Deep-Sea Life

Issue 23, September 2024

Welcome to the 23rd edition of Deep-Sea Life: an informal publication for the deep-sea biology community and beyond which is produced twice per year. Our colleagues are relentless in their work to uncover and explain our planet's deep marine world and it has never been more important to share their findings with the world. Please support our community and help to disseminate our news from the deep!

In this issue, read about research cruises to the Arctic (Hausgarten), deep-waters around islands in the Philippine Sea, canyons of the NW Atlantic and Gulf of Maine, seamounts off the coast of Chile, deep seeps on the Aleutian margin, life on the Sigsbee abyssal plain and canyons, slope and vents off British Columbia. Exciting and diverse new projects are described - why not reach out and get involved? There are always many opportunities, requests and links to some of the latest research papers. DOSI and DSBS updates too!

Submitted by our colleague Tracy Sutton - DEEPEND project Director and PI - we have selected this marvellous photograph of a Duckbill Flathead Bembrops to adorn this issue of DSL. See the accompanying article on page 25 which describes new elements of this programme which has been running for 14 years, describing pelagic life in the Gulf of Mexico.

Thanks to my fellow editors Drs. Abigail Pattenden (University of Limerick, Ireland), Eva Ramirez-Llodra (REV Ocean, Norway), Franck Lejzerowicz (University of Oslo), Bhavani Narayanaswamy (SAMS, UK) and Michelle Taylor (University of Essex, UK).

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

CroCHEt - Cross Border Coral Habitat Exploration

Meri Bilan, Anna Metaxas, Martha Nizinski and the CroCHEt cruise crew

The NOAA ship *Henry B. Bigelow* hosted CSSF ROPOS team and nine researchers from Canada and the USA for a research expedition to explore coral habitats in submarine canyons (NW Atlantic) and the Gulf of Maine from 17 -31 July 2024 (Fig.1).

CroCHEt stands for cross border coral habitat exploration, describing the main purpose of this cruise and the history behind it: this is the fourth cruise of this nature, jointly organized by Martha Nizinski from NOAA Fisheries (USA) and Anna Metaxas from Dalhousie University (Canada).

Half of the dives were carried out in submarine canyons along the continental slope of the US and Canada in the NW Atlantic; specifically, within or near the *Northeast Canyons and Seamounts National Marine Monument*, as well as in *Corsair and Georges Canyons Conservation Area* (Hydrographer, Oceanographer, Gilbert, Heezen and Corsair canyons). Although these canyons have been explored before, visiting new sites within the canyons provided additional insights into the diversity of canyon habitats. On the canyon walls we found luscious coral gardens of soft corals, gorgonians and scleractinian corals, where some colonies reached impressive sizes and left us in awe (Fig. 2 and Fig. 3).

Moving northward from the canyons, we visited the *Northeast Channel Coral Conservation Area*, where we collected data from sites previously visited in 2001, 2006 and 2014, adding another point to our time series. These data allow us to monitor long-lived species, such as corals, by measuring their density and sizes. We were happy to see many small coral colonies amidst large ones, reflecting the health of the coral populations.

Figure 1. ROPOS and science team of CroCHEt cruise on board NOAA vessel *Henry B. Bigelow*

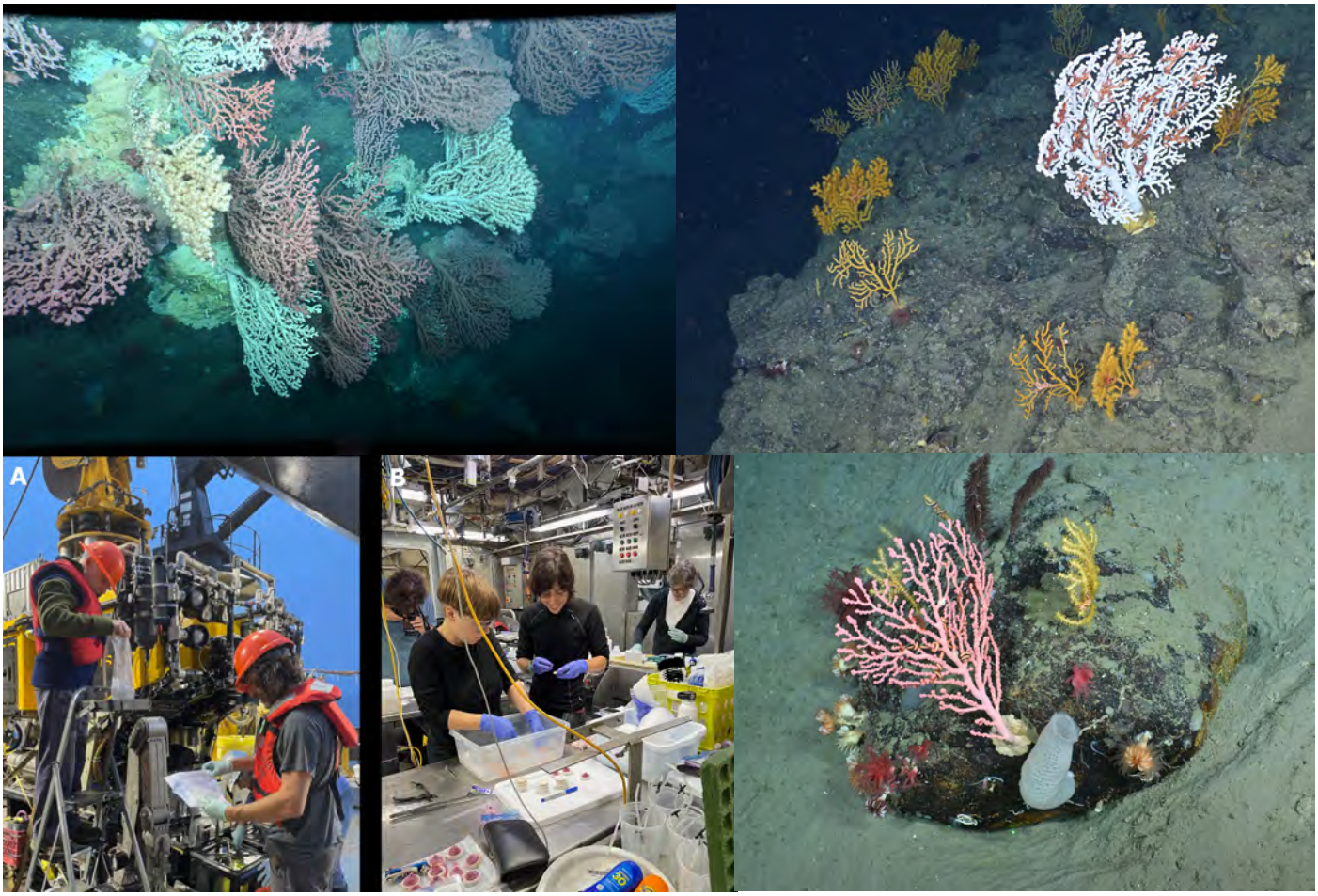
Our final destination was the central Gulf of Maine, along and across the border between Canada and USA, where we found a mix of extremely dense thickets of corals and evidence of fishing activity, such as lost fishing gear.

During the cruise we collected samples that will be used for taxonomy, genetics and isotope analysis. Some of the coral samples were kept in aquaria onboard to perform physiological measurements which will provide valuable insight into their biology and ecology (Fig. 4).

CroCHEt cruise sailed under the Challenger 150 flag, a worldwide network programme to

promote deep sea research during this decade. During the cruise we had a broadcast livestream of the ROV dives, a nice addition to our daily routine as we received emails of support, curiosity and scientific suggestions. A brief description of our findings each day can be found here: https://delmns.org/science-at-sea/.

Lastly, we dedicated one dive to Dr. Kim Juniper, a researcher that not only had an incredible contribution to science, but more importantly had a great impact on several generations of scientists and engineers, giving an example on how to lead with kindness and provide support and inspiration to the future generations (Fig. 5).



Top left: Figure 2. Dense *Paragorgia* coral garden in Corsair Canyon; Top right: Figure 3. *Paramuricea* and *Paragorgia* coral garden in Oceanographer Canyon; Bottom left: Figure 4. Post dive sample processing (A) Sampling for eDNA; (B) Sample harvest for taxonomy, genetics, isotopes and experiments; Bottom right: Figure 5. Kim Juniper rock, found in Gilbert canyon, along a long muddy slope there was one rock full of life.

Unexplored Seamounts of the Salas y Gómez Ridge

Rosanne Dodde

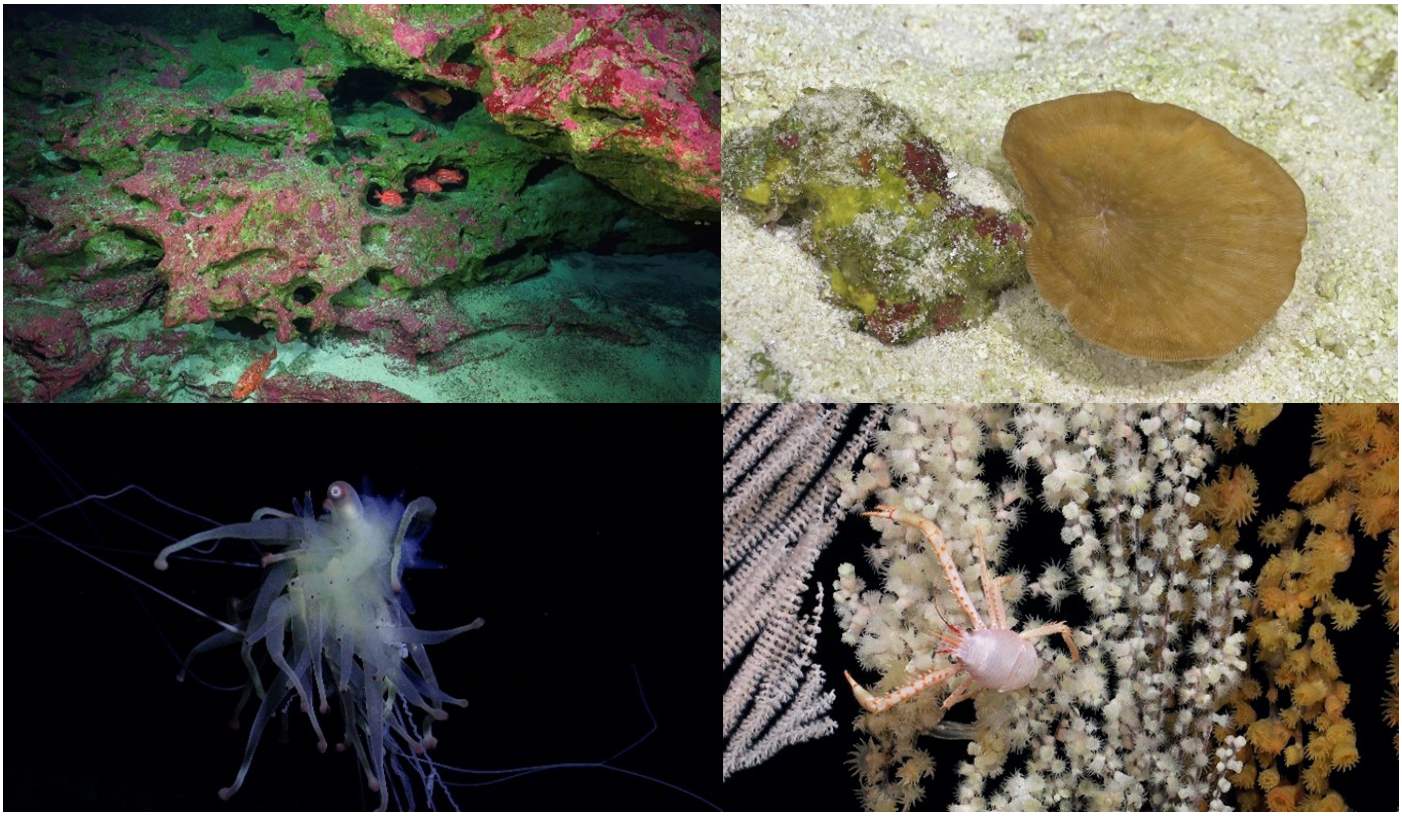
The objective of the Schmidt Ocean Institute's cruise (Fkt240224), led by Erin E. Easton, was to map the unexplored seamounts of the Salas y Gómez ridge. This ridge lies off the coast of Chile and extends to Rapa Nui (Easter Island): some of the highest marine endemism in the world can be found here. However, 73% of this remote, underexplored region lies in the high seas and is thus unprotected. By providing a better description of the region, we aim to establish one of the first high-seas marine protected areas in the Salas y Gómez Ridge.

During this cruise we found new seamounts and observed 160 species new to the area and suspect that at least 50 of these species are new to science. The new records consist of amongst others; fish, corals, molluscs, echinodermata, glass sponges, tardigrades and squat lobsters. Additionally, in the oligotrophic waters of the seamounts of Rapa Nui a

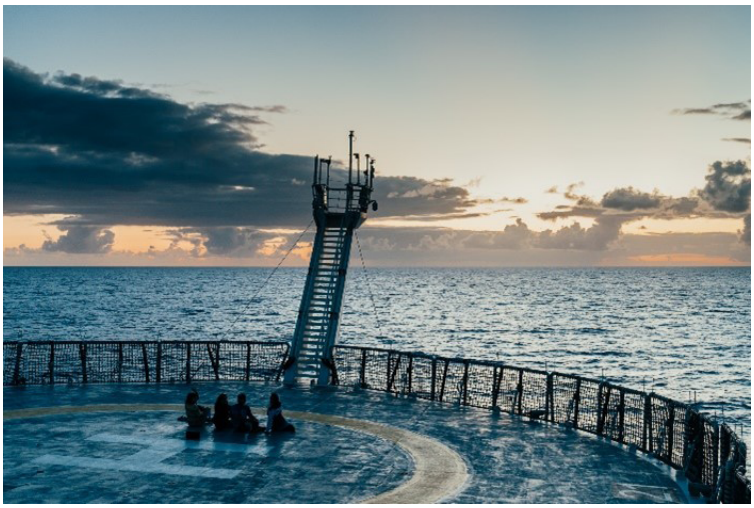
new record for the deepest photosynthetic animal in the world a Leptoceris or wrinkle coral was set at -197m. And the deepest crustose coralline algae at -350m was present in a place that I like to call 'Barbieland', here many fauna have adapted to the widespread presence of this algae by becoming pink themselves. Oh, and the last day we found a flying spaghetti monster or Bathyphysa siphonophore, which hadn't been recorded in ~15 years.

I loved the multidisciplinary science team, which consisted of mostly Chilean and Rapa Nui people, ~50% students and ~50% females in various positions. The word bored was immediately banished from my dictionary. Instead my dictionary got filled with a lot of different words considering meiofauna, robotics, spectrometry, nutrients, ocean floor geomorphology and many many genera in Spanish, Latin and English. A shoutout to the center for Ecology and Sustainable Management of Oceanic Islands (ESMOI) that was well represented on the cruise.

Not only was this information shared with me, but also with the world by the livestreams, ship-to-shores, artists on board, social media posts and ministers visiting the boat. The story started to share itself during and after the cruise; and popped up on news articles worldwide. Leonardo DiCaprio even shared about the research and pictures of the cruise were shown on the Nazdaq building during ocean day. My favourite was that we found an artist in Valparaiso, Chile with statues of the fishes they had seen on the news independently, which we found in an alley after opening an exhibition about deep sea exploration in the maritime museum.



The ship was filled with a lot of heart as the crew was absolutely amazing: from the dishwasher to the ROV pilots, all shared a passion for their job. This was my first cruise and I feel like I won at least a million dollars in the lottery. You can say I felt quite thrown in the deep end in the best way possible. And I hope to stay there for a while.



Deep Seeps on the Aleutian Margin: Methane Footprint Cruise 2

Lisa Levin

Scripps Institution of Oceanography, UC San Diego

Contact: llevin@ucsd.edu

The Methane Footprint project set out on the RV *Atlantis* to document the biological communities and their use of methane at deep seeps on the Aleutian margin. Cruise AT 50-24, a Challenger-150 expedition funded by the US National Science Foundation, was led by Lisa Levin (Scripps Institution of Oceanography, UC San Diego), Victoria Orphan (California Institute of Technology), Shana Goffredi (Occidental College), and Tina Treude (UCLA). Between May 17 and June 5, 2024 the *ALVIN* made 12 dives at 3 methane seep sites on the Aleutian continental margin: at EDGE (4970-4860 m), SHUMAGIN (4875 m – 4907 m), and SANAK (2070-2010 m). We encountered challenging weather conditions and technical problems associated with deep diving depths, but successfully sampled water, sediments, carbonate rocks, megafauna, small epifauna, infauna and microbes with the goal of characterizing seep geochemistry, microbial communities and processes (rates of methane oxidation, sulfate reduction, sulfide oxidation), faunal communities and isotope signatures indicative of methane use. Shipboard isotope enrichment incubations were carried out to identify uptake by microbes and

Figure 1. A marine snow 'blizzard' blankets tubeworms at Sanak Seep, May 30-June 5, 2024 at 2020m. Image from video taken by the submersible *ALVIN*.

animals of 13C-labeled methane, ethane and bicarbonate as well as various 15N-labeled substrates.

We unexpectedly encountered a phytodetrital blizzard above the seabed at Sanak Seep (2020 m). For the entire week we were present, high densities of large detrital aggregates obscured visibility for submersible activities and blanketed the seabed at and surrounding the seep. Effects on biota have not been studied but waters were hypoxic at the time of sampling.

Key initial findings of the cruise based on dives and shipboard observations included: an absence of authigenic carbonates, bacterial mats and vestimentiferans at water depths below 4800 m, frenulate and clam dominance at seeps 4800-4930 m, possible new species of frenulates, clams, snailfish, and a sea spider, high densities of *Lindaspio* beneath Sanak bacterial mats, and methane oxidation potential in an anemone, encrusting (pink) sponge and terebellid polychaete. The Aleutian deep seeps had in common many of the 'unrecognized' methane-filtering taxa observed in So. California seeps and others (hydroids, foraminifera, sponges) as well as gastropods characteristic of seeps.

Twenty Thousand Sequences Under the Sea

Laura Cristina Martínez Martínez, Nallely Magaña Montiel, Karla Sofía Millán López, Juan Manuel Zurita Artaloitia, Elva Escobar Briones, Liliana Pardo López

Contact: liliana.pardo@ibt.unam.mx

In the middle of the Gulf of Mexico lies the Sigsbee Abyssal Plain, the deepest area, reaching depths of over 3500 metres. The sheer distance from the coast and its depth, makes studying this area a truly exciting challenge. Fortunately, every year, Mexican scientists conduct oceanographic campaigns in this region aboard the RV *Justo Sierra*, under the lead of Elva Escobar (Instituto de Ciencias del Mar y Limnología from the Universidad Nacional Autónoma de México (UNAM)).

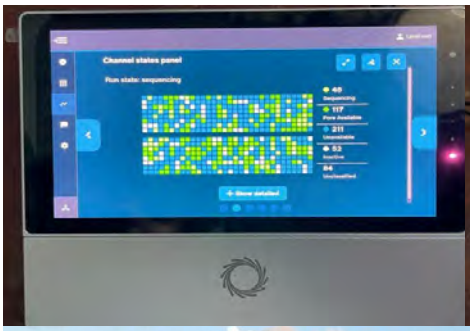
We were thrilled to take part in the SIGSBEE-2024 cruise this year, which is a Challenger 150 Ocean output. Our group at the Laboratorio de Biotecnología Marina, UNAM, is dedicated to unravelling the secrets of the bacterial diversity of the Gulf of Mexico. Since most of these microorganisms are not cultivable, we rely on metagenomic techniques to carry out this work.

