Deep-Sea Life

Issue 22, February 2024

Welcome to the 22nd edition of Deep-Sea Life: an informal publication for the deep-sea biology community and beyond. Now into our 11th year and still we have not tired of editing this newsletter. All your interesting contributions make it such a pleasure for the editorial team.

We hope you like our choice for "Photo of the Issue". We usually select either animals, people or technology but this is something a bit different – a wonderfully eye-catching logo for the Red Sea Hexplores project – a tantalizing portrayal of what may lie beneath and a lovely example of art meeting science. You can read about what this first expedition found in our Cruise News section on page 2.

Remember to mark the dates for the 17th Deep-Sea Biology Symposium in your diaries for next year – 13th to 17th January 2025. Our colleagues in Hong Kong are well ahead with preparations for what promises to be a wonderful meeting and the first ever DSBS in Asia. See page 29 for more details and early bird registration (by June 2024).

Our DOSI, DSBSoc and many other institutional and organisation accounts on social media – whether Twitter(X), Instagram, Bluesky, LinkedIn, Facebook or other platforms – are shedding light on the deep ocean, the science and the stewardship challenges, opening its wonders to an ever-growing audience from scientists, policy makers, managers, industry and the public. It is so good to see – keep up the excellent work! I hope you enjoy DSL22 with lots of news from sea, from projects and new papers etc.

Thanks to my fellow editors Drs. Abigail Pattenden (University of Limerick, Ireland), Eva Ramirez-Llodra (REV Ocean, Norway) and Franck Lejzerowicz - University of Oslo.

Dr. Maria Baker University of Southampton & DOSI Executive Director – mcb3@soton.ac.uk

A DOSI and DSBS collaborative publication. (Please note: DOSI & DSBS do not necessarily endorse the views presented in the submissions herein)

DOSI DEEP-OCEAN STEWARDSHIP INITIATIVE

DEEP-SEA BIOLOGY SOCIETY

Issue Contents

Cruise News

HEXPLORES: Secrets of the Red Sea Rift

Katrin Linse[1], Nico Augustin[2], Froukje van der Zwan[3] and the HEXPLORES Expedition Team

[1]British Antarctic Survey, BAS, [2]GEOMAR Helmholtz Centre for Ocean Research, Kiel,
[3]KAUST King Abdullah University of Science and Technology

In early October 2023, the German RV Meteor departed from Jeddah (Saudi Arabia) for the expedition M194 HEXPLORES: Hydrothermal EXPLOration of the REd Sea under the scientific lead of Nico Augustin and Froukje van der Zwan. For the next three weeks, our science team of geologists, oceanographers, microbiologists, and biologists worked closely together with the technical team of ROV *Kiel 6000* and Captain Hammacher's crew to deliver the project aims to search systematically for active hydrothermal vents in the Red Sea Rift and to study the geological system and evolution of hydrothermal ecosystems in one of the Earth's youngest oceans. Our multinational team consisted of 26 scientists and technicians from GEOMAR, KAUST, BAS, Macau University of Science and Technology, the University of Ottawa, the Saudi National Center for Wildlife, and the General Authority for Survey and Geospatial Information.

Figure 1. Expedition party of HEXPLORES. Photo by David Diekrup, copyright M194

The deep Red Sea is one of the harshest environments on the planet. With high seawater salinity and temperatures that never drop below 20°C, even at its deepest points, the Red Sea is ten times warmer than most other deep oceans. The Red Sea underwent massive changes during the last glacial maximum just 20,000 years ago, causing a major extinction of species, and much of the deep-sea life is still recovering. Therefore, we were unsure what to expect regarding microbiology and larger fauna.

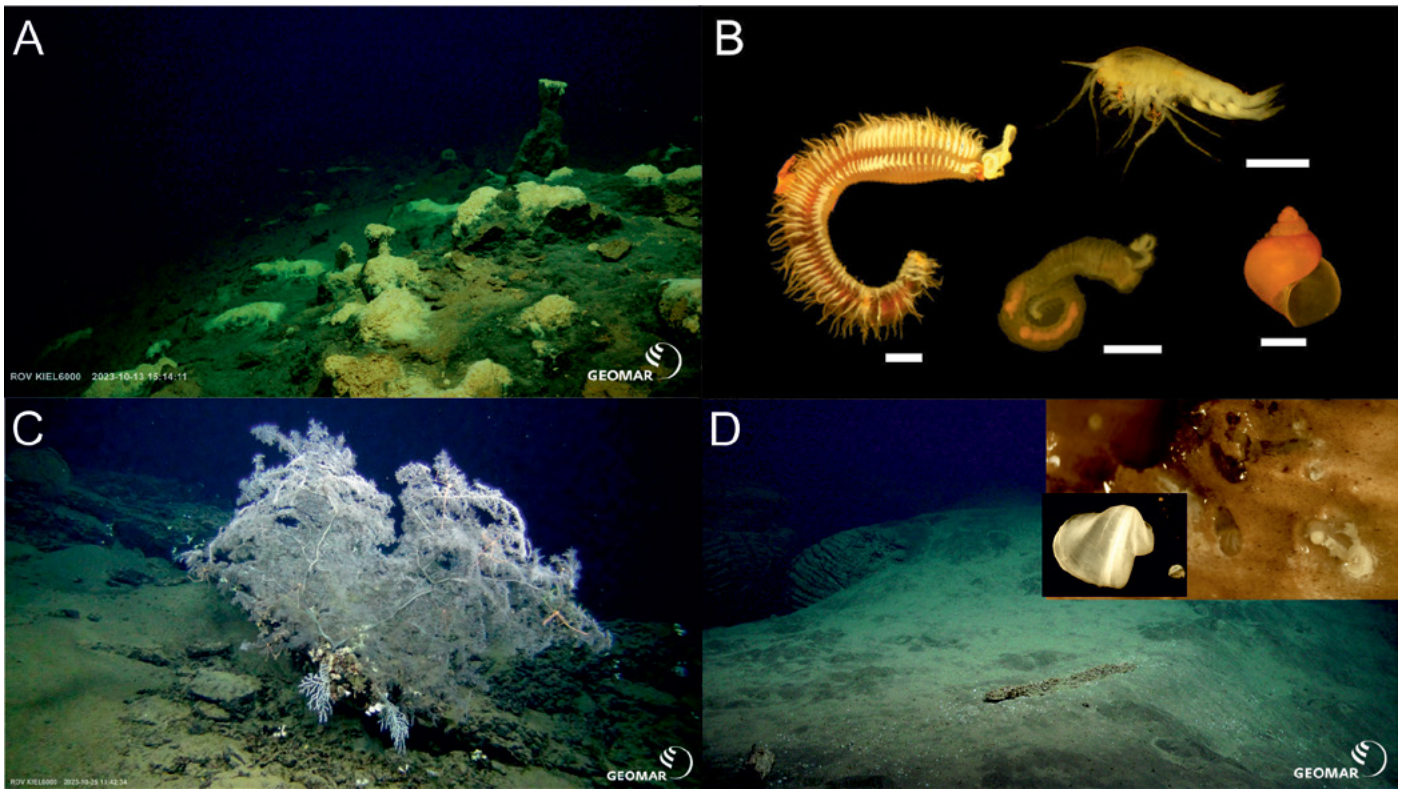


Figure 2. A) Hydrothermal activity at Mabahiss Mons volcano, B) macrofauna from Mabahiss Mons microbial mats, scale bar 1 mm, C) deep-water corals at Ramad Seamount, D) wood fall at Ramad Seamount and close-up showing teredinid bivalves. In-situ photos by ROV *Kiel 6000*, copyright GEOMAR: macrophotos by Katrin Linse, Photo by David Diekrup, copyright M194

Figure 3. HEXPLORES logo

Until recently, biological research in the Red Sea has been focusing on the unique, mostly shallow-water coral reef habitats and pelagic fauna, both with high numbers of endemic species, while studies on the deep-sea benthic fauna are scarce. As the Red Sea is a young ocean basin with an unexplored, volcanically active rift axis of almost 2,000 km, we hoped for many undiscovered vent sites, from the northern Mabahiss Mons volcano to the southern Ramad Seamount. And we were successful from our first dive with ROV *Kiel 6000*, discovering hydrothermal activity and dense bacterial mats at Mabahiss Mons. The latter did not only make the microbiologists happy, as they started experiments and cultivations on the bacteria, but also the macrobiologists, as a few polychaetes and amphipods were found. The next fourteen ROV dives enabled us to take samples and in-situ footage of unusual geomorphologic features, hydrothermal activity, and deep-water fauna along the rift axis. An unexpected find was a colonized woodfall at 670 m depth, not a hydrothermal site, but a potential chemosynthetic habitat. We learned that concurrent with the existing view, epifaunal megafauna is rare in the deep Red Sea, both in abundance and diversity – but we also realized that we have only scratched the surface of the deep-sea habitats and ecosystems existing along the Red Sea Rift. We all hope to return in the not-too-distant future for more discoveries.

Weekly reports and short cruise report of M194: https://www.ldf.uni-hamburg.de/en/meteor/wochenberichte.html

The Galapagos and la Isla del Coco UNESCO World Heritage sites and their deepest hidden treasures

Ana-Belén Yánez Suárez

The 30 days "2023 Vertical Reefs of the Galapagos Expedition" on board R/V *Falkor* (too), our multidisciplinary team of scientists (figure 1) came together to study the deep-sea vertical reefs of the Galapagos, Ecuador. Employing cutting-edge technologies, such as underwater laser scanners mounted on the ROV *SuBastian* (figure 2), we collected high-resolution data, including fine-scale maps and outstanding 3D point clouds, to unravel the environmental drivers of vertical cold-water coral (CWC) ecosystems

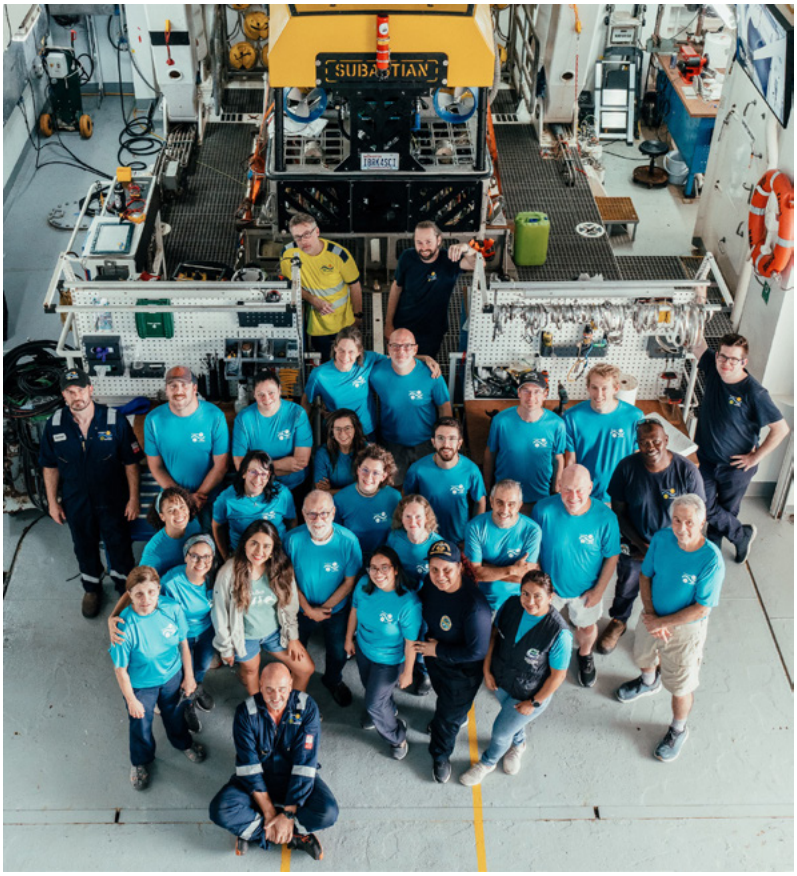


Figure 1. Scientific team 2023 Vertical Reefs of the Galapagos Expedition. Photo taken by Misha Vallejo credits to Schmidt Ocean Institute

Within the Galapagos Marine Reserve, we discovered two *Madrepora* cold-water coral reefs, one of which was over 800 m long (figure 3). Mapping was crucial in identifying areas with vertical walls and potential CWC presence. The biological team, dedicated to understanding CWC biodiversity, collected samples of various living coral species and their associates, some never sampled on the islands before (figure 4). Meanwhile, the geological team gathered fossil corals and geological samples to understand the archipelago's coral history and past oceanic conditions.

The vessel also visited La Isla del Coco, Costa Rica, to examine cold-water coral biodiversity and distribution across the oxygen minimum zone (OMZ). To our great surprise, during one dive, we encountered a stunning coral garden that seemed to be formed by one species of large yellow octocoral living in almost anoxic waters where all the substrate was covered by pink ophiuroids (figure 5). Whether these corals are the last standing or are adapted to extreme conditions remains unknown. However, the samples we collected may help to shine a light on this question.

An additional novelty included recording many different species of corals loaded with eggs or gametes (figure 6).

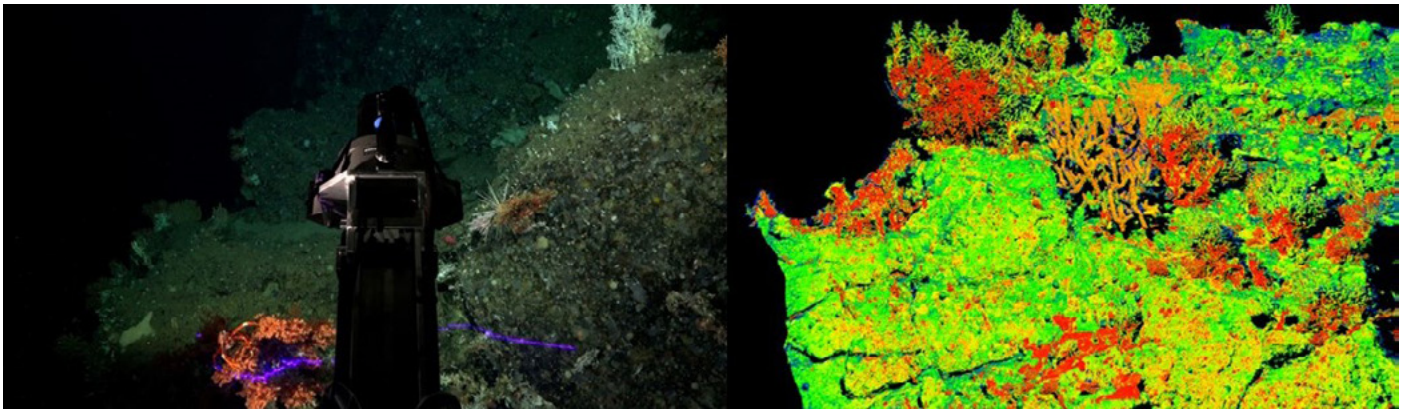


Figure 2. On the left Micro Insight Laser Scanner Voyis and on the right a point cloud of a section of a vertical wall where corals can be observed.

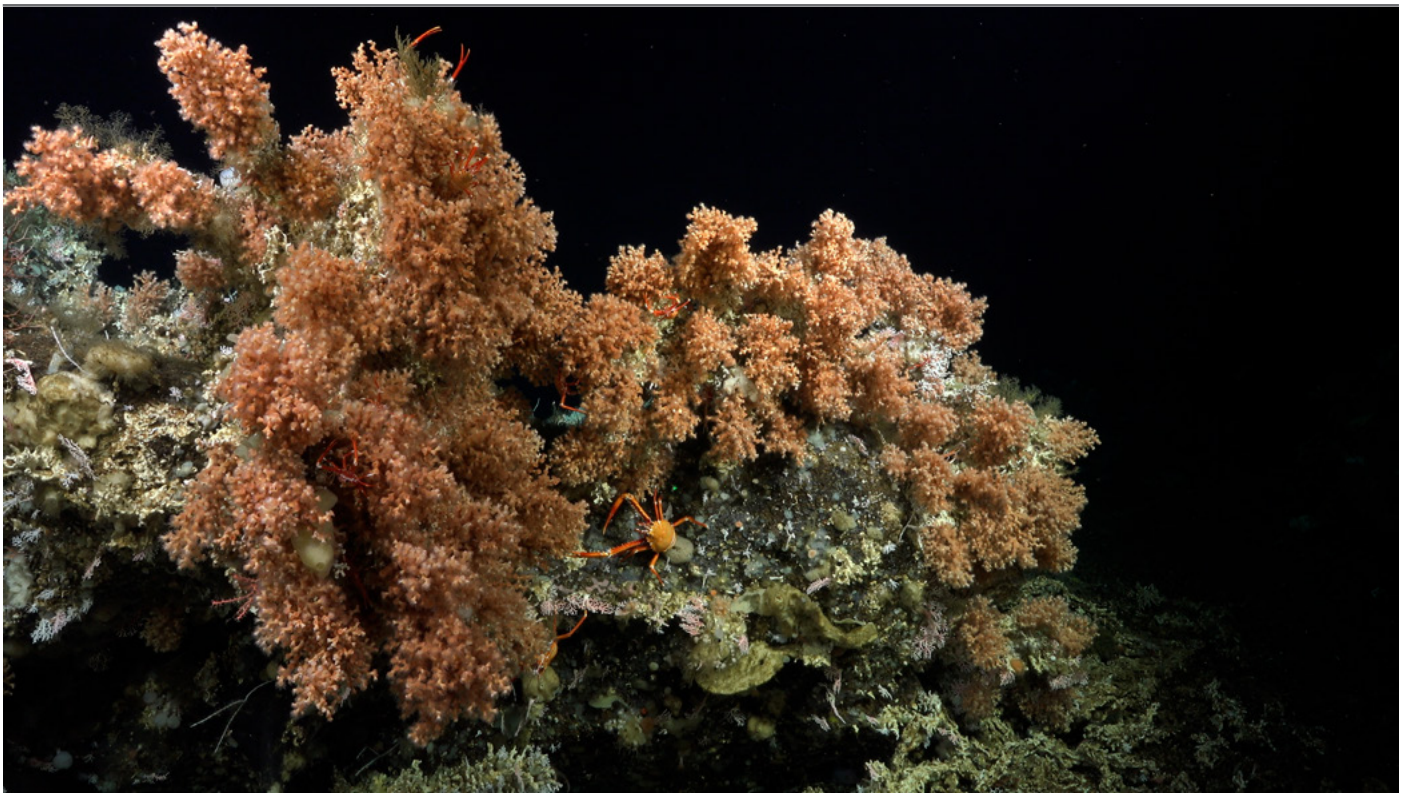


Figure 3. A section of the discovered *Madrepora* Coral Reef found in the Galapagos Islands. Image credits: Schmidt Ocean Institute, The Galapagos National Park, and The Charles Darwin Research Station

Figure 4. Clockwise: *Leiopathes* coral never found before in the Galapagos Islands; a rare species of coral-associated genus *Sternostylus* and the coral base. The size of the coral and the thickness of its base indicate that this specimen is several hundred years old. Image credits: Schmidt Ocean Institute, The Galapagos National Park, and The Charles Darwin Research Station.

Charismatic fauna was abundant. We encountered many dumbo octopuses, and when ending our last dive, a manta ray approached the ROV *SuBastian* with surprising curiosity at ~ 160 m depth, making it extremely hard to leave this unique place (figure 7).

Despite the efforts of local governments in the Eastern Tropical Pacific (ETP) to protect highly biodiverse and pristine areas like the Galapagos and La Isla del Coco through interconnected MPAs where mining and bottom trawling are not allowed, climate change is expected to have a large impact on this region. However, we lack knowledge of how deep-sea ecosystems of this region will be affected. This expedition will contribute to understanding cold-water coral reef ecology in the ETP, providing information that can be used to raise awareness about this deep-sea treasure and drive further international efforts for its long-term conservation as a shared responsibility.

