






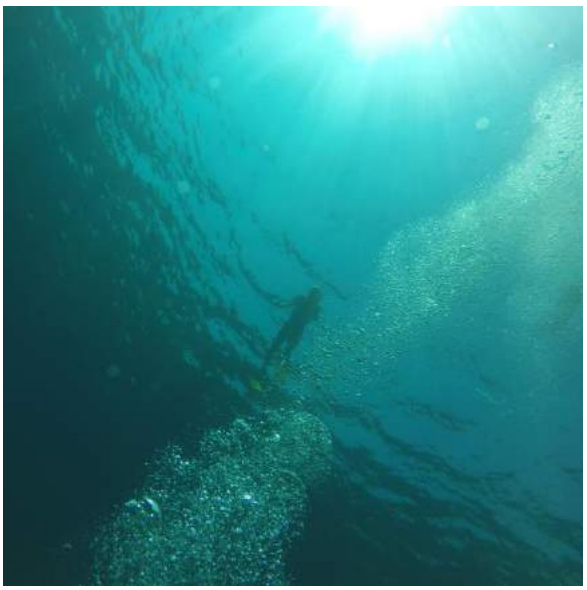



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BOOK OF ABSTRACTS

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Plenary

It’s the ecology, stupid – Willingness to pay to protect cold-water coral

Claire W. Armstrong[1]

[1] UiT The Arctic University of Norway, Tromsø. Email: claire.armstrong@uit.no

There is increasing pressure to utilize currently unused resources in the deep sea, raising questions about tradeoffs between different ecosystem services in these often unknown areas. In order to provide management input we research people’s valuation of deep ocean resources that are often distant to the public both spatially and temporally. The public’s valuation of protection of cold-water coral reefs versus economic activities such as fisheries and petroleum were assessed using so-called stated preference surveys, carried out in Norway and Ireland, over a number of years. The surveys apply both discursive approaches and internet-based settings, yet nonetheless provide some similar results in both countries, namely that people express willingness to pay to protect cold-water corals. These results are obtained despite possible conflict with extractive and consumptive economic activities in the deep sea. The findings support conservation of cold-water corals in both countries, and more generally the protection of ocean environments that provide habitat for fish. In order to more completely assess the non-use values found in our surveys in relation to commercial values connected to fisheries, a bioeconomic fisheries model is expanded to include habitat and the non-use values of cold-water corals. The results indicate that optimal fisheries management is impacted by the habitat and non-use values ascribed to cold-water corals, providing an argument for more inclusive and multi-sectorial governance in the deep sea.

Key words: Valuation, coral habitat, fisheries

Plenary

The Great Speeding Up of our Coasts and Oceans

Emma L. Johnston[1], John F. Bruno[2], and Graeme F. Clark[1]

[1]School of Biological, Earth and Environmental Sciences, University of New South Wales, NSW, 2052, Australia. e.johnston@unsw.edu.au
[2]Department of Biology, The University of North Carolina at Chapel Hill, Chapel Hill, NC, 27599, USA

Four drivers of global change are acting in concert to speed up the ecology of our coasts and oceans. Ocean warming, nutrient pollution, disturbance, and species additions, work together to increase biological and ecological rates, favoring weedy communities and causing pervasive human impacts. Ocean warming via greenhouse gas emissions is accelerating metabolic processes, with effects scaling up to populations and ecosystems. Likewise, supercharging primary production via increased resources (e.g. nutrients and light) is leading to faster, weedier communities in estuarine and coastal ecosystems. Disturbances are more frequent, resetting succession and creating permanently young assemblages, while species additions are transporting the quick-growing and the fecund. I will present recent studies that help us see into the future of biodiversity for our marine ecosystems and consider how stressors interact. Finally, I discuss how “the great speeding up” of our coasts and oceans necessitate changes to the ways we do science, attempt conservation, and use ecosystem services.

Plenary

Biodiversity redistribution in a changing climate

Poloczanska, Elvira S.

[1] Alfred Wegener Institute, Integrative Ecophysiology, Bremen, Germany

Seas and oceans are filled with species on the move – species distributions are also changing at an accelerating rate with climate-driven range shifts reported from every ocean. I will discuss evidence for detection and attribution to climate change of marine range shifts from quantitative approaches to qualitative approaches passing multiple lines of evidence. Recent research suggests range shifts can occur on short time scales, making early detection of such shifts and prompt implementation of any appropriate management strategies crucial. Range shifts more frequently occur in fast warming regions of the ocean, and seem to be closely associated with shifts in temperature isotherms ("climate trajectories"). Multiple range shifts by individual species combined with changes in abundance of climate-sensitive ones produce changes in the structure of biological communities with implications for marine living resources and management. Climate-related risks depend on the magnitude and rate of warming, geographic location and choices and implementation of adaptation and mitigation actions. I will explore the increasing risks to marine life, particularly redistribution and implications for ecosystem services, at 1.5°C, 2°C and higher levels of warming, drawing on the IPCC Special Report of Global Warming of 1.5°C.

Key words: Climate change, redistribution, climate velocity, climate risk

Plenary

Traits in Space: Enriching species occurrence data with species attributes for traits-based marine macroecology

Tom Webb[1]

[1] Department of Animal and Plant Sciences, University of Sheffield. Email: t.j.webb@sheffield.ac.uk

Many fundamental and applied questions in marine macroecology have biological traits at their heart. Traits influence how different species and species assemblages contribute towards ecosystem functioning, as well as how they are likely to respond to environmental change. Until recently, however, investigations of biological traits of marine species at macroecological scales has been hindered by a lack of available trait data. Significant gaps still exist, but existing biodiversity data infrastructure is now sufficient to begin to combine data from multiple sources, of many different types, to bring traits into wider investigations of the dynamics of marine biodiversity in space and time. This talk will explore how linking data of different types (e.g. taxonomy, occurrences, biological traits, environment) allows inferences not possible using individual datasets alone. It shows how simple traits (e.g. body size) can be combined with biogeographical databases to map ecogeographical patterns; how occurrences can be matched with environmental data to derive traits such as thermal affinity; and how multivariate analyses of traits can be useful various settings including in studies of marine invasive species. Throughout, the emphasis is on developing workflows using openly available data and open source software tools which greatly expand the range of questions we can ask and, ultimately, answer.

Plenary

Atlantic Salmon lost at sea

Ken Whelan

School of Biology & Environmental Science, University College Dublin

Despite extensive conservation measures involving constraint on fisheries and restoration of freshwater habitat, many salmon populations in both the Atlantic and the Pacific basins, particularly at the southern extremes of their ranges, have experienced an ongoing decline in productivity since at least the early 1990s. While low marine survival is generally accepted as a cause of decline for many populations, the mechanisms involved, and contributing factors, are poorly understood. In an effort to describe the migration and distribution patterns of Atlantic salmon stocks in the North Atlantic a major research programme, SALSAEA, was undertaken in 2008 - 2011. For the first time the SALSEA Merge initiative clearly defined the migration routes of post-smolts in the North East Atlantic and the major factors affecting the migration patterns of these populations. While SALSEA and subsequent research has provided additional information on the lives of Atlantic salmon in the ocean, little progress has been made in isolating the key factors regulating their survival at sea. Previous work on marine fisheries in Europe has shown that it is possible to identify a Strategic Framework that would place candidate mortality factors within an overall spatial and temporal framework, covering the full lives of salmon at sea. Such an approach would help to quantify the potential of each factor to influence survival (i.e. the “likely suspects”) and to link these dynamically in such a way that the cumulative effects of these factors could explain the variations in survival of different year classes of salmon. The concept of the Likely Suspects project was developed as a Signature Project of the International Year of the Salmon (IYS) initiative. This presentation will trace the history of recent research relating to the lives of salmon at sea and the strategic plan which is now in place to define and model the impacts of the “Likely Suspects” so as to support the management of this key species in the ocean.

Rapid Change

Talk

Rapid change

Two opposing climate change threats: sea level rise and extreme desiccation events threaten Mediterranean vermetid reef communities

G. Rilov[1]

[1] National Institute of Oceanography, Israel Oceanographic and Limnological Research (IOLR), Haifa, Israel. rilovg@ocean.org.il

Climate change threatens marine communities in a variety of, sometimes opposing, ways. Rocky shore communities in the Mediterranean, with its miniature tides, are highly threatened by even mild sea level rise (SLR), and in some areas potentially also by extreme desiccation events. I examined the potential threat of these two stressors in the Levant region (Israel) where vermetid reefs form vast, horizontal, low-shore platforms with rich ecological communities. The ecosystem is naturally exposed to prolonged desiccation events (PDEs), sometimes lasting weeks, that cause mass macroalgal bleaching and invertebrate mortality. These PDEs are caused by specific synoptic systems that climate reanalysis showed have doubled in frequency in the past four decades, considerably increasing desiccation risk to this habitat. Simultaneously, sea level in the region has risen by more then 10 cm in the past two decades, and thus further SLR threatens to completely drown the reefs. To simulate SLR threat, we followed intertidal communities on rock cores translocated to the shallow subtidal with and without cages (to exclude invasive rabbitfish grazing). After 100 days, inside cages, intertidal algae that are probably sensitive to continuous submergence were replaced by subtidal algae, and in no-cage treatments, intense grazing removed all erect algae, leaving only turf; overall biodiversity reduced in both treatments. With continued SLR, new platforms will not be formed higher on the shore because their main ecosystem engineer, the *Dendropoma* vermetid, is now ecologically extinct. Under extensive PDEs and SLR, together with ocean warming, the future of this unique ecosystem seems bleak.

Talk

Rapid change

Influence of melting glaciers on size spectra and functioning of zoobenthic communities in Arctic fjords

Barbara Górska*[1],Maria Włodarska-Kowalczuk[1]
*Corresponding author: basia@iopan.gda.pl
[1]Institute of Oceanology Polish Academy of Sciences, Sopot, ul. Powstańców Warszawy 55, 81-712 Sopot, Poland

The Arctic Ocean is currently one of the key regions for climate change effects studies. As a result of increased air and water temperature, glacier retreat is observed, what is accompanied by an increase of meltwater outflow and flux of inorganic particles to the coastal waters. What is more, increased water turbidity reduces primary production in water column.
At the community level, changes in size distributions may influence energy transfer pathways in the benthic food webs and ecosystem carbon cycling. The present study is the first assessment of the patterns and environmental controls of benthic size spectra (across both meio- and macrofauna) in Arctic fjord sediments.
The samples were collected in two Arctic fjords off West Spitsbergen, at stations which represent three regimes of varying food availability and glacial disturbance intensity. The lower availability of food resources seemed to suppress the biomass and secondary production across the whole size spectra, rather than to reshape the spectrum. At locations where poor nutritional conditions were coupled with disturbance the biomass was strongly reduced in selected macrofaunal size classes, while meiofaunal biomass and production were much higher. As a result, the partitioning of the benthic biomass and production shifted towards the meiofauna that took over the role of the benthic metazoan key-player in terms of processing the organic matter in sediments.
As both the food availability and the intensity of glacial disturbance are foreseen to change in the course of the climate warming, the results of this study can be used to predict the climate change effects on benthic communities structure and functioning in Arctic coastal waters.

Key words: size spectra; benthos; Arctic; glacial disturbance

Talk

Rapid Change

Deciphering long-term variability of the phytoplankton community in a highly variable coastal sea (Gulf of Trieste)

Vascotto I.[1,2], France J.[1] and Mozetič P.[1]

[1] National Institute of Biology, Marine Biology Station Piran, Fornače 41, 6330 Piran, Slovenia E-mail: ivano.vascotto@nib.si
[2] Jozef Stefan International Postgraduate School, Jamova cesta 39, 1000 Ljubljana, Slovenia.

The shallow and land-surrounded north-eastern Adriatic Sea has seen a change in terms of environmental drivers in the last decades. These were in turn reflected in seasonal and inter-annual variability of phytoplankton community, which was already described in this area. However, the fine-scale community structure at species/genus level still lacks the connection to driving forces. Here the structural changes in the phytoplankton community from a LTER station in the Slovenian coastal sea (2005-2017) have been analyzed using a statistical method based on hierarchical clustering and Bayesian probability. The monthly probability distribution of assemblages and the inter-annual succession patterns were obtained. Each sample was then allocated in a group using its sampling date and its group associated probability. Then, using this temporal composition model as grouping factor, the IndVal index was calculated and the typical community for each group was obtained. Six groups of phytoplankton taxa were identified and their distribution through years has been described. To reduce observer-bias a procedure of dimension reduction was then attempted and the analysis repeated. The results show a relevant improvement in terms of classification fit in comparison with simple monthly grouping. Following the wide base of phytoplankton ecology knowledge in the area, the best inter-annual succession pattern was retained for exploring connections with environmental data from the same period.

Key words: Phytoplankton, Seasonality, Assemblages, Adriatic Sea

Talk

Rapid change

Are marine species more resilient to global change than terrestrial ones?

Pol Capdevila[1*], Maria Beger[2], Iain Stott[3,4], Patrick Barks[3], Gwilym Rowlands[1] & Roberto Salguero-Gómez[1]

[1] Department of Zoology, Oxford University, Oxford, UK. *Email: pol.capdevila@zoo.ox.ac.uk
[2] School of Biology, Faculty of Biological Sciences, University of Leeds, Leeds, UK.
[3] Department of Biology, Interdisciplinary Centre on Population Dynamics (CPop), University of Southern Denmark, Odense, Denmark
[4] School of Life Sciences, University of Lincoln, Lincoln, UK.

Despite drastic loss of biodiversity during the last decades, few documented extinctions exist in the marine realm when compared to terrestrial ecosystems. The underlying causes of such differences in extinction rates remain unclear, inevitably leading to the question “are marine species more resilient to global change than terrestrial species?”. To address this question, we used open-access databases including demographic information for over 400 marine and terrestrial species from around the globe and across the tree of life. To determine differences in the demographic resilience of marine and terrestrial species, we evaluated two components of resilience: (i) resistance to disturbances, and (ii) time to recovery. We also estimated the vulnerability of species to increases in environmental variability and to changes in environmental autocorrelation, using stochastic elasticity analyses. Our results suggest that marine species do not show higher demographic resilience, nor are more vulnerable to environmental change, than terrestrial ones. Instead, phylogenetic relationships and environmental factors were more important in determining species’ resilience and vulnerability to environmental change. Nonetheless, marine species’ population growth rate was more sensitive to changes in environmental autocorrelation than terrestrial ones. Considering that climate change will alter the natural regimes of environmental fluctuations, these findings suggest that marine species may be even less resilient than terrestrial species to global change. Overall, our results do not support the hypothesis that marine systems are more resilient than terrestrial ones, and indeed point towards the opposite conclusion.

Key words: Climate change, Comparative demography, Population dynamics, Resilience

Talk

Rapid Change

From desert to sea: mechanisms Arabian pupfish use to acclimate to high salinities in the Red Sea

Lucrezia C. Bonzi[1], Alison A. Monroe[1], Michael L. Berumen[1], Celia Schunter[2], and Timothy Ravasi[1]

[1] Division of Biological and Environmental Sciences and Engineering, King Abdullah University of Science and Technology, Thuwal, Kingdom of Saudi Arabia. Email: Lucrezia.bonzi@kaust.edu.sa
[2] The Swire Institute of Marine Science, School of Biological Sciences, The University of Hong Kong, Hong Kong, SAR, People's Republic of China

The Arabian pupfish, *Aphanius dispar*, is a euryhaline fish able to live in a wide range of salinities. This cyprinodontid inhabits inland and coastal waters of the Arabian Peninsula, with populations occurring in desert ponds (0.7 – 2 ppt), and in Red Sea coastal lagoons (41 – 44 ppt). In a previous study, we found that Red Sea populations receive migrants from desert ponds, which are flushed out to the sea during flash floods. In order to survive to these abrupt events, the fish need to rapidly acclimate to more than 40 ppt change in salinity. In this study, we investigated the molecular pathways underlying the phenotypic plasticity of *A. dispar* gills during acclimation to increased salinities. Fish were collected from a desert pond and a Red Sea lagoon and habituated in aquaria at their native salinities. Desert pond fish were then transferred from 1.5 ppt to 42 ppt, and gills were sampled pre-transfer (0h), and at 6h, 24h, 3 days, 7 days and 3 weeks post-transfer. Gill samples were morphologically analysed using SEM, and their transcriptomes assembled. No mortality was recorded and no differences in gill filament morphology were detected across sampling intervals. Gene expression changes over the acclimation timeline resulted extremely rapid, with individuals from desert ponds showing similar expression to saltwater population after only 6 hours of high salinity exposure. These findings provide insights into the mechanisms of phenotypic plasticity that allow the Arabian pupfish to rapidly acclimate to salinity changes during colonization events in the Red Sea.

Key words: phenotypic plasticity; transcriptomics; ecology; fish biology

Talk

Rapid Change

Multiple stressors and the stability of marine ecosystems

Lydia White[1,2], Nessa E. O'Connor[3], Mark C. Emmerson[2] and **Ian Donohue**[3]

[1] School of Biological Sciences, Institute of Global Food Security, Queen's University Belfast, Belfast, BT9 7BL, UK.
[2] CNRS, UMR 7144, Station Biologique, 29680 Roscoff, France.
[3] Department of Zoology, School of Natural Sciences, Trinity College Dublin, Ireland. Email: ian.donohue@tcd.ie

Despite wide appreciation that multiple aspects of global environmental change can alter the stability of ecological communities, the potential stabilising role of consumers, and whether intact consumer guilds can promote resistance against perturbations, remains poorly understood. Here, we use a novel framework to quantify the simultaneous contributions of different consumer groups to multiple dimensions of the stability of a coastal rocky shore system, and test whether their contributions vary in response to different perturbations (that is, nutrients and sediments, in isolation and in combination). For some dimensions of stability, trophic complexity buffered against destabilising effects of perturbations, but the extent to which consumers stabilised algal communities were often highly context-dependant. Further, the capacity to predict consumer contributions to stability when stressors were combined from their responses to individual stressors varied among stability dimensions. However, we found that algal functional groups displayed strong co-tolerance to multiple stressors, with groups resistant to nutrient enrichment being similarly resistant to elevated sedimentation. In contrast, the resilience to both stressors was negatively correlated, such that groups recovering rapidly from one stressor recovered slowly in response to the other. We conclude that, though predicting and managing for the combined consequences of species loss and multiple stressors will be extremely challenging, many aspects of ecological responses to the complexities of environmental change are predictable with good knowledge of the system.

Key words: resilience, resistance, stability, rocky shore

Talk

Rapid change

Ocean acidification effects on top-down control of the functional species *Paracentrotus lividus* in marine benthic ecosystems

S. Farina[1], A.Chindris[1], F. Leggieri[1], M. Scolamacchia[2], I.Guala[1], G.Brundu[1], B.Loi[1], V.Asnaghi[3]

[1] IMC—International Marine Centre, Torregrande, Oristano, Italy. Email: s.farina@fondazioneimc.it
[2] University of Stirling, Institute of Aquaculture Pathfoot building, FK9 4LA, Stirling.
[3] DISTAV, University of Genoa

Oceans are becoming more acidic due to increasing anthropogenic emissions. This phenomenon is causing the loss of keystone and critical species or the reduction in their activity (e.g. predation, grazing, bioturbation), with cascading consequences at ecosystem level.
In one of the most important trophic cascade of Mediterranean benthic ecosystem, involving predatory fishes, sea urchins and macrophytes, some critical effects on the reduction of habitat complexity and interference with biological controls of grazing have been highlighted. Diet-mediated effects on sea urchin robustness in a future ocean acidification scenario have been demonstrated, and a decrease of sea urchins' density is expected due to lower defence from predation.
This study aims to estimate the increase of Paracentrotus lividus predation risk after three months under acidic condition at the most pessimistic scenario expected for the end of century (pCO_2 level of 1000 µatm). Robustness, tenacity, thickness of the exoskeleton and length of spines were measured for sea urchins acidic-conditioned, lab-controls and wild-controls. Then, they were exposed to predation pressure, transferring all the specimens, after thetering, in a Marine Protected Area to test their defence capability. Acidic-conditioned sea urchins presented thinner and less robust tests then the lab-controls and wild-controls, although substrate tenacity did not change. After 72 hours of in-situ experiment, predation of acidic-conditioned sea urchins was +11.5% then lab-controls and +57.3% then wild-controls. The effects of ocean acidification is therefore evident for the predators-sea urchins interaction, potentially causing trophic disorders in macrophyte communities as indirect effect of the unbalanced top-down control.

Key words: ocean acidification, sea urchins, predation,

Talk

Rapid change

A fuzzy model to detect Mediterranean marinas at high-risk of marine bioinvasion

Ferrario J.[1], Ulman A.[1], Facchinetti T.[2], Occhipinti-Ambrogi A.[1], Marchini A.[1]

[1] Department of Earth and Environmental Sciences, University of Pavia, via S. Epifanio 14, 27100 Pavia, Italy. Email: jasmine.ferrario@unipv.it
[2] Department of Electrical, Computer and Biomedical Engineering, University of Pavia, via Ferrata 6, 27100 Pavia, Italy.

Harbours and marinas are globally considered hot-spot areas of marine non-indigenous species (NIS) and should be prioritized for detection and management of NIS. The Mediterranean Sea is teemed by numerous ports and their monitoring is still scattered and not yet standardized in the whole basin. In this work we created a model to assess the level of risk to bioinvasion of Mediterranean marinas, based on abiotic properties of the marinas, in order to support decision makers in the prioritization of monitoring actions. A fuzzy inference system (based on 'if…then' rules) was elaborated on the basis of the results of a correlative analysis performed on data collected from 2012 to 2016 in 50 marinas along the Mediterranean coasts, which had highlighted the variables most responsible of high NIS richness in marinas: number of berths, climate type, proximity to the Suez Canal, aquaculture activities and harbours. These variables were set as input of the risk model, whose output is a risk value ranging from 0 to 100. The risk model was optimised by means of a grid search on the weights assigned to the five input variables. The optimal weights were selected to fit the observed values of NIS richness recorded in the marinas of our dataset. Finally, the model was tested with data collected from additional marinas. This fuzzy model will allow Mediterranean countries to promptly assess through the collection of simple information which marinas are at high-risk of invasion, in order to better instruct survey efforts and management measures.

Key words: non-indigenous species, monitoring, risk assessment, Fuzzy Logic

Talk

Rapid Change

Combining 10-years in-situ data with a satellite remote sensing dataset to help evaluate climate change effects on Antarctic phytoplankton communities

Ferreira, A.[1,2], Sá, C.[1,3], Brito, A.C.[1,4], Brotas, V.[1,4], Costa, R.R.[5], Guerreiro, C.[1], Mendes, C.R.B.[5]

[1] MARE-ULisboa - Marine and Environmental Sciences Centre, Faculty of Sciences of the University of Lisbon, Campo Grande, 1749-016 Lisboa, Portugal. 1. Email: ambferreira@fc.ul.pt
[2] IH – Instituto Hidrográfico, Rua das Trinas 49, 1249-093 Lisboa, Portugal
[3] CIMA – Centre for Marine and Environmental Research, University of Algarve, Campus de Gambelas, P-8005-139 Faro, Portugal
[4] Departamento de Biologia Vegetal, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal
[5] Instituto de Oceanografia, Universidade Federal do Rio Grande (FURG), Av. Itália, km 8, Rio Grande, RS 96201-900, Brazil.

The Northern Antarctic Peninsula (NAP) is regarded as a climate change hotspot. It has one of the highest worldwide warming rates (2ºC over the last 50 years), with several reported impacts throughout the marine ecosystem. Understanding the response of phytoplankton to climate change is a priority due to their key role as primary producers and in biogeochemical cycles. In order to clearly understand these effects in such remote and strongly seasonal regions, high-resolution, reliable and continuous time-series datasets are crucial, yet difficult to gather. This study aims to contribute to fill this gap by combining two complementary methodologies: satellite ocean colour remote sensing (OCRS) and in-situ sampling. The in-situ component is comprised of a 10-year (so far) valuable dataset on phytoplankton biomass and communities, including pigment data and cell counts. Remote sensing analysis will focus on chlorophyll *a*, a common proxy of phytoplankton biomass and an essential climate variable, to evaluate trends on biomass and community size and composition changes. Data from the OC-CCI project, which merges 20-years of satellite data from different sensors, will be used. This work requires a robust validation effort to account for the uneven coverage of satellite data in this region (e.g. strong cloud coverage) and ensure adequate algorithm selection and applicability. Results from a first validation exercise are presented and discussed. Also, spatiotemporal variability of chlorophyll *a* in the region are evaluated through climatology analysis. This study is expected to contribute to the knowledge on climate change impacts needed to protect marine Antarctic ecosystems.

Key words: Northern Antarctic Peninsula; phytoplankton; climate change; ocean colour remote sensing

Talk

Rapid change

Assessing effects of cumulative impacts of human pressures on nature assets

Jonne Kotta[1], Mihhail Fettisov[1], Kiran Liversage[1] and Helen Orav-Kotta[1]

[1] Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallinn, Estonia 1. Email: jonne@sea.ee

Intensification and diversification of human induced pressures in marine ecosystems have raised concern about about several sustainability-related consequences such as hypoxia and/or overexploitation of resources. Here, we present the PlanWise4Blue tool (PW4B) that assesses the cumulative impact of multiple pressures on nature assets. In order to define sensitivities of different nature assets to a plethora of pressure combinations, a meta-analysis on literature showing effects was performed and the standardized effect-sizes were calculated. In the case that impact evidence is missing, expert knowledge was used to derive the impact coefficients. When incorporating impact coefficients into the PW4B tool experimental evidence was prioritised. Some of human pressures are largely manageable and some are not (e.g. NIS). As the PW4B tool can quantify synergistic effects, the returned value of the cumulative impacts considers manageable pressures in the context of the impacts of unmanageable pressures. Spatial modelling techniques (machine learning) was used to model the the probability of occurrence and abundances of different nature assets at lattice grid with a cell size of 1 km. Users with or without science training can use the portal to estimate areas impacted and changes to natural assets caused by any combination of pressure types. The PW4B tool is used to predict the separate and synergistic effects of all human uses, either those present today or planned to be implemented in future. The tool was tested in the Baltic Sea region along with the process of the Estonian Maritime Planning.

Key words: Maritime Spatial Planning, environmental impact, Baltic Sea, online tool

Talk

Rapid change

Counter-directional body size clines within a Japanese amphidromous fish inferred from otolith analysis

Iki Murase[1], Takahiro Irie[2] and Kei'ichiro Iguchi[1]

[1] Graduate School of Fisheries and Environmental Sciences, Nagasaki University. Bunkyo-machi 1-14, Nagasaki City, Nagasaki 852-8521, Japan.
Email: iki.murase@gmail.com
[2] Atmosphere and Ocean Research Institute, The University of Tokyo. Kashiwanoha 5-1-5, Kashiwa City, Chiba 277-8564, Japan.

Geographic variation of life history traits such as body size is widely known in various taxa. Some of those traits show latitudinal dependency (i.e., latitudinal cline) since life history traits often reflect the latitudinal gradient of environmental conditions. For this reason, differential environmental gradients among localities would induce the intraspecific variation of latitudinal cline in life history traits. In this study, otoliths of 231 Japanese amphidromous fish (*Plecoglossus altivelis altivelis*) collected in 2001, were analysed in order to examine the latitudinal variation in body size, growth rate, growth period, and growth trajectory. Our results demonstrated the first evidence that their body size show both negative and positive latitudinal clines between the Sea of Japan side and Pacific Ocean side. The observed counter-directional pattern is explained by the slopes in latitudinal clines of growth rates and growth period, which are mainly affected by sea-temperature gradient. Considering this, recent climate warming would affect the intraspecific variation in life history traits of this species. We, therefore, hypothesised that high water temperature reduces the growth period of southern populations, resulting in smaller body size at the end of marine growth period. To test the hypothesis, we collect *P. a. altivelis* again in 2019. Yearly fluctuation of body size in 1990–2019 is also examined by compiling published data. By analysing variation in life history traits, we discuss how the traits of this species change in recent years.

Key words: Latitudinal cline, life history traits, amphidromous fish, temperature

Talk

Rapid Change

Local environmental conditions experienced by marine bivalves determine their physiological response to warming and high levels of pCO_2.

Navarro JM.[1,2], Thomsen I.[1], Rocha N.[1], Villanueva, P.[1], Torres, R.[2,3]

[1] Instituto de Ciencias Marinas y Limnologicas, Universidad Austral de Chile, Valdivia, Chile.
[2] Centro FONDAP de Investigación en Dinámica de Ecosistemas Marinos de Altas Latitudes (IDEAL), Universidad Austral de Chile, Valdivia, Chile
[3] Centro de Investigación en Ecosistemas de la Patagonia(CIEP), Coyhaique, Chile

Email: jnavarro@uach.cl

Abstract:
The combined effect of ocean warming and elevated carbon dioxide in seawater is expected to have significant physiological and ecological consequences on marine organisms. Estuaries and coastal zones experience changes in water temperature and pCO_2, which are more accented compared to those occurring in the open ocean. Thus, organisms inhabiting estuaries and fjords can show different responses to climate change scenarios depending the variability of their local environmental conditions. We studied the combined effects of warming and high level of pCO_2 on the physiological performance of two bivalve species inhabiting environments with different grade of variability. The mussel *Mytilus chilensis* inhabits a bay and the oyster *Ostrea chilensis* inhabits an estuary, both places located in southern Chile. In the present study, juvenile mussels and oyster were exposed for 60 d to a factorial combination of two temperatures and two pCO_2 levels. Different effects of these two factors on the physiological performance of the bivalves were observed when comparing both species. There was a significant effect of pCO_2 and temperature on the index Scope for Growth of *M. chilensis*. However, *Ostrea chilensis* was not affected by any of these two factors, neither by their interaction. These results can be explained by the different historical thermal/pCO_2 exposure of both species; the oyster inhabits a highly variable estuarine environment (daily, seasonal, and annual) while the mussel inhabits a more homogeneous environment. Results suggests that high variable conditions of the organism's environment could select for individuals more resistant to environmental changes.

Talk

Rapid change

Long-term physiological tolerance of a non-indigenous species to near-future warming and ocean acidification

Kathryn E. Pack[1,2], Marc Rius[1] and Nova Mieszkowska[2]

[1] Ocean and Earth Science, University of Southampton, Southampton, UK, Email: katpac@mba.ac.uk
[2] Marine Biological Association, Plymouth, UK

Contemporary climate change (CCC) and non-indigenous species (NIS) are two of the main drivers of current global species redistribution. Increasing evidence suggests CCC will favour NIS and facilitate their spread, but there are a lack of long-term studies assessing the resilience of NIS to future conditions. This study examines the long-term interactive effects of warming and ocean acidification on the physiology of a global NIS, *Magallana gigas*. Over a nine-month experiment, individuals were exposed to different temperatures (ambient and +4 °C, as predicted for the year 2100), pH (ambient at 7.95-8.0, 7.7, 7.5) and salinity (20, 34) and clearance rates and oxygen consumption rates were assessed monthly. We found no significant interactions between the factors, and neither temperature nor pH had an effect on clearance or oxygen consumption rates. Lower salinity significantly reduced clearance rates and increased oxygen consumption, however, salinity was within the tolerance range for *M. gigas* and it is unlikely that these levels would have a negative long-term effect on metabolism and survival. These data highlight the ability of a widespread non-indigenous species to tolerate CCC conditions. Our results suggest that this NIS could continue to colonise new areas and outcompete species more sensitive to environmental change.

Key words: Non-indigenous species, climate change, physiology, mesocosm

Talk

Rapid Change

Microplastic pollution as a possible threat for an arctic reef system and its association of ecosystem engineers

I. Pyko[1], M. Löder[2], C. Schulbert[1], M. Wisshak[3], C. Laforsch[2], A. Munnecke[1] and S. Teichert[1]

[1] GeoZentrum Nordbayern, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany. Email: ines.pyko@fau.de
[2] Tierökologie I, Universität Bayreuth, Bayreuth, Germany
[3] Abteilung Meeresforschung, Senckenberg am Meer, Willhelmshaven, Germany

The coralline red alga *Lithothamnion glaciale* forms rigid frameworks of magnesium calcite. The shelfs around the high arctic Svalbard archipelago (northern Norway) are intensely covered by these so-called rhodoliths. Drilled by boring mussels of the species *Hiatella arctica*, many rhodoliths become hollow ecospheres, inhabited by a great variety of benthic taxa. Thereby, these rhodolith communities can be regarded as arctic reef structures and increase the local biodiversity significantly, comparable to corals in the tropics. They also provide a possible nursery ground for fish. We report the first findings of microplastic ingested by individuals of *H. arctica*. Altogether, we identified eight different types of polymers via F-spectroscopy within the rhodolith-colonizing bivalves. The potential consequences for the bivalves can be manifold, including a negative impact on their function as an ecosystem-engineering organism. This would also affect the complete ecosystem of the Svalbard Shelf and its biodiversity.

Keywords: Arctic, biodiversity, ecosystem engineers, microplastic

Talk

Rapid change

From short-term experiments to ancient hyperthermal events: marine clade sensitivities to climate change conform across time scales

Carl J Reddin[1*], Paulina S. Nätscher[1], Ádám T Kocsis[1,2], Hans-Otto Pörtner[3], Wolfgang Kiessling[1]

[1]GeoZentrum Nordbayern, Department of Geography and Geosciences, Universität Erlangen-Nürnberg, Loewenichstraße 28, 91054 Erlangen, Germany
[2]MTA-MTM-ELTE Research Group for Paleontology, POB 137, Budapest, H-1431 Hungary
[3]Alfred Wegener Institute, Am Handelshafen 12, 27570 Bremerhaven, Germany

Anthropogenic increases in atmospheric CO_2 levels are raising seawater temperatures, lowering seawater oxygen concentrations and pH ('climate-related stressors', CRS), among other changes. Under such change, ecological experiments suggest some marine clades to be more vulnerable than others. However, whether these vulnerabilities directly scale up to extinction risk, or are somehow compensated e.g. by rapid range shifts, is unclear because few modern, global extinctions are unequivocally caused by CRS. The fossil record, meanwhile, documents myriad extinctions, often with strong clade selectivity, that amount to mass proportions under hyperthermal conditions. We attempt a quantitative cross-scale evaluation of the role of CRS as extinction triggers, comparing individual responses to CRS in laboratory experiments and the range shift responses to global warming over recent decades, to extinction selectivity at ancient hyperthermal events and across the sum of metazoan evolutionary history (the Phanerozoic aeon). Clades with strong negative responses to experimental CRS are most likely to go extinct at hyperthermal events, their genera also having the shortest geological durations. Among CRS, the experimental combination of seawater warming and hypoxia has the most severe impact on marine organism performance. Response details suggest chiefly metabolic constraints in setting organism performance responses to CRS, which appear to scale up to extinction probabilities of past (and potentially future?) hyperthermal events.

Key words: global warming; stressors; paleoecology; extinction

Talk

Rapid change

Human-mediated marine environments induce rapid phenotypic changes in wild fishes

Talijančić, I., Šegvić Bubić, T., Žužul, I., Grubišić, L.

Institute of Oceanography and Fisheries, Šetalište Ivana Meštrovića 63, 21000 Split, Croatia
Email: talijan@izor.hr

Plasticity represents a rapid-response mechanism that enables organisms to exhibit vast variety of phenotypic characteristics under different abiotic and biotic conditions. The bluefin tuna (*Thunnus thynnus*) farms form novel anthropogenic pressured environments in which uneaten feed influences the abundance and retention time of populations in the farm vicinity, acting as a high energy trophic and population source for aggregated wild fish. Thus, we investigated changes in phenotype of a protandrous hermaphrodite fish gilthead seabream (*Sparus aurata*) in wild (WO), farmed (FO) and farm-associated (FA) environments through morphological and ecophysiological comparisons. Body shape differences were noted in the head profile and trunk region, with FO individuals exhibiting dullest body colouration in comparison to silvery-grey colour spectrum of WO and FA populations. Primary food choice was size dependent where FA preferred fish over bivalvia food category as the convergence from male to female sex category was in progress at lower lengths in comparison to WO individuals. In summary, gilthead seabream showed high adaptive capacity in both morphological and physiological traits to the farm-associated environment and available food resources. Further studies are needed to determine temporal stability of observed adaptations in response to aquaculture induced environment, stressing the importance of re-establishing proper conservation and management measures for farm-associated fish populations.

Keywords: aquaculture, seabream, phenotype, adaptation

Talk

Rapid change

How is the increasing frequency of thermal anomalies change the extent and functioning of gorgonian forests in the Mediterranean Sea?

Eva Turicchia[1,2,3], Carlo Cerrano[3,4], Joaquim Garrabou[5], Cristina Linares[6], Marco Abbiati[1,2,3,7] and Massimo Ponti[2,3,8]

[1] Dipartimento di Beni Culturali, Università di Bologna, Via degli Ariani 1, 48121 Ravenna, Italy. Email: eva.turicchia2@unibo.it
[2] Centro Interdipartimentale di Ricerca per le Scienze Ambientali, Università di Bologna, Via S. Alberto 163, 48123 Ravenna, Italy.
[3] Consorzio Nazionale Interuniversitario per le Scienze del Mare, Piazzale Flaminio 9, 00196 Roma, Italy
[4] Dipartimento di Scienze della Vita e dell'Ambiente, Università Politecnica delle Marche, Via Brecce Bianche, 60131 Ancona, Italy.
[5] Institute of Marine Science, Spanish National Research Council, Passeig Marítim de la Barceloneta 37-49, 08003 Barcelona, Spain.
[6] Department of Evolutionary biology, Ecology and Environmental Sciences, University of Barcelona, Avda. Diagonal 645, 08028 Barcelona, Spain.
[7] Istituto di Scienze Marine, Consiglio Nazionale delle Ricerche, Bologna, Italy.
[8] Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna, Via Sant'Alberto 163, Ravenna, Italy.

