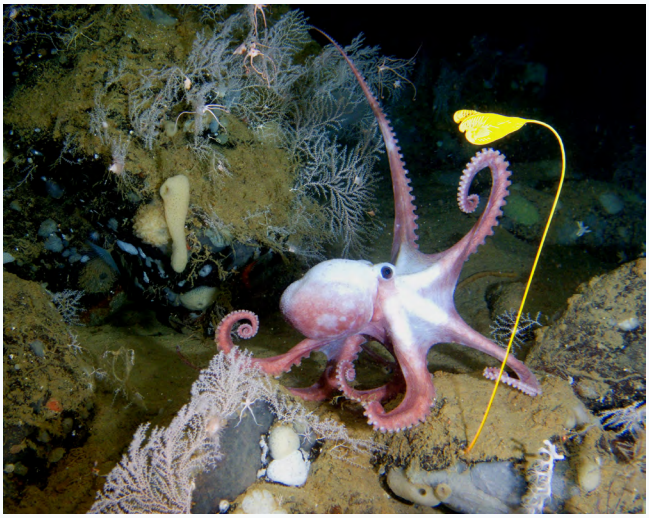
Deep-Sea Life

Issue 9, May 2017

Here we are again – now onto the ninth edition of Deep-Sea Life: an informal publication about current affairs in the world of deep-sea biology – connecting our colleagues around the globe.



This issue is dedicated to two well-known and well-loved colleagues, Torben Wolff and Graham Shimmield, who have each contributed so much knowledge to the field of ocean science, have been inspirational leaders and teachers, and were extraordinary characters. We say a sad farewell to them both – they will be affectionately remembered (see Obituary section). Torben inspired me to undertake this publication. As expressed in the first issue of DSL (March 2013), Torben's Deep-Sea Newsletter, as many of us will remember fondly, started in October 1978 and was tirelessly edited by him for 27 years (comprising 34 issues). The newsletter was intended to open regular communication between the European and, latterly, the international deep-sea community - it did the trick! When I contacted Torben in advance of Deep-Sea Life Issue 1, he was pleased that this type of communication would be re-kindled.

The photo of this issue was chosen for its sheer beauty – "Deep-sea octopus in his own garden" and perhaps is a fitting tribute to Torben and Graham. This photo captured in the Bering Sea at a depth of 2486m on 27 June 2016 shows the octopus *Moosoctopus profundorum* and Crinoid *Ptilocrinus pinnatus*. It was taken using a camera mounted on ROV, Canon PowerShot G5, f358, ISO-100 (in case you were wondering). Copyright holder: National Scientific Center of Marine Biology, Far-Eastern Branch of Russian Academy of Sciences, Vladivostok, Russia.

Once again, I would like to sincerely thank all those that have contributed to this issue of Deep-Sea Life. Your efforts are appreciated. Dr Abigail Pattenden (University of Limerick, Ireland) and Dr Eva Ramirez-Llodra (NIVA, Norway) still work alongside me to produce and edit Deep-Sea Life – they are a pleasure to work with and thank goodness for them!

Dr Maria Baker (Editor)
INDEEP Project Manager
University of Southampton

Issue Contents

Cruise News

Benthic fauna of south–western Bering Sea slope: investigations with ROV *Comanche 18*

Sergey V. Galkin[1], Georgy M. Vinogradov[1], Konstantin R. Tabachnik[1], Alexander Y. Konoplin[2], Victor V. Ivin[2], Andrey V. Gebruk[1]

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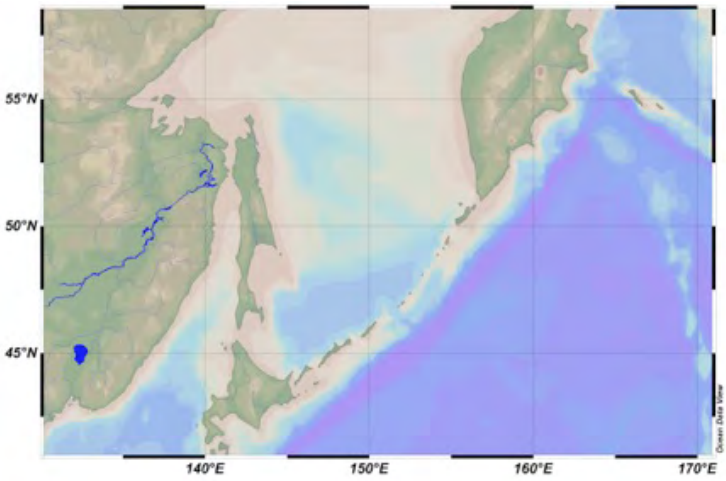
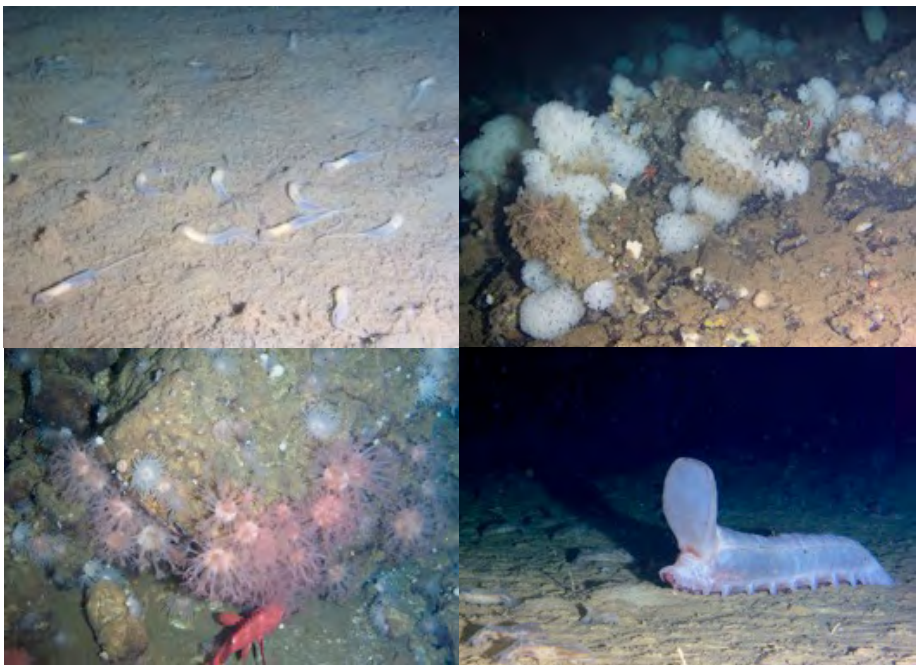
During the 75th cruise of RV *Akademik M.A.Lavrentyev* (June 2016) landscape-ecological environment and the distribution of macro and mega benthos on the northern slope of the Vulkanologov Massif (south-west Bering Sea) have been explored using ROV "Comanche 18". Seven dives were performed in the depth range from 4278 up to 349m. From technical considerations routes of dives were directed upwards along the slope. The observations were accompanied by photography, video recording and sample collection. As a result general patterns of vertical distribution of bottom communities were established. At the maximal explored depth the abyssal community is dominated by several holothurian species, among them *Kolga kamchatica* are most abundant. Starting from the depth 3600m sedimented slope is occupied by the community dominated by *Scotoplanes kurilensis*. At the depths 3000-2800m dense settlements of ophiurids (several dozens of specimens per m^{-2}) were observed. Starting from the depth of 2650m synallactid holothurians *Pelopotides solea* and red benthopelagic Trachymedusae (pres. fam. Rhopalonematidae) dominate the community. In the depth range 2290 – 1830m mass development of the acorn worms Enteropneusta (fam.



Above: The area explored during 75th cruise of RV *Akademik M.A.Lavrentyev*



Clockwise from top left: Unusually dense aggregations of acorn worms (Enteropneusta, fam. Torquaratoridae) were recorded at depths 2290 – 1830m; (top right) Dead and live sponges Farrea occa form a kind of reefs inhabited by diverse fauna. Depths 1700 – 700m; (bottom right) Abyssal pasture (depth 4278m). Holothurians: small: *Kolga kamchatica*; large: *Psychropotes longicaudata* s.l. ; (bottom left) Dominating animals of the upper slope: pink *Anthomastus* sp. (Alcyonaria) and white *Corallimorphus pilatus* (Corallimorpharia). At the bottom: rockfish *Sebastes* sp. common in this zone. Depth 450 m.

Torquaratoridae) were recorded (up to 10 specimens per m^{-2}). Above 1700m aggregations of dead and live hexactinellid sponges *Farrea occa* form the basis of landscape. Starting from the depth 700m the community is dominated by soft corals (Alcyonaria and Corallimorpharia). The summit area (390-349m) is occupied by dense settlements of zoantharians *Epizoanthus* sp. The work was partially supported by RSF grant 14-50-00095 (SG, GV, KT, and AG: collecting and processing of the material).

Discovering the Deep: Exploring Remote Pacific Marine Protected Areas

Amanda Demopoulos[1], Steven Auscavitch[2], and Brian Kennedy[3]

[1]United States Geological Survey, [2]Temple University, [3]NOAA Office of Ocean Exploration and Research

Written by: Dr. Adrienne Copeland, 2017 Sea Grant Knauss Marine Policy Fellow, in support of NOAA Office of Ocean Exploration and Research

From March 7 – 29, 2017, the U.S. National Oceanic and Atmospheric Administration (NOAA) Office of Ocean Exploration and Research and partners collected critical baseline information in the Howland and Baker Unit of the Pacific Remote Islands Marine National Monument (PRIMNM), the Phoenix Islands Protected Area (PIPA), and New Zealand's Territory of Tokelau. Using NOAA Ship *Okeanos Explorer*, the United States' first and only federal vessel dedicated to ocean exploration, the 23-day expedition gathered data to aid in the characterization of marine geology and biology throughout these areas. PRIMNM is one of the largest MPAs in the world at approximately 1,269,000 square kilometers of submerged lands and waters. PIPA is part of the Republic of Kiribati and is the largest (405,755 square kilometers) and deepest UNESCO World Heritage Site on the planet. It is mostly uninhabited and was established as a fully no-take marine protected area (MPA) in 2015. This expedition was the first time that deep-sea ecosystems in these areas were explored.

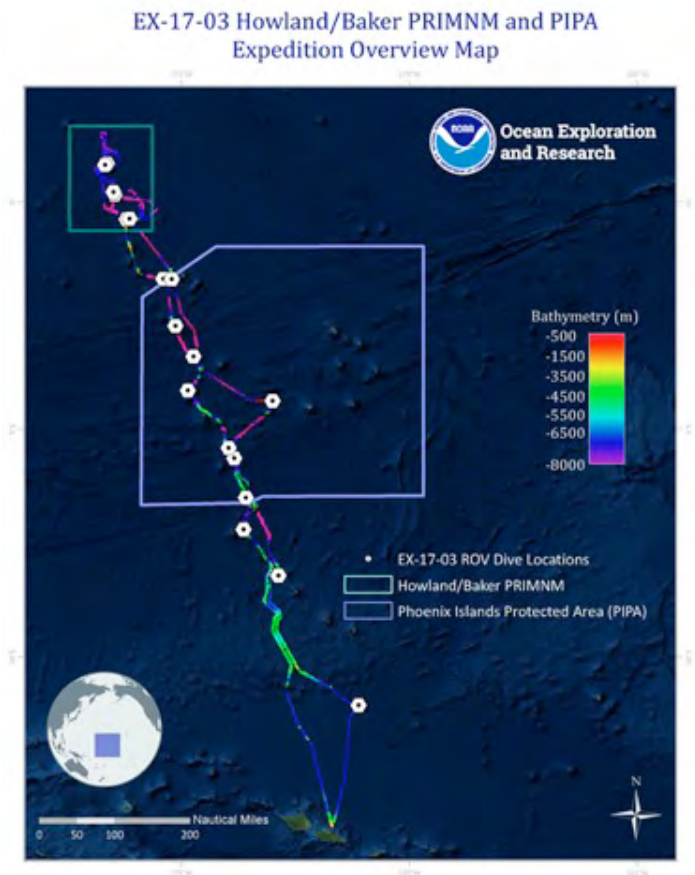


Figure 1. Overview map showing seafloor bathymetry and ROV dives completed during the expedition Discovering the Deep: Exploring Remote Pacific Marine Protected Areas part of the three-year NOAA Office of Ocean Exploration and Research Campaign to Address the Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE). Map courtesy of the NOAA Office of Ocean Exploration and Research.

The expedition team conducted 19 remotely operated vehicle (ROV) dives at depths ranging from 300 to 5860 meters. Over 300 different taxa were observed during these dives and about nine of the dive sites had a high density of biological communities. This was especially apparent within the Howland and Baker Islands and Titov Seamount, both within the PRIMNM. More than 40 of these observations included undescribed species, range extensions, depth records, or new behavioral observations. There were 36 primary biological samples (and 61 associate specimens – animals collected with the primary specimens) and four geological samples collected. Among the features being explored for the first time during this expedition was a "hadal trough," which is an area more than 6,000 meters deep. Such deep troughs are atypical in this part of the ocean; this cruise was able to provide much needed insight into the formative processes of this seafloor feature.

All of the data from this expedition are available publically through NOAA and national archives. The team collected over 15 terabytes of data that included video and still imagery, multibeam sonar and single beam echo sounder measurements, and subbottom profiles, along with current profiles, conductivity, temperature, and depth (CTD)

Top left: A rare deep-sea cirrate octopod (*Grimpoteuthis* sp.) uses the fins on either side of its head to gracefully propel itself through the water column around ROV Deep Discoverer. The scientists observed some damage on the octopod's arm and fin during a dive at an unnamed seamount within the Winslow Reef Area, Phoenix Islands Protected Area (PIPA); Top right: A caridean shrimp was observed feeding on a mid-water dragonfish at 998 meters at Ufiata Seamount within the Tokelau Seamount Chain; Bottom left: A rare mollusc, possibly a monoplacophoran, was observed at about 5,771 meters depth on the hard pavement of a sedimented plateau within the hadal trough; Bottom right: High density and diversity of coral, sponges, and associates at Titov Seamount within the Pacific Remote Islands Marine National Monument. Images courtesy of the NOAA Office of Ocean Exploration and Research, Discovering the Deep: Exploring Remote Pacific MPAs.

profiles, and dissolved oxygen measurements. During the expedition, the team mapped over 30,000 square kilometers of the ocean floor.

This expedition is part of the three-year Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE) project. CAPSTONE is a foundational science initiative to collect deepwater baseline information to support science and management decisions in and around U.S. marine protected areas in the central and western Pacific. These areas are highly remote and contain some of the last relatively pristine marine ecosystems on the planet and harbor numerous protected species, undiscovered shipwrecks, and cultural landscapes making them important areas for management and research.

Through September 2017, NOAA Ship *Okeanos Explorer* will continue to explore the central and western Pacific with upcoming expeditions in and around the Johnston Atoll Unit of PRIMNM, and the Musician's Seamount, located northwest of Hawaii. Please visit our website for more information.

#Science4HighSeas

Aurélie Spadone, International Union for Conservation of Nature (IUCN)

Top left: RV Marion Dufresne II. Copyright Gildas ROUDAUT- IRD - Institut Polaire Français IPEV Top right: Collumbellidae. Copyright IUCN/FFEM/MNHN/IRD/ Institut Polaire Français IPEV. Bottom left: Diving operations. Copyright IUCN/FFEM/MNHN/IRD/Institut Polaire Français IPEV. Bottom right: Summit area of the Walters Shoal. Copyright IUCN/FFEM/MNHN/IRD/Institut Polaire Français IPEV.

IUCN Global Marine and Polar Programme and its scientific partners - MNHN (French Natural History Museum) and IRD (French Institute of Research for Development) - carried out a new expedition at sea on Walters Shoal, a group of seamounts 700-km off the southern coast of Madagascar that rise to only 18m below sea level.

The expedition constitutes a milestone for the project led by IUCN Global Marine and Polar Programme and financed by the FFEM (French Global Environment Facility) on ''Conservation of biodiversity and sustainable exploitation of seamounts and hydrothermal vents in areas beyond national jurisdiction of the South West Indian Ocean'' (FFEM-SWIO project).

On board the RV *Marion Dufresne*, a team of 25 scientists spent 19 days exploring the Walters Shoal, dived on the summit area (between 50m and the top of the seamount) and conducted a number of oceanographic operations focusing on the benthic and pelagic communities.

In addition to helping increase knowledge and understanding of seamount ecosystems, this expedition provides an excellent opportunity to raise awareness about high seas conservation and management in the South West Indian Ocean region in the broader context of increasing discussion at the international level on this topic.

To find out more, the expedition website & blog can be accessed here; IUCN Issues brief can be found here.

Contact: Aurélie Spadone, International Union for Conservation of Nature (IUCN), Global Marine and Polar Programme,

ROC HITS (Research Of Cold seeps & How they Influence The Sea)

Cruise May-June 2017

PI Erik Cordes, Temple University, USA

The deep sea does more for us than we realize. Food, energy, drug discovery, and ecosystem services such as carbon sequestration, nutrient supply, and biodiversity. Natural methane seeps are a key part of the deep sea and are found lining the edges of the continents worldwide. On this cruise, (now underway!) we will be visiting the seeps off the Pacific coast of Costa Rica, a region of the ocean with extremely active methane release and low oxygen levels. We will find the source of the methane and determine how it is affecting the surrounding deep sea and the waters above. These studies will help evaluate the size of the seep sphere of influence, and also demonstrate the role of these seeps within the deep sea and the greater, global, marine ecosystem. We are aboard the RV *Atlantis* from Woods Hole Oceanographic Institution, and are using the *Alvin* submersible and the autonomous underwater vehicle *Sentry* to visit and study these remarkable habitats. Participants are from Temple University, Scripps Institution of Oceanography, Cal Tech, Occidental College, and the University of Rhode Island. In addition, we also have an artist on board to help us communicate this scientific research to a broad audience. Check out the cruise blog here to see our progress so far: https://www.facebook.com/roc.hits.expedition/, and our instagram: instagram.com/ROC_HITS_Expedition/

Project Focus

Multiple expeditions to explore and map deep-sea coral ecosystems in the Southeast United States in 2017

National Oceanic and Atmospheric Administration (NOAA)

Contact: daniel.wagner@noaa.gov

Last year, the National Oceanic and Atmospheric Administration (NOAA) launched the Southeast Deep Coral Initiative (SEDCI), a four-year effort that aims to study deep-sea coral and sponge ecosystems across the Southeast U.S., a region including the U.S. waters of the South Atlantic Bight, Caribbean Sea, and Gulf of Mexico. The initiative is the latest regional research effort by NOAA's Deep Sea Coral Research and Technology Program. It is led by a multidisciplinary science team from multiple NOAA offices, including National Ocean Service, National Marine Fisheries Service, and Office of Oceanic and Atmospheric Research, that works in close collaboration with other federal and academic institutions.

