which the region can benefit, and also to have a common position in European and international forums in line with the needs of a shared marine area.

Key words: MSP Directive, transboundary cooperation, public participation

CHARACTERIZATION OF BOTTOM TRAWL DISCARDS FROM THE CATALAN COAST (NW MEDITERRANEAN)

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Abstract: Multispecific fisheries generate large amounts of discards, which is an important concern for sustainable fisheries management. Monitoring the evolution of the discards and the diversity and size of the discarded species is essential to fully assess the effects of trawling on marine ecosystems and to propose effective management measures. This study aims to advance knowledge on the discards from the Catalan bottom trawl fisheries in the NW Mediterranean Sea. Discards ratio, species composition and discarding by length were analysed from data collected on board commercial trawlers, from November 2019 to December 2020 at different areas, depths and seasons. The discard ratio varied among depths ranging from 30.5 in the shallow shelf (< 75 m depth) to 14.3 in the lower slope (500 - 800 m depth). Depth was the main factor determining the species composition of the discards according to the nMDS analysis, although spatial and seasonal variability on species composition were also observed. Individuals below the Minimum Conservation Reference Size (MCRS) in the discarded catch were more abundant in shallower depths, mainly explained by the higher abundance of European hake juveniles. This study also focused on the discards of six commercial species, four fish, i.e. European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), black-bellied angler (*Lophius budegassa*), poor cod (*Trisopterus capelanus*), and two crustaceans, i.e. deep-water pink shrimp (*Parapenaeus longirostris*) and Norway lobster (*Nephrops norvegicus*). For all these species, the length at which 50% of individuals were discarded (L50) was lower than the Length at First Maturity (LFM) and the MCRS. Our findings provide relevant information to follow the Marine Strategy Framework Directive for the ecosystem approach to fisheries and to evaluate measures, such as gear selectivity and spatial management, for a sustainable management of trawling fisheries.

Key words: Trawling, fisheries, discard ratio, discard diversity.

RESIDUES OF SOLAR PRODUCTS ON LAS CANTERAS BEACH: INFLUENCE OF COVID-19

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Abstract: UV filters (UVFs) and UV stabilisers (UVSs) are emerging pollutants frequently used in personal care products (PCPs) (Wu et al., 2018), like cosmetics or sunscreens, to protect the skin from radiation (Picot-Groz et al., 2018). Since some of these compounds have been classified as toxic, bioaccumulative and persistent in the environment (Fivenson et al. 2021) and given the few existing preliminary studies (Montesdeoca-Esponda et al., 2021), it is imperative to examine them and provide extensive monitoring.

In this study, a fifteen-month monitorization was carried out to determine twelve UVFs and UVSs in different matrices of the coast of Bahía del Confital in Gran Canaria (Canary Islands, Spain) in order to observe their presence and distribution. Comparison among the found concentrations of the selected compounds during and after the confinement by COVID-19, shows how the use of PCPs could cause a direct increase of their presence in the environment.

Seawater, sediments and algae were sampled along the coast of ``Bahía del Confital´´ at eight different locations. Extraction methods based on solid phase extraction (SPE) and microwave-assisted extraction (MAE) followed by ultra-high performance liquid chromatography with mass detection (UHPLC MS/MS) were used to quantify the analytes in the liquid and solid samples.

Target UVFs and UVSs were measured in water, sediments and algae, at concentrations in the ranges 3.50-56.1 ng/L, 0.64-368 ng/g and 0.06-601 ng/g, respectively. The compounds studied had different trends of accumulationin liquid and solid samples due to their octanol/water partition coefficient (K_{ow}). Most of the samples with highest concentrations corresponded to the areas where there was more touristic activity and bathers. The obtained results showed an increase in the presence of these compounds when the population was allowed back in the beach after lockdown.

Key words: UV filters and stabilizers, seawater, sediment, algae, Las Canteras, COVID-19

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MATH4FISH
NEW TOOLS FOR MATHEMATICAL MODELING IN THE SCIENTIFIC ADVICE OF SPANISH FISHERIES

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Abstract: One of the main outputs of the MATH4FISH project will be a tool that facilitates, optimises and automates the organisation and incorporation of data into fish stock assessment models. The results of these models are currently used to provide scientific advice and to incorporate them into management strategy evaluation platforms to test different harvest control rules for fishery management. The flow of data and the difficulty of simulating scenarios has increased proportionally with the complexity of the models currently used to assess the stocks fisheries. Thanks to these models, it is possible to process all available information with great flexibility. However, these models are particularly complex and require highly specialised mathematical knowledge. A large part of the process can be automated through the creation of new tools that facilitate their development and simulations that also allow management plans to be evaluated jointly with representatives of the fishing sector. To this end, the objective of this project is the development and implementation of a robust, transparent and efficient virtual information infrastructure that will address the major needs for mathematical modelling used for scientific advice on fisheries. In particular, the project will be developed through these sub-objectives:

a) **Organisation** and **automation** of data incorporation within models.
b) **Migration** between models with emphasis on integrated models.
c) Organisation and automation of the presentation of results necessary for the approval of models in "Benchmark" processes.
d) Development of simulation environments for management strategies or plans (**MSE, Management Strategy Evaluation**).

Key words: Fisheries, Stock Assessment, Management Strategy Evaluation, Mathematical modelling, Automation.

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VIII International Symposium on Marine Sciences 2022 (ISMS)
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FISHING SELECTIVITY AND REDUCTION OF DISCARDS IN BOTTOM TRAWL FISHERIES AT NORTH EUROPEAN ATLANTIC WATERS.

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Abstract:

In the Atlantic waters of Northwest Europe, in the 'Great Sole fishing ground' (area ICES7), a bottom trawling fishery operates targeting demersal species, mainly megrim, monkfish and European hake. Due to the multi-specific nature of this mixed fishery there is a need to develop technical solutions and more selective fishing gears to minimize discarding and bycatch as a stepping-point to phase out discards in European fisheries (Uhlmann et al., 2013). But often these European regulations are difficult to achieve within the current limitations of distribution of fishing quotas and the selectivity characteristics of some fishing gears, such as trawls.
The collaborative scientist-fishing industry project 'RAPANSEL' addresses the quantification and improvement of selectivity in the fishery through the identification, development and testing of technological improvements in fishing gears. The aim is to reduce the volume of unwanted catches in the fishery preserving the catchability of the target species without endangering the economic viability of the fishing activity.
A series of 4 experimental trials have been carried out from 2018 to 2021. Observers on board a representative fishing vessel of this fleet carried out comparative studies between a modified selective codend and the common codend used by the fleet. Scientist and fishermen chose several experimental designs (following Wileman et al., 1996), setting up fishing gears in which changes were introduced to improve selectivity parameters of the gear such as mesh size, geometry shape, twine thickness, and introduction of selectivity devices as Square Mesh Panels (SMP).
In this work, the outcomes of the different tests are shown, being the square mesh panel with a 180 mm mesh size the one with the best results. This design allows a great reduction of unwanted catches due to lack of quota, such as cod and haddock, and also the escape of small target fish.