In the Mediterranean Sea, healthy coralligenous habitats may host dense populations of gorgonians that shape marine animal forests. These forests enhance the three-dimensional complexity, increase species diversity improving the resistance and resilience of coralligenous habitats. However, the integrity of gorgonian forests is threatened by several anthropogenic and global climate change-related disturbances, such as the increased frequency of exceptional storms and thermal anomalies that may induce physiological stress and increase the gorgonians susceptibility to pathogens. The repeated mass mortality events involving gorgonians, mainly triggered by thermal anomalies, have led to substantial change in the structure and functioning of vast areas of Mediterranean coastal marine ecosystems. Here, recorded mass mortality events date back to the 1980s. During the regional scale events in 1999 and 2003, the mortality of gorgonians reached values of 50-80% down to 40 m depth and over ~1000 km along the north-western Mediterranean coasts. The frequency of these phenomena appears to be increasing as well as the geographical extent of the areas affected, not sparing areas once considered as a reference for benthic communities' integrity in the Mediterranean Sea, such as Montecristo Island. To counteract the loss of these habitats, with the biodiversity they host and the ecological goods and services they provide, is necessary to reduce anthropogenic disturbances, develop habitat restoration techniques and increase our ability to predict thermal anomalies and the onset of diseases both in the short and long period.

Key words: Coral disease, Global climate change, Heatwave, Habitat mapping

Talk

Rapid Change

Clam feeding plasticity alleviate herbivore sensitivity to ocean warming and acidification

C. Van Colen[1], E. Ong[1,2], M. Briffa[2], D. Wethey[3], E. Abatith[4], T. Moens[1], S. Woodin[4]

[1] Ghent University, Biology Department, Marine Biology Research Group, Krijgslaan 281 – S8, B 9000 Ghent, Belgium. E-mail: carl.vancolen@ugent.be
[2] Marine Biology & Ecology Research Centre, Plymouth University, Plymouth PL4 8AA, UK
[3] Department of Biological Sciences, University of South Carolina, Columbia, SC 29208, USA
[4] Ghent University, Department of Applied Mathematics, Computer Science and Statistics, Krijgslaan 281 – S9, B 9000 Ghent, Belgium

Anthropogenic carbon dioxide emissions are rapidly changing seawater pH and carbonate chemistry with vast repercussions on marine biodiversity. Direct effects of both phenomena on species populations are well documented, but how interactions within communities are affected and how this affect ecosystem functioning and resilience is poorly understood. In this presentation we demonstrate how the soft-sediment community interaction network between porewater nutrients, primary producers, herbivores and bioturbating invertebrates significantly restructures in response to experimental warming and acidification (+ 3°C, - 0.4 pH units).
Under unmanipulated conditions microalgal freshness was influenced by top-down control of the epifaunal grazer *Peringia ulvae* and the omnivorous ragworm *Hediste diversicolor*, while the peppery furrow shell *Scrobicularia plana* reduced porewater nutrient availability to primary producers and inhibited population biomass of *H. diversicolor*. Under warming and acidification *S. plana* did not influence porewater nutrients, promoted microalgal freshness and no longer affected *H. diversicolor*. Using porewater hydraulic signatures we demonstrate that such change in community interactions is linked to behavioral plasticity in *S. plana*. This key species shifted from predominant filter feeding under ambient conditions to almost exclusive deposit feeding under high pCO_2 conditions, with cascading effects on nutrient supply to primary producers. Surface-dwelling microalgal consumers were more tolerant to warming and acidification in the presence of *S. plana*, most likely due to stimulatory effect of the clam on their food resources.
In summary, this study demonstrate that predicting population resilience to climate change is limited when non-lethal effects such as key species behavioral change are not considered.

Key words: behavioral plasticity, ecosystem interaction network, benthic community, ocean acidification and warming

Talk

Rapid Change

The multifaceted contributions of individual species to the stability of ecosystems

Lydia White[1,2]**,** Nessa E. O'Connor[1,3], Mark C. Emmerson[1] & Ian Donohue[3]
[1]School of Biological Sciences, Institute of Global Food Security, Queen's University Belfast, Belfast, BT9 7BL, UK
[2] Sorbonne Université, CNRS, UMR 7144 Adaptation et Diversité en Milieu Marin AD2M, Station Biologique de Roscoff, Roscoff, France, UMR 7144, Station Biologique, 29680 Roscoff, France. lydia.white@sb-roscoff.fr
[3]Department of Zoology, School of Natural Sciences, Trinity College Dublin, Ireland

Exploration of the relationship between species diversity and ecological stability has occupied a prominent place in ecological research for decades. Yet, a key component of this puzzle – the contributions of individual species to the overall stability of ecosystems – remains largely unknown. Here, we show that individual species can not only simultaneously stabilize and destabilize ecosystems along different dimensions of stability, but also that their contributions to functional (biomass) and compositional stability are largely independent. By simulating experimentally the extinction of consumer species from a coastal rocky shore, we found that species contributions to some dimensions of stability could be predicted by the strength of their interactions in the system. However, the capacity to predict the combined contribution of multiple species to stability from the sum of their individual contributions varied among stability dimensions. These results imply that the nature of the diversity-stability relationship depends upon the dimension of stability under consideration, and may be additive, synergistic or antagonistic. We conclude that, though the profoundly multifaceted and context-dependant consequences of species loss present a significant challenge, the predictability of species contributions to some dimensions of stability provide a way forward for ecologists trying to conserve ecosystems and manage their stability under global change.

Keywords: resilience, resistance, global change, disturbance

Talk

Rapid change

Effect of temperature and food limitation on the energy metabolism of two species of sea urchins from high lattitude.

Détrée C.[1], Gonzalez M.[2], Navarro J.M.[1]

[1]Instituto de Ciencia Marinas y Limnologia, Centro FONDAP de Investigación en Dinámica de Ecosistemas Marinos de Altas Latitudes (IDEAL), Universidad Austral de Chile, Valdivia, Chile
[2] Scientific Department, Chilean Antarctic Institute, Plaza Muñoz Gamero Punta Arenas, Chile
Email: camille.detree@uach.cl; jnavarro@uach.cl, mgonzalez@inach.cl

Climate change is affecting marine ectotherms distributions and the intensity of warming-induced range shift toward the Arctic and Southern Ocean is increasing. Such range shift may indirectly disturbe organisms' interactions and trophic ressources. Investigating ectotherms thermal plasticity and resilience upon increasing temperature and climate-change driven stressors has become primordial to predict the risks of global warming on the future of marine ecosystems. The Strait of Magellan in South Patagonia constitutes a unique natural laboratory due *inter alia* to its cold-temperate water temperature, its vicinity with Antarctic and the abundant marine life that dwells within it. More, numerous marine ectotherms -with however distinct geographical distributions- are at their southernmost limit of distribution. Herein, to gain a better understanding on the direct and indirect effects of global warming on the physiological rates of ectotherms from high lattitudes, we compared the metabolic response of 2 species of sea urchins (*Loxechinus albus* and *Pseudechinus magellanicus*) submitted to both temperature (predicted future temperature and cold temperature of the Antarctic Peninsula) and food limitation. Overall, a contrasting response was observed when comparing both species: temperature and food limitation had synergetic effects on *P. magellanicus'* O_2 uptake and ingestion rate while temperature was the main factor affecting *L. albus'* metabolism. However, our results suggest that *P. magellanicus* is relatively plastic to variation in temperature and could therefore be resilient to climate change-induced stressors.

Key words: Climate change, High lattitude, Ectotherms, physiology

Talk

Rapid change

Shining light on the importance of intertidal benthic primary productivity to estuarine ecosystem function

S. Mangan[1], C. A. Pilditch[1], K. Bryan[1], S. Thrush[2], A. Lohrer[3]

[1] School of Science, University of Waikato, Hamilton 3240, New Zealand 1. Email: steph_mangan@hotmail.com
[2] Institute of Marine Science, University of Auckland, Auckland 1142, New Zealand
[3] National Institute of Water and Atmospheric Research Ltd. (NIWA), Hamilton 3216, New Zealand

The penetration of light to the sea floor within coastal ecosystems provides the basis for productivity through benthic primary production. This productivity is known to fuel adjacent food webs and influence organic matter processing, carbon cycling and the transformation of nutrients. Globally, many intertidal ecosystems are either too turbid during inundation to allow benthic photosynthesis to occur or are starting to shift towards this altered ecosystem state. To compensate for this inhibition of photosynthesis, high productivity can occur during emersion, however, modifications to other functions such as nutrient processing are not so readily substituted. We deployed PAR sensors at 22 sites within 14 estuaries spanning a 10° latitudinal gradient across New Zealand to assess variability in light availability at the sediment surface of intertidal sandflats. Based on published data we estimated sites likely to have reduced productivity during inundation owing to low light availability. We supplement this time series with in situ oxygen flux data during inundation and CO_2 flux data during emersion, before estimating whether productivity during emersion could compensate for this reduction. Our results highlight the importance of incorporating emerged productivity into estimates of total system productivity and identify intertidal regions as crucial habitats in highly turbid estuaries. The predicted global decline in the extent of intertidal habitats owing to sea level rise may therefore increase the vulnerability of these ecosystems to state changes as productive regions are lost.

Key words: benthic productivity, light, microphytobenthos

Talk

Rapid Change

Can biodiversity-ecosystem function relationships predict tipping points in soft sediments? Insights from a multi-stressor national field experiment

Conrad Pilditch[1], Andrew Lohrer[2], Judi Hewitt[2,3], Candida Savage[4], Rebecca Gladstone-Gallagher[5], Terri O'Meara[5], Jen Hillmen[5] and Simon Thrush[5]

[1]School of Science, University of Waikato, Hamilton, New Zealand. Email: conrad.pilditch@waikato.ac.nz
[2]National Institute of Water & Atmospheric Research, Hamilton New Zealand
[3]Department of Statistics, University of Auckland, Auckland, New Zealand
[4]Department of Marine Science, University of Otago, Dunedin, New Zealand
[5]Institute of Marine Science, University of Auckland, Auckland, New Zealand

Cumulative effects from multiple stressors have the capacity to cause rapid and unexpected changes in ecosystem function that bare little relationship to variation in stressor loading. The cause of these so-called 'tipping points' and associated regime shifts are often only apparent with hindsight. While ecological theory has, demonstrated strong links between biodiversity and ecosystem function (BEF) there is a disjunction with empirical studies in real world settings where relationships are variable, context dependent and difficult to define. On temperate shallow coasts land derived sediments and excess nutrient inputs represent two important stressors that reduce benthic primary production through elevated turbidity and impact soft sediment ecosystems via the multiple effects associated eutrophication (e.g. loss of key benthic macrofaunal species that regulate ecosystem functions due to anoxia). We selected 24 intertidal sites in 15 estuaries across New Zealand that spanned a turbidity gradient and manipulated sediment porewater ammonium concentrations at three levels with slow release fertilizer. Seven months later we sampled benthic macrofaunal diversity, and measured solute fluxes across the sediment-water interface to estimate benthic primary production, community metabolism and nutrient processing capacity. Analyses indicate that turbidity stress altered BEF relationships with nutrient loading, an important indicator of cumulative effects. However, the functional changes we observed occurred well below major species loss and published toxicity levels. This result suggests that although BEF relationships may be useful in integrating mechanistic complexities, the disadvantage is we may not have a sensitive tool and it is often difficult to measure function at any particular scale.

Key words: cumulative effects, macrofaunal diversity, New Zealand, ecosystem function

Talk

Rapid change

Cladocora caespitosa in a rapidly changing environment: effects from eutrophication, windstorm and warming event

Louis Hadjioannou[1,2], Carlos Jimenez[2,3], Julia Hartingerova[2], Vasilis Andreou[1,2], Antonis Petrou[2], Dan Hayes[4]

[1] Department of Biological Sciences, University of Cyprus, Nicosia, Cyprus. Email: L.Hadjioannou@enaliaphysis.org.cy

[2] Enalia Physis Environmental Research Centre, Nicosia, Cyprus.
[3] Energy, Environment and Water Research Center (EEWRC) of The Cyprus Institute, Nicosia, Cyprus.
[4] Cyprus Oceanography Centre, University of Cyprus, Nicosia, Cyprus.

The effect of warming events, extreme windstorms and anthropogenically-induced eutrophication at two communities of the scleractinian coral *Cladocora caespitosa* in the Southeast of Cyprus were studied. One of the sites, Kryo Nero, is occurring in a naturally oligotrophic state, while the other, Liopetri, has been subjected to elevated nutrient concentrations as a result of a fishfarm hatchery and agricultural activities. During the warmest months of 2014 and 2015, we observed mortality of coral tissue in the monitored colonies of both areas, significantly more in 2015, associated with temperatures being higher (>29 ^{o}C) and prolonged than in 2014. A significantly larger coral tissue necrosis (ca. 17% surface area) was observed in the eutrophic area of Liopetri, affecting 95% of the colonies. The difference in effect between the sites is attributed mainly to the elevated nutrient concentrations. At Kryo Nero, an extreme windstorm in January 2015 generated swells that detached cliff boulders that collapsed on top of the colonies. Affected colonies (7%) lost an average of 50% of pigmented tissue. The recorded mortalities should serve as an alarming call, exhibiting just how vulnerable these sensitive organisms are. Results of the study shed light on the extent that climatic changes and other anthropogenically-induced factors can have on the marine environment. The outcome will provide a valuable tool for conservation planning and managing biodiversity.

Key words: SST warming, extreme windstorm, coral mortality, eutrophication

Talk

Rapid change

Observing an ongoing aggressive invasion of a large predatory crab in the pristine Arctic Kara Sea.

Anna K. Zalota[1], V. A. Spiridonov[1], S.V. Galkin[1]. A. A. Vedenin[1], A.A. Udalov, A. A. Pronin[1]

[1] *Shirshov Institute of Oceanology, Russian Academy of Sciences (SIO RAS), Moscow, Russia. azalota@gmail.com*

The sharp decrease in sea ice cover period of the Kara Sea in the mid 2000s has left this sea vulnerable to previously minimal anthropogenic impact. In comparison to its neighbouring Barents Sea, the Kara Sea has low productivity, and no commercial fishery. Main shipping traffic is due to oil and gas industry along the shore.
In 2011 a large predatory crab *Chionoecetes opilio* was detected in the Kara Sea, close to the border with the Barents Sea. In 2014 it was present throughout the entire western shelf of the Kara Sea, including the bays of Novaya Zemlya Archipelago. In consequent years its population grew rapidly, particularly in some bays such as Blagopoluchiya, where up to 8 crabs in 0.5 m^2 could be observed. Such high concentration of crabs in Blagopoluchiya Bay resulted in drastic collapse of native benthos biomass. By 2018 the local settlement of crabs in the bay began to collapse; possibly due to low food availability. Based on the population size structure f this settlement the major invasion of bay occurred in 2014 and the population has overreached its maximum capacity within the first generation. We believe that such extreme course of invasion was possible due to absence of potential predators of competitors of snow crabs in the Kara Sea. The bottom communities of this sea is not accustomed to large quantities of agile predators, since there are few species and number of benthic fishes, and no other comparable invertebrate predators.

Key words: Invasive species, Decapods, Arctic, Climate Change, Sea Ice decline

Talk

Rapid Change

Phytoplankton and Warming of the North Sea: a summary

Karen Helen Wiltshire and Mirco Scharfe

Alfred Wegener Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Biologische Anstalt Helgoland, Kurpromenade 201, 27498 Helgoland, Germany
Karen.Wiltshire@awi.de

Recurrent processes of changes in the environment such as the annual cycles of light and temperature trigger the periodicity of events (phenology) in marine plankton populations. We analysed the phenological variability of phytoplankton species (diatoms and dinoflagellates) monitored at Helgoland Roads from 1962 to 2014. Using derived temporal indices based on the cumulative percentage of annual abundance, we analyzed their temporal development and their relationships to abiotic parameters. We showed that the timing of the growth window for the diatom community at Helgoland Roads has widened to into spring and autumn. This can be related to a shift in water temperature and clearer light conditions in spring and warmer water in autumn. Upon examining the species involved we noted that not all species react in the same manner or with the same variability to environmental in temperature and light. We found that timing of phytoplankton species is highly variable. Species-specific preference differences related to seasonal variability in environmental parameters gave a complex phenological response pattern.

Poster

Rapid change

Microplastics in aquatic systems – genuine threat or over exaggeration?

Eoghan M. Cunningham[1,2], Julia D. Sigwart[1,2]

[1]School of Biological Sciences, Queen's University Belfast, Medical Biology Centre, 97 Lisburn Road, Belfast, BT9 7BL, Northern Ireland, UK. Email: ecunningham18@qub.ac.uk
[2]Queen's Marine Laboratory, Queen's University Belfast, 12-13 The Strand, Portaferry, BT22 1PF, Northern Ireland, UK.

Microplastics (synthetic polymers, <5 mm) are ubiquitous, in the environment and in the news. The potential effects of microplastics on flora and fauna are currently only established through laboratory-based exposure trials; however, such studies have come under scrutiny for employing excessive concentrations with little environmental relevance. A meta-analysis of results from published experimental (n = 128) and environmental (n = 180) studies allowed us to compare the reported impacts on organisms, and the concentrations of microplastics found in the wild. Our results highlight three issues that should be modified in future work: (1) use of extreme dosages, (2) incompatible and incomparable units, and (3) the problem of establishing truly informative experimental controls. We found that 5% of exposure trials did not use any control treatment, and 82% use dramatically elevated dosages without reference to environmental concentrations. Early studies in this field may have been motivated to produce unequivocal impacts on organisms, rather than creating a robust, environmentally relevant framework. The existing literature on the extent of plastic pollution also has limited utility for accurately synthesizing broader trends; environmental extraction studies use many different units, among which only 76% (139/180) could be plausibly converted for comparison. Future researcher should adopt the units of microparticles/kg (of sediment) or mp/L (of fluid) to improve comparability. Now that the global presence of microplastic pollution is well established, with more than a decade of research, new studies should focus on comparative aspects rather than the presence of microplastics.

Keywords: plastic pollution; meta-analysis; microplastic extractions; microplastic impacts

Poster

Rapid change

High occurrence of non-indigenous species travelling in the Mediterranean Sea by recreational boats

Ferrario J.[1], Ulman A. [1], Occhipinti-Ambrogi A. [1], Bandi A.[1], Bogi E.[2], Martínez-Laiz G.[3], Merlo G.[1], Princisgh E.[1], Scribano G.[1], Marchini A.[1]

[1] Department of Earth and Environmental Sciences, University of Pavia, via S. Epifanio 14, 27100 Pavia, Italy. Email: jasmine.ferrario@unipv.it
[2] Gruppo Malacologico Livornese, Leghorn, Italy
[3] Laboratory of Marine Biology, Department of Zoology, University of Seville, Spain

Biofouling on recreational boats was recently acknowledged by the scientific community as a key vector in the introduction and spread of marine non-indigenous species (NIS). This is particularly relevant in the Mediterranean Sea, where a high number of small boats, and their high incidence of travel, propelling the opportunities of transferring NIS from one marina to another. This work presents a large-scale analysis of fouling assemblages from about 400 recreational boat hulls, with the aim of assessing the role of recreational boating in Mediterranean bioinvasions. The boats included in this assessment had travelled at least once outside their home marina in the past 12 months and displayed visible fouling. Samples were collected in 2015-2016 in 20 Mediterranean marinas. A total of 154 species were identified, including 121 native/cryptogenic species and 34 NIS. A maximum of 10 NIS was observed on a single boat in Licata (Sicily), while the average number of NIS on the whole sampled boats was 2.5±1.9. The average percentage of NIS over the total number of species ranged from 9.9% (Sainte-Maxime, France) to 42.3% (Ostia Lido, Italy). Interestingly, only 12% of all the inspected boats were not carrying any NIS. These results testify that recreational boats travelling across the Mediterranean actively transport invertebrates on their hulls, including several NIS. The role of recreational boating in the introduction and spread of NIS should urgently be incorporated into regulations, aiming to manage this vector responsible of NIS introduction both at the Mediterranean and the European level.

Key words: marine bioinvasions, shipping, marinas, fouling organisms

Poster

Rapid change

Long-term changes of the northeastern Black Sea coastal macrozoobenthos in the XXI century

Kolyuchkina G.A.[1], Chikina M.V. [1], Syomin V.L.[2], Basin A.B. [1], Lyubimov I.V. [1]

[1]Shirshov Institute of Oceanology, Russian Academy of Sciences (SIO RAS), Nakhimovski prospect, 36, Moscow, 117997, Russia. E-mail: galka.sio@gmail.com
[2]Federal State Budget Institution of Science "Federal Research Center The Southern Scientific Centre of the Russian Academy of Sciences" (SSC-RAS), Chekhova pr., 41, Rostov-on-Don, 344006, Russia.

The Black Sea bottom ecosystem changed during the 1980-1990s due to anthropogenic eutrophication, oxygen depletion, and nonindigenous species invasions. In the early 2000s, the macrozoobenthos was characterized by the dominance of opportunistic polychaetes. In order to estimate the ongoing changes, the analysis of macrozoobenthic dynamics was carried out on the northeastern coast from 2001 to 2017. It shows that the species number and the Shennon index two-fold increased during this period. At 10-15 m a native clam *Chamelea gallina* community was present. At 20-30 m depths the similar community that was present in the 1960-1980s, was substituted by an alien ark *Anadara kagoshimensis* community in 2001-2002; and in 2003-2017 by native clams *Pitar rudis* and *Gouldia minima*. The multidimensional analysis of species abundance, biomass and composition revealed four distinct periods:1960-1980s, 2001, 2002-2007, and 2008-2017.The difference in structure of the macrozoobenthos between the 1960-1980s, 2001 and recent periods was due to the change in the bivalve characteristics. In 2001 - 2002 high abundance of arks and clams *C. gallina* was observed due to a mass spatfall observed in 2000. In 2003-2007 the biomass and abundance of bivalves were low due to the rapa whelk predator press, which allowed polychaetes and gastropods to become dominant. In 2008-2017 the species composition and the structure of the communities were similar to the 1960-1980s.Therefore, after 2008 we observe increasing biodiversity and stabilization of macrozoobenthos structure along with the native bivalves dominance.
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Key words: macrozoobenthos, long-term changes, Black Sea

Poster

Rapid change

Warming effects on biogeochemical cycling of algal wrack subsidies in Antarctic shores

López J.[1,2], Lastra M.[1,2], Troncoso J.[1,2], Sampedro L.[3] and Garcia-Gallego M.Á.[1]

[1] Universidad de Vigo, Vigo, Spain. Email: jlopez@uvigo.es
[2] Estación de Ciencias Marinas de Toralla (ECIMAT), Vigo, Spain.
[3] Misión Biológica de Galicia CSIC, Pontevedra, Spain.

Abstract
Accumulation of algal wrack is a common event in the intertidal sedimentary coastal. These external inputs of allochthonous biomass derive from detached primary producers of the neighbouring submerged rocky shores. The response in decomposition of these algal deposits to global warming has not been studied in the Antarctic coast to date. With this aim, we used passive open top chamber devices to increase soil temperature through greenhouse effect within the range predicted by the IPCC for western Antarctic Peninsula (0.5-1.5 ºC). The effect of temperature manipulation on patches of fresh *Palmaria decipiens*, and bare sand, was conducted to test the hypotheses that the biogeochemical processing of macroalgal wrack subsidies will accelerate in response to temperature increase. Results over a 14 days experiment time indicated that a small warming (less than 1 ºC) affected the wrack decomposition process through traceable increases in soil respiration as CO_2 flux, inorganic nutrients release toward the interstitial environment (C, N and P), and microbial pool gauged through the total soil DNA. Differences between warmed and control plots in total inorganic N were not significant, whereas leaching of P to the sedimentary environment decreased in 25 %. Flux in CO_2 to the atmosphere increased in 30 % in warmed sites. This study confirms the key role of free of ice Antarctic sedimentary shores in recycling ocean derived primary production and organic matter, highlighting the sensitivity of these ecosystems to a changing scenario of global warming that predicts significant increases in temperature over the next few decades.

Key words: Open top chambers, Nutrients, CO_2, Global warming.

Poster

Rapid change

Heat waves as a driver of change in mudflat macroinvertebrate communities

Shannon M. White[1], Roger J.H. Herbert[2], and Gordon J. Watson[1]

[1]Institute of Marine Sciences, School of Biological Sciences, University of Portsmouth, Ferry Road, Portsmouth, PO4 9LY, UK. Email: shannon.white@port.ac.uk
[2]Department of Life and Environmental Sciences, Bournemouth University, Christchurch House, Talbot Campus, Poole BH12 5BB, UK

The prediction for an increase in frequency, intensity, and duration of heat wave events as a result of climate change may have negative implications for intertidal marine organisms that are already subject to high temperature variability associated with solar, tidal, and seasonal cycles. Here, the effects of discrete temperature events on mudflat macroinvertebrates were investigated by simulating heat waves in a large outdoor mesocosm system designed to preserve natural sediment temperature profiles, solar and tidal cycles, and faunal densities. Community composition effects were not identified overall or for the abundance of shallow dwelling organisms that may be more vulnerable to extreme temperatures at the sediment surface. For the polychaete *Alitta virens* and the bivalve *Cerastoderma edule*, which exhibit different burrowing abilities, neither species exhibited higher mortality as a result of the heat wave simulations performed. Changes in energy reserves, however, suggested sublethal effects for both, which has implications for their vulnerability to the increased frequency, intensity, and duration of these events predicted for the future.

Key words: Heat wave, Mudflats, Macroinvertebrates

Movement and redistribution of species

Talk

Movement and redistribution of species

Age of recipient assemblages determines bio-invasion under realistic assembly rules

Jean-Charles Leclerc[1], Frédérique Viard[2], Christian Díaz[3] and Antonio Brante[1]

[1] Universidad Católica de la Santísima Concepción, Departamento de Ecología, Facultad de Ciencias, Centro de Investigación en Biodiversidad y Ambientes Sustentables (CIBAS), Casilla 297, Concepción, Chile
Email: leclercjc@gmail.com
[2] Sorbonne Université, CNRS, UMR 7144 AD2M, Station Biologique de Roscoff, Place Georges Teissier, 29680 Roscoff, France
[3] Departamento de Medio Ambiente y Energía, Facultad de Ingeniería, Centro de Investigación en Biodiversidad y Ambientes Sustentables (CIBAS), Universidad Católica de la Santísima Concepción, Concepción, Chile

The biotic resistance hypothesis predicts that NIS establishment and spread fail in diverse communities because strong biotic interactions with native species and had led to numerous strategies worldwide (e.g. increasing habitat complexity of artificial coastal structures) in order to promote the native component at the expense of the NIS. Nonetheless, the influence of native biodiversity under realistic assembly rules has, to our knowledge, never been thoroughly tested in marine environments. The relationships between diversity and invasiveness can indeed vary according to the distribution of competitive traits in the species pool and may be skewed in many possible scenarios, as the distribution of facilitative traits is also considered. We herein tested these models in marine fouling community using a controlled translocation approach from a “pristine” to an “invaded” site (experiencing higher propagule pressure) at two occasions (spring and fall). Translocated substrates were previously left being colonized for either 0, 1, 3, 7 or 13 mo. After a first sampling at the time of translocation (procedural control), panels were retrieved after 1 mo to assess recruitment patterns and after 4 mo to account for preliminary species interactions. NIS recruitment and colonization was generally greater on early stages-panels (0, 1, 3 mo) and bare space availability generally correlated with NIS recruit number. However, several NIS were either indifferent to the successional stage of the recipient assemblage or positively influenced by native habitat-forming species (barnacles and ascidians), suggesting that facilitation should deserve further attention in models of biotic resistance.

Key words: Biotic resistance, Succession, Fouling communities, Chile

Talk

Movement and redistribution of species

Space use behaviour, spatial distribution of populations and organisation models in marine guilds

Basset A.[1, 2], Marrocco V.[1], Ciotti M. [1], Cozzoli F. [1], Gjoni, V. [1], Rosati I.[1] and Shokri M.[1]

[1] Department of Biological and Environmental Sciences, University of Salento ITALY - Email: alberto.basset@unisalento.it
[2] LifeWatch ERIC Service Centre

Space use behaviour of marine organisms is attracting increasing attention. Here, we focus on key factors potentially affecting the space use behaviour of marine vertebrates, mainly fishes, and their influence on guild organisation models in marine ecosystems. This study is based on a meta-analysis of individual home range size of marine vertebrates. It considers as potential drivers of home range size individual traits as body size, functional group, trophic level and habitat selection behaviour; the latter expressed with a binary classification as ‘migratory’ vs ‘non-migratory’ species. The overall database includes 127 species, which were partitioned into functional groups according to controlled vocabularies and established classifications. Globally, allometric scaling of individual home range has been observed at all level of resolution used, on the entire database as well as within functional groups, trophic levels, ‘migratory’ vs ‘non-migratory’ species. All factors considered in this study as potential drivers of individual home range were actually observed to explain components of the variance of the body size – home range size allometric scaling. The integration of the allometric scaling obtained in relation to each of the driving factors considered suggests lottery competition as the underlying mechanism which could affect the organisation of the marine fish guilds. ‘Migratory’ species, as non-permanent members of taxonomic composition of local guilds, seem likely to determine conditions for the occurrence of lottery competitions, with stochastic recruitment of colonizing species in both functional groups and trophic levels.

Key words: Home range size, home range allometries, fish functional groups, fish guild organisation,

Talk

Movement and distribution of species

Limpets in the rough: Manipulating habitat topography to understand animal orientation decisions

Coleman, **R.A**[1]., Williams, G.A[2]., Hawkins, S.J[3] & Fraser, C.M.L.[1,2,3]

1. Coastal & Marine Ecosystems, School of Life & Environmental Sciences, The University of Sydney. Ross.coleman@sydney.edu.au
2. Swire Marine Laboratories, Hong Kong University
3. Natural Sciences, The University of Southampton

Selection of, and position/orientation within, a place to rest out unfavourable periods is a response to cues; these may be physical, biotic, social or an interaction of these. To understand resting site selection behaviours in the field, we must identify the underlying cues. Some animals can respond to changes in external stimuli whilst resting, whereas others are constrained either physically or because of costs incurred by altering place or orientation. Patellogastropod limpets are an example of the latter; their behaviour within a resting site is set from an initial decision made on arrival at that site, prior to the unfavourable conditions starting and fixed during emersion. We investigated the role of structural properties in the selection of resting-site location and subsequent behaviour in four species of limpets, as they are known to actively select certain resting sites over other available areas of habitat. We found that limpets will position themselves against edges and when the topography of their resting site is modified, individuals will later select a new resting site or alter orientation within their original resting site. The key behaviour is to locate and align along edges and other environmental attributes play no role. In contrast to organisms that can easily alter their orientation whilst at rest, such as birds and lizards, and select their orientation more commonly with respect to environmental and social cues, our findings suggest for animals that are unable to change their orientation at such short time scales structural habitat cues are the determining factor.
Not exceeding 250 words

Key words: Distribution; habitat selection; grazers; behaviour

Talk

Movement and redistribution of species

Population connectivity of humpback whales (*Megaptera novaeangliae*) recorded in the breeding grounds of the Pitcairn Islands, central South Pacific.

Terence P. Dawson[1], Robert Irving[2], C. Scott Baker[3] and Rochelle Constantine[4]

[1] King's College London, London WC2R 2LS, UK. Email: terry.dawson@kcl.ac.uk
[2] Sea-Scope Marine Environmental Consultants, Dulverton, Somerset TA22 9PW, UK.
[3] Hatfield Marine Science Center, Oregon State University, Newport OR 97365, USA.
[4] School of Biological Sciences, University of Auckland, Auckland, New Zealand.

The South Pacific Whale Research Consortium is the principal research collaboration for humpback whales (*Megaptera novaeangliae*) in Oceania, maintaining a DNA register, sound recordings and photo-identification catalogues. With funding from the International Whaling Commission Southern Ocean Research Partnership, consortium members seek to improve conservation outcomes for cetaceans in the South Pacific through an understanding of the status, health and dynamics of their populations, and the threats they face. Humpback whales in the Southern Hemisphere undertake seasonal migrations from their Antarctic feeding grounds to mating and calving areas in tropical or sub-tropical waters. From the seven breeding sub-populations recognised by the IWC, the Oceania sub-population encompasses humpback whales some of which migrate each austral winter to the waters near the Cook Islands and French Polynesia. In 2008, the Oceania sub-population was classified on the IUCN Red List of Threatened Species as Endangered on account of its small population size and slow population growth rate. In recent years, humpback whales have been observed visiting the Pitcairn Islands, a UK overseas territory located in the central South Pacific. The whales have been recorded in small groups including adult males, mothers with calves and escort whales during the austral winter months, confirming the Pitcairn Islands are being used as breeding habitat. We report on investigations currently underway, as part of the UK Darwin Initiative project No. 20-006, to assess the status of humpback whales near the Pitcairn Islands and their relationship to other sub-populations of Oceania through genetic analyses, whale song and photographic records.

Humpback whale, Oceania, Population Distributions, Genetics

Talk

Movement and redistribution of species

Early migration behaviour and mortality of Atlantic salmon (*Salmo salar*) from the Burrishoole River, western Ireland

Doogan, A.[1,2], Cotter, D.[2], Bond, N.[2], Ó'Maoiléidigh, N.[2] and Brophy, D[1]

[1] Marine and Freshwater Research Centre, Galway-Mayo Institute of Technology, Dublin road, Co. Galway, Ireland. Email: aisling.doogan@research.gmit.ie/aisling.doogan@marine.ie
[2] Marine Institute, Furnace, Newport, Co. Mayo, Ireland.

The marine migration of Atlantic salmon (*Salmo salar*) has been prioritised for research internationally as populations of *S. salar* have declined throughout the species range. In particular, it has been recommended that future research efforts focus on partitioning mortality of salmon among phases of the marine migration (NASCO, ICES). The main objective of this study was to use acoustic telemetry to partition mortality throughout the early marine phase, discuss potential causes of mortality, describe migration routes, speeds and establish diurnal influences on movements. As it has been previously shown that wild *S. salar* survive better than ranched salmon, wild and hatchery ranched smolts were tracked to determine if differences in migratory behaviour could lead to differential survival of the two groups. In 2017 and 2018, wild (n = 49) and hatchery reared (n = 81) *S. salar* smolts were tagged with acoustic transmitters. Movements were monitored through a brackish tidal lake, Lough Furnace which discharges through a short estuary into north east Clew Bay (27km) situated in the North-east Atlantic. Higher mortality rates occurred within the marine environment compared to the estuary and Lough Furnace. Preliminary results have identified some differences in time spent in Lough Furnace and movements throughout the study area between wild and hatchery smolts. Results from this study will better our understanding of how *S. salar* smolts move between freshwater and marine environments and contribute to future management and conservation efforts.

Key words: [Salmo salar, acoustic telemetry, marine migration, smolt]

Talk

Movement and redistribution of species

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Doogan, A.[1,2], Cotter, D.[2], Bond, N.[2], Ó'Maoiléidigh, N.[2] and Brophy, D[1]

[1] Marine and Freshwater Research Centre, Galway-Mayo Institute of Technology, Dublin road, Co. Galway, Ireland. Email: aisling.doogan@research.gmit.ie/aisling.doogan@marine.ie
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Key words: [Salmo salar, acoustic telemetry, marine migration, smolt]

Talk

Movement and redistribution of species

Database of macroalgae presence data: OCLE

J.A. **Juanes**[1], E. Ramos[1], F. Fernández[1], C.F. de la Hoz[1], A. Puente[1] and X. Guinda[1]

[1] Environmental Hydraulics Institute, Universidad de Cantabria - Avda. Isabel Torres, 15, Parque Científico y Tecnológico de Cantabria, 39011, Santander, Spain
1. Email: juanesj@unican.es

In recent decades, a significant shift in marine species distribution limits has been observed as a result of climate change. The studies on historical distribution of marine communities are necessary for sustainable management, but they are frequently limited by the lack of relevant data, especially when working over large areas. For this purpose, the OCLE database of hazards to marine life and synthetic information on species distribution in Europe has been developed for the historical period 1985-2015 (http://ocle.ihcantabria.com/), including standardize forms with specific metadata (sampling, type of data, complementary data, contact person) on original works (PhD thesis, Technical Reports, etc).

At present, data for 22 characteristic macroalgae taxa (e.g. *Bifurcaria, Chondrus, Corallina, Cystoseira, Ellisolandia, Fucus, Gelidium, Halopteris, Himanthalia, Laminaria, Pelvetia*) is available along the N and NW Iberian Peninsula. Further OCLE upgrades are ongoing through a collaborative process with different universities. Intertidal and subtidal distribution of these taxa per year and season has been compiled from field campaigns, own published data and valuable unpublished data. OCLE data is available for free to allow users' choice to meet different research needs, regarding the historical records. Datasets of interest can be explored on a map or downloaded in a *.csv format. Projections of representative macroalgae distributions at RCP4.5 and 8.5 are currently under progress.

The compilation of this specific biological data, addressing the collection of existing unpublished biological information that, otherwise, will be lost in next years, arises a new challenge in the field of marine climate change research.