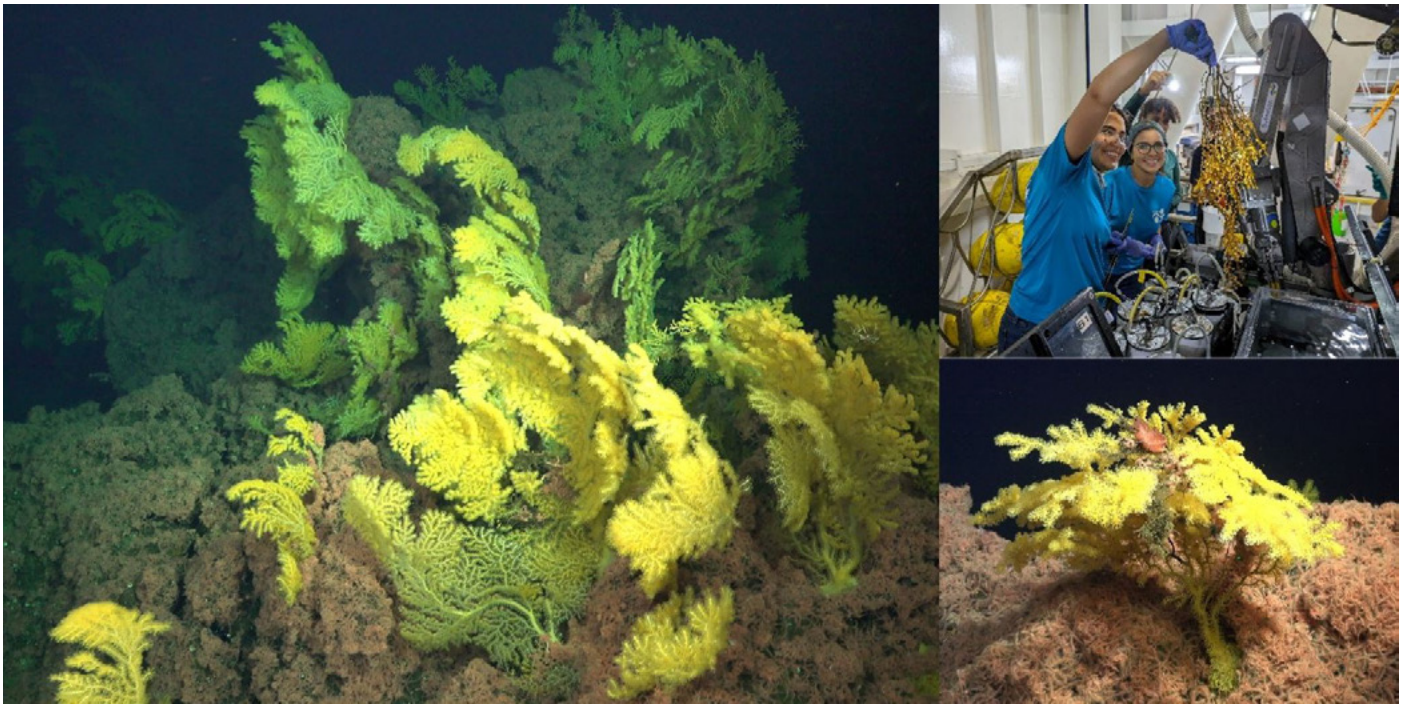


Figure 5. Clockwise: section of coral garden formed by yellow octocorals found within the OMZ; sampled coral taken from the ROV basket;in situ yellow octocoral (Family Paramuriceides). Image credits Schmidt Ocean Institute

Figure 6. On the right is a bamboo coral, and on the left is a sea pen loaded with eggs. Species were found in a newly mapped seamount near la Isla del Coco. Image credits Schmidt Ocean Institute Close-up image credits National Geographic Society.

Figure 7. Charismatic fauna in our dives in Costa Rica: a manta ray and a dumbo octopus. Image credits Schmidt Ocean Institute

This article would be incomplete without acknowledging the essential contribution of early career and senior local scientists to the cruise's success. While the *Falkor* (too) is an exceptional vessel, the warmth and helpfulness of its crew members truly made the expedition a lifetime experience.

Chief scientist of the expedition Dr. Katleen Robert, www.4d-oceans.com

La Isla del Coco PI Ana-Belén Yánez Suárez, ana-Belen.Yanez@mi.mun.ca

Collaborators

Seascape Alaska 5 Gulf of Alaska Expedition

Merlin Best

Fisheries & Oceans Canada

Contact: merlin.best@dfo-mpo.gc.ca

The Seascape Alaska 5 Gulf of Alaska Expedition aboard the NOAA Ship *Okeanos* Explorer provided an unprecedented glimpse into understudied and unexplored parts of the Gulf of Alaska. With the ROV *Deep Discoverer 2* we were able to explore these incredible ecosystems in amazing detail, including a 4000m dive off the shelf, 5 separate seamounts, canyons, a large and active cold seep, and a dense coral garden. In total 19 ROV dives were completed across the entire gulf.

With the advanced tools available on board and remote collaboration with shore-based scientists interested in the study area, we were able to make some incredible discoveries. The live-streamed video and associated data are available for any researcher to study, and samples of these rare or undocumented specimens can be borrowed from the Smithsonian Institution.

One of the most exciting discoveries was a large nursery ground area for the Deep-Sea Octopus *Graneledone boreopacifica*, on a ridge ~140km from the mouth of Prince William Sound. The team documented 18+ individual octopuses in various stages of brooding, as well as several juveniles in the area. This in addition to the *G. boreopacifica* nursery discovered off Vancouver Island in British Columbia just 3 months earlier adds a wealth of information on the brooding behaviour of this rare deep-sea predator. As little is known of the Alaskan benthic fauna below 1000m due to the limits of traditional bottom trawling, the high abundance of corals, sponges, anemones, and echinoderms were also crucial to document.

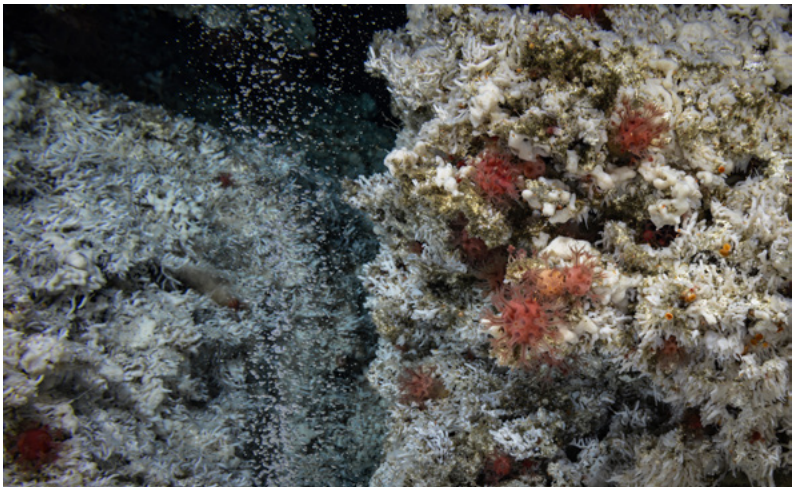


Figure 1. Cold seep

We can't talk about the Seascape Alasksa 5 Expedition without mentioning its most famous participant - the mysterious Golden Orb! This as-of-yet unidentified specimen captured the imagination of news outlets and chatrooms around the world when it was collected on a 3200m deep feature off of Welker Seamount. As many of us know, it's fairly common to find specimens that are completely unidentifiable when studying the deep sea. This survey alone collected probably a dozen unidentified specimens that researchers

on board and ashore were unable to identify. The Golden Orb and the rest are currently being accessioned at the Smithsonian, awaiting results from genetic analysis to point taxonomists in the right direction.

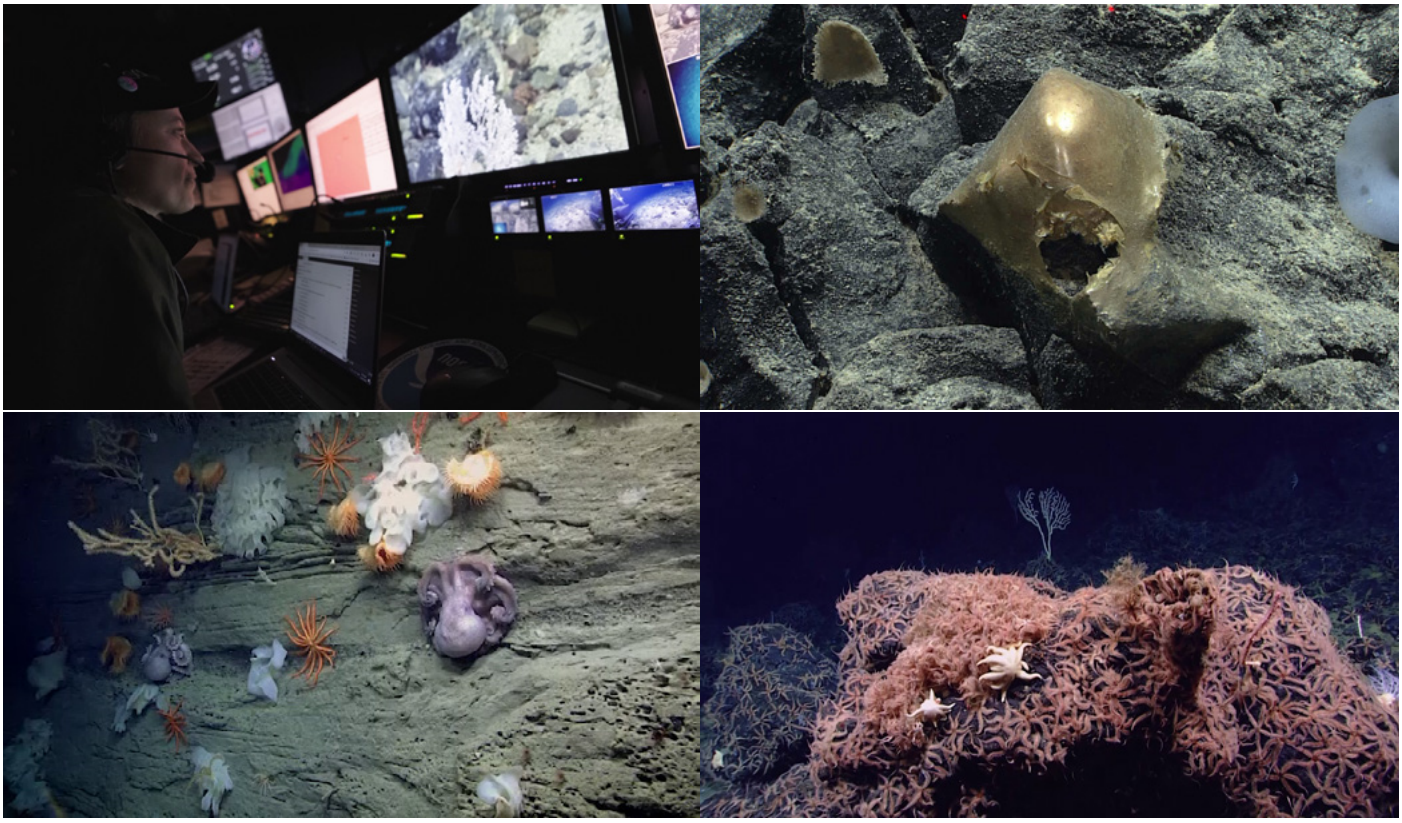


Figure 2 (top left): Control room; figure 3 (top right): Golden orb; figure 4 (above left): Octopus brooding; figure 5 (above right): Ophiuroid mat.

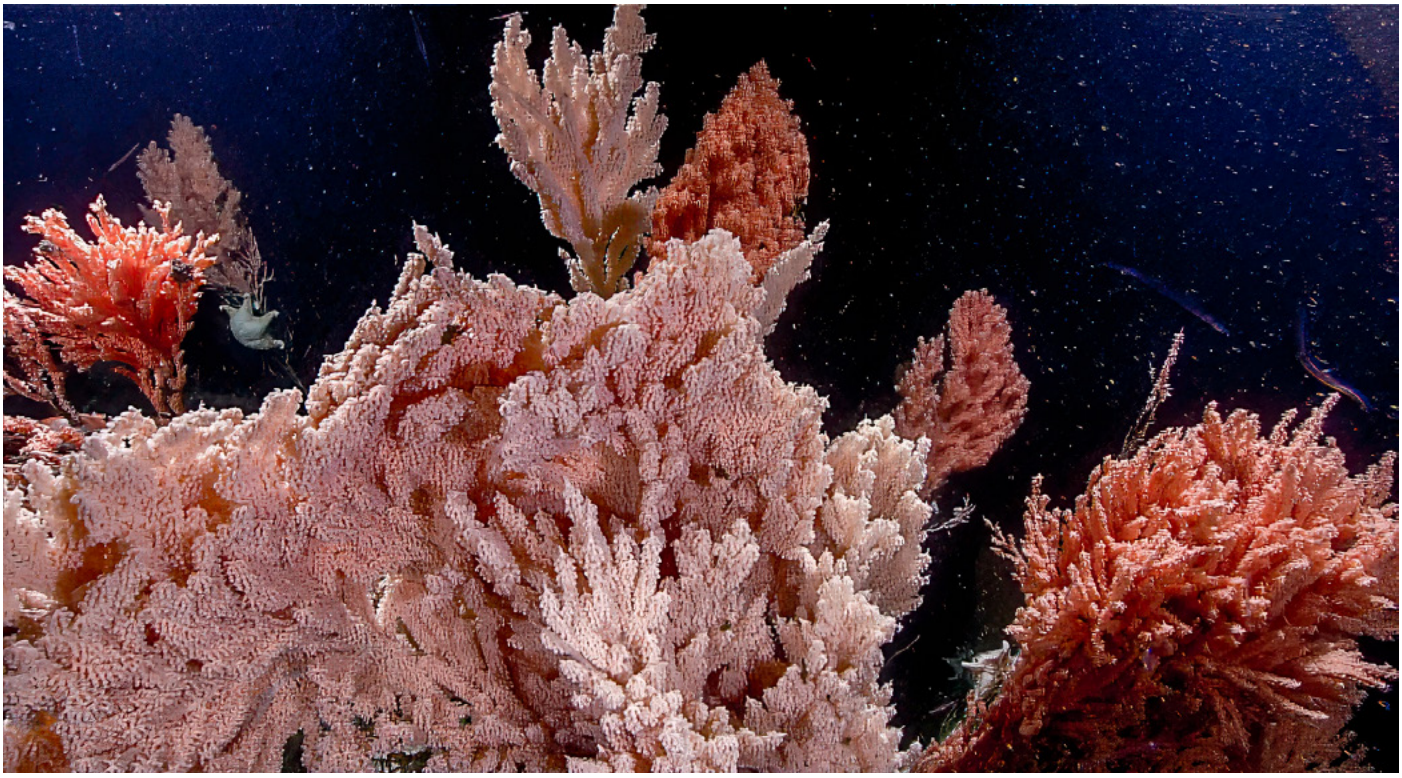


FIgure 6: Coral garden.

Other highlights include:

- A vast coral field of the large primnoid *Primnoa pacifica* in the Alexander Archipelago. The dive site was chosen based on a predictive model, and the discovery of this prolific coral habitat adds valuable ground truthing data for future modeling;

- A large and productive cold seep in Chatham Strait observed by cameras for the first time. Thick (10+ metre) authigenic carbonate structures emanated continuous bubble plumes, supporting an abundant and diverse ecosystem;
- Extremely dense ophiuroid mats associated with the Oxygen Minimum Zone on Surveyor Seamount, often completely obscuring the substrate;
- Over 28,000 square kilometres of seafloor was mapped, extending bathymetric mapping coverage in both the U.S. Exclusive Economic Zone and in international waters in support of Seabed 2030.

To learn more, check out the survey summary video produced by the Global Foundation for Ocean Exploration and NOAA Ocean Exploration, as well as the expedition website.

Trans-Pacific Triumphs

An ambitious expedition to explore the abyssal plains of the Pacific Ocean.

The Trans-Pacific Transit Expedition (TPT) is part of the Inkfish Open Ocean Program and took place on the research vessel *Dagon*. Led by Professor Alan Jamieson (Minderoo-UWA Deep Sea Research Centre) and Heather Stewart (British Geological Survey), the six legs took place between 2 June 2023 and 12January 2024. The expedition covered 20,667 nautical miles, acquired multibeam echosounder, scientific lander and water column data over approximately 52 degrees of latitude from 34.7° N to 17.3° S, and approximately 41 degrees of longitude from 159° W to 118° W.

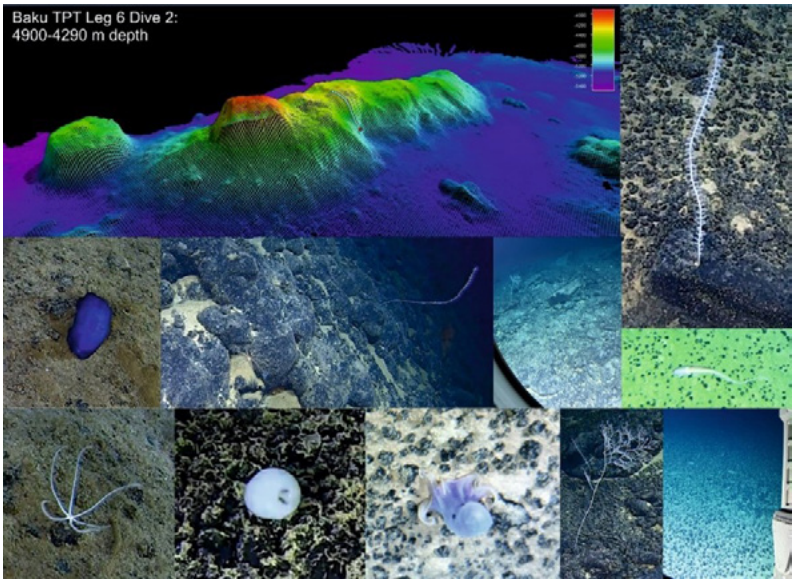


Figure 1. *Bakunawa* dive TP6_BK3_4950. Top left EM124 multibeam bathymetry data perspective view of an unnamed seamount with the overlain transect (white line) from 4900 m to 4290 m water depth. All other images various examples of the terrain and habitats encountered during the dive.

A total of 373,732 km^2 of seafloor maps were produced (roughly the same size as Japan). In total 123 scientific lander deployments took place across 43 sites. The landers *Magna, Cranch* and *Omma* each recorded 8-10 hours of high-definition video footage, acquired bottom water samples, and collected crustacean samples at each location. The landers also acquired a total of 1,209,630 m of Conductivity, Temperature and Depth (CTD) data, with bottom water samples for salinity calibration acquired from 43 sites. For Legs 5 and 6 each lander was also equipped with three 12 L Niskin bottles for active eDNA sampling. The submersible *Bakunawa* was used to undertake scientific observation of the biodiversity and geodiversity of the seafloor during Legs 5 and 6. Five submersible transects were completed resulting in more than 20 hours of high-definition video data of the seafloor, traversing a combined lateral distance of around 9 km.

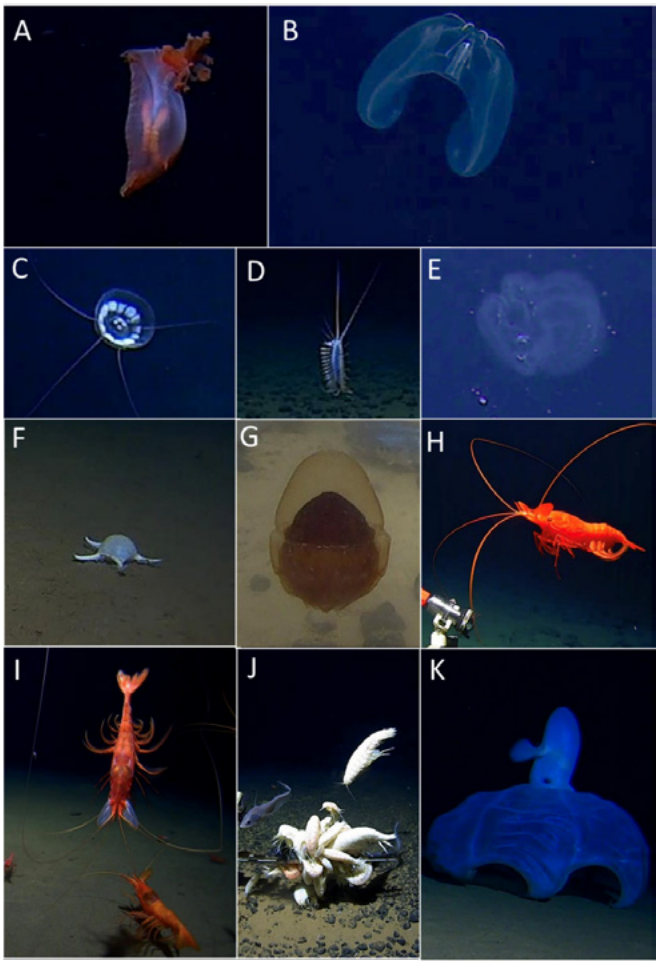


Figure 2. Abyssal invertebrate fauna where A – Sea cucumber *Enypniastes* sp., B – lobate Ctenophore, C – *narcomedusa*, D – Polychaete, E – larvacean, F – asteroid, G – *Trachymedusa*, H – *Cerataspis cf. Monstrosus,* I – *Benthesicymus crenatus*, J – the supergiant amphipod *Alicella gigantea*, and K – the big eye jelly-head octopus *Cirrothauma magna*.

Professor Alan Jamieson and Heather Stewart

These combined data will allow the scientific team to statistically investigate large scale patterns of species distribution at abyssal depths and how this is controlled by factors such as depth, temperature, habitat type, geomorphology, food supply from the surface, longitude/ latitude and distance from shore. The scale of this expedition, at abyssal depths, has seldom been attempted before.

Recent publications

Minderoo – UWA Deep Sea Research Centre

Kolbusz, J., Zika, J., Pattiaratchi, C. and Jamieson, A., 2024. Water properties and bottom water patterns in hadal trench environments. Ocean Science, 20(1), pp.123-140.