Key words: Trawling, Selectivity, Fishing technology, Discards, Bottom-trawl

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BIOLOGY OF SEA CUCUMBER *Parastichopus tremulus* IN NORTH ATLANTIC WATERS

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Abstract: The red sea cucumber, *Parastichopus tremulus* (Holothuroidea), inhabits in the northeast Atlantic, from north European waters of Norway and Iceland to southern Europe, with occasional records in the Canary Islands (Schagerström and Sundell., 2021). *P. tremulus* can be found at depths from 20 m to 1900 m, inhabiting muddy floors, mainly. This species is a medium-sized with a cylindrical and elongate body, with a red dorsal part and a white ventral part (Christophersen et al., 2020).

The red sea cucumber is poor studied and stock status is unknown since stock boundaries of this species in the area are not yet defined. This species has been discarded in trawling fisheries as a non-commercial species and lack of market. However, an increasing trend on landings of this species has been detected in bottom trawling European fisheries during last years. It is necessary to improve biological and ecological fisheries knowledge to manage appropriately the species.

P. tremulus was biologically sampled from fishing commercial catches at a monthly scheme collecting biological data (length distributions, weight, sex and maturity stage) of specimens caught at the northeast Atlantic, including several fishing grounds: Great Sole, Porcupine and Rockall. Specimens were collected between 2017 and 2018 from 400 m depth onwards. Obtained results indicate that *P. tremulus* fishing captures sizes have a mean of length of 200 mm and 200 g mean weight. The reproduction period seems to occur during winter season (December-March) in the studied area. The highest number of gonads in mature state corresponds to months of January and February. A large proportion of individuals were in resting stage from March. Outside the reproductive period, most of individuals presented poorly developed gonads. Data on biological cycle and fishing ecology contribute to a better knowledge of the species, management of this poor-data fishery and conservation of stocks.

Key words: *Parastichopus tremulus*, Reproductive cycle, Sea cucumber, Invertebrate biology, North Atlantic waters, Gonadal maturity

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CETACEAN EXCLUDER DEVICES TO MITIGATE THE DOLPHIN BYCATCH IN PAIR TRAWL FISHERIES

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Abstract:
Fishing bycatch mortality is one of the greatest threats to cetaceans worldwide. Approximately 500,000 marine mammals are accidentally caught each year by different fisheries around the world (1, 3). Over the last decade, a concerning increase in the number of strandings with bycatch evidences has been recorded in the Bay of Biscay and Iberian Coast MSFD subregion (ABI). For 2020, annual bycatch estimate of common dolphins (*Delphinus delphis*) was higher than the annual estimate, of around 4,000 individuals, for 2016-2018 in this subregion (2). OSPAR provides a threshold of 985 individuals for annual anthropogenic mortality, demonstrating their vulnerability to fishing gears.
In 2020, the European Commission stated a request on emergency measures to prevent bycatch in the Northeast Atlantic. ICES proposed several measures. To address this issue, the CetAMBICion project brings together France, Spain and Portugal, in a joint program, trying to estimate and reduce cetacean bycatch in the ABI, in collaboration with the fishing industry. The objectives are aligned with the Habitats Directive and the Common Fisheries Policy.
Bycatch and stranding rates per fishery have been used to identify the areas and gears with greatest risk of producing bycatch of cetaceans. Researchers have tested technical fishing measures, such as acoustic deterrents and cetacean excluder devices (CEDs), to mitigate bycatch on board pair trawling in northern Spain. The CED consists of a net device with a grid that allows fish to enter the net and dolphins to exit at the top of the fishing gear, being effective in releasing cetaceans and other bycaught species. Criteria for determining its effectiveness in the fishery studied must include both success rate of dolphin releases and no losses in fish catches. Therefore, each device must be designed specifically for each fishery. The first trials of devices designed for pair trawling are showing promising results.

Key words: Bycatch, Cetacean, Trawling, Technology

Acknowledgments: The authors acknowledge the collaboration of fishing associations and crews of fishing vessels during pilot experiments at sea. This work was made within the Project 'Coordinated Cetacean Assessment, Monitoring and Management Strategy in the

Bay of Biscay and Iberian Coast sub-region (CetAMBICion)' cofounded by European Commission's DG ENV/MSFD 2020 (Marine Strategy Framework Directive) call.

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ANALYSIS OF OFFSHORE WIND ENERGY IN SPAIN OPPORTUNITY OR CONFLICT? CASE STUDY: CÁDIZ

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Abstract:

Offshore wind is an unlimited, clean and renewable energy source that is presented as an alternative to achieve the objectives of decarbonisation and tackle the effects of climate change. The main objective of this work is to analyse the situation of offshore wind energy in Spain, taking the Gulf of Cadiz as a case study. In order to carry out this work, numerous and diverse sources of information have been used and the work has been divided into three stages: 1) Planning and search for information, 2) Selection of the case study and 3) Diagnosis of the case.

From the management point of view, Spain only has the Royal Decree (RD) 1028/2007 that establishes the administrative procedure for the processing of applications for authorisation of electricity generation facilities in the Territorial Sea and the "Marine Spatial Management Plans" (POEM), which are regulated through Royal Decree 363/2017 framework for the management of maritime space. In addition, there are physical and socio-economic disadvantages that mean that Spain does not have any fixed wind farms in its waters. One of the biggest drawbacks could be that it has a narrow continental shelf, so floating wind energy is presented as a possible solution. The coast of Cadiz has great wind energy potential, however, there are several disadvantages when planning a project of this magnitude.

To date, several projects have been presented but have not reached the construction phase due to this opposition. This is why there is a need for research projects to show the different opportunities it offers. In general, if this sector is to be boosted in Spain, it will be necessary to raise public awareness, promote renewable energies and review the legal framework. It can therefore be concluded that a change in public policies is necessary to speed up the process with all the guarantees regarding environmental and social impact.

Key words: Offshore wind farm, renewable energy, offshore wind energy opportunities, Marine Spatial Management Plans.

SEA TURTLE STRANDING RECORDS AND FISHING INTERACTIONS ON AN OCEANIC ATLANTIC ISLAND (TENERIFE, CANARY ISLANDS)

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Abstract:
Sea turtle populations have suffered a significant decline in recent years, mainly due to anthropogenic causes (Mazaris et al., 2017). The Canary Islands are a passage and feeding area of sea turtles (Musick, 2013). Historical stranding records in the archipelago have revealed a high frequency of strandings of *Caretta caretta* and *Chelonia mydas*. Tenerife is one of the most island with the highest turtle strandings, with 1,895 strandings recorded in 23 years (Hurtado-Pampín et al., 2022). Our study attempts to characterize these stranding records and to explore their causes, among which are the interactions with fishing gear and different types of marine debris. We have also delved into the interactions between turtles and the island's professional fishermen, incorporating small-scale artisanal fishers as informants on the current state of the turtle populations (Gilman et al., 2010; Panagopoulou et al., 2017). Their participation together with the collaboration of the La Tahonilla Wildlife Recovery Center technicians have been essential to confronting the detected issues. The study showed that the main cause of stranding for sea turtles is fishing gear that drift into Canarian waters, specifically nets and hooks. It has been characterized that this fishing gear comes from other fleets larger than the island's artisanal fleet. They are mainly influenced by the surface longlines from the East Atlantic and the Iberian Peninsula (Ferreira et al., 2003; García-Barcelona et al., 2013). Furthermore, the individuals affected by this problem in the study area correspond to juvenile sea turtles (Bolten, 2003). On the other hand, a lack of knowledge of the correct handling of stranded turtles by the fishing sector was detected. Therefore, the implementation and improvement of awareness conservation plans for sea turtle populations in Tenerife is of vital importance in order to improve the current situation (Peckham et al., 2016; Ferreira et al., 2011).