Key words: climate change, macroalgae, database, species distribution.

Talk

Movement and redistribution of species

Connectivity of Pacific halibut in North American waters: scales of movement and relevance to fishery management

Timothy **Loher**[1]

[1] International Pacific Halibut Commission, 2320 West Commodore Way, Seattle, WA 98199-1287, USA. 1. Email: tim.loher@iphc.int

Along with its Atlantic congener, Pacific halibut (*Hippoglossus stenolepis*) represent the world's largest flatfish, historically reaching lengths of nearly 3m and weighing up to 350kg. The species ranges from northern California, USA, northward throughout the Bering Sea, and westward into the Sea of Okhotsk and northern Sea of Japan. In US and Canadian waters, this population has supported commercial fisheries for over a century, and native fisheries for many centuries longer, with annual long-term average productivity estimated at approximately 20,000 tonnes. Since 1923, Pacific halibut in US and Canadian waters have been jointly managed via the International Pacific Halibut Commission (IPHC). Early IPHC research focused heavily upon tagging studies to elucidate seasonal and ontogenic movement and, hence, population structure; leading to the establishment of a series of regulatory areas within which management is currently structured. Still, dynamics associated with decadal-scale fluctuations in abundance, coupled with a recent time-series of relatively low recruitment indices, serve to highlight gaps in our understanding of behaviour and connectivity at numerous spatial and temporal scales, and debate continues regarding the geographic extent over which to calculate various stock metrics and apply specific management actions. Here, we will present results from recent electronic tagging studies – with supporting evidence from genetic and otolith microchemical analyses – that refine our understanding of mixing at time-scales relevant to prosecution of fisheries; with particular attention to connectivity among major oceanographic systems (i.e., the Gulf of Alaska, eastern Bering Sea, and Aleutian Ridge) and important regional variance within individual systems.

Key words: Pacific halibut, connectivity, management, electronic tagging

Talk

Movement and redistribution of species

Predicting the potential distribution of the Lessepsian blue swimmer crab *Portunus segnis* in the Mediterranean Sea

G. Mancinelli[1,2,3] and R. Bardelli[1]
[1] Laboratory of Ecology, Department of Biological and Environmental Sciences and Technologies (DiSTeBA), University of Salento, 73100 Lecce, Italy. Email: giorgio.mancinelli@unisalento.it
[2] National Research Council (CNR), Institute of Biological Resources and Marine Biotechnologies (IRBIM), Lesina - (FG), Italy
[3] CoNISMa, Consorzio Nazionale Interuniversitario per le Scienze del Mare, 00196 Roma, Italy

Abstract
The portunid blue swimming crab *Portunus segnis* (Forskål, 1775) is one of the earliest Lessepsian invaders, recorded in Egypt 30 years after the completion of the Suez Canal in 1868. Subsequently, it has successfully established in coastal habitats of the Levantine basin, the Aegean Sea, and more recently, Tunisian coastal waters. Here, records of *P. segnis* in the Mediterranean Sea and in native habitats were collated, georeferenced, and matched to high resolution oceanographic environmental layers. Environmental Niche Modelling (ENM) procedures were implemented to identify the main environmental factors driving the species occurrence in invaded habitats and define its Grinnellian niche. To predict the future distribution of the crab, its niche was projected into a mid- and high-severity future climate scenarios for 2050. The results showed that *P. segnis*, after invading the Mediterranean Sea, settled in areas characterized by abiotic conditions considerably different from those showed by native habitats. ENM procedures indicated maximum salinity and, to a minor extent, mean surface water temperature, as the main factors regulating the distribution of the species in the Mediterranean Sea, ultimately confirming for the southern sectors of the basin a high habitat suitability for the crab. Projections to 2050, in particular under the high-severity scenario, clearly indicated an northward expansion of *P. segnis* towards areas currently invaded by the Atlantic blue crab *Callinectes sapidus*. The possible outcomes of the co-occurrence of *P. segnis* and *C. sapidus*, in terms of competitive interactions as well as impacts on invaded coastal ecosystems, are considered.

Key words: invasive species, Portunidae, environmental niche modeling, range expansion

Talk

Movement and redistribution of species/ Rapid change

Projected copepod community changes and trait re-structuring in the North Atlantic due to changing climate

Niall McGinty[1], Andrew D. Barton[2], Nicholas R. Record[3], Zoe V. Finkel[1], David G. Johns[4], Charles A. Stock[5] and Andrew J. Irwin[1]

[1] Department of Oceanography, Dalhousie University, Halifax, NS, B3H 4R2, Canada
Email: nmcginty@mta.ca
[2] Scripps Institution of Oceanography and Section of Ecology, Behavior and Evolution, UC San Diego, CA 92093-0218, USA
[3] Bigelow Laboratory for Ocean Sciences, ME 04544, USA
[4] The Marine Biological Association, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK
[5] Geophysical Fluid Dynamics Laboratory, National Oceanic and Atmospheric Administration, Princeton University, Princeton, NJ 08540

The rapid ocean warming has had dramatic effects on the biogeography and distribution of marine species and is expected to continue well into the next century. Plankton appear particularly sensitive with documented shifts occurring in many groups over the last 50 years. We use both historical environmental and plankton (Copepod) observations to characterise the current niches of 68 species using an ensemble modelling approach (BIOMOD). Projected biogeographies are compared for the historical (1951-2000) and future (2051-2100) ocean conditions. Poleward shifts are projected for the majority of species in a North Easterly direction with the fastest shifts occurring in the temperate latitudes (11.38 km dec^{-1}) while Arctic species show a southward movement of (10.74 km dec^{-1}), benefiting from an observed ocean cooling in the sub-polar region. Diversity and turnover is greatest at the boundaries of the sub-polar and temperate region. Richness shows a distinct pattern with up to 50% change in richness observed in the North Sea and Scotian Shelf. The initial habitat area and latitudinal positions are closely coupled to the future changes in habitat area and shift in biogeographies. Basin scale shifts in community composition are observed with a median value of 12% compared with seasonal variation of 42%. Shifts in the trait structure of the communities are also expected with decreases in body size above 40 °N and a 10% increase in carnivorous dietary strategy. These changes will undoubtedly have significant effects on trophic food webs and carbon transport in the pelagic ecosystem.

Key words: BIOMOD, Copepod, niche, traits, projections.

Talk

Movement and redistribution of species

Use of a hydrodynamic model to examine behavioral response of broadnose sevengill sharks (*Notorynchus cepedianus*) to an estuarine energy landscape

Alexandra G. McInturf[1], Anna E. Steel[1], Michele Buckhorn[1], Philip Sandstrom[1,2], Christina J. Slager [3], Nann A. Fangue[1], A. Peter Klimley[1,4], Damien Caillaud[5]

[1]Department of Wildlife, Fish and Conservation Biology, University of California, Davis, CA USA; Email: amcinturf@ucdavis.edu
[2]Tacoma Public Utilities, 3628 South 35th Street, Tacoma, WA USA
[3]Aquarium of the Bay, Biological Programs/Conservation, Exhibits and Educational Engagement, San Francisco, CA USA
[4]Biological consultant, Petaluma, CA USA
[5]Department of Anthropology, University of California, Davis, CA USA

Organisms are under strong selective pressure to behave in an energetically-efficient manner. Variation in transport cost ("energy landscapes") thus generates organismal responses at various scales, from individual behavior to species distribution. We examined the behavioral response of broadnose sevengill sharks (*Notorynchus cepedianus*) to the energy landscape of the San Francisco Bay estuary. Three sharks were actively tracked using acoustic transmitters for 3-4 days. We then generated a hydrodynamic model of the estuary and calculated current vectors along each shark track to examine the effect of tidal flow on shark movements. We hypothesized that the sharks would respond according to current strength to reduce energy expenditure when moving through the channel underneath the Golden Gate Bridge. Our results indicated that sharks do adjust their behavior to follow the current flow in the channel. However, this variation did not depend on current strength. We conclude that the sharks may respond to environmental factors other than tidal flow, altering their movement at a finer scale than initially considered. Overall, our study suggests that hydrodynamic models can be used to quantify energy landscapes surrounding aquatic organisms. Given that predators specifically often forage in high-flow areas, such models may also be useful in informing the placement of marine renewable energy infrastructure and assessing the impact of other forms of anthropogenic habitat modification.

Key words: broadnose sevengill shark, active tracking, energy landscapes, hydrodynamic model

Talk

Movement and redistribution of species

Larval subsidies from bivalve aquaculture may assist with restoration programmes.

Norrie CR[1], Dunphy BJ[1], Roughan M[2], Weppe S[2], & Lundquist CJ[1,3]

[1] The University of Auckland, New Zealand Email: craig.norrie@auckland.ac.nz
[2]MetOcean Solutions Limited, Raglan, New Zealand
[3]NIWA, Hamilton, New Zealand

Shellfish beds perform a number of ecosystem functions disproportionate to their size. Anthropogenic activities have resulted in populations of species becoming severely degraded worldwide which sparked interest in restoration. Successful restoration requires an understanding of population connectivity. This determines if restored populations are sustainable through self-recruitment or larval supply from alternate source populations. Coastal bivalve aquaculture is increasing worldwide and these large farmed populations have the potential provide a larval subsidy to natural populations in an area. This study investigated larval dispersal of green lipped mussels, *Perna canaliculus*, from aquaculture sites in Northern New Zealand. This species was once abundant in the area but collapsed in the 1960s. There is currently a restoration programme in the area. A biophysical particle tracking model was used to determine potential larval dispersal pathways. A trace elemental fingerprinting study was then used to determine the natal origin of recent settlers at sites throughout the area. The model showed that larvae from only a few sites are likely to dominate settlement in the area due to number of larvae produced in these areas. The trace elemental fingerprinting study suggested the majority of recent settlers originated at a site with lower larval production. Despite the disparities in the numbers of larvae, the site at which most larvae were predicted to have originated had predicted dispersal pathways that would explain settlement throughout the study area. This study showed that larvae produced in aquaculture may contribute to natural populations if stressors are removed and settlement habitat is provided.

Key words: Larval dispersal, aquaculture, restoration, population connectivity

Talk

Movement and redistribution of species

Can environmental gradients promote non-indigenous species recruitment? The case study of the Ravenna channel-port

Massimo Ponti[1,2,3], Alessandro Tarullo[1], Barbara Mikac[2], Andrea Desiderato[4,5], Paolo Zanni[6], Laura Airoldi[1,2,3] and Marco Abbiati[2,3,7,8]

[1] Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna, Via S. Alberto 163, 48123 Ravenna, Italy. Email: massimo.ponti@unibo.it
[2] Centro Interdipartimentale di Ricerca per le Scienze Ambientali, Università di Bologna, Via S. Alberto 163, 48123 Ravenna, Italy.
[3] Consorzio Nazionale Interuniversitario per le Scienze del Mare, Piazzale Flaminio 9, 00196 Roma, Italy.
[4] Graduate Program in Zoology, Federal University of Paraná, Curitiba, Brazil.
[5] Department of Functional Ecology, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven, Germany.
[6] Independent malacologist, Ravenna, Italy.
[7] Dipartimento di Beni Culturali, Università di Bologna, Via degli Ariani 1, 48121 Ravenna, Italy.
[8] Istituto di Scienze Marine, Consiglio Nazionale delle Ricerche, Bologna, Italy.

Harbours are generally regarded as arrival and redistribution points for non-indigenous species that can be transported by both commercial and touristic marine traffic. The reduced water quality and the abundance of artificial structures may promote the development of simplified marine communities that offer reduced biotic resistance to the establishment of new competitive species, making these places receptacles of non-indigenous species. In Mediterranean ports, some species have been present for many decades or even centuries and are already naturalized, while others are recently introduced. The presence of environmental gradients within harbours could generate favourable conditions for different species. The Ravenna channel-port (northern Adriatic Sea), with over 11 km of length, is emblematic of this. The intertidal benthic communities inhabiting concrete walls drastically change along a marked gradient of pollution and confinement. In the upper half of the channel-port, the native mussel *Mytilus galloprovincialis* is replaced by the exotic mussel *Xenostrobus securis*. Beside the change in the main habitat-forming species, the number of alien species increases toward the inner part of the port. While most of the environmental management efforts are aimed at limiting the transport of individuals and propagules (e.g. cleaning hulls, developing better antifouling paints, regulate ballast waters), more attention should be directed in understanding the ecological processes behind these spatial patterns inside harbours in order to develop strategies and technologies to counteract the local establishment success of non-indigenous species within ports all-around the world. Therein, Ravenna channel-port with its strong environmental gradient may represent an ideal field laboratory.

Key words: Alien species, Marine traffic, Harbour, Mediterranean Sea

Talk

Movement and redistribution of species

Open or closed populations? The larval behaviour of the European oyster and why it matters

Ana Rodriguez-Perez[1,2,3], William G. Sanderson[1,3], Lene Friis Møller[4] and Mark James[2]

[1]Centre for Marine Biodiversity & Biotechnology, EGIS, Heriot-Watt University, Edinburgh, UK. Email: ar62@hw.ac.uk
[2]Scottish Oceans Institute, University of St. Andrews, East Sands Fife, UK
[3]St Abbs Marine Station, St Abbs, Scottish Borders, UK
[4]Danish Shellfish Centre, DTU Aqua, Technical University of Denmark, Denmark

Larval dispersal and recruitment determine the distribution and persistence of marine populations. This can be either self-recruitment, i.e. the larvae settle in the parental population, or recruitment of larvae originating from geographically distant populations. Increasing evidence suggest a high incidence of self-recruitment in marine populations, challenging the traditional view of predominantly 'open' populations with extended larval exchange. While this has been clearly demonstrated for many fish larvae, it is less clear to what extent most benthic invertebrate larvae are able to influence their fate in the water column. Passive transport is often considered to be a reasonable approximation of dispersal. However, marine invertebrate larvae respond to several stimuli, altering their position in the water column. These migrations can have profound effects on the scale and direction of their dispersal.

We investigated the vertical distribution and behaviour of the European oyster *Ostrea edulis* in the water column throughout its larval life history, and under different scenarios of light/ darkness, food/ no food, and temperature. The results provide evidence that the behaviour of *O. edulis* influences their dispersal. Larvae consistently favoured an area of the bottom comparable to the boundary layer, and they aggregated and interacted in the water column. We suggest that these behaviours reduce dispersal, and that passive larval transport models will greatly overestimate down-stream dispersal. Moreover, they will underestimate the importance of maintaining natal habitat at enough scales to help promote the retention of larvae – which settle preferentially around conspecifics. This, in turn, has implications for current restoration projects.

Key words: Larval dispersal, larval behaviour, self-recruitment, hydrodynamic modelling

Talk

Movement and redistribution of species

Effects of climate change on the sea turtles feeding ecology

Roman-Torres P[1], Klages R [2] and Eizaguirre C [1]

[1] Queen Mary University of London, School of Biological and Chemical Sciences, Mile End Road, E14NS, London, United Kingdom. 1. Email: p.a.romantorres@qmul.ac.uk
2. Queen Mary University of London, School of Mathematical Sciences, Mile End Road, E14NS, London, United Kingdom

[Abstract]
Global changes have reached an unprecedent rate and most species are impacted. To survive, they must either adapt or shift their environmental optimum to find shelter and food. Specifically, an efficient feeding strategy is an important trait that is critical for health, physiology and reproduction. Feeding ecology in marine species with long lifespans and lower evolutionary potential can be particularly complex, especially since many of these perform long-distance migrations to reach their foraging grounds. It is still unknown whether or how these migrations and their foraging strategies will be affected by global change. Focusing on sea turtles from the Cape Verde archipelago in the Atlantic, we deployed 15 satellite trackers. The transmitted data was used to perform a statistical analysis with a view to developing a stochastic model to determine their foraging movement. We reveal that after the nesting period spent in Cabo Verde, the turtles actively swim in a straight line towards a target area, off the coasts of Mauritania. Once there, a switch to foraging behaviour was observed. Interestingly, we found that loggerhead sea turtles follow a foraging pattern determined by power law velocity distributions and strong 'looping' in the foraging paths, constrained by environmental characteristics such as bathymetry and primary production. Because turtles follow mathematically predictable behaviour linked to environmental characteristics, we will be now in the position to define future feeding strategies and locations should significant environmental shifts occur in this region of the Atlantic.
[Not exceeding 250 words]

[Key words]: Sea turtles, Mathematical modelling, Cape Verde, Feeding Ecology.

Talk

Movement and redistribution of species

The role of FADs (Fish Aggregating Devices) in the dispersal of fish in Sicilian coast

Sinopoli M.[1], Allegra A.[2] , Andaloro F.[1] , Maggio T.[3], Milisenda G.[1], Cillari T[3] .

[1] Stazione Zoologica Anton Dohrn Napoli (SZN), Palermo branch, Lungomare Cristoforo Colombo n. 4521 (ex complesso Roosevelt) Località Addaura, 90149, Palermo, Italy. Email:mauro.sinopoli@szn.it
[2] Gruppo di Ricerca Applicato al Mare (GRAM), complesso Via Roma, 471 , 90139, Palermo, Italy
[3] Institute for Environmental Protection and Research (ISPRA), BIO-CIT. Lungomare Cristoforo Colombo n. 4521 (ex complesso Roosevelt) Località Addaura, 90149, Palermo, Italy

In the Sicilian seas, historically, a fishing activity exploits the attractive power of floating bodies (known by the scientific community as FADs; Fish Aggregating Devices) on juveniles of various pelagic, demersal or reef associated fish species. Fishermen use numerous anchored FADs (consisting of floating palm leaves) in rows that start from the coast and reach distances greater than 5 nautical miles (more than 500 m deep). The purpose of this study was to verify whether a system consisting of FADs located along a distance gradient from the shore might lead inshore the associated early stage fishes. In order to test this hypothesis, between April and December 2015, three fields composed of 20 FADs each were placed at increasing distances from the coast. During the study period, visual censuses were performed in the three FADs fields on the juveniles of *Balistes carolinensis*, *Caranx crysos*, *Seriola dumerili* and *Trachurus trachurus*. The results based on the comparison of species abundances in the three FADs fields and on three size classes during the association period suggest that: FADs far from the coast have a trap effect that holds the species for long time, postponing coastal recruitment; FADs located on shallow water near the coast seem to favor the recruitment to coastal habitats. Although the results seem to suggest that these devices would increase fish species, tagging experiments carried out on *Seriola dumerili* and *Caranx crysos* indicate their permanence in coastal areas only for short periods after the abandonment of the FADs.

Key words: FADs, recruitment, fishes, juveniles

Talk

Movement and redistribution of species

Ciliate epibionts - a symbiotic solution to nutrient diffusion limitation in large diatoms

JR Strickler[1,2], RM Lopes[3], Y Garcia[3], F Rusch[4], M Luz[4], J. Dabiri[5], E Kanso[6], JH Costello[7,8]

[1] University of Wisconsin-Milwaukee, Milwaukee, WI 53204, USA. Email: jrs@uwm.edu

[2] University of Texas at Austin, Port Aransas, TX 78373, USA

[3] University of São Paulo, São Paulo 05508-12

[4] Federal University of Paraná, Curitiba, Brazil

[5] Stanford University, Stanford, CA 94305, USA

[6] University of Southern California, Los Angeles, CA 90089, USA

[7] Providence College, Providence, RI 02918 USA

[8] Marine Biological Laboratory, Woods Hole, 02543 MA

Diatom-ciliate consortia benefit both members in the challenging nutritional environments of oligotrophic waters. However, the extent of behavioral modifications by the member protists within these mutualisms remain undescribed. The chain-forming diatom, *Chaetoceros coarctactus*, forms obligate, species-specific consortia with the peritrich ciliate *Vorticella oceanica* that has allowed this mutualism to achieve a widespread distribution in tropical waters. Here we use high-speed imaging, particle image velocimetry and numerical simulations to demonstrate the ability of the ciliate epibionts to generate sufficient propulsive thrust to counter sinking and potentially allow favorable positioning of the consortia within the water column. Observations will be shown in short videos.

Talk

Movement and redistribution of species

Investigating scale trace element microchemistry as a tool to track adult North Atlantic salmon populations.

Elizabeth Tray[1,3], Quentin G. Crowley[2], Deirdre Brophy[1], and Niall Ó Maoiléidigh[3]

[1] Marine and Freshwater Research Centre, Galway Mayo Institute of Technology, Old Dublin Rd, Galway, Ireland 1. Email: Elizabeth.Tray@gmit.ie
[2] Trinity College Dublin, Ireland
[3] Marine Institute, Newport, County Mayo, Ireland

Despite ongoing global conservation measures for north Atlantic salmon, the species has experienced recent population declines. Marine habitat use of salmon is still widely unknown. Microchemical analyses of scales (non-lethal) and otoliths (lethal) can provide insight into the environmental history of migrating salmon. Reconstruction of environmental histories from analyses of scale growth trajectories may however be confounded by metabolic re-working of scale calcium after deposition. The mechanism controlling post-depositional chemical exchange in fish scales is underexplored, and there is a lack of data on salmon scale calcium variability. Recent advances in material science technologies have provided new methods that allow for more precise measurement of fish scale composition.
This study aimed to: 1) use new tools to measure scale calcium variability and re-evaluate post-depositional exchange, 2) determine if trace element profiles from adult salmon scales can be used to characterize feeding grounds inhabited by returning migrants.
Scanning electron microscopy (SEM) and energy dispersive spectrometry (EDX) was used to characterize scale calcium. Laser ablation inductively coupled mass spectrometry (LA-ICP-MS) was used to investigate trace elements within scales from salmon actively feeding in Greenland, and from an Irish population of returning adults. Trace element profiles were compared between fish collected from the feeding grounds and fish collected in the rivers on their return migration, to evaluate the extent to which resorption affects the feeding ground signature. In addition, trace element data was analysed for variability to determine if individuals in the same habitat record similar trace element profiles.

Key words: Salmon, fish scale, trace element analysis, marine

Talk

Movement and redistribution of species

Distribution & growth of stocked European glass eels released in the eastern German Baltic Sea

Laura Wichmann[1,2], Björn Kullmann[2], Jens Frankowski[1], Ralf Thiel[2]

[1]Institute of Fisheries, State Research Center for Agriculture and Fisheries, Fischerweg 408, 18069 Rostock, Germany, 1. Email: Wichmann.Laura@web.de
[2]University of Hamburg, Center of Natural History, Martin-Luther-King-Platz 3, 20146 Hamburg, Germany

The recruitment of the catadromous European eel (*Anguilla anguilla*) stock has been collapsed and stagnates at historically low levels since the early 2000s despite various stock-supporting efforts.
In 2007, the EU member states were requested to elaborate eel management plans to ensure a minimum escapement biomass of at least 40 % compared to the pristine level. Most eel management plans only consider stocking measures in inland waters. To determine if stocking is also a management option in coastal waters, a stocking experiment with glass eels has been conducted in two different areas of the eastern German Baltic Sea. In both areas, over 1 Million glass eels have been stocked between 2014 and 2016. To allow discrimination of stocked from natural recruits after recapture, all stocked eels were chemically marked with alizarin red S.
In 2017 and 2018, a total number of 1127 eels were captured inside and outside of both stocking areas. 21 % (n = 235) of all investigated individuals were marked.
It was found that in 2017, 71 % of all marked eels have been recaptured within approximately <12 km of the stocking site, while one year later 56 % of all marked individuals were caught outside the stocking areas.
Furthermore, initial analyses revealed, that marked eels showed a significantly higher mean total length at the age 3+ compared to naturally recruited conspecifics in both stocking locations. This might indicate a life-history dependent growth pattern as previously observed in the American eel.

Keywords
European eel, stocking measures, marking, coastal waters

Talk

Movement and redistribution of species

Can changing distributions of benthic species be tracked using long-term datasets from volunteer divers?

Jackson, A.C.[1], Bolton, C.E.[1]

[1] Affiliation address 1.
Marine Conservation Society
Overross House,
Ross Park,
Ross-on-Wye,
Herefordshire,
HR9 7US.
Email: angus.jackson@mcsuk.org

Growing evidence makes it clear that distributions of species and patterns of diversity are changing in response to anthropogenic climate-change, sometimes with ecological and economic consequences. What is less clear is the consistency in response by different species e.g. whether ranges or phenology are changing at similar rates. Species also respond to natural conditions, stochastic processes, and other anthropogenic effects, which each provide their own influences to size and distribution of populations. Predictability of such changes and the broader implications are, as yet, poorly understood. If we are to make robust interpretations about shifts in range and to disentangle anthropogenic influences from natural processes, we need long-term data collected in a consistent manner. In the UK, we are blessed with many dedicated volunteer naturalists that contribute to the collection of such datasets. Seasearch is a project for volunteer scuba divers who have recorded and mapped distributions of benthic marine species and habitats around the British Isles and adjacent seas since the 1980s. This extensive, long-term dataset now exceeds 700,000 spatial records for benthic species, collected over 30 years. It may provide a powerful tool to assess changes in distribution. Using an ‘extent of occurrence’ methodology, we examine records of British marine species most likely to shift distribution in response to warming waters. Focus is on whether predicted trends are identified and on consistency in response. Consideration is given to development of targeted surveys for species which may act as early warnings or indicators of important ecological change.

Key words: [Seasearch, climate change, SCUBA, seabed]

Talk

Movement and redistribution of species

Subtropical thermal variation supports persistence of corals but limits productivity of coral reefs

Shelby E. McIlroy[1,2,3], Philip D. Thompson[1,2], Felix Landry Yuan[2], Timothy C. Bonebrake[2], David M. Baker[1,2]

[1] The Swire Institute of Marine Science, University of Hong Kong, Hong Kong, PR China
[2] School of Biological Sciences, University of Hong Kong, Hong Kong, PR China
[3] Email: smcilroy@hku.hk

Concomitant to the decline of tropical corals caused by increasing global sea temperatures is the potential removal of barriers to species range expansions into subtropical and temperate habitats. In these habitats, species must tolerate lower annual mean temperature, wider annual temperature ranges, and lower minimum temperatures. To understand ecophysiological traits that will impact geographic range boundaries we monitored populations of five coral species within a marginal habitat and used a year of *in situ*measures to model thermal performance of vital host, symbiont, and holobiont physiology. Metabolic responses to temperature revealed two acclimatization strategies: peak productivity occurring at annual midpoint temperatures (4-6ºC lower than tropical counterparts), or at annual maxima. Modeled relationships between temperature and P:R were compared to a year of daily sub-tropical sea temperatures and revealed that the relatively short time spent at any one temperature, limited optimal performance of all strategies to approximately half the days of the year. Thus, while subtropical corals can adjust their physiology to persist through seasonal lows, seasonal variation seems to be the key factor limiting coral productivity. This constraint on rapid reef accretion within subtropical environments provides insight into the global distribution of future coral reefs and their ecosystem services.

Key words: acclimatization, coral physiology, range expansion, thermal performance

Talk

Movement and redistribution of species

15 years of the European Ocean Biogeographic Information System (EurOBIS)

Leen Vandepitte[1], Daphnis De Pooter[1], Thomas Lanssens[1], Paula Oset-Garcia[1], Filip Waumans[1], Bart Vanhoorne[1], Francisco Hernandez[1]

[1] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende info@eurobis.org

Knowledge on species occurrences in space and time is of the utmost importance in biological research. Although species occurrence information is highly relevant and often requested by scientists, this data can be hard to find and sometimes even harder to access…

The European Ocean Biogeographic Information System – EurOBIS – was established in 2004 and helps filling this gap in our scientific knowledge, by making the largely scattered and diverse biogeographic data on marine species freely available and easily accessible online. EurOBIS brings together biogeographic data collected within European marine waters or by European researchers and institutes outside Europe, with a focus on taxonomy and distribution records in space and time and offers a number of online tools to easily query and visualize the data.

Since 2009, EurOBIS is the backbone of The European Marine Observation and Data Network Biology. EMODnet Biology makes the EurOBIS data available through its portal and offers specific tools to filter the data. Since 2014, EurOBIS is also part of the central Taxonomic Backbone of LifeWatch, which aims at standardizing species data and integrating the distributed biodiversity data repositories and operating facilities.

Over the years, the EurOBIS database structure has evolved, making it possible to not only capture presence or abundance of species but also to offer e.g. biomass data and length-measurements in a standardized and structured way. In addition, tools have been developed to help scientists to prepare their data for submission to EurOBIS.

EurOBIS currently (March 2019) holds 889 datasets, representing 24 million distribution records.

Key words:*Biogeography, species distributions, marine, Europe*

Poster

Movement and redistribution of species

A method for assessing the distribution of the alien jellyfish *Cassiopea andromeda* (Forsskal, 1775) in areas of difficult access.

Allegra A. [1], Bosch-Belmar M. [3], Castriota L.[2],Cillari T.[2], Falautano M.[2], Maggio T.[2], Milisenda G.[4] , Perzia P.[2] and Sinopoli M.[4]

[1] Gruppo di Ricerca Applicata al Mare (GRAM Soc.Coop), Via Roma 471, 90139 Palermo, Italy. *Email:gramcoop@libero.it

[2] ISPRA Institute for Environmental Protection and Research (ISPRA), Lungomare Cristoforo Colombo n. 4521 (ex complesso Roosevelt), Località Addaura, 90149 Palermo, Italy.

[3] Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Rome, Italy

[4] Stazione Zoologica Anton Dohrn Napoli, Palermo branch, Lungomare Cristoforo Colombo n. 4521 (ex complesso Roosevelt) Località Addaura, 90149, Palermo, Italy.

Cassiopea andromeda, also known as the upside-down *jellyfish, due to its benthic behaviour,* is an invasive alien species spread across the Mediterranean Sea. It has recently settled in the port of Palermo, forming a consistent population. In order to investigate this new bioinvasion and then elaborate distribution predictive models, we designed and built a specific device that allows to count and estimate organism's size located in complex areas where classical methods like ROV cannot operate, because of the presence of ropes, anchor cables and boats.
Our device has proved to be effective in counting and identifying the distribution area for *C. Andromeda* within the harbour of Palermo, as well as in detecting specimens measurements in terms of umbrella diameter. *C. Andromeda* resulted to be spatially distributed in areas with depths between 5 and 7 meters. The most common jellyfish sizes varied between 10 and 15 cm. The study of jellyfish distribution over time has highlighted a greater abundance and individuals' size in summer and autumn periods; while a decrease in terms of both abundance and size variables has been observed in winter and spring seasons.

Key words: alien species, species distribution, jellyfish, remote video

Poster

Movement and redistribution of species

Mechanisms underlying predator-driven biotic resistance against introduced barnacles on the Pacific coast of Hokkaido, Japan

Julius A. Ellrich[1], Takefumi Yorisue[2] and Kyosuke Momota[3]

[1]Marine Ecology Lab, Saint Francis Xavier University, 2320 Notre Dame Avenue, Antigonish, B2G 2W5, Nova Scotia, Canada. Email: jellrich@stfx.ca

[2]Integrative Aquatic Biology, Onagawa Field Center, Graduate School of Agriculture Science, Tohoku University, 3-1 Mukai, Konori-hama, Onagawa, Oshika, Miayagi 986-2242, Japan.

[3]Marine Environmental Information Group, Port and Airport Research Institute, 3-1-1 Nagase, Yokosuka, Kanagawa 239-0826, Japan.

Introduced species are a major threat to coastlines worldwide. Therefore, understanding biotic resistance (i.e. the ability of native species to limit introduced species), is a central goal of invasion biology. On the Pacific coast of Hokkaido, biotic resistance by native predatory dogwhelks (*Nucella lima*) limits introduced barnacles (*Balanus glandula*). Therefore, we examined mechanisms underlying this predator-driven biotic resistance. Consumption can limit introduced prey given that native predators prefer such prey. Furthermore, predator nonconsumptive effects (NCEs), that are mediated through predator-released cues perceived by prey, can limit prey recruitment, a key demographic process for prey populations. However, information on predator NCEs on recruitment in introduced prey is missing. Thus, we experimentally examined dogwhelk preferences for barnacles in the lab and dogwhelk NCEs on barnacle recruitment in the field. We found that *N. lima* preferred *B. glandula* over the native barnacle *Chthamalus dalli*, likely as *B. glandula* is the more profitable prey, as suggested by previous findings in congeneric dogwhelks. Moreover, we found that *N. lima* NCEs limited recruit density in *B. glandula* and *C. dalli*, presumably as barnacle larvae moved away from dogwhelk cues to reduce future risk of predation. Our study suggests that predator preferences for prey and predator nonconsumptive limitation of prey recruitment are mechanisms that can contribute to predator-driven biotic resistance against introduced prey. As *B. glandula* has recently been introduced to the European Atlantic coast, we propose to monitor if biotic resistance by native predators, such as *Nucella lapillus*, can limit the anticipated *B. glandula* spread.

Keywords: biological invasions, predation, predator nonconsumptive effects, *Balanus glandula*

Poster

Movement and redistribution of species

A baseline of epibenthic species distribution on the northern Adriatic mesophotic biogenic reefs

Massimo Ponti[1,2,3], Eva Turicchia[2,3,4], Sara Kaleb[5], Stefania Puce[3,6], Barbara Calcinai[3,6], Fabio Rindi[3,6], Carlo Cerrano[3,6], Annalisa Falace[3,5] and Marco Abbiati[2,3,4,7]

[1] Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna, Via S. Alberto 163, Ravenna, Italy. Email: massimo.ponti@unibo.it
[2] Centro Interdipartimentale di Ricerca per le Scienze Ambientali, Università di Bologna, Via S. Alberto 163, 48123 Ravenna, Italy.
[3] Consorzio Nazionale Interuniversitario per le Scienze del Mare, Piazzale Flaminio 9, 00196 Roma, Italy.
[4] Dipartimento di Beni Culturali, Università di Bologna, Via degli Ariani 1, 48121 Ravenna, Italy.
[5] Dipartimento di Scienze della Vita, Università di Trieste, Via Giorgieri 10, 34127 Trieste, Italy.
[6] Dipartimento di Scienze della Vita e dell'Ambiente, Università Politecnica delle Marche, Via Brecce Bianche, 60131 Ancona, Italy.
[7] Istituto di Scienze Marine, Consiglio Nazionale delle Ricerche, Bologna, Italy.

In the northern Adriatic continental shelf, hundreds of mesophotic biogenic reefs, ranging in size from tens to many thousands square meters, are scattered on sandy and muddy bottoms. The study of their epibenthic assemblages, which started in the early 2000s, is continuing with the exploration of new sites at increasingly depth and distance from the coast, providing new insights into species diversity and distribution. The first intensive survey carried out in 2013-2014 from Chioggia to Grado provided data on 55 epibenthic taxa occurring in 12 sites. The second survey, carried out in summer 2017 with the same sampling effort (12 sites, 10 photographic samples per site) but extended to two remote outcrops and with only 4 sites in common with the previous survey, recorded 83 taxa (33 added and 5 not recovered). The two deepest and farthermost outcrops, 31-32 m depth and about 27 nm off Chioggia, hosted sponge gardens mainly composed by dense populations of *Polymastia boletiformis* (Lamarck, 1815), *Polymastia mamillaris* (Müller, 1806) and *Ulosa stuposa* (Esper, 1794). Meanwhile, some previously unexplored outcrops off Grado, close to the midline between Italy and Croatia, revealed assemblages extremely rich in sponges and colonial ascidians. Among the newly recorded taxa there were 15 sponges, 2 anthozoans, 3 bryozoans and 8 ascidians.
The data currently available represent a new baseline of knowledge on the diversity of northern Adriatic mesophotic biogenic habitats. This may help to understand their resistance and resilience to human and climate change threats, and develop transboundary ecosystem-based management.

Key words: mesophotic habitats, northern Adriatic, biogenic reef, coralligenous

Poster

Movement and redistribution of species

Marine invertebrate distributions trace climate change over 450 million years

Carl J. Reddin[1], Adam T. Kocsis[1], Wolfgang Kiessling[1]
[1]GeoZentrum Nordbayern – Paleobiology, Universität Erlangen−Nürnberg, Loewenichstraße 28, 91054 Erlangen,Germany
e-mail: carl.j.reddin@fau.de

Climate shifts are expected to cause changes in species' distributions as species migrate with their thermal niche. Wide and sometimes dramatic distributional responses in marine organisms are then perhaps unsurprising given current trends of global warming. Here we assess if marine animals in the geological past consistently tracked climate change and discuss how these patterns from deep time can inform conservation efforts. We use a dataset of half a million Phanerozoic fossil occurrences and well-preserved shell oxygen isotopes for ancient climate, accounting for geographical variation in sampling effort and plate tectonic movement. We show latitudinal range shifts of marine invertebrates to be a consistent response to global temperature variation throughout the history of metazoan life. This relationship is driven by tropical taxa rather than mid-high latitude taxa, suggesting that latitudinal range shift is a more important strategy for tropical organisms to cope with global warming than for organisms from mid-higher latitudes. Observed rates of modern shifts appear to be substantially more rapid than past averages of climate-related range shift.