Ueda, H., Kitazato, H. and Jamieson, A., 2023. The submarine fault scarp of the 2011 Tohoku-oki Earthquake in the Japan Trench. Communications Earth & Environment, 4(1), p.476.

Jamieson, A.J., Maroni, P.J., Bond, T., Niyazi, Y., Kolbusz, J., Arasu, P. and Kitazato, H., 2023. New maximum depth record for bony fish: Teleostei, Scorpaeniformes, Liparidae (8336 m, Izu-Ogasawara Trench). Deep Sea Research Part I: Oceanographic Research Papers, 199, p.104132.

Priede, I.G., Jamieson, A.J., Bond, T. and Kitazato, H., 2024. In situ observation of a macrourid fish at 7259 m in the Japan Trench: swimbladder buoyancy at extreme depth. Journal of Experimental Biology, 227(3).

Lucia Bongiorni, Marzia Rovere, Marina Vingiani (Institute of Marine Sciences, National Research Council, Italy) and the PIONEER cruise team

The oceanographic cruise PIONEER “Processes in the IONian Sea: Exploring, Experimenting, Researching” was successfully conducted from 18 November to 9 December 2023 to explore the Ionian Sea, the deepest basin of the Mediterranean Sea, one of the most seismically active areas and a key for western and eastern water masses exchange in the region. This was the first operational cruise in the Mediterranean Sea of the RV Gaia Blu, an 84 meters long ocean vessel, previously named Falkor, which was donated in March 2022 by the Schmidt Ocean Institute to the National Research Council of Italy (CNR).

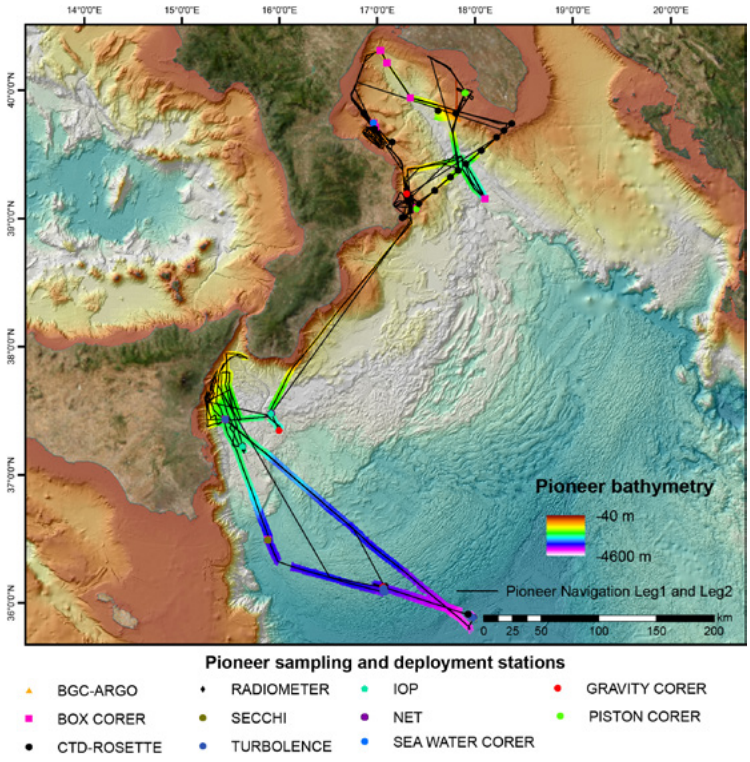


Figure 1. Map showing the overall survey and acquisition stations a of the PIONEER campain.

The expedition, led by the Institute of Marine Sciences (ISMAR), representing the largest marine community of the CNR, had a dual objective: to test the new equipment and instruments on board for the acoustic investigation and sampling of the seabed and water columns, and conduct exploratory and interdisciplinary research. Despite a huge effort in preparing and testing the new equipment and the adverse weather and sea conditions, the RV Gaia Blu navigated uninterruptedly for 22 days over a distance of 3600 nautical miles, exploring an area of approximately 130,000 square km, and collecting data from 51 sampling sites up to 4000 meters below sea level. The researchers successfully tested several sediment samplers, temperature, salinity, fluorescence and turbulence profilers, deployed rosette, radiometers, optical instrumentation and plankton nets and launched drifting buoys from the BGC-Argo fleet. Optical data are fundamental for the calibration of the algorithms used in the processing of satellite images that the CNR produces for the marine operational service of the European Copernicus programme and inter-calibrate the data returned by the BGC-Argo probe of the EURO-ARGO ERIC fleet.

The main scientific objectives of this cruise are to study the geological evolution of the seabed through the study of sediments, the microbiology and biodiversity of deep marine environments, the dynamics and mixing of water masses and their impact on climate change and ecosystem dynamics. Another goal is to estimate the pollution from microplastics, and classic and emerging contaminants in this potentially uncontaminated Mediterranean area. A large quantity of collected samples (biological and geological materials) were refrigerated or frozen and successfully transported to the CNR laboratories for further DNA, taxonomic, and biogeochemical analysis. Observations acquired during the measurement campaign will be integrated with mathematical models in order to fully understand the dynamics of the circulation and dispersion of contaminants and the transport of sediments in the Ionian Sea and in the Gulf of Taranto.

This new fundamental CNR infrastructure will allow the Italian marine scientific community to carry on the new era of oceanographic research in the open and deep sea, opening up new opportunities for international collaboration!

The PIONEER cruise was advertised to the public on CNR and ISMAR websites (in Italian), TV news, Facebook and other social media. The cruise report link can be requested to the PIONEER chief scientist, contact: Marzia Rovere, marzia.rovere@bo.ismar.cnr.it

Figure 2. Photo collage of the RV *Gaia Blu* and PIONEER cruise

Off to CCZ Once More

Adrian Glover, Chief Scientist on the RRS *James Cook*

Somewhere in the East Pacific, About Tea Time.

My colleague Thomas and I just lowered a GoPro camera on a long pole off the stern of the research ship *James Cook*. 'What will we see?' we thought, reasonably excited. The answer was nothing. Just blue. The endless clear blue of a Pacific ocean with 4000 metres of water below us. This was in fact a bit surprising. We did the same thing last night and within minutes the camera was being chomped on by a three metre long Oceanic White Tip shark.

Authors of adventurous novels for a general audience might write: 'Sharks circled the ship, ominously.' Well, I can confirm that sharks really are circling our ship, ominously. The large finned white tips, and smaller grey silky sharks. But only at night. By day it's Pacific blue and not a Megalodon or modern friends in sight.

'Blue is the colour of desert in the sea', wrote Harald Sverdrup in his 1942 book, The Oceans. Sverdrup, the oceanographer's oceanographer, multi-lingual Norwegian polymath, polar explorer and director of the Scripps Institution of Oceanography in its formative years*. He was famous enough to even have a unit of measurement named after him - the sverdrup (Sv) which measures water flow. What did he mean by desert?

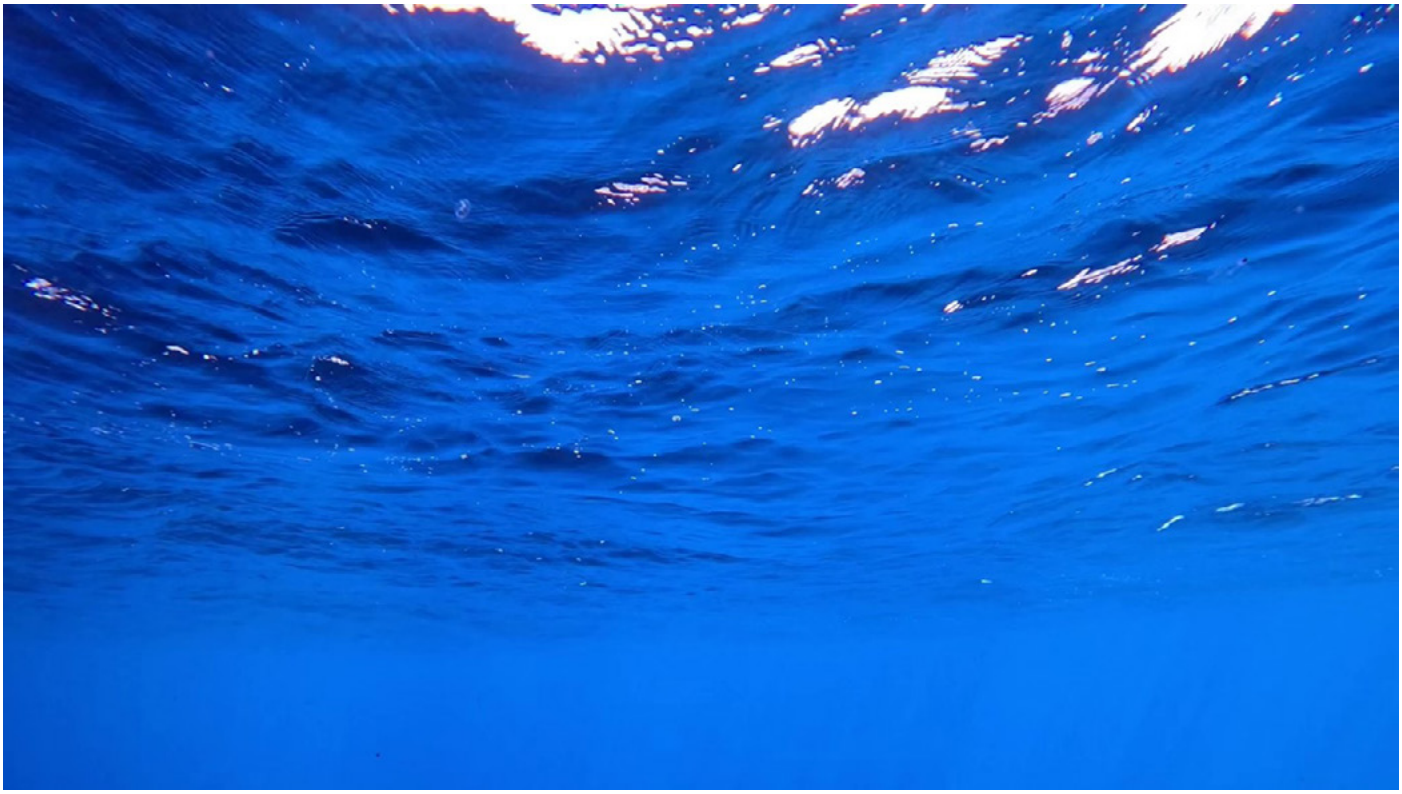


Figure 1. 'Blue is the colour of desert in the sea'. The water off the stern of the RRS *James Cook* in the eastern tropical Pacific, February 2024. Image: A Glover

Our ship is in the eastern Tropical Pacific. The waters here are oligotrophic, nutrient poor and the blue simply reflects the fact that there is less plankton in the surface, especially in the day. During these days of blue, 300 metres below us lies a great layer of plankton - the deep scattering layer - that rises up at dusk. Exactly why is something of a mystery but the prevailing theory is that organisms generally migrate away from the light to escape predators. Such as our sharks.

We are 17 scientists on board *James Cook*, and with the exception of our lone physicist Dima, are not measuring sverdrups, or even know how to. We are quite a diverse bunch, hailing from England, Wales, New Zealand, Sweden, Belgium, Chile, Russia, The Cook Islands and Ireland. We are less diverse in our specialism - almost all of us 'benthic' biologists somewhat obsessed with the weird and wonderful variety of life at the deep seabed. That 4000m of blue is something of an inconvenience, opaque to most sensors with the exception of sound waves and rather a long, cold, high-pressure journey for any instrument we care to send down there.

Craig Smith, former professor of Oceanography at the University of Hawaii once told me that in the abyssal Pacific there is a greater biomass of life in the top 1cm of a given area of seafloor mud than in the entire 4000m of water above it. This can seem surprising at first, given there is no sunlight at 4000m and the temperature is a frigid 1.5°C. But there is a relatively simple explanation: things denser than water such as dead algae, animals and their poop, sink. This is what we somewhat whimsically call 'marine snow'. An endless dark snowfall forming the vast drifts of abyssal muds that characterise our planet. Billions of tonnes of organic carbon buried into the deep, most of which will never reappear, thrust down over millions of years into the subduction zones of the Earth's crust and gone forever.

At some places in the middle of the Pacific Ocean, far from where the Earth's crust is being formed, geologists have measured the age of deep sediment layers at 180 million years. That is an extraordinarily long snowfall, and a reminder of just how old some of our ocean basins are. To understand it, think of the context. Just 20,000 years ago, mammoths, hippos and early humans happily walked across what we now call the North Sea: a solid fixture in our historical but not geological, memory. Most of our continental shelves are, in geological terms, newly formed habitats - ones we have come to depend on for our food, transport and a host of other services.

Age, or 'deep time' as geologists sometimes call it is very important when it comes to explaining rather a lot of things

about the abyssal muds that Thomas and I are floating over right now. For one thing, let us consider the north-eastern tropical Pacific where, sitting on the seabed over a 6 million square kilometre region called the Clarion-Clipperton Zone (CCZ), is a vast deposit of polymetallic nodules, potato-sized mineral accretions discovered during the voyage of HMS *Challenger* 150 years ago. These strange nodules form very slowly at rates and methods rather poorly understood.

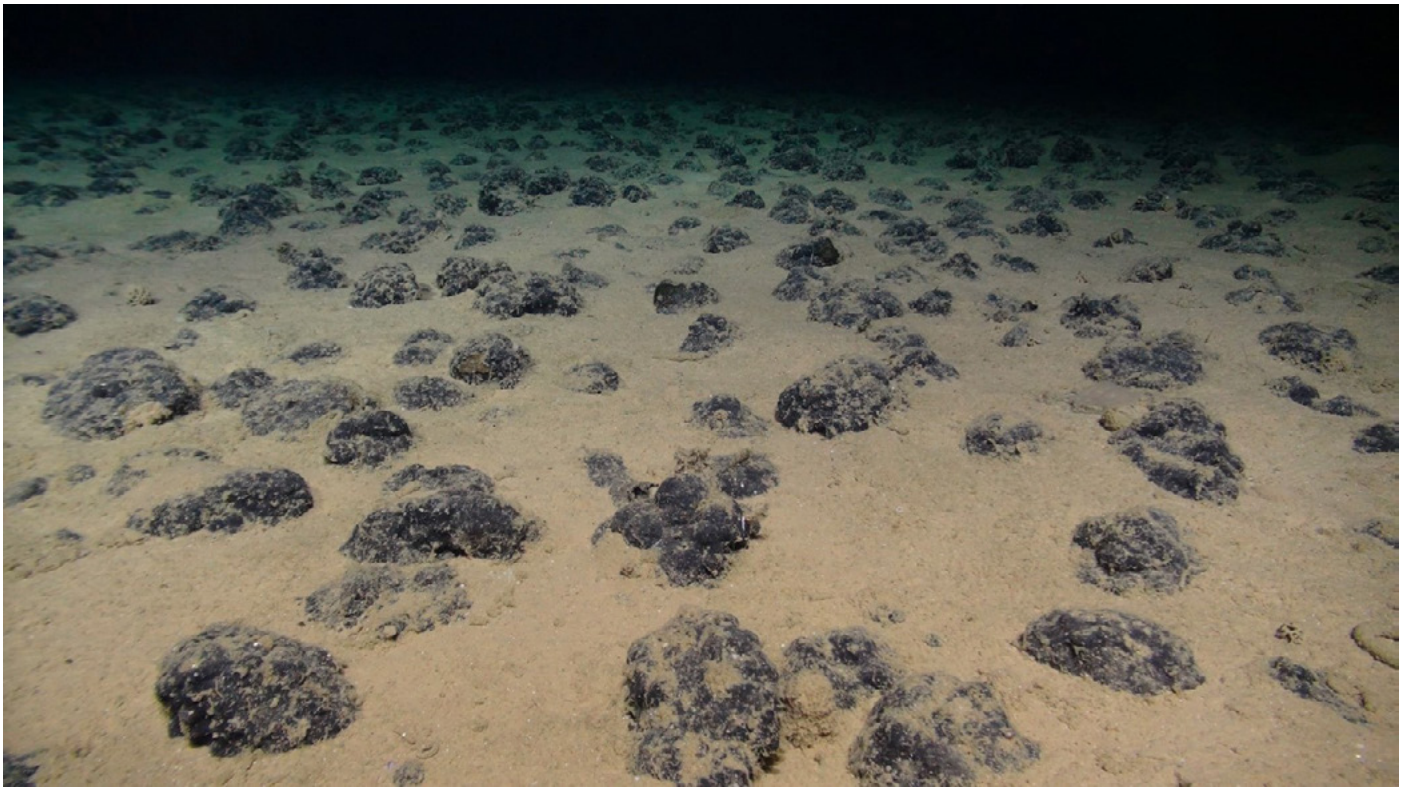


Figure 2. Polymetallic nodules on the seafloor in the eastern tropical Pacific. Image: NERC SMARTEX Project.

An oft-quoted figure is that the nodules form at a rate of '1-2' mm per million years. However, a quick search of the literature will show you a whole range of rates, from 1mm per million years to 100mm per million years. It seems that the manganese oxide that makes up most of the nodule can grow at wildly different speed: in the soupy top layer of sediment, it grows much faster than in the water above the sediment. A 10cm nodule (a typical size) is thus anything between 1 million and 100 million years old, which is clearly not a very accurate estimate.

What is clear is that the nodules are, just like the Pacific Ocean basin in which they sit, very old indeed. They hoard not only time, but space too. The CCZ is a vast region that would occupy most of the continent of Australia. A vast amount of time, and a vast amount of space is a clue to a sort of paradox in deep-sea biology: why are there so many deep-sea species?

The early explorations of the CCZ were focussed on the nodules as a potential mineral resource, rather less to their biology. We can forgive the first collectors there - a typical view of the seabed at 4000m where we are working looks to be complete barren on first glance. But as is always the case - look more closely and you find things. Tiny sponges and bryozoans grow on the nodules, just a few mmm in size. In the muds between the nodules, small crustaceans, worms and molluscs are surprisingly diverse. Drive across the seafloor in a robotically-controlled submarine and after some time, you find larger animals too. The famous 'gummy squirrel' sea cucumber or intricate, beautiful glass sponges.

One of the questions we are focussed on is why this diversity can exist in an environment so seemingly devoid of food - Sverdrup's blue desert. We also want to know how diversity and species composition changes over relatively small scales of up to one hundred km in the CCZ. We have noticed in previous expeditions that when you move across the CCZ the species change too. But we want to model this accurately for the first time, understand it more deeply and

ultimately collect the sort of data that is useful to inform debates on the conservation of the region.

Dr Adrian Glover is at sea on the SMARTEX project, funded by the Natural Environment Research Council. You can follow on twitter at #smartexccz and at the website.

*For a fascinating insight into Sverdrup and Scripps see Munk & Day 2002 https://tos.org/oceanography/assets/docs/15-4_munk.pdf

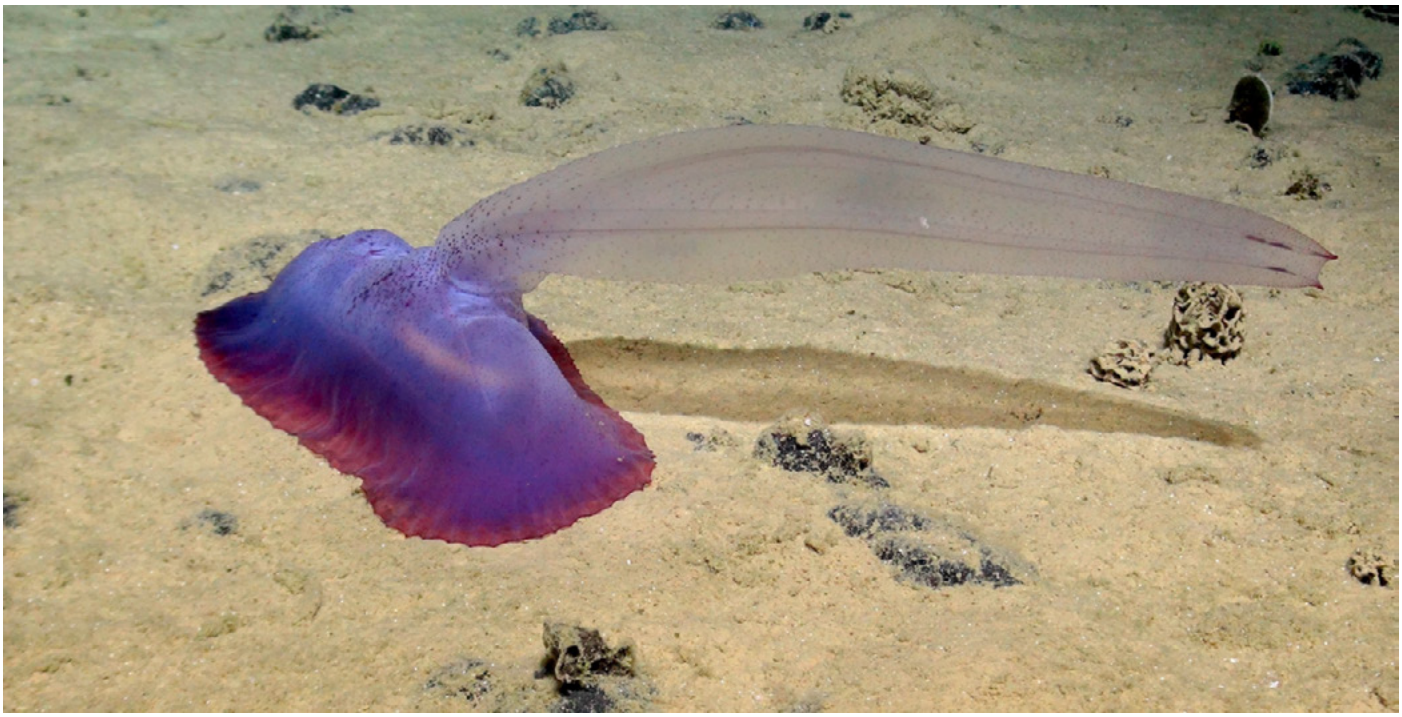


Figure 3. ‘The gummy squirrel’. Image: NERC SMARTEX Project.