Guided by the SEDCI science plan, the initiative has five research expeditions planned for this year, in addition to ten complementary research projects focused on seafloor mapping, species identification, environmental monitoring, habitat suitability modeling, and data mining. Expeditions planned for 2017 include (1) two expeditions aboard the NOAA Ship *Nancy Foster* that will survey deep-sea coral habitats off Florida using an ROV and multibeam mapping, (2) a 12-day expedition aboard the NOAA Ship *Pisces* that will survey deep-water canyons off North Carolina using AUV *Sentry*, and (3) two expeditions aboard the R/V *Manta* that will survey deep-water banks in the Northwestern Gulf of Mexico using ROV *Mohawk*. These research expeditions will be led by NOAA scientists Peter Etnoyer, Martha Nizinski and Emma Hickerson, respectively, and include partners from academic institutions and federal agencies.

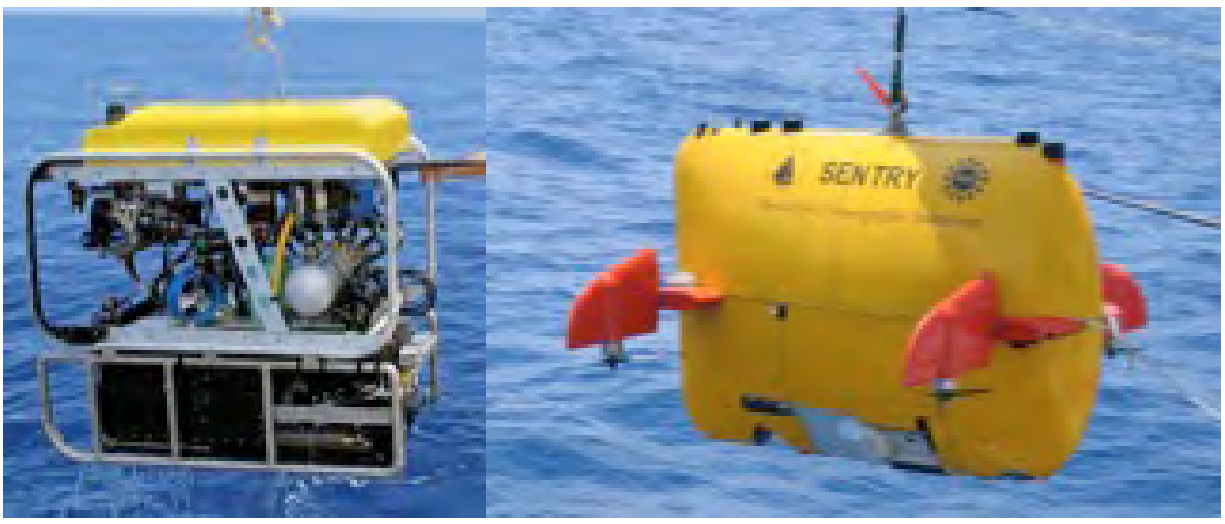


Figure 1 (Left): ROV Mohawk will be used during two 2017 expeditions that will survey deep-water (50-300 m) banks in the Northwestern Gulf of Mexico in support of management of the Flower Garden Banks National Marine Sanctuary (credit: NOAA/UNCW-UVP). Figure 2 (Right): AUV Sentry will be used during a 2017 expedition that will survey deep-water canyons off North Carolina (credit: NOAA/WHOI).

The overall objective of SEDCI is to collect scientific information in order to improve the management and conservation of deep-sea coral ecosystems. In particular, there are several proposals for the establishment of managed areas in deep waters of the Southeast U.S., including proposed expansions of the Flower Garden Banks National Marine Sanctuary, potential new habitat areas of particular concern in the Gulf of Mexico, and new special management zones in the

U.S. South Atlantic. SEDCI expeditions will target many of these areas this year, and additional expeditions are planned in 2018-2019. Funding for SEDCI expeditions is provided by NOAA through the Deep Sea Coral Research and Technology Program, the Office of Exploration and Research, the Southeast Fisheries Science Center, the Office of National Marine Sanctuaries, and the National Centers for Coastal Ocean Science.

Figure 3: Map showing the three geographic regions where the Southeast Deep Coral Initiative will operate in 2016-2019. Areas where deep-sea corals are protected through fishing restrictions are shown in orange. (Credit: NOAA).

Deep-sea modelling

Henry Ruhl[1], Andrew Yool[1], Jennifer Durden[2], Charlotte Main[3], Katherine Dunlop[4] & Andrew Sweetman[4]

[1]National Oceanography Centre, Southampton, UK, [2] Norwegian University of Science and Technology, [3]MBARI , [4]Heriot-Watt University

The National Oceanography Centre, along with UK and international collaborators, has been applying a spectrum of modelling tools to address questions relating to ecology and human impact in the deep sea. This research has investigated how variations in time, location, depth, currents, temperature, seafloor shape, as well as other ecological factors influence benthic communities.

The partitioning of stocks and flows of carbon in the abyss were examined using linear inverse models to estimate the importance of benthic functional groups under differing periods of food supply (Dunlop et al., 2016), and topographic settings (Durden et al., in press). Three-dimensional, time-resolved particle tracking has been used to investigate the pathways by which potential accidental oil releases from the seafloor or water column in the West of Shetland area may impact the ocean and seafloor (Main et al., 2017). At a global scale, our benthic modelling has used forcing from Intergovernmental Panel on Climate Change (IPCC) greenhouse gas emission scenarios to explore future change. This work has included examination of expected changes in deep-sea temperature, oxygen, pH, and food supplies (Sweetman et al., 2017). Additionally, changing food supply has been used to force a global-scale benthic model to estimate future change in size-specific biomass (Yool et al., in press).

The evolution of these tools in the future should allow for improvement in both their ability to represent benthic ecosystems, and in their utility for bridging knowledge from scales of in situ observations to scales of management and policy.

Dunlop, KM, D van Oevelen, HA Ruhl, CL Huffard, LA Kuhnz, KL Smith Jr. 2016. Carbon cycling in the deep eastern North Pacific benthic food web: Investigating the effect of organic carbon input. Limnology and Oceanography. (DOI: 10.1002/lno.10345).

Durden, JM, HA Ruhl, C Pebody, SJ Blackbird, D van Oevelen. 2017. Differences in the carbon flows in the benthic food webs of abyssal hill and plain habitats. Limnology and Oceanography. (DOI: 10.1002/lno.10532).

Main, CE, A Yool, NP Holliday, EE Popova, DOB Jones, HA Ruhl, 2017. Simulating pathways of subsurface oil in the Faroe–Shetland Channel using an ocean general circulation model. Marine Pollution Bulletin 114: 315-326.

Sweetman, AK, AR Thurber, CR Smith, LA Levin, C Mora, C-L Wei, AJ Gooday, DOB Jones, M Rex, M Yasuhara, J Ingels, HA Ruhl, CA Frieder, R Danovaro, L Würzberg, A Baco, BM Grupe, A Pasulkax, KS Meyer, KM Dunlop, L-A Henry, J Murray Roberts. Major impacts of climate change on deep-sea benthic ecosystems. Elementa: The Science of the Anthropocene 5: doi.org/10.1525/elementa.203.

Yool, A, AP Martin, TR Anderson, BJ Bett, DOB Jones, and HA Ruhl. 2017. Big in the benthos: Future change of seafloor communities in a global-scale, body size-resolved model. Glob. Change Biol. DOI: 10.1111/gcb.13680.

New NOAA water column exploration initiative

Amanda Netburn, Cooperative Institute for Ocean Exploration, Research & Technology

Florida Atlantic University and NOAA Ocean Exploration & Research

NOAA's Office of Ocean Exploration and Research (OER) and its partner, the Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) at Florida Atlantic University, are leading an effort to strengthen exploration-based activities in the water column. A vastly understudied and challenging environment, the water column comprises >90% of the inhabitable volume on Earth, contains much of the planet's biomass and biodiversity, and is the location of essential biogeochemical processes such as carbon sequestration. The water column exploration endeavor kicked off in February in Honolulu, HI with the ASLO (Association for the Sciences of Limnology and Oceanography) 2017 Aquatic Science Meeting session, Characterizing Exploration in the Water Column, and the workshop, From Surface to Seafloor: Exploration of the Water Column, held on March 4-5, 2017.

The nearly 50 participants at the workshop included experts in chemical oceanography, microbiology, midwater ecology, biologging, eDNA, mooring-based observations, ROV-based investigation, technology development, and more. Breakout sessions covered baseline characterizations of the water column, key scientific questions and data gaps, leveraging existing opportunities, and recommendations for organizing a dedicated water column exploration program. There was rigorous discussion on all of these topics, and OER and CIOERT received valuable input that will guide future water column exploration initiatives. Recommendations will be incorporated into NOAA Ship Okeanos Explorer expeditions and funding priorities as appropriate. A listserv, Water Column Explorers, has been created to facilitate communication within this community, and provide a venue to update interested colleagues. Please contact amanda.netburn@noaa.gov if you would like to join this listserv.

Collaboration with history – Azorean fishermen and deep-sea scientists

Meri Bilan

MARE – Marine and Environmental Sciences Centre, Universidade dos Açores

One of the major challenges of deep-sea research lies in the high cost associated with sampling such a remote environment. In the Azores, our current level of knowledge on the diversity of deep-sea habitats could have only been achieved through our close collaboration with local fisherman. Since 2007, Azorean scientists have worked with the bottom hook-and-line fleet for collecting information on deep-sea fauna but also to obtain general information on the fishing operations.

At the beginning of this year, four European H2020 projects (ATLAS, DiscardLess, MERCES and SponGES), in collaboration with the Azores fisheries observer program (POPA), have joined efforts to put two observers onboard fishing vessels (Figure 1). The role of the observers is to collect data and biological samples that will feed into different tasks of the projects. The collaboration that has been ongoing for almost 6 months has proven to be successful and is further bridging links between local fishermen and scientists.

Figure 1: *Manuel de Arriaga* fishing boat

This observer program will benefit ATLAS and SponGES projects by providing specimens of cold-water corals, sponges and their associated fauna for taxonomy, genetic, biodiversity and biogeography studies as well as to increase our understanding on deep-sea ecosystem functions and continuing assessing fisheries impacts on vulnerable marine ecosystems (Figure 2). These efforts will contribute to the acquisition of essential knowledge about North Atlantic deep-sea habitats, develop, improve, and validate biodiversity spatial distribution models, help guide sustainable Blue growth development and support integrated Maritime Spatial Planning in the North Atlantic. When possible, observers are collecting live cold-water corals that will be used in the context of the MERCES project to test techniques of coral transplantation and evaluate its applicability for the active restoration practices of degraded coral gardens (Figure 3).

Figure 2 (left): *Callogorgia verticillata* caught by long-line fishing (Meri Bilan in the picture). Figure 3 (right): Observer and scientist in aquaria: (left Antonio Godinho (scientist), right: Rodrigo Sa da Bandeira (observer))

Another important task of this observer program is to collect fisheries-related data to the Discardless project, mainly to produce improved estimates of discard practices in the Azores hook-and-line deep-sea fisheries. Discardless case study in the Azores aims at evaluating the efficiency of management measures to reduce unwanted by-catch of deep-water sharks, increase survival of released sharks, and meet the requirements of the Common Fisheries Policy in general and the Landing Obligation in particular.

By integrating resources from four distinct H2020 projects this observer program will run for 12 months, and is a good example of the importance of collaboration between different research projects for collecting scientific information for very distinct but complementary purposes.

- ATLAS: http://www.eu-atlas.org/
- DiscardLess: http://www.discardless.eu/
- MERCES: http://www.merces-project.eu/
- SponGES: http://www.deepseasponges.org/
- POPA: http://www.horta.uac.pt/projectos/popa/index_EN.htm

SFI project – Exploiting and conserving deep-sea genetic resources

Claire Laguionie Marchais

National University of Ireland Galway

Starting in September 2016, the 5-year Science Foundation Ireland project "exploiting and conserving deep-sea genetic resources" focuses on biodiscovery research in Irish deep-sea Cnidaria and Porifera. The aims are three-fold:

1) find new bioactive natural products from deep-sea corals and sponges in Irish offshore waters;

2) develop informed bioprospecting approaches to maximise the chance of finding these compounds in hard to sample environments such as the deep sea;

3) inform conservation planning in relation to biodiscovery hotspot clusters.

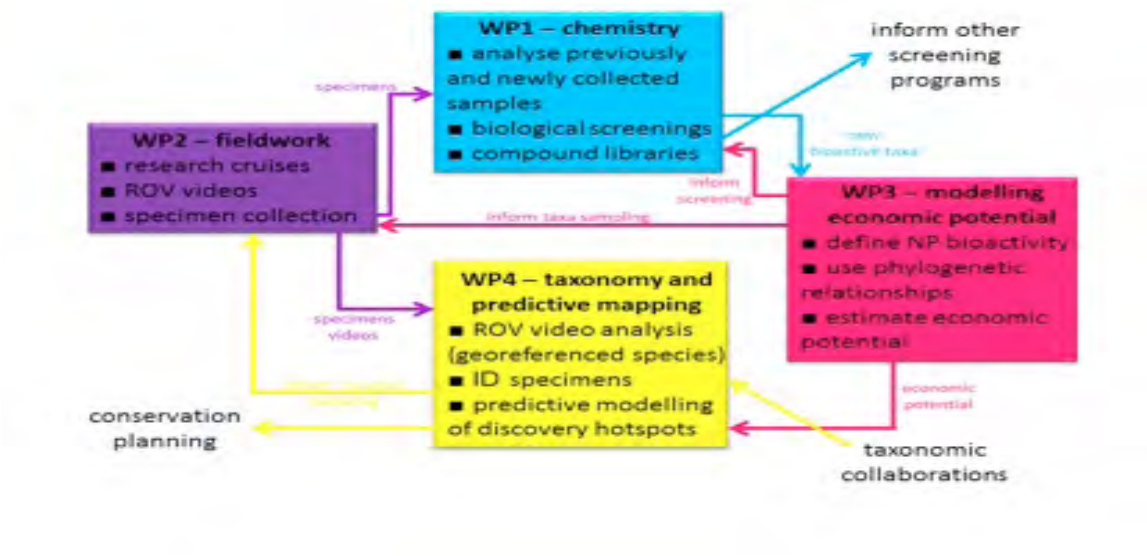
Figure 1: Example of Irish deep-sea Cnidaria and Porifera.

The project is timely and significant as, for example, the potential value of anti-cancer drugs alone from marine organisms has been estimated to be between a billion and 5 trillion US dollars. The deep sea has remained stubbornly out of reach of natural products chemists due to the difficulty of accessing samples there as well as the sparse knowledge of the biodiversity. The deep sea is, however, a particularly interesting target for biodiscovery for two reasons. Firstly the extreme conditions (e.g., high pressures) under which organisms live, necessitate physiological and cellular adaptations increasing the likelihood of finding unique secondary metabolites. Secondly, the deep sea is dominated by the phyla Porifera and Cnidaria and, since the 1990s, almost 80% of novel marine natural products from invertebrates have been derived from these two groups. Ireland, with its nearly 900,000 ha of sea floor, prevalence of submarine canyons, and

highly diverse coral mounds, is rich in Cnidaria and Porifera communities and has great potential for marine genetic resources. Increased access to remotely operated vehicles (ROVs) is opening up new collection opportunities.

One issue with the deep sea is that we do not always know which species are present, as survey work to date has been limited, and only a small area has been sampled. By using predictive modelling, both to predict the likelihood of a taxon containing novel bioactives, and by predicting the distribution of species, we can maximize the likelihood of obtaining 'hits' in future biodiscovery work. These data can be used to stimulate conservation policy debate to ensure these important genetic resources are adequately conserved for future exploitation.