Key words: global warming; stressors; paleoecology; range shift

Poster

Movement and redistribution of species

A Tool to Rapidly Assess Spatiotemporal Changes in Species Distributions

Mridula Srinivasan[1], John F. Kennedy[1] and Tim Haverland[1]

[1] NOAA Fisheries Office of Science and Technology, 1315 East-West Highway, Silver Spring, MD 20910, USA 1. Email: mridula.srinivasan@noaa.gov

The ArcGIS Emerging Hot Spot Analysis (EHSA) can be an effective tool to address broad-scale wildlife management needs. Here, we evaluated the use of the EHSA to determine if there was a spatiotemporal distribution shift in a dolphin population off Kaikoura, New Zealand. The EHSA tool calculates two statistics to examine spatiotemporal patterns in dolphin sighting densities: (1) the Getis-Ord Gi statistic to identify the location and degree of spatial clustering of sightings, and (2) the Mann-Kendall trend test to analyze temporal trends across the time series. We used these results to categorize bins using the EHSA tool with a time-step of 1 year and different neighborhood distances per season. A tour boat company provided dolphin sightings data (1995-2013; n = 8,658) for the analysis. We assumed equal tour boat effort and normalized sightings by number of trips per tour-year and austral season. The EHSA tool results in the generation of 16 hot and cold categories based on significance in trends and clustering. Results show that dolphins exhibit persistent and intensifying hot spots. However, there was no apparent northward or southward shifts but distinct seasonal differences with (50%) core areas increasing from austral summer to winter. We further explored linkages with climate parameters to assess our ability to predict future distribution patterns. Finally, since the process steps were created in ArcGIS 10.5 Model Builder for portability and repeatability with some customization in Python, we can quickly test similar systematic or non-systematic datasets for assessing species distributional shifts over time.

Key words: Emerging Hot Spot Analysis; spatial statistics; species distribution; marine mammals

Poster

Movement and redistribution of species

Dispersal footprint on water: Availability of Sr concentration of larval shells in widely distributed gastropods

T. **Irie**[1]

[1]Atmosphere and Ocean Research Institute, The University of Tokyo. Kashiwanoha 5-1-5, Kashiwa City, Chiba 277-8564, Japan. Email: irie@aori.u-tokyo.ac.jp

[Abstract text]Not exceeding 250 words
A majority of marine invertebrates experience a planktonic stage in early ontogeny. However, it is quite difficult to estimate ecological parameters about their dispersal (e.g., the length of larval period, exact dispersal distance, etc.) due to a technological deficiency. The population genetic approach is a powerful tool to grasp the strength of gene flow among populations, but it provides little information on the migratory footprint of each individual. This defect might be covered by looking at the carbonate skeleton built in the larval stage, because it often records the environmental conditions experienced during ontogeny. For this reason, I am focusing on the chemical composition of larval shells in a widely distributed species of intertidal gastropods. A previous study demonstrates that strontium concentration (Sr/Ca) in shells positively depends on growing temperature in post-juvenile individuals after settlement of the gold-ringed cowrie (*Monetaria annulus*). In the present study, I examined the Sr concentration of larval shells using an electron probe microanalyzer (EMPA), and compared the observed values to the calibration curve established in the post-juvenile individuals. The Sr/Ca of larval shells was approximately 0.0023 mol/mol, which reaches 37°C when applying it to the functional relationship between temperature and Sr/Ca for post-juvenile conspecifics. The estimated temperature seems to be too warm for this species, and is highly likely to be overestimated. Accordingly, I conclude that an alternative functional relationship specialized for the planktonic larvae must be newly established by rearing veligers at different constant temperatures.

Key words: larval shells, strontium, planktonic larvae, molluscs

Poster

Movement and redistribution of species

Boreal marine fauna from the Barents Sea disperse to Arctic Northeast Greenland

Adam J. Andrews[1,2]*, Jørgen S. Christiansen[2,3], Shripathi Bhat[1], Arve Lynghammar[1], Jon-Ivar Westgaard[4], Christophe Pampoulie[5], Kim Præbel[1]

[1]Norwegian College of Fishery Science, Faculty of Biosciences, Fisheries and Economics, UiT The Arctic University of Norway, Norway
[2]Department of Arctic and Marine Biology, Faculty of Biosciences, Fisheries and Economics, UiT The Arctic University of Norway, Norway
[3]Environmental and Marine Biology, Åbo Akademi University, Turku, Finland
[4]Institute of Marine Research, Tromsø, Norway
[5]Marine and Freshwater Research Institute, Reykjavik, Iceland

*Authors to whom correspondence should be addressed, e-mail: adamjonandrews@gmail.com

As a result of ocean warming, the species composition of the Arctic seas has begun to shift in a boreal direction. One ecosystem prone to fauna shifts is the Northeast Greenland shelf. The dispersal route taken by boreal fauna to this area is, however, not known. This knowledge is essential to predict to what extent boreal biota will colonise Arctic habitats. Using population genetics, we show that Atlantic cod (*Gadus morhua*), beaked redfish (*Sebastes mentella*), and deep-sea shrimp (*Pandalus borealis*) recently found on the Northeast Greenland shelf originate from the Barents Sea, and suggest that pelagic offspring were dispersed via advection across the Fram Strait. Our results indicate that boreal invasions of Arctic habitats can be driven by advection, and that the fauna of the Barents Sea can project into adjacent habitats with the potential to colonise putatively isolated Arctic ecosystems such as Northeast Greenland.

Key words: Atlantic cod**,** Barents Sea, population genetics, dispersal routes.

Fundamental Biological Traits

Talk

Fundamental biological traits

Marine species traits in the LifeWatch Taxonomic Backbone

Stefanie Dekeyzer[1], Wim Decock[1], Kevin Verfaille[1], Bart Vanhoorne[1], Thomas Lanssens[1] and Leen Vandepitte[1]

[1]Flanders Marine Institute (VLIZ), InnovOcean Site, Wandelaarkaai 7, 8400 Oostende, Belgium.
stefanie.dekeyzer@vliz.be

The importance of describing species patterns, and the underlying processes, is essential to assess the status and future evolution of marine ecosystems. This requires biological information on functional and structural species traits such as feeding ecology, body size, reproduction, life history, etc.
Basic trait information was already available within the World Register of Marine Species (WoRMS):

- Biological and ecological traits
- Taxonomic traits (e.g. paraphyletic groups)
- Human-defined traits (e.g. Red List species)

Within the EMODnet Biology project and the LifeWatch Taxonomic Backbone, this initiative was taken one step further, and ten traits were prioritized to document: Taxonomy, Environment, Geography, Depth, Body size, Substratum, Mobility, Skeleton, Diet, and Reproduction.
Criteria for selecting these traits were: applicability to most taxa, easy availability, and that their inclusion would result in new research and/or management applications.
Taxonomy and environment related information is available within WoRMS, whereas geography data are available through the Ocean Biogeographic Information System (OBIS).
During 2018, the skeleton information was supplemented in WoRMS. Currently, almost 4.000 accepted marine species have information regarding their supporting structure, enclosures, and composition.
Body size information has been collected for distinct (taxonomic) groups, which resulted in more than 6.000 accepted marine species having quantitative body size information within WoRMS. An ongoing traits data mining exercise is combining body size with benthos-plankton information, extracted both from WoRMS and EurOBIS, to assign functional groups such as macrobenthos, microplankton, etc. to the taxa in WoRMS.
All trait information collected in WoRMS is made available through a dedicated thematic traits portal.

Talk

Fundamental biological traits

Aggregated trait data for global questions: coverage and fitness for use

Jennifer A. Hammock[1], Katja S. Schulz[1]

[1] Smithsonian Institution. Email: hammockj@si.edu

Increasingly, trait datasets are becoming available for re-use, supporting large scale ecological models and secondary analyses. As more sources produce better structured and openly shareable data, significant taxonomic coverage is possible for some key traits and attributes- size, habitat, motility, trophic guild, trophic relationships, etc. The Encyclopedia of Life currently hosts ~8M attribute records for ~400k taxa from >70 open data sources (March 2019). Our aggregation priorities follow the Essential Biodiversity Variables (Kissling et al, 2018) and other global scale research data priorities. Our primary strategy is partnership with specialist open data aggregators; we are also developing tools for documenting evolutionarily conserved attributes that scale quickly toward global taxonomic coverage.

To support trait data discovery, integration and re-use, data sets should be well structured, properly annotated and free of licensing or contractual restrictions so that they are ‘findable, accessible, interoperable, and reusable’ for both humans and machines (FAIR principles; Wilkinson et al., 2016). Identifiers for taxa, localities, agents, publications, traits and trait values should be shared by or mapped between data hubs to support interoperability. Preservation of attribution metadata and tracking of credit through derived data products promote both open data sharing and re-use of aggregated data resources for large scale research questions.

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Key words: data integration; graph data; secondary analysis; open data

Talk

Fundamental Biological Traits

Maternal effects buffer biased sex ratios in species with temperature dependent sex determination – the case of the loggerhead turtle

Emma C. Lockley[1], Thomas Reischig [2] and Christophe Eizaguirre[1]

[1] Queen Mary University of London, School of Biological and Chemical Sciences, Mile End Road, E14NS, London, United Kingdom. Email: e.c.lockley@qmul.ac.uk
[2] Turtle Foundation, An der Eiche 7a, 50678 Cologne, Germany

Climate change presents a novel challenge for species that exhibit temperature-dependent sex determination (TSD). For many sea turtle populations, rising temperatures are expected to result in extreme feminisation and biased offspring sex ratios. To date, most research into how sea turtles may respond to temperature change has focused on behavioural plasticity. Yet, sex steroid hormones are known to influence the sex determination process. Thus, natural differential maternal transfer of such hormones may be a physiological mechanism with which to cope with thermal change in sea turtle species. Here we tested this hypothesis for an endangered population of loggerhead sea turtles, *Caretta caretta.* In a field experiment, we controlled for incubation temperature variation by standardising the depth of 28 nests. We measured the circulating estradiol (E_2) and testosterone (T) levels in nesting females and their offspring, along with yolks at oviposition. Using offspring hormone profiles and affinity propagation clustering, we successfully confirmed individual sex in a non-lethal manner. From this, we found a parabolic relationship between the E_2:T concentrations within yolks at oviposition and the ultimate clutch sex ratio. Males were produced at low concentrations of equal investment in E_2 and T, whereas elevated investment in either hormone resulted in a feminised clutch. Our results demonstrate that maternally derived hormones have the capacity to influence sex determination in loggerhead turtles. This element of trans-generational plasticity of the TSD mechanism may have the potential to buffer the impact of changing climates on offspring sex ratios and should be incorporated into conservation management.

Key words: Temperature-dependent sex determination, climate change, maternal effects, conservation.

Talk

Fundamental Biological Traits

Securing the future of the Critically Endangered Angelshark (*Squatina squatina*) through multidisciplinary approaches to study this rare, cryptic elasmobranch

Joanna Barker[1,2,3], David Jiménez Alvarado[1,4], Eva Meyers[1,5], Ben Wray[2,6], Jake Davies[2,3], Maria Belén Caro[1], Michael Sealey[1], David Jacoby[7]

[1] Angel Shark Project: Canary Islands **Email: joanna.barker@zsl.org**
[2] Angel Shark Project: Wales
[3] Conservation & Policy, Zoological Society of London, NW1 4RY, UK
[4] EcoAqua, Universidad de Las Palmas de Gran Canaria, Islas Canarias, España
[5] Zoological Research Museum Alexander Koenig, Bonn, Germany
[6] Natural Resources Wales, Maes y Ffynnon, Gwynedd, LL572DW, UK
[7] Institute of Zoology, Zoological Society of London, NW1 4RY, UK

The Critically Endangered Angelshark (*Squatina squatina*) is one of the most threatened marine species in European waters; they are particularly susceptible to the combined impacts of fishing and habitat degradation, due to their coastal location and biology (large, flat-bodied animals with low fecundity). Following estimated declines of over >80% in the last 50 years, Angelsharks have a unique stronghold in the Canary Islands and smaller populations still exist in some parts of their former range, including off the coast of Wales, UK.

Limited understanding of Angelshark habitat use, movement and site fidelity at all life stages is a major factor preventing effective species protection and conservation. Without this detailed ecological data, the efficacy of management decisions and conservation initiatives cannot be measured in a rigorous scientific manner.

The Angel Shark Project was set up in 2014 to secure the future of Critically Endangered angel sharks across their range and has two focal projects - Angel Shark Project: Canary Islands and Angel Shark Project: Wales. This presentation will outline the key initiatives developed to improve understanding of adult Angelshark ecology to safeguard the future of this species. Topics presented will include use of diver sightings to investigate Angelshark distribution; development of innovative tagging techniques to understand habitat use and movement; and collecting information from fishing and local communities to understand historic and current Angelshark presence in Wales.

Key words: Angelshark, elasmobranch, conservation, ecology

Talk

Fundamental Biological Traits

Investigation of juvenile Angelshark (*Squatina squatina*) habitat in the Canary Islands to inform protection of this Critically Endangered species

Michael Sealey[1]**,** Joanna Barker[1,2], David Jiménez Alvarado[1,3], Eva Meyers[1,4], Maria Belén Caro[1]

[1] Angel Shark Project: Canary Islands **Email: mikejsea@gmail.com**
[2] Conservation & Policy, Zoological Society of London, NW1 4RY, UK
[3] EcoAqua, Universidad de Las Palmas de Gran Canaria, Islas Canarias, España
[4] Zoological Research Museum Alexander Koenig, Bonn, Germany

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

A key focus for Angel Shark Project: Canary Islands (ASP:CI) (a collaborative initiative between Universidad de Las Palmas de Gran Canaria, Zoological Research Museum Alexander Koenig and Zoological Society of London) 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.

Research over the last four years has identified that juvenile Angelsharks are present across a number of shallow, sheltered beaches in the Canary Islands. The team have identified two confirmed nursery areas, 13 potential nursery areas and 21 beaches where juvenile Angelsharks are observed. 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 were 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

Talk

Fundamental biological traits

Effects of sewage discharge on macrofaunal communities nearby the underwater sewage duct of Trieste (northern Adriatic Sea) on temporal scale

Vesal S.E.[1, 2], Nasi F. [1], Auriemma R.[1] and Del Negro P[1]

[1]Oceanography section, National Institute of Oceanography and Applied Geophysics - OGS, Trieste, Italy; svesal@inogs.it

[2] Life Science Department, University of Trieste, Trieste, Italy

Human activities have the potential to alter the diversity and composition of biological communities in natural environments, which can cause changes in ecosystem functioning. This has led to the development of environmental assessment techniques that take into account species identity, as organisms can contribute differently to various ecosystem processes. In this study Biological Trait Analysis (BTA) was used to assess the influence of municipal wastewater discharge on macrofaunal communities nearby the sewage outfall in the Gulf of Trieste. Sediments were sampled at 18 stations, in two sampling periods (November 2016 and April 2018), nearby the diffusional zone of the duct disposal plant. The stations were positioned along an increasing distance from the main outfall, the source of organic inputs. In November a low value of functional diversity (FDisp) was observed only at the station closest to the main outfall, whereas on April FDisp decreased toward the station located at 100 meters from the pipe. Clear patterns were shown for traits as adult longevity, reproductive frequency, mobility and feeding habits. Short life span, semelparous, sessile and surface deposit feeder are major expressed in stations subjected to continuously sewage depositions. In spite of stressed sediment conditions observed at the end of the duct, the dominance of *Capitella capitata*, with high bioturbation activity (being a conveyor) could have increased the sediment reworking within sediments layers. Overall, the functional analysis of macrozoobenthic communities in the area surrounding the sewage outfall of Trieste suggests that these soft-bottoms are affected by a moderate organic stress.

Key words: Macrofauna; Sewage discharges; Biological Traits Analysis; Functional Diversity

Talk

Fundamental biological traits

Gametic isolation proteins in the model of intertidal snails sibling species.

Arseniy A. Lobov[1,2], Arina L. Maltseva[1], Marina A. Varfolomeeva[1], Natalia A. Mikhailova[3] and Andrei I. Granovitch[1]

[1] Department of Invertebrate Zoology, St Petersburg State University, St Petersburg, Russia. Email: arseniylobov@gmail.com
[2] Laboratory of regenerative biomedicine, Institute of Cytology Russian Academy of Sciences, St Petersburg, Russia
[3] Department of Cell Culture, Institute of Cytology Russian Academy of Sciences, St Petersburg, Russia

At the European sea shores, subgenus *Neritrema* (genus *Littorina*) is represented by two groups of closely related species: “obtusata”: *L. obtusata*, *L. fabalis*; and “saxatilis”: *L. saxatilis*, *L. arcana*, *L. compressa*. Although they are characterized by unique distribution pattern along the intertidal area, they coexist in sympatry, demonstrate similar morphology and breeding behaviour. This species are low moving, dioceous and polygamic (females are promiscuous and store sperm of several males). Some species tend to form ecotypes (e.g. *L. saxatilis*).
We were interested in barriers maintaining species identity in this system. First, we tested are there interspecies copulation and what are mating preferences? Most males copulated with conspecific females, although mating with heterospecific partners was observed regularly. This focused further study on postcopulatory prezygotic barriers, which still were not studied in Caenogastropoda. Among results of a complex proteomic analysis of male reproductive tissues was the identification of a novel protein with no known domain structure – LOSP. This protein is specifically expressed in the paraspermal cell line and most probably transferred to the female during insemination. The parasperms and their products might contribute to reproductive isolation via involvement in sperm competition. Congruently, LOSP is highly variable between species except *L.saxatilis*/*L.arcana* were LOSP most variable, but species form mixed clusters. LOSP might participate in gametic isolation and we have confirmed the previous idea that *L.saxatilis*/*L.arcana* have not diverged yet and there is strong reinforcement between them.
The project is supported by the grant of the Russian Foundation for Basic Research number 18-34-00873.

Talk

Fundamental Biological Traits

Have we underestimated the effects of ocean acidification on different biological traits?

Cristian A. Vargas[1], L. Antonio Cuevas[1], Paulina Aguayo[1, 2], Nelson A. Lagos[1,3,4] & Bernardo R. Broitman[3,5]

[1] Department of Aquatic System, Faculty of Environmental Sciences, Universidad de Concepcion, Concepcion, Chile. crvargas@udec.cl
[2]Millennium Institute of Oceanography (IMO), Universidad de Concepcion, Concepcion, Chile
[3]Center for the Study of Multiple-Drivers on Marine Socio-Ecological Systems (MUSELS), Universidad de Concepción, Concepción, Chile
[4]Centro de Investigación e Innovación para el Cambio Climático (CiiCC), Facultad de Ciencias, Universidad Santo Tomás, Santiago, Chile
[5]Universidad Adolfo Ibáñez, Viña del Mar, Chile

Phenotypic plasticity is ubiquitous along the wide and heterogeneous environmental gradients of coastal ecosystems. Hence, the response of different local populations to Ocean Acidification (OA) scenarios becomes clear only when many geographic regions are included in experimental approaches. Here, we perform a comprehensive meta-analysis synthesizing results of > 100 studies examining the effects of ocean acidification on different biological traits. Using the geographic location where animals were sourced for each study, we characterized local pCO_2 conditions (mean and extreme values) using information from the global surface pCO_2 (LDEO) database. Our results evidenced that a significant fraction of OA experiments examined were conducted within the range of natural variability in pCO_2 of the source populations. Moreover, negative $\log_e$-response ratios were more commonly observed in species exposed to pCO_2 changes far from the average and extreme pCO_2 levels experienced in their native habitats. Our results reveal the potential role of adaptive phenotypic plasticity as a reservoir of resilience for different taxa under changing ocean conditions. The additional evidence that emerges from this large data set of published results is that experiments conducted with coastal marine species exposed to open ocean OA scenarios might have significantly underestimated the impact of OA on different biological traits. As a consequence, experimental designs aimed at the study of climate change and/or ocean acidification though manipulative experiments should incorporate the natural variability experienced by source populations rather than consider absolute values.

Key words: Ocean Acidification, Biological Traits, Meta-analysis, Phenotypic plasticity

Talk

Fundamental biological traits

Functional patterns of macrofauna at the Arctic deep-sea observatory HAUSGARTEN

M. Käß[1,2], M. Chikina[3], A. Vedenin[3] and T. Soltwedel [1]

[1] Alfred Wegner Institute, Helmholtz Centre for Polar and Marine Research, Am Handelshafen 12, 27570 Bremerhaven, Germany. Email: melissa.kaess@awi.de
[2] Carl von Ossietzky University of Oldenburg, Faculty of Mathematics and Science, Carl-von-Ossietzky-Str. 9-11, 26129 Oldenburg, Germany.
[3] P.P. Shirshov Institute of Oceanology RAS, 36, Nahimovski prospect, Moscow, Russia.

Macrobenthos plays an important role in ecosystem processes such as bioturbation, particle reworking and ventilation of the soil. Nevertheless, explaining the relationship between biodiversity and ecosystem function (BEF) remains a difficult task. This holds also true in remote polar regions such as the LTER observatory HAUSGARTEN in the Fram Strait. The local hydrographic regime is mainly influenced by the warm northern-bound West Spitsbergen Current, and the southwards flowing cold and less saline East Greenland Current. The currents are causing regional differences in sea-ice coverage. Distribution patterns of the sea-ice play a major role in determining the flux of potential food to the seafloor, thus shaping benthic communities. Recently, functional and biological trait analysis (BTA) became an important tool to investigate BEF-relationships in marine environments. However, this approach is relatively new for Arctic regions, especially deep-sea ecosystems. Therefore, our study aims to determine functional characteristics on a depth gradient in the deep Fram Strait.
Deep-sea samples (1000 – 5500m) were collected in the Arctic autumn of 2018 on board of RV *Maria S. Merian*. An USNEL box corer (0.25m²) was deployed at nine sites along the bathymetric transect of the LTER observatory HAUSGARTEN offshore Svalbard. All material was treated trough a 0.5-mm sieve and fixed in 4% formalin. The specimens were identified to species level wherever possible and after assigning to modalities of selected traits used for BTA to observe functional changes along the depth gradient.
Preliminary results on community structure and resulting functional differences between the benthic communities will be presented.

Key words: Macrobenthos; biological traits; ecological function; Fram Strait

Talk

Fundamental biological traits

Littorina snails and environmental stress: the first to measure the second.

Arina A. Maltseva[1], Marina A. Varfolomeeva[1], Irina Y. Babkina[1], Anna V. Kursheva[2], Inna P. Morgunova[2], Paul E. Renaud[3] and Andrei I. Granovitch[1]

[1] Department of Invertebrate Zoology, St Petersburg State University, Universitetskaya 7-9, 199034, St Petersburg, Russia. Email: arina.maltseva@spbu.ru
[2] Department of the Oil-and-gas-bearing capacity of the Arctic and the World Ocean, VNIIOkeangeologia, Angliyskiy 1, 190121, Saint-Petersburg, Russia
[3] Akvaplan-niva AS, Fram Centre, Langnes, 9296 Tromsø, Norway

Intertidal zone is expectedly under high risk of anthropogenic pollution by a variety of contaminants, coming with coastal runoff, ocean waters, and from atmosphere. Intertidal communities can be important indicators of ecosystem health in areas subject to threats from municipal and industrial pollution, like oil drilling, production, refining and shipping. Periwinkles (genus Littorina, Caenogastropoda, Mollusca) are among the most common inhabitants of rocky shores in the North Atlantic with six species recorded for the Barents Sea. Littorina species are important players in intertidal food-webs, being grazers of bacterial biofilms, micro- and macroalgae; in turn, they are consumed by a variety of fish, birds, and invertebrate predators; also, they harbor a spectrum of parasitic worms. Their abundance and important ecological roles made periwinkles model organisms for ecological and evolutionary studies. In our project we established them as indicators of environmental pollution. Based on geochemical data from several coastal sites in comparison we assessed a set of variables at different levels of analysis: individual (shell form, proteomic and metabolomic profiles), populational (size-age structure, sex ratio, mean fecundity, rate of developmental abnormalities), biocenotic (host and parasitic species composition and abundances). We showed that periwinkles from populations affected by anthropogenic stressors are particular in several aspects; the most important are as follows. In polluted locations (1) snails are clearly different in terms of proteome and metabolome; (2) the number of developmental abnormalities is 2-4-fold-increased; (3) physiological differences between snails, inhabiting different tidal levels, are smeared.
The study is supported by the RFBR grant 18-54-20001.

Key words: pollution, intertidal community, Littorina

Talk

Fundamental biological traits

Prevalence of pelagic dependence among coral reef predators across an atoll seascape.

Christina Skinner[1], Steven P. Newman[1,2], Aileen C. Mill[1], Jason Newton[3] and Nicholas V. C. Polunin[1]

[1] School of Natural and Environmental Sciences, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK. Email: c.e.skinner@ncl.ac.uk
[2] Banyan Tree Marine Lab, Vabbinfaru, Republic of the Maldives.
[3] NERC Life Sciences Mass Spectrometry Facility, Scottish Universities Environmental Research Centre, Rankine Avenue, East Kilbride G75 0QF, UK.

Coral reef food webs are complex, vary spatially and remain poorly understood. Particular large predators, notably sharks, are subsidised by pelagic production on outer reef slopes, but how widespread this dependence is across all teleost fishery target species and within atolls is unclear. North Malé Atoll (Maldives) includes oceanic barrier as well as lagoonal reefs. Nine fishery target predators constituting 57% of the local fishery target species biomass at trophic levels 3-5 were selected for analysis. Data were derived from carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$) and sulfur ($\delta^{34}S$) stable isotopes from predator white dorsal muscle samples, and primary consumer species representing production source end-members. Three-source Bayesian stable isotope mixing models showed that uptake of pelagic production extends throughout the atoll, with predatory fishes showing equal planktonic reliance between inner and outer edge reefs. Median plankton contribution was 65-81% for all groupers and 68-88% for an emperor, a jack and snappers. Lagoonal and atoll edge predators are equally at risk from anthropogenic and climate-induced changes which may impact the linkages they construct, highlighting the need for management plans that transcend the boundaries of this threatened ecosystem.

Key words: Stable isotopes, trophic ecology, connectivity, plankton

Talk

Fundamental biological traits

Combination of molecular and morphological characteristics to assess different origins

Žužul, I., Šegvić-Bubić, T., Talijančić, I., Katavić, I., Grubišić L.

Institute of Oceanography and Fisheries, PO Box 500, Šetalište Ivana Meštrovića 63, 21000 Split, Croatia
Email: zuzul@izor.hr

The Gilthead seabream, *Sparus aurata* L, is one of the most important species in the Mediterranean for the aquaculture and fisheries sector, yet there is a lack of evidence of the magnitude and geographic scale of interbreeding as a repercussion from individual escape events. In order to assess population characteristic, combination of molecular and morphological characteristics was used to investigate wild and farmed gilthead seabream origin from the Adriatic coast and to assess the impact of genetic introgression of escapees to the wild seabream populations. Morphological traits were quantified by the application of homologous anatomical points of geometric morphometry (Talijančić et al., 2018) and are matched with multilocus genotypes (Žužul et al., in press) aiming to classify success of individuals with respect to their origin using Monte-Carlo simulations and cross validation with K-overlapping method implemented in the AssignPOP package (v.1.3-0) R software (Chen et al., 2018). Evaluated baseline data collected from source populations resulted in higher assignment accuracy and performed assignment test on unknown individuals predicted populations and membership probability. Since escaped evenest occurred regular, it is necessary to develop proper tools to identify escapees and to establish protocols for rapid and successful determination. The results of this study will provide the basis for forming good management practices of escapes scenarios.
Key words: origin traceability, seabream, escapees

Talk

Fundamental biological traits

Feeding preferences of seven dominant fouling species: trophic specialists or generalists?

Ninon **Mavraki**[1,2], Steven Degraer[1] and Jan Vanaverbeke[1,2]

[1] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management, Vautierstraat 29, 1000 Brussels, Belgium, Email: nmavraki@naturalsciences.be
[2] Marine Biology Research Group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Ghent, Belgium

Offshore wind farms in the Southern North Sea are proliferating rapidly and add large quantities of artificial hard substrate into soft-bottomed areas. These substrates are rapidly colonized by fouling species, with some found along the entire depth gradient and others restricted to limited parts of the pile. This patchy distribution of mainly sessile suspension feeders along the depth gradient might lead to spatial variation of their trophic behaviour. This study investigates the intra-specific spatial variation in the isotopic signatures of seven dominant fouling species: *Mytilus edulis*, *Diadumene cincta*, *Metridium dianthus*, *Jassa herdmani*, *Necora puber*, *Pisidia longicornis* and *Ophiothrix fragilis*. The species were sampled at six locations along the depth gradient and around a wind turbine in the Belgian part of the North Sea. From each of the species, the carbon and nitrogen stable isotopes were analysed, and characteristics of their trophic niche (eccentricity (E), angle (θ) and overlaps) investigated using the package SIBER. Potential food sources were also investigated using the package SIMMR. Most of the investigated species feed on different food items at different locations, suggesting that this trophic plasticity is a key to their success as fouling organisms on larger areas of wind turbines. On the other hand, species that specialize in one food source independently on their location have a limited vertical expansion. In addition, trophic niches from individuals sampled closer to the sea floor were elongated along the $\delta^{13}C$ axis, reflecting the use of multiple food sources available in environments with higher habitat complexity.

Key words: trophic plasticity, offshore wind farms, selectivity

Talk

Fundamental biological traits

Linking traits across ecological scales determines functional resilience to disturbance

Rebecca V. Gladstone-Gallagher[1,2*], Conrad A. Pilditch[2], Fabrice Stephenson[3], Simon F. Thrush[1]
[1] University of Auckland, Auckland, New Zealand (email: rebecca.gladstone-gallagher@auckland.ac.nz)
[2] University of Waikato, Hamilton, New Zealand
[3] National Institute of Water and Atmospheric Research Ltd., Hamilton, New Zealand

The Anthropocene has seen a global explosion of ecological disturbances, and maintaining critical ecosystem functions in the face of escalating rates of species loss and change has become a priority. Characterising the attributes that make ecosystems resilient to this change is critical. Functional diversity is commonly used as a surrogate measure of function, where groups of species with similar functional traits are considered functionally redundant and theoretically buffer against some level of species loss; but this framework ignores the resistance and recovery capacity of communities that occurs across multiple spatial and temporal scales. We develop a more complete theory of functional resilience to disturbance that links processes operating across multiple scales of ecological organisation (from individual species to landscape scales). Specifically, we explore how different combinations of scale-dependent resilience attributes are linked to functional resilience against disturbances that vary in intensity, spatial extent, and frequency. To demonstrate these concepts, we characterise a seafloor community of macroinvertebrates by resilience attributes (including individual species traits, population connectivity, and functional group species richness). Using a conceptual Bayesian Network model, we demonstrate how functional diversity of the community responds to different disturbance regimes. We show that with increasing disturbance extent (spatial or temporal), functional resilience switches from being dominated by attributes at the landscape scale (recovery attributes) to being dominated by attributes at the individual species scale (resistance attributes). Characterising communities by multi-scale resilience attributes provides a new approach to practically assessing vulnerability of marine ecosystems in the face of cumulative disturbances.

Key words: Functional traits, Recovery, Resistance, Stressor

Poster

Fundamental biological traits

The tufted ghost crab *Ocypode cursor* in the Mediterranean Sea: an updated overview of its distribution

G. Mancinelli (1,2,3), F. Belmonte (5), P. Carlino (4), E. Panzera (4), L. Potenza (4), and G. Belmonte (3,5)

[1] Laboratory of Ecology, Department of Biological and Environmental Sciences and Technologies (DiSTeBA), University of Salento, 73100 Lecce, Italy. Email: giorgio.mancinelli@unisalento.it
[2] National Research Council (CNR), Institute of Biological Resources and Marine Biotechnologies (IRBIM), Lesina - (FG), Italy
[3] CoNISMa, Consorzio Nazionale Interuniversitario per le Scienze del Mare, 00196 Roma, Italy
4 Centro recupero tartarughe marine del Museo di Storia Naturale del Salento, 73021 Calimera (LE), Italy
[5] Laboratory of Zoogeography and Fauna, Department of Biological and Environmental Sciences and Technologies (DiSTeBA), University of Salento, 73100 Lecce, Italy. genuario.belmonte@unisalento

Abstract
The tufted ghost crab *Ocypode cursor* (Linnaeus, 1758) is one of the two crustacean species protected by the Barcelona and Bern Conventions in the Mediterranean Sea; it is highly sensitive to anthropic perturbations of beach environments, and it is considered a good bioindicator of their quality. Here the first occurrence of the species for peninsular Italy is documented, representing also the northernmost record from the Mediterranean Sea. Information are complemented with a thorough overview of its distribution in the basin; georeferenced occurrence data are eventually matched with chronological information and oceanographic layers to provide an advanced resolution of the temporal pattern of range expansion of the crab together with a first assessment of its environmental requirements and bioclimatic niche. Crabs of the genus *Ocypode* are recognized as active bio-turbators of beach environments while *O. cursor* has been observed predating turtle nests; thus, a final effort is made to verify the degree of co-occurrence of the species with nesting sites of *Caretta caretta*, in order to assess whether the diffusion of the crab in the Mediterranean Sea may represent a potential threat for the endangered loggerhead turtle.

Key words: Brachyura, endangered species, bioindicator, bioclimatic niche

Poster

Fundamental biological traits

The ecology of yellow gurnard *Trigla lucerna* in a temperate estuary

J. Campos[1], **S. Costa-Dias**[2], P.T. Santos[3] and I. Jorge[4]

[1] CIIMAR – UP, Interdisciplinary Centre of Marine and Environmental Research of the University of Porto, Terminal de Cruzeiros do Porto de Leixões, Avenida General Norton de Matos, s/n, 4450-208 Matosinhos, Portugal
[2] ICBAS – UP, Institute of Biomedical Sciences - University of Porto, Rua Jorge Viterbo Ferreira 228, 4050-313 Porto, Portugal. Email: scdias@icbas.up.pt
[3] FCUP – UP, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, s/n, 4169-007 Porto, Portugal
[4] IPMA (former IPIMAR – CripCentro, Canal das Pirâmides, Aveiro), Portugal

Of meaningful economic importance, the yellow gurnard *Trigla lucerna* is a nectobenthic marine fish which uses estuaries as nursery grounds. In this work, the growth and feeding ecology of *T. lucerna* was followed during 9 months in the population from Mondego estuary (Portugal). Juveniles (>4.7cm TL) were found to enter the estuary in spring when temperature and salinity increased. They remained in the area until autumn or early winter, when they migrated seawards. Older gurnards (2-5 years) entered sporadically in the estuarine area mainly in autumn and winter. During the estuarine period of life, gurnards growth can be described according to the following von Bertalanffy's model equation:
$Lt = 51.40\ [1-e^{-0.148(t+0.5007)}]$
Feeding ecology of gurnards tends to specialization with a narrow trophic niche, based on four main groups of prey. The preferential prey was *Crangon crangon*, followed by *Carcinus maenas*; Mysids and small Teleostei were a secondary prey. Annelids, Gastropods and Bivalvia were accidentally ingested. Results are discussed according to seasonal and ontogenic changes.

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Key words: diet, growth, estuaries

Poster

Fundamental biological traits

Impacts of the invasive Atlantic blue crab *Callinectes sapidus* on the benthos of a Mediterranean lagoon: an experimental manipulation

L. Cilenti[1], L. Cannarozzi[1], A. Specchiulli[1], T. Scirocco[1], G. Mancinelli[2]

[1]CNR-IRBIM 1. Email: lucrezia.cilenti@cnr.it; laura.cannarozzi93@gmail.com; antonietta.specchiulli@cnr.it; tommaso.scirocco@cnr.it;
[2]UniSalento 1 Email: giorgio.mancinelli@unisalento.it

The blue crab *Callinectes sapidus* Rathbun, 1896 (Decapoda,Brachyura, Portunidae), is native to the western coasts of theAtlantic Ocean, was first reported In the Mediterranean Sea in the 50's and is to date distributed in most coastal areas of the basin.
In native habitats, *C. sapidus* has long been recognized to influence the structure and function of benthic food webs, either as a keystone species regulating carbon flows or by reducing prey abundance and inducing trophic cascades. Scarce information are to date available on the ecological impact of the species in invaded habitats. In this study a field exclusion-inclusion manipulation was carried out from November 2017 until August 2018in the Lesina Lake (SE Italy), to assess the effects caused by *C. sapidus*on the lagoon ecosystem, in particular on the seagrass *Nanozostera noltii* and on the macrobenthic community.
In inclusion cages, the blue crab determineda decrease in theorthotropic rhizome biomassof the seagrass, confirmed by an increase in the numberof floating leaves, probably caused by the crab burrowing activity. In addition, considerable changes were observed in the composition of the macrobenthos, in particular for crustacean taxa, suggesting that competitive or predatory interactions between the crab and the dominant representatives of themacrobenthic assemblage. As the first quantitative assessment of the ecological impact of *C. sapidus* in invaded habitats, the present investigation provided original and useful information for a comprehensive risk assessment of the species in European waters.

Poster

Fundamental biological traits

Gut microbiomes and host species divergence: metabarcoding study in intertidal snails' cryptic species.