Project Focus

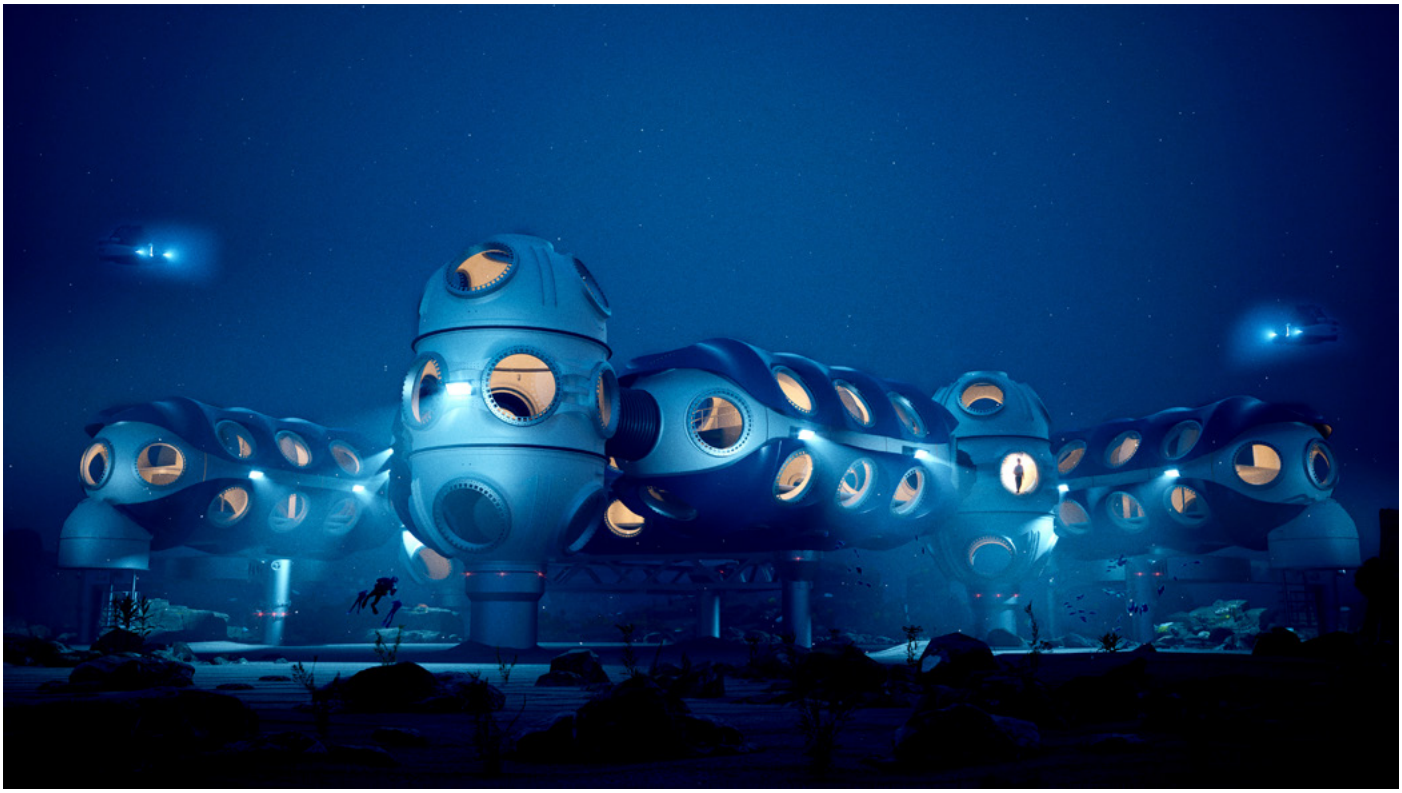
DEEP: A Sustained Subsea Human Presence for Science and Exploration

Dawn Kernagis, PhD

Contact: dawn.kernagis@deep.com

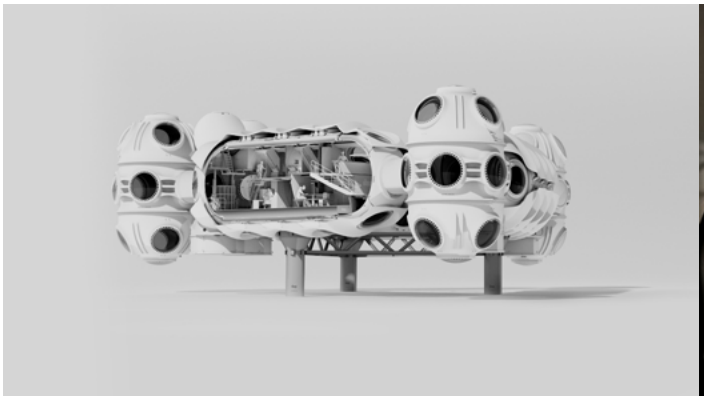
About DEEP

DEEP is an ocean technology company that is developing capabilities to allow humans to maintain a sustained presence undersea via a system of underwater habitats that are modular and redeployable, work-class submersibles, and diver training and performance optimization. DEEP technology will enable scientists to live underwater at depths of up to 200 meters for up to 28 days at a time, with the ability to conduct research and exploration excursions from the habitat deeper than 200 meters.



Approach

DEEP is 70,000+ engineering hours into the development of this integrated subsea system. The habitat system, called Sentinel™, can be configured (internally and externally) at any scale and re-configured at depth between missions



without the need to recover to the surface. This flexibility and modularity of configuration will allow for missions that range from a six-crew, short-term deployment to variable sites, to 50+ crew members living and working in a semipermanent subsea research station.

The Sentinel has been designed for operation at either one-atmosphere, or at ambient pressure up to 200 meters of depth. One atmosphere operations enable visits to the Sentinel via submarine transfer, which is ideal for individuals without diving qualifications. Ambient operations allow for diving excursions at ambient pressure or deeper through the habitat's two moonpools.

The Sentinel power systems are based on a microgrid architecture and are designed to work with a renewable power and satellite communications buoy, allowing DEEP to move away from the use of a financially and environmentally expensive Dive Support Vessel (DSV) stationed on the surface during dive operations. DEEP is also working with the world-leading certification body DNV to ensure that Sentinel is the world's first subsea habitat to achieve third-party certification.

In addition to the habitat and submersible systems, DEEP is developing a series of diver training modules to enable a scientist with any diving skill level to be a habitat research crew member. This training will develop the next generation of science and exploration aquanauts, or 'Aquans', to participate in future subsea research and exploration missions.

To initiate engagement with the marine science community, DEEP issued an initial Request for Information in November 2023 for public feedback on research use cases that would be made possible, or enhanced, by a sustained human undersea presence. RFI responses informed potential future requirements for DEEP technology and provided a roadmap for future collaborative and funding opportunities.

Connecting with DEEP

To receive updates on the progress of DEEP's mission, you can join the 'Aquan Network': https://www.deep.com/aquan/

There will also be future calls for collaboration with DEEP as we develop our research partnership opportunities. To ensure that you receive updates on research opportunities with DEEP, you can follow us on LinkedIn, Instagram, and Twitter.

If you have questions or want to reach out to DEEP regarding science capabilities or collaborations, you can also contact the Director of Scientific Research, Dr. Dawn Kernagis, at dawn.kernagis@deep.com.

Rocky seafloor — Underestimated driver for Habitat Heterogeneity and Benthic Biodiversity (RUBBLE)

Torben Riehl[1,2]; Angelika Brandt[1,2]; Pedro Martínez Arbizu[3]

[1]Senckenberg Research Institute and Natural History Museum, Marine Zoology Department, Germany; [2]Department of Biological Sciences, Institute of Ecology, Evolution and Diversity, Johann Wolfgang Goethe University Frankfurt, Germany; [3]Senckenberg Am Meer, German Centre for Marine Biodiversity Research (DZMB), Germany

Contact: torben.riehl@senckenberg.de

Although assumed largely sedimented and homogeneous for a long time, decades of seafloor exploration have increasingly revealed heterogeneity of the abyssal seafloor. High-resolution hydroacoustic maps of the Vema Fracture Zone (VFZ) created during the Vema-TRANSIT project (Devey 2015, Devey *et al*. 2018, Riehl *et al*. 2018) show that exposed rocks are a common type of seabed there, introducing significant heterogeneity. These bedrock patches are distributed across almost the entire extent of the VFZ covering crustal ages in the range of 0–110 Ma. Over 5 % of the ~95,000 km^2 of studied seafloor likely are bare rock, while ~33 % belonged to a transition category. Scaled up to the entirety of the Atlantic fracture zones it is estimated that ~264,000 km^2 of fracture zones in the Atlantic have high hard-rock exposure potential (Riehl *et al*. 2020).

This finding helped to dissipate the view that the abyssal seafloor is featureless, providing evidence of extensive rocky habitats along fracture zones in the Atlantic abyss (Smith 2020) and is relevant in a biodiversity context for three reasons: first, the distribution of habitats in the abyss is fundamental to understanding the distribution of life on Earth (Smith *et al*. 2008); second, frequently the occurrence of rocky substrates in largely soft-sediment ecosystems is associated with enhanced biodiversity (Meyer *et al*. 2016, Vanreusel *et al*. 2016); and third, these ecosystems are increasingly threatened by anthropogenic impacts, including climate change, seafloor mining, and pollution (Glover and Smith 2003, Smith *et al*. 2008, Amon *et al*. 2020).

Figure 1. R/V *Meteor* off Iceland in 2011. Picture by Torben Riehl.

The RUBBLE project aims at unravelling and understanding links between habitat heterogeneity and abyssal benthic biodiversity in abyssal sediments across space and time. By conducting quantitative and qualitative benthos and sediment sampling at fine scale RUBBLE will take into consideration geological, ecological and evolutionary perspectives, from seabed formation to modelling biodiversity and species distributions. We predict that rocky seafloor patches and the bottom topography introduced by bedrock

influence biodiversity in five principal ways: (1) provision of habitats (e.g., attachment sites for sessile organisms), caves and crevices; (2) provision of a range of water-current exposures transporting food particles and larvae; (3) modulation of currents and formation of turbulence resulting in sediment sorting and gradients of particle size and food availability; (4) fragmentation of sediment biotopes restricting connectivity between (semi-) isolated abyssal sediment habitats and their inhabitants; (5) sediment dynamics: wherever a variation of slope angles occurs, temporal variability of sediment accumulation and redistribution through slumping may increase habitat diversity.

Project duration and start date: 18 months from October 2024.

Working area: eastern Vema Fracture Zone (VFZ) about 100-120 km south of Elena Seamount, ca. 1,500 km east of the nearest active plate boundary of the Vema transform at the Mid-Atlantic Ridge and ca. 1,000 km west of the nearest African continental slope; ca. 4,500 m depth.

Expedition dates: R/V *METEOR* cruise M205, 22. October (Las Palmas de Gran Canaria, Spain) - 28. November 2024 (Fortaleza, Brazil).

References:

Amon DJ, Kennedy BR, Cantwell K, Suhre K, Glickson D, Shank TM, Rotjan RD (2020) Deep-sea debris in the Central and Western Pacific Ocean. Frontiers in Marine Science.

Devey CW (2015) RV SONNE Fahrtbericht / Cruise Report SO237 Vema-TRANSIT. Geomar Report 23: 130. https://doi.org/10.3289/GEOMAR_REP_NS_23_2015

Devey CW, Augustin N, Yeo IA (2018) Raw multibeam EM122 data and data products: SONNE cruise SO237 (North Atlantic). Available from: https://doi.org/10.1594/PANGAEA.893352.

Glover AG, Smith CR (2003) The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. Environmental Conservation 30: 219–241.

Meyer KS, Young CM, Sweetman AK, Taylor J, Soltwedel T, Bergmann M (2016) Rocky islands in a sea of mud: biotic and abiotic factors structuring deep-sea dropstone communities. Marine Ecology Progress Series 556: 45–57.

Riehl T, Kaiser S, Brandt A (2018) Vema-TRANSIT — An interdisciplinary study on the bathymetry of the Vema-Fracture Zone and Puerto Rico TRench as well as Abyssal AtlaNtic BiodiverSITy. Deep Sea Research Part II: Topical Studies in Oceanography 148: 1–6. https://doi.org/10.1016/j.dsr2.2018.01.007

Riehl T, Wölfl A-C, Augustin N, Brandt A, Devey CW (2020) Discovery of widely available abyssal rock patches prompts rethinking origins of deep-sea biodiversity. Proceedings of the National Academy of Science 117: 15450–15459. https://doi.org/10.1073/pnas.1920706117

Smith CR (2020) The heterogeneous abyss. Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.2010215117

Smith CR, De Leo FC, Bernardino AF, Sweetman AK, Martínez Arbizu P (2008) Abyssal food limitation, ecosystem structure and climate change. Trends in Ecology & Evolution 23: 518–528.

Vanreusel A, Hilario A, Ribeiro PA, Menot L, Martínez Arbizu P (2016) Threatened by mining, polymetallic nodules are required to preserve abyssal epifauna. Scientific Reports 6: 26808. https://doi.org/10.1038/srep26808

The Nekton Maldives taxonomic workshop: Exploring the biodiversity of shallow, mesophotic and deep-sea communities in Maldives

Mohamed Ahusan[1], Nuria Rico-Seijo[2], Farah Amjad[2], Erika Gress[2,3], Shafiya Naeem[1], Toufiek Samaai[4,5,6,7], Kaveh Samimi-Namin[8,9,10], Lucy C Woodall[2,11], Paris V Stefanoudis[2,12]

[1]Maldives Marine Research Institute, Maldives. [2]Nekton Foundation, United Kingdom. [3]James Cook University, Australia. [4]Department of Forestry, Fisheries and the Environment, South Africa. [5]University of Cape Town, South Africa. [6]University of the Western Cape, South Africa. [7]Iziko South African Museums, South Africa. [8]Naturalis Biodiversity Center, Netherlands. [9]University of Oxford, United Kingdom. [10]Natural History Museum, United Kingdom. [11]University of Exeter, United Kingdom. [12]Oxford University Museum of Natural History, United Kingdom.

The Nekton Maldives Taxonomic Workshop took place at the Maniyafushi Research Station in the Maldives between 12 and 23 February 2023. This workshop had two primary objectives. Firstly, it aimed to identify species from biological samples and underwater imagery collected during the Nekton Maldives Mission in 2022. Secondly, it sought to facilitate training and knowledge exchange sessions between early career researchers from the Maldives and international

taxonomists. These sessions were designed to share knowledge and introduce fundamental taxonomy concepts and enhance practical identification skills for common reef benthic groups and major zooplankton taxonomic groups. A total of 24 people from 10 different countries were directly or indirectly involved with the workshop comprising nine taxonomic experts, eleven trainees and four organisers. Collectively, we identified 278 biological specimens including potentially undescribed species of hydroids, black corals, sponges and octocorals, 318 morphotypes for underwater footage and zooplankton composition congruent with previous reports from the Indian Ocean Region. Next steps will

involve depositing the specimens into a more permanent facility to facilitate the process of specimen description and knowledge transfer.

Link to paper: https://doi.org/10.3897/rio.9.e114370

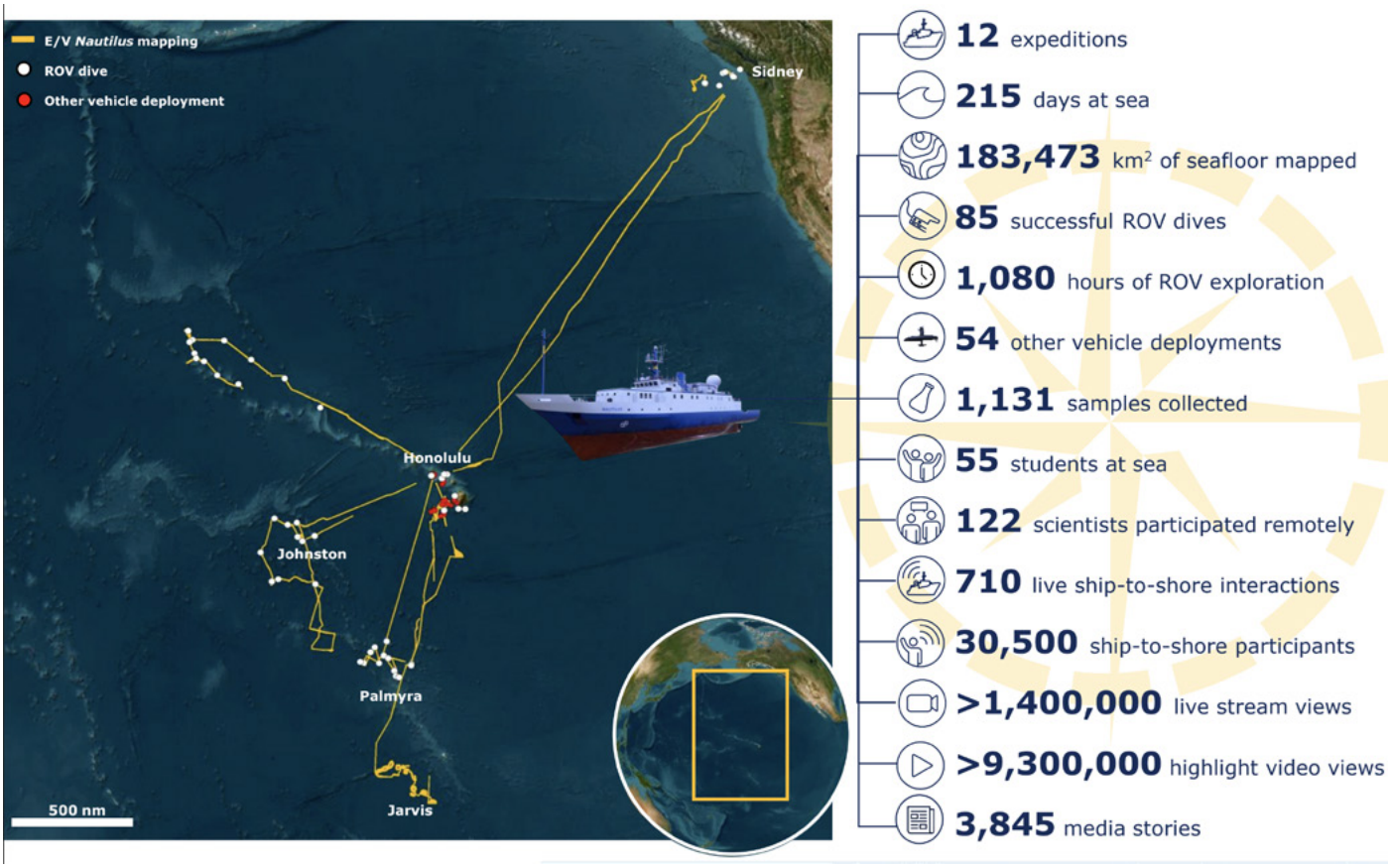
2023 E/V *Nautilus* Field Season Summary

Overview

In 2023, E/V *Nautilus* completed 12 telepresence-enabled expeditions that explored deep-sea environments across the Pacific via seafloor mapping operations, ROV dives, and various other emerging technologies. Collectively, 2023 expeditions mapped over 183,000 km^2 and completed 85 ROV dives to depths exceeding 5,400m that surveyed a wide diversity of habitats and geological features, including seamounts, hydrothermal vents, and World War II wrecks, among many others.

Kingman & Palmyra

Between May 16-June 14, E/V *Nautilus* explored the deep-sea biology and geology surrounding Kingman Reef and Palmyra Atoll. Funded by NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute, the expedition mapped over 24,095 square kilometers of seafloor and completed 16 ROV dives that explored 10 different seamounts at depths between 1,100-3,100 m. Noteworthy ROV observations included recording two new species of jellyfish, high-density coral gardens at three different locations, and a significant range expansion of bone-eating worms. In



addition to exploring previously unsurveyed areas, the expedition included the first-time ROV integration of a Raman spectrometer, which was used to collect in situ data on the chemical composition of the seafloor for comparison to lab-based analyses of collected samples.