In previous campaigns, the main difficulty we encountered while analyzing metagenomic data has been the viability of the collected samples. These often succumb during transport from the vessel to the laboratory, located at the Instituto de Biotecnología, (IBT), UNAM (a 375 km journey), as the extracted DNA is either insufficient or of poor quality. Therefore, we decided to bring the laboratory to the sea this year.

For this purpose, the Unidad Universitaria de Secuenciación Masiva y Bioinformática (UUSMB) of IBT provided us their *MinION Mk1C* unit. This amazing technology allows

us to conduct massive sequencing in any location without the need for bulky equipment. With this tool, it is possible to obtain complete 16S ribosomal gene sequences, which, combined with the use of cutting-edge databases and software, lets us identify bacterial diversity down to the species level.

The DNA-extracted samples were obtained from surface water (10 metres depth), deep water (3,650 metres depth), and subsurface sediment. The sequencing was successful, and the obtained reads were transported on a hard drive to our laboratory, where we are currently processing the information.



Considering that certain bacterial genera are used as bioindicators of ocean health, we can use this technique to monitor changes in their communities and maintain annual records of these. Since this methodology allows for classification at the species level, its application could enable the identification of even more specific bioindicators. It's a great way to track the ocean's health and maintain records of it.

Photography by: María Fernanda Rivera Orozco

Searching for Larvae in the Arctic Ocean

Johanna Weston

Woods Hole Oceanographic Institution

What do bivalves, polychaetes, and echinoderms have in common? They are invertebrates that live on the seafloor as adults. Like caterpillars are to butterflies – larvae can look quite different to adults, undergoing a metamorphosis as they settle back down to the ocean floor. Studying these young animals' distribution is imperative, especially in regions like the Arctic, where the impacts of global climate change are accelerated.

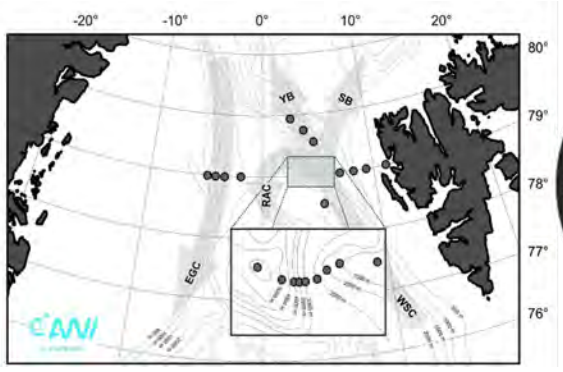


Figure 1. Left- HAUSGARTEN map. Right – Logo for PS143-1. Credits: Alfred Wegner Institute

With travel funding from the Deep-Sea Biology Society, I joined Dr. Kirstin Meyer-Kaiser of the Woods Hole Oceanographic Institution (WHOI) on a research expedition aboard the vessel R/V *Polarstern*. Leaving Bremerhaven, Germany, we steamed for seven days to the research area—the HAUSGARTEN, a long-term ecological research (LTER) observatory in the Fram Strait between Greenland and Svalbard. On the expedition PS143/1, we aimed to characterize larval dispersal across the ocean floor and determine whether new species might expand their distributions northward.

Figure 2. Left – Kirstin Meyer-Kaiser and I recovering a hand-net in the ice. Right – We are picking larvae from a hand net sample. Credits: Kirstin Meyer-Kaiser.

Whenever the CTD was in the water, we followed behind it with our 63 µm mesh hand net to search the upper 20 m. Once the samples were on the ship, we worked shoulder-to-shoulder at dissecting microscopes, picking out larvae from amongst the phytoplankton blooms and active copepods. Once we picked out all the larvae, we imaged each morphotype on a compound microscope and cataloged it into tubes.

All the fieldwork was a success. We amassed a collection of >2400 larvae which were stored in 370 tubes from 39 sampling actions at 26 stations. We confidently identified many species thanks to the identification work by MIT-WHOI Joint Program PhD student Kharis Schrage. Three of my personal favorites were (1) *Galathowenia oculata* – a segmented worm larvae with a translucent oval body and an umbrella of iridescent blue spines; (2) *Ophiocten gracilis* – a brittle-star pluteus with a beautiful skeleton dinner-bell triangle; and (3) *Balanus balanus* – an acorn barnacle larva that like a happy cartoon whale.

Figure 3. Left- *Galathowenia oculata* larvae. Center- *Ophiocten gracilis pluteus*. Right- *Balanus balanus* cyprid. All images at 50x. Credits: Kirstin Meyer-Kaiser/Johanna Weston.

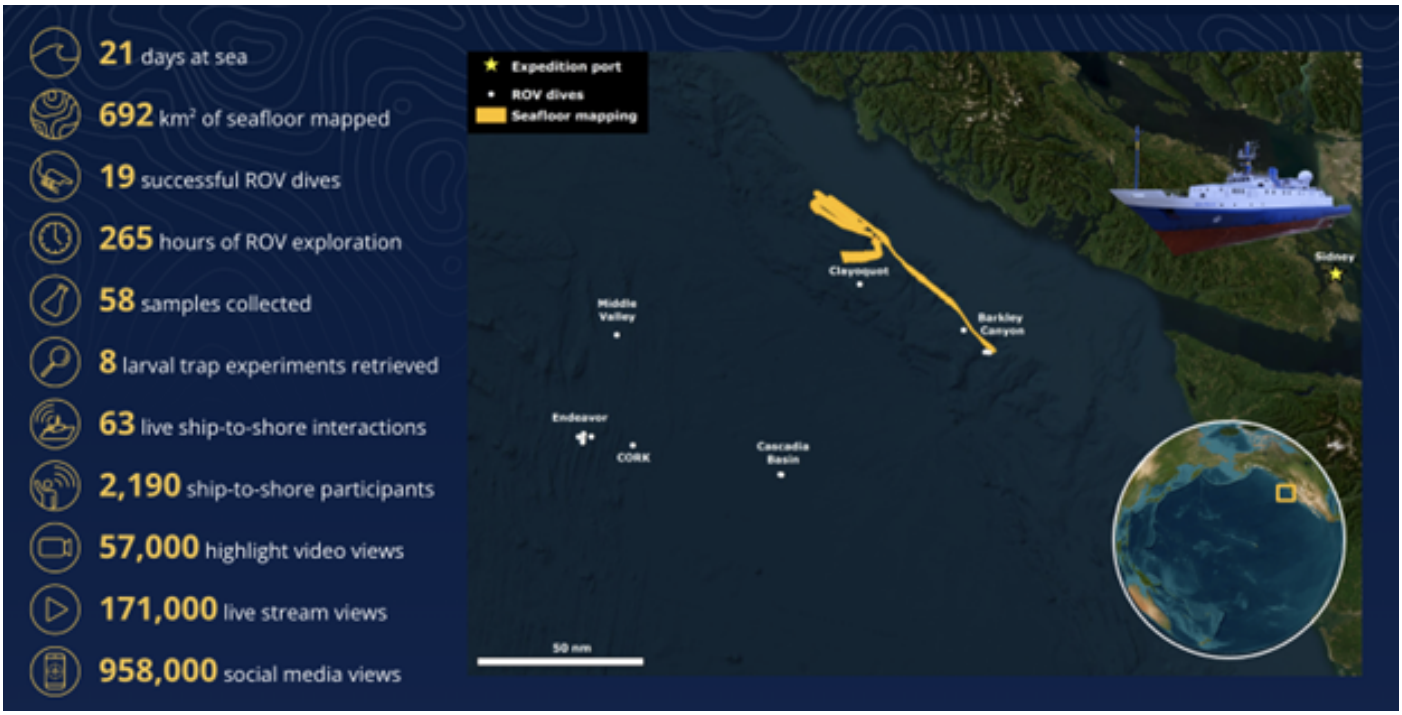
Excitingly, some morphotypes were not on Kharis's list! The next step at WHOI is determining their taxonomic identifications with DNA barcoding. Then, we will analyze patterns in community diversity and compositions and pair

them with key oceanographic data, like temperature, salinity, and phytoplankton community, to better understand how larvae are transported between the North Atlantic and the Central Arctic.

From the tiniest larvae to the most powerful predators, our Blue Planet hosts immense beauty. I am grateful for the unforgettable and research-expanding opportunity to be part of HAUSGARTEN's scientific legacy and work alongside many kind, curious, and dedicated scientists and crew. THANK YOU DEEP-SEA BIOLOGY SOCIETY!

#ONCabyss2024 - Maintenance and Exploration of Ocean Networks Canada Cabled Observatory

Meghan Paulson, Yuko Lin, Allison Fundis, Jamie Zaccaria, and Daniel Wagner

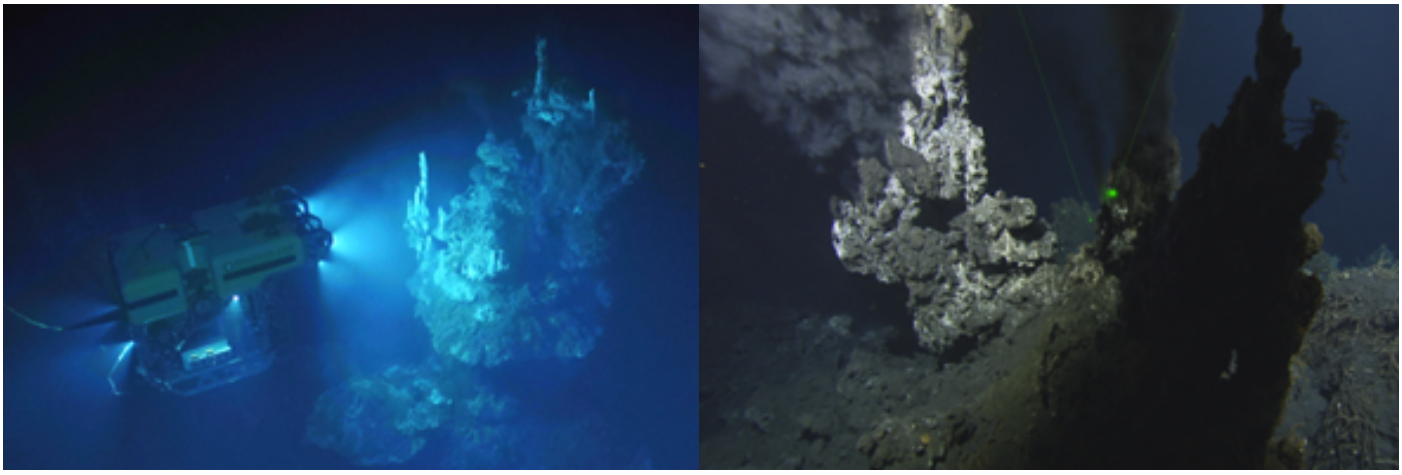


From June 6-27, 2024, Ocean Networks Canada (ONC) and the Ocean Exploration Trust (OET) conducted a telepresence-enabled expedition aboard E/V *Nautilus* to provide maintenance of ONC's cabled NEPTUNE observatory. Located off British Columbia, the NEPTUNE observatory consists of an 800-kilometer loop of fiber optic cable that connects numerous instruments, thereby providing high-resolution temporal observations not afforded by traditional ship-based exploration. The expedition marked the eighth year of the successful partnership between ONC and OET.

During this 21-day expedition, E/V *Nautilus* supported remotely operated vehicle (ROV) and seafloor mapping operations, as well as deployed and recovered various instruments in support of the observatory's annual maintenance program. Over 692 km² of seafloor were mapped using the mapping sonars of E/V *Nautilus*, focusing on previously unmapped areas between Barkley Canyon and Clayoquot Slope.

The expedition also completed 19 successful ROV dives with OET's ROVs *Hercules* and *Atalanta*, at depths ranging from 370 to 2,664 meters for a total dive time of close to 265 hours. ROV dives focused on deploying and recovering various sensors as part of ONC's routine maintenance, in addition to conducting visual surveys at six different observatory sites. A total of 58 primary samples were collected during ROV dives, including 7 biological specimens, 15 push cores, 25 water samples, and 11 gas-tight hydrothermal plume samples, which will support ongoing temporal studies on the physical and biological processes across ONC's observatory sites. Eight larval trap experiments were recovered. ROV surveys included high-resolution multibeam surveys with a ROV-mounted Norbit wideband sonar at Endeavour and

Middle Valley, and brief photogrammetry surveys at Endeavour Hydrothermal Vents and the Clayoquot Slope whale fall site.



The expedition also completed multiple ROV dives within the Endeavour Hydrothermal Vents Marine Protected Area, well-known for its large smoking chimneys and unique biodiversity. These were the first observations of the site since seismic activity along the Juan de Fuca Ridge occurred in March of 2024, which included a peak of more than 200 earthquakes per hour and a 4.1 magnitude event.

The expedition also included over 61 hours of deck operations not associated with ROV dives, including the deployment of three CTD rosette casts, two moorings, six sediment traps, and five ocean bottom seismometers. In collaboration with the cable ship Cable Innovator, the team was finally able to lay a secondary replacement cable at Cascadia Basin, which had been delayed for several years.

Like all E/V *Nautilus* expeditions, the mission included a large focus to engage the public. Live-streams from the expedition received over 170,000 views and highlight videos garnered over 57,000 views. Expedition content on ONC's and OET's social media accounts received close to 1 million impressions. The team hosted 63 live ship-to-shore interactions with schools, community and professional events, reaching over 2,190 people across America, Europe, and Oceania. Data collected during the expedition and from sensors installed on the network will be archived and made publicly available via Oceans 3.0, ONC's advanced data management system.

Project Focus

JAMSTEC KM24-03 (Leg 2) Deep-Sea Cruise: Report on the cnidarians of the Daito Islands, Philippine Sea

Kurt Bryant B. Bacharo[1], Leah Ann Bergman[2], Hiroki Kise[3], Asuka Sentoku[1], Hiroyuki Yokooka[4], Atsuo Ohno[4], Shinji Tsuchida[2], Yoshihiro Fujiwara[2], James Davis Reimer[1]

[1]Graduate School of Engineering and Science, University of the Ryukyus, Japan; [2]Research Institute for Global Change (RIGC), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan, [3]Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST), Japan, [4]Institute of Environmental Ecology, IDEA Consultants, Inc., Japan

The KM24-03 (Leg 2) deep-sea research cruise (April 27 - May 12, 2024) marked the first research expedition of the "Deep-Sea Archaic Refugia in Karst (D-ARK)" project (https://www.jamstec.go.jp/dark/e/) led by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). One of the objectives was to document the diversity of marine invertebrates unique to the deep waters (>200m) of Minami-daito and Kita-daito islands in the Philippine Sea.

During the deep-sea cruise, two remotely operated vehicles (ROVs), *KM-ROV* and ROV *Crambon*, were utilized allowing us to directly observe benthic anthozoans and gelatinous zooplankton flourishing on the seafloor and in the water column, respectively. Noticeably, the seafloor in the explored sites was distinct, with caves and crevices frequently encountered. Mini-ROVs and a deep-sea endoscope (Fig. 1) on the *KM-ROV* were used to reveal the faunal assemblages hiding inside these hollow spaces.

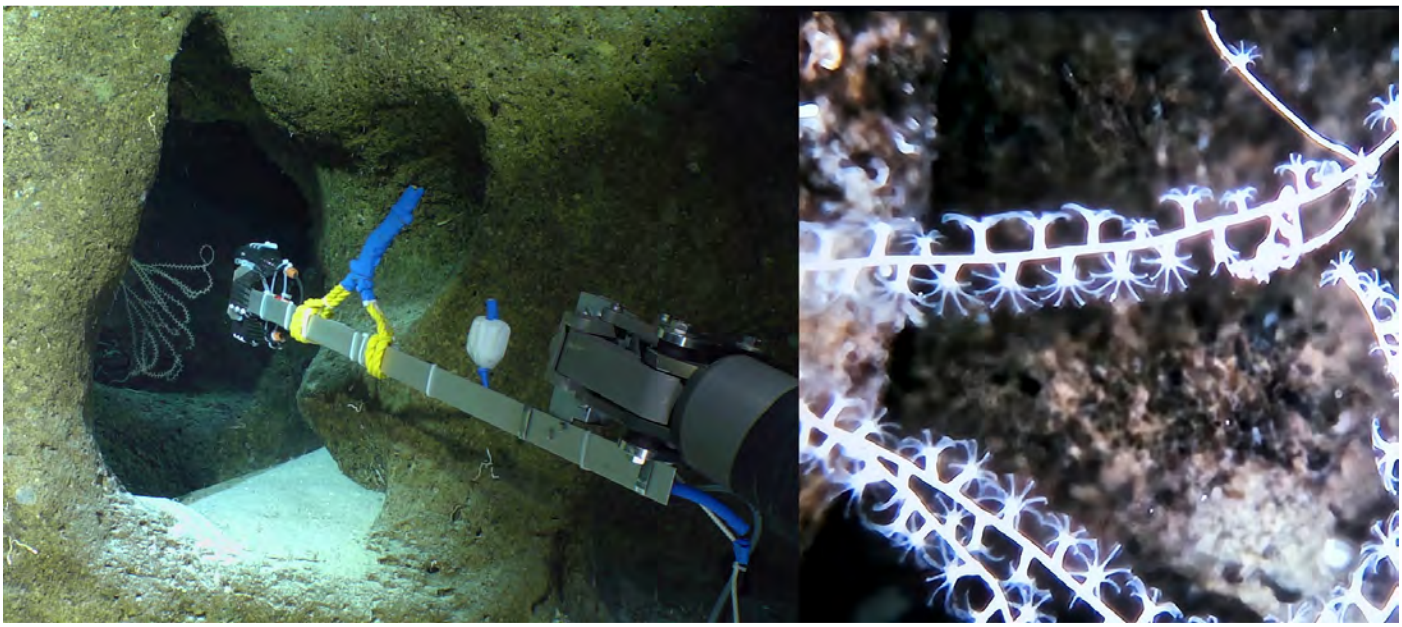


Figure 1. A colony of deep-sea octocoral hiding inside a crevice at 539-m depth in Minami-Daito was observed using the *KM-ROV* deep-sea endoscope (left). A photo showing its polyps taken by the deep-sea endoscope camera (right).

Selective sampling led to the collection of 33 anthozoan samples including species belonging to Scleractinia, Octocorallia, Hydrozoa, Antipatharia, and Zoantharia (Fig. 2). On-board cnidarian specialists classified and identified specimens immediately after being brought to the surface. Examination of the gross morphology was conducted while specimens were still alive and intact, followed by preservation in ethanol for molecular analysis, and fixation in

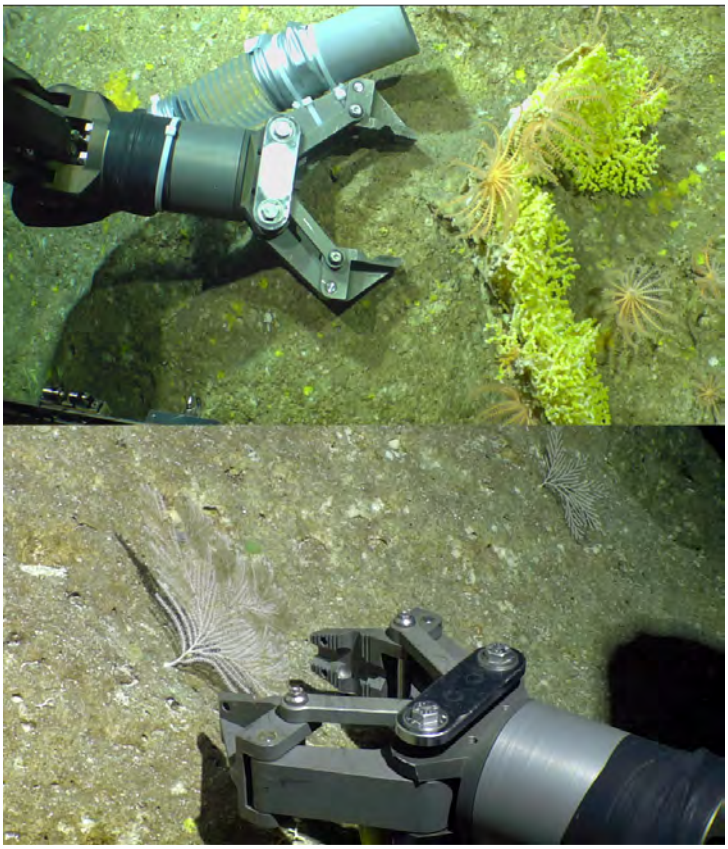


Figure 2. Some of the deep-sea anthozoans collected by KM-ROV in Minami-daito include *Corallizoanthus* with Brisingidae attached to a *Pleurocorallium* host (top), and Primnoidae (bottom).