Gafarova Elizaveta[1], Maltseva Arina[1], Panova Marina[2], Varfolomeeva Marina[1], Mikhailova Natalia[3], Granovich Andrei[1]

1 Department of Invertebrate Zoology, St. Petersburg State University, Universitetskaya 7/9, St. Petersburg, 199034. Email (Gafarova Elizaveta): st047483@student.spbu.ru
2 Gothenburg University, Dept. of Marine Sciences, Strömstad, Sweden, SE 452 96
3 Center of Cell Technologies, Institute of Cytology RAS, Tikhoretsky ave, 4, St-Petersburg, 194064

The importance of gut symbionts for normal metabolic functioning, immunity, reproduction, etc. was demonstrated for both vertebrates and invertebrates. Gut microbiome is a host species-specific community of symbiotic microorganisms. The composition of this community mirrors niche partitioning between the hosts' species due to even faint differences in food quality. In respect to closely related host species, both fine spatial differentiation of populations and alimentary preferences affect digestive modes, spectrum of engulfed microorganisms and inevitably change species-specific microbial community. Moreover, specific and balanced microbial community formation can be regarded as significant attribute during speciation. Marine intertidal molluscs of the subgenus Neritrema, genus Littorina (L.saxatilis, L.arcana, L.compressa, L.obtusata, L.fabalis) are common inhabitants of intertidal zone in the North Atlantic region. They are consumers of bacterial biofilms and grazers of micro- and macroalgae. Intertidal zone is characterized by diverse factors/stressors with values gradually changing along vertical gradient and Littorinas, inhabiting different zones of intertidal area, are generally accepted as a reliable example of early stages of ecology-driven speciation. The analysis of this species group allows to compare the scale and nature of differences in microbial communities associated with ecotypes of one species and between related species with different evolutionary distances. Within this project we characterized typical environmental microbial communities of biotopes inhabited by Littorinas and the gut symbionts of different snails to make a conclusion about possible evolutionary effects on host-symbionts association as a whole system.

Key words: ecological speciation, littoral molluscs, cryptic species, microbiome

Poster

Fundamental biological traits

The use of time-lapse cameras for studies of three-spined stickleback *Gasterosteus aculeatus* population dynamics and nesting behaviour

Evgeny A. Genelt-Yanovskiy[1], Pavel V. Saveliev[2], Tatiana S. Ivanova[2] and Mikhail V. Ivanov[2]

[1] Zoological Institute RAS, Email: genelt.yanovskiy@gmail.com
[2] Saint Petersburg State University, emails: Pavel Saveliev - ananasovnet11@gmail.com, Tatiana Ivanova - tut2000@gmail.com, Mikhail Ivanov - ivmisha@gmail.com

[Abstract text]
Beach seine is currently the main tool in field studies of *Gastetosteus aculeatus* during breeding season in the White Sea. Since this approach requires high field research effort and can be very destructive, the main goal of this study was to test wether the time-lapse cameras can be applied to describe the daily changes in abundance and nesting behaviour in three-spined sticklebacks. We used a set of Brinno TLC200 Pro Cameras installed in waterproof boxes below the water tide mark at three typical breeding sites in Kandalaksha Bay particularly (1) small enclosed bay with dense eelgrass Zostera marina beds, (2) large open bay with sandy bottom partly covered by eelgrass, and (3) shallow semi-isolated lagoon featuring high day temperatures, slow tidal currents and prevailance of green filamentous algae on a shingle bottom. Among several setup designs tested, facing cameras upwards from the bottom provided the highest clarity and resolution of images allowing to destinguish sexes of fishes, especially separating pregnant females from mature males and non-mature individuals. This design also provided more reliable results for analysis of directions of fish movements. Our experiments showed that female stickleback schools are keeping in the upper water layer just behind the surface. The abundance of fishes at the in the nearshore area during the first weeks of breeding season in June was significantly higher at the low tide, yet movements towards the shore was the prevailing indicating continuous arrival of new fishes to the breeding grounds.

Key words: three-spined stickleback, time-lapse, breeding, White Sea

Poster

Fundamental biological traits

Subarctic salt marsh foraminifera under seasonal ice

Elena Golikova[1], Marina Varfolomeeva[1], Sergei Korsun[1, 2]

[1] Saint-Petersburg State University 1. Email: e_golikowa@spbu.ru
[2] P.P. Shirshov Institute of Oceanology of Russian Academy of Sciences

The subarctic region (50-70°N) is characterized by the largest annual temperature range with harsh winters and mild summers. Low temperatures in winter result in ice cover of water bodies. Subarctic salt marshes, a type of coastal wetlands in the upper intertidal zone vegetated with halophytes, are covered with fast ice several months a year. Salt marsh foraminifera are abundant meiofaunal protists widely used in paleoenvironmental and ecological studies. All data on salt marsh foraminifera have been obtained in summer. Here, we report the first winter reconnaissance of salt marsh foraminifera from the subarctic White Sea. The samples were collected in March 2018 in the high marsh from under ice 40 cm thick and stained with Rose Bengal. A total of 5 species were found, among which 3 with bright RB coloration. Living abundances were low: 14 ind. /10cm^3 of *Jadammina macrescens*, 1-4 - *Balticammina pseudomacrescens*, 1 - *Trochammina inflata*, and 2 - *Ovammina opaca.* Dead abundances were similar to those observed in summer. The topmost centimeter of soil was frozen into the ice foot. Living specimens resided in wet and salty soil 2-3cm beneath. We infer that insulation by the ice protects the subsurface part of the population from freezing and elimination, and the few survivors are the pool which will proliferate in summer. Supported by RFBR grant 18-54-20001.

Key words: [salt marsh, foraminifera, subarctic, ice]

Poster

Fundamental biological traits

Bathymetric variations in benthic size spectra, production and carbon demand in Arctic deep-sea (Fram Strait)

Barbara Górska*[1],Maria Włodarska-Kowalczuk[1], Thomas Soltwedel[2]
*Corresponding author: basia@iopan.gda.pl
[1]Institute of Oceanology Polish Academy of Sciences, Sopot, ul. Powstańców Warszawy 55, 81-712 Sopot, Poland
[2]Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar und Meeresforschung, Am Handelshafen 12, 27570 Bremerhaven, Germany

We present bathymetric patterns in benthic community structure and functioning at the Long-term Ecological Research observatory HAUSGARTEN in the Fram Strait. Area of investigations were localized in marginal ice zone, which is one of the most productive Arctic marine ecosystem. High productivity in area of investigation was reflected in higher benthic standing stocks than in other deep-sea Arctic regions. Decrease of benthic standing stock towards greater depths is a globally observed pattern. The rate of biomass, average individual biomass and secondary production of meiofauna and macrofauna decrease with increasing water depth was similar to globally observed trends. Decline of standing stock with depth in the present study were stronger in macrofauna than in meiofauna. Also macrofaunal contribution to benthic carbon demand decreases towards greater depths. That resulted in bathymetric increase in meiofauna:macrofauna biomass, production and carbon demand ratio and a transition from macrofauna to meiofauna dominated system from shelf towards deeper ocean zones.
Based on benthic biomass size spectra analysis we observed that with increasing water depth biomass in all size classes decreased. However, the shape of benthic biomass size spectra and slope of normalized spectra little changed along bathymetric transect in the Fram Strait. Bimodal shape of spectrum was observed at almost all stations, but the width of size spectra decreased towards greater depths, what was caused by reduction of number of macrofaunal size classes as the biggest classes were eliminated.
Results of our studies may suggest that although sizes of organisms decrease with increasing water depth, the functioning of benthic metazoan community remain little changed.

Key words: benthos; size spectra; Arctic; deep-sea

Poster

Fundamental biological traits

Seasonal dynamics of the predatory fish feeding in the inshore zone of the White Sea with emphasize on the role of threespine stickleback *Gasterosteus aculeatus*

Tatiana S. Ivanova[1] , Anastasia E. Bakhvalova[1], Mikhail V. Ivanov[1] and Dmitry L. Lajus[1]

[1] Saint Petersburg State University, Tatiana Ivanova - tut2000@gmail.com, Mikhail Ivanov - ivmisha@gmail.com, Anastasia Bakhvalova - nastyabakhvalova94@gmail.com, Dmitry Lajus - dlajus@gmail.com

[Abstract text]
Threespine stickleback *Gasterosteus aculeatus* is currently the most numerous fish species in the White Sea. In the early summer they migrate inshore for spawning, thus becoming a part of the coastal food webs. We studied seasonal dynamics of feeding of several coastal fish species to evaluate the role of stickleback in their diet. Samples were collected from late May till September 2015 using a set of gillnets in shallow protected inlets with dense seagrass beds. Among totally 18 fish species found, of which atlantic cod, navaga, european and fourhorn sculpins, pacific herring and rainbow smelt are the most numerous. In the late May and June, adult stickleback become the key prey for cod, sculpins and navaga. In early July adult stickleback migrate offshore, and appearing juveniles are consumed by navaga, cod, herring and smelt. Since late August - September, when the juveniles migrate offshore, predatory fish switch to other fish species and invertebrates. Therefore, threespine stickleback play a significant role in the feeding of coastal fish in period of their high abundance in inshore zone. When the number of stickleback decreases, the predatory fish shift to other available prey

Key words: three-spined stickleback, predator-prey interactions, White Sea

Poster

Fundamental biological traits

The first step towards a lake: specific patterns of biota of the marine lagoon

Mikhail V. Ivanov[1] , Tatiana S. Ivanova[1] , Ekaterina A. Movchan, Natalia V. Polyakova, Elena V. Rybkina, Igor A. Stogov, and Dmitry L. Lajus[1]

[1] Saint Petersburg State University, Tatiana Ivanova - tut2000@gmail.com, Mikhail Ivanov - ivmisha@gmail.com, Dmitry Lajus - dlajus@gmail.com, Natalia Poliakova - nvpnataly@yandex.ru, Ekaterina Movchan - movchan_ekaterin@mail.ru, Elena Rybkina - onebat@yandex.ru, Igor Stogov - igor_stogov@yahoo.com

Postglacial rebound in the White Sea area result in gradual transformation of marine inlets and lagoons into freshwater lakes. This study deals with first steps of such transformation exemplified by Koliushkavaya Lagoon in the Kandalaksha Bay studied since 2009. The Lagoon area is 65,000 square m and depth up to 4.5 m. Sea water comes here only with spring tides. Water in the Lagoon is several degrees warmer than in the sea during the warm season. Eelgrass *Zostera marina* and filamentous algae grow here abundantly. Species diversity of zooplankton is generally lower than in the sea, but some rare species are abundant in the Lagoon. Macrozoobenthos is similar to that in the sea but occur only up to 2 m depth. Fishes are represented by 8 species. Pacific herring, threespine and ninespine sticklebacks are overwintering in the Lagoon but not in the adjacent shallow parts of the sea. The Lagoon is actively used by sticklebacks for spawning. Abundance, sex and size structure of spawning threespine stickleback are similar to the sea, but juvenile mortality in the Lagoon is lower. In addition, juveniles stay here for longer than in coastal parts of the sea. The species composition of threespine stickleback parasites in the Lagoon differs from that in the sea. The main factor driving composition of the Lagoon biota is limited water exchange. It directly impacts zooplankton and ichthyofauna and indirectly benthos through anoxia and filamentous algae through elevated temperature.

Key words: White Sea, semi-isolated lagoon, species diversity

Poster

Fundamental biological traits

Surviving guide for charophytes in the eutrophic lagoon: distribution of oospores and their relationship to environmental factors

Vaiva Stragauskaite[1], Martynas Bučas[1]

[1] Klaipėda University, Marine Research Institute, Universiteto ave. 17, LT-92294 Klaipėda, Lithuania
Email: vaiva.stragauskaite@jmtc.ku.lt

Charophytes are a part of littoral submerged vegetation, which provide important ecosystem functions and services such as habitats, nursery and feeding grounds and storage of nutrients. For many charophytes species, the dispersion, colonization and maintenance of populations depend entirely on the oospore bank. The absence of macrophyte propagules or infertile propagules is one possible explanation for absence of charophytes in suitable areas. The distribution of oospores in the largest lagoons of the Baltic Sea is understudied; therefore, we aimed to assess the spatial patterns of oospores and their correspondence to the stands of charophytes and physical environment factors in the Curonian lagoon. These results are important for evaluation of current status of charophytes and for development of macrophyte indicators for water quality assessment according to the Water framework directive.
Oospores in the lagoon were sampled in 2017-2018 period within the Lithuanian part. Only 3 from 5 frequent species of charophytes in the lagoon were found form the oospores, from which *Chara contraria* dominated. The highest densities of empty and viable gyrogonites and oospores were observed at sheltered and shallow areas (1 m depth) with high coverage of *C. contraria*. Empty oospores were found at more than 2 m depth and in the areas with low coverage of charophytes. We did not find any oospores in the areas where charophytes were not recorded over the past 50 years. Empirical relationships between the distribution of oospores and environmental factors are discussed.

Keywords: marophytes, gyrogonites, wave exposure, depth, Curonian lagoon

Poster

Fundamental biological traits

Differences on the total energy content in females anchovies in two consecutive years

Txurruka, E.[1], Cotano, U.[2] and Villate, F.[1, 3]

[1] Department of Plant Biology and Ecology, Faculty of Science and Technology, University of the Basque Country (UPV/EHU), PO box 644, 48080 Bilbao. Email: estibalitz.txurruka@ehu.eus
[2] AZTI. Herrera Kaia, Portualdea z/g, 20110 Pasaia, Gipuzkoa.
[3] Research Center for Experimental Marine Biology and Biotechnology (Plentzia Marine Estation; PiE-UPV/EHU) Areatza Pasalekua, 48620 Plentzia-Bizkaia.

Anchovy fisheries are a relevant source of income for the Basque Country economy. Due to their and consecutive failures in annual recruitment, these fisheries came to a closure between the years 2005 and 2010. Condition factors based in life weights have a limited utility when estimating well-being status of a fish population. Quantification of energy reserves is much more biologically informative, especially in the critical phases of overwintering and reproduction, but it requires more time and resources. Some studies suggest that larger or older females have more energy content than smallest ones, so they can invest more energy to reproduction. The aim of this work was to see the differences between two ages (age 1 and age 2) in female anchovy energy content (E-tot (J)) for two consecutive springs: May-2016 and May-2017. Results of t-test analyses showed that there were significant differences ($p<0.05$) between ages. In both years, the highest values are for anchovies of age 2 (2016: E-tot=57252.06±25401.4; 2017: E-tot=80344.4±26714.3). As a consequence of those higher values, anchovies of age 2 can invest more energy in the critical phase of reproduction. Moreover, the higher values of those individuals of the year 2017 suggest that these females contribute relatively more to the stock productivity than those of previous year.

Key words: anchovy, female, age, energy content

Poster

Fundamental biological traits

In situ methods to quantify kelp productivity

Lydia White[1] & Dominique Davoult[1]

[1] Sorbonne Université, CNRS, UMR 7144 Adaptation et Diversité en Milieu Marin AD2M, Station Biologique de Roscoff, Roscoff, France. lydia.white@sb-roscoff.fr

Marine macroalgae commonly exhibit high rates of growth and primary productivity and as such are likely to play fundamental roles in carbon cycling. There is a clear need for integrative approaches and rigorous sampling and measurement techniques within the context of Ecosystem Functioning research and development of such tools remains a priority for ecologists. We are currently developing *in situ* methodologies for measuring the metabolism of subtidal macroalgal-dominated communities – specifically kelps – to allow more accurate estimates of kelp forest productivity rates. We will quantify photosynthetic parameters for multiple kelp species, during different stages of their growth, in conjunction with seasonal monitoring of biomass production. We will also investigate how climate-driven substitutions of foundation species might influence kelp forest productivity by comparing two habitat-forming species of kelp with contrasting thermal affinities. Results will provide insights into how shifts in the relative dominance of species, and consequently their functional traits, might have knock on consequences for important ecosystem process and natural carbon sequestration.

Key words: primary productivity, kelp forest, foundation species, carbon sequestration

Poster

Fundamental biological traits

Opportunistic omnivory leads to local adaptation in feeding behaviour and contrasting function across latitudes

Jean-Charles Leclerc[1,2*], Thibaut de Bettignies[3,4], Florian de Bettignies[1], Hartvig Christie[5], João N Franco[6], Cédric Leroux[1,7], Dominique Davoult[1], Morten F. Pedersen[8], Karen Filbee-Dexter[4,9] and Thomas Wernberg[4,8]

[1]Sorbonne Université, CNRS, UMR 7144 AD2M, Station Biologique de Roscoff, Place Georges Teissier, 29680 Roscoff, France
[2]Universidad Católica de la Santísima Concepción, Departamento de Ecología, Facultad de Ciencias, Centro de Investigación en Biodiversidad y Ambientes Sustentables (CIBAS), Casilla 297, Concepción, Chile
[3]UMS Patrimoine Naturel (PATRINAT), AFB-CNRS-MNHN, CP41, 36 rue Geoffroy Saint-Hilaire, 75005 Paris, France
[4]School of Biological Sciences & UWA Oceans Institute, University of Western Australia, 39 Fairway, Crawley 6009, WA, Australia.
[5]Marine biology Section, Norwegian Institute for Water Research, Oslo, Norway
[6]CIIMAR, Terminal de Cruzeiros de Leixões. Av. General Norton de Matos, 4450-208 Matosinhos, Portugal
[7]Sorbonne Université, CNRS, FR 2424, Station Biologique, Place Georges Teissier, 29680 Roscoff, France
[8]Department for Science and Environment (DSE), Roskilde University, PO Box 260, 4000 Roskilde, Denmark
[9]Benthic Communities Research Group, Institute of Marine Research, His, Norway

Consumptive interactions can have major implications for the structure and dynamics of communities, and investigating how they vary across broad spatial scales and environmental gradients can increase our understanding of how these processes might change in the Anthropocene. As the environment is getting warmer and biodiversity is redistributed, consumers can be forced to shift to novel resources and adjust the strength of their interactions with available prey, and in turn this could affect their function in ecosystems.
Our study aimed to determine the function of an ectotherm omnivore, the red sea urchin Echinus esculentus, which co-occurs with the habitat-forming kelp Laminaria hyperborea along its entire latitudinal distribution from Portugal to northern Norway in the northeast Atlantic. Using a combination of gut content and stable isotope analyses, we determined the diet and trophic position of sea urchins at two sites in Portugal, France, southern Norway and northern Norway. We related these results to latitude and the abundance and distribution of putative food items at each site in order to determine possible drivers of diet (temperature, food availability) and adaptive foraging strategies. Omnivory and diet did not vary with latitude, but rather depended on food availability within and between sites. Our results demonstrate that, likely to maintain a necessary mixed diet, the sea urchin adapts its foraging strategy to match the small-scale distribution of food items in its habitat. Diet flexibility may occur in response to food source redistribution at multiple spatial scales. Across these scales, the way key consumers adapt their foraging strategy to food limitation may challenge our understanding of their influence on food web dynamics and ecosystem functions along current and future environmental gradients

Key words: Food web, Urchin grazing, Seaweeds, Kelp forest, Echinus esculentus, Laminaria hyperborea

Blue Growth

Talk

Blue Growth

A Bayesian network model for assessing ecological risk and economic impacts for spatial marine management options

Patricia **Breen**[1], Oliver Tully[2], Stephen Hynes[3], Christine Loughlin[1], Yves Reecht[2], Terry Morley[1]
[1] School of Geography and Archaeology and the Ryan Institute, National University of Ireland Galway, Newcastle Road, Co. Galway, Ireland **patricia.breen@nuigalway.ie**
[2] The Marine Institute, Rinville, Oranmore, Co. Galway
[3] Socio-Economic Marine Research Unit, National University of Ireland Galway, Newcastle Road, Co. Galway, Ireland

Further developments in spatial assessments of human pressures and impacts are required in order to implement ecosystem-based marine management. These data are necessary for assessment of management measures that include ecological and economic costs and benefits. Here, we assessed the risk of benthic abrasion from fishing on the west coast of Ireland. Risk was quantified spatially, on a per cell bases, as the ratio between mortality and recovery. Risk was considered high if mortality exceeded recovery. We subsequently developed a Bayesian network model, incorporating ecological risk and economic data to compare three management scenarios: i) business as usual, ii) exclusion of fishing vessels over 18m within 6 nautical miles (68% of study area) and iii) a representative network of marine protected areas (MPAs) closed to all fishing vessels (11% of study area). The business as usual scenario indicated that risk was high for 85% of the study area. Excluding vessels over 18m within 6nm resulted in a 13% reduction in high risk cells, impacting approximately €1.4 million of landings, €1.1 million of indirect output and 29 full time equivalent employees. The MPAs, resulted in a 1.4% reduction of high risk cells. Within MPAs, risk fell but increased in surrounding cells. This scenario impacted €156,387 in landings, €120,418 in indirect outputs and 3 full time equivalent employees. Further development of a mortality-recovery ratio to assess risk would be applicable across multiple habitats, human activities and pressures. The Bayesian network approach allows spatial assessment of management options even in data limited scenarios.

Key words: Bayesian network model, risk assessment, benthic impacts, fisheries

Talk

Blue growth

Quantification of ecosystem services provided by infaunal shellfish in temperate estuaries.

Rullens V.[1], Lohrer A.M.[2] and Townsend M.[3], Pilditch C.A.[1]

[1] Department of Biological Sciences, University of Waikato, Hamilton, New Zealand
Email: verarullens@gmail.com
[2] National Institute of Water and Atmospheric Research, Hamilton, New Zealand
[3] Waikato Regional Council, Hamilton, New Zealand

Studying the multitude of ecosystem services (ES) provided by infaunal shellfish beds is crucial for a more complete understanding of their contribution to human well-being and the value they generate. In estuaries, spatial and temporal variation in underlying biophysical structures and processes, as well as patchiness in shellfish distribution, result in variable ecosystem function (EF) and ES delivery. Our work has focussed on quantifying multiple services provided by infaunal filter-feeding shellfish that affect estuarine health and quality in temperate estuaries. Through activities including sediment reworking and filter-feeding, infaunal shellfish contribute to water clarity improvement, nutrient recycling and nitrogen removal by enhancing coupled nitrification-denitrification in the sediment. In this research, we quantified service provision from two key infaunal filter-feeding shellfish in New Zealand by conducting benthic incubations over natural density gradients on intertidal sandflats and in subtidal channels. Results indicate density-dependent differences in productivity and nutrient fluxes during light and dark incubations and strong differences between the two habitats. By linking population structure, processes and functions, to the delivery of ecosystem services, we can elucidate the mechanisms underpinning services, quantify service delivery, and improve our understanding of spatial variation in service supply. Identifying and quantifying multiple services simultaneously will improve our ability to inform sustainable use of natural resources and help direct management and restoration efforts.

Key words: Ecosystem services, Interactions, Quantification, Shellfish

Talk

Blue Growth

Implementing remote sensing as a tool towards supporting marine aquaculture off the Portuguese coast

Ferreira, A.[1, 2], Palma, C.[2], Brotas, V. [1,3], Borges, C. [2], Brito, A.C.[1,3]

[1] MARE-ULisboa - Marine and Environmental Sciences Centre, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal. 1. Email: ambferreira@fc.ul.pt
[2] IH – Instituto Hidrográfico, Rua das Trinas 49, 1249-093 Lisboa, Portugal
[3] Departamento de Biologia Vegetal, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Aquaculture is one the fastest growing markets in the food production sector, making up half of the global fish production. Remote sensing is increasingly used in aquaculture as a valuable planning tool. Remote sensing allows for low-cost, synoptic observations of coastal waters, delivering valuable data towards the monitoring and identification of productive areas for aquaculture. In the Portuguese coastal waters, aquaculture is still characterized by small operations and an overall low production. Nevertheless, high habitat diversity and good water quality ensure a high growth potential for aquaculture along the coast. This work seeks to apply ocean colour remote sensing products to the Portuguese coast with the goal of identifying suitable areas for the implementation of marine aquaculture units. Plus, this study will also focus on phytoplankton phenology (i.e. phytoplankton bloom duration and timing), which will be essential for the management of aquaculture operations. It will use available long-term, continuous and high-resolution remote sensing datasets, such as from the OC-CCI project, which merges 20-years data from several ocean colour sensors. This work will benefit from a thorough in-situ dataset on the Portuguese coast, which will be used to validate the remote sensing data. Results from an exploratory analysis on phytoplankton biomass variability and phenology are presented and discussed. This study is expected to provide insight and support to stakeholders, contributing to sustainable marine aquaculture in Portugal.

Key words: marine aquaculture; remote sensing; Portuguese coast; chlorophyll a

Talk

Blue Growth

A stakeholder-driven set of Essential Variables describing status and quality of functions, services, benefits and risks in Protected Areas

Herman Hummel[1], Valerie Kalle[1], Louise Bienfait[1], Yolande Boyer[2], Rutger de Wit[2], Christiaan Hummel[1]

[1] Royal Netherlands Institute for Sea Research and Utrecht University, Yerseke, the Netherlands. Email: herman.hummel@nioz.nl
[2] Centre for Marine Biodiversity, Exploitation and Conservation (MARBEC), University of Montpellier, France

To assess and understand the actual and potential Societal Goods and Benefits (SG&B) a Protected Area (PA) can deliver, it is important to properly describe and analyse the current and future Ecosystem Functions (EF) of the area, the Ecosystem Services (ES) they deliver, and the pressures imposed on them (Risks). For this an agreed harmonised set of indicators for EF, ES and Risks, so-called Essential Variables (EV), has to be available. It is imperative that the quality status of each EV should be sufficiently high to allow for sustainable delivery of SG&B.

We will present an inventory and analysis of the most important EV, comprised of ecological, socio-economic and cultural attributes in PA. On basis of EV we made a first assessment of the quality status of European PA. Four surveys were carried out to assess type and quality of EV. Over 120 PA managers, rangers and scientists of 26 PA participated.

Thirty EV were selected applicable to PA in different realms, marine and terrestrial. EV include Population dynamics and Primary production as priority EF, Charismatic landscape or Leisure activities as priority ES, and Overexploitation or Change in species as priority Risks.
The quality status of European PAs on basis of EV was perceived as being average to good.

Because of their general applicability in marine and terrestrial PAs the selected EV form an ideal basis for further studies on the current status and future developments of the quality, benefits and risks in PAs.

Key words: Essential Variables, Ecosystem Services, Protected Areas, Ecosystem Functions, Risks

Talk

Blue Growth

Ecosystem valuation of coastal ecosystems for improving water quality underpins blue growth

Watson G.J. [1], Preston J. [1], Watson S.[1].

[1]Institute of Marine Sciences, University of Portsmouth, Ferry Road, Portsmouth, PO4 9LY
Emails: gordon.watson@port.ac.uk, joanne.preston@port.ac.uk, sclw@hotmail.co.uk

A critical environmental challenge for sustainable blue growth is that coastal waterbodies are increasingly eutrophic resulting in impacts on the services and goods provided by habitats and species. Many are also protected under national and international conservation legislation. Improving water quality is essential to meeting legislative requirements, protecting key habitats, improving public health, but also for a sustainable marine economy. Much of Europe's coastline is of high nature conservation value and has significant maritime industries. However, interventions to improve water quality are confounded by an inability to assess natural capital in terms of the function of critical habitats (e.g. oyster reefs, soft sediments, seagrasses) and keystone species (e.g. *Ostrea edulis, Hediste diversicolor, Crepidula fornicata*) in controlling water quality. Using the Solent region of the UK as a case study, we will combine relevant literature with GIS mapping software to generate maps and area coverage for dominant habitats and key species. Net flows of nutrients will be calculated based on habitat extent and species life history e.g. traits, densities and then adjusted for season, temperature and future climate scenarios. The economic metrics we produce for each habitat and species valuation is critical for stakeholders and policymakers so that natural assets are discussed in language that funders and government understand. Ultimately, these data are required to facilitate financial contributions for mitigation and wider environmental improvement schemes to be generated and applied, thus ensuring blue growth is fully supported.

Key words: oyster, natural capital, seagrass, polychaete

Talk

Blue Growth

Ecological footprint and ecosystem services from seaweed cultivation: a methodological approach to ensure best practice

Jose M. Fariñas-Franco[1], Antoine Fort[1], Maeve Edwards[2], Martin White[3], Stephen Nash[4], Manuel Tey García[1], Inés Coca Tagarro[1], Lucas Avila[1], Mark P. Johnson[2], and Ronan Sulpice[1]

[1] Plant Systems Biology Lab, School of Natural Sciences and Ryan Institute, Galway, Ireland. Email: josemaria.farinasfranco
[2] School of Natural Sciences, Ryan Institute, NUI Galway, Galway, Ireland
[3] Earth and Ocean Sciences, Ryan Institute, NUI Galway
[4] School of Civil Engineering, NUI Galway, Galway, Ireland

Macroalgae such as kelp are keystone species crucial for the functioning of marine ecosystems creating habitats of high biodiversity. With seaweed having an increasingly important role in Europe's Blue Economy, current and predicted market demand could also put excessive pressure on natural habitats without implementation of comprehensive regulations. As an alternative to wild harvesting, nearshore macroalgal aquaculture can provide a reliable supply to industry, likely at a lower environmental cost. However, there is a need to move beyond desk-based studies and gather real-world data to quantify impacts and ecosystem services associated with seaweed cultivation.
As part of the H2020 EU GENIALG Project, we are conducting comprehensive monitoring of 1ha test site located in SW Ireland to assess the ecological footprint of sugar kelp aquaculture. Using a BACI approach to measure biotic and abiotic parameters ensures that potential impacts from the farm, positive and negative, are detected against natural variability. Results obtained during the first year of monitoring suggest reduced siltation and water turbidity underneath the farm might benefit seagrass habitats of high conservation importance. Other positive effects such as excess nutrient removal, biodiversity enhancement and the role of cultivated seaweed as fish nurseries will also be discussed. By expanding this monitoring to other European seaweed farms, we will fill-in knowledge gaps in our understanding of the environmental implications of scaled-up seaweed aquaculture. Ultimately, the results will help develop evidence-based guidance to inform site selection and contribute to the licensing process.

Key words: seaweed; aquaculture; biodiversity; environmental impacts;

Talk

Blue growth

Investigation of mucus in the sponge *Haliclona* (*Rhizoniera*) *indistincta* (Bowerbank, 1866) and assessment of its biotechnological potential

M. V. **Marra**[1], K. Sepčič[2], D. J. Thornton[3], O. P. Thomas[4] and G. P. McCormack[1]

[1] Molecular Evolution and Systematics Laboratory, Zoology Department, Martin Ryan Institute, National University of Ireland Galway, Galway, Ireland. Email: mariavittoria.marra@nuigalway.ie
[2] Department of Biology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, 1000, Ljubljana, Slovenia
[3] Wellcome Trust Centre for Cell-Matrix Research, Faculty of Biology, Medicine and Health, University of Manchester, Manchester, United Kingdom
[4] Marine Biodiscovery, School of Chemistry, National University of Ireland Galway, Galway, Ireland

Sponge species from the Order Haplosclerida produce a large array of bioactive compounds, including those with antimicrobial properties, and some of these sponges also produce mucus with different physical properties. Understanding the composition of mucus is of great interest for sponge biology in order to determine if mucus is involved in defence and/or symbiotic interactions with microbes. We have investigated the sponge *Haliclona* (*Rhizoniera*) *indistincta* (Bowerbank, 1866), which produces a 'tacky' type of mucus, in order to relate the nature of its mucus to both bioactivity potential and microbial diversity of this species. *H. indistincta* produces a class of potent cytotoxic compounds known as 3-alkylpyridinium alkaloids and when observed via transmission electron microscopy its tissue is virtually devoid of bacteria. In order to characterise the molecules responsible for mucus production, we firstly looked for presence of mucins in this sponge via an integrative approach that involved histochemistry, immunohistochemistry, mass spectrometry and transcriptomics. True mucins were not found in *H. indistincta*, therefore we are testing the alternative hypothesis that the mucus-type material of this sponge is comprised of large polymers of 3-alkylpyridinium compounds. Once isolated, these polymers will be tested for their biological activity. Here we present a summary of all the results collected on the nature of the mucus-type material produced by *H. indistincta* and the cells that we consider responsible for its production.

Key words: *Haliclona indistincta*, mucus, 3-alkylpyridinium polymers, cells with inclusions.

Talk

Blue growth

Biodiversity in the deep-sea mining frontier based on a new integrative taxonomy

Drennan. R[1], Wiklund. H[1,2], Neal. L[1], Rabone. M[1], Dahlgren. TG[2,3], Glover. A. [1]

[1] Natural History Museum London, Life Sciences Department, UK. Email: r.drennan@nhm.ac.uk
[2] University of Gothenburg, Department of Marine Sciences, Sweden.
[3] Norwegian Research Centre NORCE, Norway

The blue economy concept is built around a co-ordinated, sustainable approach to the management and development of ocean resources and at-sea industrial activity. In recent years, commercial interest in deep-sea mining has surged, targeting a potential wealth of mineral resources that could provide vital components for modern electronics, including metals essential to green technologies that may contribute to a low-carbon future. However, deep-sea habitats, the majority of which occur in areas beyond national jurisdiction (ABNJ), remain among the most unexplored ecosystems on the planet, raising the question of how we can sustainably manage this industry and protect these ecosystems without knowledge of the animals that live there.

Here we present a summary of our new integrative DNA and morphology-based taxonomic datasets documenting the baseline biodiversity of the Clarion-Clipperton Zone, a region of the abyssal central Pacific undergoing intense exploration for potential deep-sea mineral extraction, and potentially one of the most biodiverse sedimented marine habitats on the planet, with the majority of species recovered from the region new to science. We highlight new data on the biogeographic ranges and diversity of the abyssal Pacific benthos. We also discuss how a taxon-focused approach can be used to highlight key or indicator taxa for ecosystem monitoring and preserving ecosystem services.

Key words: [ABNJ, Blue Economy, New Species, Conservation]

Talk

Blue growth

Chemodiversity and health benefits of our native Macroalgae

Torres Sweeney[1,3], Brigkita Venardou[1], Ruth Rattigan[2], Marco Garcia-Vaquero[1], Gaurav Rajauria[2], Claire Keily[1], Stafford Vigors[2], Fiona Mc Cartney[2], Marion Ryan[1], Kevin Thornton[1], Rajeev Ravindran[1], John V. O'Doherty[2,3].

[1]School of Veterinary Medicine, University College Dublin, Ireland Affiliation address 1. Email: torres.sweeney@ucd.ie
[2]School of Agriculture and Food Science, University College Dublin, Ireland.
[3] Beacon Bioeconomy Research Centre, University College Dublin, Ireland

Chemodiversity in nature has arisen from plants and animals developing protective molecules to survive in varying complex biosystems. Many of these molecules have anti-inflammatory, antimicrobial and/or anti-oxidant properties, which help the host to survive a wide spectrum of environmental challenges. We hypothesise that these non-nutritive molecules can be used in the diet to support the developing gastrointestinal tract of mammals. The mammalian gastrointestinal tract is a dynamic environment, where a symbiotic relationship exists between the immune system, the resident microbiota and the digestive system. The early establishment of this relationship is fundamental to the development and long-term maintenance of gut homeostasis, with unfavorable alterations in the composition of the microbiota, known as dysbiosis, being implicated in many conditions including irritable bowel disease in humans and post-weaning diarrhoea in pigs. Our overall objective is to develop clean, green, extraction and purification methodologies to identify extracts from macroalge that have anti-inflammatory, prebiotic and antioxidant properties in the gastrointestinal tract. Common macroalgal species including *Ascophylum nodosum*, *Laminaria Digitata* and *Laminaria Hyperborea* are the focus of our research. The weaned-piglet is used as the experimental model, as the piglet undergoes a natural post-weaning dysbiosis during this time period. We have identified specific extracts that are anti-inflammatory and prebiotic during this sensitive time period.

Key words: [Macroalgae, extraction, prebiotic, anti-inflammatory]

Talk

Blue Growth

How can plumes generated by deep-sea mining be minimised to reduce environmental impact?

Author

P.P.E**. Weaver** Seascape Consultants Ltd., Jermyns House, Jermyns Lane, Romsey SO51 0PE, UK **phil.weaver@seascapeconsultants.co.uk**

R. Boschen-Rose Seascape Consultants Ltd., Jermyns House, Jermyns Lane, Romsey SO51 0PE, UK

As the possibility of deep-sea mining gets ever closer manufacturers are designing and building prototypes of mining machines. The International Seabed Authority's draft regulations on exploitation of mineral resources in the Area (ISBA/24/LTC/WP.1/Rev.1) make frequent references to the application of "good industry practice", "best environmental practices (BEP)" and "best available techniques (BAT)" and the incorporation of "best available scientific evidence". However, BEP and BAT are difficult to define for such a new industry as there are no existing activities. This talk will outline some of the issues related to environmental impacts of deep-sea mining on ecosystems, especially the generation and management of plumes. Sediment-laden plumes are generated during the collection of minerals from the seabed, and return of waste water from surface processing. Common plume impacts include smothering, clogging of feeding appendages, burial of organisms and potentially toxic effects. This talk will discuss the characteristics of the different mining plumes, and some of the potential technical solutions that are being investigated to minimise their impacts. The talk will seek input from the audience on how plumes can be managed to reduce their environmental impact. The presenters will feed this back to some of the European manufacturers who are part of the Blue Harvesting project, which aims to develop a collector for nodule mining with a low environmental impact. This may help to set a high standard for BEP and BAT thereby making an important contribution to the European Blue Economy.