Key words: Sea turtles, *Caretta caretta*, *Chelonia mydas*, stranding, fishing gear, longline fisheries, productivity

Acknowledgments: This research was only possible by constructing collaborative knowledge between fishers, scientists, and local experts. We would like to thank all the fishers that collaborated with this study, especially the secretaries and leaders of the *cofradías* in Tenerife. We would also like to acknowledge the island government, *Cabildo de Tenerife*, and especially to Agustín Espinosa and the managers of Centro de Recuperación de Fauna Silvestre La Tahonilla, for their essential and valuable contribution as experts and for their advice and encouragement. This study was partially funded by Grupo de Acción Costera de Tenerife (GAC) through the project "Outreach and awareness actions on sea turtle populations in the waters of Tenerife," which was managed thanks to the Fundación General Universidad de La Laguna support.

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RISK OF BIOINVASION CAUSED BY BALLAST WATER FOR THE PORT OF LAS PALMAS

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Abstract:

Shipping activities play a key role in the introduction of non-indigenous species (NIS) into coastal ecosystems, and ballast water acts as a central vector for transporting NIS between ports around the world. According to the Ballast Water Management Convention (IMO, 2004), a risk assessment must be carried out to avoid the release of new viable harmful species. This work analyses the risk assessed with a model (David, M., & Gollasch, S., 2018) that allows an evaluation according to the eight principles prescribed in the G7 guidelines of the International Maritime Organization (IMO, 2007). An application of this model was carried out using a three-year data of ships calling at the port of Las Palmas (Canary Islands, Spain). Besides, as part of the @Blueport project, a monitoring of NIS was done in 2021 similarly to a previous sampling from 2014, to pinpoint the introduction of new NIS in the port. The monitoring and risk results were compared to other regional studies on origin of NIS in the archipelago, and to other possible vectors (e.g. natural dispersion and biofouling) facilitating the transport of NIS. The uncertainty of the information on presence of the invasive species was considered as an indicator of increased risk as the model could overestimate the potential introduction of NIS. Thus, the precautionary principle of the IMO could lead to managing and treating large volumes of ballast water categorized as unacceptable risk.

Key words: (3 to 6 key words):

Canary Islands, Ballast Water, Risk Assessment, Non-Indigenous Species.

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DESCRIPTION, THREATS AND MANAGEMENT OF MARINE PHANEROGAMS (*Posidonia oceanica*) IN ANDALUCIA

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Abstract: Urban expansion plus development of infrastructures and a variety of economic activities in the Andalusian coastline result in a sort of negative impacts over the meadows of marine phanerogams (Ruiz et al., 2015). Furthermore, this species are keystone species whose loss involve the death of many others (Mills, 1993). At present, there is a monitoring network of Posidonia oceanica (POSIMED). This monitoring network shows a demographic decrease in 2012-2020 (Informe Regional, 2020) of Posidonia oceanica.
The results of this study indicate the demographic and density variation of Posidonia oceanica in Andalucia. Moreover, this study establishes the different management measures to keep or improve the Posidonia oceanica status in Andalucia.

Key words: Posidonia oceanica, urban, expansion, keystone, Andalucía.

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FISHING HOOKS IN CANARY ISLANDS MARINE WILDLIFE – A LETHAL RELATIONSHIP

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Abstract: Professional and recreational fishing are two widely spread activities in the Canarian archipelago, where a broad variety of marine wildlife species and marine-bound species can be found. Therefore, it is important to recognize how fishing-activities impact over the marine species of the Canary Islands.
In this study, seven cases of marine wildlife species (including avian and reptiles) were necropsied as part of the Animal Health Surveillance Program coordinated by the Canarian Government (Red VIGIA). Between 2020 and 2022 seven animals presented fishing hooks attached to the body surface or ingested. In a grey heron (*Ardea cinerea*) two fishing hooks were located attached to the body, in another grey heron, a yellow-legged gull (*Larus michaellis*) and two loggerhead sea turtles (*Caretta caretta*) they were ingested and in an eurasian whimbrel (*Numenius phaeopus*) they were found attached to the legs as well as ingested. They caused internal organ perforation and inflammatory lesions in adjacent soft tissues that led to secondary bacterial infections. Also oesophageal obstructions by the hook and inflammation impair feeding, leading to starvation in several individuals. In another yellow-legged gull that died due to a systemic protozoal infection the finding of a hook in the ventricle was considered an incidental finding.
Fishing hook traumas can result in death by causing life-threatening lesions, leading to sepsis or inanition. This preliminary study confirms that fishing activities are negatively affecting the Canarian marine wildlife. Further investigations are needed to understand the impact of this anthropic activity on marine species populations.

Key words: Fishing hooks, seabirds, turtles, marine wildlife species, Canary Islands.

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THE MARINE RESERVE OF FISHING INTEREST OF THE GUADALQUIVIR RIVER: AN EVALUATION OF THE INSTRUMENT

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Abstract:

In 2004, an important part of the Guadalquivir River mouth was declared as a Marine Reserve of Fishing Interest (MRFI), resulting in the zoning of three priority areas (A, B and C) in order to manage the different activities. In 2010, a new zone was added (D), resulting in 402 km^2 for the whole MRFI. The purpose of this research is to evaluate the effectiveness of the MRFI instrument and its management since the reserve creation 18 years ago. The evaluation was structured in two main sections: a governance analysis in the reserve, based on the Decalogue for the integrated management of coastal areas (Barragán, 2010; 2014); and a human well-being analysis, following the criteria of the 7 categories defined by Jones et al., 2020. The results indicate a lack of leadership in the management of the MRFI, which has resulted in poor coordination among the main actors, and weak functioning of the Monitoring Commission. The lack of strategic planning in the reserve, not even having a specific annual budget to plan long-term actions, has resulted in a simplified management effort structured by those zones. These analyses revealed zoning have become the objective of the instrument, instead of being just on action. In summary, the MRFI of the Guadalquivir River is characterized by its reactive management. A clear example of this, is the management response generated to face the invasive species of blue crab *Callinectes sapidus* (Carmona and Flores, 2020), whose urgent control required from long-time regulation changes according to the current model. This research proposes recommendations to improve the governance system of this MRFI in order to achieve an adaptive ecosystem-based management in accordance to the management needs of this dynamic reserve.

Acknowledgments: We appreciate the collaboration of each of the stakeholders interviewed for sharing their experiences in the MRFI of the Guadalquivir River

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HISTORY OF AN INVASION: *Cronius ruber* IN THE WEBBNESIA ECOREGION

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Abstract: Non-indigenous species (NIS) are considered invasive species when they induces a harm for human health or are causing a negative impact at ecological or economical scale (Ref). Nevertheless, the ecological impact stemming from a biological invasion is the most poorly understood aspect of the invasion process (Ref). As a case study, we described and discussed the time-line of a marine NIS detection in Oceanic Islands and the efforts to elucidate its potential as invasive species. Life history traits of *Cronius ruber* are summarized. Reproductive biology, fecundity, reproduction period, growth, foraging behavior and feeding ecology were presented. The invasiveness of the species was screened using the Aquatic Species Invasiveness Screening Kit. Monitoring strategies were presented to describe the evolution of their biomass, the possible introduction vectors and the time since introduction. Finally, we emphasized the importance of international collaboration and the application of long-term monitoring programs to face the major driver in biodiversity loss.