Figure 3. Some gelatinous zooplanktons observed include unidientified calycophoran siphonophore (top), *Forskalia* (bottom left) and *Solmissus* (bottom right).

formalin for further morphological, ultrastructural, and histological examinations.

Apart from sessile cnidarians, our attention was also caught by several floating medusae (Fig. 3) that would unexpectedly pass by the camera frames throughout the ROVs' descents and ascents. These pelagic invertebrates observed in the midwater and the benthic boundary layer were annotated from the ROV videos using the annotation software Squidle+.

Our preliminary observations revealed numerous species thriving around the deeper waters of these isolated coral atolls. Laboratory works and video analyses are still ongoing and once these are completed, findings on the documented benthic and pelagic cnidarians will be published accordingly. These include extending the known geographic and bathymetric range of many taxa and providing formal species descriptions to putatively undescribed species. Part of these results will also be communicated during the 17th Deep-Sea Biology Symposium (DSBS) in Hong Kong in early 2025. The D-ARK project is supported by the Ocean Shot Research Grant Program, and the involvement of K.B.B. was made by possible by a grant from the Nippon Foundation-Nekton Ocean Census Programme.

Newly Launched:

The Innerspace Deep Sea Science Initiative

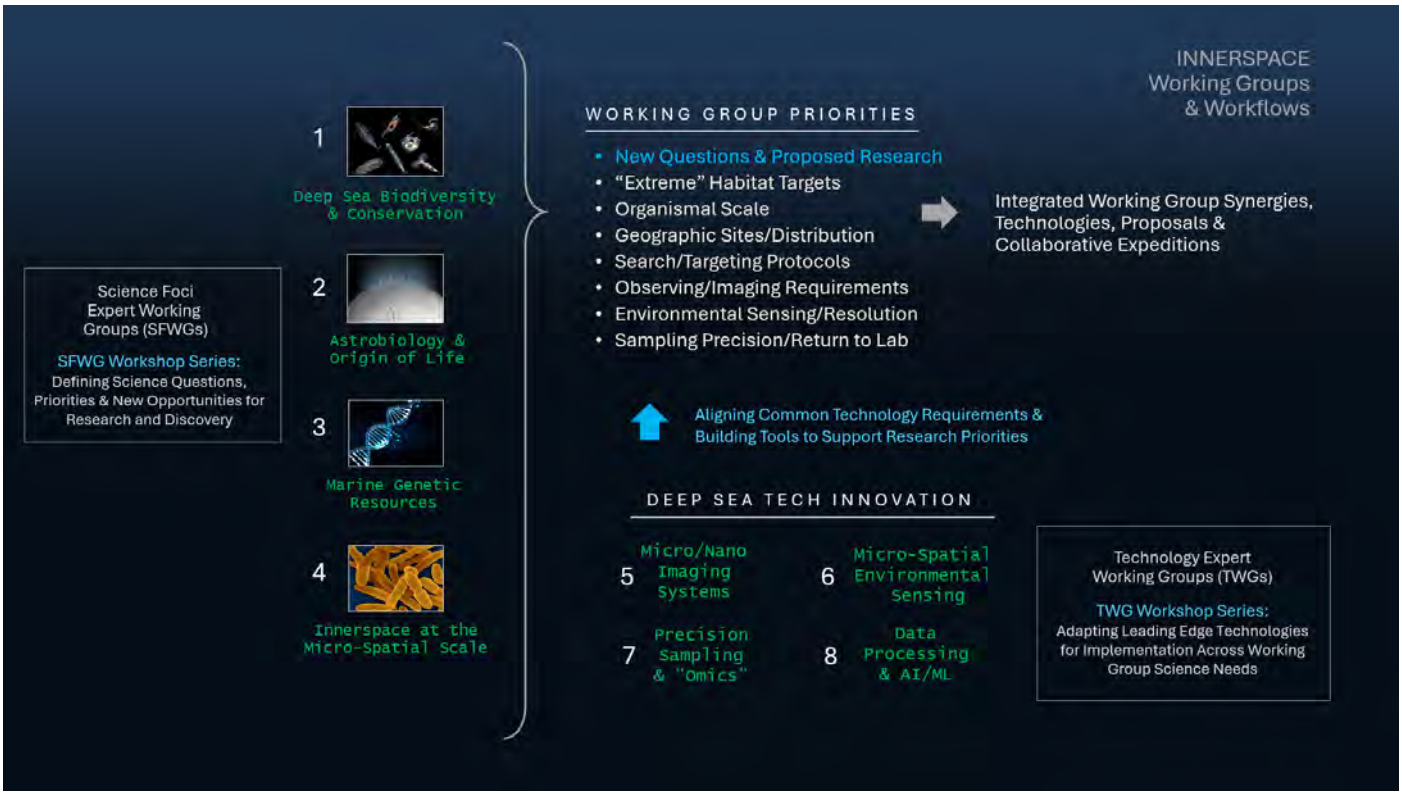
Figure 1. NASA's Mars Curiosity Rover

The **Innerspace Deep Sea Science Initiative** is a new project launched through a partnership between Global Oceans, a US-based 501(c)3 operating foundation and the **Center for Life in Extreme Environments (CLEE)** located at Portland State University.

The initiative will host a new research, operations, student training, and public outreach platform centered at CLEE and jointly managed by both organizations with participation from international collaborators and partner institutions. **Innerspace** will focus on exploring important scientific questions about deep sea biodiversity, adaptation, and survival in extreme and abyssal ocean environments. It will catalyze fresh thinking about the integration of new technologies to enable integrated high-resolution microscopic imaging, micro-spatial environmental sensing, precision biosampling, and omics-level analyses of organisms from the macro- to the nano-scale.

Innerspace will catalyze and host scientific investigations that span biological life across habitats from hydrothermal vents to frozen methane seeps, hypersaline habitats, and hypoxic zones. It will bring together engineering expertise, new technologies, and scientists studying abyssal ecosystems and biophysical adaptations to extreme environments. A transdisciplinary approach will cut across disciplinary silos and bring together fresh thinking about what is technologically possible for deep sea exploration at environmental extremes.

The project will link collaborators to design and deploy new approaches to microscopic and nanoscopic imaging together with precision bio-sampling in deep sea habitats, and for top-side omics-level analyses. Access to deep sea habitats to 6,000-meters will be enabled by the redesigned *Innerspace 6000 OEV* robotic ocean exploration vehicle and *Innerspace 6000 TIA* towed instrument array both owned by Global Oceans, together with other vehicles and instrumented landers. The redesigned OEV will host an extensible instrument platform inspired by the instrument arm of NASA's Mars Curiosity Rover (Figure 1).



The OEV instrument arm will support a suite of standard interface options for power, communications, and mechanical connection, to enable interchangeable linkage of instruments at the end of the arm platform; and will function as an "open source" instrument platform for modular guest instruments.

Innerspace Working Groups will provide the research framework for these investigations and will shape the technologies that are developed, adapted, and deployed to enable this work. Integrative workshops (Figure 2) will host four Science Working Groups representing active and important areas of investigation linked to deep sea research, to develop a series of far-reaching questions to be addressed with Innerspace deep sea vehicles, emerging technologies, and novel instrumentation.

Four Science Working Groups include Deep Sea Biodiversity & Conservation, Astrobiology & Origin of Life, Marine Genetic Resources, and Innerspace at the Micro-Spatial Scale. Technology Working Groups will collaborate to develop and co-design cross-cutting technologies and instruments that can answer core questions. Four Technology Working Groups include Micro/Nano Imaging Systems, Precision Sampling & Omics-level Analysis, Micro-Spatial Environmental Sensing, and Data Processing & AI/Machine Learning Applications.

A project prospectus and summary brochure have been completed and the Global Oceans website has more information about the Working Groups rationale and vehicle platforms. Major funding partners are currently being developed for the project. Interested scientists, students, institutions, advisors, and commercial partners are invited to get in touch and collaborate!

Contacts:

Jim Costopulos, CEO
Global Oceans
jcostopulos@global-oceans.org

Amie Romney, PhD
Interim Director
Center for Life in Extreme Environments (CLEE)

Portland State University
arom2@pdx.edu

Annie Lindgren, PhD
Interim Associate VP Research
Portland State University
Founding Director
Center for Life in Extreme Environments (CLEE)
arl3@pdx.edu

Update from DOSI

It has been another busy period for DOSI since the last edition of Deep-Sea Life back in February. Perhaps the most salient activity, as it entailed the mobilisation of several DOSI working groups and members, was the UN Ocean Decade Conference in Barcelona last April. The event provided the opportunity for DOSI – and particularly for the Challenger 150 Programme (DOSI's UN Ocean Decade-endorsed science programme) – to lead and participate in various formal and informal sessions, as well as to host a dedicated deep-ocean-focused booth alongside other Decade-endorsed deep-ocean projects, such as DOOS, Digital DEPTH, JETZON and One Deep Ocean. The event and our active participation in it was instrumental for publicising our collective missions, expanding our audience and ensuring the deep-ocean is on the lips and minds of those responsible for its governance and development – indeed, the deep sea was specifically mentioned in the resulting Barcelona Statement, the official output of the Conference. An expanded account of DOSI's attendance at the Conference can be made available upon request. Challenger 150 has also since released its Year 3 Highlights – accessible here.

Another important engagement for DOSI has been attending this year's sitting of the International Seabed Authority's Council and Assembly (ISA29, parts I and II, in March and July, respectively). As well as contributing to discussions around the exact wording of the draft exploitation regulations (part of The Mining Code), the DOSI delegation hosted Side Events and presented new Policy Briefs and Information Sheets, ensuring that Parties and stakeholders to the ISA are fully up-to-date with the latest scientific knowledge on the potential ecological effects of deep-sea mining.

DOSI also had a presence at the fourth session of the Intergovernmental Negotiating Committee to develop an international legally binding instrument on plastic pollution, including in the marine environment (INC-4), which took place in April. Formal recognition that the deep ocean is the ultimate sink for marine plastic pollution, where it remains permanently damaging and is commercially irretrievable, is DOSI's key message at the negotiations, which to date have paid scant attention to the deep ocean.

DOSI delegations have attended various other intersessional meetings of intergovernmental processes such as the Paris Agreement (i.e., Climate; UNFCCC SB60 meeting), the Convention on Biological Diversity (SBSTTA26 & DSI meetings), the BBNJ Treaty (PrepCom meeting) and the UN Ocean Conference (stakeholder meeting), keeping abreast of developments whilst also preparing materials for dissemination at the upcoming Conference of the Parties for each

process.

Closer to home, there's been a 'changing of the guard' in the DOSI Office, as we've bid a fond farewell to the outgoing Director of Communications – Brandon Gertz – and extended a warm welcome to our new Communications Manager, Elin Thomas. Elin is based in Western Perth, Australia, and takes control of the DOSIcomms@gmail.com email address, thus ensuring continuity in our public-facing Comms profile.

Lastly, preparations are underway for the next DOSI Day, to be held back-to-back with the 17th Deep Sea Biological Symposium in Hong Kong on 12 January 2025. DOSI Day is a rare but valuable opportunity for the DOSI membership and other interested parties to come together face to face to discuss DOSI's track record and shifting priorities against the ever evolving stage of deep-ocean governance, management and sustainable development. Anyone interested in DOSI Day is encouraged to complete this short survey, so that we may tailor the event to accommodate most people's preferences. Hopefully see you there!

Building on 20 years of the ALBEX benthic lander

Andrew Davies, Jane Carrick, Kristofer Gomes

University of Rhode Island, Rhode Island, USA

Figure 1. URI's Davies Lab research group with ALBEX 2.0 in our workshop at The Graduate School of Oceanography.

Autonomous benthic landers are widely used in the deep sea. Capable of long-term deployments in some of the most remote benthic habitats, landers provide valuable information about the physical environments that deep-sea organisms experience through time. They operate on the principle of a drop weight, often acoustically triggered, and an appropriate amount of buoyancy to enable its retrieval at the surface following release of the weight. Their design and operation, despite the simplicities in principle, require a nuanced understanding of ocean technology, including metal behavior and corrosion, buoyancy and weight, as well as accurate understanding of how the lander will behave both in the water column and on the seafloor.

In 2004, Gerard Duineveld and colleagues published the first manuscript describing the use of the Autonomous Lander for Biological Experiments (ALBEX) in the journal Marine Ecology Progress Series (Duineveld et al., 2004). Since then, the ALBEX lander has been a constant presence in deep-sea studies around the world, providing numerous time series observations within deep-sea canyons, cold-water coral communities and sponge grounds. The endurance of ALBEX can be attributed to the skilled engineers and scientists at the Royal Netherlands Institute for Sea Research (NIOZ), and the resulting stability, reliability and flexibility of the platform that has developed over the last two decades. Now managed by Furu Mienis at the NIOZ, the ALBEX platform continues to be used and refined with new sensors and observation approaches being integrated as the platform is deployed across numerous research projects.Over the last 18 months, a new generation of ALBEX, dubbed the ALBEX 2.0, has been developed at the Graduate School of Oceanography, University of Rhode Island that is building on the ground-breaking work of Duineveld, Mienis and colleagues at the NIOZ.

The core of the ALBEX 2.0 is depth-rated to 6000 m, stands 7 ft tall x 7 ft wide, and weighs nearly 2500 lbs in air when fully outfitted with a suite of instruments, including an acoustic current profiler, optical fluorometer/turbidity sensor, oxygen sensor, CTD, sediment trap and camera system. In spite of their size, the ALBEX 2.0 is designed to continue the versatility of the platform; sensor attachment points adorn the entire aluminum frame for ease of reconfiguration to various sensor loads and ballast adjustments. This design allows for easy attachment of a range of additional sensors, including particle pumps, hydrophones and active echosounders, as needed on a project-to-project basis. Paired with acoustic releases that utilize Sonardyne's state-of-the-art USBL positioning system, the landers can also be precisely tracked through the water column, allowing for their placement to within 10 ft of any site target.

Figure 2. Two ALBEX 2.0 landers ready for deployment aboard the NOAA Ship *Nancy Foster*. Photo: Jess Kaelblein, URI Inner Space Center

URI's ALBEX 2.0 landers were constructed to fill significant knowledge gaps for the restoration of deep-sea coral communities in the northern Gulf of Mexico that were injured in the Deepwater Horizon oil spill. The first prototypes of the updated design were successfully deployed from the NOAA ship Nancy Foster in April as part of the Mesophotic and Deep Benthic Communities (MDBC) restoration projects, led by the National Oceanic and Atmospheric Administration and Department of the Interior. These landers will remain at depths of more than 1300 meters, collecting high temporal resolution environmental time series as well as physical samples of particle flux from the surface and imagery of biotic interactions for a full year. Future deployments will continue to support MDBC restoration in the northern Gulf of Mexico, and data streams from our deployments will provide essential insight into the physical-ecological processes that determine the fate of cold-water corals in the region, including their exposure to anthropogenic impacts and restoration potential following the Deepwater Horizon oil spill nearly fourteen years earlier.

References

Duineveld GCA, Lavaleye MSS, Berghuis EM (2004) Particle flux and food supply to a seamount cold-water coral community (Galicia Bank, NW Spain). Marine Ecology-Progress Series 277: 13-23. https://www.int-res.com/abstracts/meps/v277/p13-23/

New Regional Partnership for Deep Ocean Exploration in the Eastern Tropical Pacific

In July 2024, the Charles Darwin Foundation for the Galapagos Islands (CDF, Ecuador), along with partners Smithsonian Tropical Research Institute (STRI, Panama), Friends of Cocos Island Foundation (FAICO, Costa Rica), University of Costa Rica's Center for Ocean Research and Limnology (CIMAR) and the Marine and Coastal Research Institute of Colombia (INVEMAR) met in Panama to hold the inception meeting for a new regional scientific partnership. This alliance has been established to advance in-country exploration and research on deep-water habitats and seamounts within the Eastern Tropical Pacific (ETP) in order to support improved management of deep-ocean multi-country seascapes, recognizing the vast 95% of unexplored deep hidden oceanic habitat connecting marine protected areas in the region.

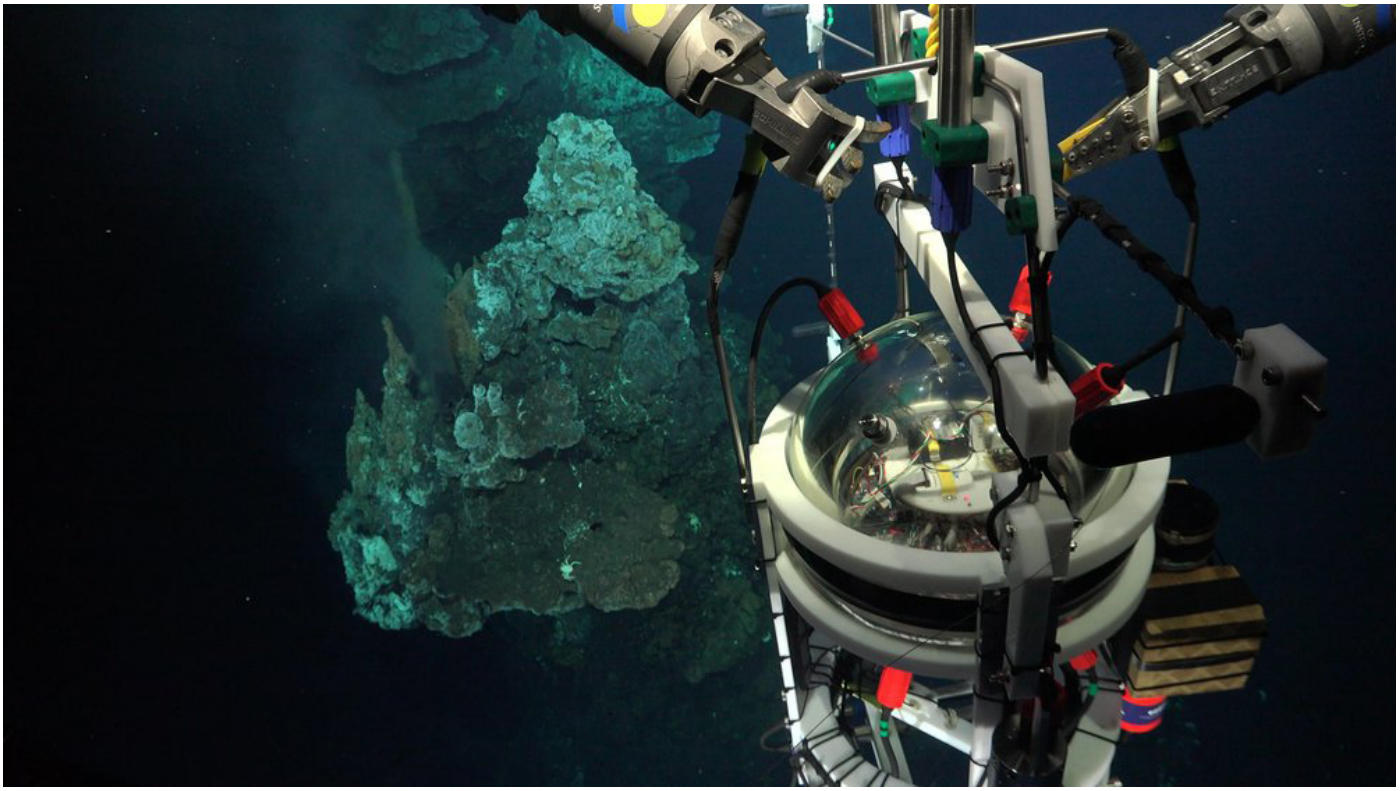


Figure 1. Deep ocean exploration on ROV *SuBastian*

The two-day meeting, hosted by partner organization STRI, brought all partners together to discuss the most pressing challenges as well as opportunities for deep ocean research in the region and plan next steps towards building local capacity and strengthening collaboration. Topics included the complexities involved in securing appropriate research vessels equipped with the kind of affordable technology capable of exploring vast depths, as well as the need for regional and global collaboration in taxonomy and genetic analysis of samples, in order to better understand hidden ocean biodiversity. The group is committed to working together to establish scientific priorities and questions for the region as a first step in the development of a shared regional research agenda for deep ocean science.