The project is divided into four work packages:



PI – Dr. Louise Allcock (NUIG), co-PI - Dr. Mark Johnson (NUIG), co- PI Pr. Bill Baker (USF), postdoc -Dr. Ryan Young (NUIG), postdoc - Dr. Claire Laguionie Marchais

For further information, please contact: Dr. Claire Laguionie Marchais (NUIG); Website under construction at http://marinescience.ie/

News: Workshop on sustainability in marine biodiscovery, June 7-9th, Galway, Ireland: http://susmarb.weebly.com/

The Strait of Messina where deep-sea fishes land on the beach

Modica Maria Vittoria[1]*, Stefanni Sergio[1]*, Tarallo Andrea[1]*, Vecchi Fabrizio[1], Oliverio Marco[2], Di Capua Iole[1], Buschi Emanuela[1,3], Furfaro Giulia[4], Mariottini Paolo4, Santini Francesco[5], Stanković David[6], Tamburrini Federica[1]

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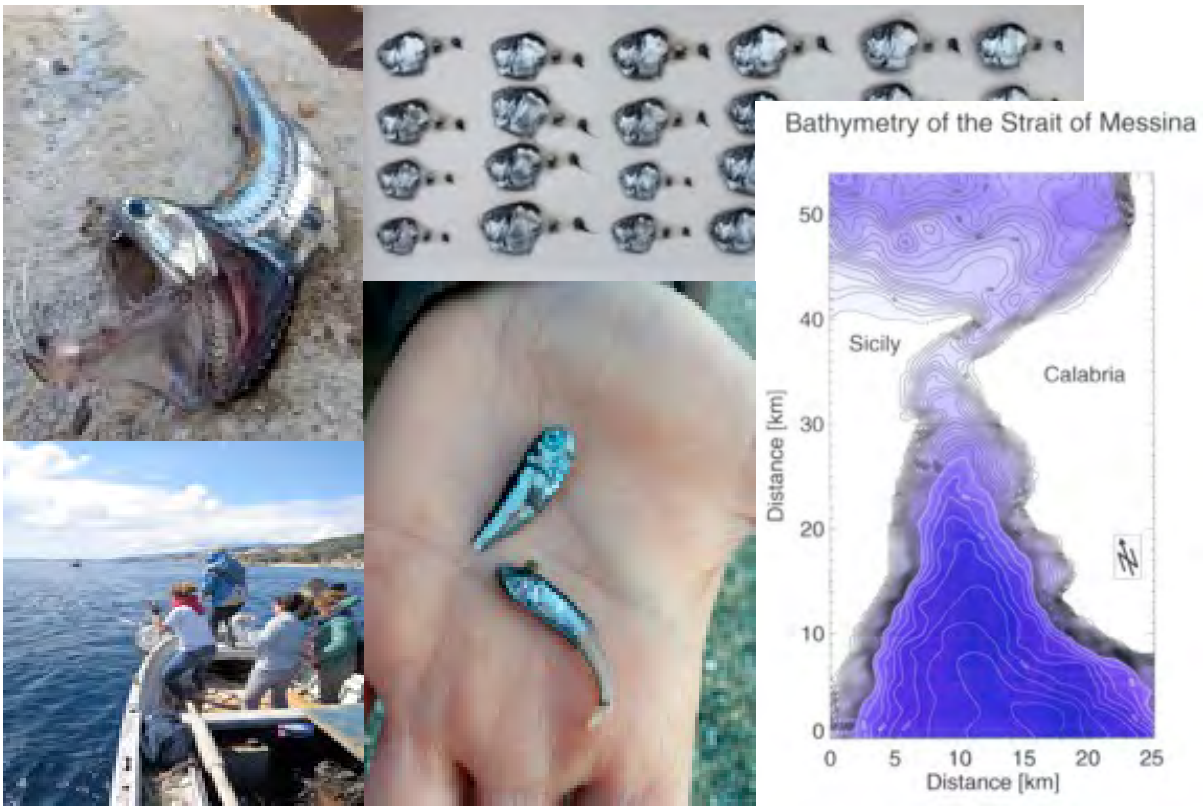
The Strait of Messina is a narrow passage between the southern tip of the Italian peninsula and the island of Sicily, allowing the merging of the Tyrrhenian and Ionian Seas. The existence of strong and unpredictable currents that characterize the area has been known since ancient times, and has contributed to the origin of legends about marine

monsters (Scylla and Charybdis) that would swallow unwary fishermen. The Messina Strait possesses a peculiar geomorphology, including a ridge with the shallowest depth of 64 m slowly degrading toward the Tyrrhenian Sea on its northern face, reaching a depth of 1,000 meters off the Bay of Milazzo, and 2,000 meters north of the island of Stromboli. The southern slope is, however, much steeper, descending very sharply towards the Ionian Sea, so that the seabed between the cities of Messina and Reggio reaches depths below 400-500 meters. One of the most significant aspects of the Strait is the constant 27-28 cm difference in sea level of the two basins, a difference that gradually decreases until leveling off at the point of contact between the Tyrrhenian and the Ionian Seas. This phenomenon results in intense gradient tides on both directions of the Strait, with the onset of surging tidal currents that on occasion may reach remarkable speed. These currents are active throughout the water layers, from the bottom all the way up to the surface. Furthermore, due to the peculiar morphology of the seabed, the water flows tend to gain additional strength, creating real abyssal storms and culminating in strong upwelling of deep waters in combination with a series of counter-current vortexes. These events are particularly strong during the Perigean spring tides, when the new full moon coincides closely in time with the perigee of the moon — the point when the moon is closest to Earth. Such tides can generate unusually strong upwelling of deep waters, pulling many organisms from the deep first to the surface of the strait, and then eventually onto the shore, due to wind-sustained drift. This is made possible by the fact that when many deep-sea organisms - including several species of fishes - become trapped into strong currents, they are unable to escape, and are then dragged to the surface very quickly, suffering massive barotrauma that either kills or severely incapacitates the animals.



Several previous studies have already reported on the organisms that beached after those peculiar events (Guglielmo, 1969; Genovese et al., 1971; Guglielmo et al., 1973; Scotto Di Carlo et al., 1982).

This year the upwelling event reached its peak between the 27th and 30th of March, and a group of researchers from the Stazione Zoologica Anton Dohrn, as well as several Italian universities, carried out a short - but intensive - sampling expedition to gather deep-sea fishes that had beached along the Calabria shore line of the Strait of Messina, from the beach of Cannitello to Villa San Giovanni. In order to determine how short-term variation of the zooplankton community structure in this area was affected by the complex system of currents, we also collected zooplankton samples with oblique and horizontal hauls using a WP2 net (200 µm mesh size) in front of Capo Faro beach, observing

a swarm of larval stages of the euphausiid *Thysanöessa gregaria* concentrated near the surface.

During the sampling expedition several hundred individuals belonging to 18 different fish species (including 12 species of deep sea fishes) were collected and preserved in ethanol, RNAlater, or cryogenically for future studies on population genetics, functional genomics, and trophic ecology. Most of the beached fish specimens were in a remarkably good state of preservation, with several specimens found still alive, indicating a very recent beaching event.

This stranding phenomenon provided an unprecedented opportunity to sample normally hard-to-get deep-sea fauna without the need to use expensive oceanographic vessels, substantially reducing sampling costs.

List of deep water fish species collected at the Cannitello beach during the Abyss Day 2017

Order	*Family*	*Species*
AULOPIFORMES	PARALEPIDIDAE	*Arctozenus risso*
AULOPIFORMES	PARALEPIDIDAE	*Sudis hyalina*
MYCTOPHIFORMES	MYCTOPHIDAE	*Myctophum punctatum*
MYCTOPHIFORMES	MYCTOPHIDAE	*Electrona rissoi*
MYCTOPHIFORMES	MYCTOPHIDAE	*Hygophum benoiti*
MYCTOPHIFORMES	MYCTOPHIDAE	*Diaphus holtii*
MYCTOPHIFORMES	MYCTOPHIDAE	*Ceratoscopelus maderensis*
OSMERIFORMES	MICROSTOMATIDAE	*Nansenia oblita*
STOMIIFORMES	STOMIIDAE	*Chauliodus sloani*
STOMIIFORMES	STERNOPTYCHIDAE	*Argyropelecus hemigymnus*
STOMIIFORMES	PHOSICHTHYIDAE	*Vinciguerria attenuata*
STOMIIFORMES	STERNOPTYCHIDAE	*Maurolicus muelleri*

References:

Genovese S, Berdar A, Guglielmo L (1971) Spiaggiamenti di fauna abissale nello Stretto di Messina. Atti della Società Peloritana di Scienze Fisiche Matematiche e Naturali 17: 331–370.

Guglielmo L (1969) Spiaggiamenti di Eufausiacei lungo la costa messinese dello Stretto dal dicembre 1968 al dicembre 1969. Boll Pesca Piscic Idrobiol, 24: 71-77.

Guglielmo L, Costanzo G, Berdar A (1973) Ulteriore contributo alla conoscenza dei crostacei spiaggiati lungo il litorale messinese dello Stretto. Atti della Società Peloritana di Scienze Fisiche Matematiche e Naturali 19: 129-156.

Scotto Di Carlo B, Costanzo G, Fresi E, Guglielmo L, Ianora A (1982) Feeding ecology and stranding mechanisms in two lanternfishes, Hygophum benoiti and Myctophum punctatum. Mar Ecol Prog Ser 9: 13-24.

Hundreds of Russian Hat sponges collected from Ocean Tracking Network (OTN) Halifax Line

Anja Samadzic

Ocean Tracking Network

A unique species of marine sponge has been collected from a series of Ocean Tracking Network moorings near Halifax, Nova Scotia. OTN technicians discovered hundreds of sponges densely settled and growing on moorings during a

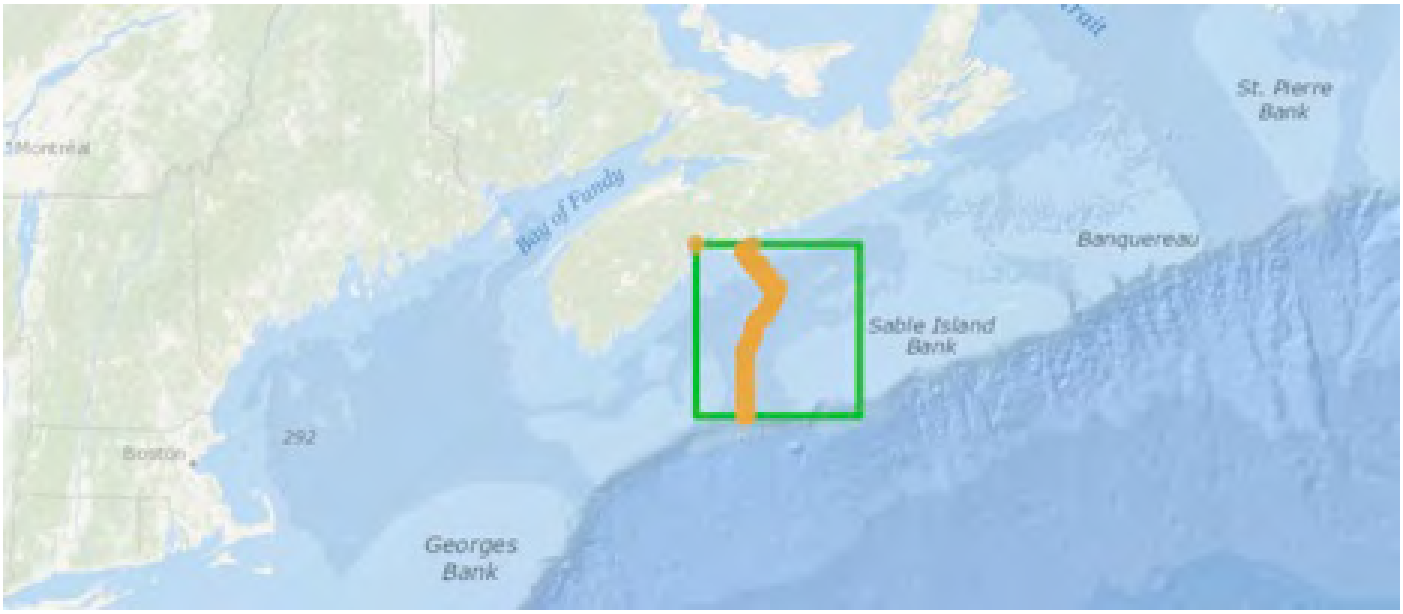


Figure 1: OTN's Halifax Line

routine service trip of the Halifax Line — OTN's longest acoustic tracking array, which includes 184 bottom-moored stations over 200 kilometres from Halifax to the Scotian Shelf break.

Figure 2: Two mooring floats containing live Russian Hat samples.

The species was identified as the Russian Hat sponge (*Vazella pourtalesi*) by Dr. Ellen Kenchington, a research scientist with Department of Fisheries and Oceans Canada (DFO). Dr. Kenchington studies Russian Hats through the EU Horizon 2020-funded SponGES project, a scientific initiative conducting research on deep-sea sponges to improve the preservation and sustainable exploitation of Atlantic marine ecosystems.

On December 7, 2016 OTN technicians, accompanied by DFO personnel, embarked on a trip to collect samples for further analysis. The majority of offshore moorings contained hundreds of Russian Hat sponges, which were collected and brought to DFO – Bedford Institute of Oceanography (BIO). Two mooring floats containing live samples were also brought to BIO.

This finding, that led to a partnering between OTN and the SponGES project, will help understand species distribution and assist with conservation efforts of marine sponges and their habitats.

The Russian Hat samples collected from OTN's moorings will be used to study the genetic diversity, structure, growth rates, reproductive biology, recruitment and connectivity of this unique species of sponges which form dense grounds in the Emerald Basin off the southern tip of Nova Scotia.

This valuable find will provide an opportunity to uncover unknown information about Russian Hat sponges. Additionally, collected samples will serve to increase researchers' understanding of how these sponges adapt to ocean climate change and human-caused impacts such as pollution.

DFO Deep-Sea Vazella Sponges Video

BENEFICIAL (Biogeography of the northwest Pacific fauna. A benchmark study for estimations of alien invasions into the Arctic Ocean in times of rapid climate chance)

Angelika Brandt

Senckenberg Research Institute and Natural History Museum, Frankfurt, German

During the past six years, the biology of the bathyal, abyssal and hadal faunas of all size classes (meio- macro-, and megabenthos) of the NW Pacific have been intensively investigated based on an MoU between Russian and German partners. A total of four Russian-German and German-Russian expeditions with both RV Akademik M.A. Lavrentyev as well as RV Sonne have provided a wealth of data on the systematic, evolution and biogeography of the Sea of Japan, Sea of Okhotsk, the Kuril-Kamchatka Trench (KKT) and the NW Pacific open abyssal plain. Goals of these expeditions were to study the biodiversity, biogeography and trophic characteristics of the benthic organisms in different northwest (NW) Pacific deep-sea environments and to compare more isolated deep-sea basins with more easily accessible ones (Sea of Japan vs. Sea of Okhotsk) and to test whether the hadal of the KKT isolates the fauna of the Sea of Okhotsk to the fauna of the open NW Pacific area. The Aleutian Trench (AT) is connected to the KKT and the Arctic Bering Sea as well via the Kamchatka Strait which is about (191 km wide) and 4420 m deep). The aim of our proposed project is to deliver a sound biogeographic baseline study of the NW Pacific area including the data being available from the Aleutian Trench and the southwestern Bering Sea. We aim at compiling a novel book on the biogeography of the NW Pacific faunas, which will also provide information on highly abundant key species which might potentially invade the Arctic Ocean in future (both from the hadal but also shallower deep-sea areas of the NW Pacific) under decreasing sea-

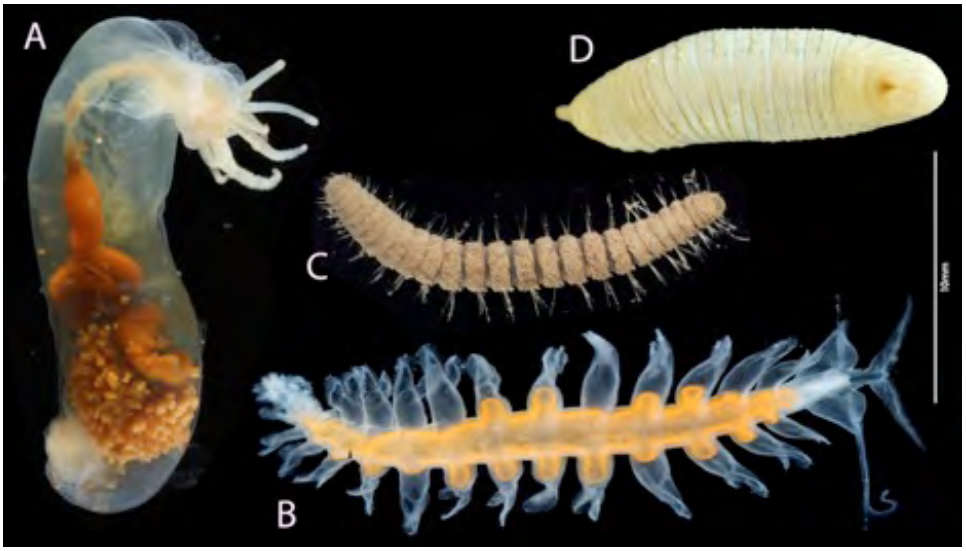


Figure 1: Some pelagic (A, B) and benthic (C, D) polychaetes collected during the KuramBio II expedition: A – *Poeobius* sp., B – *Tomopteris* sp., C – *Brada* sp., D – *Kesun* sp. (Foto by Anastassya S. Maiorova).

ice conditions. Our data will serve as a solid basis and benchmark for predicting potential species invasions supported by the retreat of Arctic Ocean sea ice. Thus our data will be beneficial for the assessment of state and quality of the Arctic marine ecosystem in a changing environment.

The main objectives are to:

1. Describe important and frequent species from the northwest Pacific area based on our expedition material sampled

since 2010,

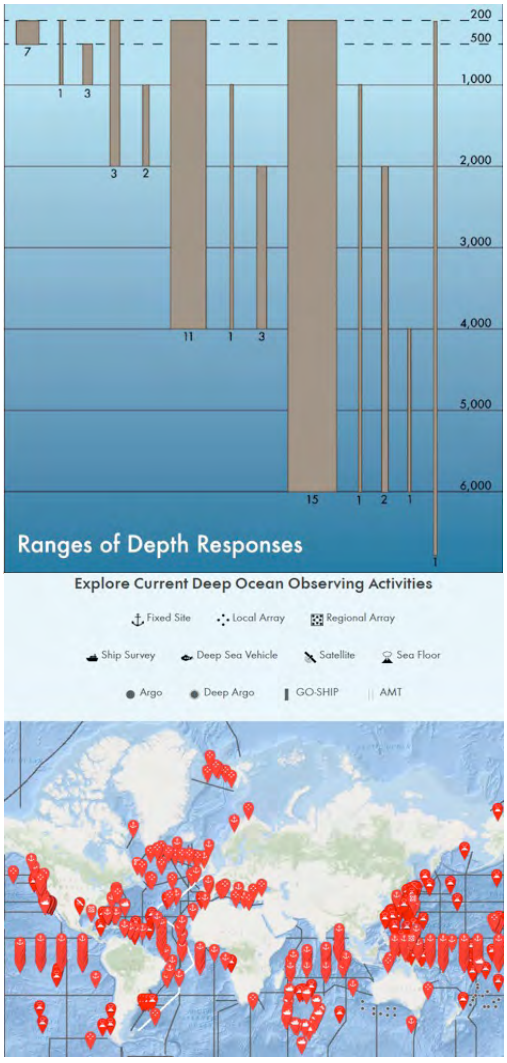
2. Perform an international workshop on the biogeography of the northwest Pacific fauna in Germany,

3. Publish a book on the biogeography resulting from the workshop and including the most important information on faunal key groups which have the potential to immigrate the Arctic Ocean in times of changing climate and retreat of sea ice and,

4. Disseminate this information globally via international databases (e.g. via CeDAMar and OBIS).We hypothesize that our compilation of the composition and distribution of the northwest Pacific fauna will already shed light on

climate change related range shifts in biogeography of selected species.