Ocean Networks Canada Neptune Observatory

Between June 25-July 18, E/V *Nautilus* conducted an expedition in support of Ocean Networks Canada's cabled NEPTUNE observatory located off the coast of British Columbia. Funded by Ocean Networks Canada, the expedition supported seafloor mapping and ROV operations around five different observatory sites, as well as deployed numerous instruments as part of Ocean Networks Canada's annual maintenance program. The expedition mapped over 3,811 km² and completed 20 successful ROV dives at depths between 370-2,700 m that surveyed a wide diversity of deep-sea habitats, including the spectacular Endeavour Hydrothermal Vents.

Hawai'i - British Columbia Transit Mapping

From June 16-25 and July 19-31, E/V *Nautilus* conducted two expeditions focused on seafloor mapping during transits between British Columbia and Hawai'i. Funded by Ocean Networks Canada with additional support from NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute, these expeditions mapped over 47,472 km², which mostly consisted of abyssal plains, but also included passage over unmapped portions of the Mendocino, Pioneer, and Murray

fracture zones, as well as several unnamed seamounts.

Johnston

Between August 2-29, E/V *Nautilus* explored the deep-sea biology and geology surrounding Johnston Atoll. Funded by NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute, the expedition mapped over 32,259 km^2 and completed 11 successful ROV dives that explored depths between 1,000-3,200 m. Noteworthy ROV observations included the first-ever record of a deep woodfall community in the US Pacific Remote Islands Marine National Monument, high-density coral gardens at nine different locations, evidence of extensive past lava flows at the summits of seamounts, and some deep-sea observations of in-place reef outcrops. Preliminary observations indicate that 14 biological samples collected on this expedition represent either new species or new records for the region.

Papahānaukmokuākea Marine National Monument

Between September 1-28, E/V Nautilus explored the deep-sea natural and cultural resources in the northernmost and least explored section of the Papahānaumokuākea Marine National Monument. Funded by NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute, the expedition mapped over 23,466 km^2, including five different seamounts. The expedition also completed 12 successful ROV dives to depths of 600-5,400 m, which included the deepest dives ever conducted off E/V Nautilus. ROV highlights included the discovery of one of the largest pink coral forests known, as well as comprehensive archaeological surveys of three historically significant aircraft carriers lost during the Battle of Midway.

Multi-Vehicle Exploration

From October 1-19, E/V *Nautilus* conducted an expedition focused on integrating multiple emerging technologies. Funded by NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute, the expedition combined the complementary exploration capabilities of uncrewed surface vehicle DriX from the University of New Hampshire, the autonomous underwater vehicle Mesobot from Woods Hole Oceanographic Institution, the Deep Autonomous Profiler from the University of Rhode Island, alongside E/V *Nautilus*' mapping capabilities. During 18 days at sea, these complementary technologies were used to explore the Geologists Seamounts, a poorly known group of seamounts located south of Hawai'i. Expedition highlights included over 425 hours of multi-vehicle operations, including periods when DriX, Mesobot and the Deep Autonomous Profiler were all simultaneously deployed, while E/V *Nautilus* conducted independent mapping operations up to 37 kilometers away. Guided by data collected by the fisheries sonar on DriX, Mesobot was directed into specific portions of the water column to conduct targeted surveys.

Office of Naval Research Technology Demonstration

From October 22-November 5, E/V *Nautilus* surveyed some of the most complex deep-sea terrain around the Hawaiian Islands using a new wide-field camera array system and wideband multibeam sonar mounted on ROV Hercules. During 14 days at sea, these technologies were used to gather high-resolution video and sonar data, as well as quickly develop high fidelity models of the seafloor. Funded by the Office of Naval Research, the expedition completed 15 successful ROV dives that explored complex topographical features at 385-1,660 m depths, including steep ridges, pinnacles, canyons, hydrothermal vents, and submarine wrecks from World War II. In addition to successfully integrating the new widefield camera, the expedition developed important protocols to increase the efficiency of seafloor surveys. Specifically, multibeam data collected during the ROV approach to the seafloor was used to develop detailed seafloor maps, and then precisely move the ROV towards areas of interest without wasting time searching for targets.

Hawai'i Mapping

From November 7-17, E/V *Nautilus* mapped and characterized offshore environments south of the Main Hawaiian Islands. Funded by NOAA Ocean Exploration and BOEM via the Ocean Exploration Cooperative Institute, the expedition mapped over 5,911 km^2 and completed seven deployments of the Deep Autonomous Profiler to maximum depths of 4,600 m, during which continuous video, CTD environmental and passive acoustic data were collected, in addition to 166 water samples for the study of eDNA, nutrients and particulate organic matter. In addition to surveying deep ocean environments, the expedition included topside seabird surveys, a first for E/V *Nautilus*.

Jarvis Mapping

From November 19-December 19, E/V *Nautilus* mapped the seafloor around Jarvis Island. Funded by NOAA Ocean Exploration via the Ocean Exploration Cooperative Institute, the expedition mapped over 40,445 km^2, focused on filling data gaps in the Jarvis Unit of the Pacific Remote Islands Marine National Monument. Dedicated mapping around Jarvis revealed numerous cratered seamounts, ridges and mounds. In addition to providing a rich foundation for future deep-sea exploration in this region, mapping data on this expedition will also support decision making relating to the Monument Management Plan that is currently being developed and the proposed designation of the area as a National Marine Sanctuary.

Broader Impacts

E/V *Nautilus* expeditions in 2023 surveyed some of the most remote areas in the Pacific and successfully integrated various emerging technologies while sharing the excitement of discovery live with millions of people of all ages. Expeditions were planned and executed around priorities of the scientific and resource management community to close knowledge gaps. Operations focused on exploring previously unsurveyed areas, thus contributing directly to the US National Strategy for Ocean Mapping, Exploration and Characterization, Seabed 2030, and the UN Decade of Ocean Science for Sustainable Development. The successful integration of several emerging technologies continued to expand the capabilities for multi-vehicle exploration, thereby helping to catalyze the force-multiplier of autonomy. Expedition activities also advanced NOAA mission priorities, particularly in terms of understanding ocean changes, sharing that knowledge with others, and conserving marine ecosystems. This work also helped advance priorities on education, diversity and inclusion by providing opportunities for individuals with historically marginalized identities to participate in expeditions. Finally, the data collected on these missions is an essential precursor to future explorations, which will undoubtedly lead to many more discoveries throughout the region. To this end, data and samples collected on these missions have been deposited in publicly-available repositories to enable follow-on science and management activities.

One Connected Ocean

How do schoolchildren learn to care about the ocean? And how can we help create that spark? The One Connected Ocean project has been all about connecting these dots. Since 2022, it has brought together ocean scientists from the Stockholm Resilience Centre at Stockholm University with educators at Universeum, a national science centre located in Gothenburg that attracts over 600,000 visitors annually, including 75,000 schoolchildren in school groups.

Figure 1. Learning about deep-sea life

The project aims to contribute directly to the UN Decade of Ocean Science for Sustainable Development, particularly its

tenth challenge: “Change humanity’s relationship with the ocean”.

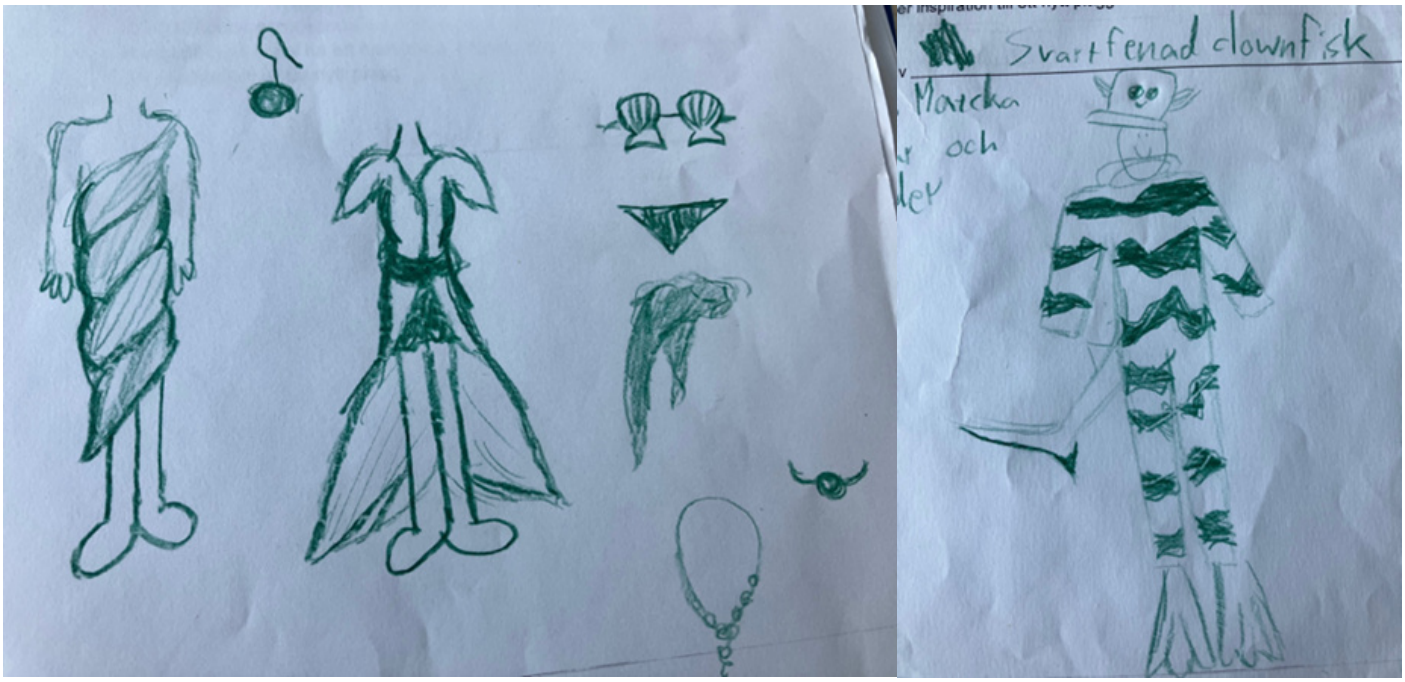


Figure 2 (above). Ocean-inspired clothing line designed by Gothenburg schoolchildren

Working closely with Universeum staff, the science team from the Stockholm Resilience Centre co-developed curricula for visits by class groups of local schoolchildren, who now get a hands-on interactive experience learning about ocean sustainability issues ranging from the diversity of fishing practices around the world to ocean plastic pollution.

They also get introduced to a number of iconic deep-sea species, and learn about how marine species have inspired biomimetic innovations around the world. As one part of this exercise, the schoolchildren get a chance to dream up their own ocean-inspired innovations. Many students decided to design new clothing designs inspired by ocean creatures, and some even created their own exhibition at their school. While the focus of the project has been to inspire and build awareness among others, it has become a source of inspiration and a favorite activity for many of the scientists in the team.

The project has been supported by a grant from the Swedish research council Formas. For more information, contact Louse Hård af Segerstad (louise.hard@su.se).

Updated Guide Aids Deepwater Animal Identification

NOAA Ocean Exploration’s Benthic Deepwater Animal Identification Guide has become a popular and trusted ocean science community resource and is used (and contributed to) by ocean scientists around the world to help identify animals seen during deep-ocean exploration. With the release of its fourth version in January 2024, the guide is now searchable and includes animals seen in deep waters of the Atlantic along with deepwater animals of the Pacific from earlier versions of the guide.

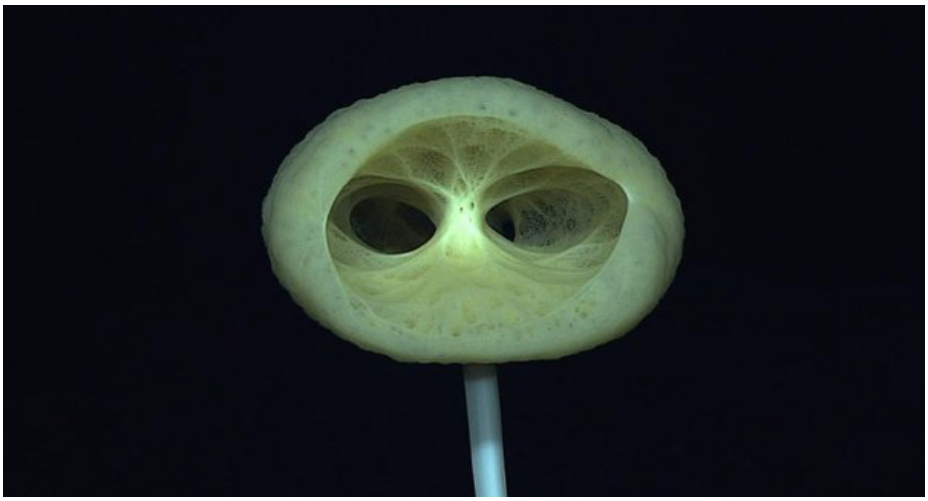


Figure 1. When it first appeared in the Benthic Deepwater Animal Identification Guide, this sponge was unknown to science. It has since been formally described and given the name Advhena *magnifica* (meaning "magnificent alien"), because of its resemblance to the alien from the movie E.T.: The Extra-Terrestrial. Its images in the guide have been updated accordingly. Image courtesy of NOAA Ocean Exploration, 2015 Hohonu Moana.

The guide contains still images of marine animals seen in their native habitat. Since its launch in 2016, this guide has grown from 1,685 images to 6,322 and counting. To aid animal identification, the images are organized by major taxa and are searchable by keyword, depth, and location. Information for each animal, to the extent known, includes taxonomic name (phylum, class, order, family, genus, and species — following the World Register of Marine Species (WoRMS) taxonomic classification); location of observation (latitude and longitude, depth, ocean, region, locality — e.g., seafloor feature); and a link to the landing page of the dive during which it was seen.

Images were captured from video collected with cameras on remotely operated vehicle (ROV) *Deep Discoverer* during expeditions on NOAA Ship *Okeanos Explorer* in the Pacific between 2015 and 2017 as well as a 2019 expedition to the New England Seamounts and along the North American continental margin. Identifications from taxonomic experts were made during live ROV dives as well as after, following close examination of images and collected samples.

The guide has evolved from a pilot project to share exploration results to a valued exploration tool. While its primary audience remains the scientific community, it's also being used to train artificial intelligence to automate animal detection in underwater video, educate the next generation of ocean scientists, and generate ocean interest among the public.

NOAA Ocean Exploration and its data team at NOAA's National Centers for Environmental Information will continue to enhance and expand the guide, adding new functionalities and new images, including images from other parts of the global ocean. Identifications will be updated on a periodic basis to correct errors reported by experts and reflect taxonomic revisions and new descriptions accepted in WoRMS. To report errors or provide feedback on or input to this guide, email NOAA Ocean Exploration's Data Management Team at oer.info.mgmt@noaa.gov

Namibian Deep-Ocean Benthos Collection Workshop

DOSI and the Namibian Ministry of Fisheries and Marine Resources

Swakopmund, Namibia. 30 October – 3 November 2023

In collaboration with colleagues from the Namibian Ministry of Fisheries and Marine Resources (NatMIRC), and DOSI members from South Africa, Portugal and the UK, we organised an in-person, hands-on workshop in Swakopmund, Namibia in October/November 2023.

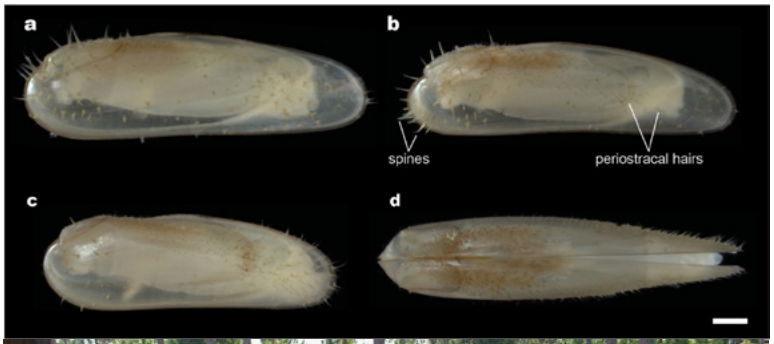
DOSI has a solid history of collaboration with NatMIRC starting with a first deep-sea benthos workshop in Namibia in April 2016 which prompted a drive by Namibian colleagues to establish a deep-ocean benthic sampling programme in Namibian waters in association with their annual fisheries research expeditions for hake, monk and crab. This was

followed up with continued support and a 2020 online training workshop around the fundamentals of sampling, processing, storage, data management and VMEs. The 2023 workshop goals were to exchange practical knowledge around identification and taxonomic classification of the deep-ocean Namibian benthic invertebrates collected during the fisheries expeditions from 2020 onwards. The collections are required for the eco-certification work focused around needs for the Marine Stewardship Council (MSC) Standard V 2.01 P2 Habitat Condition. The MSC Fisheries Standard is the leading international standard for sustainable fishing and is used to assess whether fisheries are well-managed and environmentally sustainable. It is fully expected that the Namibian collections will also inspire future deep-ocean taxonomic and ecological research papers led by Namibian scientists. DOSI is committed to continue to work with NatMIRC to support on-going efforts to further explore and identify the deep fauna of Namibia's EEZ and to extend networks of collaboration across Africa. DOSI secured funding from The Ocean Foundation and One Ocean Hub to support this 2023 workshop and we are most grateful to them for their donations.

THE NIPPON FOUNDATION-NEKTON OCEAN CENSUS

First New Species Dedicated to Ocean Census Uncovered in Undersea Forest in Alabama

The Ocean Genome Legacy Center at Northeastern University, Massachusett, USA, has recently contributed a new species to The Nippon Foundation-Nekton Ocean Census programme. The mussel, named *Vadumodiolus teredinocola*, represents both a new genus and species of bathymodiolin mussel.



Discovered at a depth of 18 metres in the submerged remains of an ancient bald cypress forest off Alabama's coast, *Vadumodiolus teredinocola* thrives in what is now known as the Alabama Undersea Forest. This unique site, believed to have been submerged between 72,000-45,000 years ago due to sea level rise, features well-preserved tree stumps and fallen limbs, resembling an ancient riverbank.

Prof. Dan Distel, Director of the Ocean Genome Legacy Center said, "In protecting our planet, lack of knowledge is the greatest challenge — we

Figure 1 (top). Morphology of *Vadumodiolus teredinicola*. (a) holotype (6317L-B); (b) paratype 6317L-D, (c) paratype (6317L-C), (d) paratype (6317L-A); (a–c) left side view; (d) dorsal view. Scale bar, 1.0 mm.
Figure 2 (bottom). Researchers Marvin Altamia (OGL, Northeastern University), Bailey Miller (University of Utah), Dan Distel (OGL, Northeastern University), and Margo Haygood (University of Utah), are shown here dissecting wood samples collected at the Alabama Undersea Forest. Photo credit: Brian Helmuth (Northeastern University)

cannot protect what we do not know and understand. This new species discovery, and the many to follow, are critical pieces of an extraordinary puzzle. By exploring the incredible diversity of life in the sea and the rich information hidden in its genomes, we learn the best ways to safeguard our planet's delicate ecosystems. We are thrilled to contribute to Ocean Census in this extraordinary journey of discovery and preservation."

Vadumodiolus teredinocola, a tiny marine mussel that can easily fit on the tip of your pinky finger, marks a significant find. It is the first shallow-water member of its group, previously known only in cold, dark, deep-sea environments ranging from 100 metres to over 4,000 metres (300 feet to more than 13,000 feet). This group includes giant mussels that feed on toxic gases — hydrogen sulphide and methane — spewed from deep-sea volcanic hot springs called hydrothermal vents.

As the first species named and described under the new Ocean Census programme, this discovery kickstarts a global mission to uncover 100,000 new ocean species over the next decade. Launched by The Nippon Foundation and Nekton, the programme aims to bridge the knowledge gap in marine life and enhance global ocean exploration capabilities.

Alex Rogers, Science Director, Ocean Census said, "This species demonstrates that this group of mussels are found not only in deep-sea environments, such as on wood or in chemosynthetic ecosystems like hydrothermal vents and seeps, but also in shallow waters. It fills in an important gap in our understanding of the evolution of these animals, which is particularly special. We look forward to other researchers globally contributing their findings to Ocean Census as well as joining us on our expeditions to seek out new life."

Joining as a founding partner, the Ocean Genome Legacy Center brings over two decades of marine genomics expertise to the Ocean Census Alliance.