This ambitious regional alliance for deep ocean research is supported by the Bezos Earth Fund who, along with the Gordon and Betty Moore Foundation, awarded the Charles Darwin Foundation a grant totaling $7 million over a five-year period to help advance deep-ocean conservation in the Eastern Tropical Pacific region.

The core components of this project include:

- Mapping and characterization of deep ocean features in four ETP countries leading to an improved baseline understanding of the distribution and state of deep-ocean systems in the region
- Improved understanding of climate change impact and socio-ecological factors determining the health and resilience of linked ETP deep ocean systems
- Innovative technology and analysis applied to fast-track robust regional deep-ocean research for conservation.
- Research findings integrated into management of linked regional ETP deep-water systems for improved ocean conservation.

A successful week at the DEEPEND Project Sponge Identification & Training Workshop

Dr Tammy Horton

National Oceanography Centre, Southampton, UK

Figure 1. Image of the Sponge Taxonomic Experts (Clockwise from top left): Joana Xavier (CIIMAR- University of Porto, Portugal), Paco Cárdenas (Museum of Evolution, Uppsala University, Sweden), Pilar Rios (IEO-Gijón, Gijón, Spain), Andreu Santín (CIIMAR - University of Porto, Portugal), Javier Cristobo (IEO-Gijón, Gijón , Spain), Christine Morrow (Queens University, Belfast, Northern Ireland), Celso Domingos (CIIMAR- University of Porto, Portugal), Julie Light (Glass Artist, UK).

A fantastic week of collaborative work took place from the 4 - 8 March 2024, with seven invited taxonomic experts attending to share their knowledge of the Porifera (Sponges) with the Discovery Collections Team at the National Oceanography Centre, Southampton. The Sponge Identification & Training Workshop was part of DEEPEND (DEEPEND: Deep-ocean resources and biodiscovery), a project funded by the UK DEFRA Global Centre on Biodiversity for Climate Programme. The DEEPEND project is a collaborative effort to study the societal value of biodiversity in the deep-sea.

Marine organisms are a promising resource for useful natural products such as medicines. The potential use of biodiversity - or marine genetic resources (MGR) - has yet to be thoroughly explored in the deep sea. These organisms offer the exciting potential discovery of new gene clusters that direct the formation of enzymes and small molecules. These could have useful biotechnological and pharmaceutical applications, including the discovery of novel antibiotics, coming at a time when society faces an antimicrobial resistance crisis. Marine sponges are known to be important sources of novel natural products, yet the identification of sponge taxa (many of which are new to science) requires specialist taxonomic expertise.

Figure 2. The Discovery Collections Team (Left to Right) Amanda Serpell-Stevens, Georgina Valls Domedel & Tammy Horton.

The workshop aimed to provide training for the Discovery Collections Team and improved taxonomic identifications for abyssal sponge taxa currently held in the Discovery Collections at NOC. These materials largely originate from the Porcupine Abyssal Plain Sustained Observatory, Whittard Canyon, Mid Atlantic Ridge and Haig Fras areas in the North Atlantic, and also selected specimens from the Central Pacific in the Clarion Clipperton Zone, collected during the SMARTEX project.

During the week we had presentations from the experts of the SponBIODIV project on each of the major sponge groups, and hands-on laboratory training in the preparation of sponge spicules for microscopic examination. The aims of the workshop were met with ease, with over 200 identifications made during the week and a workshop report is now in preparation detailing the results. A number of publications are also planned summarising the findings of the workshop. In addition to the incredible science findings, we also enjoyed making new connections and had a lot of fun learning from our new 'sponger' friends. We were all amazed by the microscopic beauty of the sponge spicules, and our resident glass artist, Julie Light, had plenty of inspiration and even created some glass spicules to delight the spongers!

Learn more about DEEPEND: https://www.nhm.ac.uk/our-science/research/projects/deep-sea-systematics-ecology/deepend.html

Follow Tammy on 'X': @tammy_horton #DiscoveryCollections

FathomVerse: Gaming for Ocean Exploration

Kakani Katija, Lilli Carlsen, Emily Clark, Giovanna Sainz, Joost Daniels, Kevin Barnard, Ellemieke Berings, Meggy Pepelanova, GAF van Baalen

Contact: www.fathomverse.game | fathomverse@mbari.org

About FathomVerse

FathomVerse is a mobile game that allows ocean enthusiasts to interact with real underwater images to improve the artificial intelligence that helps researchers study ocean life. The game combines immersive imagery, compelling gameplay, and cutting-edge science to inspire a new wave of ocean explorers. Available for free on the App Store and Google Play, FathomVerse empowers anyone with a smartphone or tablet to take part in ocean exploration and discovery. Read the press release to learn more.

Approach & Early Results

Scientists estimate that 30-60% of life in the ocean is still unknown to science. Filling that knowledge gap is vital if we want to understand how all ocean ecosystems are being impacted by humans. With advances in imaging, we can capture imagery of the ocean. However, to accelerate the processing of this data using AI, we need people to continuously verify its performance. That's where FathomVerse comes in. Every action taken by FathomVerse players

helps to improve and train machine learning models, increasing our annotated global datasets to discover all ocean life.

Between the launch of FathomVerse on May 1 and mid-August, 2024, we've had >11.5K downloads from >130 different countries and generated over 5.1M annotations. Imagery comes from FathomNet, as well as partners that include: Schmidt Ocean Institute, MBARI, NOAA Ocean Exploration, Ocean Exploration Trust, Ocean Networks Canada, and Ocean Observatories Initiative. The collective actions of gameplayers have resulted in >20K images being identified to one of 45 morphological animal groups. .

What You Can Do

Play FathomVerse: App Store | Google Play
Join the Community: Discord | Instagram | TikTok
Stay up-to-date: Subscribe to our Newsletter

Connections, unlikely and deep: How a deep-sea inspired coffee communicates science in new ways

What could a great cup of coffee and the bottom of the sea possibly have in common?

To most, not much. But a creative team of Japanese scientists and coffee artisans have found something deeper, perhaps even something beautiful in this unlikely pairing, opening a new avenue to communicate science.

A need to communicate deep-ocean science

For the majority of people, the deep ocean is out of sight and out of mind. These habitats are inaccessible, requiring specialized technology to explore. Historically, deep-sea science has been highly exclusive, available to only a privileged few. Yet the deep sea is our planet's largest habitat, making up more than 70% of the space available for life on Earth. The deep sea plays a critical role in the global ocean ecosystem, provide opportunity to inspiration and discovery, and are already threatened by human activities. Even in the deepest parts of the ocean, the hadal zone, depths 6000 – 11,000 m, the impacts of humans are already felt, before we fully understand the life in these regions.

The more we learn about the world around us, the more we learn to care. Communicating not only information but sharing the wonder of an environment requires meeting audiences in many different ways, not just through lecturing or textbooks, but by meeting people where they are.

To foster new connections between people and the deep ocean, Dr. Hiroshi Kitazato of the Tokyo University of Marine Science and Technology and Danish Center for Hadal Research, world-renowned expert in the ocean's deepest zone, the trenches, set out on a new challenge: to brew a coffee inspired by the deep, a "hadal blend."

Why coffee?

For many people, coffee provides a way to connect, an opportunity for meeting and discussion. Coffee hours can bring dialogue, new relationships, and forge common ground. Coffee itself can bring a mindful, present experience for the drinker as well, providing the chance to connect to the senses.

In this project, Dr. Kitazato sought to use bring the sensory experience offered by coffee to foster connections to the deep sea. Most means of communicating science involve one or two senses – relaying information through auditory and visual systems. Could the powerful emotional connections that come with smell and taste be leveraged to communicate science in deeper ways? Could a bridge between science and society involve building understanding and connections not through a one-way transfer of facts and data, but through a shared experience? Dr. Kitazato describes this idea as a "convergence of knowledge," a way to unite experience, feeling, art, and science to bring new connections. This time, the connections would come through coffee.

Developing a hadal blend

But, what would the deep ocean taste like? Salty? Dark? Perhaps too literal an interpretation. Instead, the team sought

to capture the feelings, the essence of a hadal ecosystem in a coffee.

For inspiration, Dr. Kitazato interviewed an international community of scientists working on hadal organisms, asking them to describe the words and phrases that embody the hadal realm for them. For many, the deep-sea environment may bring to mind words like “harsh” or “inhospitable”, but those who study these habitats described a different picture. To the people who study and who love these trenches, these are places of quiet, of depth, complexity, peace, a slow pace, of curiosity, and full of possibilities.

From the interviews, the themes of depth and of time emerged strongly. A seemingly simple or even funny question—*what might the deep-sea taste like* — brought new opportunities for dialogue and exploration, particularly in relation to these two themes.

Depth itself is describes the physical property of water, which reaches up to 11,000 m in the Mariana Trench, the ocean’s deepest waters, creating pressures of up to 15,000 pounds per square inch, about the equivalent of an elephant standing on top of your thumb. With increasing depth also comes cold temperatures, lack of sunlight, limited food availability, and changes in oxygen concentrations. Scientifically, depth is complex. We also use the word depth to evoke complexity, layers of meaning. In this sense, the deep sea is also deep, home to a world of complex, multifaceted processes and rich biodiversity forming closely linked webs and connections. Deep-sea trenches are places of discovery and curiosity, where we challenge the limits of technology to understand the limits of life, understanding new layers of adaptation and diversity on our planet. Yes, a hadal coffee must surely have depth.

Time also became a key theme. Some may have been lucky enough to find a place in nature where time seems to stand still. The still, peaceful beauty of the deep ocean could be this place. In a sense, time in the deep ocean really does move differently for organisms. Biological rates, such as how quickly an organism respires or the pace of its movements and muscle contractions, depend on the temperatures in which those processes take place. In the hadal zone, where temperatures are a frigid 1–2°C, the pace of life may indeed be slower for many organisms. On the other hand, trenches are dynamic environments, not only because of the interesting organisms that inhabit these depths, but because of the very processes that make the trenches deep. Most of the hadal zone is so deep due to tectonic plates that form Earth’s crust. When one plate slides under another, a process called subduction, a deep-sea valley can be created, building the trench. The motion of these plates is slow, on the order of 3–8 cm per year, depending on the location, comparable to the growth rate of human fingernails. As the stresses of these movements build, earthquakes occur, bringing with them underwater avalanches that cascade through these trench sites. In these moments, time in the trench would not feel slow or unmoving, instead quickly changeable and active. A hadal coffee would need to be peaceful to enjoy, evoking the beauty and timelessness of a deep-sea habitat, but would also need to change and grow over time, revealing new depths of flavor.

In collaboration with Dr. Kitazato, through trials and testing, the Sarutahiko Coffee Co Ltd developed the hadal blend, inspired by these images and ideas. The coffee brings a sweet smell of chocolate at first encounter, building in complexity with berry and fruity flavors over time. The coffee is designed to invoke the experiences of depth and of time for the drinker, to truly be a hadal blend.

In addition to the blend itself, the packaging displays beautiful art inspired by hadal organisms and deep-sea technology. The drinker meets the hadal snailfish, the supergiant amphipods, hadal sea lilies called crinoids, and sea anemone. Descriptions of the hadal environment and the rationale behind the coffee’s creation invite the drinker into this otherwise inaccessible realm.

Lasting impacts

The hadal blend coffee was launched at the museum shop of the National Museum of Nature and Science of Japan

during the period of its Special Exhibition "The OCEAN-the Origin of Life" where we exhibited hadal videos and organisms. More than 300,000 audience members visited the exhibition during its installment. The exhibition has been favorably received by visitors who learned a lot through watching and observing hadal organisms and landscapes.

After visiting the museum, they brought the hadal blend coffee back to their homes. They could taste the hadal worlds again and again through enjoying this coffee, forging powerful connections and opening opportunities to consider a habitat far beyond most individual experiences. The coffee was popular, even out of stock at the museum shop a couple of times. Through this experience, the "hadal" world remained in visitors' hearts as unforgettable memories.

Although it may seem unlikely, the project reveals that such a deep and rich world, an opportunity for connection with one of our planet's most remote habitats, can be found right at home, in a cup of coffee.

Ocean Discovery League receives $1.2MM NOAA grant for the development of its next-generation deep ocean sensor system

Ocean Discovery League (ODL)—led by National Geographic deep-sea explorer and DOSI Advisory Board member Dr. Katy Croff Bell—has received a $1.2 million ocean technology transition grant from NOAA and the Integrated Ocean Observing System (IOOS) for the development of its next-generation deep ocean sensor and camera system. This award is one of the largest single investments in easy-to-use, low-cost technology specifically targeting the deep sea.

As part of this award, ODL will develop the deep-diving, low-cost Deep Ocean Research & Imaging System (DORIS) to lower the financial and technical barriers to deep-sea exploration and research. DORIS builds on previous modular systems developed by ODL and is a novel, customizable tool consisting of interchangeable sensing and operational modules that can be configured to meet the mission of individual projects. The high degree of flexibility and ease of use allows users to create a technological solution that meets their unique needs.

The primary goal of this system is to reduce the reliance on technical expertise for operation and deployment. DORIS will aim to achieve an operational depth of 6,000 meters and include a suite of modules, including sensing modules (e.g., O_2/CO_2, CTD sensors) and operational modules (e.g., lighting). The grant is in partnership with the Pacific Islands Ocean Observing System (PacIOOS), Woods Hole Oceanographic Institution (WHOI), and the University of Nebraska at Lincoln.

The broader impact of DORIS is placing the tools of ocean exploration directly into the hands of communities across the Pacific, providing them with the capacity to monitor a changing ocean in regions where climate resilience is the primary concern and resources are scarce. DORIS will expand access to exploration technology and broaden participation for more equitable and efficient discovery, conservation, and management. Because of its modular and portable nature, it can enable communities to target specific areas of concern within their local environments.

For more information about this project, follow ODL online at www.oceandiscoveryleague.org and on social media at @OceanDiscLeague.

Worlds colliding: DEEPEND pelagic program expands to deep-reef environments to examine benthopelagic coupling

Tracey Sutton (DEEPEND Director/PI)

Guy Harvey Oceanographic Research Center, Nova Southeastern University, Dania Beach, FL, USA

Contact: tsutton1@nova.edu

The DEEPEND (Deep Pelagic Nekton Dynamics; www.deependconsortium.org) program has been studying the epipelagic, mesopelagic, and bathypelagic fauna of the Gulf of Mexico for the last 14 years (and counting). Some of the major findings include: 1) documentation of extraordinary pelagic species richness [in a global context] in the deep Gulf; 2) the classic "3-layer paradigm" of the oceanic ecology is better represented as a highly connected continuum of species and processes across depth and time [i.e., a highly integrated system]; 3) over half of all fish species occuring in the Gulf spend all or part of their lives in the pelagic domain; and 4) open ocean ecosystems are not immune to human disturbance, as evidenced by dramatic and persistent declines in pelagic life after the *Deepwater Horizon* oil spill disaster.

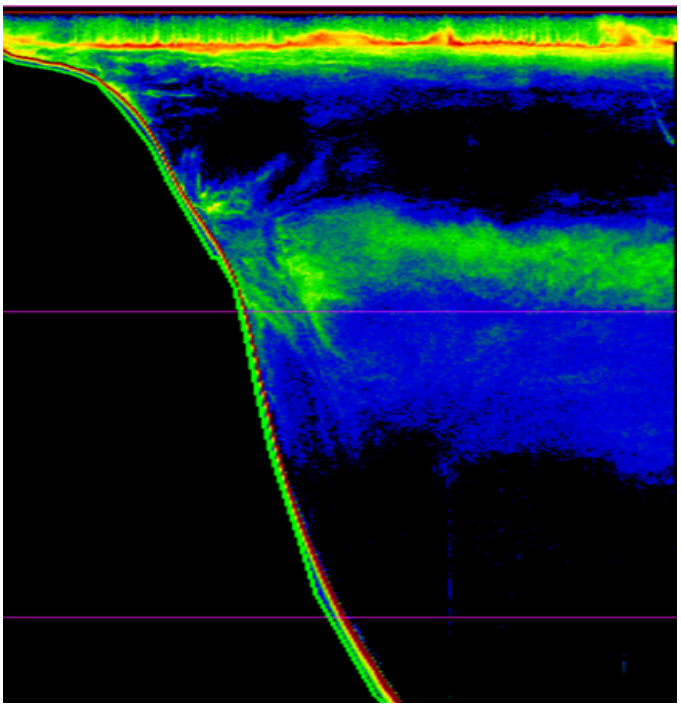


Figure 1. Example echogram of a mesopelagic deep-scatteing layer "spallting" into deep-benthic habitat in the northern Gulf of Mexico. Image courtesy of Kevin Boswell/DEEPEND.

Given the progress made offshore, we are excited to announce an addition to the DEEPEND research portfolio, a detailed examination of the interactions of mesopelagic and deep-benthic (particularly deep coral) assemblages along the outer continental slope. This new activity, entitled "*Deep-Sea Benefits*," will begin field surveys in September 2024 and extend four years in total (news release can be found here). This project will run parallel to, and integrate data from, DEEPEND's sustained sampling further offshore. It will also integrate research efforts from existing "Mesophotic and Deep Benthic" projects in the Gulf (e.g., benthic lander observations, ROV surveys), as well as with concurrent oceanic cetacean studies (e.g., passive acoustic monitoring, airborne observation). We anticipate the end goal to be an integrated assessment of vertical connectivity in one of the most dynamic deep-sea ecotypes in the World Ocean. All future DEEPEND and DEEPEND|Deep-Sea Benefits cruises will be badged under the Challenger 150 project (challenger150.world) North Atlantic Working Group. As always, we welcome input and will be happy to support as many collaborative efforts as possible.