Key words: Mining plumes, environmental impact

Poster

Blue growth

Cost benefit analysis of survey methods for assessing intertidal sediment disturbance: a bait collection case study

Shannon M. White[1], Martin Schaefer[2], and Gordon J. Watson[1]

[1]Institute of Marine Sciences, School of Biological Sciences, University of Portsmouth, Ferry Road, Portsmouth, PO4 9LY, UK. Email: shannon.white@port.ac.uk
[2]Department of Geography, University of Portsmouth, Buckingham Building, Lion Terrace, Portsmouth, PO1 3HE, UK

Bait worms collected from intertidal sediments represent a highly valuable resource equivalent to traditional fisheries with potentially comparable impacts. In protected sites where intertidal sediments represent a feature of conservation interest, local management organisations must be able to make affordable assessments of bait collection and Unmanned Aerial Vehicle (UAV) surveys may serve in this respect. Here, we compared the efficacy, costs and benefits of using aerial imagery from a UAV survey for assessing the extent of bait collection (using distinctive scars) on intertidal sediments against that of aerial imagery from the Channel Coastal Observatory (CCO) and a traditional walk-over survey. Aerial imagery eliminates time costs and risks to personnel crossing difficult mudflat terrain and provides a broad perspective over the shore, allowing for accurate delineation of disturbed areas directly from the imagery. Digitising disturbed sediment areas was the most time-consuming aspect of each method; highest for the walk-over. For aerial imagery, image analysis algorithms could be tested for bait collection assessment as a means of improving cost-effectiveness. While the CCO aerial imagery was freely available, the assessment was restricted to years and locations with imagery available. Considerations for UAVs include high up-front costs for personnel training, equipment, and software and the potential for restrictions on UAV flights in sensitive areas and by flight regulations. Nonetheless, UAVs offer the opportunity to collect aerial imagery specific to the needs of the survey at hand at the time and location of interest and with additional surveys the up-front costs would become more economical.

Key words: Bait collection, UAVs, Cost-benefit, Drones

Poster

Blue Growth

MARLIN – a large-scale/high resolution information system for marine biological data as a backbone for marine management

Gregor von Halem[1], Anne Elsner[1], **Sabrina Schulz[1, 2]**, Erik Böhm[1]
[1]Federal Maritime and Hydrographic Agency
[2] Email: sabrina.schulz@bsh.de

Large-scale/high-resolution integrated marine ecological information systems combine diverse ecological and environmental data in space and time (such as biodiversity and trophic relationships). This holistic approach facilitates new directions for the analysis and modeling of ecological patterns and processes, creating a platform for the development and the application of advanced marine management and regulation tools.
Funded by the German Federal Ministry for Economic Affairs and Energy (BMWI) (FKZ 0325921), a web-based information network for marine biological data is now under development at the German Federal Maritime and Hydrographic Agency (BSH) in cooperation with the FTZ of Kiel University and the Alfred-Wegener-Institute (AWI).
After completion the MARLIN network combines longterm, quality checked spatial biological data from environmental impact assessments (EIA) and monitoring of all German offshore windfarm and grid projects.
It includes species distribution maps, abundance and biomass information as well as measures of biodiversity over time and space.
Aggregated products will be published as web services for the public. Moreover, MARLIN offers intuitive selection tools for individual data selection or tailor made product generation workflows (use cases) and comfortable data download functionalities for authorized users.
Here, we present MARLIN as a powerful tool for management purposes in the context of assessing regulation issues such as the temporal and spatial variability of species diversity, abundance and biomass. We argue that large-scale/high-resolution information systems constitute a sound scientific base for improved monitoring assessments and ultimately for a sustainable ecosystem management.

Keywords: Fish, Seabirds, marine mammals, migratory birds, benthos, offshore renewables, information system, large-scale data, monitoring efficiency, marine management and regulation

Poster

Blue growth

The systematic meta-evaluation of ecosystem services and related valuation methods generated by selected Baltic Sea ecosystem species

Heckwolf Melanie[1], **Peterson Anneliis[2]**, Horne Paula[3], Jänes Holger[4], Karttunen Kaisa[5], Kotta Jonne[2], Künne Jana[1], Liversage Kiran[2], Mäkilä Kimmo[3], Orav-Kotta Helen[2], Reusch Thorsten B.H[1], Ruuskanen Olli-Pekka[3], Savikurki Anni[5], Sajeva Maurizio[3].

[1] GEOMAR Helmholtz Centre for Ocean Research Kiel. Email: mheckwolf@geomar.de
[2] Estonian Marine Institute, University of Tartu. Email: anneliis.peterson@ut.ee
[3] Pellervo Economic Research PTT. Email: maurizio.sajeva@ptt.fi
[4] School of Life and Environmental Sciences, Deakin University. Email: hjanes@deakin.edu.au
[5] Edistysmielisen tutkimuksen yhdistys ry (e2). Email: kaisa.karttunen@e2.fi

The concept of natural capital was developed to designate potential and actual benefits that humans are able to derive from ecological processes in the form of ecosystem services. Because of the widespread degradation of ecosystems and their associated services, international and Europe-wide sustainability policies have been established to regulate their use. Therefore, it has become crucial to understand the complex socio-ecological interactions associated to multiple human activities. To this aim, a systematic review has been developed to a) categorize all ecosystem services of the Baltic Sea provided by submerged vegetation, seagrass beds and mussel reefs, b) assess the validity of valorisation of those services, and c) assess their interactions and trade-offs. The study also reviewed existing non-monetary and monetary valuation methods of ecosystem goods and services and related impacts and assessed their ability to capture and explain their environmental, economic and social dimensions, including the positive and negative synergies with human well-being. Altogether 3089 papers addressed ecosystem services in the Baltic Sea. Only a small fraction of those provided information about existing monetary and non-monetary valuation methods. The study represents a robust analysis of current science-policy interaction and knowledge transfer on selected ecosystem services. Study outcomes identifies a huge knowledge gap in the quantification and mapping of the majority of ecosystem services as well as in the applicability of valuation methods. The review forms a critical knowledge base for successful implementation of the EU directive on maritime spatial planning and the EU 2020 Biodiversity Strategy.
Keywords: ecosystem services; Baltic Sea; literature review; valuation

Poster

Blue growth

Fuzzy Cognitive Modelling (FCM): a bottom-up stakeholder driven approach to help managing Protected Areas.

Christiaan Hummel[1], Jaap van der Meer[2] and Herman Hummel[1]

[1] Royal Netherlands Institute for Sea Research and Utrecht University, Yerseke, the Netherlands. Email: christiaan.hummel@nioz.nl
[2] Royal Netherlands Institute for Sea Research and Utrecht University, Texel, the Netherlands.

Ecosystem Services (ES) are the contributions of ecosystems to society. Societal Goods and Benefits (SG&B) can be obtained from these ES. Protected Areas (PA) are one of the most important tools in conservation science, maintaining species and habitat diversity, thereby forming refugia for natural functioning and sustainable preservation of associated ES. The spill-over effect of PA may enhance ES in the surrounding area. PA should be properly managed to enhance their protection and secure sustainable delivery of SG&B within and outside PA.

To be able to properly manage a PA, it is key that as many stakeholders as possible endorse the management of PA. With our poster, we will present a novel way of incorporating opinions of several stakeholders in the management of PA through Fuzzy Cognitive Modelling (FCM), as exemplified through a pilot in the Dutch Wadden Sea

FCM can be used for mapping and analysing human perception of a system. FCM can include the perception of various stakeholders regarding risks, functions or benefits in a PA together with knowledge from different sciences as biology, physics, socio-economics, towards an integrative view. Mapping these different perceptions is important to enhance the support for a PA and thereby the protection level. Also, FCM can be used for elucidating potential conflicts that may hinder the proper management of a PA, and identify (disciplinary or geographic) areas where future research could be focused, leading to a better management. Such better managed PA ultimately will enhance the sustainable delivery of important SG&B.

Key words: protected areas, stakeholder engagement, ecosystem services, fuzzy cognitive modelling

Poster

Blue growth

The biodiversity of 9 polychaete families from regions at risk from seabed mining in the abyssal central Pacific Ocean

Drennan. R[1], Wiklund. H[1,2], Neal. L[1], Rabone. M[1], Dahlgren. TG[2,3], Glover. A. [1]

[1] Natural History Museum London, Life Sciences Department, UK. Email: r.drennan@nhm.ac.uk
[2] University of Gothenburg, Department of Marine Sciences, Sweden.
[3] Norwegian Research Centre NORCE, Norway

Annelida comprise one of the most abundant and diverse faunal groups in abyssal soft-bottom ecosystems. Here we present the remarkable biodiversity of benthic annelids collected from the Clarion-Clipperton Zone (CCZ) in the abyssal central Pacific Ocean through an integrative taxonomy of 9 polychaete families with the description of many species new to science, utilising a combination of morphological and genetic data, including high-resolution specimen photography and molecular phylogenetic analyses.
Commercial interest in deep-sea mining has rapidly increased in recent decades, driven by the potential wealth of mineral resources found in these ecosystems. The CCZ, a region comparable in size to the continental USA, has been the subject of intense exploration as its seafloor is known to contain high densities of polymetallic nodules, potato-sized mineral accretions that sit on or at the sediment-water interface, rich in metals such as cobalt that comprise vital components of modern electronics, and which may be key to implementing wide-scale green technology in the future. Like much of the deep sea, the CCZ remains largely unexplored, though initial research suggests that it may be one of the most biodiverse sedimented marine habitats in the world. Documenting the biodiversity and ecology of the CCZ using high-quality taxonomic methods will be integral to understanding the environmental implications of potential seabed mining and implementing a sustainable “blue growth” approach. For example, we discuss the discovery of nodule-associated taxa, highlighting the importance of polymetallic nodules as microhabitats themselves – an important consideration for the conservation of CCZ biodiversity.

Key words: [Taxonomy, ABNJ, Blue Economy, New Species]

Poster

Blue Growth

Enhancing the environmental and economical sustainability of aquaculture through integration of sponges – an assessment of current knowledge

Thanos Dailianis[1] and Manolis Mandalakis[1]

[1] *Institute of Marine Biology, Biotechnology and Aquaculture; Hellenic Centre for Marine Research; Heraklion Crete, Greece* Email: thanosd@hcmr.gr

While aquaculture is outpacing food production from capture fisheries and expected to play a major role in future economies, it exerts pressure to adjacent marine habitats mainly via the release of organic load and other substances. Among bioremediation candidates to mitigate organic pollution, sponges appear prominent due to specific traits including: (a) water filtration at a high ratio relative to their body volume, (b) retention efficiency of minute organic particles, including nano- and picoplankton, (c) capacity to feed on dissolved organic matter. Rearing of sponges in adjacence to fish farms has been proposed, based on their sessile nature, regeneration capacity and extended lifespan, but has not yet been implemented at the operational level. Notably, this can induce added value through the economic interest of the sponges themselves, since Porifera is the most prominent marine phylum in terms of production of bioactive substances with pharmaceutical or industrial potential. Hence, integration of sponges in aquaculture emerges as a promising outlook, expected to support sustainable bioremediation through profitability and thus satisfy the global demand for blue growth in the following years. Herein, we review existing knowledge regarding the suitability of sponge taxa for integration, with particular focus on: (a) performance in cultivation, (b) retention and bioaccumulation capacity, and (c) bioproduction potential. An evaluation of the so far investigated candidates and their potential is performed, alongside with the identification of knowledge gaps and future challenges towards the establishment of integrated aquaculture of sponges for bioproduction and environmental remediation.

Key words: bioremediation, pollution, mariculture, Porifera

Poster

Blue growth

Project RecBio – Contribution to the management and conservation of the biological resources of the Portuguese Northwest coast

S. Costa-Dias[1], C. Mendes[1], C. Teixeira[1], A. Afonso[1] and A.A. Bordalo[1]

[1] ICBAS – UP, Institute of Biomedical Sciences - University of Porto, Rua Jorge Viterbo Ferreira 228, 4050-313 Porto, Portugal. Email: scdias@icbas.up.pt

Within the European Union, standards and directives are produced at the Community level, and member states are responsible for transposing them into the national legal criteria. However, the motivation and scientific support at the origin of decision making is not always accessible to the end user. Indeed, in the case of the fisheries policy, local knowledge and observations, or the contributions of the fishermen themselves, hardly reach the decision maker.
Having in mind the present situation, the main objective of the current project is to contribute to a better management and conservation of the marine biological resources of the coastal zone of Northern Portugal, particularly between the Minho and Lima rivers, where small-scale fisheries have major economic and social importance, in strict compliance with the European legal framework.
The specific objectives include the identification of interests and needs, definition of priority areas and most relevant species, identification of current fishing gears and the eventual replacement by low impact gears, and professional training on fisheries ecology and resources management, particularly adapted to the environment were the activities are carried out.
Finally, the compilation of existing data and the acquisition of new knowledge on the biological resources of this coastal zone, will allow an analysis of the trends of relevant species, leading to a better management, always in touch with the fisheries community, through a dedicated participatory and integrative approach.

Acknowledgments: Operation MAR-01.04.02-FEAMP-0025, co-founded by the European Maritime and Fisheries Fund (EMFF), through the Operational Program MAR2020.

Key words: fisheries, management, biological resources

Poster

Blue growth

The prebiotic potential of *Ascophylum nodosum* extracts is influenced by the extraction methodology used

Brigkita Venardou[1], Mary J. McDonnell[2], Marco Garcia-Vaquero[1], Gaurav Rajauria[2], John V. O'Doherty[2,3], Torres Sweeney[1,3]

[1]School of Veterinary Medicine, University College Dublin, Ireland Affiliation address 1. Email: brigkita.venardou@ucdconnect.ie
[2]School of Agriculture and Food Science, University College Dublin, Ireland.
[3]Beacon Bioeconomy Centre, University College Dublin, Belfield, Dublin 4.

Seaweed-derived bioactive compounds exhibit various beneficial activities in humans and animals. A factor influencing their concentrations, and subsequent bioactivity, is the extraction method. Our aim was to evaluate the *in vitro* prebiotic potential of three differently-extracted *Ascophyllum nodosum* samples. The samples were produced using either solid-liquid extraction with water (AN-W), or ethanol (AN-EtOH) as solvent or high pressure-assisted extraction with water as solvent (AN-HPW). All extracts were two-fold diluted from 2 mg/ml to 0.25 mg/ml. *Lactobacillus plantarum* (LP), *L. reuteri* (LR) and *Bifidobacterium thermophilum* (BT) were used at 10^6-10^7 colony-forming unit(CFU)/ml. Each concentration of each extract and controls (0 mg/ml) were incubated for 18 h at 37 °C aerobically or anaerobically (BT). Final bacterial concentrations were determined by spread plating. All experiments were carried out in triplicate with technical replicates. All data were logarithmically transformed and analysed using PROC GLM (SAS 9.4). AN-HPW increased BT (≤0.9 LogCFU/ml, $P<0.05$) at all concentrations and LR and LP (0.2 LogCFU/ml, $P<0.05$) at 2 mg/ml and 1mg/ml, respectively. AN-W increased BT (≤0.6 LogCFU/ml, $P<0.05$) at 1-2mg/ml, but decreased both lactobacilli; LP ≤0.7 LogCFU/ml and LR ≤5.4 LogCFU/ml at all concentrations ($P<0.05$). AN-EtOH increased LP (≤0.7 LogCFU/ml, $P<0.05$), but reduced LR (≤5.7 LogCFU/ml, $P<0.05$) at all concentrations and BT (≤4 LogCFU/ml, $P<0.05$) at 1-2 mg/ml. In conclusion, *A. nodosum* extracts displayed different prebiotic activities *in vitro* depending on the extraction method used with AN-HPW being the most promising.

Key words: *Ascophyllum nodosum*, prebiotic, extraction

Poster

Blue growth

The *in vitro* effects of *Laminaria digitata* and *Ascophyllum nodosum* extracts on selected intestinal commensals and pathogens of weaned piglets

Brigkita Venardou[1], Mary J. McDonnell[2], Marco Garcia-Vaquero[1], Gaurav Rajauria[2], John V. O'Doherty[2,3], Torres Sweeney[1,3]

[1]School of Veterinary Medicine, University College Dublin, Ireland Affiliation address 1. Email: brigkita.venardou@ucdconnect.ie
[2]School of Agriculture and Food Science, University College Dublin, Ireland.
[3]Beacon Bioeconomy Centre, University College Dublin, Belfield, Dublin 4.

While the inclusion of certain seaweed extracts in weaner piglet diets leads to a beneficial gut microbial profile, the mode of action is not known. The aim of this study was to evaluate the prebiotic and antimicrobial potential of *Laminaria digitata* and *Ascophylum nodosum* extracts *in vitro*. Both extracts were two-fold diluted from 2 mg/ml to 0.25 mg/ml. The following strains were used at 10^6-10^7 colony-forming unit (CFU)/ml concentrations: *Lactobacillus plantarum*, *L. reuteri*, *Bifidobacterium thermophilum*, Enterotoxigenic *Escherichia coli* O149 and *Salmonella enterica* ser Typhimurium PT12. Each concentration of each extract and controls (0 mg/ml) were incubated for 18 h at 37 °C aerobically or anaerobically (*B. thermophilum*). Final bacterial concentrations were determined by spread plating. All experiments were carried out with technical replicates on three independent occasions. All data were logarithmically transformed and analysed using the PROC GLM (SAS 9.4). The *L. digitata* extract increased *B. thermophilum* 0.7 LogCFU/ml at 0.25 mg/ml ($P<0.05$) and ≥1 LogCFU/ml from 0.5-2 mg/ml ($P<0.05$), with no effect on lactobacilli. The *A. nodosum* extract increased *B. thermophilum* up to 0.9 LogCFU/ml at all concentrations tested ($P<0.05$). Additionally, a 0.2 LogCFU/ml increase of *L. reuteri* and *L. plantarum* was observed at 2 mg/ml ($P<0.05$) and 1mg/ml ($P<0.05$), respectively. Both extracts displayed no antimicrobial activity against ETEC or *S.* Typhimurium. In conclusion, both extracts exhibited bifidogenic activity in vitro, with an additional slight increase of *Lactobacillus spp.* for *A. nodosum*, indicating a prebiotic potential.

Key words: *Laminaria digitata*, *Ascophyllum nodosum*, prebiotic

Poster

Blue growth

A seaweed derived laminarin extract enhances growth and intestinal health in post-weaned pigs

Ruth Rattigan[1], Torres Sweeney[2,3], Shane Maher[1], Kevin Thornton[2], Gaurav Rajauria[1], John V. O'Doherty[1,3]

[1] School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, Ireland
Email: ruth.rattigan@ucdconnect.ie
[2] School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland

[3]Beacon Bioeconomy Centre, University College Dublin, Belfield, Dublin 4.

Interest in seaweed derived laminarin as an alternative to in-feed medications for weaned pigs has intensified due to its potential growth enhancing and anti-microbial effects. This study examined the effects of increasing the dietary inclusion level of laminarin from a 65% purified extract on pig growth and intestinal health post-weaning (PW). 96 weaned pigs (8.4 (SD 1.09) kg) were blocked by live weight, litter and sex and randomly assigned to: 1) basal diet; 2) basal + 100ppm laminarin; 3) basal + 200ppm laminarin; 4) basal + 300ppm laminarin (3 pigs/pen). On day 15 PW, 8 pigs from the basal group and the 300ppm laminarin group were euthanised for sample collection. Intestinal tissue was collected to examine morphology and measure the expression of genes involved in nutrient transport, while caecal and colonic digesta was collected for the enumeration of selected microbiota using QPCR. The 300ppm laminarin group had higher feed intake than all other groups ($P<0.001$) and higher daily gains than the basal group ($P<0.05$). Laminarin supplementation increased villus height in the duodenum and jejunum ($P<0.05$) and increased the expression of various nutrient transporters - *SLC2A8/GLUT8* (duodenum), *SLC2A2/GLUT2*, *SLC2A7/GLUT7*, *SLC15A1/PEPT1* and *FABP2* (jejunum), and *SLC16A1/MCT1* (colon). Laminarin supplementation reduced *Enterobacteriaceae* numbers in the caecum ($P<0.05$), and increased lactobacilli numbers ($P<0.05$), total volatile fatty acid concentrations and the molar proportions of butyrate ($P<0.01$) in the colon. In conclusion, 300ppm laminarin from a 65% purified laminarin extract has potential, as a dietary supplement, to improve performance and intestinal health in the post-weaned pig.

Key words: Laminarin, post-weaning, intestinal health, growth performance

Poster

Blue growth

Effect of increasing dietary inclusion level of a seaweed derived fucoidan extract on the growth and intestinal health of pigs post-weaning

Ruth Rattigan [1], Torres Sweeney [2,3], Stafford Vigors[1], Shane Maher[1], Kevin Thornton[2], Gaurav Rajauria[1] and John V O'Doherty[1,3]
[1] School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, Ireland
ruth.rattigan@ucdconnect.ie
[2]School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland
[3]Beacon Bioeconomy Centre, University College Dublin, Belfield, Dublin 4.

The detection of antimicrobial and immunomodulatory activities of fucoidan aroused interest in its use for the promotion of growth and intestinal health of pigs in the turbulent post-weaning (PW) period. This study examined the effects of increasing the dietary inclusion level of fucoidan from a 44% purified extract, on PW growth and intestinal health. 72 weaned pigs ((8.4 (SD 1.06) kg) were blocked by live weight, litter and sex and randomly assigned to: (T1) basal diet; (T2) basal diet + 125 ppm fucoidan; (T3) basal diet + 250 ppm fucoidan (3 pigs/pen). On d15 PW, 8 pigs from the basal and 250ppm fucoidan groups were sacrificed for sample collection. Intestinal tissue was collected for gene expression analysis and caecal and colonic digesta was collected to analyse the microbiota using 16s rRNA gene sequencing. The 250ppm fucoidan group had reduced diarrhoea scores from d0-14 ($P<0.05$), but daily gains and feed intake did not differ from the basal group. Fucoidan supplementation reduced the expression of *CLDN5* in the duodenum, *SCL5A1/SGLT1* and *SI* in the jejunum, and *FABP2* and *SLC5A1* in the ileum ($P<0.05$). Fucoidan supplementation reduced the relative abundance of Turicibacter and increased Helicobacter in the caecum, and increased VFA concentrations ($P<0.05$) and the expression of *SLC16A1/MCT1* in the colon ($P<0.05$). In conclusion, fucoidan is not suitable as a dietary supplement for pigs, due to its lack of growth promoting activities and negative effects on the expression of nutrient transporters and digestive enzymes in the small intestine.

Key words: fucoidan, post-weaned pigs, intestinal health, microbiota

Poster

Blue growth

Title: Investigation of the cytotoxicity of Irish brown seaweed extracts

Fiona McCartney[1], Marco Vaquero-Garcia [2], Gaurav Rajauria[1], John V O'Doherty[1,3] and Torres Sweeney[2,3]
[1] School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, Ireland
Email: Fiona.mccartney@ucd.ie
[2] School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland
[3]Beacon Bioeconomy Centre, University College Dublin, Belfield, Dublin 4.

The aim of this study was to investigate the cytotoxicity of three brown seaweeds, *Ascophylum nodosum*, *Laminaria digitata* and *Laminaria hyperborea* using the human intestinal cell line, Caco-2. Seaweeds are believed to contain bioactive compounds, such as fucoidan and laminarin, that are beneficial to animal and human health. They also contain defensive molecules such as mannitol and alginates that are of concern. When developing extraction methodologies to purify beneficial compounds, it is imperative to assess the cytotoxicity of the resultant extracts. Extracts of *A. nodosum*, *L. digitata* and *L. hyperborea* were prepared using high pressure assisted extraction. Parameters such as time, temperature and the seaweed to solvent ratio were varied to produce samples A1-A4 for each seaweed. Cytotoxicity was determined using the MTS cell viability assay. Caco-2 cells were seeded at a density of 2×10^4 cells/well in 96-well plates for 24h. Cells were then exposed to a range of concentrations (0.01-5mg/ml) of the extracts for 24h. Triton™ X-100 (0.1% v/v) was used as a positive control. Optical density was measured at 490 nm. The cytotoxicity of the extracts varied between extraction methods. All seaweeds were non-cytotoxic at concentrations below 1mg/ml. Extracts from *L. digitata* and *hyperborea* were non-cytotoxic when extracted using the A1 method. Seaweeds extracted using the A3 method were cytotoxic at 5mg/ml. *L. digitata* (A2 and A4 extract) and *A. nodusum* (A4 extract) significantly decreased cell viability from 2.5mg/ml. Using cytotoxicity as an indicator, we identified the optimal parameters for extraction of each individual seaweed.

Key words: seaweed, cytotoxicity, Caco-2 cells.
Funded by Science Foundation Ireland under project entitled: The Macroalgal Fibre Initiative: 'natural molecules naturally' (14/1A/2548).

Poster

Blue Growth

The effect of feeding the seaweed extract laminarin on pig performance and the intestinal microbiome in the post-weaning period

Stafford Vigors[1], John V O'Doherty[1,3], Mary J McDonnell[1], **Ruth Rattigan[1]**, and Torres Sweeney[2,3]

[1]UCD School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4.
[2]UCD School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4.
[3]Beacon Bioeconomy Centre, University College Dublin, Belfield, Dublin 4.

Ruth Rattigan: ruth.rattigan@ucdconnect.ie
Keywords: gut microbiome, weaning, pigs, seaweed, laminarin

Marine macroalgal derivatives such as laminarin have been considered as potential bioactive compounds in swine nutrition to improve post-weaning pig performance. However, a comprehensive understanding of the impact of these extracts on the intestinal microbiome and its subsequent influence on performance is not well characterized. Therefore, the objective of this study was to evaluate the effects of supplementing the diet of newly weaned pigs with laminarin, on animal performance and the intestinal microbiota using 16S rRNA gene sequencing. At 28 days of age, newly weaned pigs (n=54) were assigned to one of two dietary groups: 1) basal diet and 2) basal diet + 300 ppm laminarin for a 14-day period. On day 15, nine pigs per treatment (one from each pen) were humanely euthanized and high-throughput sequencing of the V3-V4 hypervariable region of the bacterial 16S rRNA gene was performed on the Illumina MiSeq. Pigs fed the laminarin-supplemented diet had increased average daily feed intake, growth rate and body weight compared to pigs fed the control diet ($P<0.05$). Pigs fed the laminarin supplemented diet had reduced abundances of *Enterobacteriaceae* ($P<0.05$) compared to pigs fed the control diet. In contrast, the beneficial *Prevotellaceae* were positively correlated with ADFI, ADG, total VFA, acetic, propionic, butyric and negatively correlated with isovaleric acid. Hence, supplementation with laminarin may accelerate the adoption of pigs to a post-weaning diet by promoting the proliferation of bacterial species that favourably enhance nutrient digestion and reduce the load of pathogenic bacteria impacting pig performance.

Poster

Chosen theme: Blue growth

EBB – The European Blue Biobank

M. V. **Marra**[1], O. P. Thomas[2] and G. P. McCormack[1]

[1] Molecular Evolution and Systematics Laboratory, Zoology Department, Martin Ryan Institute, National University of Ireland Galway, Galway, Ireland. Email: mariavittoria.marra@nuigalway.ie
[2] Marine Biodiscovery, School of Chemistry, National University of Ireland Galway, Galway, Ireland

Biobanks contribute to conservation of marine diversity by complementing traditional in-situ conservation techniques with ex-situ methods that are safe and reproducible for short, medium, and long-term storage of biological specimens. EBB project aims to establish the European Blue Biobank, a world class centrally curated marine biobank operated by the European Marine Biological Resource Centre (EMBRC-ERIC) with the idea to support Marine Biological and Ecological Research, Development and innovation by facilitating access to Marine Biological Resources. The EBB will set the standard for harmonized operation of its distributed marine biobanking facilities by **d**eveloping new technological tools and common procedures for the ex-situ maintenance of diverse groups of Marine Biological Resources, and harmonizing the transregional application of the regulations on access to genetic resources and sharing the benefits of their use (i.e. ABS regulations).
The project partnership, primarily located in the Atlantic Area, is formed by a multidisciplinary team that comprises some of the world´s most important marine biobanks located in Norway, Ireland, United Kingdom, France, Spain and Portugal along with four clusters of marine biotechnology, six companies active in the field of marine biotechnology, and the relevant government departments in Spain, Portugal and the U.K. responsible for access to genetic resources – the ABS Competent National Authorities (CNAs). In this manner, the project brings together providers (biobanks), end-users (researchers from industry, clusters and academia), and CNAs to work together to promote consensual national implementation of ABS regulations. The Ryan Institute and Carna Research Station are the Irish academic partners of EBB.

Key words: European Blue Biobank, European Marine Biological Resource Centre, marine conservation, blue biotechnology, ABS regulations.

General session

Talk

General Session

Recent changes in subtidal macroalgae distribution in N Spain (Gulf of Biscay)

X. **Guinda**[1], E. Ramos[1], C.F. de la Hoz[1], A. Puente[1] and J.A. Juanes[1]

[1] Environmental Hydraulics Institute, Universidad de Cantabria - Avda. Isabel Torres, 15, Parque Científico y Tecnológico de Cantabria, 39011, Santander, Spain
1. Email: xabier.guinda@unican.es

The N and NW coast of the Iberian Peninsula (Bay of Biscay) is an interesting area to carry out studies on significant changes in the distribution of habitat-forming seaweeds in a relative short period of time. Along this regional sea, both intertidal and subtidal canopy forming macrophytes have been documented as suffering significant retreats in the last two decades, possibly related to climate change effects. A great concern arises regarding the new distribution patterns in macroalgae communities and the role of emerging invasive species.

Looking for responses on the effect of different environmental factors, specific surveys were implemented to characterize the actual distribution of subtidal macroalgae along the coasts of Cantabria, following a sampling protocol previously applied thirteen years ago. The present work shows the changes observed, between 2005 and 2018, in macroalgae communities of this coastal region and relates them to changing environmental conditions. The results obtained show the practical disappearance of extensive populations of kelps and changes in the surface covered by other representative macroalgae, relating them to changes in met-ocean conditions in the last decades. As a preliminary consequence, available substrates released by these species have been substantially colonized by fast-growing ephemeral species, and even by invasive species such as *Asparagopsis armata*, which have led to an impoverishment of the ecological value of these marine habitats. Based on those results, different management scenarios are discussed.

Key words: macroalgae, species distribution, subtidal, temporal shifts.

Talk

General Session

Seahorse Hotels: use of artificial habitats to support recovery of the endangered White's seahorse

Michael Simpson[1], Rebecca L. Morris[2], David Harasti[3], Ross A. Coleman[1]
[1] University of Sydney, Coastal and Marine Ecosystems, School of Life and Environmental Sciences, NSW 2006, Australia, Email michael.simpson@sydney.edu.au; [2]National Centre for Coasts and Climate, School of Biosciences, The University of Melbourne VIC 3010, Australia; [3]Fisheries Research, NSW - Department of Primary Industries NSW 2315, Australia

Increased urbanisation, and the associated loss of natural habitats, has led to significant declines in many marine species with numerous species now considered threatened. One such species is the White's seahorse *Hippocampus whitei*, which is often observed inhabiting artificial structures such as protective swimming nets in Sydney Harbour. Specially designed artificial habitats, or modifications to existing artificial structures, have long been implemented as a conservation tool for many species.
Three designs of artificial habitat (Seahorse Hotels) were installed at two sites in Nelson Bay, New South Wales. Regular surveys for seahorses were conducted at these sites, including marking of individuals for population analysis, in order to explore whether such structures would be able to sustain a population of seahorses in an area where natural habitat had significantly declined. Differences in seahorse abundance (including epifauna prey numbers and epibiotic growth) across the three hotel designs were measured in order to explore whether additional habitat would increase success in attracting seahorses.
The seahorse hotels sustained an estimated population of 63.918 seahorses (95% confidence limits 56.789 and 71.942) from November 2017 to November 2018. There were no significant differences in seahorse abundance between the three hotel designs, and no significant differences in epifauna or epibiotic growth between designs. These results indicate that additional complexity in these artificial structures is not necessary to sustain seahorse populations. This is important, as one of the focuses of species conservation work is determining cheap and accessible methods for helping recover threatened species worldwide.

Key Words: Conservation, Urbanised Habitats, Syngnathidae

Talk

General Session

Copepod manipulation of oil droplet size distribution

Marco Uttieri[1,2], Ai Nihongi[3], Peter Hinow[4], Jeffrey Motschman[5], Houshuo Jiang[6], Miquel Alcaraz[7] and J. Rudi Strickler[3]

[1] Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, Villa Comunale, 80121, Naples, Italy. Email: marco.uttieri@szn.it
[2] CoNISMa (National Interuniversity Consortium for Marine Sciences), Piazzale Flaminio 9, 00196, Rome, Italy.
[3] School of Freshwater Sciences, University of Wisconsin-Milwaukee, Milwaukee, WI, 53204, USA.
[4] Department of Mathematical Sciences, University of Wisconsin - Milwaukee, Milwaukee, WI, 53201, USA.
[5] Department of Mechanical Engineering and Materials Science, Duke University, Durham, NC, 27708, USA.
[6] Applied Ocean Physics and Engineering Department, Woods Hole Oceanographic Institution, Woods Hole, MA, 02543, USA.
[7] Institut de Ciències del Mar (CSIC), Passeig Marítim de la Barceloneta 37–49, 08015, Barcelona, Catalonia, Spain

Key words: [enter up to 4 key words]

Oil spills are one of the most dangerous sources of pollution in aquatic ecosystems. Owing to their pivotal position in the food web, pelagic copepods can provide crucial intermediary transferring oil between trophic levels. In this study we show that the calanoid *Paracartia grani* can actively modify the size-spectrum of oil droplets. Direct manipulation through the movement of the feeding appendages and egestion work in concert, splitting larger droplets (Ø = 16 µm) into smaller ones (Ø = 4–8 µm). The copepod-driven change in droplet size distribution can increase the availability of oil droplets to organisms feeding on smaller particles, sustaining the transfer of petrochemical compounds among different compartments. These results raise the curtain on complex small-scale interactions which can promote the understanding of oil spills fate in aquatic ecosystems.

Talk

General session

Population connectivity of stalked barnacles *Pollicipes pollicipes*

Marina Parrondo[1*], Marieke E. **Feis**[2*], Marion Ballenghien[2], Juliette Chiss[2], Joana Nascimento Fernandes[3], Paloma Morán[4], Christophe Lejeusne[5], Sidi Yahya Cheikhna Lemrabott[6,7], Eric Thiebaut[2], Didier Jollivet[2] and Yaisel J. Borrell[1]

[1] Department of Functional Biology, University of Oviedo, Oviedo 33006, Spain
[2] Sorbonne Université, CNRS, Station Biologique de Roscoff, Laboratoire Adaptation et Diversité en Milieu Marin, UMR 7144, CS90074, 29688 Roscoff Cedex, France. Email: marieke.feis@sb-roscoff.fr
[3] MARE – Marine and Environmental and Sciences Centre, Laboratório de Ciências do Mar, Universidade de Évora, Apartado 190, 7521-903 Sines, Portugal
[4] Departamento de Bioquímica, Genética e Inmunología, Universidad de Vigo, Ciudad universitaria de Vigo, Campus Universitario Lagoas-Marcosende s/n, 36310 Vigo, Pontevedra, Spain
[5] UMR 7263 – IMBE, Institut Méditerranéen de la Biodiversité et d'Ecologie Marine et Continentale, Aix-Marseille Université, Station Marine d'Endoume, Rue de la Batterie des Lions, 13007 Marseille, France
[6] l'Institut Mauritanien de Recherches Océanographiques et de Pêches, B.P. 22, Nouadhibou, Mauritania
[7] Conservation Ecology Group, Groningen Institute for evolutionary life science, University of Groningen, Nijenborgh 7, 9747 AG Groningen, The Netherlands
* These authors contributed equally to this study and therefore share first-authorship

Stalked barnacles *Pollicipes pollicipes* live on exposed rocky shores from Dakar in Senegal to Brittany in France. They are heavily exploited for human consumption in some parts of their range and their market value in Spain and Portugal can be over 200 Euro/kg. Because of past overexploitation, stock management was put into place with different local strategies in Portugal, Spain and France. To support fisheries management decisions towards a sustainable harvest of stalked barnacle stocks on regional scales, understanding regional as well as broad scale connectivity between stocks, and the role of larval dispersal in this process is a central issue. During the last decades, different tools have been developed to estimate large scale connectivity in marine organisms including biophysical modelling and genetic studies. In this context, we present the first results on population connectivity between stalked barnacle populations at the scale of the NE Atlantic through molecular analyses. Stalked barnacles were collected all across its distribution range up to the northern range edge; in total 25 locations in Mauritania, Morocco, Portugal, Spain and France were sampled. Population genetic structure was analysed with 20 microsatellite markers. Multivariate analyses were performed to determine spatial patterns of genetic diversity and to assess population structure. Results will be discussed in relation to the hydrodynamics at regional scales and the improvement of the spatial management of stalked barnacle stocks.

Key words: connectivity, larval dispersal, population genetics, phylogeography

Talk

General session

Strong inter-annual and seasonal patterns revealed by a 10 year time-series of benthic community data at Station L4, a Western Channel Observatory site

Joana Nunes[1], Amanda Beesley[1], Sarah Dashfield[1], Caroline L. McNeill[1], Thomas Mesher[1], Christine Pascoe[1], Ana Queirós[1], Paul Somerfield[1], Liz Talbot[1] and Steve Widdicombe[1]

[1] Plymouth Marine Laboratory, Prospect Place, Plymouth, PL1 3DH, UK 1. Email: jonu@pml.ac.uk

The Western Channel Observatory (WCO) is one of the most comprehensively sampled benthic-pelagic observatories worldwide. Regular oceanographic and pelagic sampling at the WCO has been carried out since 1988, and these data have been invaluable for satellite data validation and ecosystem model development. One of WCO's main stations, L4, is a representative coastal station, 5 nautical miles off the coast of Plymouth, with a water depth of 50m, a muddy sand seabed and experiences thermally induced seasonal stratification every year. Since 2008, L4 has been sampled every month for a range of benthic fauna (megafauna, macrofauna, meiofauna, benthic microbes) and seabed characteristics (sediment grain size, organic content). In addition to these samples, L4 provides weekly data on pelagic environmental conditions (temperature, nutrients, oxygen, carbonate chemistry) and pelagic biology (phytoplankton and zooplankton abundance and biomass, primary production and pelagic pigments).