The Deep Ocean Observing Strategy: Developing a Network for Sustained Physical, Chemical, and Biological Observation in the Deep Sea



Now that observations have illuminated the deep ocean below 200 meters – exposing highly diverse, deep-sea ecosystems and resources - experts are coming together to develop a strategy for sustained, global deep ocean observations. The Deep Ocean Observing Strategy (DOOS) considers essential ocean variables, key geographic regions, readiness for implementation and emerging technologies that will provide a blueprint for deep-sea observing over the coming decades.

DOOS addresses this challenge by connecting scientists, industry experts, and policy scholars to integrate ocean observations, improve our deep ocean knowledge, assess environmental pressures, and highlight societal benefits. DOOS leadership hosted an exploratory workshop at the Scripps Institution of Oceanography December 2016 to develop a coordinated plan and outline steps required to turn the deep ocean observing 'strategy' into a global observing network. Workshop delegates outlined the following objectives for DOOS over the next decade:

- Build an understanding of what is most important to observe
- Provide a hub for integration opportunities
- Coordinate observations to improve efficiency, standards, and best practices
- Develop deep observing requirements

- Build readiness in observing technology and techniques
- Foster availability, discoverability, and usability of deep ocean data
- Create a community science implementation plan

DOOS works in close cooperation with the Global Ocean Observing System (GOOS) framework of the Intergovernmental Oceanographic Commission (IOC). A DOOS steering committee will guide efforts designed to support the objectives

MBON
Marine Biodiversity Observation Network

above and guide deep sea community efforts. For more information, including an inventory of deep-ocean observing and the DOOS scoping workshop report please visit: www.deepoceanobserving.org or contact info@deepoceanobserving.org.

Introducing the Marine Biodiversity Observation Network (MBON) to our deep-sea community

Maria Baker, MBON deep-sea liaison, University of Southampton, UK; Frank Muller-Karger, University of South Florida, USA; Mark Costello, University of Auckland, NZ & Isabel Souza Pinto, University of Porto, Portugal.

The vision of this new initiative, the Marine Biodiversity Observation Network (MBON), is a community of practice that



strengthens understanding of marine biodiversity and coordinates monitoring of associated changes over time through scientific observations, thereby facilitating ecosystem conservation, sustainability, and good management practices.

As MBON moves forward, it is important to ensure that the deep-sea community is aware of and engages with this programme, especially with respect to long-term deep-sea observations (e.g. via DOOS – see page 17). Geographically, MBON will focus on international collaboration to achieve worldwide activity. The current leadership comprises three Co-chairs (photographs from left to right): Frank Muller-Karger, Mark Costello and Isabel Souza Pinto.

With a format comparable to DOSI, MBON is a network rather than a legally-incorporated structure or organization.

As a community of practice and collaboration, groups can engage in relatively informal or formal agreements. MBON is a “coalition of the willing” who agree to share knowledge and know-how to evaluate changes of biodiversity in the ocean, including data, products, protocols and methods, data systems and software. Members of this network are anticipated to include government agencies, academic institutions, researchers, research and non-governmental organizations, and commercial organisations.

As background, the following summary is adapted from the MBON Implentation Plan:

Governments and scientists around the world have recognized the need for information to evaluate changes in biodiversity. For example, to evaluate progress toward the U.N. Sustainable Development Goals (including SDG 14), Aichi Targets of the Convention on Biological Diversity (CBD), global assessments such as those by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), and the UN World Ocean Assessment. These include changes in the abundance of living resources, species’ of ecological and conservation importance, and invasive species, from the coast to deep-sea.

To address this need for information, the Marine Biodiversity Observation Network (MBON) was established within the Group on Earth Observations (GEO) Biodiversity Observation Network (GEO BON). The goal of MBON is to develop a global community of practice for the collection, curation, analysis and communication of marine biodiversity data. This requires coordination and collaboration between countries, organisations and individuals involved in the Group on Earth Observations (GEO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and many other organisations.

The MBON Implementation Plan is currently being finalised and building membership and opportunities to develop international and thematic (e.g. coral reef) marine observation networks is well underway. It is collaborating with the Global Ocean Observing System (GOOS) of IOC to develop standardised minimum metrics of marine biodiversity as part of the Essential Biodiversity Variables (EBVs) of GEO BON and Essential Ocean Variables (EOVs) proposed by GOOS. MBON emphasizes objective knowledge of changes in marine life and ecology, and promotes the integration of regional datasets through systems such as the Ocean Biogeographic Information System (OBIS). Thus MBON is working with OBIS which is developing standards for data management and publication that enable integration and analysis of marine biodiversity data.

During 2017, MBON will formalise its governance and establish an International Secretariat by 2018. The MBON vision and strategy, and proposals on marine EBV and EOV, will be published for independent peer-review and community engagement. During 2017 and 2018, examples of international and thematic MBON will be demonstrated, including applications of EBV to show spatial and temporal trends in marine biodiversity. These will continue to be supported by research and development of field and laboratory methods, data management protocols, and products useful in marine biodiversity research, education and policy.

http://geobon.org/networks/thematic-bons/marine-bon/

Save the Date: May 30th, 1 pm ET

EPA's Trash Free Waters Program webinar

Dr. Lucy Woodall

Plastics in the Deep Sea

Join at: http://epawebconferencing.acms.com/trashfreewaterswebinar/

Dr. Woodall is a marine biologist based at the University of Oxford and is funded by Nekton. Her current research focuses on elucidating the processes that drive biodiversity in the marine biome and understanding the resilience of the ocean. She seeks to understand the impacts of human activities on the marine environment. In particular, she has led deep sea research into microplastics and marine litter, and continues to engage and consult on these issues with national and international bodies. She has worked across the globe, from seahorse conservation genetics in the shallows of the Mediterranean, to the biogeography of remote seamounts in the Atlantic and Indian Oceans.

This webinar is the fifth in a monthly series on plastics and microplastics in the environment. The next webinar in this series will be on June 27th at 1 pm ET. For further information, contact Margaret Murphy (murphy.margaret@epa.gov).

Meetings & Workshops

EREGS Workshop

A workshop to discuss elements of the ISA Discussion Paper on the development and drafting of Regulations on Exploitation for Mineral Resources in the Area (Environmental Matters)

1-3 February 2017, Scripps Institution of Oceanography, La Jolla, California

Workshop Co-Leads: Lisa Levin & Verena Tunnicliffe

Figure 1: from Left to right (ish): David Billett, Megan Jungwiwattanaporn, Aline Jaeckel, Eva Ramirez-Llodra, Anna Metaxas, Prideel Majiedt, Cindy Van Dover, Matt Gianni, Craig Smith, Amber Cobley, Rachel Boschen (hidden!), Maria Baker, Elva Escobar, Lisa Levin, Verena Tunnicliffe, Jen Le, Alison Swaddling, Jeff Ardron, Kristina Gjerde.

The overall objective of this DOSI workshop, co-funded by Kaplan Fund and PEW, was to evaluate and review the ISA discussion paper for environmental elements of the exploitation regulations from a (predominantly) scientific perspective. DOSI has made comments on all previous stakeholder engagement calls from the ISA in terms of their exploitation regulations and for these latest regulations focussing on environmental matters we plan to be in a good position to provide a comprehensive response when called for. The ISA has a huge and difficult task ahead and the DOSI Minerals WG members hope to help, alongside others, towards ensuring significant (and crucial) scientific expert input at an early stage.

This workshop brought together 20 DOSI experts from a variety of disciplines and countries to deliberate on key aspects of the regulations. In advance of the workshop, each participant was required to review assembled documents that allowed us to assess positions, precedents, research and current thoughts on seabed mining. Small groups of participants considered over 40 documents and presented distillations to the Workshop.

At the outset, our specific workshop aims were to:

- Define scientific principles, concepts and information that must underlie the different elements of exploitation environmental regulations including SEA, baseline studies, impact assessment and monitoring.
- Identify specific scientific issues that must be addressed within exploitation environmental regulations, and recommend approaches.
- Advise on scientific criteria and technologies for specific regulatory protocols, decision-making processes.
- Highlight scientific knowledge gaps relevant to environmental regulation of exploitation mining, ways to fill these and ways forward under uncertainty and the absence of information.
- Discuss applicability of environmental regulations across resource types, scientific differences that may require resource-specific adaptation, and ways to incorporate this flexibility into ISA wording and regulations.
- Develop a preliminary response to the issued Draft and a protocol for formulating a full response.

Presentations and discussions around key relevant literature were made and breakout groups were formed to discuss specific topics emerging such as VMEs, definitions, environmental baselines, environmental goals, guiding principles, EIAs and an operational definition of serious harm.

A full workshop report was produced along with a brief to ISA with our overview (available on DOSI website). Eva Ramirez-Llodra presented our EREGS meeting deliberations during a meeting in Berlin (see article below).

"Towards and ISA Environmental Management Strategy for the Area" workshop by UBA/BGR/ISA, Berlin, 19-24 March 2017.

Amber Cobley

University of Southampton & Natural History Museum, London, UK. A.cobley@nhm.ac.uk

At this workshop, experts across environmental science and law, ISA members, contractors, State representatives and NGOs assessed the Discussion Paper on the development and drafting of Regulations on Exploitation for Mineral Resources in the Area (EREGS). The workshop aim was provided by Michael Lodge, Secretary-General, International Seabed Authority (ISA) in his introduction to recent ISA developments: "In broad terms, the objective of this workshop is to help the Authority to design a strategy for environmental management of deep-seabed mining. More specifically, the workshop is timed so as to present an opportunity to provide input to the design of the environmental provisions."

Highlight topics were presented as four discussion papers prepared in advance by experts; adaptive governance, project-

specific environmental impact assessments; using and developing standards for activities in the Area – procedural considerations; environmental standards. The event was a helpful balance of overview presentations highlighting key issues and discussion events, which ensured each topic received the variety of expertise present.

Common themes throughout the workshop were: the ISAs mandate, roles and functions are clearly defined within UNCLOS, and any environmental strategy must fit within these boundaries. The Authorities lack of capacity financially and expertly is preventing vital large-scale environmental assessments and we need stronger cooperation between all stakeholders (e.g. more MIDAS & JPI Oceans). Understanding regional governance in the Area is vital as provision is nothing without enforcement, and States have a role to play here. How prescriptive the EREGS should be was in disagreement, but it was agreed that development of clear objectives could alleviate uncertainty. To address uncertainty, it was noted adaptive management will help future-proof EREGS, however, specific mechanisms to enable this are uncertain and need development. Finally, understanding overlap between exploration and exploitation will help advise the overall mechanism of the Mining Code.

Presentations were given by: Dr. Lisa Levin on serious harm; Dr. Eva Ramirez-Llodra on the outputs of the DOSI-INDEEP Scripps EREGS workshop (see page above) where the DOSI flowchart (Aline Jaeckel) was considered to be a helpful tool to understand and further discuss the EREGS; Dr. David Billett on the PEW EREGS workshop (London, March 2017) ; Dr. Robin Warner on environmental law principles; Dr. Malcom Clark on the EIA/EIS framework; Dr. Phil Weaver and Dr. Dan Jones presented regional governance issues and spatial management approaches. Examples of breakout discussion events held were; on the environmental strategy – who, how, by when? (Aline Jaeckel & Kristina Gjerde et al.); how to involve science effectively (Gordon Paterson); and regional governance – criteria and who is in charge? (Kristina Gjerde, Amber Cobley and Sabine Gollner).

World Conference on Marine Biodiversity
Montréal 2018

4th World Conference on Marine Biodiversity

May 13-16, 2018, Palais des Congrès, Montreal, Quebec

The World Conference on Marine Biodiversity (WCMB) has become the major focal assembly to share research outcomes, management and policy issues, and discussions on the role of biodiversity in sustaining ocean ecosystems. This meeting will bring together scientists, practitioners, and policy makers to discuss and advance our understanding of the importance and current state of biodiversity in the marine environment. Through a mix of keynote sessions and contributed talks the conference program will address marine biodiversity across a deliberately wide range of relevant sectors. Participation will be encouraged from the broadest possible range of stakeholder groups from academics to industry.

Register for 4th WCMB at www.wcmb2018.org

Calling all deep-sea ichthyologists……

The 10th Indo-Pacific Fish Conference (https://ipfc10.criobe.pf/) has 3 sessions which maybe of interest to the deep-sea community:

1. Evolution and biology of 'primitive' and fossil fishes

2. Biology, Ecology, Evolution and Conservation of Chondrichthyan fishes

3. Biology and Evolution of deep-sea fishes

Marine Imaging Workshop 2017

Timm Schoening and Jennifer Durden

Contact: info@imaging-workshop.com; marine-imaging-workshop.com

The Marine Imaging Workshop 2017 brought together academics, research scientists and engineers, as well as industrial partners to discuss these developments, along with applications, challenges and future directions. It was held at the GEOMAR Helmholtz Center for Ocean Research Kiel, Germany on 20-24 February 2017, and involved more than 100 attendees.

Attendees were treated to keynote talks by Jules Jaffe ("From the Titanic to the tiny: 30 years of inventing underwater imaging systems"), Yoav Schechner ("Opportunities in distributed imaging through scatter") and Sönke Johnsen ("Seeing the underwater world through the eyes of animals"). Technical presentations and posters were focused on seven themes: Strategy, Sensors, Annotation, Machine learning, 3-D imaging, Data Management and Applications. The workshop format included break out discussion sessions on the current state-of-the-art and future directions of six themes: Planning to use marine imagery to a scientific aim, Multi-disciplinary expertise for marine imaging, Semantic image annotation, Data management in this data-rich field, Access to and development of marine imagery tools, and The future of marine imaging. This year, a half-day was dedicated to interactive sessions where attendees

could a variety of imagery manipulation, annotation and data management software, including online annotation with Squidle+, video mining with Ocean Networks Canada Data Preview, 3-D image calibration and scene reconstruction using Agisoft PhotoScan, annotation and data management with MBARI's Video Annotation and Reference System, and shape morphometry with SHERPA.

A report on the outcomes of the meeting will be circulated shortly to all participants and via the INDEEP mailing list.

We look forward to the Marine Imaging Workshop 2019, to be held at Ocean Networks Canada in Victoria, Canada.

Figure 1: Participants of the Marine Imaging Workshop 2017 in the Lithothek of GEOMAR.

Scientist Profiles

Yann Lelièvre

Ecology of hydrothermal vent ecosystems

Ifremer, Deep-sea laboratory, France and Pierre Legendre laboratory, Université de Montréal, Canada

Contact: yann.lelievre10@gmail.com; yann.lelievre@ifremer.fr

After studying coastal oceanography at the University of Le Havre (France), I have continued my studies with a Master degree at Joseph Fourier University (Grenoble, France) to study alpine ecology. It was during an internship in the rainforests of Madagascar in order to characterize the reptile diversity that I realized my true passion was the ocean. I was therefore accepted into the Masters program at the European Institute for Marine Studies (Brest, France), where I was fascinated by the hydrothermal ecosystems. Jozée Sarrazin gave me the opportunity to participate to my first oceanographic cruise, on the Mid-Atlantic ridge (MoMARSAT 2014). I am currently in my third year of my Ph.D., in co-direction between the Deep-sea laboratory (Ifremer, France) and the Université de Montréal (Canada) under the supervision of Pierre Legendre, Jozée Sarrazin and Marjolaine Matabos. My project aims to improve our understanding of the temporal dynamics of macrofaunal communities associated with hydrothermal vents using seafloor observatory data.

Understanding the ecological processes operating within the hydrothermal environments is a particular challenge for deep-sea hydrothermal research. Until now, temporal dynamics studies of these ecosystems were based on annual or pluri-annual visits, performed with Remotely Operated Vehicles (ROV) or submersibles, limiting our ability to understand the vent dynamics on longer time-scales (> years). Therefore, the emergence of seafloor observatories open new research avenues for deep-sea ecology. One of my research goals is to understand the external forcings that influence the communities' dynamics, by using the multidisciplinary nature of these infrastructures and especially, data from the Ocean Networks Canada observatory. Deployed at 2196 m depth on the Grotto hydrothermal vent edifice (Juan de Fuca Ridge, northeast Pacific), the TEMPO-mini ecological module is at the core of my thesis, and provide quasi-continuous video imagery of an assemblage of siboglinids tubeworms. In addition, my participation to the "Expedition 2015: Wiring the Abyss" gave me the opportunity to collect samples on this hydrothermal site in order to characterize the diversity as well as to reconstruct the trophic network of siboglonid assemblages. The results obtained will provide new knowledge about the functioning and dynamics of hydrothermal communities (Lelièvre et al. 2017). They constitute a major step forward in the understanding of the functioning of these environments. Another outcome will be the development of a protocol for the acquisition and analysis of temporal data from observatories.

You can find my latest paper on the influence of tides and surface storms on the hydrothermal vents invertebrates in the Hot of the Press section! Please do not hesitate to contact me if you know of any post-doctoral (or any other) opportunities or for more information about my work and/or experience.