Top Takeaways from the 2024 Early Career Deep-Sea Expedition Leadership Masterclass

Alexander Yin[1], Alycia Smith[2], Alyssa Schultz[3], Amanda Kahn[4], Bonnie Teece[5], Eleanor Arrington[6], Emanuel Pereira[7], Joan M. Alfaro-Lucas[8], Michelle Hauer[9], Sina Wallschuss[10], Titus Cañete[11], Tremaine Bowman[12]

[1]University of Rhode Island, USA; [2]Heriot-Watt University, Scotland; [3]Texas A&M University, USA; [4]Moss Landing Marine Laboratories, San José State University, USA; [5]NASA Jet Propulsion Laboratory, USA; [6]UC Santa Barbara, USA; [7]Instituto de Biodiversidad y Biología Experimental y Aplicada (IBBEA, UBA-CONICET), Argentina; [8]University of Victoria, Canada; [9]University of Rhode Island, USA; [10]University of Cape Town, South Africa; [11]Large Marine Vertebrates Research Institute Philippines; [12]The University of the West Indies, Jamaica

The Masterclass, led by the Crustal Ocean Biosphere Research Accelerator (COBRA), is a 13-week virtual course to empower participants with the skills and resources needed to effectively and thoughtfully design, fund, conduct and report on research cruises, intertwined with best DEI practices. This year's Masterclass covered global deep-sea assets, building a team, writing proposals and securing funding, developing respectful concepts, preparations, thriving at sea, data management, reporting, outreach, and law and policy. An ongoing focus showed how these topics fed into fellows' dream cruise ideas. Expert support came from people in the field, including Randi Rotjan, Julie Huber, Beth Orcutt, Andrew Fisher, Geoff Wheat, and Rosalynn Sylvan, featuring weekly synchronous meetings, pre-class materials to review, asynchronous communication via Slack, and weekly collections of resources.

Fellows recounted memorable takeaways from the class:

"I really enjoyed the week on Team Science. Exploring the literature showing the impact of the choices you make when populating your scientific team pleasantly surprised me. Now I am more aware of the diverse nature of factors that contribute to the collective success of a deep-sea project."

"The week on "Introduction to Deep Data" was insightful as it demonstrated the importance of having a clear plan when navigating repositories of deep-sea data, and the challenges faced finding and using data for specific needs. I found the tools provided through this class to be highly useful in making the discovery process more accessible."

"This course was incredible; I learned a lot about deep-sea exploration, and the assets available for it, including the latest samplers. In particular, the Dream Cruise project was most useful, where we designed a deep-sea expedition from concept to final report. After this course, I hope to realize my dream project in the SW Atlantic Ocean, off Argentina."

"This class is special; it isn't something you can find in textbooks or courses. I found the "Proposal and Funding" and "Cruise Preparation" weeks to be eye-opening. Although I've participated in offshore cruises, I never had the opportunity to be part of pre-planning. Hearing first-hand experiences and tips from professionals in many different aspects while organising our "dream cruise" projects was invaluable."

"As someone working in a country where deep-sea research infrastructure, technology and expertise is limited, discussions on utilizing global assets and building equitable collaborations resonated deeply. Sessions on funding and navigating international partnerships provided insights for prospective projects. Additionally, the emphasis on respectful and inclusive planning broadened my perspective on engaging local stakeholders. This Masterclass has provided the skills needed for leading a deep-sea expedition and reinforced the importance of fostering DEIA throughout the process."

"This was the most insightful course I've taken throughout my PhD. The content was unique, and the small group, interactive sessions with experts, all-round support and one-on-one interactions fostered broad and interesting conversation. This Masterclass covered areas of the trade that are not taught and must be learnt through experience. Getting those insights in one neat package was invaluable."

2025 applications are due September 27th!

Drawing Inspiration from the Deep

Meghan Jones

Figure 1. Abyssal Grenadier, 24" x 24" acrylic on canvas. Photo reference credit to Professor Jamieson of the Deep Sea Minderoo-UWA Deep-Sea Research Centre

Working primarily with acrylic on canvas Meghan Jones uses her deep appreciation and love for the natural world to enhance the biological sciences with Fine Art paintings. Her work depicts fauna from our deepest ocean habitats, either shown in situ as a descriptive portrait or used as imagery within a surrealist composition. She is obsessed with finding the beauty in the microscopic, hidden and unusual, by presenting the viewer with a unique version of an organism they might otherwise never consider. Her work is an effort to connect us all through the wonder of the natural world, and extend a call to protect and value all organisms.

Meghan is currently contracted with Rowman and Littlefield publishing house to author and illustrate a children's book about deep sea environments to be released in 2026. Tentatively titled "The Unusual Ocean:

Figure 2. Nova Canton Trough Snailfish, 16"x 20" acrylic on canvas.Photo reference credit to Professor Jamieson of the Deep Sea Minderoo-UWA Deep-Sea Research Centre

Who Lives in the Deep", this book will be written for children aged 8-12 and feature the fauna of our most unusual and challenging deep-ocean habitats with a focus on fascination not sensationalism. You can find more of Meghan's work and follow her for updates on the book release at https://www.instagram.com/studio_mbj .

I would like to extend a special thank you to Professor Jamieson of the Deep Sea Minderoo-UWA Deep-Sea Research Centre for his generous photo permissions.

Meetings & Workshops

Save the date!

World Conference on Marine Biodiversity 2026 in Bruges

www.wcmb2026.org

We are thrilled to invite you to the seventh edition of the World Conference on Marine Biodiversity, which will be held from November 17-20th 2026 (WCMB 2026).

The World Conference has always travelled, and after fifteen years, it will again be hosted in Europe. Your local organizing institute is the Flanders Marine Institute (VLIZ), and the Conference will take place in the historical city of Bruges (Belgium).

In the same tradition of previous editions, the 2026 World Conference on Marine Biodiversity will once again be a major assembly opportunity to share research outcomes, management and policy topics, offer a platform to discuss current as well as emerging marine biodiversity issues, and identify ways to protect and sustainably manage marine ecosystems and their resources. The conference will bring together scientists, practitioners and policy makers, aiming to discuss and advance our understanding of the importance, past, current and future state of marine biodiversity.

The seventh edition of the World Conference will fly the UN Ocean Decade flag, as it has been endorsed as a UN Ocean Decade Event. The overall theme of the Conference is "***The marine biodiversity insights we need, for the ocean we want***". As the Conference will take place a little over halfway through the UN Ocean Decade, it will provide an excellent opportunity to take stock of ongoing actions and initiatives, but also evaluate what still needs to be tackled by the end of the Decade.

Want to stay informed about the World Conference on Marine Biodiversity 2026? Check out the website at www.wcmb2026.org.

Do not forget to register for our mailing list and newsletter at http://www.wcmb2026.org/newsletter and follow us on social media:

- Twitter (X) https://x.com/wcmb2026
- LinkedIn https://www.linkedin.com/in/world-conference-on-marine-biodiversity-378410326/

We're very much looking forward to welcoming you in 2026!

Leen Vandepitte

On behalf of the VLIZ local organizing committee

Climate change and the Argentine Deep Sea

With support from Fulbright Program, the University of Buenos Aires, CONICET and DOSI, a series of activities were conducted in August 2024 to raise awareness of and engage scientists on the deep sea in Argentina, its vulnerability to climate change, and opportunities for multi-sectoral management. Lisa Levin, with participation of C.L. Wei and M.E. Bravo offered (in person and online) a three-day course to approximately 60 students and scientists from multiple Argentine institutions titled "**Climate Change and the Deep Sea**" at the University Buenos Aires.

Eight lectures covered climate change in the deep sea, climate projections for Argentine deep water, deep-sea ecosystems and their vulnerability to climate change, ecosystem services, biodiversity-climate connections, science-policy interface for the deep ocean, climate-smart spatial management in the deep sea, marine carbon dioxide removal impacts on the deep sea and opportunities for international policy and science network engagement. This was followed by a two-day in person workshop for researchers titled "Climate Change, Conservation and Sustainability in the Deep Ocean of Argentina" aimed at bringing together scientists from different disciplines and institutions (23 Scientific Research Institutions and Universities) to raise awareness about the amount of deep sea held by Argentina and discuss the influence of climate change and science of management of the Exclusive Economic Zone and Extended Continental shelf of Argentina.

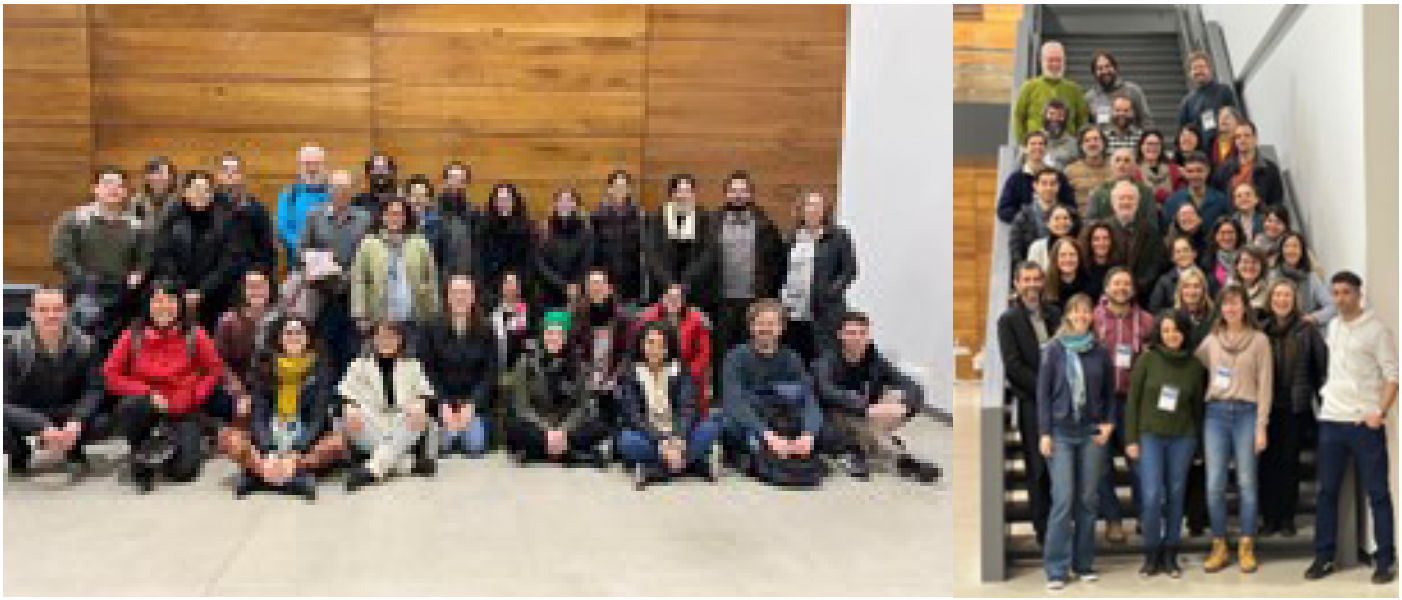


Figure 1. In person attendees of the Deep Sea and Climate course (left) and researcher workshop (right) at the University of Buenos Aires.

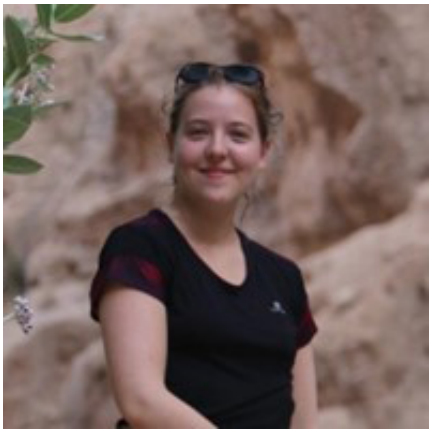
Discussions focused on Climate Change, Biodiversity, Ecosystem Services, Spatial Planning and National Governance, and International Engagement as they relate to the Argentine Deep Ocean. A series of key messages, proposed actions and workshop outputs were developed to strengthen deep-sea science in Argentina. On August 26 Lisa Levin met with directors and scientists of the National Institute of Fisheries Research and Development (INIDEP) in Mar Del Plata to discuss activities of the institute and opportunities for engagement on the deep ocean and climate change. DOSI opportunities were discussed in detail and a presentation was given on low oxygen on continental margins. On August 28 Levin gave an open conference (streamed by YouTube) entitled “Frontiers in Biodiversity, Dynamics and Management of Pacific Methane Seeps” at IGeBA-CONICET. A high-level policy-maker consultation is planned for September 9 to bring energy, fisheries, conservation, international policy and science sector representatives together to discuss climate and the Argentine deep sea environmental management.

Scientist Profiles

Isabel De Block

National Oceanography Centre (NOC, Southampton UK)

Early Career Researcher



I am currently working as an early career scientist at the National Oceanography Centre (NOC), collaborating with Dr. Erik Simon-Lledó on investigating the long-term impacts of deep-sea mining on megafauna in the Clarion-Clipperton Zone (CCZ). My work involves annotating AOV images taken one year post-impact of a mining simulation in the NORI-D area of the eastern CCZ, conducting statistical analyses to assess changes in the megafauna community structure and functional species composition, and to identify any signs of recovery after a year.

Previously, I worked at the Flanders Marine Institute (VLIZ), where I created an overview of the pelagic ecosystem in the Belgian part of the North Sea. Before that, I was at the Royal Belgian Institute for Natural Sciences (RBINS), where I investigated the impact of bottom trawling fisheries on hard substrate habitats and their communities in the Belgian North Sea.

I hold two master's degrees, one in Marine Biology via the IMBRSea program and an additional one in Economic Policy. The latter I pursued to understand the non-biological aspects of deep-sea mining, such as communicating with mining company representatives and working closely with policymakers and jurists on a global scale.

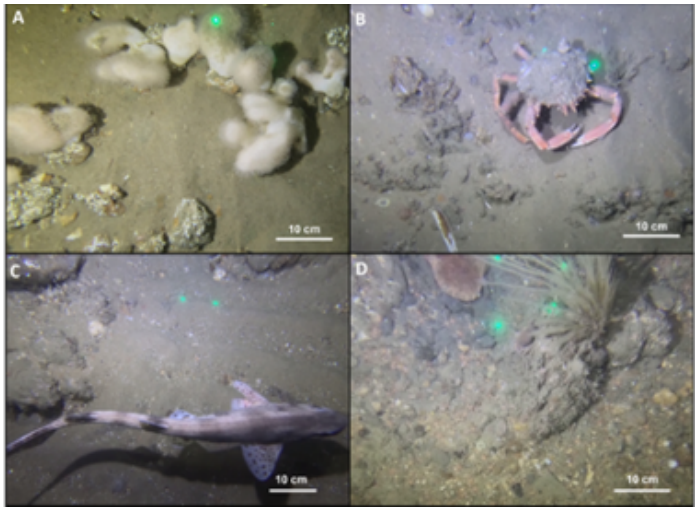


Figure 1. Hard substrate habitat. Image by the RBINS, MARECO

I am aiming for a PhD focused on the ecological drivers of biodiversity and community structure in the deep sea. I want to explore how extreme conditions of the deep, like high water pressure, impact deep-sea species both morphologically and ecologically. The deep sea has always captivated me with its alien environmental conditions, and I am eager to investigate how these conditions influence functional community composition.

Feel free to reach out for collaboration or visit me at the NOC!

Email: isabel.deblock@noc.ac.uk or isabel.deblock@gmail.com

Twitter: @Isabel_De_Block

Marcos R. dos Reis Junior

Institute of Oceanography, University of São Paulo

Early Career Researcher

Contact: mandepromarcos@usp.br

Marcos R. dos Reis Junior is a biologist and is currently pursuing a Master's degree in Biological Oceanography at the Institute of Oceanography, University of São Paulo (IO-USP). His research focuses on understanding the evolutionary convergence of troglomorphic traits in deep-sea fish species, particularly Ophidiiformes. He is also interested in taxonomy, morphology, ecology, and the diversity of deep-sea fish. Marcos is affiliated with the Laboratory of Fish Diversity, Ecology, and Evolution (DEEP Lab) at IO-USP, where he is developing his MSc project. He participated in the DEEP-OCEAN project, developed by DEEP Lab, where he had the opportunity to analyze novel biological samples from the southwestern Atlantic. Additionally, he co-founded the artistic initiative Shinkai Gyotaku, which aims to promote the diversity of Brazilian fish through the Gyotaku technique in natural prints. https://www.researchgate.net/profile/Marcos-Reis.

Opportunities

Special Feature: Submissions Welcome:

Deep-Sea Mining of Polymetallic Nodules: Environmental Baselines and Mining Impacts from the Surface to the Seafloor

Guest Editors: Jeff Drazen, University of Hawaii at Manoa; Jeroen Ingels, Florida State University; Jessica Fitzsimmons, Texas A&M University

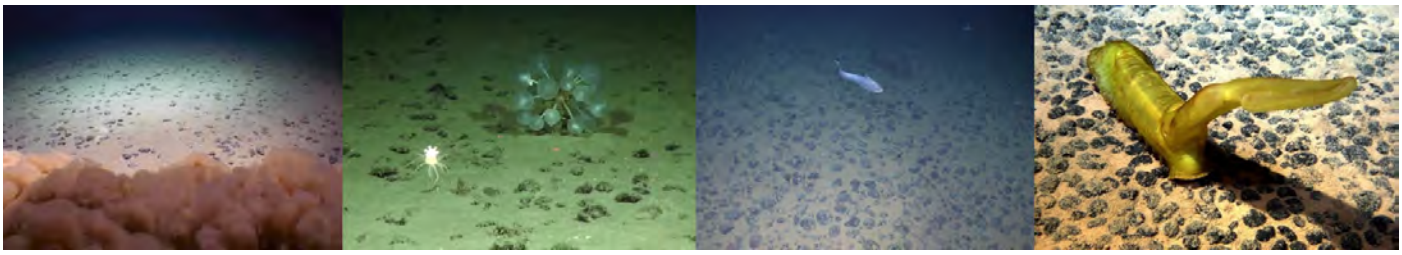


Image credits from left to right: Sediment plume – UH DeepCCZ project (2018); Star like sponge – UH DeepCCZ project (2018); Rattail fish swimming over a bed of nodules – UH/JAMSTEC in association with The Metals Company (2022); Yellow gummy-squirrel sea cucumber- Ifremer, Nodinaut (2004)

As the Anthropocene progresses, the possibility of polymetallic nodule mining in the deep sea draws nearer, in both international waters and in nations' exclusive economic zones. However, our understanding of the baseline conditions and dynamic properties of these remote environments, a prerequisite to future detection of mining impacts, remains limited. For this special Elementa Feature we welcome all studies investigating abyssal and water column ecosystem baselines and mining trial impact studies in polymetallic nodule mining zones. We particularly encourage submission of integrative studies across different biotas and environmental conditions to provide solid descriptions of the state and dynamics of these ecosystems. In addition, we envisage studies using different scientific disciplines to address meaningful questions about the nature and mechanics of nodule mining impacts, the repercussions for biodiversity and ecosystem function across various spatial and temporal scales, and the ability of these systems to recover.

Should you wish to submit your study to this special feature, please log in here. In the submission process you will be asked to provide the special feature name "Deep-sea Mining of Polymetallic Nodules".

Submission deadline: September 30, 2024

https://online.ucpress.edu/elementa/pages/deep-sea_mining_of_polymetallic_nodules?SscVersionId=5160

PhD position: Deep-sea biodiversity and function in a changing Arctic Ocean

Deadline 30 August 2024

Are you passionate about the Deep Sea and the Arctic Ocean? And looking for an exciting PhD opportunity in an internationally renowned Polar and Marine Research Center in Northern Germany?

Then check out our PhD position "Deep-Sea Biodiversity and Function in a Changing Arctic Ocean"

Based at AWI, the goal of the project is to investigate the diversity and function of benthic deep-sea communities in the Arctic Ocean, and assess their temporal and spatial distribution in relation to different levels of sea-ice cover, primary

production, and carbon flux. As part of the Benthos team, you will combine microbial community analyses with an emphasis on molecular tools, biogeochemical measurements, and contextual ecosystem information from long-term studies to identify environmental drivers of changes in benthic diversity and ecosystem functioning. The expected starting date is 1 December 2024 or as soon as possible thereafter.