Analysis of the benthic faunal datasets reveals strong inter-annual and seasonal patterns in community abundance, biomass, biodiversity and ecosystem function across the 10 years of sampling. Different elements of the fauna are shown to exhibit seasonal patterns based upon body size and functional traits. Here we present these patterns and explore the relationship between faunal variability and key biological environmental drivers.

Key words: [benthic communities, biodiversity, ecosystem function, time-series]

Talk

General Session

Museum collections as a chronicle for long-term monitoring: a case of benthic gastropods from the Kola Meridian transect (Barents Sea)

Ivan O. Nekhaev[1], Alexey V. Merkuliev[2]

[1] Saint Petersburg State University, Universitetskaya Emb. 7-9, 199034, Saint Petersburg, Russia. Email: inekhaev@gmail.com
[2] Zoological Institute of Russian Academy of Sciences, Universitetskaya Emb. 1, 199034, Saint Petersburg, Russia.

Consequences of global change cannot be reliably estimated without long term monitoring programs. Kola Meridian, a transect along the 33°30’E in the Barents Sea is the oldest monitoring area in the Arctic. Regular (usually annual) oceanological and hydrobiological investigations along the transect has been carried out since 1899 up to present. However, materials stored in the museum collections remains the main source of the faunistic information obtained during the period observation, while only minor part of data was published. We re-examined (using optical microscopy and SEM) all samples of shell-bearing gastropods from the Kola Meridian stored in Zoological Institute of RAS and Saint Petersburg State University (SPBU). We found only 151 museum lots from 65 samples, which constitute a very small portion of total material collected along the transect. About one-third of them (54 lots) were misidentified or consist of individuals which cannot be identified to species level. Majority of studied samples (40) was collected during the period 1899-1920. Species composition revealed by museum materials substantially differs from published check-lists and recent results. Hence, extant collections do not provide a reliable baseline for the Kola Meridian. We propose that the storage of zoological material in public collections should be an essential part of the long-term monitoring programs.
The study was supported by the Russian Scientific Foundation (grant No 18-74-00010). Work with the SEM was performed at the Interdisciplinary Center for Nanotechnology of SPBU in the course of the project by the Grant Council of the President of Russia No MK-4797.2018.4.

Key words: Arctic, climate change, monitoring, Gastropoda

Talk

General session

Developing monitoring approaches for Marine Protected Areas: insights from the Croker Carbonate Slabs Special Area of Conservation.

Tammy Noble-James[1,2], Alan Judd[3], Markus Diesing[4], David Clare[1], Andrew Eggett[2], Briony Silburn[1] & Graeme Duncan[2]

[1] Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, UK. Email: tammy.noble-james@cefas.co.uk

[2] Joint Nature Conservation Committee, Peterborough, UK.

[3] The Alan Judd Partnership, UK.

[4] Norges Geologiske Undersøkelse, Trondheim, Norway.

The UK has an obligation to monitor the status of the marine environment, in accordance with a number of international and domestic policies. A key tool for meeting these obligations is the implementation and monitoring of a network of Marine Protected Areas (MPAs) within UK waters. The UK MPA monitoring programme provides evidence against which the condition of designated features may be assessed, both at the feature and MPA scales. In this presentation we discuss the development of MPA-specific approaches to monitoring and indicators of feature condition, focusing on a study conducted at the Croker Carbonate Slabs (CCS) Special Area of Conservation (SAC)

The CCS SAC is designated for 'Submarine structures made by leaking gases', otherwise known as methane-derived authigenic carbonates (MDAC). MDAC structures perform important functions, including formation of reef-like habitats on soft seabed, sequestration of greenhouse gases, and primary production by chemosynthetic communities. Twenty-seven European MPAs have been designated for MDAC, however they are poorly studied from a conservation perspective. Effective management of MDAC in the UK requires assessment of 'feature attributes' (as defined by Statutory Nature Conservation Bodies). The CCS study represents the first UK effort to monitor feature attributes of MDAC using a comprehensive multidisciplinary approach, combining geophysical, geological, mineralogical, petrographical, chemical, ecological and taxonomic disciplines. Here we present the results and provide recommendations for monitoring of MDAC (and similar habitats) to maximise cost-effectiveness, whilst optimising scientific robustness.

Talk

General session

Blue mussel (*M. edulis*): Carbon stores to be prioritised in Marine Protected Areas?

Hannah **Lee**[abc], William Sanderson[ac] and Karen Diele[bc]
Corresponding author: hzl1@hw.ac.uk

[a]Centre for Marine Biodiversity and Biotechnology (CMBB), ILES, EGIS, Heriot-Watt University, Edinburgh, Scotland, UK. EH14 4AS
[b]Edinburgh Napier University, Edinburgh, Scotland, UK. EH14 1DJ
[c]St Abbs Marine Station, Harbour, Eyemouth. TD14 5PW

Since 2009 research focusing on marine ecosystems as carbon stores has been gaining traction, where historically work has focused on terrestrial stores[1]. Within this 'blue carbon' research, there has been a disproportionate bias towards photosynthetic marine ecosystems[2,3]. A three-tiered ecosystem review of potential blue carbon stores in the Scottish marine environment highlighted bivalve beds as significant stocks of biogenic carbonate, in the form of shell accumulation[4]. However, no account has been made that includes bed-associated mud deposits[2,4,5]. As bivalve restoration projects gain momentum[6], improving the understanding of the potential service provision by these habitats, in terms of carbon storage and water quality management, is vital for advising marine management[3]. In this study, the first full carbon stock assessment was undertaken for a blue mussel bed in the Dornoch Firth Special Area of Conservation. The use of the 'Loss on Ignition' method and CHN analysis are compared and the carbon stock assessment is discussed within the context of the better studied photosynthetic marine ecosystems and the management of Marine Protected Areas.

Key words: Blue carbon, *Mytilus edulis*, Scotland, Stock assessment

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Talk

General session

Management of Invasive Species in Marine Protected Areas: The case of lionfish in eastern Mediterranean

Periklis Kleitou[1], Jason M. Hall-spencer[1], Demetris Kletou[2], Charalampos Antoniou[2], Niki Chartosia[4], Louis Hadjioannou[3], Ioannis Savva[2], Carlos Jimenez[3], Andreas C. Dimitriou4, Antonis Petrou[3], Spyros Sfenthourakis[4], Maria Christou[2], Vasilis Andreou[3] and Sian Rees[1]

[1] School of Biological and Marine Sciences, University of Plymouth PL4 8AA, Plymouth, United Kingdom. Periklis.kleitou@plymouth.ac.uk

[2] Marine & Environmental Research (MER) Lab Ltd, 202 Amathountos Avenue, Marina Gardens, Block B, Offices 13-14, Limassol 4533, Cyprus.

[3] Enalia Physis Environmental Research Centre, Acropoleos 2, Aglantzia, 2101, Nicosia, Cyprus.

[4] Department of Biological Sciences University of Cyprus P.O. Box 20537, 1678 Nicosia

The establishment of Marine Protected Areas (MPAs) and restrictions on fishing have been advocated as ways to mitigate local pressures, related to coastal development and fishing. However, the rapidly increasing number of invasive species entering the Mediterranean pose a real threat and an increasing regional pressure to the resilience of the ecosystems. It has been recently shown that some Mediterranean MPAs host higher biomass of non-indigenous fish compared to adjacent unprotected area. Given the difficulties in preventing introductions, mainly through the Suez Canal, management options fall under control and eradication. Targeted removal of invasive species have been suggested as a promising measure to control their spread in MPAs. To this end, we coordinated small removals of the recent Lessepsian immigrant lionfish *Pterois miles* (Bennett, 1828), in highly infected MPAs at the eastern Mediterranean. Preliminary results indicate that seabed habitat features are a major factor influencing lionfish following removals. Furthermore, we will organise a derby to demonstrate the ability of divers to reduce lionfish populations. Social and ecological impact of the derby will be monitored while market potential of caught lionfish will be investigated. Insights on management of invasive species including monitoring and removing invasive species, as well as motivation factors of citizen-divers in participating in removal events will be discussed.
This work is supported by the LIFE financial instrument of the European Union – RELIONMED project [Grant Agreement LIFE16 NAT/CY/000832].

Key words: Lionfish; Invasive Species; Marine Protected Areas; Citizen-science;

Talk

General session

Behavioural traits, feeding ecology and native prey naiveté, will Mediterranean lionfish invaders be as successful as their western Atlantic counterpart?

Daniele D'Agostino[1], Carlos Jimenez[2], Tom Reader[1], Luois Hadjioannou[2], Marios Josephides[3] and David Feary[4]

[1]School of Life Sciences, University of Nottingham, Nottingham, NG7 2RD, United Kingdom
[2]Enalia Physis Environmental Research Centre, Acropoleos 2, Aglantzia 2101, Nicosia, Cyprus
[3]Marine Environment Division, Department of Fisheries and Marine Research, Ministry of Agriculture, Rural Development and Environment, 1416, Cyprus
[4]MRAG Ltd, 18 Queen Street, London, W1J 5PN, United Kingdom

The invasion of *Pterois sp*. and consequent detrimental effect on native fish populations in the western Atlantic Ocean has spurred concerns for the fish biodiversity of the Mediterranean Sea, where a lionfish invasion from the Red Sea (i.e. Lessepsian invasion) has recently begun. Here, we sought to compare the key traits that have contributed to the invasive success of lionfish in the Atlantic with the Mediterranean invaders – lionfish predatory behaviour, feeding ecology and the prey naiveté of native fish species.

Our finding suggests that, similar to the Atlantic invaders, Lessepsian lionfish are crepuscular generalist predators that predominately prey upon small body-sized demersal fish. However, they also indicates that lionfish does not predate prey strictly in relation to their abundance, but also in relation to their specific morphological and behavioural traits.

Similar to what found in the Atlantic, comparisons between native and invasive prey species suggest that native fish are naïve towards Lessepsian lionfish, Notably, the most hunted species in the Mediterranean was the damselfish *Chromis chromis*, which was also the species showing the highest level of naïveté. This is particularly worrying as *C. chromis* is a key trophic species in the Mediterranean marine coastal ecosystem, any substantial reductions in abundance may have substantial flow-on effects to the wider marine community.

Overall, our results imply that Lessepsian lionfish show very similar predatory behavioural traits to their western Atlantic counterparts. Due to the early temporal period of the Mediterranean invasion, the full effects of the increasing lionfish population have not been recorded. However, our work shows that we may expect the same level of reef fish biomass loss recorded in the Atlantic, and potential substantial negative change in the structure and biodiversity of reef communities and the services they provide to coastal communities within the Mediterranean.

Talk

General session

How predation risk and competition influence habitat use of perch (*Perca fluviatilis*)

Christina Henseler[1], Marie C. Nordström[1], Anna Törnroos[1], Martin Snickars[1] and Erik Bonsdorff[1]

[1] Environmental and Marine Biology, Åbo Akademi University, Artillerigatan 6, Biocity, 20520 Åbo, Finland, Email: christina.henseler@abo.fi

Habitat complexity plays a crucial role in structuring fish communities, and interspecific interactions, e.g. between predator and prey, are known to be affected by the degree of habitat complexity. To examine effects of habitat complexity and interspecific interactions on habitat use of perch (*Perca fluviatilis*), we conducted aquarium experiments documenting the habitat occupancy of perch in presence and absence of potential predator and competitor fish species. We tested three habitat types (macrophyte, rock, sand) representing typical shallow coastal habitats of the northern Baltic Sea. Habitats were paired in experiment aquaria, resulting in three habitat combinations. For all combinations, habitat use of perch was recorded in three different treatments, consisting of a) 2 perch, b) 2 perch plus one pike (*Esox lucius*, predator treatment), c) 2 perch plus one ruffe (*Gymnocephalus cernua*, competitor treatment). Without predator or competitor present, perch occupied the structurally more complex macrophyte habitat more frequently than the rock or sand habitat, which in turn were used in approximately equal amounts. In the presence of pike and ruffe, however, perch altered their habitat occupancy in some of the habitat combinations, potentially expressing avoidance of the other fish species. For instance, both pike and ruffe were present more often in the macrophyte habitat during macrophyte – rock trials, whereas perch shifted their habitat use more towards the rock habitat in these predator and competitor treatments. This study emphasizes the importance of biological interactions, illustrated by the potential of predation and competition to structure fish communities in relation to habitat complexity.

Key words: Habitat complexity, Fish community, Predation, Competition

Talk

General session

Interactions between eelgrass (*Zostera marina*) and the Baltic clam (*Macoma balthica*)

Lukas **Meysick**[1], Alf Norkko[2,3], Max Gräfnings[4], Karine Gagnon[1], Christoffer Boström[1]

[1] Environmental and Marine Biology, Faculty of Science and Engineering, Åbo Akademi University, Artillerigatan 6, 20520 Åbo, Finland, Email: lukas.meysick@abo.fi; karine.gagnon@abo.fi; cbostrom@abo.fi
[2] Tvärminne Zoological Station, University of Helsinki, J.A. Palméns väg 260, 10900 Hangö, Finland, Email: alf.norkko@helsinki.fi
[3] Baltic Sea Centre, Stockholm University, Stockholm, Sweden
[4] Conservation Ecology Group, Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen, The Netherlands, Email: m.l.e.grafnings@rug.nl

Seagrass meadows are in decline all over the world, calling for new strategies for successful restoration. Facilitation through co-occurring organisms has gained much attention in the recent years with promising results. While many studies have focused on interactions between seagrass and epifaunal bivalves, such as blue mussels or oysters, infaunal bivalves have gained considerable less attention. Here we tested the interactions between eelgrass, *Zostera marina*, and the Baltic clam, *Macoma balthica* to see whether *M. balthica* could benefit ongoing restoration efforts. We conducted a manipulative field experiment in the Archipelago Sea, Finland, planting 60 plots á 16 shoots of eelgrass in a subtidal environment landwards to an extensive eelgrass meadow. Bivalves were added in 9 densities (plus control) from 300-3000 ind m^{-2}. Plots were recollected after 2 months (n=30) and again after 14 months (n=30). Linear regression revealed no effect of *M. balthica* abundance on plant traits (including shoot-, root-, and rhizome-biomass, spatial extension, shoot density, leaf production) neither after 2 nor after 14 months. In fact, plots increased in biomass, density and extension in all treatments significantly over the investigated period. A complementary aquarium experiment confirmed those results, indicating that the effect of *M. balthica* on eelgrass performance is limited. Our results therefore suggesting that *M. balthica* is not suitable to facilitate restoration of eelgrass.

Talk

General session

Evaluation of biodiversity at 5 estuaries in Japan using environmental DNA metabarcoding method

Hyojin Ahn[1,2], Manabu Kume[1], Yuki Terashima[1], Feng Ye[1,3], Satoshi Kameyama[3], Yoh Yamashita[1], Masaki Miya[4], Akihide Kasai[2]

[1]Connectivity of Hills, Humans and Oceans Unit, Field Science Education and Research Center, Kyoto University, Kyoto 606-8502, Japan / Email: ahn.hyojin.4a@kyoto-u.ac.jp
[2]Faculty of Fisheries Sciences, Graduate School of Fisheries Sciences, Hokkaido University, Hakodate, Hokkaido 041-8611, Japan
[3]Center for Environmental Biology and Ecosystem, National Institute for Environmental Studies, Tsukuba, Ibaraki 305-8506, Japan
[4]Department of Ecology and Environmental Sciences, National History Museum and Institute, Chiba 206-8682, Japan

Biodiversity is one of the important parameters to evaluate the current condition of the environment. To investigate biodiversity at different 5 estuaries of Japan, we used environmental DNA (eDNA), the uprising powerful method to detect macroorganisms. Water samples for eDNA were collected from river mouths and adjacent coastal areas of Aka River, Tama River, Miya River, Takatsu River and Sendai River. A total of 68 Families, 192 species were detected from studied areas. Among them, 11 species occurred at every river. Some of the rare fishes including endangered species were successfully detected by present survey. Biodiversity was highest at Sendai River and lowest at Tama River, clearly reflecting the environmental variation of each river: more developed or more natural. Even though the environmental index of development such as nutrient was low at both Aka and Sendai River, Sendai River had more diverse species including many of tropical/ subtropical ones, as it located in the southern part of Japan. Also, species compositions were varied by rivers that freshwater species occurred at Aka, Miya, Takatsu River whereas they took only a small proportion at Sendai River and even not detected at Tama River, due to the environmental features (e.g. salinity, width of river mouth). Obtained results were in very good accordance with the environmental conditions of each river, suggesting its potential ability and vision of eDNA.

Key words: environmental DNA, biodiversity, estuary, coastal area

Talk

General session

Larval performance of a potent invader in a steep salinity gradient within the Western Baltic Sea

Ola Mohamed Nour[1], Christian Pansch[1], Meike Stumpp[2]

[1]Department of Benthic Ecology,GEOMAR-Helmholtz Zentrum für Ozeanforschung Kiel,24105 Kiel, Germany. Email:onour@geomar.de
[2] Department of Comparative Immunobiology - Zoological Institute, Christian-Albrechts University, 24118 Kiel, Germany.

Biological invasions of marine organisms, as a result of human activities, are frequently recorded at a global scale, usually causing significant impacts on composition and functioning of local ecosystems. Despite a high taxonomic diversity of invasive species, crustaceans are amongst the most successful invaders. Advantageous biological and physiological characteristics are thought to explain their success. Crustaceans are tolerant to many environmental disturbances, and they constitute complex life-history traits and modes of reproduction. Benthic decapods develop through a complex life cycle comprising a series of planktonic larval stages, and a benthic juvenile to adult stage. We examined the effect of salinity on larval development of the grapsid crab *Hemigrapsus takanoi*, a recent invader to the Western Baltic Sea population, native to the western Pacific Ocean. The results showed that higher (>20 psu) than natural (10-20 psu) western Baltic Sea salinities are required for *H. takanoi* larval development. Successful development to megalopa stages occurred only at salinities between 20 to 35 psu. No larvae developed further than the fifth zoea at salinities lower than 15 psu. Only very few larvae metamorphosed to the third (10 psu) and the second (5 psu) zoeal stage. This study gives valuable insights into local adaptation and the future success of *H. takanoi* as means of invasion potential and distribution patterns within the Baltic Sea.

Key words: Salinity tolerance, Zoeal development; *Hemigrapsus* takanoi; Invasion.

Talk

General Session

Ecosystem function and diversity: the Dublin Bay intertidal model

Wilson, James G.
Zoology Dept., TCD, Dublin 2, Ireland. jwilson@tcd.ie

Sustainable management of marine resources depends on an understanding of the mechanisms behind the delivery of benefits provided by Ecological Goods and Services (EGS) generated by the operations of the marine systems. Central to this delivery of EGS is system function which is increasingly under anthropogenic pressure. In this paper, the function is modelled productivity ($kJ.site^{-1}.y^{-1}$) of the macrozoobenthos communities of the Dublin bay intertidal as a function of biodiversity and community structure. Four measures of diversity (species numbers S, Pielou's Evenness J', Taxonomic Distinctness $\Delta*$, and the W-statistic) were tested against four selected biodiversity/function models (linear model, rivet/redundancy model, keystone model and idiosyncratic model). For species' numbers, the positive exponential equation (keystone model) was consistently the 'best-fit'. The relationship of other diversity measures against production was more varied, consistently negative for J' and largely non-significant for taxonomic distinctness ($\Delta*$) and the W-statistic. It is suggested that system function largely follows the keystone models, that is it depends on a good fit between the species present and the resource available, with the likelihood increasing with increasing numbers of species. As a consequence, any future changes in the Dublin Bay intertidal may have serious implications for the functioning of the system and the EGS so delivered.

Key words:
Dublin Bay, intertidal, biodiversity, productivity

Talk

General session

Long-term changes in the structure of macroalgal communities in the Azores

Prestes A.C.L.[1], Moreu I.[1], Cacabelos E.[1,2], Martins G.M.[1,3], Faria J.[1] and Neto A.I. [1]

[1]cE3c/ABG - Centre for Ecology, Evolution and Environmental Changes/Azorean Biodiversity Group and Faculdade de Ciências e Tecnologia, Departamento de Biologia, Universidade dos Açores, Rua da Mãe de Deus, 9500-321 Ponta Delgada, São Miguel, Açores, Portugal. Email: afonso.cl.prestes@uac.pt
[2]MARE – Marine and Environmental Sciences Centre, Quinta do Lorde Marina, 9200-044 Caniçal, Madeira Island, Portugal
[3]AQUAZOR – Marine Aquaculture and Biotechnology of the Azores, 9500-331 Ponta Delgada, Azores, Portugal

Long-term studies are a powerful and fundamental tool to investigate environmental changes over prolonged periods. Long-term research will be especially important for tacking large-scale emerging problems confronting humanity such as resource management, increasing human population and climate change, mitigation and adaptation. Here we investigate how current shallow-water macroalgal communities compare to those that were found 20 years ago in the Azores using the methodology used by Neto in 1997 to ensure comparability between current and historical data. In both periods (1993/1994 and in 2016/2017) the percentage cover of macroalgae was estimated destructively at both 5 and 15 m depths at multiple sites. Algae were grouped into morpho-functional groups and temporal changes in community structure were analysed using abundance similarity indices. Multivariate analyses of the data revealed significant variations in the structure of macroalgae communities over time. Univariate analyses showed that, although some macroalgal groups such as, articulated corallines, foliose, canopy and filamentous algae, have not changed over the 20-yr period, a significant decrease in the relative abundance of corticated and corticated foliose macroalgae was found, especially at 15 m depth. These changes are tentatively interpreted as a consequence of the predicted increase in the abundance of herbivorous fish, although this needs to be tested experimentally in the field.

Key words: temporal changes, morpho-functional groups, shallow subtidal, seaweeds

Talk

General session

Effect of time in the lab and diet on the physiology and behaviour of a ubiquitous Atlantic crab (*Cancer irroratus*)

Eugueni Matveev, Iain J. McGaw

Memorial University of Newfoundland. Email: ematveev@mun.ca

When collecting wild animals for laboratory experiments, common practice dictates they are “acclimated” prior to the start of trials. The aim of this project was to investigate the effect of storage time (3 months) and diet (mixed or mono) on changes in the condition of animals. The metabolic rate, activity level, hemolymph protein level, claw strength, and appetite of the Atlantic rock crab (*Cancer irroratus*) were repeatedly measured over the period of three months. While diet type did not have a significant effect on most measured parameters, the time crabs were maintained in the lab did. Over time, the variation in hemolymph protein density decreased; this was due to a decline in crabs with high initial levels and an increase in crabs that initially had lower protein density levels. This change correlated positively with amount eaten, which was, in part, a function of diet type. Mean activity levels increased significantly over three months although the patterns of activity varied between crabs. In contrast, the standard metabolic rate decreased significantly as crabs spent more time in the lab. Previous studies acclimated crabs anywhere from 1-10 weeks prior to experiments. This work suggests that by using a wide variation in acclimation times one might get varied results from experiments, which affects both the repeatability of results and ability to compare across studies. I conclude that depending on the specific nature of the experiment, different acclimation times may be appropriate, and that effect of storage time is an important consideration for repeated measures.

Key words: acclimation time, diet, crab, physiology

Talk

General

Tracking waste from aquaculture into infauna communities in the Marlborough Sounds; combining community and biochemical data in a quantitative analysis

R. **McMullin**[1], Steve Wing[1] and Kimberley Hageman[2]

[1] University of Otago, NZ, 1. mcmre958@student.otago.ac.nz
[2] Utah State University, Utah, USA

Development of high input aquaculture farming of salmon creates significant challenges and opportunities in the context of ecosystem-based management. Here we have used environmental chemistry to model the fate of organic waste from aquaculture operations in wild food webs, and we describe how trophic linkages are altered.

We collected grab samples at five farm sites, and three reference sites in the Marlborough Sounds. Our analysis of patterns in density and biomass of infaunal, invertebrate communities among sites, along with stable isotope data (δ^{13}C and δ^{15}N), allowed us to model net incorporation of organic matter from salmon-farm waste in terms of biomass per-unit area, into benthic communities.

We observed a decrease in the utilisation of salmon feed as an organic matter source by infaunal communities with increasing distance from the farm, and that the isotopic tracer of salmon waste was still detectable at 300m distance from the farms in multiple functional groups. Significant declines in average community trophic level with increasing proximity to farms were also evident, and this has consequences for the capacity of communities to utilise organic matter from farms.

Our data are among the first to attempt to quantify the flux of salmon-farm waste entering infaunal food webs, and to highlight species that are likely to be important waste processors. Results from this study have implications for understanding how marine communities respond to further development and expansion of aquaculture, and how negative impacts may be mitigated.

Keywords: aquaculture, stable isotope analysis, food webs, ecosystem-based management

Talk

General session

Food quantity and quality in Barkley Canyon (NE Pacific) and its influence on macroinfaunal community structure

N. Campanyà-Llovet[1,2], P.V.R. Snelgrove[2,1], F. de Leo[3,4]

1Biology Department, Memorial University of Newfoundland, St. John's, NL A1B 3X9, Canada: ncil58@mun.ca
2Department of Ocean Sciences, Memorial University of Newfoundland, St. John's, NL A1C 5S7, Canada
3 Ocean Networks Canada, University of Victoria, PO Box 1700 STN CSC, Victoria, NC V8W 2Y2, Canada
4Department of Biology, University of Victoria, PO Box 3080, Victoria, NC V8W 2Y2, Canada

The highly heterogeneous nature of submarine canyon physical landscapes can influence organic matter spatial distribution and thus benthic community and food web structure. We therefore studied patterns in quantity and quality (i.e., nutritional value for benthic organisms) of sediment and their influence on macroinfaunal community structure in Barkley Canyon (NE Pacific) at multiple spatial scales (10s - 100s of meters). Noting different degradation rates among food variables, we inferred that the freshest organic matter reaches bottom waters of Barkley Canyon at 400 m, where ambient currents at the canyon head region likely concentrate primary productivity from surface waters. Evidence of deposition first appeared at 600 – 800 m. Degraded organic matter accumulated at 1500 and 2000 m where the comparatively fine sediments adsorb a greater proportion of available organic material than at shallower depths but limited delivery of surface primary productivity reduces overall food quality. Despite clear differences in food quantity and quality among sites (100 s of m apart), dissolved oxygen primarily drove macrofaunal distribution, along with hydrocarbons, indicative of a chemosynthetic ecosystem. At smaller spatial scales (10 s of meters) we found greater food patchiness associated with the topographically complex upper canyon (≤800 m). We also found distinct communities at smaller spatial scales (10 s of m apart) at 200 m, where fatty acid biomarkers distinguished a food patch rich in zooplankton. Organic matter distribution appears to influence macroinfaunal community structure more strongly at smaller spatial scales in contrast to major stressors (i.e., oxygen) that act over larger scales.

Keywords: Submarine canyons, Food quality, Oxygen minimum zones, Benthic community structure

Talk

General session

Estimation of phytoplankton group composition using HPLC pigment analysis in a highly urbanized estuary (Golden Horn Estuary, Turkey)

Fuat Dursun

Institute of Marine Sciences and Management, Istanbul University, Istanbul, Turkey
e-mail: fuat.dursun@istanbul.edu.tr

Phytoplankton communities are investigated with regular monitoring studies around the world. Traditionally, phytoplankton groups are determined by microscopic techniques. These techniques require extensive time for sampling effort and microscopical examination. So it is not possible to analyse numerous samples in a short time period. Furthermore, identifying small-sized phytoplankton groups (e.g. picoplankton, ≤ 2 µm) can be difficult, because of their indefinite external morphological features. It is really important to perform phytoplankton studies in a shorter time and also they should involve broader areas. For this purposes, marker pigments have been used alternatively to estimate phytoplankton composition in recent years. This study focuses on the: 1) characterization of phytoplankton group composition by using microscopy and 2) investigation of marker pigments (chlorophyll-*a*, chlorophyll-*c*, peridinin, 19'butanoyloxyfucoxanthin, fucoxanthin, zeaxanthin, alloxanthin, 19'hexanoyloxyfucoxanthin, diadinoxanthin, chlorophyll-*b* and ß-carotene) distribution with High Performance Liquid Chromatography (HPLC). Surface water samples were collected from the Golden Horn Estuary from 3 sampling stations between October 2018 and June 2019. Bi-weekly to monthly data was evaluated with environmental parameters (Secchi disc depth, temperature, salinity, pH and dissolved oxygen). As a result, two methodologies were compared and applicability of group specific marker pigments as a tool to estimate phytoplankton composition in the region was considered.

Key words: Phytoplankton, pigment, HPLC, Golden Horn Estuary

Talk

General session

Urbanisation reduces the diversity of intertidal canopies of Sargassaceae along north Portuguese coast.

Marcos **Rubal**[1,2], Ana Catarina Torres[1,2] and Puri Veiga[1,2]

[1] Centre of Marine and Environmental Research (CIIMAR), Matosinhos, Portugal
marcos.garcia@fc.up.pt
[2] Department of Biology, Faculty of Sciences, University of Porto

Canopy-forming macroalgae are the main element of some of the more diverse and productive coastal habitats around the world. However, canopy-forming macroalgae are very sensitive to anthropogenic disturbances. In coastal urban areas, intertidal organisms are exposed to the interactive effect of several anthropogenic disturbances that can modify the community's structure and diversity. Due to their sensitivity, canopy-forming macroalgae are a good indicator of the effects of urbanisation. Along the North-East Atlantic shores many studies explored the effect of anthropogenic disturbances on canopy-forming macroalgae but, mainly focused on kelps and fucoids. However, along the intertidal rocky shores of the Atlantic coast of the Iberian Peninsula, the most abundant and frequent canopy forming macroalgae belong to the family Sargassaceae (i.e. genus *Cystoseira*, *Bifurcaria* and *Sargassum*). To explore the effect of urbanisation on these intertidal canopy-forming species the diversity and assemblage structure of canopy species was compared among four urban and four non-urban shores from north Portugal. Intertidal canopy assemblages on urban shores were dominated by the non-indigenous *Sargassum muticum* that was the only canopy-forming species on three of the four studied urban shores. Canopy assemblages on non-urban shores were more diverse including species of the genus *Cystoseira* and *Bifurcaria* in all the shores. Moreover, patches of canopy-forming species on urban shores were always monospecific, while at non-urban shores multispecific patches were common. Therefore, results suggest that urbanisation reduces canopy´s biodiversity and results in loss of biodiversity and ecological services.

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Key words: Urbanisation, canopy, Sargassaceae, North Portugal.

Talk

General session

Effects of harvesting on the mollusc assemblage associated with mussels

Puri **Veiga**[1,2], Leandro Sampaio[1,2], Catarina Ramos Oliveira[1,2], Juan Moreira[3], Jesús S. Troncoso[4], Marcos Rubal[1,2]

[1] Centre of Marine and Environmental Research (CIIMAR), University of Porto, Porto, Portugal. Email: puri.sanchez@fc.up.pt
[2] Department of Biology, Faculty of Sciences, University of Porto
[3] Department of Biology (Zoology) & Centro de Investigación en Biodiversidad y Cambio Global (CIBC-UAM), Universidad Autónoma de Madrid, Cantoblanco, E-28049 Madrid, Spain
[4] Department of Ecology and Animal Biology, Faculty of Marine Sciences, University of Vigo, Vigo, Spain

The blue mussel, *Mytilus galloprovincialis* is an ecologically and economically relevant species. It is very abundant in the Atlantic coast of the Iberian Peninsula where is harvested in natural systems and/or cultured intensively on rafts. Aquaculture production is dependent on their abundance in natural environments because juveniles are collected in rocky shores and then attached to ropes on rafts. Moreover, it provides habitat for many species, enhancing local biodiversity.
The objective of this study was to explore effects of harvesting on mollusc assemblages associated with mussels. To achieve this, two rocky shores, where mussels are intensively harvested, were selected in Galicia (NW Iberian Peninsula). At each shore, two different sites were considered; at each site, 4 replicates (10x10cm) of harvested mussel clumps and 4 replicates of non-harvested clumps (control) were collected. Size and number of mussels at each replicate were compared between treatments (harvested-control). Moreover, molluscs at each replicate were identified to species level. Abundance, taxon richness, Pielou index and assemblage composition of molluscs were compared between treatments by means of univariate and multivariate techniques. Results pointed out that harvested clumps showed a lower and more homogenous mussel size than control clumps as expected. Regarding molluscs, their abundance and diversity were significantly higher in harvested clumps. This could be related to the importance of the surrounding landscape in shaping invertebrate assemblage structure and the age of the clump. Moreover, the interaction between treatment and site was significant for the multivariate assemblage structure.
Acknowledgements: Project No.30181 co-financed: Compete-2020, Portugal-2020, ERDF, FCT

Key words: Mytilus galloprovincialis, harvesting, molluscs, Iberian Peninsula

Poster

General session

Relationship between sediment accumulation and the fauna associated with mussel beds

Ana Catarina Torres [1,2*], Marcos Rubal[1,2], Maria João Queirós[1,2,3], Isabel Sousa-Pinto [1,2], Puri Veiga [1,2]
[1] Centre of Marine and Environmental Research (CIIMAR), University of Porto, Porto, Portugal
[*] email: up200906002@fc.up.pt

[2] Department of Biology, Faculty of Sciences, University of Porto
[3] Institute of Biomedical Sciences Abel Salazar ICBAS, University of Porto

Upon arrival to rocky coasts, sediment can accumulate in the environment, changing composition, structure and dynamic of assemblages. Mytilus galloprovincialis, which is the most abundant mussel species on the Portuguese coast, due to its morphology and sessile life-style can accumulate sediment. Since mussel beds harbour diverse assemblages of invertebrates, sediment accumulation may affect these assemblages. The objective of this study was to explore the correlation between sediment accumulation on mussel beds and the abundance and diversity of their associated fauna. For this, two rocky shores, each one with six plots (2x2m) were selected and three replicates were collected at each plot.
In order to study the relationship between the accumulated sediment in mussel beds and the abundance (N), richness (S), Shannon index (H') and Pielou index (J') of their associated assemblages, Spearman rank correlations were done. DistLM was also used to test the significance of the relationship between the quantity of sediment and the structure of the faunal assemblage on M. galloprovincialis.
Spearman correlations for N and S showed positive and significant correlations with the quantity of sediment, whereas those for H' and J' presented significant but negative correlations. DistLM showed that the whole structure of the associated assemblages with mussels were significantly correlated (almost 75%) with the quantity of sediment. In conclusion, the sediment accumulation seems to play an important role in shaping abundance and structure of invertebrate assemblages associated with mussel beds.
Acknowledgements:
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Key words: sediment accumulation, Mytilus galloprovincialis, associated fauna, north Portugal

Poster

General session

Is this a keystone species? The moonsnails at the White Sea can shape the community by eliminating large prey.

Dmitriy A. Aristov[1, 2]
[1] Zoological Institute of RAS, White Sea Biological Station, Universitetskaya emb. 1, St.-Petersburg 199034, Russia 1. Email: amauropsis@gmail.com
[2] Laboratory of Marine Benthic Ecology and Hydrobiology, Krestovskiy pr. 19, St.-Petersburg 197110, Russia

The cascading effect of invertebrate predators is well known. They affect the community via eliminating the herbivorous species and facilitating the primary production, or eating out the fast-growing species and thus provide space for slow-growing species. Effect of predators like moonsnails (Naticidae: Caenogastropoda) can be easily detected in the environment as they leave perforated shells as a result of attack. Earlier we have shown that Islandic moonsnail *Amauropsis islandica* at the White Sea prefers the largest available Baltic clams *Limecola balthica* and mean size of clams decreases with the increasing of abundance and mean size of predators. In present study, we compare the occurrence of littoral species in smaples with different mean size of *Limecola* (living and perforated) and number of perforated valves at two tidal flats in 2001-2018. Correspondence analysis revealed that mean size of either living or perforated *Limecola* significantly predicts the species list in samples and the number of perforated valves does not affect species composition. While some species react to the decreasing of mean perforated *Limecola*, others respond to decreasing of mean size of the living *Limecola*. We believe, the impact of the large Baltic clams on the community structure differs from the smaller ones by more intensive bioturbation and organic influx. Supported by RFBR grant 18-34-00405 and the ongoing Program of the Russian Academy of Sciences "Dynamics of structure and functioning of White Sea ecosystem and adjacent arctic seas " (AAAA-A19-119022690122-5).

Key words: *Amauropsis islandica*, *Limecola balthica*, White Sea

Poster

General session

Impact of non-indigenous copepod species in the copepod community of two contrasting estuaries of the Bay of Biscay.

Barroeta, Z[1, 3], Uriarte, I.[2, 3], Villate, F.[1, 3] and Iriarte, A.[2, 3]

[1] Department of Plant Biology and Ecology, Faculty of Science and Technology, University of the Basque Country (UPV/EHU), PO Box 644, 48080 Bilbao. 1. Email: ziortza.barroeta@ehu.eus
[2] Department of Plant Biology and Ecology, Faculty of Pharmacy, University of the Basque Country (UPV/EHU), Paseo de la Universidad 7, 01006 Gasteiz.
[3] Research Centre for Experimental Marine Biology and Biotechnology (Plentzia Marine Station; PiE-UPV/EHU) Areatza Pasalekua, 48620 Plentzia-Bizkaia..