Inge van den Beld

Distribution and ecology of cold-water corals in submarine canyons and the impact of marine litter

Contact : Ingevdbeld@gmail.com

I recently completed my PhD at Ifremer on the distribution and ecology of cold-water coral habitats in the submarine canyons of the Bay of Biscay, North-East Atlantic Ocean. The continental slope of the French part of the Bay of Biscay is incised by more than 100 submarine canyons. Only a few studies about the distribution of cold-water corals in this basin have been undertaken so far. However, most of these studies focussed on the reef-building scleractinians *Lophelia pertusa* and *Madrepora oculata*, they only involved a couple of canyons and studies using image footage are rare. During my PhD, I have analysed image footage acquired by a Remotely Operated Vehicle and a towed camera. These images were collected in 24 canyons. Both the distribution of habitats formed by the reef-building scleractinians *L. pertusa* and *M. oculata* were observed, as well as habitats formed by other species of colonial and solitary scleractinians, black corals, gorgonians and sea pens. A paper about the distribution of these habitats has been recently published in Frontiers in Marine Science, entitled : Cold water coral habitats in submarine canyons in the Bay of Biscay (see Hot Press Section). Further, I have provided the first estimations of the diversity and species communities of these different habitats. In addition, the distribution of marine litter and its putative impact on cold-water coral habitats was also investigated.

For eight years, my work has been devoted to the study of the ecology of cold water corals, notably through image analyses. In the Netherlands and then in Ireland, I investigated fish associated with corals. I arrived in France in order to work on the cold-water corals itself as well as the faunal community.

At this point in my career, I am looking for an opportunity to deepen my knowledge about cold-water coral habitats or broaden my research horizon on deep-sea ecosystems and their conservation. It would be great if a future post-doc or other position would be in an interdisciplinary environment. If anyone knows any positions or you would like to have more information, please, feel free to contact me by mail Ingevdbeld@gmail.com. Thank you in advance !

Opportunities

Adviser, Oceans Governance – Trade, Oceans and Natural Resources Division

Location: Pall Mall, London SW1
Closing date: 7 June 2017
Salary: £72,447 gross + benefits

We have an excellent opportunity for an Adviser, Oceans Governance to work within our Trade, Oceans and Natural Resources Division.

The Trade, Oceans and Natural Resources Division is one of the major policy advisory divisions of the Commonwealth Secretariat. It brings together two key streams of work covering the research and advocacy, technical support and joint programming elements of trade, oceans and natural resources in the Commonwealth. The Oceans & Natural Resources (ONR) Team, as part of the Trade, Oceans and Natural Resources Division, supports the development efforts of Member countries through the provision of legal and economic advice, technical assistance and capacity building. A significant part of the Team's work is of an advisory nature, delivered through a combination of in-house and external legal, policy and economic expertise.

The successful candidate will be responsible for the delivery of specialised strategic, policy, technical and/or economic advice to Commonwealth Member countries and regional organisations concerning critical elements of ocean's governance and the development of ocean-based economies. In particular, the successful candidate will be responsible for managing projects under the ocean governance programme of ONR and delivering strategic, policy and technical and/or economic advice, either alone or as part of a multi-disciplinary team, within their area of expertise.

To be considered, you will need a post-graduate degree in a relevant area of specialisation, with an emphasis on environmental economics, renewable energy technologies, ocean-based industries and/or the management of living and non-living marine resources including international fisheries. You will also need to have a minimum of ten years' experience at a senior level relating to maritime boundaries and ocean governance gained in government ministry, as a consultant or in the private industry, in an international context. This experience should be in areas related to trends in international ocean governance, sustainable ocean-based economies and law of the sea issues.

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See more at: http://thecommonwealth.org/jobs/adviser-oceans-governance-trade-oceans-and-natural-resources-division#sthash.gi5pRSuG.dpuf

ON-BOARD TRAINING OPPORTUNITY

POGO is pleased to announce that with support from the Nippon Foundation and in partnership with the University of Liverpool, University of Southampton and Plymouth Marine Laboratory, it is offering a NF-POGO Visiting Fellowship for training on-board the GEOTRACES North Atlantic "FRidge" cruise in 2017-18.

The selected candidate will have the opportunity to visit the University of Liverpool and Plymouth Marine Laboratory (PML) in the United Kingdom, for one month prior to the start of the cruise to participate in analytical training, cruise preparation and planning. To sail on the cruise on 20th December 2017 (departing from Southampton) and ending on 1st February 2018 in Guadeloupe. Following the cruise they will spend approximately one additional month at PML, learning to quality control and analyse the results statistically, and interpret them in the context of the cruise scientific aims. The fellow will make biogeochemical observations concerned with dissolved oxygen and nutrients.

The programme is open to scientists, technicians, postgraduate students (PhD/MSc) and post-doctoral fellows involved in oceanographic work at centres in developing countries and countries with economies in transition.

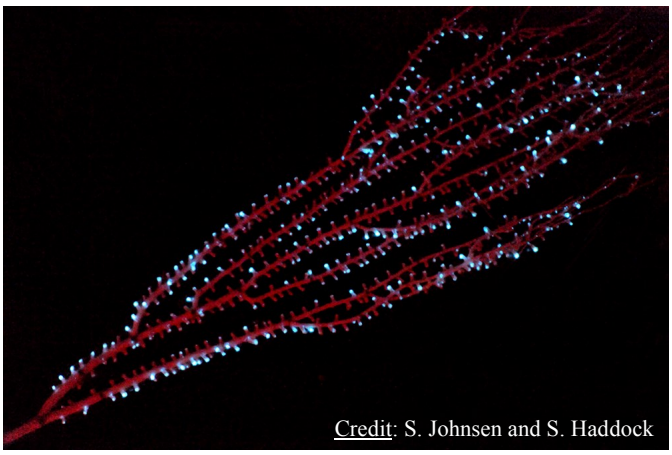
The application deadline is 31st May 2017. Please visit http://ocean-partners.org/nf-pogo-fellowship-fridge-cruise-2017 for further details.

Wanted

Report bioluminescent species in the deep-sea benthos!

Experts in benthic species, PhD students going on a cruise, postdocs working on hydrothermal animals, lovers of mud-biology…

WE NEED YOU!



Credit: S. Johnsen and S. Haddock

Bioluminescence is a dominant ecological trait on earth. 76% of macroscopic pelagic organisms are known to be bioluminescent. However, we don't know as much about the bioluminescent capabilities of benthic organisms.

1 – Go online http://bit.ly/bentlight to find the Bentlight file

2 – Follow the protocol to describe bioluminescence in benthic species during your sampling

3 – Report your observations

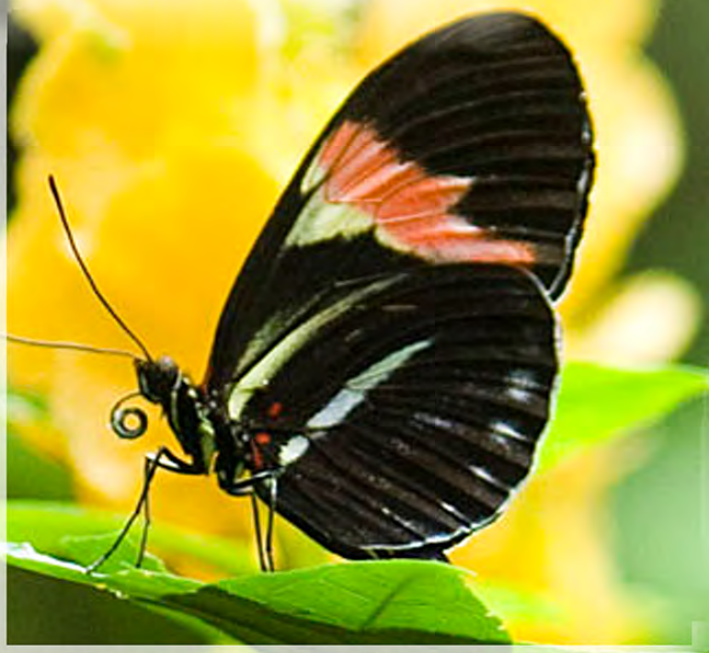
For more information: S. Martini (smartini@mbari.org)
SHD Haddock (haddock@mbari.org)

MBARI Monterey Bay Aquarium Research Institute

CALL FOR PAPERS

Ecology launches a new series

The Scientific Naturalist



This new series continues the very successful Natural History Notes series in *Frontiers in Ecology and the Environment*. All submissions to The Scientific Naturalist will include a photo and showcase in an accompanying essay the natural histories of organisms, opening up questions or new hypotheses. Submissions about animals, plants, fungi,or microorganisms are all welcome. See an example at:
http://onlinelibrary.wiley.com/doi/10.1002/fee.1418/full

Submissions should consist of a striking, high-quality photo documenting some interesting or previously unknown aspect of an organism's life cycle or ecology, accompanied by an essay of no more than 1500 words total, explaining why it is scientifically interesting or significant. This will cover two pages in *Ecology*. Submissions will be reviewed based on equal consideration of the scientific interest and writing quality of the accompanying essay and the artistic quality and natural history significance of the photo.
The photo and essay should:

- Illustrate a rare, unusual, or fascinating organism, behavior, process, or other natural phenomenon that will inspire and engage us in natural history
- Describe something new or important in ecology, evolution, conservation, phenology, or human-environment interactions that challenges existing theories and points in new directions
- Represent a scientific "aha" or "wow" moment ("I didn't know that!") in your own research
- Raise open questions or generate new hypotheses

The submissions will be reviewed and edited for scientific content and the quality of the writing by an editorial board devoted solely to these notes.

Papers including photos should be submitted to https://mc.manuscriptcentral.com/ecology

More details are available in the types of contributions section of the author guidelines at:
esajournals.onlinelibrary.wiley.com/hub/journal/10.1002/(ISSN)1939-9170/resources/author-guidelines-ecy.html

Hot off the Press

Astronomical and atmospheric impacts on deep-sea hydrothermal vent invertebrates

Lelièvre Y, Legendre P, Matabos M et al. (2017)

Proceedings of the Royal Society B: Biological Sciences

Ocean tides and winter surface storms are among the main factors driving the dynamics and spatial structure of marine coastal species, but the understanding of their impact on deep-sea and hydrothermal vent communities is still limited. Multidisciplinary deep-sea observatories offer an essential tool to study behavioural rhythms and interactions between hydrothermal community dynamics and environmental fluctuations. Here, we investigated whether species associated with a *Ridgeia piscesae* tubeworm vent assemblage respond to local ocean dynamics. By tracking variations in vent macrofaunal abundance at different temporal scales, we provide the first evidence that tides and winter surface storms influence the distribution patterns of mobile and non-symbiotic hydrothermal species (i.e., pycnogonids *Sericosura* sp. and Polynoidae polychaetes) at > 2 km depth. Local ocean dynamics affected the mixing between hydrothermal fluid inputs and surrounding seawater, modifying the environmental conditions in vent habitats. We suggest that hydrothermal species respond to these habitat modifications by adjusting their behaviour to ensure optimal living conditions. This behaviour may reflect a specific adaptation of vent species to their highly variable habitat.

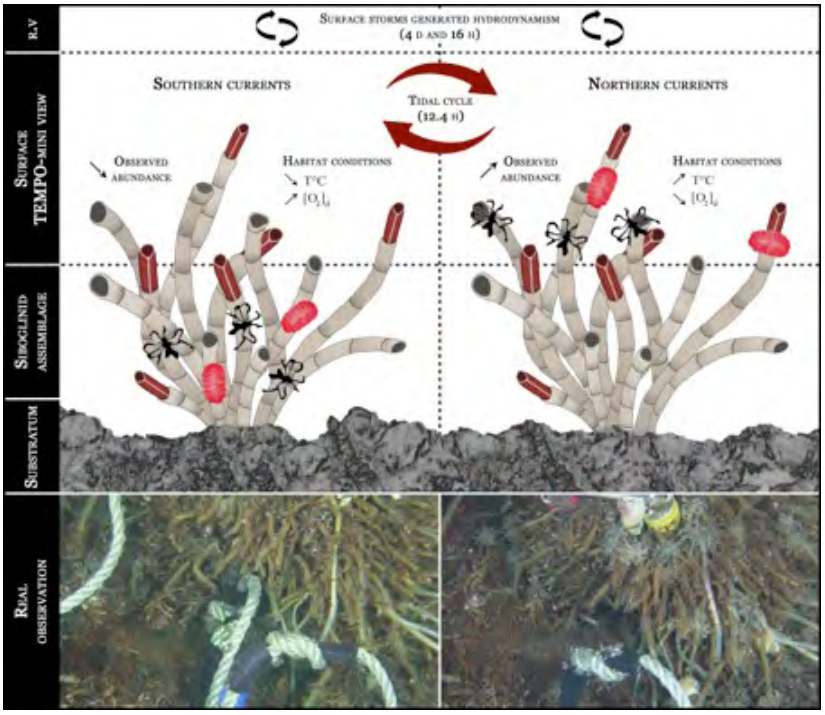


Figure 1: Schematic representation of the influence of ocean tides and local surface storms on the hydrothermal abiotic environment and vent species' dynamics, associated to real observation. Oscillatory currents affect the balance between hydrothermal fluid inputs and the surrounding seawater, modifying the physical and chemical conditions of the vent habitat. Hydrothermal species react to these habitat modifications by adjusting their behaviour, e.g. by moving up and down the tubeworm assemblage. The left and right sides represent the two states observed in relation to the tides. The horizontal dashed lines separate the different compartments from the Ridge Valley (R.V.) at the top, the surface of the bush (area visible with TEMPO-mini) in the middle and within the bush (invisible to the human eye) at the bottom.

Link to the paper: http://rspb.royalsocietypublishing.org/content/284/1852/20162123

Bioluminescence in the ocean is a dominant ecological trait!

Martini S & Haddock S (2017)

Nature Scientific Reports, 45750

Bioluminescence is frequently seen as an exotic phenomenon and mainly representative of the deep or abyssal ecosystems. One of the explanations for its perception as an obscure phenomenon is that the technologies allowing the observation and quantification of marine animals *in situ*, in the dark and in the deep ocean remain limited. However, the emission of light by living organisms is without doubt in the top five of the most engaging topics in oceanography for outreach!

What is the importance of bioluminescence in the ocean?

In this study, based on 17 years of ROV pelagic observations in Monterey Bay merged with information and organisms' descriptions from the literature, we found that 76% of organisms observed are known to be bioluminescent. More interestingly, this percentage remains stable from the surface to the deep ocean, down to 3900m depth. Bioluminescence is not restricted to a few deep abyssal species!

Distribution of bioluminescence: an ecological trait.

Despite its prevalence, this capability is not evenly distributed over taxa. More than 90% of cnidarians, ctenophores and polychaetes are bioluminescent, while, on the other hand, less than 15% of pteropods, chaetognaths or thaliaceans (salps and doliolids) observed are bioluminescent. For each of these taxonomic groups, we also found that the distribution of bioluminescent and non-bioluminescent organisms over depth follows specific patterns: Non bioluminescent ctenophores and scyphozoans, for example are only present in the upper part of the water column, while luminous chaetognaths are only found deep. Such observations still have to be related to ecological functions.

Given that the deep ocean is the largest habitat on earth by volume, bioluminescence can certainly be said to be a major ecological trait on earth. Continuing the development of instrumentation for automated bioluminescence detection *in situ* can certainly give strong inputs on global biomass distribution in the oceans from the surface to the deep sea.

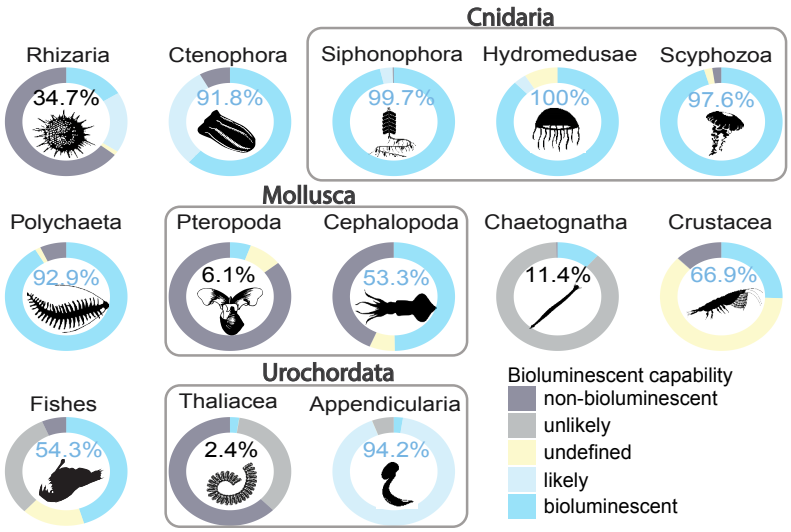


Figure 1: Bioluminescence capability over the main observed taxa. The undefined organisms were not taken into account in the numerical percentages. Silhouettes are from http://phylopic.org.

Link to paper: https://www.nature.com/articles/srep45750

Biological responses to disturbance from simulated deep-sea polymetallic nodule mining

Jones D, Kaiser S, Sweetman A et al. (2017)

PLoS ONE 12(2): e0171750

Commercial-scale mining for polymetallic nodules could have a major impact on the deep-sea environment, but the effects of these mining activities on deep-sea ecosystems are very poorly known. The first commercial test mining for polymetallic nodules was carried out in 1970. Since then a number of small-scale commercial test mining or scientific disturbance studies have been carried out. Here we evaluate changes in faunal densities and diversity of benthic communities measured in response to these 11 simulated or test nodule mining disturbances using meta-analysis techniques. We find that impacts are often severe immediately after mining, with major negative changes in density and diversity of most groups occurring. However, in some cases, the mobile fauna and small-sized fauna experienced less negative impacts over the longer term. At seven sites in the Pacific, multiple surveys assessed recovery in fauna over periods of up to 26 years. Almost all studies show some recovery in faunal density and diversity for meiofauna and mobile megafauna, often within one year. However, very few faunal groups return to baseline or control conditions after two decades. The effects of polymetallic nodule mining are likely to be long term. Our analyses show considerable negative biological effects of seafloor nodule mining, even at the small scale of test mining experiments, although there is variation in sensitivity amongst organisms of different sizes and functional groups, which have important implications for ecosystem responses. Unfortunately, many past studies have limitations that reduce their effectiveness in determining responses. We provide recommendations to improve future mining impact test studies. Further research to assess the effects of test-mining activities will inform ways to improve mining practices and guide effective environmental management of mining activities.