For any questions you may have, you are very welcome to get in touch with Christina Bienhold (Christina.Bienhold@awi.de).

Figure 1. Work during RV Polarstern expedition PS138 to the Central Arctic Ocean. Left: The research icebreaker *Polarstern* is anchored to an ice floe. Right: Recovery of deep-sea sediments with the TV-guided Multiple Corer. (Esther Horvath, AWI).

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

The AleutBio (Aleutian Trench Biodiversity Studies) expedition, conducted aboard RV SONNE from 24 July – 26 September 2022, 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.

AleutBio is project 59.2 of the UN Decade of Ocean Sciences for Sustainability and contributes to the Challenger 150 programme.

The deadline for submission of articles is currently scheduled for the end of November 2024.

TOPICAL COLLECTON IN MARINE BIODIVERSITY

Diversity and distribution of Cold-Water Corals in Arctic and North-Atlantic waters

Guest Editors: Saskia Brix, Steinunn H. Olafsdottir, Gudmundur Gudmundsson, Kaveh Samimi- Namin, Severin Korfhage, Julia Sigwart

https://link.springer.com/journal/12526/updates/17178708

This topical collection invites contributions that enhance our understanding of cold-water coral systematics and integrated taxonomy approaches. We aim to explore species diversity, distribution, biogeography, and the ecological roles of corals as eco-engineers, with a particular focus on conservation.

The aim is to increase general knowledge of cold-water coral species (CWCs). Our goal is to underscore the significance of Atlantic and subarctic CWCs, increase knowledge about these species, and raise awareness of Iceland's marine biodiversity and the North Atlantic waters. We seek to elucidate the connectivity of CWCs throughout the Atlantic Ocean and uncover hidden diversity in museum collections.

Additionally, this collection will emphasize the value of global Red List assessments in supporting the conservation and protection of these vital, yet often threatened, species. We welcome descriptions of new species and taxonomic revisions, aiming to reveal unknown biodiversity and advance our scientific understanding of CWCs. Description of species new to science and taxonomic revisions are most welcome; a key ingredient to further our understanding of CWC diversity and related conservation issues.

Please submit your manuscript to https://www.editorialmanager.com/marb

Submission Deadline April 1, 2025

Wanted

WANTED: Tissue samples of Synaphobranchidae (Teleostei: Anguilliformes)

Dear Colleagues of DOSI and DSBS,

I'm a PhD student at the Oceanographic Institute of the University of São Paulo, Brazil, researching the genomics of deep-sea cutthroat eels from the family Synaphobranchidae. For my research, I am looking for tissue samples of Synaphobranchid eels, particularly of the genera *Atractodenchelys, Haptenchelys,* and *Synaphobranchus*.

My current project aims to understand the phylogenetic relationships within the family Synaphobranchidae, focusing on the delimitation and distribution patterns of the genus *Synaphobranchus*. To advance in the study, I need to increase sampling from various parts of the worlds' oceans.

If you have upcoming expeditions that may collect synaphobranchid species, please save some muscle samples in ethanol and keep the voucher specimens for confirmation. I will be happy to work collaboratively with you.

Please do not hesitate to get in touch by sending an email to: heloisacaixeta@usp.br

Best regards,

Heloísa De Cia Caixeta, PhD student, MSc

DEEP Lab - Laboratory of Diversity, Ecology and Evolution of Fishes Oceanographic Institute of the University of São Paulo, São Paulo – Brazil

Hot off the Press

How Do Scientists Explore the Deep Seafloor?

Katherine L. C. Bell, Jessica A. Sandoval, Brian R. C. Kennedy

Frontiers for Young Minds (2024)

From 200 to nearly 11,000 m (about 600–33,000 feet) below sea level and covering two-thirds of our planet, the deep ocean is Earth's largest—and most critical—habitat. The deep ocean is very important to people for many reasons. For example, it provides foods that we eat, it balances Earth's climate, and it is a wild unknown space for people to enjoy and explore. Despite its importance, the deep sea is the least explored area on our planet because it is so big, deep, dark, cold, and salty. Researchers need to use special tools such as ships and deep-sea robots to create maps, make new discoveries, and understand how the ocean works and how it affects people and the planet.

Link to paper: https://kids.frontiersin.org/articles/10.3389/frym.2024.1392048

Discovery of deep-sea cold seeps from Argentina host singular trophic linkages and biodiversity

M.E. Bravo, S. Principi, L.A. Levin, J.P. Ormazabal, C. Ferronato, F. Palma, J. Isola, A.A. Tassone

Deep–Sea Research I 211 (2024) 104361

Chemosynthetic ecosystems host unique geological, biogeochemical, microbial and faunistic settings, which provide key ecosystem services for human wellbeing. In the Argentine continental margin, the existence of chemosynthetic ecosystems is still unknown. We present the first finding of chemosynthetic ecosystems in the Argentine deep sea. We assessed and compared biological and geological settings for cold seeps in the Malvinas Basin and Colorado Basins and a control site (no gas) in the Colorado Basin. We found two cold seeps with crater-like geomorphic features (pockmarks) of 500-m and 1000-m in diameter at depths of ~500 m. Both cold seeps exhibited methane gas bubbles trapped at the surface of the seafloor, one exhibited seepage into the water column. Cold seeps hosted dense benthic macroinvertebrates (≥300 μm) assemblages consisting mainly of polychaetes, peracarid crustaceans and mollusks. The fauna from Argentine seeps exhibited δ13C and δ15N stable isotope signatures indicative of multiple trophic levels, supported by both chemosynthetic and photosynthetic sources of energy. The difference in bubbling to the water column was not associated with different trophic input of chemosynthetically-derived sources of energy, suggesting that gas input is mediated by the bubbles trapped in the seafloor sediments. The presence of gas bubbles trapped in the surface sediments of the ocean floor allowed the detection of ecological and trophic characteristics of active chemosynthetic ecosystems. Integration of the sub-bottom dimension can help improve our understanding of the interactions of chemosynthetic ecosystems with seafloor fluid flow in a more reliable manner than the gas plumes. These cold seeps host significant biodiversity and ecosystem functions of the deep ocean. They fall within areas tendered for oil and gas industry development, but have not been a focus of conservation efforts to date. Information provided here can inform effective conservation actions and improve our understanding of the distribution of chemosynthetic ecosystems worldwide.

Link to paper: https://doi.org/10.1016/j.dsr.2024.104361

New interactive machine learning tool for marine image analysis

H. Poppy Clark, Abraham George Smith, Daniel McKay Fletcher, Ann I. Larsson, Marcel Jaspars and Laurence H. De Clippele

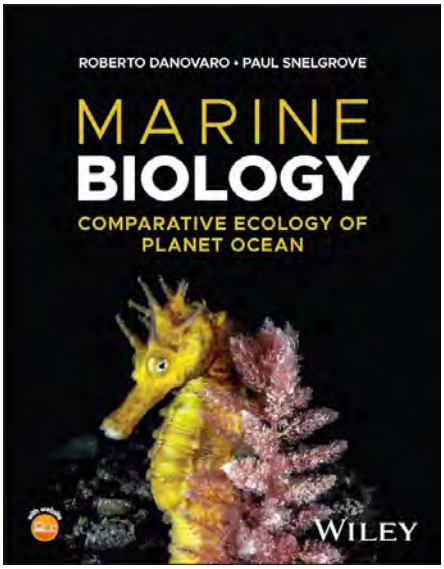
R. Soc. Open Sci.11231678

Advancing imaging technologies are drastically increasing the rate of marine video and image data collection. Often these datasets are not analysed to their full potential as extracting information for multiple species is incredibly time-consuming. This study demonstrates the capability of the open-source interactive machine learning tool, RootPainter, to analyse large marine image datasets quickly and accurately. The ability of RootPainter to extract the presence and surface area of the cold-water coral reef associate sponge species, *Mycale lingua*, was tested in two datasets: 18,346 time-lapse images and 1,420 remotely operated vehicle video frames. New corrective annotation metrics integrated with RootPainter allow objective assessment of when to stop model training and reduce the need for manual model validation. Three highly accurate M. lingua models were created using RootPainter, with an average dice score of 0.94 ± 0.06. Transfer learning aided the production of two of the models, increasing analysis efficiency from 6 to 16 times faster than manual annotation for time-lapse images. Surface area measurements were extracted from both datasets allowing future investigation of sponge behaviours and distributions. Moving forward, interactive machine learning tools and model sharing could dramatically increase image analysis speeds, collaborative research and our understanding of spatiotemporal patterns in biodiversity.

Link to paper: http://doi.org/10.1098/rsos.231678

Marine Biology: Comparative Ecology of Planet Ocean

Roberto Danovaro and Paul Snelgrove



"Marine Biology: Comparative Ecology of Planet Ocean" provides a learning tool to those who love the ocean. It will help them to understand and learn about the life that populates it, the extraordinary adaptations of marine organisms to their environment, and the spectacular variety of marine life forms that inhabit the many marine habitats and contribute to the life support system of Planet Ocean.

The book introduces marine biology by seeing the ocean through the eyes of its inhabitants, describing the properties of sea water, the surface waters and its currents, and the characteristics of the seabed according to how marine organisms perceive, exploit, and shape them. This book explains to the reader and those who love the ocean not only how to recognize the most common marine organisms and habitats, from the coast to great depths, but it also explains their complex life cycles and the environmental factors controlling their distribution, reproduction, and growth. Finally, the book evaluates the role that living biota play in how different marine ecosystems function in order to understand better their characteristics, peculiarities, and threats.

This book offers an up-to-date and comprehensive text on the study of marine biology, presenting insights into the methodologies scientists have adopted for the study of marine ecosystems. It also includes chapters about human impacts on marine biodiversity, from overfishing to climate change, from pollution (including microplastics), to alien-

species invasions, from conservation of marine resources to the restoration of degraded marine habitats.

The authors developed this text for Bachelor and Master's level students taking classes on marine biology and marine ecology, but it will also interest high-school students and marine enthusiasts (dive masters, tour guides) who wish to deepen their knowledge of marine biology.

Link to book: Marine Biology: Comparative Ecology of Planet Ocean | Wiley

---

Changes to upper-ocean ecosystems may directly impact abyssal scavenger communities

Daniëlle S. W. de Jonge, Alycia J. Smith, Andrew K. Sweetman

Limnology and Oceanography.

Human pressures are changing ocean environments, such as a shift from fish- to squid-dominated ecosystems in overfished, poorly oxygenated environments. After death, carcasses of upper ocean fauna sink to the seafloor where they provide food for demersal scavengers. It is unclear how shifts in carcass type impact abyssal scavengers. We performed baited benthic camera lander deployments in the Cabo Verde Abyssal Basin to test how a shift from fish- to squid-dominated carrion could modify abyssal scavenger ecology. At the fish bait, peak scavenger abundance was greater and occurred later for the majority of observed fauna. However, removal rates of squid bait were up to 10-fold greater, and a significantly different community composition developed, favoring faster organisms with lower chemosensory thresholds. At the fish bait, slower organisms were less disadvantaged as the bait persisted for longer periods allowing the development of a more complex community and dense amphipod aggregations. The rapid squid consumption indicates that the accumulation of this type of food fall at the seafloor may not occur, preventing scientific observations necessary to estimate the importance of squid carrion to the biological C pump and deep-sea food webs. As such, the flux of squid carrion to the seafloor is likely greater than currently recognized in this part of the Atlantic. The differences observed between bait types indicate how future changes in upper ocean ecosystems may impact abyssal scavengers and their ecosystem functions, including controlling seafloor biomass, regulating the behavior of benthic fauna, and contributing to nutrient cycling and energy transfer.

Link to paper: https://doi.org/10.1002/lno.12603

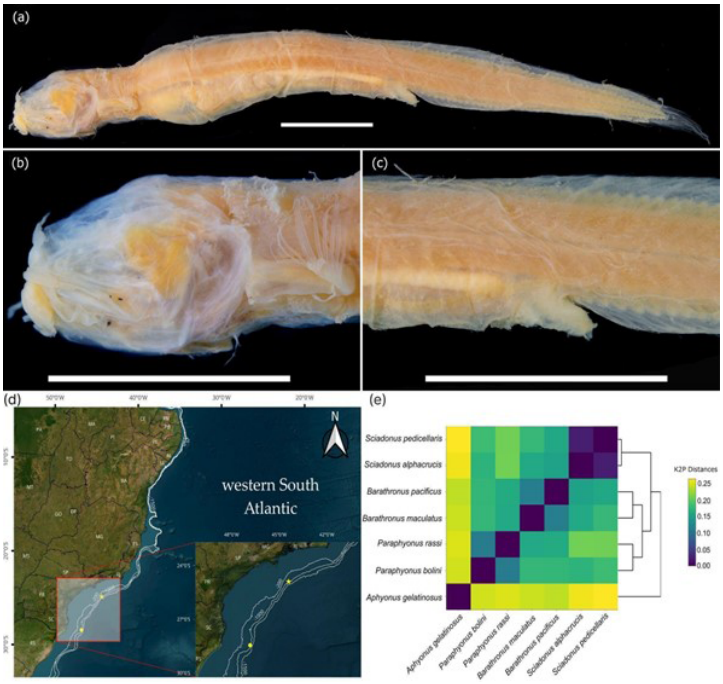
New report of the rare *Sciadonus alphacrucis* Melo *et al*., 2022 (Teleostei, Ophidiiformes, Bythitidae), DNA barcoding, and range extension in the western South Atlantic

Marcos Roberto dos Reis Júnior, Heloisa De Cia Caixeta, Claudio Oliveira, Marcelo, Roberto Souto de Melo

Journal of Fish Biology 2024,1-5

Corresponding author: mandepromarcos@usp.br

Sciadonus alphacrucis Melo, Gomes, Møller & Nielsen, 2022 is a rare deep-sea species, previously known from only two specimens collected off São Paulo State, southeastern Brazil, in the western South Atlantic. Herein, we report a new specimen of *S. alphacrucis* collected on the continental slope off Santa Catarina State, southern Brazil, thereby extending its known distribution by 420 km. Additionally, we provide the new meristic and morphometric data, the molecular



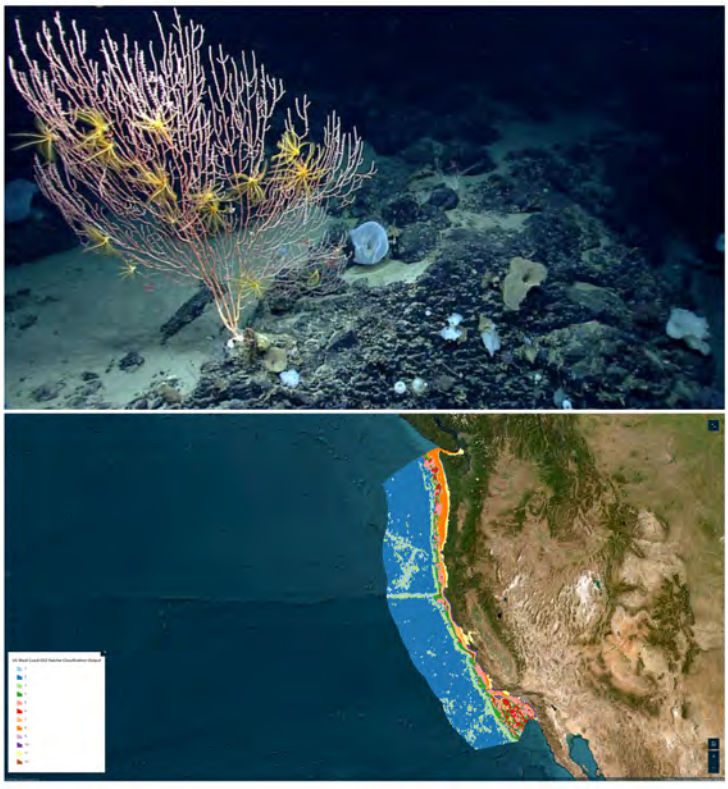
identification using sequences of the cytochrome c oxidase subunit I (COI), an updated distribution map, and a discussion of troglomorphic traits.

Link to paper: https://doi.org/10.1111/jfb.15896

Figure 1. New specimen of male Sciadonus alphacrucis, MZUSP (130244), 72.4 mm SL, western South Atlantic, Santa Catarina State, off Florianopolis, 930–950 m depth, 03 Apr. 2022, R/V Alpha Crucis. (a) body in lateral view; (b) a detail of the head in lateral view in detail; (c), a detail of male reproductive apparatus in lateral view. pictures of preserved specimen; (d) known distribution of Sciadonus alphacrucis in the western South Atlantic, including type locality (yellow star), and the new record (yellow circle) along the southeast Brazilian coast; (e) heatmap of K2P distances between sequences of Sciadonus available on BOLD Systems. Scale bar equals 10 mm.

A new StoryMap on benthic habitat classification

DOOS Habitat & Ecological Mapping for Place-Based Management Working Group



In October 2023, the Deep Ocean Observing Strategy (DOOS) convened a Deep Ocean Collective Solution Accelerator event, bringing together community expertise through a series of concurrent workshops. As part of this effort, the Habitat Conservation and Marine Spatial Planning workshop group created a StoryMap, offering an overview of the classification of benthic (seafloor) habitats, built from ideas and techniques discussed during the workshop. Readers who want to use the approaches outlined here to implement habitat classification can find links to companion tutorials for R and ArcGIS in the Open Science Tutorials section of this StoryMap.

DOOS is an international, community-based group endorsed by the UN Ocean Decade. The DOOS Habitat Mapping & Ecological for Place-Based Management Working Group focuses on:

Figure 1: Example of deep benthic habitats and US west coast EEZ habitat classification generated with multivariate clustering. Five environmental and terrain layers were used: Temperature at the seafloor, salinity at the seafloor, terrain slope, Broad-scale Bathymetric Position Index (BBPI, which characterizes large geomorphological features, such as abyssal plains), Fine-scale Bathymetric Position Index (FBPI, which characterizes small features, such as seamounts and submarine canyons).

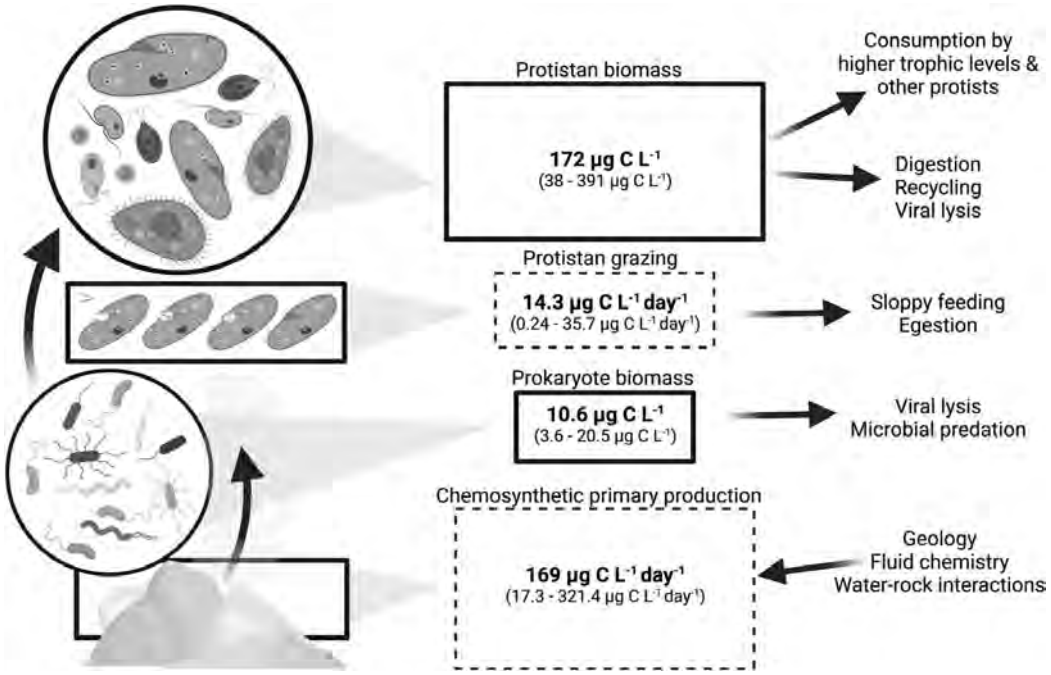
- Helping advance the field of benthic habitat/ecological mapping in spatially-managed areas.
- Increasing capacity related to datastream planning, applying GIS tools to generate useful habitat maps.
- Implementing open science and FAIR data principles as it relates to this topic.