The mussel *Vadumodiolus teredinocola* was recently detailed in the journal Deep Sea Research Part 1 204 (2024) 104220:https://www.sciencedirect.com/science/article/pii/S0967063723002595?via%3Dihub

Scientists and institutes are invited to support the mission to reach its target by dedicating their discoveries to Ocean Census. For more information visit: oceancensus.org/Science

Meetings & Workshops

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY | 17DSBS Deep-Sea Biology Symposium 13-17 January 2025 Hong Kong SAR, China

About News & Events Program Registration Abstract Venue General Information Media Center Contact Us

Message from the Chairman

We are honored and excited to welcome you to the Hong Kong University of Science and Technology (HKUST) which will host the 17th Deep-Sea Biology Symposium (17DSBS). This will be the first time that the DSBS is held in Asia. The 17DSBS thus provides a unique opportunity for international participants to meet colleagues in Asia where deep-sea research has been flourishing over the past decade.

Developing from a fishing village over a century ago to a major maritime city nowadays, Hong Kong has a very strong sea heritage. At HKUST, the new Department of Ocean Science aims to establish a solid research and education platform for multi-disciplinary marine science and technology. Together with marine scientists from other local tertiary institutes, we are working hard to organize the 17DSBS as a forum for participants to share their achievements in deep-sea biology, as well as to network and connect with colleagues for future research collaborations. In the 17DSDS program, we will include plenary talks by eminent deep-sea biologists, workshops for young scientists, enjoyable social events, and excursions to some famous maritime localities in Hong Kong (such as the Mai Po Inner Deep Bay Ramsar Site and the rhyolitic columnar rock formation in Sai Kung, which has recently been designated as one of the first 100 International Union of Geological Sciences (IUGS) Geological Heritage Sites).

Looking forward to a pleasurable experience with all our participants in Hong Kong in January 2025.

Pei-Yuan Qian
Chairman, Organising Committee of 17DSBS

Scientist Profiles

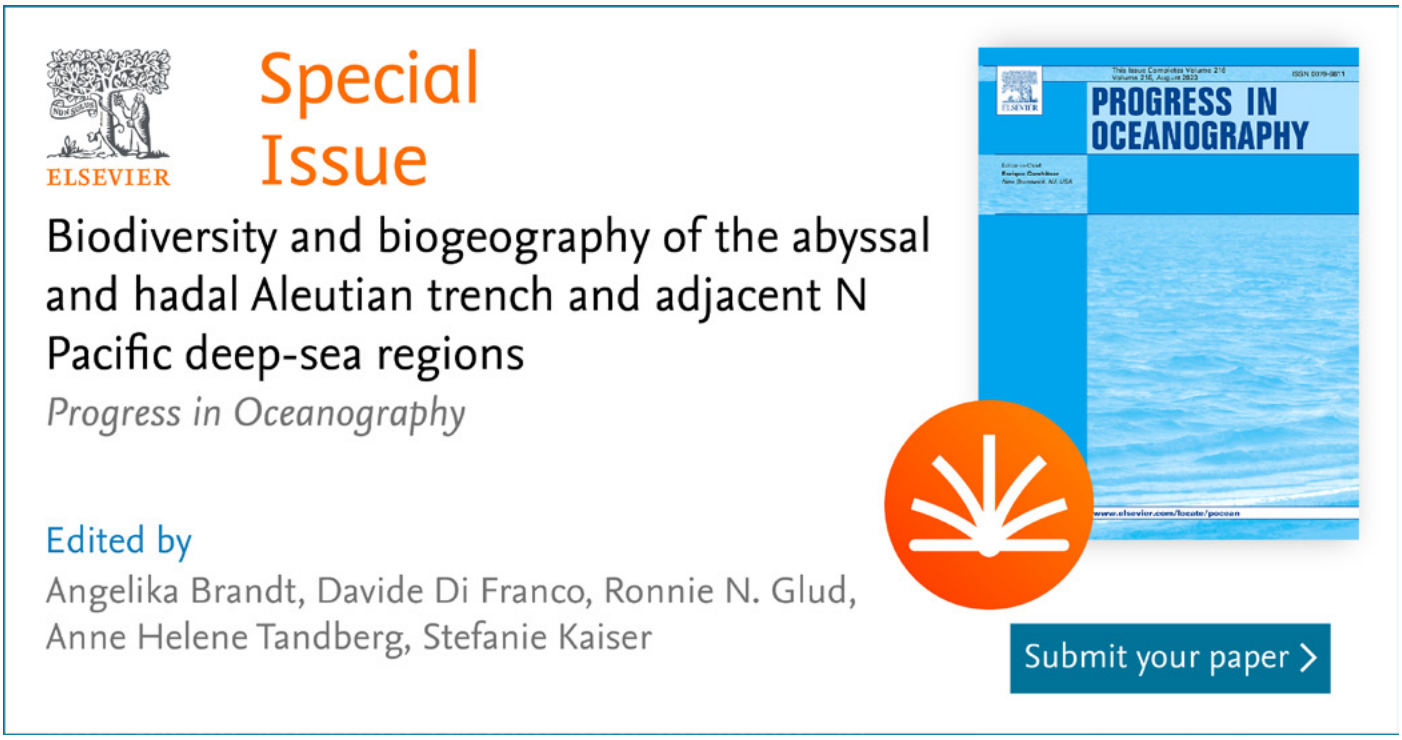
Lucia Bongiorni

Institute of Marine Sciences of the National Research Council of Italy (CNR-ISMAR, Venice)

Lucia Bongiorni PhD, is senior researcher at the Institute of Marine Sciences of the National Research Council of Italy (CNR-ISMAR, Venice). Her main studies focus on microbial diversity and functioning and in the association between microbes and marine fauna (particularly corals) in coastal and deep-sea areas. She is also interested in the use of eDNA and other emerging technologies for biodiversity studies and conservation and restoration strategies for marine environments. She has participated in several national and international (EU) projects, oceanic cruises and scientific expeditions in the Mediterranean and Arabic Seas, NE Atlantic and Indo Pacific Oceans. She is associate editor for Deep-Sea Environments and Ecology, Frontiers in Marine Science, https://www.researchgate.net/profile/Lucia-Bongiorni.

Contact: lucia.bongiorni@ismar.cnr.it

Opportunities



Call for Papers: Special Issue in Progress in Oceanography

Biodiversity and biogeography of the abyssal and hadal Aleutian trench and adjacent N Pacific deep-sea regions.

The AleutBio expedition, conducted aboard RV *SONNE* from July 24 to September 6, 2022, particularly targeted the biodiversity and biogeography of the abyssal and hadal regions of the Aleutian Trench and its adjacent deep-sea areas in the North Pacific. Focused on understanding the effects of rapid climate change, our investigation aimed to discern alterations in species composition across the North Pacific, Bering Sea, and Arctic Ocean, with a particular emphasis on the eastern Aleutian Trench (SO293). Our aim was to reveal the structured composition, diversity of species, biogeographical patterns, and evolutionary trajectories of the fauna inhabiting the trench, spanning from protists to meio-, macro-, and megafauna.

In our forthcoming special volume, “Biodiversity and Biogeography of the Abyssal and Hadal Aleutian Trench and Adjacent North Pacific Deep-Sea Regions,” we call for papers specifically addressing the hadal and abyssal regions of the Aleutian Trench. This volume will highlight the findings of the AleutBio expedition, integrating new insights from the broader biogeographic area and historical datasets to provide a comprehensive understanding of these remote and ecologically significant marine ecosystems.

The deadline for submission of articles will be the end of November 2024.

Journal of Ocean Technology
An open access, technological publication of the
Fisheries and Marine Institute of Memorial University

Sensing the Ocean: Lights, Cameras, Sensors

V19N3 fall 2024

The fall 2024 issue of the *Journal of Ocean Technology* (JOT) will focus on sensing the ocean. We invite the submission of peer-reviewed technical papers, essays, and short articles for this issue.

Technical papers (peer reviewed) describe innovative research and present the results of new (i.e., not previously published) research in ocean technology, and be no more than 7,500 words in length. Student papers are welcome.

Essays present well-informed observations and conclusions and identify key issues for the ocean community in a concise manner. They are written at a level that would be understandable by a non-specialist. As essays are less formal than a technical paper, they do not include abstracts or a listing of references. Typical essay lengths are up to 3,000 words.

Short articles are between 400 and 800 words and focus on how a technology works, evolution or advancement of a technology plus viewpoint/commentary pieces.

All papers, essays, and short articles are published online in open access format – making them accessible to anyone, anywhere in the world.

Important deadlines

Technical paper submissions: May 17, 2024. **This should be the full paper.**

- A panel of experts will be established for each paper to conduct the peer-review process and determine publishing suitability.

Expressions of interest (EOI) for essays and short articles: May 17, 2024

- After May 17, the JOT team will review all submitted EOIs and prepare a content outline. Should your EOI be accepted, the deadline for submission of materials is July 19.

Format

Expressions of interest for essays and short articles should contain the following information:

- Proposed title of article
- Type of article (essay – up to 3,000 words; or short article – up to 800 words)
- Name(s) and affiliation(s) of author(s)
- Short summary of article (no more than 200 words)

Submit both technical papers and expressions of interest to:
dawn.roche@mi.mun.ca

World Ocean Assessment III is Underway

Make your research available!

Lisa Levin, Angelee Annasawmy, Ana Colaço, Marta Coll, Erik Cordes, Becky Hitchin, David Vousden

The third cycle of the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects (the "Regular Process"), also known as the World Ocean Assessment is underway. Section 4 of WOA III will be focused on providing detail of the changes that have occurred in the ocean since WOA II (i.e., over the period of 2019-2024) and therefore will directly relate to specific chapters in WOA II (https://www.un.org/regularprocess/woa2). Chapter 5 in this section will cover a number of deep-sea habitats. The relevant habitats and coordinating authors are listed below. Each has assembled a writing team who will work to prepare a zero draft later in 2024. The audience for the World Ocean Assessment is policy makers, so the focus will be on synthesis and assessment.

If you have recent work that advances or alters understanding of one of these habitats, in particular with respect to drivers, pressures, state, impact and responses, please share your work with the relevant coordinating author listed below. Several writing teams (Coldwater Corals and Sponges, Seamounts, Sargasso Sea) lack experts in their respective fields. If you are interested, please email the coordinating author listed below to be added to the UN pool of experts database and join the WOA III.

Sub-chapter 5e: Cold water corals and sponges	Erik Cordes	erik.cordes@temple.edu
Sub-chapter 5j: Continental slopes and submarine canyons	Miquel Canals	miquelcanals@ub.edu
Sub-chapter 5l: Seamounts and pinnacles	Angelee Annasawmy	angelee-pavanee.annasawmy@ird.fr
Sub-chapter 5m: Abyssal plains	Becky Hitchin	elegaer@gmail.com
Sub-chapter 5n: Pelagic domain	Marta Coll	mcoll@icm.csic.es
Sub-chapter 5o: Ridges, plateaus and trenches	Ana Colaço	maria.aa.colaco@uac.pt
Sub-chapter 5p: Hydrothermal vents and cold seeps	Lisa Levin	llevin@ucsd.edu
Sub-chapter 5q: Sargasso Sea	David Vousden	davidvousden@oceangov.org

Moku Art Studio proudly presents its first annual virtual exhibition Under the Sea. This exhibition showcases artists who are passionate about the ocean and its future. Our vision is to help the ocean be inspiring and engaging through art and change humanity's relationship with it. We believe that art is a perfect vehicle to highlight the important science you are involved with in protecting our oceans!

As part of our exhibition Under the Sea, we are looking to collaborate with scientists and collect quotes about why your research is important, why you love the ocean and why others should care for it too! We want to display them on our homepage so we can inspire artists and our viewers to know more.

If you would like to participate, just fill out the form here. We look forward to reading and showcasing your insights. If you are also an artist, please feel free to look at our Open Call.

Wanted

Deep seabed sediment samples at end of useful life wanted

I am seeking deep seabed sediment samples or polymetallic nodules at the end of their useful scientific life. I do not mind in what state they are stored, nor their quantity. I will pay delivery costs if they occur.

Context: I am a human geography postdoc working in Marine Governance at the Helmholtz Institute for Functional Marine Biodiversity (HIFMB), under the Alfred-Wegener-Institut.

My current project focuses on the regulations being created for deep seabed mining, and particularly the idea from UNCLOS that the international seabed is the 'common heritage of mankind'. Despite the International Seabed Authority's more narrow interpretation of who counts as a stakeholder, the UNCLOS mandate implies that everyone has a stake in the seabed and in the development of these regulations.

My project explores whether it is possible to prompt non-scientists to care about the international seabed and become an active stakeholder when it is so remote and inaccessible.

Anticipated Use: I would use the samples for filming and also for sensory exploration (touching, smelling, etc) with other academic and non-academic participants to explore whether physical encounter creates a sense of connection with the seabed. You might think about it more along the lines of an artwork than a lab-based study.

I anticipate the project will result in a short film and a book. You/your lab would be included in the acknowledgments of outputs that make reference to the samples and be sent a copy of the film.

Please do not hesitate to get in contact by sending an email to Amelia Hine: amelia.hine@hifmb.de

---

WANTED: Dive Records

The Ocean Discovery League and partners at Boston University and Scripps Institution of Oceanography are seeking metadata for deep submergence camera deployment locations. We are collecting metadata for as many remotely operated (ROV), human-occupied (HOV), autonomous vehicle (AUV), and drop camera deployments as possible as part of a global initiative to capture a holistic view of the total percentage of the deep seafloor that has been visually observed. We have collected records for over 50,000 deployments from twelve countries and over twenty institutions, but we still need more.

We would love to hear from anyone with records they would be willing to share. We only require the deployment date, location, maximum depth, and the type of vehicle (ROV, HOV, drop cam, etc.). Please get in touch with briankennedy@oceandiscoveryleague.org to discuss a sharing agreement. We are happy to develop a data protection plan that fits your needs.

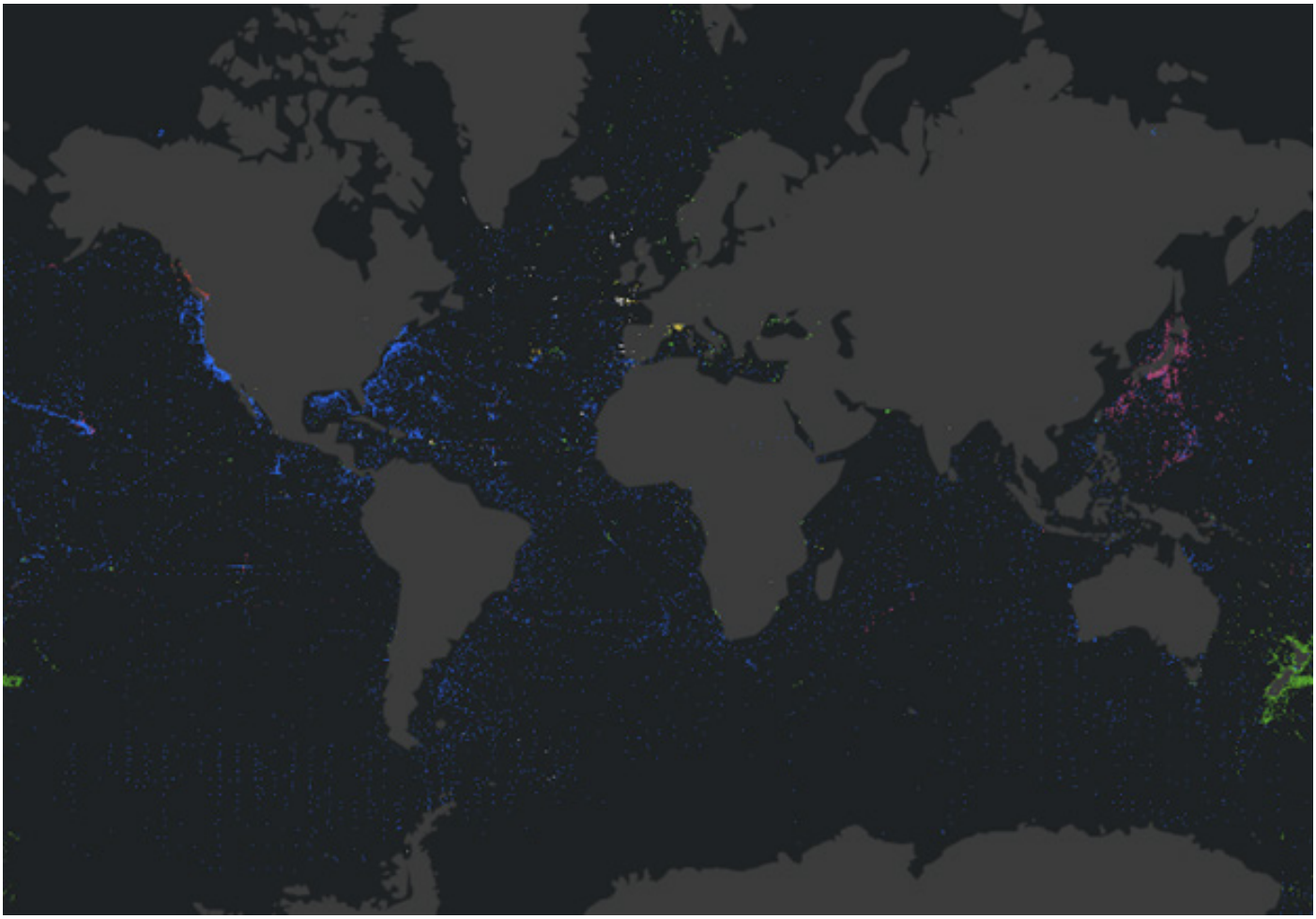


Figure 1. Geographic locations for the current collection of approximately 50,000 deep submergence activities. Each point represents an individual activity, colored according to its organizing country.

Hot off the Press

Monitoring ecological dynamics on complex hydrothermal structures: A novel photogrammetry approach reveals fine-scale variability of vent assemblages

Loïc Van Audenhaege*, Jozée Sarrazin, Pierre Legendre, Garance Perrois, Mathilde Cannat, Aurélien Arnaubec, Marjolaine Matabos

Limnology and Oceanography 9999, 1–14 (2024)

*loicva@noc.ac.uk

We set out to characterize the fine-scale processes acting on interannual dynamics of deep-sea vent fauna by using a novel approach involving a 5-yr time series of 3D photogrammetry models acquired at the Eiffel Tower sulfide edifice (Lucky Strike vent field, Mid-Atlantic Ridge). Consistently, with the overall stability of the vent edifice, total mussel cover did not undergo drastic changes, suggesting that they have been at a climax stage for at least 25 yr based on previous data. Successional patterns showed consistency over time, illustrating the dynamic equilibrium of the ecological system. In contrast, microbial mats significantly declined, possibly due to magmatic events. The remaining environmental variability consisted of decimeter-scale displacement of vent outflows, resulting from their opening or closure or from the progressive accretion of sulfide material. As a result, vent mussels showed submeter variability in the immediate vicinity of vent exits, possibly by repositioning in response to that fine-scale regime of change. As former studies were not able to quantify processes at submeter scales in complex settings, this pioneering work demonstrates the potential of 3D photogrammetry models for conducting long-term monitoring in the deep sea. We observed that the ability of mussels to displace may enable them to cope with changing local conditions in a stable system. However, the long-term stability of mussel assemblages questions their capacity to withstand large-scale disturbances and may imply a low resilience of these “climax” communities. This suggests that they may be particularly vulnerable to the negative effects of mining activities in hydrothermal ecosystems.