Link to paper: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0171750

Major impacts of climate change on deep-sea benthic ecosystems

Sweetman A, Thurber A, Smith C et al. (2017)

Elementa Science of the Anthropocene 5:4

The deep sea encompasses the largest ecosystems on Earth. Although poorly known, deep seafloor ecosystems provide services that are vitally important to the entire ocean and biosphere. Rising atmospheric greenhouse gases are bringing about significant changes in the environmental properties of the ocean realm in terms of water column oxygenation, temperature, pH and food supply, with concomitant impacts on deep-sea ecosystems. Projections suggest that abyssal (3000–6000 m) ocean temperatures could increase by 1°C over the next 84 years, while abyssal seafloor habitats under areas of deep-water formation may experience reductions in water column oxygen concentrations by as much as 0.03 mL L^{-1} by 2100. Bathyal depths (200–3000 m) worldwide will undergo the most significant reductions in pH in all oceans by the year 2100 (0.29 to 0.37 pH units). O2 concentrations will also decline in the bathyal NE Pacific and Southern Oceans, with losses up to 3.7% or more, especially at intermediate depths. Another important environmental parameter, the flux of particulate organic matter to the seafloor, is likely to decline significantly in most oceans, most notably in the abyssal and bathyal Indian Ocean where it is predicted to decrease by 40–55% by the end of the century. Unfortunately, how these major changes will affect deep-seafloor ecosystems is, in some cases, very poorly understood. In this paper, we provide a detailed overview of the impacts of these changing environmental parameters on deep-seafloor ecosystems that will most likely be seen by 2100 in continental margin, abyssal and polar settings. We also

consider how these changes may combine with other anthropogenic stressors (e.g., fishing, mineral mining, oil and gas extraction) to further impact deep-seafloor ecosystems and discuss the possible societal implications.

Link to paper: https://www.elementascience.org/article/10.1525/elementa.203/

Polymetallic nodules, sediments, and deep waters in the equatorial North Pacific exhibit highly diverse and distinct bacterial, archaeal, and microeukaryotic communities

Shulse C, Maillot B, Smith C, Church M (2016)

MicrobiologyOpen, 00:1–16

Concentrated seabed deposits of polymetallic nodules, which are rich in economically valuable metals (e.g., copper, nickel, cobalt, manganese), occur over vast areas of the abyssal Pacific Ocean floor. Little is currently known about the diversity of microorganisms inhabiting abyssal habitats. In this study, sediment, nodule, and water column samples were collected from the Clarion-Clipperton Zone of the Eastern North Pacific. The diversities of prokaryote and microeukaryote communities associated with these habitats were examined. Microbial community composition and diversity varied with habitat type, water column depth, and sediment horizon. *Thaumarchaeota* were relatively enriched in the sediments and nodules compared to the water column, whereas Gammaproteobacteria were the most abundant sequences associated with nodules. Among the Eukaryota, rRNA genes belonging to the *Cryptomonadales* were relatively most abundant among organisms associated with nodules, whereas rRNA gene sequences deriving from members of the *Alveolata* were relatively enriched in sediments and the water column. Nine operational taxonomic units (OTUs) were identified that occur in all nodules in this dataset, as well as all nodules found in a study 3000– 9000 km from our site. Microbial communities in the sediments had the highest diversity, followed by nodules, and then by the water column with <1/3 the number of OTUs as in the sediments.

Link to article: http://onlinelibrary.wiley.com/doi/10.1002/mbo3.428/full

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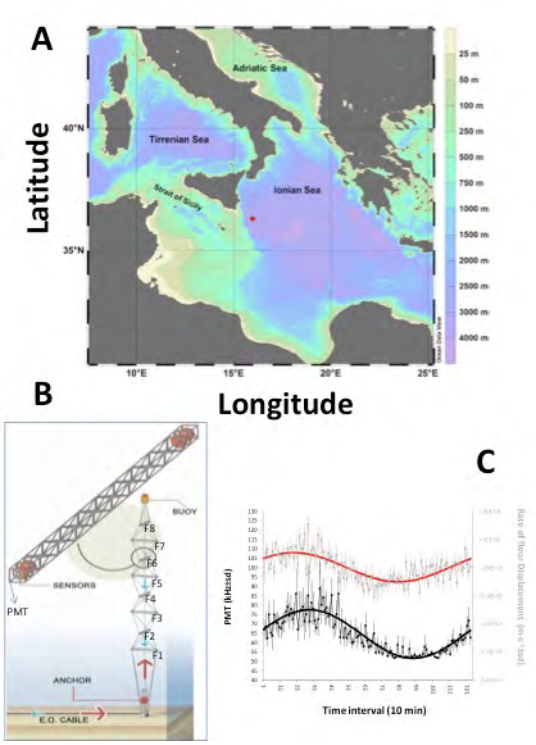
Inertial bioluminescence rhythms at the Central Mediterranean KM3NeT deep-sea neutrino telescope

Aguzzi J, Fanelli E, Ciufardi T et al. (2017)

Nature Scientific Reports 7, Article number: 44938

In the deep sea, the sense of time is dependent upon geophysical fluctuations other than the day-night, such as internal tides and atmospheric-related inertial currents. Deep-sea neutrino telescopes instrumented with light detecting Photo-Multipliers Tubes (PMT) can be used to describe the synchronization of bioluminescent activity of abyssopelagic organisms with hydrodynamic cycles close to the seabed. PMT readings at 8 floors (from 3349 to 3069 mab) of the KM3NeT-Italy Neutrino Telescope (Sicily; Fig. 1A, B) were used to characterize rhythmic bioluminescence pattern in June 2013, in response to depth-oriented water mass movements. We found a significant ($p<0.05$) 20.5 h periodicity in the bioluminescence signal, corresponding to inertial fluctuations. Waveform analysis of PMT and water flow data was carried out to identify phases (i.e. the timing of peaks) by subdividing time series upon the length of detected inertial periodicity. A phase overlap between rhythms and cycles suggests a mechanical stimulation of



bioluminescence (Fig. 1C), as organisms carried by currents collide with the telescope infrastructure, resulting in the defensive emission of light. A bathymetric shift in PMT phases indicated that drifted organisms travelled in discontinuous deep-sea undular vortices consisting of chains of inertially pulsating mesoscale cyclones/anticyclones, which are to date still poorly known.

Link to paper: https://www.nature.com/articles/srep44938

Figure 1: Location and bathymetry (A) of the KM3NeT-It telescope in the Central Mediterranean (the red dot; Ionian Sea South-East of Sicily at 36° 16′ N, 16° 06′E). Telescope tower structure (B) reporting the eight-floor (as "F") positioning and the arm holding the 2 photomultipliers (PMT) at its extremes. In (C), we reported the waveform analysis outputs for data sets in bioluminescence in June 2013 for floor no. 7 (depth: 3109 m), indicating the occurrence of temporally coherent peaking over the inertial day (i.e. time series subdivided into 123 sub-segments, as equivalent to 1230 min, according to periodogram analysis outputs). Waveforms are shown with associated standard errors. That analysis can be used as a proxy of the effect of currents on bioluminescence stimulation, based on the collision of pelagic animals against the telescope tower infrastructure.

Environmental hazard assessment of a marine mine tailings deposit site and potential implications for deep-sea mining

Mestre N, Rocha T, Canals M et al. (2017)

Environmental Pollution. Volume 228: 169–178

Portmán Bay is a heavily contaminated area resulting from decades of metal mine tailings disposal, and is considered a suitable shallow-water analogue to investigate the potential ecotoxicological impact of deep-sea mining. Resuspension plumes were artificially created by removing the top layer of the mine tailings deposit by bottom trawling. Mussels were deployed at three sites: i) off the mine tailings deposit area; ii) on the mine tailings deposit beyond the influence from the resuspension plumes; iii) under the influence of the artificially generated resuspension plumes. Surface sediment samples were collected at the same sites for metal analysis and ecotoxicity assessment. Metal concentrations and a battery of biomarkers (oxidative stress, metal exposure, biotransformation and oxidative damage) were measured in different mussel tissues. The environmental hazard posed by the resuspension plumes was investigated by a quantitative weight of evidence (WOE) model that integrated all the data. The resuspension of sediments loaded with metal mine tails demonstrated that chemical contaminants were released by trawling subsequently inducing ecotoxicological impact in mussels' health. Considering as sediment quality guidelines (SQGs) those indicated in Spanish action level B for the disposal of dredged material at sea, the WOE model indicates that the hazard is slight off the mine tailings deposit, moderate on the mine tailings deposit without the influence from the resuspension plumes, and major under the influence of the resuspension plumes. Portmán Bay mine tailings deposit is a by-product of sulphide mining, and despite differences in environmental setting, it can reflect the potential ecotoxic effects to marine fauna from the impact of resuspension of plumes created by deep-sea mining of polymetallic sulphides. A similar approach as in this study could be applied in other areas affected by sediment resuspension and for testing future deep-sea mining sites in order to assess the associated environmental hazards.

Link to paper: http://www.sciencedirect.com/science/article/pii/S026974911632574X

Pollen from New Zealand pine forests may be altering remote deep-sea ecosystems

Leduc D & Rowden A (2017)

Ecosystems

Pollen from New Zealand pine forests has been shown to travel more than 1500km through wind and ocean currents, and sink thousands of metres into the ocean to reach some of the world's deepest ecosystems.

The study is based on sediment samples from the Kermadec and Tonga trenches north of New Zealand, obtained in collaboration with scientists from the USA, UK, Denmark, Germany and Japan. The findings show pine pollen is common, even in these remote deep-sea ecosystems. Pollen was found to be particularly abundant in the deepest part of the Tonga Trench, some 10,800m deep – and the second deepest point of the world's oceans.

The steep topography of trenches is thought to funnel fine particles that sink from the surface waters of the sea, leading to high accumulation of fine material, including pollen, at their deepest point. The study also found that areas where pollen is most abundant harbour the most life, suggesting that pollen may be a food source for some deep-sea organisms. Pine pollen was observed inside small, single-celled organisms called gromiids, which ingest the pollen and may derive nutritional benefits from it. This unsuspected source of land-derived food originating from exotic pine plantations may be altering deep-sea food webs. Deep-sea ecosystems are typically characterised by very low availability of food sinking from the surface, and any new food source is likely to get used by the organisms that live in the sediments.

Figure caption: Photomicrograph showing gromiid from Horizon Deep, Tonga Trench (10 811 m water depth) with ingested pine pollen shown by arrow. Scale bar = 100 microns.

Pines produce particularly large amounts of pollen which can travel very long distance by wind and ocean currents, reaching remote offshore areas where little or no other pollen is found. The replacement of native forest by forests of exotic pine likely led to an increased transport of pollen to offshore areas. Monterey pine was introduced to New Zealand in the early 20th century, with more than one million hectares of pine forest now established. These forests produce an estimated 4.5 million tons of pollen each year. The accumulation of pine pollen may represent an unsuspected carbon sink. The gradual burial of pine pollen, part of which is highly resistant to decomposition, likely contributes to the sequestration of land-derived carbon.

Further research is planned by NIWA scientists to investigate just how much carbon and nutrients are being transported by pine pollen to the deep sea around New Zealand, and to better understand the contribution of pollen to the diet of deep-sea organisms.

Link to paper: http://rdcu.be/rtjd

The role of infaunal functional and species diversity in short-term response of contrasting benthic communities to an experimental food pulse

Belley R & Snelgrove P (2017)

Journal of Experimental Marine Biology and Ecology, 491, 38–50

Benthic communities play a major role in organic matter remineralization but the role played by macrofauna functional and taxonomic diversity remains elusive. To investigate this topic, we collected sediment cores from two different continental shelf locations near British Columbia, Canada, that differed in diversity to determine how the communities would respond to organic enrichment in the short term (~24h). We added phytodetritus to half of the cores, measured benthic oxygen and nutrient fluxes in natural and enriched incubations, identified macrofauna, and calculated a suite of functional and taxonomic diversity indices. We found that benthic communities in Saanich Inlet (SI) and the Strait of Georgia East (SoGE) differed significantly in composition and that this difference corresponded to significant differences in benthic flux rates between sites. Multivariate analyses showed that the higher taxonomic (Simpson's diversity) and functional richness (FRic) observed in SoGE explained generally higher benthic flux rates at SoGE compared to SI. In enriched incubations, the higher species richness observed at SoGE explained most of the enhanced benthic flux rates measured in SoGE compared to SI. Our study also identified mean densities of detritivores and omnivores as primary predictors of the higher benthic flux rates measured in enriched incubations in SoGE compared to SI. These results suggest that detritivores and omnivores are the first functional groups of macrofaunal organisms to ingest fresh phytodetritus on the seafloor, and point to their primary importance in short-term remineralization of organic matter following phytoplankton bloom deposition on the seafloor. Our results further indicate that sediments with higher functional diversity may process organic matter and regenerate nutrients more quickly than lower diversity sediments, and that diversity loss may have negative consequences for ecosystem functioning of continental shelf sediments.

Link to paper: http://www.sciencedirect.com/science/article/pii/S0022098117301508

Differences in the carbon flows in the benthic food webs of abyssal hill and plain habitats

Durden JM, Ruhl HA, Pebody C, et al. (2017)

Limnology and Oceanography

Inputs of detritus from the surface ocean are an important driver of community dynamics in the deep sea. The assessment of the flow of carbon through the benthic food web gives insight into how the community is sustained, and its resilience to fluctuations in food supply. We used a linear inverse model to compare the carbon flow through the food webs on an abyssal hill and the nearby plain at the Porcupine Abyssal Plain sustained observatory (4850 m water depth; northeast Atlantic), to examine the partitioning of detrital input in these substantially different megafaunal communities. We found minimal variation in carbon flows at the plain over two years, but differences in the detrital inputs and in the processing of that carbon input between the hill and plain habitats. Suspension feeding dominated metazoan carbon processing on the hill, removing nearly all labile detritus input to the system. By contrast, half of all labile detritus was deposited and available for deposit feeders on the abyssal plain. This suggests that the biomass on the hill is dependent on a more variable carbon supply than the plain. The presence of millions of abyssal hills globally suggests that the high benthic biomass and respiration, and reduced deposition of detritus may be pervasive, albeit with varying intensity.

Link to article: http://onlinelibrary.wiley.com/doi/10.1002/lno.10532/abstract

The giant deep-sea octopus *Haliphron atlanticus* forages on gelatinous fauna

Hoving H & Haddock S (2017)

Nature Scientific Reports 7, Article number: 44952

Feeding strategies and predator-prey interactions of many deep-sea pelagic organisms are still unknown. This is also true for pelagic cephalopods, some of which are very abundant in oceanic ecosystems and which are known for their elaborate behaviors and central role in many foodwebs. We report on the first observations of the giant deep-sea octopus *Haliphron atlanticus* with prey. Using remotely operated vehicles, we saw these giant octopods holding medusae in their arms. One of the medusae could be identified as *Phacellophora camtschatica* (the egg-yolk jelly). Stomach content analysis confirmed predation on cnidarians and gelatinous organisms. The relationship between medusae and *H. atlanticus* is discussed, also in comparison with other species of the Argonautoidea, all of which have close relationships with gelatinous zooplankton.

Link to paper: http://www.nature.com/articles/srep44952

Video of the encounter: http://j.mp/haliphron

MBARI article about the back story of the paper: http://www.mbari.org/a-giant-deep-sea-octopus-is-a-sucker-for-jellies/

Resilience of benthic deep-sea fauna to mining activities

Gollner S, Kaiser S, Menzel L et al. (2017)

Marine Environmental Research (in press; 26 p.)

With increasing demand for mineral resources, extraction of polymetallic sulphides at hydrothermal vents, cobalt-rich ferromanganese crusts at seamounts, and polymetallic nodules on abyssal plains may be imminent. Here, we shortly introduce ecosystem characteristics of mining areas, report on recent mining developments, and identify potential stress and disturbances created by mining. We analyze species' potential resistance to future mining and perform meta-analyses on population density and diversity recovery after disturbances most similar to mining: volcanic eruptions at vents, fisheries on seamounts, and experiments that mimic nodule mining on abyssal plains. We report wide variation in recovery rates among taxa, size, and mobility of fauna. While densities and diversities of some taxa can recover to or even exceed pre-disturbance levels, community composition remains affected after decades. The loss of hard substrata or alteration of substrata composition may cause substantial community shifts that persist over geological timescales at mined sites.

Link to paper: http://www.sciencedirect.com/science/article/pii/S0141113617302441

Relationship between 'live' and dead benthic foraminiferal assemblages in the abyssal NE Atlantic.

Stefanoudis P, Bett B & Gooday A (2017)

Deep Sea Research Part I: Oceanographic Research Papers, 121. 190-201.

Dead foraminiferal assemblages within the sediment mixed layer provide an integrated, time-averaged view of the foraminiferal fauna, while the relationship between dead and live assemblages reflects the population dynamics of different species together with taphonomic processes operating over the last few hundred years. Here, we analysed four samples for 'live' (Rose-Bengal-stained) and dead benthic foraminifera (0–1 cm sediment layer, >150 µm) from four sites in the area of the Porcupine Abyssal Plain Sustained Observatory (PAP-SO; NE Atlantic, 4850 m water depth). Two sites were located on abyssal hills and two on the adjacent abyssal plain. Our results indicate that the transition from live to dead benthic foraminiferal assemblages involved a dramatic loss of delicate agglutinated and organic-walled tests (e.g. *Lagenammina, Nodellum, Reophax*) with poor preservation potential, and to a lesser extent that of some relatively fragile calcareous tests (mostly miliolids), possibly a result of dissolution. Other processes, such as the transport of tests by bottom currents and predation, are unlikely to have substantially altered the composition of dead faunas. Positive live to dead ratios suggest that some species (notably *Epistominella exigua* and *Bolivina spathulata*) may have responded to recent phytodetritus input. Although the composition of live assemblages seemed to be influenced by seafloor topography (abyssal hills vs. plain), no such relation was found for dead assemblages. We suggest that PAP-SO fossil assemblages are likely to be comparable across topographically contrasting sites, and dominated by calcareous and some robust agglutinated forms with calcitic cement (e.g. *Eggerella*).