Key words: invasion process; invasive crabs; NIS; life history traits; monitoring; risk assessment tool.

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RADIOLOGICAL IMPACT OF EL HIERRO SUBMARINE VOLCANO ON THE BROWN ALGAE *Lobophora variegata*

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In this work, we present the radiological impact in the surroundings of the Tagoro submarine volcano several years after its eruptive analysing marine environmental samples. For this purpose, besides collecting coastal water, brown algae *Lobophora variegata* were collected along the coastal perimeter of El Hierro island, with the aim of using them as an environmental dosimeter due to their high accumulation power. Radionuclides analysed by alpha and gamma spectrometry were ^{238}U, ^{234}Th, ^{234}U, ^{226}Ra, ^{210}Pb, ^{210}Po, ^{235}U, ^{228}Th, and ^{40}K. The activity concentrations, concentration factors (CF) and ratios were calculated for all the samples considering the area affected by the volcano and the unaffected area. In the latter case, *L. variegata* algae collected on Las Canteras beach were also analysed. Lower values of activity concentrations for ^{234}Th and ^{234}U were measured in La Restinga zone (1310 ± 50 Bq/Kg; 5.8 ± 0.6 Bq/Kg) than ones obtained in the other areas non affected by the volcano (1660 ± 70 Bq/Kg; 7.5 ± 0.6 Bq/Kg); however, they were higher in El Hierro (1570 ± 60 Bq/Kg; 94 ± 8 Bq/Kg) than in Las Canteras (600 ± 30 Bq/Kg; 77 ± 8 Bq/Kg). Respect to coastal water samples, activity concentrations for ^{210}Po measured in El Hierro island were considerably higher both in volcano zone and in Las Canteras beach. The calculated CF in algae from both islands do not seem to show any noticeable difference. For the ratios among the radionuclides, those close to equilibrium were associated to conservative radionuclides (^{234}U and ^{238}U) and those in not equilibrium to reactive particle (^{234}Th, ^{210}Po and ^{210}Pb). Finally, two-way ANOVAs tested for differences in the radionuclides' activity concentrations and the activity concentration ratios, between the two areas (affected and non-affected) and sites within each area were performed. Significant differences between El Hierro and Las Canteras, mainly for ^{40}K and ^{234}Th were found.

Key words: Submarine volcano, Brown algae, Environmental dosimeter, Natural radionuclides

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FEEDING HABITS OF AMPHIPODS ASSOCIATED WITH FISH-FARS IN THE MEDITERRANEAN SEA

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Abstract: Mediterranean aquaculture is characteristically developed in off-coast areas, located between 0.5 to 3 km from the shore. There, fish-farms provide suitable surfaces and food supply for a wide group of marine species able to colonise and settle on these artificial structures. Amphipods are the most important group of invertebrates associated with fouling communities on aquaculture facilities, where maintain high population densities and take advantage of aquaculture wastes (Fernandez-Gonzalez et al. 2017, 2018). The aim of this study is to analyse the feeding habits of amphipods associated to fish-farms in order to determine the importance of feed pellets as new trophic resource in comparison to other potential diet components. For this, gut contents of amphipod species commonly found in fish-farm fouling were examined using the technique developed by Guerra-García and Tierno de Figueroa (2009), quantifying main diet components such as detritus, phytoplankton, crustacean, or other marine preys. A total of 110 specimens were examined. The dominant diet component for all studied species was detritus, representing between 90- 95% of gut content. Other representative components were dinoflagellates (2%) found in *Caprella equilibra* or animal preys such as crustaceans and nematods (5%) in *Elasmopus rapax*. The high content of detritus in amphipods associated with fish-farming facilities may be directly related to organic matter intake from uneaten feed pellets and other aquaculture wastes, which have been shown using other techniques such as fatty acids profile (Gonzalez-Silvera et al. 2015, Fernandez-Gonzalez et al. 2018). More studies using gut contents together with other detection techniques are necessary to verify the origin of the organic matter ingested and the potential of amphipods as biofilters of aquaculture waste in the marine environment.

Key words: Amphipods, fouling, gut contents, aquaculture, Mediterranean

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COMPUTED TOMOGRAPHY: A USEFUL DIAGNOSTIC IMAGING TECHNIQUE BEFORE NECROPSY PROTOCOL

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Abstract: Diagnostic imaging techniques are advantageous methods for helping diagnose without altering the animal's current state (Lugo-Fagundo et al., 2021). In particular, computed tomography allows us to observe the different tissues with a different grayscale. These will be related to the ability of the tissues to reflect X-rays.
For the diagnosis of the cause of death, a necropsy protocol is necessary (Jsseldijk et al., 2019). It is essential to follow the protocol to have a standardization of the method and to be able to observe objectively. However, some adaptations of the protocol may be influenced by the situation (species, sex, condition of the specimen, etc.). Before the necropsy, a diagnostic imaging technique can give an idea of the condition of the tissues inside the animal (Kot et al., 2020). Consequently, the protocol can be refined to improve the diagnostic purpose. For example, the knowledge of a probable foreign body, displayed with a different grayscale, can lead to operation, during necropsy in a specific body region, with greater attention to visualizing the body and the consequent lesions. Therefore, carrying out diagnostic imaging prior to the necropsy is an excellent help for diagnosis.
Between January 2021 and March 2022, computerized tomography scans were carried out on 22 specimens belonging to 6 different species (*Stenella coeruleoalba, Stenella frontalis, Delphinus dephis, Tursiops truncatus, Globicephala macrorhropsynchus, Grampus griseus*) prior to the necropsy protocol. The main findings were fractures, pneumothoraxes and the presence of foreign bodies.

Key words: Computed tomography, foreign body, diagnostic imaging techniques

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MAPPING AND ASSESSING THE MARINE GREEN INFRASTRUCTURE IN THE CANARY ISLANDS: AN APPROXIMATION THROUGH AN ECOSYSTEM SERVICE SUPPLY APPROACH

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Abstract: Integration and operationalization of ecosystem services (ES) into coastal and marine planning processes has got growing political and scientific interest in the past decades. We have explored the existing literature reviews for the European Seas to build an ES matrix to assess and map the supply of multiple ES for the first time at a regional scale in the Canary Island. Enabling data harmonisation through international classifications, we have assessed the causal relationships between 34 benthic habitats and 42 ES. Existing geospatial data on both coastal and deeper habitats distribution have been applied to map the ES abundance. It has been possible to confirm either the presence or absence capacity of habitats to provide ES in 58.9% of the cases. Results showed that ES concentration near the coast is noticed in volcanic islands with limited and abrupt continental shelf. Besides, cultural ES were the most well covered and that provisioning ES have been underestimated in the study area as well as services provided by deep-sea habitats. The developed ES matrix is a flexible and easy to update framework in the light of future new information. The generated ES maps can be interpreted as the marine green infrastructure of the Canary Islands following the ecosystem service-based approach. The usage of the ecosystem service concept enables to incorporate the potentially large societal benefits that marine ecological structures can provide to islander's well-being. This study serves as a foundation in the Canary Islands for ES integrated assessments considering the functioning of marine ecosystems further as well as the cumulative impacts of the maritime activities. Finally, we highlight a series of limitations to be considered to inform decision-making in the search for sustainability.