Link to article: https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.12486

360 dive at Eiffel Tower from your phone (auto-generated captions for English): https://www.youtube.com/watch?v=NG0MADsGp98

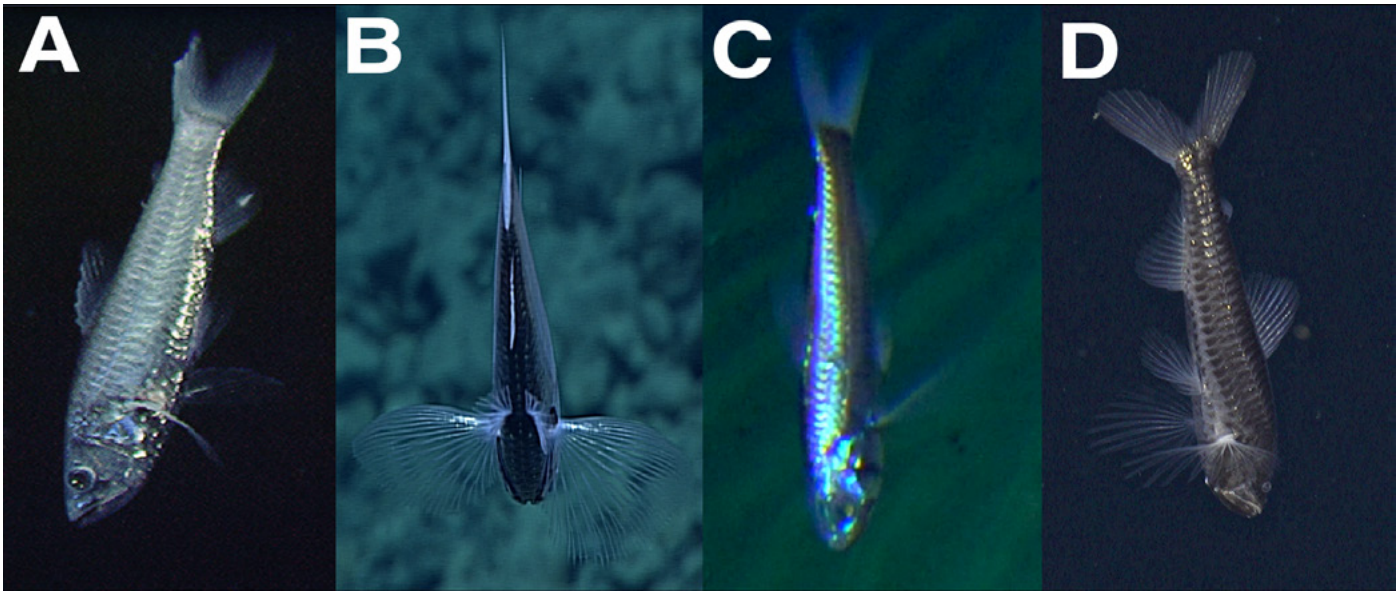
Face-Down, Tail-Up: Unusual In Situ Behavior of the Blackchins *Neoscopelus macrolepidotus*, *Neoscopelus microchir*, and *Scopelengys tristis* (Myctophiformes: Neoscopelidae)

L.A. Bergman, Y. Fujiwara, V.E. Assad, J.E. Perelman, J.C. Drazen, D.J. Lindsay

Diversity 2023, vol. 15(7), pp. 837

Orienting vertically with the head facing upward allows fish to look for the shadow of their prey against ambient light, while also making their own shadow smaller to predators beneath them. Here, the authors describe the in situ behavior of three midwater fish in the family Neoscopelidae, *Neoscopelus macrolepidotus, Neoscopelus microchir,* and *Scopelengys tristis*, all of which were observed facing vertically with the head downward. This behavior allows the fish

to diminish its shadow to hide from predators while hunting prey below. Assessing unique behaviors helps us better understand the role of these and other poorly studied deep-sea fishes.



Link to article: https://doi.org/10.3390/d15070837

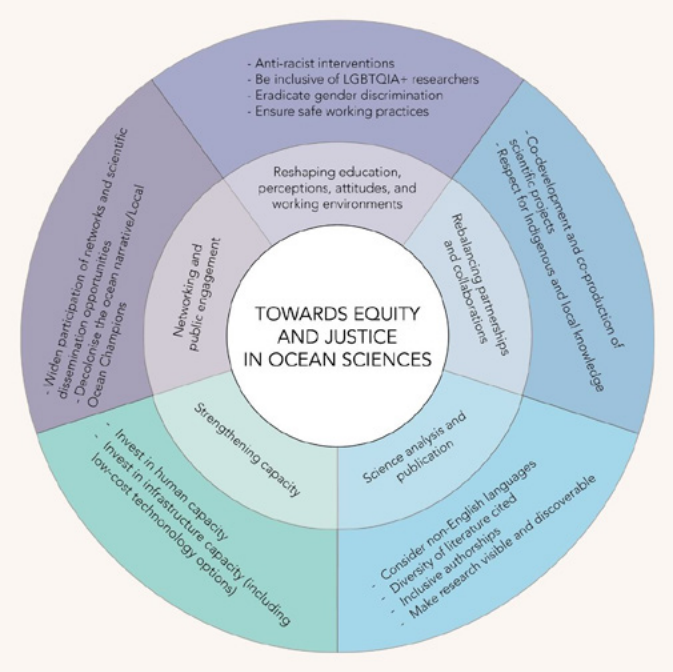
Towards equity and justice in ocean sciences

Asha de Vos[1,2], Sergio Cambronero-Solano[3,4], Sangeeta Mangubhai[5], Leila Nefdt[6,7], Lucy C. Woodall[8,9] & Paris V. Stefanoudis[8,10]

[1]Oceanswell, Sri Lanka. [2]The University of Western Australia Oceans Institute, Australia. [3]Universidad Nacional, Physics Department, Costa Rica. [4]Pelagos, Costa Rica. [5]Talanoa Consulting, Fiji. [6]University of Cape Town, Department of Biological Sciences, South Africa. [7]University of Cape Town, Marine and Antarctic Research centre for Innovation and Sustainability, South Africa. [8]Nekton Foundation, UK. [9]University of Exeter, Centre of Ecology & Conservation, UK. [10]Oxford University Museum of Natural History, UK.

npj Ocean Sustainability, Volume 2: 25 (2023)

The global scientific community is currently going through a self-reckoning in which it is questioning and re-examining its existing practices, many of which are based on colonial and neo-colonial perceptions. This is particularly acute for the ocean research community, where unequal and unbalanced international collaborations have been rife. Consequently, numerous discussions and calls have been made to change the current status quo by developing guidelines and frameworks addressing the key issues plaguing our community. Here, we provide an overview of the key topics and issues that the scientific community has debated over the last three to four years, with an emphasis on ocean research, coupled with actions per stakeholder groups (research community, institutions, funding agencies, and publishers). We also outline some key discussions



that are currently missing and suggest a path forward to tackle these gaps. We hope this contribution will further accelerate efforts to bring more equity and justice into ocean sciences.

Link to article: https://doi.org/10.1038/s44183-023-00028-4

Institutionalising science and knowledge under the agreement for the conservation and sustainable use of marine biodiversity of areas beyond national jurisdiction (BBNJ): Stakeholder perspectives on a fit-for-purpose Scientific and Technical Body

Christine Gaebel, Paula Novo, David E. Johnson, J. Murray Roberts (2024)

Marine Policy, Volume 161

The use of science, scientific information, and other knowledge to inform decision-making is increasingly recognised as an integral feature of environmental governance – a governance principle which is reflected in the new agreement for the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ Agreement). To support the integration of science and knowledge, the BBNJ Agreement establishes a Scientific and Technical Body (STB) and confers the task of finalising the formulation and function of this new advisory body to the Conference of Parties once the agreement enters into force. Therefore, it is a critical time for careful consideration of what is needed to achieve an effective STB. However, to date, there is limited research on what a fit-for-purpose STB would involve for BBNJ or what is needed to operationalise this in practice. As such, we aim to fill this knowledge gap by providing insights garnered from semi-structured interviews with key BBNJ stakeholders. Using qualitative content analysis, we identify and examine eight characteristics that stakeholders deem as important qualities for the STB to encompass, as well as challenges and opportunities for operationalising these qualities in practice. Our findings indicate that a fit-for-purpose STB extends beyond the mere production of high-quality scientific advice - it also necessitates the inclusion and due consideration of other fundamental qualities such as inclusivity and equity, transparency, flexibility, and synergy with the existing governance framework, amongst others, as well as proactive consideration of trade-offs associated with different design choices. These findings are pertinent to the forthcoming endeavour of designing and implementing an STB under the BBNJ Agreement, and more generally, provide insights on normative qualities that stakeholders perceive as important for science-policy interfaces.

Link to article: https://www.sciencedirect.com/science/article/pii/S0308597X23005316

The North-east Atlantic Margin: A Review of the Geology, Geography, Oceanography, and Vulnerable Megabenthic Ecosystems of the Continental Slope of Ireland and the United Kingdom

Declan Morrissey, Aaron Lim, Kerry L. Howell, Martin White, Andrew J. Wheeler, A. Louise Allcock (2023)

Oceanography and Marine Biology. An Annual Review, Volume 61

The Irish–Scottish margin is geologically and oceanographically heterogeneous. Source waters of subpolar and subtropical origin interact with banks, seamounts, submarine canyon systems, escarpments, and mound provinces resulting in rich and diverse benthic communities that are influenced by local and regional hydrodynamics (e.g., internal waves, tides, and local turbulence). Reef habitats formed by the cold-water coral *Desmophyllum pertusum* are particularly well studied, such that controls on reef and mound formation are relatively well understood. The distribution of some other Vulnerable Marine Ecosystems (VMEs), such as sponge fields formed by *Pheronema carpenteri*, and xenophyophore aggregations, is known due to both field observations and predictive modelling. Some VMEs are poorly known, for example, coral gardens, where in many cases even the characteristic species are not fully identified. The autecology of some component species has been studied, but for others, knowledge is almost completely lacking. The evidence for increased biodiversity associated with all these habitats is clear and all suffer anthropogenic impacts.

Link to article: https://www.taylorfrancis.com/chapters/oa-edit/10.1201/9781003363873-6/

Environmental filtering along a bathymetric gradient: A metabarcoding meta-analysis of free-living nematodes

Macheriotou, L., Derycke, S., & Vanreusel, A. (2023)

Molecular Ecology, 32, 6177–6189

Identifying and understanding patterns of biological diversity is crucial at a time when even the most remote and pristine marine ecosystems are threatened by resource exploitation such as deep-seabed mining. Metabarcoding provides the means through which one can perform comprehensive investigations of diversity by examining entire assemblages simultaneously. Nematodes commonly represent the most abundant infaunal metazoan group in marine soft sediments. In this meta-analysis, we compiled all publicly available metabarcoding datasets targeting the 18S rRNA v1-v2 region from sediment samples to conduct a global-scale examination of nematode amplicon sequence variant (ASV) alpha diversity patterns and phylogenetic community structure at different depths and habitats. We found that nematode ASV richness followed a parabolic trend, increasing from the intertidal to the shelf, reaching a maximum in the bathyal and decreasing in the abyssal zone. No depth- or habitat-specific assemblages were identified as a large fraction of genera were shared. Contrastingly, the vast majority of ASVs were unique to each habitat and/or depth zone; genetic diversity was thus highly localized. Overwhelmingly, nematode ASVs in all habitats exhibited phylogenetic clustering, pointing to environmental filtering as the primary force defining community assembly rather than competitive interactions. This finding stresses the importance of habitat preservation for the maintenance of marine nematode diversity.

Link to article: https://doi.org/10.1111/mec.17201

From what-if to what-now: Status of the deep-sea mining regulations and underlying drivers for outstanding issues

Pickens C., Lily H., Harrould-Kolieb E., Blanchard C., Chakraborty, A. (2024)

Marine Policy

The paper analyses the status of the ISA's exploitation regulations after the November 2023 session, and identifies more than 30 major issues outstanding, with a brief explanation of each. The authors consider the underlying causes where issues are poorly progressed, including: divergent views, lack of information, and lack of time dedicated to the topic. Overall, the paper concludes that negotiation of the regulations is likely to continue for some time, and past the 2025 'aim' date recently identified by the ISA's Council.

Link to article: https://www.sciencedirect.com/science/article/pii/S0308597X23005006

Inactive hydrothermal vent microbial communities are important contributors to deep ocean primary productivity

Amanda M. Achberger, Rose Jones, John Jamieson, Charles P. Holmes II, Florence Schubotz, Nicolette R. Meyer, Anne E. Dekas, Sarah Moriarty, Eoghan P. Reeves, Alex Manthey, Jonas Brünjes, Daniel J. Fornari, Margaret K. Tivey, Brandy M. Toner & Jason B. Sylvan.

Nature Microbiology (2024)

Active hydrothermal vents are oases for productivity in the deep ocean, but the flow of dissolved substrates that fuel such abundant life ultimately ceases, leaving behind inactive mineral deposits. The rates of microbial activity on these deposits are largely unconstrained. Here we show primary production occurs on inactive hydrothermal deposits and quantify its contribution to new organic carbon production in the deep ocean. Measured incorporation of 14C-bicarbonate shows that microbial communities on inactive deposits fix inorganic carbon at rates comparable to those on actively venting deposits. Single-cell uptake experiments and nanoscale secondary ion mass spectrometry showed chemoautotrophs comprise a large fraction (>30%) of the active microbial cells. Metagenomic and lipidomic surveys of inactive deposits further revealed that the microbial communities are dominated by Alphaproteobacteria and Gammaproteobacteria using the Calvin–Benson–Bassham pathway for carbon fixation. These findings establish inactive vent deposits as important sites for microbial activity and organic carbon production on the seafloor. Further, the primary production shown here represents a vital ecosystem service provided by inactive deposits. This finding must be considered in regards to the current debate about seafloor mining.

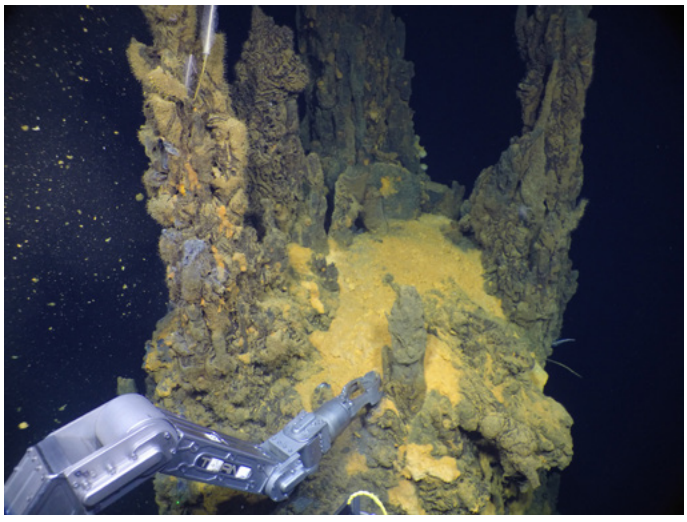


Figure 1. HOV *Alvin* sampling inactive sulfide at the Mosh Pit site during Dive 5019, 9°47'N East Pacific Rise. Photo credit: Jason Sylvan, Chief Scientist, Texas A&M University; Alvin Operations Group; National Science Foundation; © Woods Hole Oceanographic Institution.

Link to article: https://doi.org/10.1038/s41564-024-01599-9

Generating affordable protection of high seas biodiversity through cross-sectoral spatial planning

Léa Fourchault, Farid Dahdouh-Guebas, Daniel C. Dunn, Jason D. Everett, Jeffrey O. Hanson , KristineC.V. Buenafe, Sandra Neubert , Avise Dabalà, Kanthi K.A.S. Yapa, Stefano Cannicci, Anthony J. Richardson (2024)

One Earth, Volume 7, Issue 2

Over the past 20 years, the industrial use of the high seas has accelerated. In addition to fishing and shipping, deep-sea mining is now also a major driver of this “blue acceleration.” Each stakeholder has its own suite of impacts on species, communities, and ecosystems - and there is increasing evidence that their cumulative impacts generate negative synergies. We developed a systematic conservation planning approach combining ecological and socioeconomic data from the fishing, shipping, and - for the first time - deep-sea mining sectors to examine the utility of a cross-sectoral approach. Applying our framework to the Indian Ocean, we show that the cross-sectoral spatial plan meets the same conservation targets at a lower overall cost and using a smaller area compared with sector-specific plans implemented simultaneously. In addition, we identify areas that are best suited to conservation using a replacement cost metric. Our approach ensures affordable biodiversity protection throughout the water column, including deep-sea vents, plateaus and seamounts. It can thus serve as a first step toward the implementation of the recently signed High Seas Treaty.

Link to article (open access until 29th February): https://www.sciencedirect.com/science/article/pii/S2590332223005614?dgcid=coauthor

---

Wooden steps to shallow depths: A new bathymodiulin mussel, *Vadumodiolus teredinicola*, inhabits shipworm burrows in an ancient submarine forest

Marvin A. Altamia, Hannah J. Appiah-Madson, Falco Poulin, Bruno Huettel, Maxim Rubin-Blum, Nicole Dubilier, Harald R. Gruber-Vodicka, Nikolaus Leisch, Daniel L. Distel.

Deep Sea Research Part I: Oceanographic Research Papers 204: 104220 (2024)

Large mussels of the mytilid subfamily Bathymodiolinae are common inhabitants of deep-sea hydrothermal vents and cold seeps, where gill-borne symbionts allow them to utilize energy-rich compounds such as hydrogen sulfide and methane to support abundant growth. This subfamily also includes smaller symbiont-bearing mussels found on deep-sea wood and organic deposits. Phylogenetic analyses suggest that wood association is ancestral to bathymodiolin evolution. This observation led to the “wooden steps” hypothesis, which proposed that wood and other large organic deposits have acted as evolutionary steppingstones, introducing the progenitors of the modern vent and seep Bathymodiolinae to their remote environments. Although this hypothesis implies an evolutionary trajectory from shallow to deep water, no bathymodiolin species that grows and reproduces at depths less than 100 m has yet been formally described. Here we describe a new bathymodiolin genus and species, *Vadumodiolus teredinicola*, found growing and reproducing at a depth of 18 m in uninhabited shipworm burrows in the remnants of an ancient submerged bald cypress forest off the coast of Alabama. These results demonstrate that the bathymodiolin radiation has not been limited to deep water and that specific association with wood has led to the successful invasion of both deep and shallow marine environments.

Link to paper: https://doi.org/10.1016/j.dsr.2023.104220

Occurrence of Deep-sea Spider crab, Phalangipus hystrix (Miers, 1886), (Family: Epialtidae) Off Thoothukudi Coast of Gulf of Mannar, India

(08° 22.871'N 78° 22.409'E - 08° 31.912'N 78° 25.327'E) (185 to 318 M)

Vaitheeswaran Thiruvengadam

Enduring collections continue to explore new offshore Thoothukudi coast of Gulf of Mannar regions, India, between the longitude and latitude, off Thoothukudi region, India (08° 22.871'N 78° 22.409'E - 08° 31.912'N 78° 25.327'E) at a depth of 185 to 318 M and one berried female specimen was found in the fish landing centre, during nocturnal occurrence. One specimen of the said species was collected as an incidental catch in the deep sea trawl fisheries off Thoothukudi coast of Gulf of Mannar, Phalangipus hystrix (Miers, 1886), (Family: Epialtidae). Undescribed specimens and other valuable species are expected from relatively by-catch and unexplored marine habitats from Thoothukudi fishing harbour, Thoothukudi coast of Gulf of Mannar region. In particular, many species of marine invertebrates fauna and flora found in habitats from deep-sea to semi-terrestrial beaches in this region.

Contact author: vaitheeswaranthiruvengadam69@gmail.com

Towards a scientific community consensus on designating Vulnerable Marine Ecosystems from imagery

Baco AR, Ross R, Althaus F, Amon D, Bridges AEH, Brix S, Buhl-Mortensen P, Colaco A, Carreiro-Silva M, Clark MR, Du Preez C, Franken M, Gianni M, Gonzalez-Mirelis G, Hourigan T, Howell K, Levin LA, Lindsay DJ, Molodtsova TN, Morgan N, Morato T, Mejia-Mercado BE, O'Sullivan D, Pearman T, Price D, Robert K, Robson L, Rowden AA, Taylor J, Taylor M, Victorero L, Watling L, Williams A, Xavier JR, Yesson C. (2023)

PeerJ 11:e16024

Management of deep-sea fisheries in areas beyond national jurisdiction by Regional Fisheries Management Organizations/Arrangements (RFMO/As) requires identification of areas with Vulnerable Marine Ecosystems (VMEs). Currently, fisheries data, including trawl and longline bycatch data, are used by many RFMO/As to inform the identification of VMEs. However, the collection of such data creates impacts and there is a need to collect non-invasive data for VME identification and monitoring purposes. Imagery data from scientific surveys satisfies this requirement, but there currently is no established framework for identifying VMEs from images. Thus, the goal of this study was to bring together a large international team to determine current VME assessment protocols and establish preliminary global consensus guidelines for identifying VMEs from images. An initial assessment showed a lack of consistency among RFMO/A regions regarding what is considered a VME indicator taxon, and hence variability in how VMEs might be defined. In certain cases,

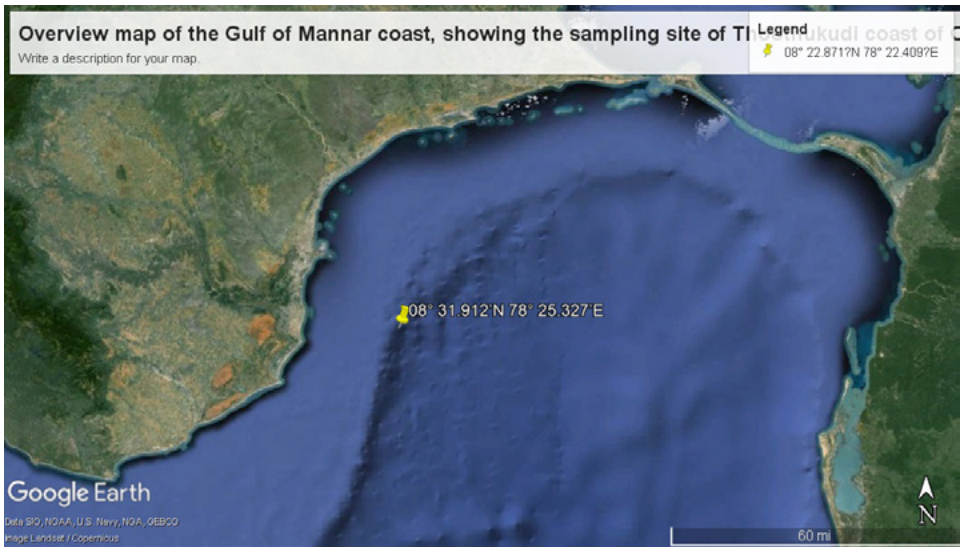


Figure 1. Overview map of the Gulf of Mannar coast, showing the sampling site of Thoothukudi coast of Gulf of Mannar, India, (08° 22.871'N 78° 22.409'E- 08° 31.912'N 78° 25.327'E) at a depth of 185 to 318 M

Figure 2. Ventral (top) and dorsal (bottom) view- Phalangipus hystrix (Miers, 1886), (Family: Epialtidae)

experts agreed that a VME could be identified from a single image, most often in areas of scleractinian reefs, dense octocoral gardens, multiple VME species' co-occurrence, and chemosynthetic ecosystems. A decision flow chart is presented that gives practical interpretation of the FAO criteria for single images. To further evaluate steps of the flow chart related to density, data were compiled to assess whether scientists perceived similar density thresholds across regions. The range of observed densities and the density values considered to be VMEs varied considerably by taxon, but in many cases, there was a statistical difference in what experts considered to be a VME compared to images not considered a VME. Further work is required to develop an areal extent index, to include a measure of confidence, and to increase our understanding of what levels of density and diversity correspond to key ecosystem functions for VME indicator taxa. Based on our results, the following recommendations are made: 1. There is a need to establish a global consensus on which taxa are VME indicators. 2. RFMO/As should consider adopting guidelines that use imagery surveys as an alternative (or complement) to using bycatch and trawl surveys for designating VMEs. 3. Imagery surveys should also be included in Impact Assessments. And 4. All industries that impact the seafloor, not just fisheries, should use imagery surveys to detect and identify VMEs.