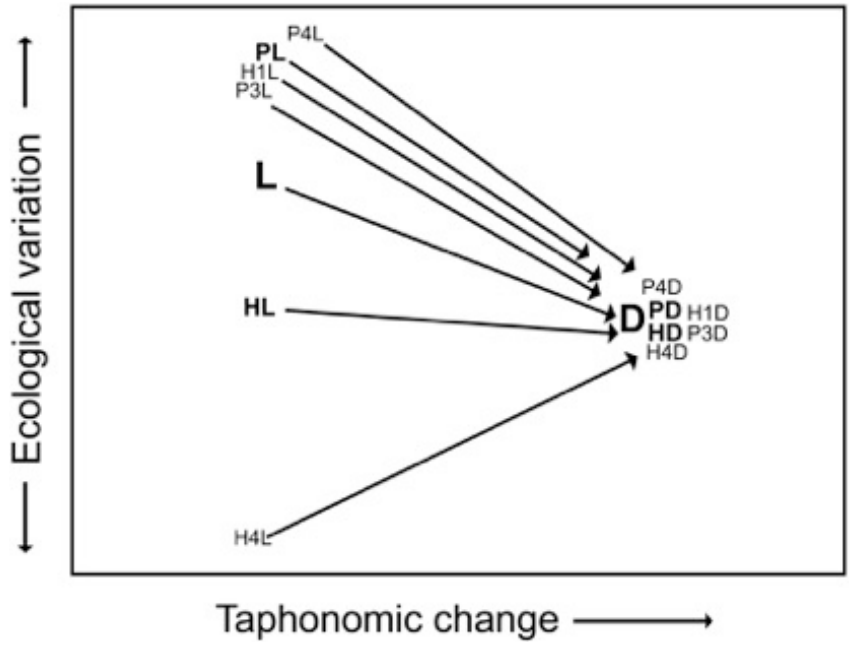


Figure: 2-d Non-metric multi-dimensional scaling ordination plots of live (L) and dead (D) foraminiferal assemblage composition in samples from the PAP-SO area, based on Bray-Curtis dissimilarity of log (x+1) transformed relative abundance data. Note compositional shift related to topographic setting (hills, H; plain, P), and striking difference between live and dead assemblages. (HL, hills live [H1L+H4L]; PL, plain live [P3L+P4L]), HD, hills dead [H1D+H4D]; PD, plain dead [P3D+P4D]; L, live [HL+PL]; D, dead [HD+PD]).

Link to paper: http://www.sciencedirect.com/science/article/pii/S0967063716302588

Cold-Water Coral Habitats in Submarine Canyons of the Bay of Biscay

Van den Beld I, Bourillet J-F, Arnaud-Haond S et al. (2017)

Frontiers in Marine Science

The topographical and hydrological complexity of submarine canyons, coupled with high substratum heterogeneity, make them ideal environments for cold-water coral (CWC) habitats. These habitats, including reefs, are thought to provide important functions for many organisms. The canyons incising the continental slope of the Bay of Biscay have distinct morphological differences from the north to the south. CWCs have been reported from this basin in the late nineteenth century; however, little is known about their present-day distribution, diversity and environmental drivers in the canyons. In this study, the characteristics and distribution of CWC habitats in the submarine canyons of the Bay of Biscay are investigated. Twenty-four canyons and three locations between adjacent canyons were sampled using a Remotely Operated Vehicle (ROV) or a towed camera system. Acquired images were annotated for habitat type (using the CoralFISH classification system), substrate cover and coral identification. Furthermore, the influence of hydrological factors and geomorphology on the CWC distribution was investigated. Eleven coral habitats, formed by 62 morphotypes of scleractinians, gorgonians, antipatharians and seapens, inhabiting hard and/or soft substrate, were observed. The distribution patterns were heterogenous at regional and local scales; the south Bay of Biscay and the southeastern flank favored soft substrate habitats. Biogenic and hard substrate habitats supported higher coral diversities than soft substrate habitats and had similar species compositions. A higher coral species turnover characterized soft substrate habitats. Substrate type was the most important driver of the patterns in both distribution and composition. Observations of coral reefs on steeper areas in the canyons and coral rubble on flatter areas on the interfluve/upper slope support the hypothesis that canyons serve as refuges, being less accessible to trawling, although natural causes may also contribute to the explanation of this distribution pattern. The results of this study fed into a proposal of a Natura 2000 network in the Bay of Biscay where management plans are rare.

Link to paper: http://journal.frontiersin.org/article/10.3389/fmars.2017.00118/full

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Bottom trawling and oxygen minimum zone influences on continental slope benthic community structure off Vancouver Island (NE Pacific)

De Leo F, Gauthier M, Nephin J et al. (2017)

Deep Sea Research Part II: Topical Studies in Oceanography, Volume 137, Pages 404–419

Understanding responses of benthic ecosystems to cumulative impacts of natural stressors, long-term ocean change and increasing resource exploitation is an emerging area of interest for marine ecologists and environmental managers. Few, if any, studies have quantitatively addressed cumulative effects in the deep sea. We report here on a study from the continental slope off Vancouver Island (Canada) in the northeast Pacific Ocean, where the Oxygen Minimum Zone impinges on seabed habitats that are subjected to widespread bottom trawling, primarily by the fishery for thornyhead (*Sebastolobus* ssp.). We examined how the benthic megafauna in this area was influenced by varying levels of dissolved oxygen and trawling activity, along a depth gradient that was also likely to shape community composition. Continuous video and sonar records from two ROV surveys (50 linear km total; depth range 300–1400 m) respectively provided data on faunal attributes (composition, abundance and diversity) and the frequency of trawl door marks on the seabed. Faunal and trawl data were compiled in a geo-referenced database along with corresponding dissolved oxygen data, and pooled into 500 m segments for statistical analysis. Trawl mark occurrence peaked between 500 and 1100 m, corresponding to areas of slope subjected to hypoxia (<1.4 ml l^{-1}) and severe hypoxia (<0.5 ml l^{-1}). A combined

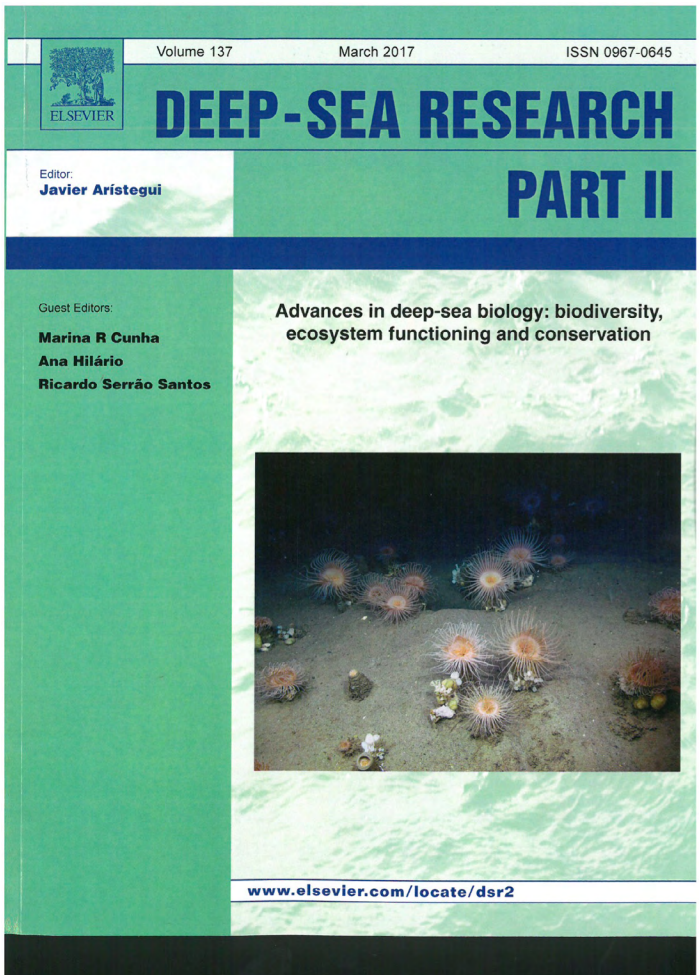
total of 266,251 megafauna organisms from 87 taxa were enumerated in the two transects. Significant megafaunal assemblages according to depth, trawling intensity and bottom water dissolved oxygen concentration were identified by PERMANOVA analyses, with characterizing taxa identified for all three factors. Depth, dissolved oxygen and trawl mark density accounted for 21% to 52% of the variability in benthic community structure according to multiple regression (DISTLM) models. Species richness was highest at intermediate depths and in areas subject to intermediate levels of trawling, and higher under hypoxia than under severe hypoxia. These statistically significant trends demonstrate that the structuring influences of bottom trawling on deep-sea benthic communities can be observed even where communities are being shaped by strong environmental gradients.

Link to paper: http://www.sciencedirect.com/science/article/pii/S0967064516303769

Advances in deep-sea biology: biodiversity, ecosystem functioning and conservation. An introduction and overview

Cunha M, Hilario A & Santos R (2017)

Deep–Sea Research Part II 137 (2017) 1–5



Once considered as monotonous and devoid of life, the deep sea was revealed during the last century as an environment with a plethora of life forms and extremely high species richness (Rex and Etter, 2010). Underwater vehicle developments allowed direct observations of the deep, disclosing unique habitats and diverse seascapes, and other technological advances enabled manipulative experimentation and unprecedented prospects to pursue novel research topics (Levin and Sibuet, 2012; Danovaro et al., 2014). Alongside, the growing human population greatly increased the pressure on deep-sea ecosystems and the services they provide (Ramirez-Llodra et al., 2011; Thurber et al., 2014; Levin et al., 2016). Societal changes further intensified worldwide competition for natural resources, extending the present footprint of impacts over most of the global ocean (Halpern et al., 2008). In this socio-economic context, and in tandem with cutting edge technological advances and an unclear legal framework to regulate access to natural resources (Boyes and Elliott, 2014), the deep sea has emerged as a new opportunity for industrial exploitation and novel economic activities. The expanding use of the deep sea prompted a rapid reply from deep-sea scientists that recommended “a move from a frontier mentality of exploitation and single-sector management to a precautionary system that balances use of living marine resources, energy, and minerals from the deep ocean with maintenance of a productive and healthy marine environment, while improving knowledge and collaboration” and proposed “three directions to advance deep-ocean stewardship: i) protection and mitigation, ii) research, and iii) collaborative governance” (Mengerink et al., 2014). The European Marine Board position paper 22 (Rogers et al., 2015) further examined the key societal and environmental

drivers confronting the deep sea and the role of deep-sea research to deliver future knowledge needs for science and society; a clear and consistent message from consultation with wider stakeholders was the need for fundamental knowledge of deep-sea ecosystems. Enhanced deep-sea knowledge is crucial to establish baselines and assess long term impact of human activity on ecosystems and it is also instrumental to inform environmental impact assessments, strategic management plans, effective decision making, environmental regulation and ocean governance (Rogers et al., 2015).

The deep sea is currently one of the most exciting frontiers for all fields of biological research not only because the new discoveries and paradigms stimulate advances in major ecological and evolutionary hypotheses but also because the societal challenges imposed by increasing rates of environmental change and expanding use of the oceans demand novel approaches and a close interaction with economic agents, managers and policy-makers.

Since their first edition in 1977, the international Deep-Sea Biology Symposia (DSBS) have been vital fora for exchange of knowledge on the most recent deep-sea explorations and scientific advances. Previous conferences have been held in Stockholm and Kristineberg, Sweden (1977), La Jolla, USA (1981), Hamburg, Germany (1985), Brest, France (1988), Copenhagen, Denmark (1991), Heraklion, Greece (1994), Monterey Bay, USA (1997), Galway, Ireland (2000), Coos Bay, USA (2003), Southampton, UK (2006), Reykjavík, Iceland (2010) and Wellington, New Zealand (2012). In 2015 the 14th Deep-Sea Biology Symposium (14DSBS), was held in Aveiro, Portugal (31 August–4 September). The call was for contributions in a wide range of topics with two main purposes:

Advance fundamental knowledge on deep-sea ecosystems: biodiversity - the fabric of ecosystem functioning: genetic, organismal and ecological diversity; the identities, life modes, roles and distribution of species and biomass; ecosystem functioning – the flow of matter and energy: production and growth; trophic interactions, connectivity; change – the ultimate driver of life and death: response of individuals and communities to environmental variability and to natural or anthropogenic disturbances at various spatial and temporal scales; adaptation; evolution.

Enhance links between deep-sea research and industry, management and policy: ecosystem modelling - improving predictability to inform management: habitat suitability, biophysical modeling, trophic web modeling; environmental assessments: impact of human activities on biodiversity, functioning and services of the ecosystem; establishing baselines, monitoring good environmental state; evaluate success of conservation measures; synergies with industry: opportunistic research, sharing data; knowledge transfer; policy advice: inform decision making, environmental regulation and ocean governance.

The 14DSBS attracted close to 400 participants representing universities, private and government institutions, NGOs, industry, and the media; more than 200 oral communications and 250 posters were presented and several workshops and side events took place during the meeting. Participants of the 14DSBS were subsequently invited to submit manuscripts under three broad themes that emerged as the main focus of the current deep-sea research: i) fundamental knowledge on the biodiversity and ecology of deep-sea ecosystems; ii) understanding life histories and deep-sea connectivity; iii) conservation and stewardship of the ocean. This special issue of Deep Sea Research II assembles a selection of 39 papers presented during this symposium, showing important advances in these three themes.

Link to publication: http://www.sciencedirect.com/science/article/pii/S0967064517300310

Giant protists (xenophyophores, Foraminifera) are exceptionally diverse in parts of the abyssal eastern Pacific licensed for polymetallic nodule exploration

Gooday A, Holzmann M, Caulle C et al. (2017)

Biological Conservation, Volume 207, Pages 106–116

Xenophyophores, giant, fragile, agglutinated foraminifera (protists), are major constituents of the abyssal megafauna in the equatorial Pacific Clarion-Clipperton Zone (CCZ), a region where seabed mining of polymetallic nodules may occur in the future. As part of a baseline study of benthic communities we made extensive collections of xenophyophores in two areas (UK-1 and OMS) licensed for exploration by the International Seabed Authority. Based on test morphology, we distinguished 36 morphospecies (34 new to science) among 130 specimens. Twenty of these morphospecies yielded 184 DNA sequences, a 14-fold increase in genetic data for xenophyophores that confirms their high diversity in the eastern CCZ. A further 15 morphospecies (8 new to science) were recognised in samples from two other areas (APEI-6 and Russian exploration license area) within or adjacent to the CCZ. This large number of species confirms that the CCZ is a focal area for xenophyophore diversity. More broadly, it represents an unprecedented increase in the known global diversity of xenophyophores and suggests that many species remain undiscovered in the World's oceans. Xenophyophores are often sessile on nodules in the CCZ, making these delicate organisms particularly vulnerable to mining impacts. They can also play a crucial role in deep-sea ecosystems, providing habitat structures for meiofaunal and macrofaunal organisms and enhancing the organic content of sediments surrounding their tests. The loss of xenophyophores due to seabed mining may therefore have wider implications for the recovery of benthic communities following major human disturbances on the abyssal seafloor.

Link to paper: http://www.sciencedirect.com/science/article/pii/S0006320716304633

The Community Structure of Deep-Sea Macrofauna Associated with Polymetallic Nodules in the Eastern Part of the Clarion-Clipperton Fracture Zone

De Smet B, Pape E, Riehl T et al. (2017)

Frontiers in Marine Science, vol. 4, article 103

Deep-sea areas characterized by the presence of polymetallic nodules are getting increased attention due to their potential commercial and strategic interest for metals such as nickel, copper, and cobalt. The polymetallic nodules occur in areas beyond national jurisdiction, regulated by the International Seabed Authority (ISA). Under exploration contracts, contractors have the obligation to determine the environmental baseline in the exploration areas. Despite a large number of scientific cruises to the central east Pacific Ocean, few published data on the macrofaunal biodiversity and community structure are available for the abyssal fields of the Clarion-Clipperton Fracture Zone (CCFZ). This study focused on the macrofaunal abundance, diversity, and community structure in three physically comparable, mineable sites located in the license area of Global Sea Mineral Resources N.V. (GSR), at ~4,500 m depth. A homogeneous but diverse macrofaunal community associated with the sediment from polymetallic nodule areas was observed at a scale of 10 to 100 s of km. However, slight differences in the abundance and diversity of Polychaeta between sites can be explained by a decline in the estimated flux of particulate organic carbon (POC) along a southeast-northwest gradient, as well as by small differences in sediment characteristics and nodule abundance. The observed homogeneity in the macrofaunal community is an important prerequisite for assigning areas for impact and preservation reference zones.

Figure 1: Macrofauna collected from a nodule-rich habitat in the GSR exploration area at about 4,500m depth in the Clarion-Clipperton Fracture Zone (CCFZ). From left to right: isopode (Haploniscidae), cumacean, polychaete (Goniadidae). Images © UGent, GSR

However, a precautionary approach regarding mining activities is recommended, awaiting further research during the exploration phase on environmental factors structuring macrofaunal communities in the CCFZ. For instance, future studies should consider habitat heterogeneity, which was previously shown to structure macrofauna communities at larger spatial scales. Acknowledging the limited sampling in the current study, a large fraction (59–85%; depending on the richness estimator used and the macrofaunal taxon of interest) of the macrofaunal genus/species diversity from the habitat under study was characterized.

Link to article: http://journal.frontiersin.org/article/10.3389/fmars.2017.00103/full

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Novel benthic foraminifera are abundant and diverse in an area of the abyssal equatorial Pacific licensed for polymetallic nodule exploration

Goineau A & Gooday A (2017)

Nature Scientific Reports 7, Article number: 45288

The benthic biota of the Clarion–Clipperton Zone (CCZ, abyssal eastern equatorial Pacific) is the focus of a major research effort linked to possible future mining of polymetallic nodules. Within the framework of ABYSSLINE, a biological baseline study conducted on behalf of Seabed Resources Development Ltd. in the UK-1 exploration contract area (eastern CCZ, ~4,080 m water depth), we analysed foraminifera (testate protists), including 'live' (Rose Bengal stained) and dead tests, in 5 cores (0–1 cm layer, >150- µm fraction) recovered during separate megacorer deployments inside a 30 by 30 km seafloor area.