Key words: Ecosystem services, Marine Spatial Planning, Ecosystem-based approach, Outermost regions, Matrix model, Canary Islands.

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ANTHROPIC FACTORS AS A CAUSE OF DEATH OF MARINE BIRDS IN THE CANARY ISLANDS

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Abstract: In the Canary Islands, the impact of human activities on marine birds is unknown. This study aims to evaluate which species are affected, frequency of affectation, most vulnerable species and anthropogenic activities are involved, in order to implement future preventive measures for conservation.
In the present study, complete standardized necropsies of Canarian seabirds have been carried out, which, through the Animal Health Surveillance Program coordinated by the Government of the Canary Islands (Red Vigía Canarias), have been sent to the Veterinary Faculty of the University of Las Palmas de Gran Canaria. With the collaboration of the Clinical and Analytical Toxicology Service (SERTOX), the presence or absence of toxic substances and their involvement in the cause of death were determined.
Inclusion criteria: Marine birds necropsied during 2020 and 2021, complete standardized necropsies and anthropic death as a pathological entity. Cases of interaction with fishing have been excluded from this study. 57 animals belonging to 9 different species (A.cinerea, A.purpurea, B.bulweri, C.diomedea borealis, C.alexandrin, C.dubius, E.garzetta, L.Michaellis, P.haliaetus), exceeded the criteria for inclusion and exclusion of a total of 291 necropsied animals. An analysis of frequencies (absolute and relative) and Pearson's Chi-square test ($p<0.05$) were performed to establish the comparison of proportions between the variables analyzed (etiological diagnosis, type of trauma, species, body condition, origin and presence of microplastics in the digestive system).
The etiological diagnoses were categorized into: Intoxication, electrocution and anthropogenic trauma. The traumas were categorized as: collision with a wind turbine, collision with an overhead power line, collision with a motor vehicle, collision with an aircraft, poaching, and being run over. Preliminary results reveal that 92.99% die from trauma (illegal hunting, collision with an aircraft and collision with a wind turbine, the most frequent traumas). 5.26% due to intoxication and 1.75% due to electrocution.

Key words: Anthropogénic, collision, seabirds, necropsy, Canary Islands.

Acknowledgments: This work has been performed with the economic and logistical support from the "Dirección General de Lucha Contra el Cambio Climático y Medio Ambiente" under the creation of the Canarian Network for the Surveillance of the Wildlife Health (Orden Nº134/2020 de 26 de mayo de 2020).

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LOOKING AT THE OCEANS FROM THE RIVERS. MODELING QUALITY AND QUANTITY OF WATER RESOURCES UNDER THE CLIMATE CHANGE EFFECTS

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Abstract: Environmental assessment, as well as social assessment, economic instruments, and information and monitoring systems support the entire process towards integrated water management.
Once able to understand the functioning of the ecosystems in a given basin, the next step is to understand how the human being, directly or indirectly, can affect the stability of this ecosystem and how this alteration can affect society.
As a small contribution to this long process, this study describes the capacity and suitability of a calibrated hydrological model (Soil and Water Assessment Tool, SWAT) as a decision and support tool, considering the long-term impact of water management.
The use of a model cannot guarantee the best possible plan, but it can help define and value many alternatives.
The present study focuses on the Guadalete basin, where extreme climatic conditions occurred in the past have led to disastrous, often catastrophic, situations.
Despite the satisfactory hydrological calibration results obtained with the model (R^2 = 0.62 and NSE = 0.73), a greater effort is recommended for data monitoring during rainy periods, in order to obtain statistically significant results in those periods of strong flow regime and consider, in such a way, the results of the effects of climatic changes and their influence on the physical, chemical and biological characteristics.
Anyhow, it is extremely important to have a sufficiently long register of observed data, which allows not only to understand the main hydrological processes of the basin, but also to help improve the performance of the model.
In this same way, the results of the model can be used, together with the other rivers of the Andalusian Atlantic slope and coupling the hydrological model to a hydrodynamic model, to predict the evolution of estuary plumes in the Gulf of Cadiz.

Key words: Guadalete, hydrological model, water management, climate changes

MARINE MICROBIAL COMMUNITIES AS A PROXY TO EVALUATE WATER QUALITY: LAS CANTERAS BEACH (GRAN CANARIA ISLAND) AS A CASE STUDY.

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Increased population density, tourism and leisure activities on coastal regions are potentially altering marine ecosystem due to different anthropogenic impacts. Las Canteras, an urban beach hosting a high marine biodiversity, is not exempt from these impacts. Hence, the need to evaluate periodically its current status and sustainability. Conventionally, the coastal water quality in the beach, in terms of microbial affection, has been monitored only by examining fecal bacteria. Here we present a complementary approach using flow cytometry, to identify how smaller organisms inhabiting aquatic ecosystems (such as bacteria and phytoplankton) may respond to changes in inorganic and organic nutrients. The aim is to derive indicators of the environmental status of coastal ecosystems, based on microbial organisms, that could be considered in future monitoring programs (e.g. EU MSFD). In this recent study, we carried out a monthly sampling at eight points along Las Canteras, to look at the response of microbial organisms to physical (temperature) and biogeochemical (inorganic and organic nutrients) environmental drivers. Our results show that, in spite of observed temporal (seasonal) and spatial (sample locations) variability, the nutrients and microbial indicators gave evidence of a healthy ecosystem. The sensitivity of our approach, however, allowed to identify small signals of perturbation. There were significant differences in microbial abundances before and after the COVID lockdown, as well as between stations, with Peña La Vieja presenting the lowest abundances and Hotel Cristina, Reina Isabel and Playa Chica the highest ones. We also found that the ratio of bacteria with high and low nucleic acid content (HNA/LNA) correlated significantly with total organic carbon. This result supports previous observations in other coastal locations of Gran Canaria affected by untreated sewage outfalls, pointing out the HNA/LNA as a potentially fast, early warning proxy to detect organic carbon contamination in coastal regions and beaches.

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VIII INTERNATIONAL SYMPOSIUM
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POSTER COMMUNICATIONS

CITIZEN SCIENCE AND THE SEA: CHALLENGES AND OPPORTUNITIES

ULPGC Universidad de Las Palmas de Gran Canaria
Universitat de Barcelona
Universidad Católica de Valencia San Vicente Mártir
UCA Universidad de Cádiz
Universitat d'Alacant Universidad de Alicante
Universidade de Vigo

JELLYFISH TRACKING IN SOUTHWESTERN MEDITERRANEAN SEA: A CITIZEN SCIENCE AND SCIENTIFIC FIELD SURVEY ALLIANCE

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Abstract: Jellyfish (Cnidaria and Ctenophora) are an essential component of the marine ecosystems and represent a potential source, positive or negative, for several economic' activities. Jellyfish outbreaks and Non-Indigenous Species (NIS) introduction can shift the ecological community structure and energy transfer. Despite their importance in the ecosystem's function and services, jellyfish fauna diversity and phenology knowledge are uneven, the southern Mediterranean Sea being poorly investigated. Based on field surveys and a citizen science sighting program between 2004 and 2020, we present the spatial distribution of 13 conspicuous jellyfish taxa and the phenology of the eight most frequently detected species (*Aurelia solida*, *Cotylorhiza tuberculata*, *Pelagia noctiluca*, *Phyllorhiza punctata*, *Rhizostoma pulmo*, *Rhopilema nomadica*, *Olindias muelleri* and *Velella velella*) in Tunisian two ecoregions, the Western Mediterranean and the Tunisian Plateau. The 17 years surveys showed a shift in the phenology of several species *R. pulmo*, *A. solida* (NIS), *R. nomadica* (NIS) and *P. noctiluca*. Additionally, citizen science revealed *P. punctata* (NIS) spatial spreading and the distinct phenology between the two ecoregions populations. The combination of citizen science and scientific survey, the last one reinforced during poor coastal activities seasons (late fall to early spring), enables tack changes in conspicuous jellyfish dynamics in the Mediterranean Sea.