Link to the StoryMap: https://storymaps.arcgis.com/stories/f453ff55688747509bf9adda989df110

Microbial eukaryotic predation pressure and biomass at deep-sea hydrothermal vents

Sarah K Hu, Rika E Anderson, Maria G Pachiadaki, Virginia P Edgcomb, Margrethe H Serres, Sean P Sylva, Christopher R German, Jeffrey S Seewald, Susan Q Lang, Julie A Huber

The ISME Journal, Volume 18, Issue 1 (2024)



Deep-sea hydrothermal vent geochemistry shapes the foundation of the microbial food web by fuelling chemolithoautotrophic microbial activity. Microbial eukaryotes (or protists) play a critical role in hydrothermal vent food webs as consumers and hosts of symbiotic bacteria, and as a nutritional source to higher trophic levels. We measured microbial eukaryotic cell abundance and predation pressure in low-temperature diffuse hydrothermal fluids at the Von Damm and Piccard vent fields along the Mid-Cayman Rise in the Western Caribbean Sea. We present findings from experiments performed under *in situ* pressure that show cell abundances and grazing rates higher than those done at 1 atmosphere (shipboard ambient pressure); this trend was attributed to the impact of depressurization on cell integrity. A relationship between the protistan grazing rate, prey cell abundance, and temperature of end-member hydrothermal vent fluid was observed at both vent fields, regardless of experimental approach. Our results show substantial protistan biomass at hydrothermally fueled microbial food webs, and when coupled with improved grazing estimates, suggest an important contribution of grazers to the local carbon export and supply of nutrient resources to the deep ocean.

Link to paper: https://doi.org/10.1093/ismejo/wrae004

Threats to Our Ocean Heritage: Two new books and a call for interest for a third

The Ocean Foundation

This year, The Ocean Foundation, in partnership with the Lloyd's Register Foundation, released two volumes focused on threats to both natural and cultural heritage in the ocean. These books are free, open access e-books, with the option of ordering a paperback copy. The first volume, edited by Charlotte Jarvis, focuses on bottom trawling. Regarded as a damaging practice by marine ecologists there is also clear evidence of harm caused to underwater cultural heritage. This volume takes the reader through case studies that document this damage and highlights the need to work with fishing communities to achieve better management regimes.

The second, edited by Michael Brennan, concentrates on potentially polluting wrecks. Largely a legacy of two World Wars, these wrecks contain a cargo or large volume of fuel oil. Structural decay over time and climate impacts, such as increased storminess, mean that we are now entering a decade of heightened risk of a catastrophic pollution event. However, a complex regulatory framework has resulted in overreliance on costly 'emergency response' interventions. A more strategic approach to management of this threat must be developed. Some of these wrecks may even lie in areas of proposed deep seabed mining, which will be a chapter in the upcoming third book: *Threats to Our Ocean Heritage: Deep Seabed Mining*.

This volume is currently in progress. It will focus on the issues concerning damage to cultural and natural heritage that need to be acknowledged, investigated and documented before any adequate assessment of the acceptability of DSM can be made. There will be chapters on the BBNJ Treaty, potentially polluting wrecks, the ecological impact of DSM, the potential destruction of heritage associated with the Middle Passage and World War II graves, intangible cultural heritage and connections to the sea, and more. We are seeking additional contributions. Proposals for chapters on memorialisation and engagement with impacted communities would be particularly welcome.

If you're interested in contributing, please send an email to the editor, Charlotte Jarvis: Charlotte.jarvis98@gmail.com

---

Laying waste to the deep: parallel narratives of marine carbon dioxide removal and deep-seabed mining

Lidström, S., Levin, L.A. & Seabrook, S.

npj Ocean Sustain 3, 36 (2024)

The deep ocean is increasingly featured in climate solution discussions. An emerging narrative suggests that marine carbon dioxide removal (mCDR) is essential to meet global climate targets. The argument made is similar to claims that deep-seabed mining (DSM) is necessary to enable widespread electrification, in that both are framed as helping to address climate change. We compare the structure and history of these narratives, highlighting that while potential negative impacts on marine life have emerged as a central feature in debates about DSM, environmental and social risks associated with mCDR are yet to receive similar recognition. In light of this comparison, we argue that potential harm needs to be further emphasized in considerations of deploying mCDR.

Link to paper: https://doi.org/10.1038/s44183-024-00075-5

Marine lebensspuren: improving the classification of seafloor traces from underwater imagery and observations

Miguez-Salas O., Przeslawski R., Rodrıguez-Tovar F.J., Uchman A., Bett B.J., Durden J.M. and Riehl T.

Frontiers in Marine Science, 11:1371097

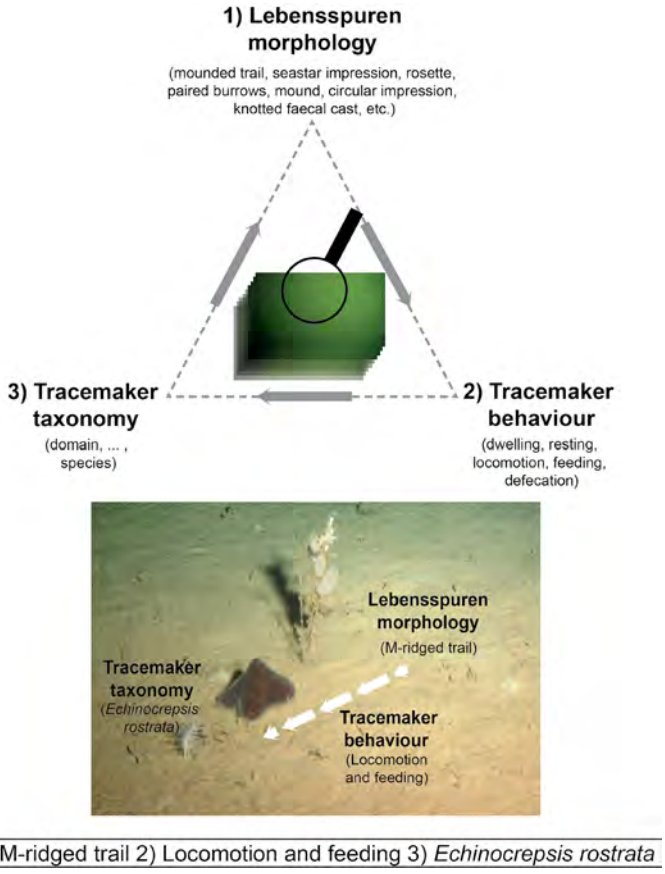


Figure 1. Criteria for characterizing lebensspurren

Within the depths of the ocean, the interplay between benthic fauna and seafloor sediment occurs through bioturbation, which can leave behind preserved traces known as lebensspuren. These lebensspuren are common features within deep-sea environments. However, studies examining lebensspuren lack standardized ichnotaxobases. While some classifications are based on morphological descriptions or behavioral assignments, consensus is absent. This absence of standardized terminology impedes comparisons across studies and regions. We delve into the constraints of characterizing marine lebensspuren through underwater observations and propose potential ichnotaxobases for further classification. Given that many classifications will rely on still images of marine environments, we suggest a classification system based on a combination of three criteria (Fig. 1) morphology (e.g., M-ridged trail), 2) behavioral determinations (e.g., locomotion and feeding), and 3) tracemaker taxonomy (e.g., *Echinocrepis rostrata*). We offer a set of recommendations to address each of these criteria. Additionally, we discuss the utility of open nomenclature given the wealth of information contained in still images. In our contribution (https://doi.org/10.3389/fmars.2024.1371097), we present examples of how this classification can be applied to contribute to an online repository of marine lebensspuren and facilitate consistent global comparisons.

Lebensspuren are common features of deep-sea landscapes, being more abundant than their tracemakers, rendering them promising proxies for inferring biodiversity. In the literature, the density-diversity relationships between lebensspuren and benthic fauna remain unclear and contradicting correlations have been proposed (i.e., negative, positive, or even null correlations). We present a study (https://doi.org/10.5194/bg-21-641-2024) where lebensspuren and benthic fauna were characterized taxonomically at eight deep-sea stations in the Kuril Kamchatka Trench area. Diversity correlation was observed at specific stations, showing both

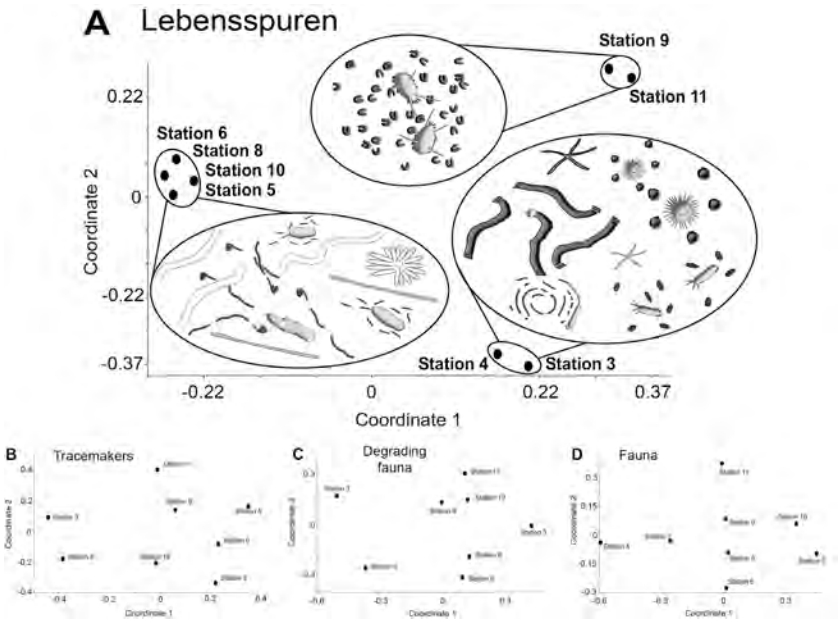


Figure 2. Lebenspurren density correlations

negative and positive correlations depending on: 1) the number of unknown tracemakers (especially significant for dwelling lebensspuren), 2) the multiple origins of particular lebensspuren, and 3) the tracemakers producing different lebensspuren. Lebensspuren and total faunal density were not correlated. However, lebensspuren density was either positively or negatively correlated with tracemaker densities, depending on the lebensspuren morphotypes. A positive correlation was observed for resting lebensspuren, while negative correlations were observed for locomotion-feeding lebensspuren. Thus, lebensspuren diversity may be a good proxy for tracemaker biodiversity when the lebensspuren-tracemaker relationship can be reliably characterized. Lebensspuren-density correlations vary depending on the specific lebensspuren residence time, tracemaker density and associated behavior (Fig. 2). We suggest that lebensspuren density and diversity correlations should be related specifically to tracemakers rather than to the benthic fauna in general. On a global scale, abiotic (e.g., hydrodynamics, substrate consistency) and other biotic (e.g., microbial degradation) factors may also play an important role.

Link to paper: https://doi.org/10.3389/fmars.2024.1371097

The emerging picture of a diverse deep Arctic Ocean seafloor: from habitats to ecosystems

Ramirez-Llodra and Meyer et al.

Elementa: Science of the Anthropocene (Accepted)

Interest in the deep Arctic Ocean is rapidly increasing from governments, policy makers, industry, researchers, and conservation groups, accentuated by the growing accessibility of this remote region by surface vessel traffic. In this review, our goal is to provide an updated taxonomic inventory of benthic taxa known to occur in the deep Arctic Ocean and relate this inventory to habitat diversity. To achieve this goal, we collected data for Arctic metazoan deep-sea taxa from open-access databases, information facilities, and non-digitised scientific literature, limiting the collection to the area north of 66°N and below 500 m depth (excluding all shelf seas). Although notable progress has been made in understanding the deep Arctic using novel technologies and infrastructure, this data gathering shows that knowledge of deep-sea benthic Arctic communities remains very limited. Yet, through our compilation of habitat maps, we show that the Arctic contains a high diversity of geomorphological features, including slopes, deep basins, submarine canyons, ridges, and seamounts, as well as chemosynthesis-based and biogenic (biologically engineered) ecosystems. To analyse taxon richness and density, using both morphological and molecular data, we compiled 75,404 faunal records with 2,637 taxa. Phyla with the most records were the Arthropoda (21,405), Annelida (13,763) and Porifera

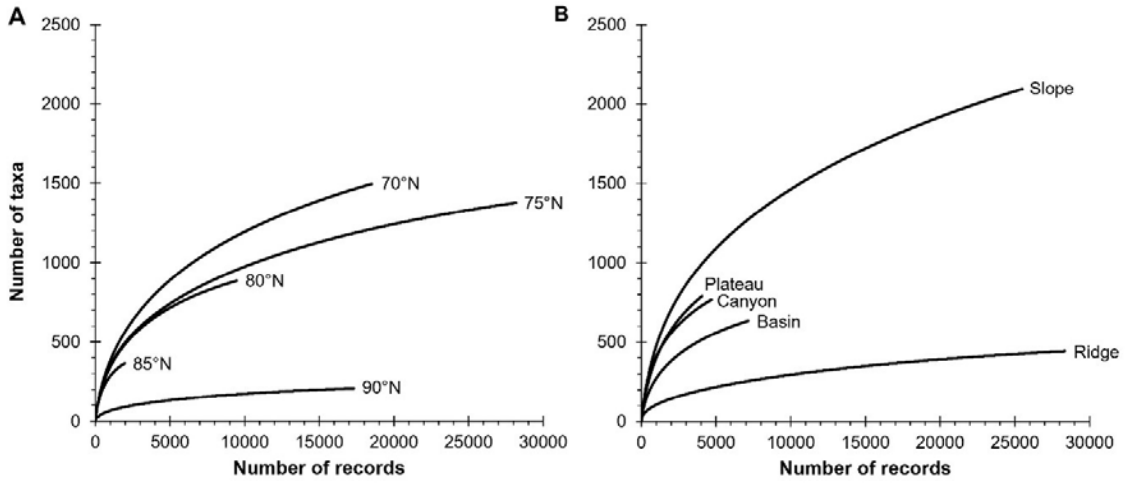


Figure 1. Rarefaction curves of number of taxa against number of records for the deep Arctic Ocean. Rarefaction curves for A) 5-degree latitudinal bands and B) geomorphological features.

(12,591); phyla with the most documented taxa were the Arthropoda (956), Annelida (566) and Mollusca (351). An overview of the dominant groups inhabiting the different geomorphological features highlights regions in the deep Arctic where data are particularly scarce and increased research efforts are needed, particularly the deep basins of the central Arctic Ocean. This scarcity of deep benthic Arctic biodiversity data creates a bottleneck for developing robust management and conservation measures in a rapidly changing region, leading to a call for international collaboration and shared data to ensure understanding and preservation of these fragile Arctic ecosystems.

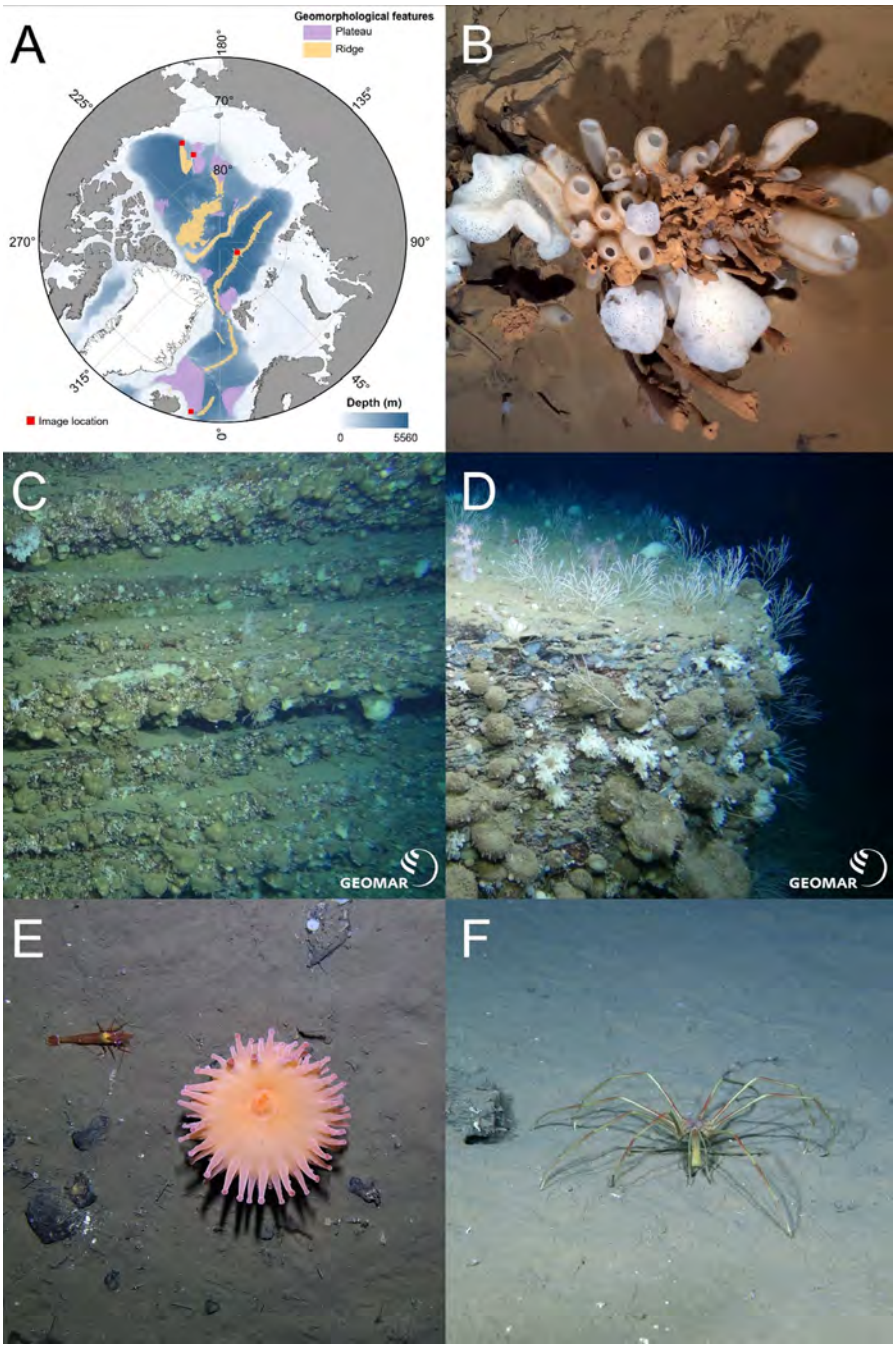


Figure 2. Representative fauna observed on the ridges and plateaus in the deep Arctic Ocean. A) Locations of the representative images; B) glass sponges on the Gakkel Ridge (Source: Thomas Soltwedel, AWI, Deep-Sea Research Group); C,D) vertical *Geodia* walls with Asbestopluma *(Asbestopluma) furcata* Lundbeck, 1905 and *Gersemia von Marenzeller*, 1878 on Ægir Ridge (source: James Taylor and Saskia Brix, DZMB Senckenberg, GEOMAR Kiel 6000); and E) *Pycnanthus densus* Carlgren, 1921 and *Bythocaris* on the Northwind Ridge and F) *Colossendeis proboscidea* (Sabine, 1824) on the Chukchi Plateau (Source: Irina Zhulay and Katrin Iken, The Hidden Ocean 2016: Chukchi Borderland, NOAA, University of Alaska Fairbanks, Oceaneering-DSSI).