In both categories (live and dead) we distinguished between complete and fragmented specimens. The outstanding feature of these assemblages is the overwhelming predominance of monothalamids, a group often ignored in foraminiferal studies. These single-chambered foraminifera, which include agglutinated tubes, spheres and komokiaceans, represented 79% of 3,607 complete tests, 98% of 1,798 fragments and 76% of the 416 morphospecies (live and dead combined) in our samples. Only 3.1% of monothalamid species and 9.8% of all species in the UK-1 assemblages are scientifically described and many are rare (29% singletons). Our results emphasise how little is known about foraminifera in abyssal areas that may experience major impacts from future mining activities.

Link to paper: https://www.nature.com/articles/srep45288

Megafauna of the UKSRL exploration contract area and eastern Clarion-Clipperton Zone in the Pacific Ocean: Echinodermata

Amon D, Ziegler A, Kremenetskaia A et al. (2017)

Biodiversity Data Journal 5: e11794.

There is growing interest in mining polymetallic nodules from the abyssal Clarion-Clipperton Zone (CCZ) in the tropical Pacific Ocean. Despite being the focus of environmental studies for decades, the benthic megafauna of the CCZ remain poorly known. In order to predict and manage the environmental impacts of mining in the CCZ, baseline knowledge of the megafauna is essential. The ABYSSLINE Project has conducted benthic biological baseline surveys in the UK Seabed Resources Ltd polymetallic-nodule exploration contract area (UK-1). Prior to these research cruises in 2013 and 2015, no biological studies had been done in this area of the eastern CCZ. Using a Remotely Operated Vehicle and Autonomous Underwater Vehicle, the megafauna within the UKSRL exploration contract area (UK-1) and at a site ~250 km east of the UK-1 area were surveyed, allowing us to make the first estimates of megafaunal morphospecies richness from the imagery collected. Here, we present an atlas of the abyssal echinoderm megafauna observed and collected during the ABYSSLINE cruises to the UK-1 polymetallic-nodule exploration contract area in the CCZ. There appear to be at least 62 distinct morphospecies (13 Asteroidea, 5 Crinoidea, 9 Echinoidea, 29 Holothuroidea and 6 Ophiuroidea) identified mostly by imagery but also using molecular barcoding for a limited number of animals that were collected. This atlas will aid the synthesis of megafaunal presence/absence data collected by contractors, scientists and other stakeholders undertaking work in the CCZ, ultimately helping to decipher the biogeography of the megafauna in this threatened habitat.

Figure 1 (left) cf. Hymenaster morphospecies 2 observed in situ on seafloor in the UKSRL exploration contract area. Scale bar is 10 cm. Image attribution: DJ Amon & CR Smith, University of Hawai'i. Figure 2 (right) cf. Amperima morphospecies observed in situ on seafloor in the UKSRL exploration contract area. Scale bar is 10 cm. Image attribution: DJ Amon & CR Smith, University of Hawai'i.

(Note: this is the first of four installments of image atlases on the megafauna from the UKSRL claim and eastern CCZ derived from the imagery and samples from two ABYSSLINE cruises (2013 and 2015). These atlases are an effort to standardize taxonomy across the region and aid in deciphering species ranges).

Link to paper: http://bdj.pensoft.net/articles.php?id=11794

High Abundance of the Epibenthic Trachymedusa *Ptychogastria polaris* Allman, 1878 (Hydrozoa, Trachylina) in Subpolar Fjords along the West Antarctic Peninsula

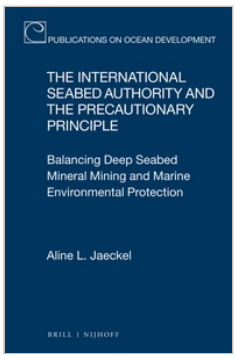
Grange L, Smith C, Lindsay D et al. (2017)

PLoS ONE 12(1): e0168648

Medusae can be conspicuous members of seafloor communities that may attain appreciable abundances near or on the seabed; however little is known about the gelatinous zooplankton that inhabit deep-sea benthic boundary layers (Smith 1982; Larson et al., 1992; Miyake et al., 2002, 2005; Toyokawa et al., 2003; Lindsay & Pagès 2010). Here we report seafloor densities of the epibenthic trachymedusa, *Ptychogastria polaris* Allman 1878 (Hydrozoa: Trachylina: Ptychogastriidae) in the sediment floored basins of two subpolar fjords, Andvord and Flandres Bays, along the West Antarctic Peninsula at 436-725 m, confirming species identification with megacore-collected voucher specimens based on morphological characteristics and DNA barcoding. This trachymedusa has been observed previously in the cold, high latitude systems of both the northern and southern hemispheres, with a circumpolar distribution in Arctic and sub-Arctic areas, however only in disjunct reports from Antarctic waters near Gauss Station (66'02 °S, 90'20 °E) and the South Shetland Islands (61-63 °S, 53-61 °W). *Ptychogastria polaris* was a common component of the epifauna, reaching densities of 13 m^{-2}, with mean densities in individual basins ranging from 0.06-4.19 m^{-2}. These densities are 2 to 400-fold higher than previously reported for the trachymedusa in either the Arctic or Antarctic. Although the majority (~80%) of individuals recorded were observed on soft sediments and therefore classified as benthopelagic, a morphologically similar species, presumably the same trachymedusa, was present in the water column near the bottom of the fjords and attained abundances of up to 7 m-2 of the seafloor. We hypothesise that the fjords provide a prime habitat for the development of dense populations of *P. polaris* and that high seafloor densities of the trachymedusa might be the result of both high and varied food inputs to the fjord floor (described in Grange & Smith 2013). We conclude that dense populations of *P. polaris* in the water column and at the seafloor may contribute significantly to the process of pelagic-benthic coupling, connecting the pelagic and benthic subsystems in the WAP fjord ecosystems in a variety of ways (e.g. by contributing prey and fecal material, and undertaking short swimming excursions into the benthic boundary layer (Larson et al., 1992; Stübing et al., 1998; Schnack-Schiel & Isla 2005; Gili et al 2006; Boero et al., 2008). This study provides new insights into the abundance, distribution and phylogenetic analysis of P. polaris.

Photograph of a live Ptychogastria polaris, in Andvord Bay. Photograph courtesy of © Maria Stenzel.

Link to paper: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0168648



The International Seabed Authority and the Precautionary Principle

Balancing Deep Seabed Mineral Mining and Marine Environmental Protection

Aline L. Jaeckel, ***Macquarie Law School***

With the transition to the commercial-scale exploitation of deep seabed minerals, the International Seabed Authority's obligation to protect the marine environment is being tested. In *The International Seabed Authority and the Precautionary Principle*, Aline L. Jaeckel provides the first in-depth analysis of the Authority's work in regulating and managing deep seabed minerals.

This book examines whether and to what extent the Authority is implementing the precautionary principle in practice. This includes the development of adequate environmental protection standards as well as procedural safeguards and decision-making processes that facilitate risk assessment and risk management. In doing so, the author offers an insightful example of how the precautionary principle can be translated into a practical management tool.

READERSHIP:

All interested in the International Seabed Authority, the regulation and management of deep seabed minerals, the implementation of the precautionary principle, and law of the sea and international environmental law.

For more information see https://www.brill.com/pood

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Subject

International Law › Law of the Sea
International Law › Environmental & Energy Law

Obituaries

Torben Wolff

21 July 1919 – 2 May 2017

A Great Grandmaster of the Deep

Figure 1: Torben (foreground) at work during the Galathea Expedition, 1952

From Paul Tyler, University of Southampton, UK

Dear Deep-sea Colleagues,
As many of you will now be aware Torben Wolff, one of the pioneers of modern deep-sea biology has died at the age of 97. Below is his obituary from Jorgen Olesen, accompanied by photographs and tribute from Robert George, but Maria thought it would be nice to record some of my thoughts on his passing. Although I have never been to sea with him I have interacted extensively with him at the Deep-sea Biology Symposia over the years. He was one of the driving pillars of deep-sea biology from the time of the *Galathea* expedition and as our science entered the modern era in the sixties and early seventies. To aid international collaboration, which we take for granted today, he instituted the Deep-sea Newsletter in hard copy (pre-digital) that was posted out to a few institutions and thus trickled down to us, the most junior of researchers. Today's Deep-sea Life has inherited that mantle and keeps alive that international collaboration. Torben also was a driving force behind the deep-sea biology symposia. He attended all meetings, until he became too frail to travel, and was a vigorous presence at those meeting stimulating colleagues and students alike. And no one is ever going to forget his rendition of the Haka as the conference banquet – even at 80 years old! I hope you will all spare a moment's though for Torben Wolff, one of the greats of deep-sea biology.

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From Jørgen Olesen, University of Copenhagen, Denmark

IN MEMORIAM

Dr. Torben Wolff, known all over the world as just Torben, nestor of oceanography and carcinology, friend, colleague, mentor for three generations of marine scientists, and promoter of science to the public at all levels, died in his sleep 2 May 2017 at the age of 97. Torben got his cand.mag. degree from the University of Copenhagen in 1947 and was awarded the Dr.phil. degree in 1963. His career at the Zoological Museum started in 1953. He was Associate Professor and Curator of Crustacea from 1962 until he retired in 1989, from 1966 as Head of Department of Marine Invertebrates, with a break in 1980-83 as Director of the Danish Aquarium.

Before his permanent attachment at the Zoological Museum Torben took part in three cruises that defined his life ever after: the *Atlantide* expedition to West Africa 1945-46, The Danish Rennell Expedition 1951, and first and foremost as second in command on the *Galathea* Expedition around the world 1950-52. Later, in 1962, he led the *Noona Dan* expedition to the Bismarck–and Solomon Islands. After these experiences he was invited to participate in American, Russian and French deep-sea expeditions incl. a 4000 m deep dive with a French bathyscaph off Madeira in 1966.

Torben authored about 70 scientific papers (and many hundred short articles in 'popular' media on oceanography in the widest sense). He wrote several taxonomic studies in the now famous *Galathea* Report, but his tour-de-force was the monumental 'The systematics and biology of bathyal and abyssal Isopoda Asellota' *Galathea* Report 6: 1-320, from 1962, in which he introduced his views on the taxonomy of the group and summarised all available systematic and geographic knowledge, thus establishing a comprehensive new platform for the study of asellote Isopoda.

Torben would not have been the Torben we knew without engaging himself wholeheartedly in many international and national organizations, committees and policy fora in oceanography and nature conservation. In this, he followed in the footsteps of his own mentor and dear friend Professor Anton Bruun.

In November 2016 Torben, to his great pleasure, had an asteroid named after him as 'Asteroid 6577 Torbenwolff'. Torben was the ultimate extrovert. He will long be remembered for his all-encompassing freely aired enthusiasm that inspired many who worked with him or met him at conferences and meetings and at social gatherings (who can forget his rendition of the Māori war dance the Haka).

Let our thoughts go to his wife Lisbeth who traveled with Torben all over the world and supported him (and not infrequently reined him in a bit!) throughout their 63 years together.

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From Robert George (George Institute for Biodiversity and Sustainability)

HONOURING TORBEN

I discussed my plans to sample hadal fauna in Puerto Rico Trench while visiting Torben in Copenhagan. He told me that in *Galathea* expedition they lost trawls and dredges at the floor of Puerto Rico Trench at 9000 m. I took Torben's advice to do a thorough bathymetric and seismic mapping of the trench floor when I led the expedition to Puerto Rico Trench during the GILLISS EXPEDITION. We successfully sampled the trench floor at 9200 and I named a new species of hadal isopod *Storthyngura torbeni* George to honor Torben (*Storthyngura torbeni* in the painting of Hadal life in Puerto Rico Trench).

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Clockwise from top left: Bob George and Torben Wolff in Copenhagen; TorbeN Wolff, Bob George and Tony Rice (Three Amigos); 1976 meeting in Edinburgh - Bob George, Bob Hessler and Torben Wolff; UNCW Marine Biology students Caroline and Nancy with Torben Wolff with his bicycle and Bob George in Copenhagen.

Graham Shimmield

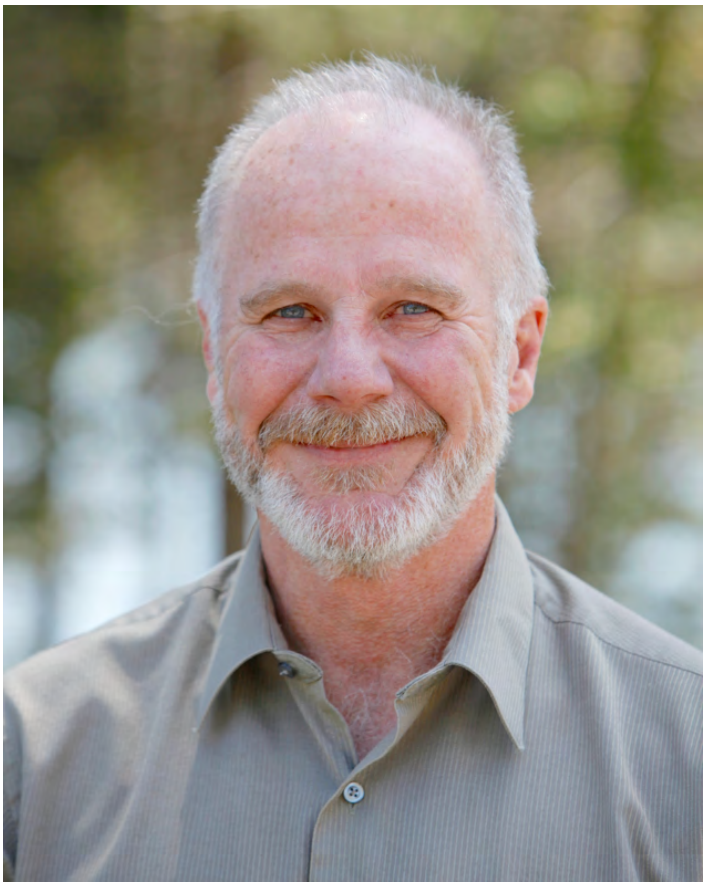

Photo credit: Bigelow Laboratory for Ocean Sciences

Obituary by Darlene Trew Christ

The ocean and the marine science community lost one of its visionaries in 2017.
Graham Shimmield, executive director of Bigelow Laboratory for Ocean Sciences, died Dec 24, 2017 at 58 years old after a hard-fought battle with cancer.

A globally recognized leader in oceanography, Shimmield served in his role at Bigelow Laboratory since 2008. During his tenure, he transformed the organization, building upon its longstanding scientific reputation to develop a $32-million marine research and education campus in East Boothbay, Maine, which opened in 2012, along with a $6-million residence facility, named in his honor, that will be formally dedicated on May 12, 2017.

“Graham was an accomplished scientist, a visionary leader, and a kind and compassionate human being who changed our organization and our lives,” said Ben Twining, a vice president and senior research scientist at Bigelow Laboratory who is now serving as interim executive director. “We were very lucky to have him at the helm for the last nine years.”

Shimmield published more than 70 peer-reviewed scientific articles, earning recognition as a Fellow of the Royal Society of Edinburgh, a Fellow of the Royal Society of Biology, and a recipient of the prestigious Plymouth Marine Sciences Partnership Medal. He held an array of leadership positions with national and international groups during his career, including president and vice president of the European Federation of Marine Sciences and Technology Societies; chairman of the European Census of Marine Life; member of the board of trustees and executive committee for the Consortium for Ocean Leadership; and chairman of the International Science Advisory Board for the Decommissioning of Man-Made Structures in the North Sea, Oil & Gas.

Since arriving in Maine in 2008, he served on the boards of the Maine Innovation Economy Advisory Board, Maine Space Grant, Maine Sea Grant, and advisory boards for Maine Maritime Academy and Mount Desert Island Biological Laboratory. In 2013, he was elected to the Board of Trustees for the Consortium for Ocean Leadership in Washington, DC. In July 2015, he was named as one of the top 50 “Bold Visionaries Defining Our State” by Maine Magazine.

“Graham was perpetually curious. He was not only a problem solver, a big thinker, but an explorer at heart, “ said Darlene Trew Crist, who served as Bigelow Laboratory’s director of communications under Graham’s leadership. “Months before he was diagnosed, and just shy of his 56th birthday, he traveled 3,000 meters below the ocean’s surface aboard the Alvin realizing a dream to see the bottom of the ocean he had spent his life studying. Then one month later, he climbed 5,636 meters high to reach the summit of Pico de Orizaba in Mexico—the third highest peak in North America. Graham’s zest for adventure, knowledge, inclusiveness, and fairness were unmatched. ”

Shimmield was born in Pointe-a-Pierre, Trinidad, on Dec 1, 1958. A citizen of the United Kingdom, he received a Ph.D. from the University of Edinburgh in Scotland. His research focused on identifying indicators of climate change and examining human impacts on the ocean. Throughout his career, his work took him to every ocean on the planet, from Pacific coral reefs impacted by El Niño to polar regions affected by melting sea ice.

In 1997, Shimmield became managing director of the Scottish Association for Marine Science, where he served until moving to the United States to assume his role at Bigelow Laboratory for Ocean Sciences. There he led the independent, not-for-profit research institution that studies the ocean and how it is changing – from the biology and ecology of marine microorganisms to large-scale ocean processes that affect the global environment.

“Under Graham’s leadership, Bigelow Laboratory has nearly doubled in size, developed significant education programs, launched a successful philanthropy program to support our work, and increased the reach and impact of our science through expanded outreach and our Centers for Venture Research,” Twining said. “Graham was also committed to contributing to innovation and growth in Maine’s economy through our research and partnerships around the state.”

To help support his legacy, the Laboratory has established an endowment fund in Shimmield’s honor. Contributions to the Dr. Graham Shimmield Endowment Fund may be sent to Bigelow Laboratory for Ocean Sciences, PO Box 380, East Boothbay, ME, 04544.

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