Keywords: Hydrozoa, Scyphozoa, Cubozoa, Ctenophora, phenology, spatial distribution, ecoregions, Tunisia

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DIVERSIMAR PROJECT: MARINE CITIZEN SCIENCE IN THE NORTH AND NORTHWEST IBERIAN COAST

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Abstract:
Marine citizen science can play an important role in understanding the ocean responses to global change and other pressures to marine systems. Citizen science projects guide public participation combining research with environmental education and science divulgation [1, 4]. The DIVERSIMAR project (https://diversimar.cesga.es/) aims to register biodiversity data of the North and Northwest Iberian coast and is a way for science and society to interact and collaborate [3]. A system to integrate both the available scientific information (on distribution, biology and ecology of marine species) and the new information provided by volunteers has been designed. In a first step, volunteers contact directly the scientists providing photos, videos and any other information about their findings. Technological innovations such as smartphone devices equipped with cameras become a powerful tool for data collection because the images have associated metadata such as date and position [2]. In a second step, these records are verified, validated and stored in the project GIS database that can be consulted in the DIVERSIMAR Map Viewer (https://diversimar.cesga.es/visor/index.php).

Different stakeholders, from scientists to citizens, and from fishermen to marine environmental organisations, can get involved in this citizen project. The wide-ranging observations on coastal flora and fauna (such as the occurrence and regularity of jellyfish blooms, the sporadic report of species that have never been observed in a region before, the apparition of invasive species, the presence of kelp forests or the sighting of protected species) allow to increase the temporal and spatial data acquisition and play an important role in monitoring the coastline and the intertidal zones. The information gathered by mapping habitats and by determination of abundance and distribution of native and invasive species demonstrate the scientific value of citizen monitoring to help managers to develop management plans and conservation strategies such as EU Marine Strategy framework Directive.

Key words: Marine citizen science, Biodiversity, GIS

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MONITORING WATER QUALITY WITH A DO-IT-YOURSELF MODULAR INSTRUMENT

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Abstract: Monitoring water transparency provides an indicator of the environmental status of the water body. One parameter to estimate the water transparency is the light diffuse attenuation coefficient (Kd) (Mobley, 1994). Historically, water transparency has been measured with a simple and inexpensive tool: The Secchi disk, a black and white disk that is lowered from above the water surface and tracked visually until it goes out of sight (Pitarch, 2020). Despite it being a valuable index of visual water clarity, the quality of its measurements is user-dependent, owing to differences between observers (Bruckner, 2018). In addition, ZSD (Secchi disk depth) measured data is discrete in time, and it is dependent on external factors such as water surface conditions and sunlight intensity. For this reason, we need electronic devices to get accurate measures and facilitate evaluations on a long-term scale for water quality monitoring.

This need to develop novel approaches for monitoring environmental data is reflected in the recent growing attention toward citizen science (Njue *et al.,* 2019). Citizen science is an expanding practice in which scientists and citizens actively collaborate to produce new knowledge for science and society (Vohland *et al.,* 2021). Nowadays, we can find a wide range of projects to monitor aquatic ecosystems thanks to the progress in marine citizen science, especially enabled and promoted through technological developments (Garcia-Soto *et al.,* 2021).

Within the framework of H2020 MONOCLE project, it is developed the KduPRO, a cost-affordable and DIY (Do-It-Yourself) moored system evolved from the KdUINO (Bardaji *et al,* 2016). It is based on a modular system of light sensors, independent of each other, measuring the irradiance at different depths. The depth of each module can be modified according to the requirements of the project or the environment, offering to the user a custom array of sensors. To estimate Kd, the KduPRO measures the light intensity in the PAR (Photosynthetically Active Radiation) band at several depths in the water column.

The affordable cost, ease of use and measurement repeatability make the KduPRO a potentially valuable tool for anyone interested in monitoring water quality, including fisheries, diving clubs, citizen volunteer groups, schools, research groups, and local governments to get involved in water quality monitoring programs.

Key words: Water quality, marine citizen science, Do-It-Yourself, KduPRO, KdUINO, Kd, PAR

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CITIZEN SCIENCE TO ASSESS GRAZING PRESSURE ON SPONGE POPULATIONS

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Abstract: Sponges, like other sessile organisms, have developed chemical defences against predators; yet, certain organisms such as opisthobranchs have specialized to overcome these defences in order to feed on sponges and, commonly, live on them. Although numerous cases of specialized grazer-sponge interactions are known, there is limited research on grazing pressure on natural populations. Grazing may add an additional stress to abiotic factors like warming and acidification, which are already detrimental for marine life. We are running a citizen science project, "Bite a sponge" (www.biteasponge.com), aiming at (i) explore predator prevalence on sponge populations over time, and (ii) investigate whether there is a correlation between the life cycle, the aggregation patterns and the seasonality of these predators and the sponge health. This citizen science project has as well an educational component, using opisthobranchs as flagship species to increase awareness on sponge diversity and their ecological role in the ecosystem. Our study case is the predator-sponge interaction between *Aplysina aerophoba* and the heterobranch *Tylodina perversa*. The project is supported by a group of 8 experienced divers from the "Club d'Immersió de Biologia", the diving club based at University of Barcelona. Together with these volunteers, we are running a survey of the sponge population in l'Escala (Girona). We combine two monitoring approaches, seasonal transects in different depths (0-5, 5-10, 10-15m) and picture tracking of 20 sponges over 14 months, with and without grazer, distributed in the three different depth ranges, and including 3 different sizes (0-5, 5-10, >10cm of maximum height of sponge tube) to study ecological variables of both species and its interaction. We are looking forward to expand this principle to other locations and species and are welcome collaborations towards this goal.

Key words: citizen science, sponge, heterobranch, grazing

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CONSOLIDATION AND CAPITALIZATION OF CITIZEN SCIENCE: ANGELSHARK (*Squatina squatina*) POPULATION STRUCTURE, DISTRIBUTION AND HABITAT USE.