Link to paper: https://doi.org/10.7717/peerj.16024

In situ observations of three deep-sea cephalopods in the central Mediterranean Sea

Pietro Battaglia, Simonepietro Canese, Eva Salvati, Silvestro Greco (2023)

Marine Biology

The development of in situ observational tools has significantly contributed to the study of deep-sea cephalopods and exploration of their habitat in the last decades. In this paper, we report in situ observations of rarely observed deep-sea Mediterranean cephalopods (*Chiroteuthis veranyi, Chtenopteryx sicula*, and *Octopoteuthis sicula*). These cephalopods were encountered during a scientific expedition, aimed at characterizing the biodiversity of a deep-sea area in the northern Ionian Sea. Images and video were collected by a remotely operated vehicle (ROV) between 537 and 1248 m. Chromatic, postural, locomotor, and bioluminescent behavioural components were reported for each species. This was the first time that *O. sicula* was filmed in its habitat and all individuals showed hovering and an arm spread posture with the arm tips exposed, producing an intermittent bioluminescence. Furthermore, our observations on six living specimens of *C. sicula* represent exceptional events, since this species was only observed once in the eastern

Mediterranean in 2012. Overall, five females and a mature male of *C. sicula* were observed; the male had a large dorsal light organ. Finally, an individual of *C. veranyi* was observed consuming a large lanternfish (Myctophidae). In the near future, in situ explorations in the Mediterranean should be implemented to shed light on deep-sea cephalopods inhabiting this basin and fill information gaps on the biology, ecology, and behaviour of elusive species.

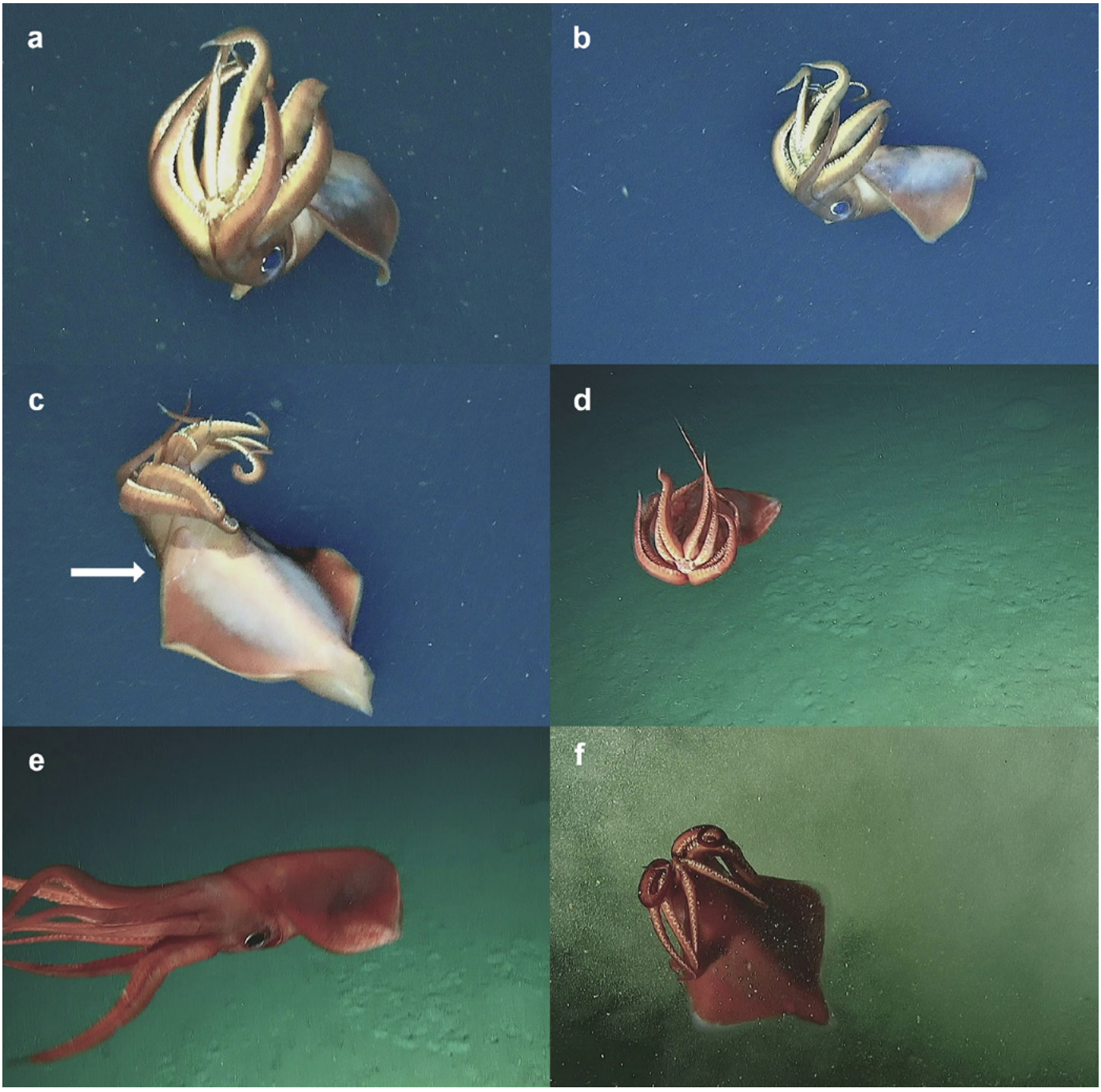


Figure 1. Specimens of *Octopoteuthis sicula* observed during the ROV survey. a), b) Oct-sic-1 in a "hovering" position; c) particulars of the color pattern of Oct-sic-1; spermatangia on the dorsal mantle can be observed (white arrow); d) Oct-sic-2 in a "hovering" position; e dark color pattern of Oct-sic-2; f) particular of the color pattern of Oct-sic-3 having a dark body with a pale edge of fins.

Link to article: https://doi.org/10.1007/s00227-023-04264-7

Obituaries

Don Walsh, Deep Sea Submariner and Ocean Explorer, Dies at 92

Trieste interior in 1963. US Navy Photo

This is someone who needs no introduction to our readers. The work and adventurous spirit of Don Walsh, the legendary ocean explorer, will undoubtedly continue to inspire those that come after him for many decades. In 1960, with his colleague Swiss oceanographer Jacques Piccard, he ventured to the deepest point in our ocean in the bathyscaphe Trieste. Among so many other achievements, he also authored the "Oceans" column in U.S. Naval Institute Proceedings as he was passionate about ocean literacy among those who sailed upon the ocean but gave little thought to what happened and lived beneath.

In November 2023, Gidget Fuentes of the US Naval Institute wrote an excellent piece about Don's life achievements and of the person he was.

https://news.usni.org/2023/11/13/retired-navy-capt-don-walsh-deep-sea-submariner-and-ocean-explorer-dies-at-92

Deep-Sea Biology Society News

The Deep-Sea Biology Society is thrilled that its activities are being pursued with the enthusiasm of its members, the energy of its early career researchers, and largely followed on various media.

We have been coordinating with the local organization committee at The Hong Kong University of Science and Technology, your host for the 17th Deep-Sea Biology Symposium next year. They finalized the schedule for plenaries and sessions, and the website is about to go live at 17dsbs.hkust.edu.hk. The Society offers awards for this (and other) conferences. Please visit our website to apply for a "Conference Support Award" (formerly the "Participation Support Award": https://dsbsoc.org/conferences-support).

We created an "Art & Science" activity, to help bridge Arts & Science. Professional artists and talented scientists have joined the Society as "Artist" members and this pool of creative minds inspired by deep sea life is growing. Please meet and read their statements and biographies on the website at https://dsbsoc.org/artist/, and follow the registration guide to join (https://dsbsoc.org/art-science). We believe that by combining ideas and goals, artists and Scientists can push deep-sea exploration far beyond the limitations of technology and inequity. Below, a contribution to Deep-Sea Life by Ivan Volski!

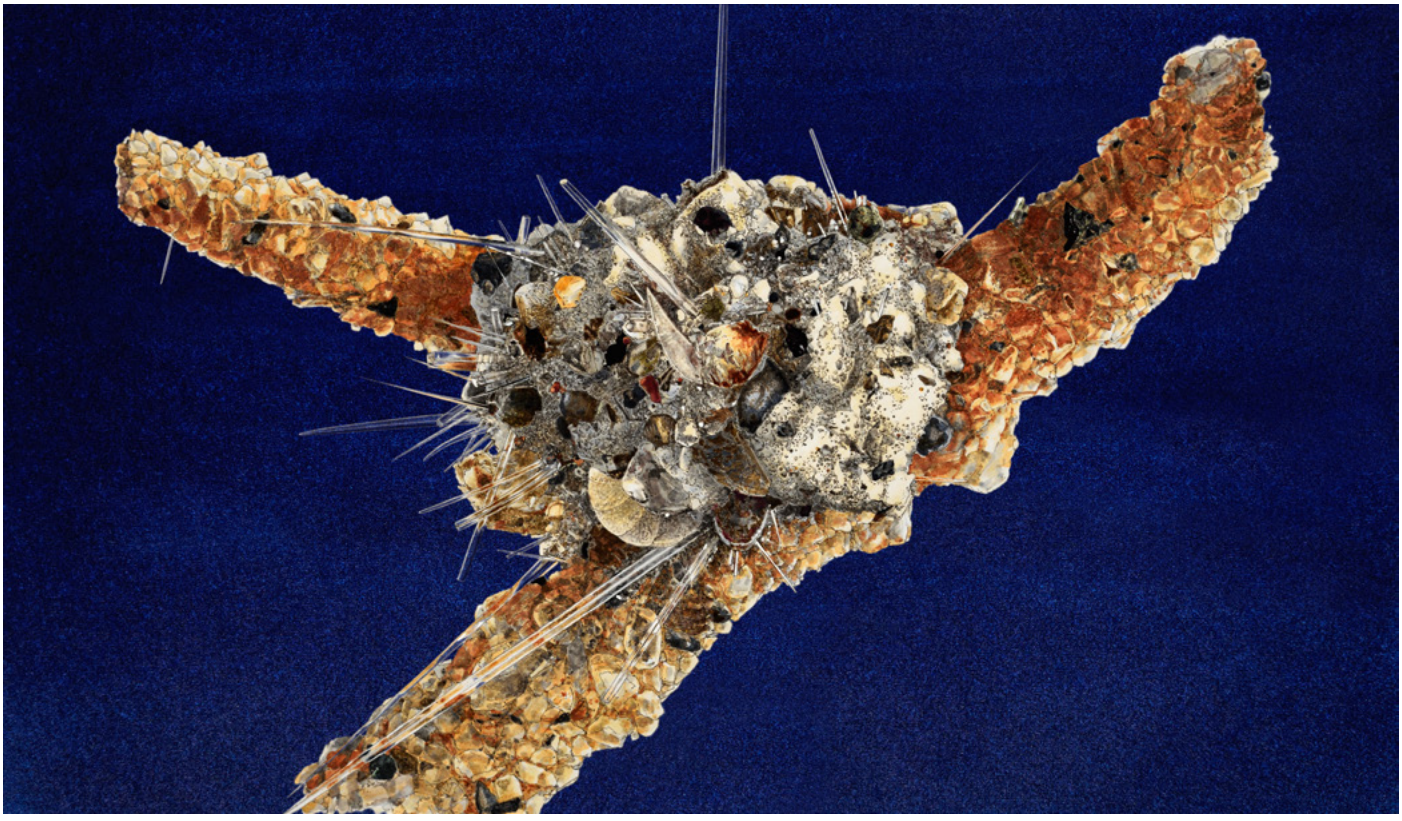


Figure 1. *Crithionina hispida* attached to *Rhabdammina* sp., IceAGE2 / POS-456, stn. 882-4. Markers on paper / digital processing, 2023.
Crithionina hispida from the Iceland-Faroe Ridge, IceAGE2 expedition (R/V *Poseidon* cruise 456), station 882 (440 m).
The drawing in fig.1 above shows large (> 3 mm across), whitish and spiky, monothalamous foraminifer *Crithionina cf. hispida* which is attached to the two fragments of *Psammosiphonella discreta*, another large agglutinated foraminifer. The lumpy wall of *Crithionina* contains copious amounts of a fine-grained mortar and is encrusted by numerous protruding sponge spicules and mineral grains, also cementing the fragments of *Psammosiphonella* in a Y-shaped structure.
Picked by me and Franck Lejzerowicz while sorting foraminifera at Sandgerði field station in 2013. All *Crithionina* specimens had a lot of detrital matter covering their test surface. This layer was wiped out each time, resulting in test wall damage (broken off spicules or cracks). In the specimen shown, the test is intact but positions of a few spicules were reconstructed. Habitat characteristics from Meißner *et al.* (2014): sandy mud partially with minor portion of gravel. Numerous large *Rhabdammina* tests are visible on the surface of the sediment sample.

Our Early-Career and Students Officers have been expanding the "Student and ERC" section of our public website, and we now offer a language translation button for better integration. Our presence on various outlets to promote science,

to highlight our artist partners and to update our non-member followers on social media platforms is strong, thanks to the efforts of the social media team. We recruited additional volunteers and a new Trustee: the Media Officer will coordinate posts more regularly about members and artists - see Janet's message below.

The Society is thriving thanks to its 382 members, amongst whom we are developing new ways for interactions and networking. Slack is our main communication tool as it reaches 908 persons (duplicate accounts were removed), includes non members, and allows for anyone to make announcements. As only 120 accounts are active and that messages are most visible at the #general channel, we may demote accounts to this single-channel to afford the Pro version and retrieve previous messages. The Society voted in favor of a members directory and will be experimenting via a login-protected feature to help "match-making" among experts and/or artists. We are developing new ways to discover relevant experts and coordinating with DOSI and other initiatives to reload the INDEEP expert list into a shared, centralized resource for deep-sea biologists. Stay tuned!

Please join and contact us to learn more about the Society's activities and achievements,

Franck Lejzerowicz - Communications Officer

Trustees reports

Early Career - Pierre Methou

We are continuing our activities aimed at young researchers with finally the posting of two new web pages on our site to highlight the opportunities offered by the mentoring network (https://dsbsoc.org/mentoring-network/) which has existed for six years already and by the DSBSoc Seminar Series (https://dsbsoc.org/seminar-series/) that we have started between 2022 and 2023.

Regarding the seminar series, we are relaunching it this year to make up for the delay until our next congress in January 2025 in Hong Kong. We have already received requests from a few volunteers with some very exciting presentations coming up. The detailed program should follow shortly. If you would also like to present your latest work during these seminars, do not hesitate to contact us (early_career@dsbsoc.org). Priority is given to students & early careers but any DSBS members are welcome.

On a more personal note, I also joined my first DSBS related conference as a trustee at CBE7 in São Paulo. This was a wonderful gathering with many interesting talks, well represented by early career scientists I would like to particularly congrats Olivia Pereira from Scripps Institution of Oceanography who received the Diane Adams awards, created in memory of Diane Adams during CBE6, but also Jacob Wynne from Oregon state University who received the best poster award and Joan Alfaro Lucas from University of Victoria who received the best talk award. I hope to see many other exciting presentations from early career and students at our next conference in Hong Kong in a bit less than a year from now.

Media - Janet Ferguson-Roberts

I am excited to begin my new role as the DSBSoc Media Trustee! I have served on the Social Media Team for almost 2 years now, running the Twitter/X and Twitter-like accounts, and it is a great pleasure to continue to work with Franck and Ariane, and in collaboration with Pierre and Katie to build our community. There are exciting new things to come!

I created the Deep-Sea Biology Society Bluesky account (@dsbsoc.bsky.social) on Sept. 2, 2023. Since then, it has gone through multiple phases of development. At first, I was attempting to replicate the style of our former Twitter

account, following anyone in the deep-sea scientific community and scrounging for any relevant posts that I could find. It was a mix of old and new posts by legitimate people in the deep-sea scientific community mixed with random accounts posting relevant content, then more people joined and I was able to improve the quality and only repost from legitimate accounts. I made it a goal to repost at least one post every day and held strong with that until after the holidays, when I became the Media Trustee (we will get help with this soon). I requested for us to be added to the to the #MarineLife , #Science and #SciArt curated feeds, for which we are now a regular contributor. We are receiving likes from people who follow the feeds but need more academics and professionals to participate. In an attempt to remedy this, I created a list called 'Deep-Sea Scientific Community' so that I would still be able to view posts by deep-sea scientists separately from all accounts that we follow and therefore, be able to follow many more academics and professionals so that we can encourage them to interact with our posts. To start with, I have begun to seek out those in marine biology. Bluesky is now publicly viewable, and invite codes are no longer required to set up an account – so, you are more than welcome to join us there!

Our X (formerly Twitter; @DSBSoc) account is still alive and kicking, featuring both original posts and reposts, and our Mastodon (@dsbsoc.mstdn.science) and Instagram (@dsbsoc) accounts are going strong, focusing mostly on original posts.

Awards - Julia Sigwart

Congratulations to the two recent Conference Award winners: Michelle Neitzey, Department of Molecular and Cell Biology, University of Connecticut, and Flávia Tiemi Masumoto, Institute Oceanographic of the University of São Paulo! Michelle will be attending the AGU Ocean Sciences Meeting to present her work on mesophotic and deep-sea coral ecosystems. Flávia applied in advance to attend 17DSBS in January 2025. The award assessors were all impressed with the diversity and quality of the applications, reflecting a lot of exciting activity across the membership!

Remember the annual deadline for Research Awards is coming up on 30 April! Research awards support small research projects, or to gather preliminary data toward a larger project, or travel money to connect collaborators or facilitate special training or access to collections. If you have questions about a potential application, please email <awards@dsbsoc.org>. All members are eligible to apply; however, we do not normally grant any funding to scientists in permanent employment. Apply here: https://docs.google.com/forms/d/1jiOPoeU0EYjp506hCtxvbnYCl6m0T9D_vs4d8MZ6i18/edit

---

To contact us, please email the Trustees:

President, Dr. Michelle Taylor (University of Essex, UK): president@dsbsoc.org

Secretary, Dr. Alexis Weinnig (Temple University, USA): secretary@dsbsoc.org

Treasurer, Dr. Neus Campanyà-Llovet (University of the Azores): treasurer@dsbsoc.org

Membership and Data Protection, Dr. Erin Easton (University of Texas Rio Grande Valley, USA): membership@dsbsoc.org

Awards Officer, Prof. Dr Julia Sigwart (Senckenberg Society for Nature Research, Germany): awards@dsbsoc.org

Diversity Officer, Alycia J. Smith (Heriot-Watt University, Edinburgh): diversity@dsbsoc.org

Conference Officer, Prof. Pei-Yuan Qian (Hong Kong University of Science and Technology, China): conferences@dsbsoc.org

Students Officer, Katharine T. Bigham (Victoria University of Wellington, New Zealand): students@dsbsoc.org

Early-Career Officer, Dr. Pierre Methou (Ifremer / JAMSTEC): early_career@dsbsoc.org

Development Officer, Prof. Erik Cordes (Temple University, USA): development@dsbsoc.org

Communications Officer, Dr. Franck Lejzerowicz (University of Oslo, Norway): communications@dsbsoc.org

Social Media Officer, Janet Ferguson-Roberts and: socialmedia@dsbsoc.org

Best wishes,

The Trustees of the Deep-Sea Society