The increase in marine trading and transportation has facilitated the occurrence of non-indigenous species (NIS), which is one of the main causes of changes in biodiversity and in the communities structure of aquatic systems. This phenomenon is more evident in estuaries with port facilities, where new species are introduced mainly by ballast water. Since 1998, a monitoring program of the zooplankton community is being carried out in the contrasting estuaries of Bilbao and Urdaibai (Bay of Biscay). The first one is a man-modified system, highly polluted in the past but under recovery process at present, while the second one supports a low-moderate anthropogenic impact and is including in a Biosphere Reserve. In the year 2001, the occurrence of two NIS copepods (*Acartia tonsa* and *Oithona davisae*) was detected in both estuaries, and in 2010 the occurrence of a third one (*Pseudodiaptomus marinus*). Spatio-temporal variations and effects of these NIS on the copepod community, however, was found to be different between estuaries. In the estuary of Bilbao, *A. tonsa* and *O. davisae* reached high density and became the most abundant copepods of the inner part of the estuary, thus contributing to the restoration of the copepod community by increasing total abundance largely. In contrast, in the estuary of Urdaibai, *A. tonsa* has replaced in summer the previously dominant species of the inner part of the estuary, i.e. *A. bifilosa*, not affecting total copepod abundance. Unlike in the estuary of Urdaibai, *P. marinus* has successfully settled in the estuary of Bilbao.

Key words: non-indigenous species (NIS), copepods, impact, estuaries.

Poster

General session

The role of artificial material for benthic communities – establishment of different concrete materials to a natural hard ground environment

Lydia R. Becker[1,2,3], Kai Bischof[3], Ingrid Kröncke[2,4], Andreas Ehrenberg[5], Volkert Feldrappe[5]

[1]INTERCOAST Research Training Group, University of Bremen, Leobener Strasse, 28359 Bremen, Germany. lkohlmorgen@marum.de
[2]Senckenberg am Meer, Dept. for Marine Research, Südstrand 40, 26382 Wilhelmshaven German
[3]Department of Marine Botany, University of Bremen, Leobener Str. NW2, 28359 Bremen, Germany
[4]Institute for Chemistry and Biology of the Marine Environment, University of Oldenburg, Schleusenstr. 1, 26382 Wilhelmshaven, Germany
[5]FEhS – Institut für Baustoff-Forschung eingetragener Verein (e.V.), Bliersheimer Straße 62, 47229 Duisburg

Concrete and steel are the materials mostly used in artificial coastal structures (eg. harbours, causeways, dikes, piers and breakwaters). They are colonized by specialized hard-bottom biota consisting of macroalgae and associated invertebrates, but typically less diverse than the natural hard ground assemblages. For our experiments, 15 blocks of five concrete materials (15x15x15cm), containing different granulated blast furnace slag and binding agents, were deployed in April 2016 in a natural hard ground environment near to Helgoland Island (German Bight). In order to study succession on artificial materials a regular photographic documentation was conducted. Further, we investigated if differences in settlement between different types of concrete materials can be observed after one year of deployment. All blocks were investigated, regarding species composition and coverage. This study presents first results of statistical analyses, indicating differences in settlement on the different materials. Overall, our study provides new insights into the ecology of artificial substrates.

Key words: concrete, succession processes, natural habitats, artificial material

Poster

General Session

Tools for Microplastic Analyses in Ecological Research

Sonja M. Ehlers[1,2], Jan Maxein[1,2], Werner Manz[2], Jochen H. E. Koop[1]

[1]Department of Animal Ecology, Federal Institute of Hydrology, 56068 Koblenz, Germany
[2]Institute for Integrated Natural Sciences, University of Koblenz-Landau, 56070 Koblenz, Germany
Email: Ehlers@bafg.de

Aquatic ecosystems worldwide are exposed to plastic debris. As microplastics (< 5 mm) are considered as emerging anthropogenic pollutants, their effects on organisms are often assessed in ecotoxicological studies. However, to understand the interactions between microplastics and animals, it is essential to implement robust and cost effective analytical tools which enable microplastic analysis in ecological research. Although polymer identification requires expensive equipment such as a micro-Fourier-transform infrared spectroscope and cannot be afforded by every lab, there are inexpensive and time effective tools when it comes to studying microplastic interactions with animals *in vivo*. At the German Federal Institute of Hydrology, we recently developed a novel low-cost method to analyse microplastic interactions with animals (i.e. invertebrates) which are exposed to microplastics in aquaria. The great advantage of this method is that microplastic consumption and excretion can directly be observed and that e.g. egestion speed can be measured while leaving the animal in an environment where it can behave normally (aquarium). In many studies, animals (such as copepods) have to be transferred to a Petri dish under a microscope in which they likely do not show their normal behavior due to stress. Furthermore, our new method can be applied to microplastic experiments in marine, freshwater and terrestrial organisms. Another matter of expense in microplastic research is that often, expensive fluorescent microbeads are purchased and fed to organisms. Therefore, we would like to draw attention to a cost effective way to obtain easily visible microplastics that can be used for microplastic effect studies.

Key words: synthetic polymers, affordability, behavioral biology, observational study

Poster

General session

Invasions create competitors: How novel interactions among native and invasive parasites modify host-parasite coevolution

Marieke E. **Feis**[1,2], Leo Gottschalck[2] and K. Mathias Wegner[2]

[1] Sorbonne Université, CNRS, Station Biologique de Roscoff, Laboratoire Adaptation et Diversité en Milieu Marin, UMR 7144, CS90074, 29688 Roscoff Cedex, France. Email: marieke.feis@sb-roscoff.fr

[2] Department Coastal Ecology, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Wadden Sea Station Sylt, Hafenstraße 43, 25992 List/Sylt, Germany

Within parasite communities infecting the same host, ecological theory predicts that two species should evolve distinct niche use to avoid direct competition. Biological invasions can create situations however, where competition could not select for different niche occupancy and closely related parasites species compete for the same host resources for the first time since their lineages split. Such novel interactions cannot only alter the evolutionary trajectories of both parasite species, but will also feed back onto coevolutionary interaction of native parasites with the host. Here, we show how the invasion of the parasitic copepod *Mytilicola orientalis* creates competition with the native congeneric parasite *Mytilicola intestinalis*, and how this novel menage a trois feeds back on the immune response of the host *Mytilus edulis*. Manipulating competition among the parasites in controlled infection experiments shoed that, although both species occur in the same section of the mussel gut, competition between the parasites is weak and shows similar impact on host condition in either simultaneous or sequential infections. Triplet transcriptomics of matching host and parasite samples however revealed that the novel interaction of the invader with the host changes the transcriptional activity of many more genes and processes than the interaction with the established and coevolved parasite. Our results therefore not only show the utility of biological invasions of parasites to study coevolutionary processes, but also shows that responses to novel host-parasite interactions can lead to massive reactions on the molecular level that are not reflected in host or parasite phenotypes.

Key words: invasive marine parasites, co-infection experiments, RNAseq, coevolution

Poster

General Session

Microplastic pollution in marine sediments surrounding Iceland

Loughlin, C.[1], Mendes, A.[2], Morrison, L.[2], and Morley, A.[1]

[1] School of Geography and Archaeology, National University of Ireland, Galway University Road, Galway, Ireland 1. Email: Christine.Loughlin@nuigalway.ie

[2] School of Natural Sciences and Ryan Institute, National University of Ireland, Galway, Ireland

Microplastic pollution is widespread throughout the marine environment and has been recorded in marine sediments. Depositional trends and distribution of microplastics in the benthos is important for determining the end fate of microplastics and the likelihood of availability to benthic organisms. The data presented in this study is the first distribution analysis of presence, depth and distribution of microplastics in marine sediments from Iceland. The top 0-5 cm of 8 multicores were visually examined for microplastics (5 mm - 250 µm size range) using a dry-sieving method. 348 microplastics, characterized as fibers, were recovered from all sites and classified as secondary microplastics. Using age models created by radiocarbon dating we found that debris was not limited to modern sediments deposited since production and disposal of plastics began in the 1940s. We therefore infer that fibers must be mixed downwards within the sediment via bioturbation. Further, the spatial analysis of microplastic depositional trends revealed higher abundances of debris in (1) sediments with high organic matter, (2) locations sheltered from fast currents and (3) commercial fishing grounds, which coincide with known cod feeding and breeding spots. A random selection (22%) of the sample was tested using a Raman Spectrometer to confirm polymer character. The various types of polymers and colors signify a variety of potential sources such as the breakdown of fishing gear or the dispersion of microplastics from wastewater. This study highlights the extent at which microplastics are deposited across varying depositional environments and the need for consistent benthic monitoring.

Key words: microplastic, microfiber, benthic, pollution

Poster

General session

Spatial distribution patterns of Chilean benthic marine macroinvertebrates

Loreto **Pino**, Tom Webb

Department of Animal and Plant Sciences, University of Sheffield. Email: lpino1@sheffield.ac.uk

Our research aims to robustly quantify spatial patterns in the diversity of benthic marine macroinvertebrates along the Chilean continental shelf. Traditional distribution patterns proposed for Chilean benthic macroinvertebrates suggest that diversity hotspots are located south of 42°S, specifically inside the Chiloé Archipelago. However, other studies have found the highest species diversity south of 52°S. These estimates of diversity are also affected by variations in sampling effort. Thus, the estimated diversity gradient of Chilean benthic macroinvertebrate species might be significantly influenced by differences of sampling effort along the latitudinal gradient of Chile. To address this, we have constructed a database of Chilean benthic macroinvertebrates. The database was gridded into equal area cells of 55 x 55 km. Each species occurrence was assigned to an ecoregion of the Marine Ecosystems of the World: Humboldtian, Central Chile, Araucanian, Chiloense, and Channels and Fjords. Rarefaction/extrapolation and Species Accumulation Curves were used to compare sampling effort influence between ecoregions. Hotspots were defined as the top 5% most diverse grid cells in terms of Incidence Coverage Estimator. Controlling for sampling effort in this way, we find a gradient in species diversity from Northern to Southern Chile. The Channels and Fjords ecoregion presents the highest observed and expected species richness. The uneven sampling effort throughout Chile influences the observed species density mostly in Chiloense ecoregion. Hotspots of estimated species richness are observed south in Channels and Fjords ecoregion, specifically South of Tierra del Fuego and in the Strait of Magellan.

Key words: Spatial distribution, Regional scale, Benthic ecosystems, Macroinvertebrates

Poster

General session

Marine litter in the Central and Southern Tyrrhenian Sea: Monitoring benthic debris on trawlable bottoms.

Profeta A. [1], Giordano D.[1], Perdichizzi A. [1], Armeli-Minicante E[1]., Salvati D. [1], Soraci F. [1], Porcino N. [1], Trifiletti A., D'Iglio C. [1] and Rinelli P. [1]

[1] Institute of Biological Resources and Marine Biotechnologies (IRBIM-CNR), Sp. San Raineri, 86 – 98122 Messina (ME), ITALIA. Email: adriana.profeta@iamc.cnr.it

Marine litter is included among descriptors for evaluating Good Environmental Status (GES) of the Sea in the framework of Marine Strategy Framework Directive (MSFD). The bottom trawling method is considered to be the most suitable for evaluation and monitoring Sea-floor litter. The present study aims to investigate the density and typology of marine litter collected in 140 hauls during two MEDITS trawl surveys carried out in the Central and Southern Tyrrhenian Sea (GSA 10) in 2017 and 2018. All debris present in the catches were separated from fish catch, photographed, classified and weighted according to MEDITS-Handbook of 2017. A total of 1222 items were collected, in a depth range between 15 and 678 m, reaching a weight of 324.48 kg. Plastic was the most abundant category in both years, occurring in 96.43% of the hauls, and plastic food wrappers were the most abundant items (19.72 % of the total), followed by plastic bags (19.39%). Comparing the two years there was an increase in the number of pieces of litter collected, from 561 in 2017 to 661 in 2018. On the contrary, the total weight decreased (195.24 kg in 2017, 129.243 in 2018). This suggests that more smaller fragments have been captured.

Key words: marine litter, trawl survey, Central and Southern Tyrrhenian Sea, plastic

Poster

General session

Multiple conservation designations: What impact on the effectiveness of marine protected areas in the Irish Sea?

Constance M. Schéré[1], Terence P. Dawson[1] and Kate Schreckenberg[1]

[1] Geography Department, King's College London, Bush House (NE), 40 Aldwych, London WC2B 4BG. Email: constance.schere@kcl.ac.uk

Human activity is directly affecting the marine environment through overfishing, coastal pollution, invasive alien species, and habitat destruction. A wide array of methods is being applied to adequately manage and protect marine resources, such as ocean zoning, regulating the harvest of species, enforcing catch limits, and establishing marine protected areas (MPAs). MPAs are designed to meet both biological and socioeconomic needs. The Irish Sea is a busy waterway under the jurisdiction of six entities (Northern Ireland, the Republic of Ireland, the Isle of Man, Scotland, England, and Wales). There are almost 200 conservation designations across 111 MPA sites, with many sites having multiple designations (national, EU, and international). Data is lacking on the effectiveness of these protected areas in reaching their conservation objectives due to sites being inadequately monitored. Do multiple designations ensure better protection of the marine environment, or is the Irish Sea home to paper parks, offering little protection? Metadata compiled from the World Database on Protected Areas and conservation reports from MPA managers were used to answer this question. The evidence suggests that multiple-designation MPAs are more likely to have a publicly-available management plan and be monitored. Of those who do have a management plan, it appears that multiple designations are linked to better conservation outcomes. The race to meet 10% protected area target set by the Conservation on Biological Diversity may be compromising effective planning, as on the Isle of Man, where no conservation objectives have been set for the newly-established 'marine nature reserves' (MNRs).

Key words: marine protected areas, marine conservation, conservation designations, ocean and coastal management

Poster

General session

A new record of marine tardigrade from the Northwest Atlantic Ocean

Steven L. Schulze[1] and Emma S. Perry[2]

[1] Rutgers University, Camden, New Jersey, USA. Email: steveschulze@gmail.com
[2] Unity College, Unity, Maine, USA.

Tardigrades are microinvertebrates with a cosmopolitan distribution and that exist in both marine and terrestrial environments. There are few Records of Occurrence of marine tardigrades from the Northwest Atlantic Ocean. Intertidal species are of evolutionary interest in that they may clarify the transition of tardigrades between marine and terrestrial environments. Here, we report tardigrades recovered from barnacles at Barnegat Lighthouse, New Jersey, USA.

Thirty-eight specimens were examined with phase-contrast microscopy and an additional five with scanning electron microscopy. Those specimens whose full complement of claws could be resolved average an 8,8,8,7 configuration. Body lengths average 243.10 µm, which falls within the range expected for medium-sized *Echiniscoides* taxa. Appendages appear on all legs. Cirri A and E are present, as are primary clavae and cephalic papillae. Internal and external cirri terminate in a starlike array of projections. The dorsal cuticle is warty without a substructure of smaller points. The female gonopore is a six-lobed floret.

We provisionally consider these specimens to be *Echiniscoides* cf. *pollocki*. Within the genus, only *E. pollocki* and *E. horningi* have both a warty cuticle and an 8,8,8,7 claw configuration. *E. horningi* has a pair of tertiary clavae, however, which is lacking in our specimens and in *E. pollocki*. Moreover, the cephalic appendages of our specimens terminate in a starlike array of projections, which is typical of *E. pollocki*. Photography of the anus and male gonopore and analyses of samples from the type location are necessary to positively identify our specimens.

Key words: Tardigrada, Atlantic Ocean, intertidal

Poster

General session

Responses of the ragworm Hediste diversicolor (Polychaeta) to seawater acidification due to potential CO_2 leakage from the CCS sub-seabed storage site in the Baltic Sea

A. Sokołowski[1] and D. Brulińska[1]

[1] University of Gdańsk, Institute of Oceanography, Al. Piłsudskiego 46, 81-378 Gdynia, Poland. Email: oceas@univ.gda.pl

Ocean acidification is globally recognized as a modifying factor to the diversity, functioning and production of the marine ecosystems. Carbon Capture and Storage (CCS) technology was consequently developed as a tool to mitigate the increased emission of CO_2. CCS involves capture, transport, injection and storage of CO_2 into subterranean reservoirs, with assumed only minor environmental safety drawbacks. There is, however, a risk of future CO_2 leakage from sub-seabed storage sites to the sea-floor sediments and overlying water which reduces drastically pH at a local scale. In this study, the impact of CO_2-induced seawater acidification on the ragworm *Hediste diversicolor* (Nereidae, Polychaeta) from the southern Baltic Sea (the Gulf of Gdańsk) was determined and quantified using short-term (56-day) mesocosm experiments. By setting experimental conditions within a broad range of seawater pH 7.7-6.3, which simulates potential scenarios of changes in acidity of the overlying bottom water if there is carbon dioxide leakage from the sub-seabed storage site, the biological response of this polychaete was investigated to support environmental risk assessments of CCS implementation in the southern Baltic Sea. Increased water acidity caused changes in survival rate of the ragworm, its physiological traits (e.g. metabolic activity measured as oxygen consumption rate) and biometric measures (a partial length of L3, i.e. the sum of the lengths of the prostomium, peristomium and the first chaetiger).

Poster

General session

Maximum length and age of stargazer, *Uranoscopus scaber* Linnaeus, 1758.

Sulić Šprem Jadranka[1], Dobroslavić Tatjana[2] and Kožul Valter [3]

[1] Dubrovnik Natural History Museum, Androvićeva 1, 20000 Dubrovnik, Croatia.
Email: jadranka.sulic.sprem@pmd.hr
[2] Department of Aquaculture, University of Dubrovnik, Ćira Carića 4, 20000 Dubrovnik, Croatia
[3] Institute for Marine and Coastal Research, University of Dubrovnik, Kneza Damjana Jude 12, pp 83, 20000 Dubrovnik, Croatia

A female of stargazer, *Uranoscopus scaber* Linnaeus, 1758 was caught by demersal trawl net in December 2011 in the area of the southern Adriatic Sea. Total length and weight of individual was 36 cm and 337.85 g. The gonads were in matured phase of development and weighted 0.304 g. Sagittal otoliths were used for age determination and according to the total number of hyaline zones the specimen was 8 years old. The total length of the specimen was the maximum observed length for species *U. scaber* in the Adriatic Sea and the second largest length in the entire area of its natural distribution. The individual with a higher total length (38 cm) was found in the records of the International game fishing association. The age of 8 years is the maximum age reported for this species in the area of its distribution.

Key words: *Uranoscopus scaber*, Adriatic Sea, maximum length, maximum age

Poster

General session

Spatio-temporal monitoring of the impact of the wastewater from a canning industry on benthic ecosystem and organic matter fluxes

Marina Gómez[1,2], Rosario de la Huz[1,2], Fernando Aneiros[1,2], Marcos Rubal[3,4], Puri Veiga[3,4], Ana Catarina Torres[3,4], Jesús López[1,2], Mariano Lastra[1,2] and **Jesús Troncoso**[1,2]

troncoso@uvigo.es

[1] Dept. of Ecology and Animal Biology – Faculty of Marine Sciences – University of Vigo (Spain)
[2] ECIMAT, Marine Research Center– University of Vigo (Spain)
[3] Laboratory of Coastal Biodiversity – Interdisciplinary Centre of Marine and Environmental Reserach (CIIMAR/CIMAR) – University of Porto (Portugal)
[4] Department of Biology – Faculty of Sciences – University of Porto (Portugal)

The Galician Rías Baixas has one of the marine ecosystems with the highest biodiversity of the world, and 80% of the fish canning industries in Spain are located in this coast. These industries are characterized by high water consumption and the subsequent emission of large quantities of wastewater with high salinity and high concentrations of DOC and nutrient. The monitoring of these areas is important in order to assess the impact of wastewater on diversity of benthic ecosystem. With this aim 4 sampling stations were established: 2 potentially impacted close to the discharge point of a canning industry and 2 control stations located at about 1000 m at both sides of the effluent point. At each station 6 samples with a Van-Veen grab, 5 for the study of the fauna and 1 for the sediment were taken, plus water samples with a Niskin bottle for the physico-chemical characterization. Furthermore, sediment traps were installed to measure matter fluxes towards the sediment. Samplings were carried out seasonally throughout a year cycle in order to integrate the temporal variability of the benthic assemblages. The results show that taxa richness and H´ were significantly lower at impacted stations while variables such as the flux of organic matter showed a clear seasonal pattern. It can be concluded that the wastewater has a moderate impact on the benthic ecosystems and this impact is seasonal and seems to be modulated by coastal currents.

Key words: benthic ecosystem, wastewater, sediment traps, biodiversity

Poster

General session

Predictive model of hydrocarbons and faunal diversity around offshore oil platforms based on long-term onitoring data

Marina A. Varfolomeeva[1], Vadim M. Khaitov[1,2], Paul E. Renaud[3] and Andrey I. Granovitch[1]

[1] Department of Invertebrate Zoology, St.Petersburg State University; Russia. Email: m.varfolomeeva@spbu.ru
[2] Kandalaksha State Nature Reserve; Russia.
[3] Akvaplan-niva; Tromsø Norway.

Sediment contamination from petroleum production can strongly impact benthic communities. Monitoring data, however, can be confounded by different background conditions, different histories of activity and pollutant-release events. This makes it difficult to draw general conclusions about impact from single-site analyses. Integration of data from many sites is necessary to allow capturing more general patterns of spatial and temporal variation. Models constructed using data from regions with varying histories of oil development can be used to directly model the impact on communities and characterise quantitative relationships between environmental variables and community descriptors. Such models can also help predict these relationships in less-studied regions.

Using the data from the Norwegian Environmental Monitoring Database, we modelled sediment hydrocarbon concentration and Shannon-Wiener diversity around the North Sea oil platforms. We also assessed performance of those models on the two independent sets of the North and Barents Sea data. Hydrocarbon concentration non-linearly changed with duration of oil production, decreased with distance from the rig, depended on mud and lead content. Diversity depended on distance, oil production duration, and decreased with hydrocarbon concentration. The models of hydrocarbon distribution and Shannon-Wiener diversity, that had been initially developed for the North Sea, also performed well on independent data from the same location, and less well on the Barents Sea data.

The study was supported by Russian Foundation for Basic Research grants RFBR 14-04-93083 and 18-54-20001.

Key words: hydrocarbon pollution, biodiversity, predictive model, long-term dynamics

Poster

General Session

Brimming with bugs - The influence of preservation on saltmarshes and their highly diverse invertebrate communities.

Taylor **Vogt**[1]

[1] Affiliation address 1. Flinders University, Adelaide, South Australia. Email: vogt0013@flinders.edu.au

Saltmarsh habitats have recently been under threat from anthropogenic modifications and sea level rise, leading towards major habitat loss. Globally, saltmarsh research has prioritized vegetation and sediment characteristics, resulting in comparatively less understanding on saltmarsh habitat preservation and associated fauna. Natural, degraded and reserve sites were used to investigate invertebrate communities in South Australian saltmarshes. It was expected that natural and reserve sites would show similar invertebrate diversities and community structures and would be greater than the degraded site. Invertebrates were sampled using pitfall traps and sweep nets. A total of 182 morphospecies were identified across 54 families where five times more morphospecies were caught in sweep nets. Greater numbers of morphospecies and families were recorded in natural and degraded saltmarshes using sweep nets, however natural saltmarshes displayed the lowest species evenness and diversity. Degraded saltmarshes had reduced species richness, diversity and evenness of invertebrates caught in pitfall traps and were all lower than natural and reserve saltmarshes. Chironomidae and *Helograpsus haswellianus* were the most abundant invertebrates in all sites, showing significant differences between reserve and degraded sites. Distance-based linear models inferred that reserve and degraded invertebrate communities were distinct, however natural saltmarshes were a combination of the two sites. Our findings suggest that saltmarsh invertebrate communities are susceptible to habitat modification and are more likely to impact certain lifestyles (i.e. ground-dwelling). Saltmarshes present highly diverse invertebrate communities which should be explored seasonally, regionally and globally to establish a better representation of saltmarsh biodiversity.

Key words: *insects, intertidal, ecosystem, Australia*

Poster

General Session

Horizontal and Vertical distribution of micro-plankton in central Mediterranean Sea

G. Belmonte and J. Vannini
Laboratory of Zoogeography and Fauna, Department of Biological and Environmental Sciences and Technologies (DiSTeBA), University of Salento, 73100 Lecce, Italy.
genuario.belmonte@unisalento.it

Abstract
Micro-plankton has been collected during an oceanographic cruise in the frame of the EU Marine Strategy program to assess the plankton biodiversity status of Italian Seas, in the centre of the Mediterranean, in the period July-August 2017. Samples have been collected from a total of 32 stations, and from 3 different depths at each station, for a total of 96 samples. A volume of 5-10 litres of water has been filtered (on a 10 μm mesh sized sieve) per each sample.
A total of 200 categories (identified at the minimum taxonomic level possible) have been recognized with some new local records. Microplankton data of the present collection were the first never recorded from one of the nine Italian marine sectors recognized by Marine Biology Italian Association (the sector number 5, completely unknown until the present report). Dinophyta, as a group, and Tyrrhenian Sea (Italian marine sectors 2 and 3) showed the highest species richness. Adriatic Sea (Italian marine sectors 7, 8, and 9) showed the highest abundance of individuals. As regarding the Ecological Diversity, Ionian Sea (Italian marine sector 6) showed the highest indexes.
A preliminary biogeographic partitioning is proposed on the basis of the data obtained (taxa presence and abundance), showing the simplification of communities and reduction of spatial differences going from surface to deeper waters.

Key words: Microplankton, Dinophyta, Tintinnina, Biodiversity assessment

Poster

General session

Study of meiofauna assemblages living on *Bugula neritina* (Linnaeus, 1758) in anthropogenic marine areas

Francisco J. García-García[1] ,Marcos Rubal[2, 3], Juan D. Delgado-García[1], Puri Veiga [2, 3], Inés Martínez-Pita[1], José M. Guerra-García[4]

[1] Department of Physical, Chemical and Natural Systems, Faculty of Experimental Sciences, University Pablo de Olavide, E-41013, Seville, Spain. e-mail Francisco J García-García: fjgargar@upo.es

[2]Department of Biology, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 4169-007 Porto, Portugal

[3] Centre of Marine and Environmental Research CIMAR/CIIMAR, University of Porto, Novo Edifício do Terminal de Cruzeiros do Porto de Leixões Avenida General Norton de Matos, S/N 4450-208 Matosinhos Portugal

[4] Departament of Zoology, Faculty of Biology, University of Sevilla, Avda Reina Mercedes 6, 41012 Sevilla, Spain

Abstract

Marinas involve building of a high amount of artificial structures in the marine environment that modify the original environmental conditions and faunal communities. The fouling biota is usually composed by macroalgae and invertebrates as arborescent bryozoans and hydroids which house small mobile or interstitial epifauna associated to them. The bryozoan *Bugula neritina* is a common species in marinas that grows forming upright, bushy and branching tufts, up to 15 cm. Some studies have explored the diversity of macrofauna harboured by different species of bryozoans, but the meiofauna assemblages associated to this taxon remains unexplored. The present study provides the first spatial characterization of the meiofauna associated with the bryozoan *B. neritina* in anthropogenic marine areas as marinas. For this aim colonies of *B. neritina* were collected from marinas at different points of Atlantic and Mediterranean shores of Andalusia (South Spain). Environmental factors and the amount of habitat (i.e. bryozoans colony volume) were also analysed. A total of 4194 individuals and 12 taxa were found. Meiofauna assemblages of these colonies were dominated by nematods (49.2%), copepods (23%), amphipods (13.1%), ostracods (6%), bivalves (5.6%) and polychaetes (1.7%). Another six taxa were rare (less than 1% in abundance). The structure of meiofauna assemblage did not show any significant correlation with the amount of habitat. Therefore, the amount of habitat provided by *B. neritina* does not shape the abundance and diversity of meiofaunal assemblage living in this bryozoan.

Key words: Meiofauna, *Bugula neritina*, South Spain, Marinas.

Poster

General session

Size-density patterns in phytoplankton communities: a global perspective

Gjoni, V.[1], Cozzoli F. [1], Stanca E. [1], Roselli L. [3] and Basset A.[1, 2]

[1] Department of Biological and Environmental Sciences, University of Salento ITALY - Email: gjoni.vojsava@unisalento.it
[2] LifeWatch ERIC Service Centre
[3] Environmental Protection Agency of the Apulia Region, ITALY

The mechanisms underlying coexistence of phytoplankton species, with similar nutrient requirement in a relatively isotropic environment, have been addressed with different approaches involving dynamic equilibria. A relative invariance of phytoplankton community size structure, when compared with taxonomic species composition, has been recently observed suggesting that size structure has a major architectural role in the process of defining phytoplankton biodiversity. Here, we analyse the patterns of size density relationships in phytoplankton communities of lagoon-type ecosystems across a large-scale latitudinal gradient, with a focus on the Cross Community Scaling Relationships (CCSR) describing the patterns of variation of individual density and average individual body size in representative samples of phytoplankton communities.
This study aims to: *i.* describe CCSRs shape and consistency with (or deviation from) expectation on phytoplankton communities, *ii.* analyse patterns of CCSR variability within and among a large number of lagoon ecosystems, reflecting large scale in latitude, and *iii.* evaluate the effect of potential ecosystem drivers that are known to influence phytoplankton communities. To this aim, we performed a study using the already-existing data from 135 sampling sites, 15 lagoon ecosystems complexes in 5 continents (Australia, Brazil, Maldives, Scotland and Mediterranean). The dataset include 422 taxa and 142800 individual cells, analysed for the assessment of their taxonomic identification, individual body shape and body size. The results emphasize biogeographical patterns of species richness and related patterns of variation of both slopes and intercepts of the CCSR, which allow to have inference on competitive interactions between phytoplankton species and on energy flows across ecosystems.

Poster

General Session

EUROBUS – Towards a EURopean Observatory of the non-indigenous calanoid copepod Pseudodiaptomus marinus

WGEUROBUS (contribution presented on behalf of the WG by **Marco Uttieri**)

Since 2007, the non-indigenous calanoid copepod *Pseudodiaptomus marinus* Sato, 1913 is expanding its distribution in European waters at an unexpectedly fast pace. In addition to this aspect, this species presents interesting biological traits which make it of potential use for baseline as well as applied research topics. The WGEUROBUS stemmed from the shared interest of researchers from different Countries to focus on the various aspects of the biology and ecology of *P. marinus*. In the present contribution, the manifesto of the WG is presented, providing an updated view of the European distribution of *P. marinus*, as well as defining priority research lines that can be developed in the framework of the EUROBUS project.

Poster

General session

Using science fuel to drive a change: a case study involving microplastics, whale sharks and stakeholders in the Maldives

Alina M. Wieczorek[1*], Ibrahim Shameel[2], Katie Hindle[2], Iru Zareer[2], Giulia F. Donati[34]
**Alina.Wieczorek@nuigalway.ie*
[1]Ryan Institute, School of Natural Sciences, National University of Ireland Galway, Ireland
[2]Maldives Whale Shark Research Programme, Maldives
[3]Landscape Ecology, Department of Environmental Systems Science, ETH Zurich, Switzerland
[4]Landscape Ecology, Swiss Federal Research Institute WSL, Birmensdorf, Switzerland

Due to their remote location and increasing tourism, the Maldives struggle with their waste management. The environmental consequences of this are reflected in the results of a recent study reporting microplastics to be particularly abundant in this Archipelago. However, the Maldives also feel the great responsibility to protect their unique marine habitats, home to an astonishing biodiversity, including many threatened species. Among these, the endangered whale shark (*Rhincodon typus*). Whale sharks are of high economic value the “island nation” as the opportunity to encounter them lures tourists from all over the world and tourism has become the largest economy of the Maldives. It would thus be prudent from an ecological and economic point of view to protect and preserve their habitats and achieve good environmental status. Here, we aim to open the dialogue with the community and key actors by using findings of microplastic ingestion by whale sharks. Their feeding strategy, filtering up to 614 m3/h of sea water, make them particularly prone to microplastics ingestion. This is of concern as microplastic ingestion by other fish species has been shown to cause reductions in food uptake and predatory performance, and act as a vector of toxins, which can bioaccumulate and lead to endocrine disruption and hepatic stress. While there has been an initial effort to investigate microplastic interactions with whale sharks, to date, such research has been based on presence of plasticisers in their tissues. Through the analysis of faecal matter, we identified a non-invasive method to provide empirical evidence of microplastic ingestion by whale sharks. At present time, ten faecal samples were collected and we proceeded to the analysis of five initial samples, each of which contained microplastics. Using these findings, we provided scientific evidence of the extend of microplastic pollution in the Maldives and its potential consequences for the unique marine species inhabiting these waters. We engaged with a series of stakeholder through a survey to to create a shared problem framing conducted workshops which each of the tourism sector, policy makers, local scientists as well as the general public to develop collaborative solutions between and within keystone actors. We now aim to use the help of a long-established local NGO to empower and support stakeholders to implement their solutions, but also to contribute to their efforts when introducing new regulations for marine protection.

Poster

General session

Motivations and Concerns of Early Career Marine Scientists

[1]Wieczorek AM, [2]Abdelouahab H, [3]Buselic Garber I, [4]Courtene-Jones W, [5]de Bettignies F, [6]Fais M, [7]Custódio M, [8]Gammage LC, [9]Gillis LG, [10]Greene E, [11]Laukert G, [12]López Acosta M, [13]Lubośny M, [14]McKenna R, [15]Moréno - Andrés J, [16]Palma Esposito F, [17]Piarulli S, [10]Porter K,[18]Pradhan HK, [19]Protopapa M, [20]Romagnoni G, [21]Scopetani C, [22]Silva Rocha AC, [23]Suaria G, [24]Turk Dermastia T, [25]Våge S, [26]Vieira RP

**Alina.Wieczorek@nuigalway.ie*

[1]Ryan Institute - National University of Ireland Galway, Ireland; [2]Institut National de Recherche Halieutique, Morocco; [3]Institute of Oceanography and Fisheries, Croatia; [4]Scottish Association for Marine Science, UK; [5]Sorbonne Université, France; [6]Universidade de Vigo, Spain; [7]University of Aveiro - Centre for Environmental and Marine Studies, Portugal; [8]University of Cape Town - Marine Research Institute, South Africa; [9]Leibniz Centre for Tropical Marine Research, Germany; [10]AquaTT, Ireland; [11]GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany; [12]CSIC - Centre for Advanced Studies of Blanes, Spain; [13]Institute of Oceanology - Polish Academy of Sciences, Poland; [14]Galway Mayo Institute of Technology, Ireland; [15]University of Cádiz, Spain; [16]National Research Council, Italy; [17]Alma Mater Studiorum - University of Bologna, Italy; [18]Alfred-Wegener-Institut - Helmholtz-Zentrum für Polar- und Meeresforschung, Germany; 19Hellenic Centre for Marine Research, Greece; [20]University of Oslo - Faculty of Mathematics and Natural Sciences, Norway; [21]Consorzio Nazionale Interuniversitario per le Scienze del Mare, Italy; [22]MARE - Marine and Environmental Sciences Centre, Portugal; [23]Institute of Marine Sciences - National Research Council of Italy, Italy; [24]Marine Biology Station - National Institute of Biology, Slovenia, [25]Universitetet i Bergen, Norway; [26]The Centre for Environment - Fisheries & Aquaculture Science, UK

EuroMarine is committed to supporting early career researchers and promote bottom-up science from the marine science community. The “Orienting Young Scientists of EuroMarine (OYSTER)” group was formed in early 2018 to engage with young scientists and soon expanded to include a forum of 20 PhDs and post-docs from member institutions located through 13 countries. OYSTER aims to: (1) ENGAGE with and represent early career scientists within the EuroMarine network; (2) CONTRIBUTE towards the cohesive outreach and capacity building of early career scientists across EuroMarine member organisations; (3) DEVELOP initiatives to support and integrate young researchers within the European marine landscape. Recently, OYSTER ran a survey which was distributed to institutions across Europe, to develop advice for EuroMarine in matters pertaining to the support and development of early career researchers. The feedback collected from this survey, gives insight into current issues concerning young scientists and will facilitate the development of a supportive network to address some of these issues.

Poster

General session

Population structure and genetic diversity of the European lobster (*Homarus gammarus*)

M. Pavičić[1], T. Šegvić-Bubić[1], I. Žužul[1], D. Vrdoljak[1], S. Matić-Skoko[1]
[1] Institute of Oceanography and Fisheries, 21000 Split, Croatia
*pavicic@izor.hr

The European lobster (*H. gammarus*) inhabits whole Adriatic Sea and has high market value. Therefore, fishing pressure on this species is very high and intense. We used microsatellite genotyping to assess population structure of European lobster. Nine populations were genotyped using 15 microsatellite loci divided in three multiplex. Seven populations were from Adriatic Sea, one from Aegean Sea (Greece) and one from Corsica (France), covering the central and eastern Mediterranean regions. Allelic richness per locus ranged from 5.59 ± 1.76 to 6.36 ± 1.53 while the inbreeding coefficient (F_{IS}) was highest in sampled population near Pula (0,035). The low global F_{ST} (0.00819) among populations was noted, with pair-wise comparisons only been significant for Adriatic-Aegean and Adriatic-Tyrrhenian samples. Such high gene flow within the Adriatic basin and slight gene break toward other basins has been further confirmed by Bayesian clustering analysis where samples clustered in accordance to the basin origin. To our best knowledge, population structure of European lobster within the Adriatic was investigated here for the first time, aiming to detect potential impact of high fishing pressure on genetic level and to provide recommendations for better management.

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