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Abstract: Citizen science has become an increasingly important resource in ecological research. Angel Shark Project: Canary Islands works very closely with dive centers across a uniquely large 'hotspot' of the Critically Endangered angelshark, *Squatina squatina* - the Canary Islands -with the aim to collect vital data using a citizen science approach to describe the distribution and ecology of Angelsharks in coastal waters. In this sense, the Angel Shark Sighting Map is a fundamental tool for compiling information from dive centres across the archipelago, with the involvement of citizen science divers increasing the effort to search for and record angelsharks. These data have been used, together with scientific analysis, to inform habitat suitability for this cryptic threatened species. The analysis focused on the population structure and habitat use of Angelsharks using a Species Distribution Model to examine realised and potential distribution patterns, and determine the relative importance of environmental predictors on S. squatina occurrence. According to citizen science data utilised inside MAXENT, angelshark habitat appropriateness is poor in coastal locations during warmer months, with fewer occurrences despite a little change in sampling effort. Bathymetry's primary relevance may signal the importance of depth for reproductive activity and possibly diel vertical migration, whereas aspect may serve as a proxy for protected habitats away from the open ocean. Substrate as a predictor of female habitats in spring and summer may signal that soft sediment is sought for birthing places, aiding in the identification of areas crucial to reproductive activity and hence locations that may benefit from spatial safeguards.

Key words: Angelshark, *Squatina squatina*, citizen science, habitat suitability model, conservation, Canary Islands

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THE USE OF CITIZEN SCIENCE PLATFORMS TO VALORIZE OUR COASTS: "CENTINELAS DE LA COSTA"

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Abstract: "Centinelas de la Costa" aims, through a coordinated team of different entities and experts in coastal research, to promote the scientific culture of citizens, in terms of the changes that our coast shows as a consequence of different natural processes or of anthropic origin. It is articulated in two main actions with different spatial scope:

(i) Action at the regional level: with the aim of implementing and promoting the means and resources already available within the international initiative of CoastSnap towards different sectors of society. Adding to existing resources, new functionalities have been implemented and a contest has been launched to encourage the use of the CoastSnap App and generate community.
(ii) Action at the local level: a common space and format of a mobile application has been created, "Centinelas de la costa", that allows the different members of the project team to provide solutions according to the specific needs of each location. This action is complemented with training days for volunteers in data collection, in collaboration with local agents.

Key words: Citizen science, beach monitoring, CoastSnap, scientific dissemination, environmental education.

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ENHANCING ARTIFICIAL INTELLIGENCE FOR AQUATIC-CENTRIC OPPORTUNISTIC DATASETS

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Abstract: Abundant opportunistic and amateur data is generated during popular activities such as whale-watching and SCUBA diving. There is a scarcity of understanding how Artificial Intelligence (AI) can be applied to such big data and how it may be combined for assessing population of specific marine biodiversity. Although Machine learning (ML) approaches have been widely used in aquatic environments, amateur footage is prone to significant issues e.g. (sun reflection hinders the detection of cetaceans at the sea-surface). We employ Computer Vision (CV) algorithms (Visual Attention Retargeting) to imagery during the model's inference phase, reducing visual artefacts caused by solar radiation on the water-surface and making cetaceans more evident. Results indicate an improvement of 32.48% on the precision of the AI model, therefore yielding an increase in performance by 17.68% (F1 = .177). We demonstrate the feasibility of using such techniques as a valid method to improve ML models' accuracy, and discuss such application for opportunistic footage.

Key words: Computer Vision, Marine Sciences, Opportunistic Datasets, Marine Biodiversity, Citizen Science, Artificial Intelligence.

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BioMARathon: THE MARINE BIOBLITZ

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Abstract:

Citizen science is a tool that will contribute, increasingly, to improve the knowledge of the natural environment and face the Sustainable Development Goals with the involvement of the citizens, acquiring new information and data that will be used in scientific studies or in governance (Soacha et al, 2022).
In these terms, it is important to energize activities that allow the citizens in scientific projects and be part of the entire decision-making process, with data endorsed by the academy. The use of citizen science has relevant results, for example in terms of floods (Ferri et al, 2019; Lanfranchi et al, 2014), monitoring of odors (https://odourobservatory.org/; Bax et al, 2020) or for example, in terms of biodiversity, the study of the bird communities (Tulloch, 2013). But, in marine environment, they are few in proportion the knowledge contributions of the citizen science in this area.
Our group aims to create tools that permit the citizen contribute with the science in all entire decision-making process, and in this case we created the initiative BioMARathon, a marine Bioblitz (citizen census of biodiversity in a concrete dates and locations) to acquire the maximum number of marine species in the Catalan coast.
To improve the engagement of the activity, we use the Quintuple helix model of innovation (Liñan et al, submitted) that includes the participation of enabled entities to energize the citizens and the involvement of local administrations to recognize the work and results of the initiative.
We want to expose the highlight of the project with a poster that shows the excellent work of the citizens in this bioblitz, with more of 1060 taxas censored, 117 participants and more of 10000 observations of biodiversity in this first attempt that will repeat this 2022. All the data are disponible in Natusfera: https://natusfera.gbif.es/projects/biomarato-2021-catalunya

Key words: Marine Bioblitz, Marine citizen science, Citizen science engagement, Marine biodiversity, Citizen science platforms

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REDPROMAR: THE OBSERVER NETWORK OF THE MARINE ENVIRONMENT IN THE CANARY ISLANDS

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Abstract: RedPROMAR is a citizen science network promoted by the Government of the Canary Islands and formed by more than 3,000 users and supported by more than 80 collaborating entities, whose main aim is to contribute to the monitoring of marine life and ecosystems in the archipelago. Consolidated in the Canary Islands and expanding to the rest of the Macaronesian archipelagos, it works as an early warning network. RedPROMAR focuses on marine science outreach to the general population, while giving voice to responsible conducts associated with activities related to the marine environment.
As a tool, RedPROMAR has the biggest open access digital guide of marine species in the Macaronesian region. Five priority groups have been identified: (i) threatened species, (ii) key species for marine ecosystems, (iii) proliferation of gelatinous organisms and blooms of algae and cyanobacteria, (iv) exotic species and (v) rare species. In addition, thanks to the priceless input of the observers in the APP, to date, more than 36,000 sightings have been registered, of more than 4,800 different species, which has enabled the identification of needs and priorities to promote projects that provide an immediate and long-term response. In addition, with all the information generated, more than 40 scientific publications have been developed by different research groups. Currently, several projects are being developed and a large elasmobranch monitoring project is being promoted in the Canary archipelago through the use of biological monitoring program, rescue of traditional ecological knowledge and monitoring techniques based on acoustic telemetry, satellite telemetry and visual tagging.
In conclusion, we can affirm that a well-informed society can support robust citizen science, which helps administrations to have a deeper understanding of what happens in marine ecosystems.

Key words: Citizen science, Marine biodiversity, Early warning network

Acknowledgments: This work would not be possible without the co-financing of The European Regional Development Fund (ERDF) and the support of the more than 3,000 observers of the network.

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MONITORING OF SEA ICE IN THE ANTARCTIC THROUGH REMOTE SENSING

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Abstract

The study of Antarctica sea ice by remote sensing began a few decades ago. The aim of this project is to determine the effectiveness of the different marine ice remote sensing products and the accuracy of passive microwaves, as well as to know the trends of sea ice thickness (SIT) between 2011 and 2020.

We used the LEGOS Altimetric SIT Data that is based in CryoSAT (CS) to estimate the sea ice freeboard and uses both Snow Depth (SD) data from AMSR and LEGOS Altimetric Snow Depth (ASD) from Altika satellites[1]. The SIT derived from the SMOS satellite by the University of Bremen[2] has been compared with CS2+AMSR2 and CS2+ASD products. A comparison of the presence of data at each coordinate between the Sea Ice Concentration (SIC) of AMSR-2 and the SIT of SMOS has also been made. Finally, all SIT and SIC data from 2011 to 2020 have been extracted from CS2+AMSR2 and CS2+ASD.

Throughout 2019, AMSR-2 detects more SD thickness in the outer areas of West Antarctica and LEGOS ASD in the interior of the eastern part. SMOS and CS+AMSR show consistent results with respect to sea ice presence. Comparison of SIT between CS2 + AMSR2 and CS2+ASD shows that it is the combination with AMSR2 that results in a greater thickness, with the maximum at about 2 m. Similarly, when comparing the same variable between CS2+AMSR2 and SMOS we see big differences where CS+AMSR2 clearly shows much thickness than SMOS, this is because SMOS saturates at 50 cm providing greater sensitivity to thinner sea ice.

In terms of trends, between 2011 and 2020 both the SIT and the ice volume detected by CS2+AMSR are greater than CS2+ASD. There is a clear loss in the volume and thickness of ice during the decade, but 2016 appears to be the lowest.

Key words

Remote sensing, passive microwaves, Antarctica, Snow Depth, Sea Ice Thickness and Sea Ice Concentration

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WHAT TO EXPECT FROM ALTERNATIVE MANAGEMENT STRATEGIES TO CONSERVE SEABIRDS? HINTS FROM A DYNAMIC MODELLING FRAMEWORK APPLIED TO AN ENDANGERED POPULATION

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Abstract: The worldwide decline of seabird populations due to the combined effects of global and regional changes is creating immense challenges for managers and conservationists. Predicting population responses to proposed management strategies could provide the most effective tools to prevent, halt and reverse ongoing declines. System dynamic modelling frameworks are considered particularly relevant to interrelate biological, ecological and environmental characteristics and to predict population trends. A system dynamics model was designed, compiling diverse information concerning a relict population of the European Shag located in western Iberia, to outline the most effective management options for its conservation. The simulations demonstrate that mortality caused by invasive animals and bycatch mortality were the main reasons for the current population decline. Without management interventions, a decrease of 8 % was projected for the next decade, which could be mitigated by specific conservation actions. The results show the usefulness of dynamic modelling frameworks to understand local cause-effect relationships and species responses to ecosystem management under changing environmental conditions. We highlight that the framework proposed, after specific parameterisation, could be easily adaptable to other species within similar socio-ecological systems.

Key words: Population dynamics; Ecological indicators; Umbrella species; Environmental management; Marine protected areas; Gulosus aristotelis

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MODELLING THE IMPACT OF FISHERIES AND OCEANOGRAPHIC VARIABLES ON THE MAIN TARGET SPECIES OF THE ANDALUSIAN PURSE SEINE FLEET

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Abstract: Small pelagics are one of the most important group of fishes in the world due to their ecologic significance in the trophic web (Casaucao et al., 2021). Small pelagics are the main target of world fishery industry, and European anchovy, European sardine, mackerel and horse mackerel represent 43.7% of the total landings in Andalusia (southern Spain) (Báez et al., 2021; Castro-Gutiérrez et al., 2022). Others works have studied impact of climatic oscillation in their ecology (Báez & Real, 2011; Leitão et al., 2014; Jghab et al., 2019). This work had as main objective analyze the different factors that could be affecting the abundance of these small pelagics in the both main andalusian fishing areas: Gulf of Cadiz and North Alboran Sea. For that purpose, multiple Generalized Additive Models were performed using different oceanographic variables and landing time series as explanatory variables. The explanatory variables were also included lagged up to three years. A total of 4776 partial models were performed and eight models (the best one for each species in both areas) were extracted to analyse them. GAM models explained up to 61% of total variance. Most of the models showed a strong non-linear relationship between different fish landings, and all models showed primary production as a key environmental factor to explain variations in the abundance of these small pelagics. However, results also revealed differences in the fishing pressure for each specie in both fishing grounds. The use of non-linear models as an analytic tool could be useful for improving the knowledge on small pelagics and the management of the small pelagics fishing industry.

Key words: Small pelagics, Generalized Additive Models, Gulf of Cadiz, North Alboran Sea, Purse seine

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VIII International Symposium on Marine Sciences 2022 (ISMS)
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EFFECTS OF SEASONALITY ON THE STRUCTURE AND FUNCTIONING OF A MEDITERRANEAN SEA ECOSYSTEM

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Abstract: The Mediterranean Sea is characterized by a strong seasonality impacting species distribution and community dynamics, which may have implications for the structure and functioning of the marine ecosystem. However, there is generally a lack of seasonal data for marine organisms, which results in ecosystem assessments being based on estimates from specific times of the year, not accounting for seasonality. In this study, we investigated changes in ecosystem structure and functioning when using seasonal input data *vs* annual averages for a marine ecosystem in the northwestern Mediterranean Sea. We used data from two oceanographic surveys conducted in winter and summer 2013 in the southern Catalan Sea (Spain). We then used the Ecopath with Ecosim (EwE) modelling approach to develop three mass-balanced ecosystem models that represented two contrasting seasons, (winter and summer) and an annual average. We used ecological indicators related to ecosystem structure, functioning traits and energy flow to compare and explore changes derived from these three ecosystem representations, and found variations in ecosystem structure and energy transfer. We discuss the implications that the use of data from a specific time of the year in ecosystem models may have on our understanding of ecosystem ecology. Our results highlight the need to conduct seasonal oceanographic surveys to capture seasonality dynamics when modelling marine coastal areas.

Key words: Ecosystem model, Ecopath with Ecosim, Mediterranean Sea, seasonality, ecological indicators.

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BIOGEOCHEMICAL SIMULATION OF SALMON FARMS IN A PATAGONIAN FJORD (CHILE).

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Abstract:

The numerical simulation model CROCO has been applied to the Aysen fjord (Chilean Patagonia) to develop a salmon farm-managing tool. A six grid configuration was used, starting with a 4 km precision grid (approximately 80ºW-72ºW and 60ºS-35ºS) up to the finer 65 m grid in the inner part of the fjord. The Corcovado Gulf is covered by the child grid, and two grandchild cover the Chonos archipelago and Aysen fjord. Nested on this last grandchild two more grids allow the desired precision in the fjord.

The bathymetry used was obtained mixing the latest version of the GEBCO 2020 bathymetry with the SHOA bathymetry (Servicio Hidrográfico y Oceanográfico de la Armada), with some corrections close to the coast in the inner part of the fjord (Galderic et al, 2014). Initial conditions and boundary conditions for salinity and temperature, both components of the horizontal velocity and the sea surface height where applied using the Copernicus Global Ocean 1/12º forecast system (https://doi.org/10.48670/moi-00016). The atmospheric forcing was applied using a three nested configuration of the WRF model (Weather Research and Forecasting) covering the parent, child and both grand-child grids.

The model was run with all possible Physics and coupled with the PISCES biogeochemical model. The results from the model were compared with available sea surface data at different points inside and outside of the Corcovado Gulf (Puerto Ancud, Puerto Montt, Melinka) as well as two points inside Aysen fjord (Chacabuco and an ADCP mooring). The model showed to properly reproduce the tide amplification inside Corcovado, and towards the fjord. Comparisons were also made with current data inside the fjord, and with thermometer data, as well as with biogeochemical data next to the fish tanks .

Key words: numerical, modelling, Aysen.

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