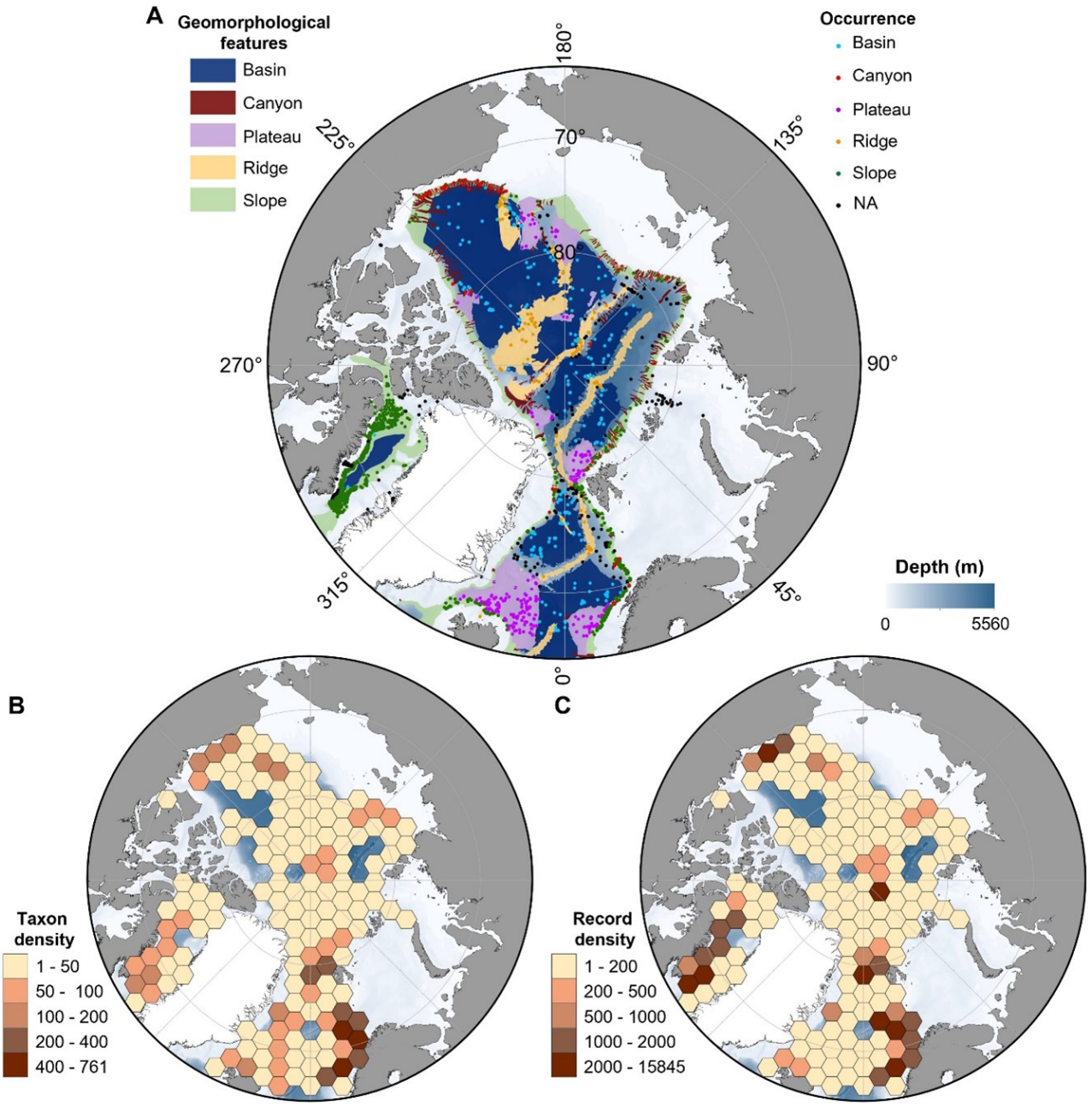


Figure 3. Maps of the Arctic Ocean (66–90°N) showing records in the compiled dataset by geomorphological feature. A) Each point represents the occurrence of a record from a water depth of >500 m; the colours of the points relate to the habitats they overlap. Not applicable (NA, black points) indicates points that do not overlap entirely with a specific geomorphological feature. B) Map showing the density of reported taxa per hexagon, where hexagons are equally sized areas of approximately 50,000 km2; transparent hexagons indicate areas where no data were readily available. C) Map showing the density of reported occurrence records per 50,000 km2 equal-sized hexagons.

Evidence of dark oxygen production at the abyssal seafloor

Andrew K. Sweetman, Alycia J. Smith, Danielle S. W. de Jonge, Tobias Hahn, Peter Schroedl, Michael Silverstein 5, Claire Andrade, R. Lawrence Edwards, Alastair J. M. Lough, Clare Woulds, William B. Homoky, Andrea Koschinsky, Sebastian Fuchs, Thomas Kuhn, Franz Geiger & Jeffrey J. Marlow

Nature Geoscience - Brief Communication

Deep-seafloor organisms consume oxygen, which can be measured by *in situ* benthic chamber experiments. Here we report such experiments at the polymetallic nodule-covered abyssal seafloor in the Pacific Ocean in which oxygen increased over two days to more than three times the background concentration, which from *ex situ* incubations we

attribute to the polymetallic nodules. Given high voltage potentials (up to 0.95 V) on nodule surfaces, we hypothesize that seawater electrolysis may contribute to this dark oxygen production.

https://doi.org/10.1038/s41561-024-01480-8

Coral microbiomes are structured by environmental gradients in deep waters

Vohsen, S.A., Herrera, S.

Environmental Microbiome 19, 38 (2024)

Coral-associated microbiomes vary greatly between colonies and localities with functional consequences on the host. However, the full extent of variability across the ranges of most coral species remains unknown, especially for corals living in deep waters which span greater ranges. Here, we characterized the microbiomes of four octocoral species from mesophotic and bathyal deep-sea habitats in the northern Gulf of Mexico, *Muricea pendula, Swiftia exserta, Callogorgia delta*, and *Paramuricea biscaya*, using 16S rRNA gene metabarcoding. We sampled extensively across their ranges to test for microbiome differentiation between and within species, examining the influence of environmental factors that vary with depth (53–2224 m) and geographic location (over 680 m) as well as the host coral's genotype using RAD-sequencing. Coral microbiomes were often dominated by amplicon sequence variants whose abundances varied across their hosts' ranges, including symbiotic taxa: corallicolids, Endozoicomonas, members of the Mollicutes, and the BD1-7 clade. Coral species, depth, and geographic location significantly affected diversity, microbial community composition, and the relative abundance of individual microbes. Depth was the strongest environmental factor determining microbiome structure within species, which influenced the abundance of most dominant symbiotic taxa. Differences in host genotype, bottom temperature, and surface primary productivity could explain a significant part of the microbiome variation associated with depth and geographic location. Altogether, this work demonstrates that the microbiomes of corals in deep waters vary substantially across their ranges in accordance with depth and other environmental conditions. It reveals that the influence of depth on the ecology of mesophotic and deep-sea corals extends to its effects on their microbiomes which may have functional consequences. This work also identifies the distributions of microbes including potential parasites which can be used to inform restoration plans in response to the *Deepwater Horizon* oil spill.

Link to paper: https://doi.org/10.1186/s40793-024-00579-0

Homeocurvature adaptation of phospholipids to pressure in deep-sea invertebrates

Winnikoff, J.R., Milshteyn, D., Vargas-Urbano, S.J., Pedraza-Joya, M.A., Armando, A.M., Quehenberger, O., Sodt, A., Gillilan, R.E., Dennis, E.A., Lyman, E., Haddock, S.H.D., Budin, I.

Science, 384, no. 6703

Hydrostatic pressure increases with depth in the ocean, but little is known about the molecular bases of biological pressure tolerance. We describe a mode of pressure adaptation in comb jellies (ctenophores) that also constrains these animals' depth range. Structural analysis of deep-sea ctenophore lipids shows that they form a nonbilayer phase at pressures under which the phase is not typically stable. Lipidomics and all-atom simulations identified phospholipids with strong negative spontaneous curvature, including plasmalogens, as a hallmark of deep-adapted membranes that

causes this phase behavior. Synthesis of plasmalogens enhanced pressure tolerance in *Escherichia coli*, whereas low-curvature lipids had the opposite effect. Imaging of ctenophore tissues indicated that the disintegration of deep-sea animals when decompressed could be driven by a phase transition in their phospholipid membranes.

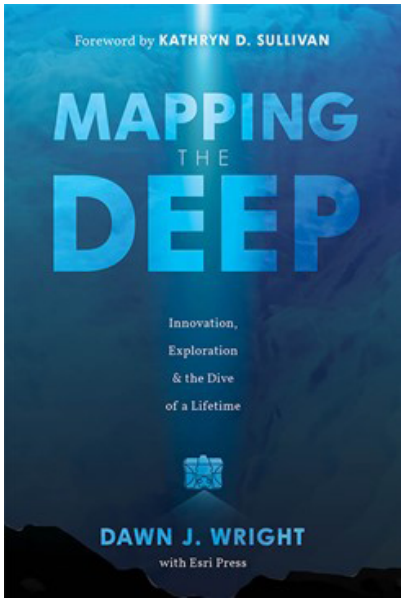
Link to paper: https://www.science.org/doi/10.1126/science.adm7607

Media coverage:

- https://www.science.org/content/article/how-jellyfish-survive-pressures-would-crush-you-oblivion
- https://www.scientificamerican.com/article/how-delicate-comb-jellies-withstand-ocean-depths-but-melt-away-on-land/

Mapping the Deep: Innovation, Exploration, and the Dive of a Lifetime

Dawn J. Wright



Mapping the Deep takes you on an adventure into the depths of Challenger Deep, showcasing one woman's perseverance and innovation needed for ocean exploration.

Embark on an extraordinary journey to the depths of the ocean, featuring a foreword by Kathryn D. Sullivan.

Oceanographer Dawn Wright made history in 2022 when she became the first Black person to visit Challenger Deep, the deepest and most unexplored place on Earth—a trip that took her over 10,000 meters beneath the Pacific Ocean's surface. We know less about the ocean floor than we do about the surface of the moon. To date, barely one-fifth of the seabed has been mapped in high resolution. As an ocean scientist and explorer, Dawn has made it her mission to change that.

Mapping the Deep takes you on an extraordinary adventure with an extraordinary woman into the depths of Challenger Deep, showcasing the perseverance and innovation needed for ocean exploration. With a focus on Dawn's historic dive, her personal journey, and the cutting-edge technology that made the expedition possible, this book highlights the crucial importance of mapping the ocean and its profound impact on our planet's future. Prepare to be inspired—from the fascinating history of the area and the incredible stories of its explorers to the diverse marine life that lives within.

Through a blend of history, fascinating facts, and beautiful images, Mapping the Deep offers a unique perspective on the challenges and triumphs of deep-sea exploration.

As Esri's chief scientist, Dawn Wright aids in strengthening the scientific foundation for Esri software and services, while also representing Esri to the scientific community. A specialist in marine geology, with record-setting submersible dives in *Alvin* (to the East Pacific Rise), *Pisces V*, and the *Limiting Factor* (to Challenger Deep), she has also authored and contributed to some of the most definitive literature on marine GIS. Dawn is an elected member of both the US National Academy of Sciences and the US National Academy of Engineering, as well as a fellow of the American Association for the Advancement of Science, The Oceanography Society, and the Geological Society of America. She holds lifetime achievement awards from the American Association of Geographers, the Geological Society of America, and WINGS WorldQuest Women of Discovery. Dawn is also professor of geography and oceanography at Oregon State

University, where she was named Oregon Professor of the Year in 2007. She has coauthored several books for Esri Press, including Ocean Solutions, Earth Solutions and the GIS for Science series.

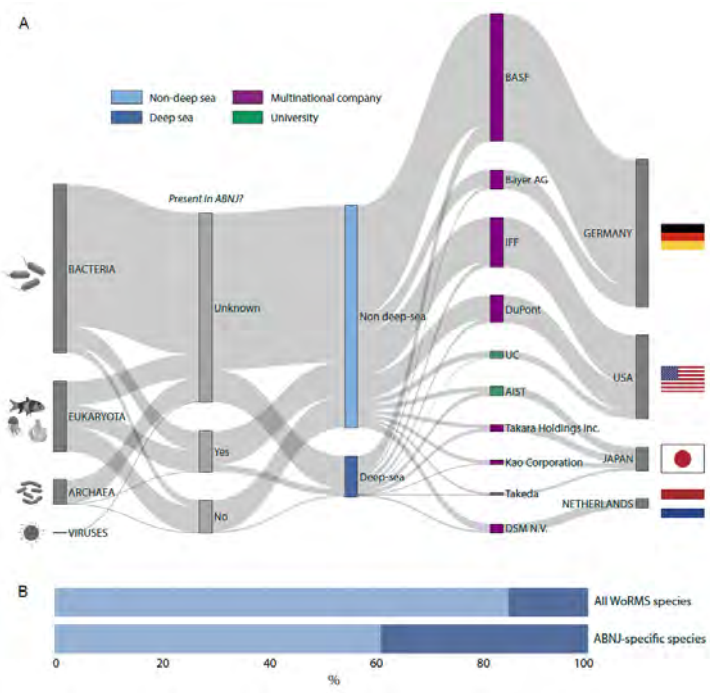
Link to book: Mapping the Deep: Innovation, Exploration, and the Dive of a Lifetime | Esri Press | Esri Press

Growing Prominence of Deep-Sea Life in Marine Bioprospecting

Zhivkoplias, E., Jouffray, JB., Dunshirn, P., Pranindita, A., Blasiak, R.

Nature Sustainability 7, 1027–1037 (2024)

Recent developments in marine bioprospecting are highlighted in our article, which presents a novel database of marine genes referenced in patent filings. Marine bioprospecting — the search for genetic and biochemical material from marine organisms — plays a crucial role in addressing public and environmental health applications, including disease treatment, diagnostics, and bioremediation. Here, we introduce the Marine Bioprospecting PATent (MABPAT) database, which includes 104,467 genetic sequences linked to 4,779 patents. Major corporations like BASF, IFF, and DuPont have incorporated sequences from 949 species, representing 58% of referenced marine-origin species.



Notably, microbial life in the deep sea, predominantly found beyond national jurisdiction, is attracting substantial economic interest, with the top ten patent holders filing marine gene patents that reference sequences from deep-sea life. This reveals that deep-sea organisms are increasingly recognized as valuable sources for natural product discovery. Our findings provide an updated understanding of the marine bioprospecting landscape and contribute to the sustainable use of marine biodiversity.

These insights are particularly timely as the High Seas Treaty is being ratified, emphasizing the importance of stewardship of deep-sea ecosystems. We also found that some innovations are already utilizing genetic sequences sourced from marine species found exclusively in Areas Beyond National Jurisdiction (ABNJ), which are applied in a broad range of technological applications.

For more information, visit the MABPAT database at https://mabpat.shinyapps.io/main/. For inquiries, contact the corresponding author, Erik Zhivkoplias, at erik.zhivkoplias@su.se.

Link to paper: https://doi.org/10.1038/s41893-024-01392-w

It's Your Opinion

Live Inland? Deep-Sea Science Matters to You, too.

Dane Whicker

Contact: biodiversitypodcast@gmail.com

They're two different worlds, separated from each other by vast distances both horizontal and vertical. One is a world without light, where strange and alien creatures live bizarre lives among abyssal plains, superheated chemical vents, and underwater lakes. And the second: a world far away from the salt, where mountains reach toward the radiant sun that feeds green growth along rivers, in forests, and on agricultural fields. But these two worlds are more connected than most know.

If you live inland, the deep ocean may simply be out of sight, out of mind - but we cannot deny the benefits that we reap from the deep. It sequesters carbon, supports healthy fisheries, has provided enzymes for COVID-19 tests… and recent evidence suggests it may even generate lightless oxygen!

Deep seabed mining may be poised to take this amazing resource away before we truly understand it. A potential loss of yet-unknown medical breakthroughs, technological innovations, and climate solutions is something no one – inlander or coastal resident – can afford. Per international law, the deep sea is our common heritage: so inland or not, we have a powerful voice. And we can start by using it to uplift and support the scientific effort aimed at understanding these beautiful, abyssal waters… before we lose the chance.

Listen to Peak & Plunge, a podcast about inland-ocean connections that covers topics like this, here!

Visit the Inland Ocean Coalition project here.

Obituaries

Renowned microbial biologist, Professor Craig Cary, leaves a legacy in extreme ecosystems

08 Mar 2024

It is with great sadness that we report that Professor Craig Cary, who dedicated his life to research in some of the world's toughest environments, passed away in March this year aged just 69. This obituary text was adapted from the full obituary by the University of Waikato, NZ, where he worked for 20 years.

40 years of research

Professor Cary dedicated 40 years to the study of microbial life in extreme environments, including deep-sea hydrothermal vents and Antarctic soils. Craig participated in over 29 deep-sea expeditions to hydrothermal vents, 45 dives in research submersibles and spent 18 seasons conducting groundbreaking research in Antarctica with over 22 deployments – something only a handful of people across New Zealand have had the honour of doing. His last visit to Antarctica was in November 2023.

Appointments and accolades

Craig held several key roles at the University, including Assistant Vice-Chancellor PBRF, Director of the International Centre for Terrestrial Antarctic Research, Director of the DNA Sequencing Unit and Associate Dean Research within the School of Science, and was Professor of Biomedical, Molecular and Cellular Biology. His research also established close ties with Antarctica New Zealand where he also served as Deputy Director and then Director of the New Zealand Antarctic Research Institute.

Born in the United States, Craig earned his Bachelor of Science at the Florida Institute of Technology in 1976, and a Master of Science at San Diego State University in 1982. He completed his PhD at the University of California, San Diego's Scripps Institution of Oceanography in 1989.

In the early 90s, Craig worked as a postdoctoral Research Assistant at Oregon State University and took his first academic position at the University of Delaware in 1994. During this time, he researched the deepest parts of the ocean aboard the manned Deep Sea Submersible Alvin. Craig joined the University of Waikato in 2004 but continued to work part

time at the University of Delaware.

Generous personality

Beyond his scholarly achievements, Craig was known for his unwavering passion for mentorship. Countless students and colleagues benefited from his guidance, and his positive influence will be felt for years to come.

From Craig's arrival at Waikato, he began changing the paradigm on microorganisms in Antarctica, with several seminal contributions published with international coauthors in Nature journals.

In his early research career at the University of Delaware, Craig made many trips to the deep ocean floor aboard the Deep Sea Submersible DSV Alvin. From the DSV Alvin, Craig and his colleagues conducted in situ experiments and collected samples that allowed them to define previously unknown life around deep-sea hydrothermal vents.

In these deep, dark, very high-pressure environments, Craig and his collaborators discovered life thrived where the hot anoxic fluids mixed with cold oxygenated water in the ocean deep. These thermophilic microbes play an important role in converting chemical energy into food for the rest of the vent community, now known to include over 300 species. Craig and his team went on to explore and document the 'wilderness' of genes existing at the vents, in one of the first ever metagenomic studies of any environment.

Strong ties to Antarctica

Craig made discoveries that fundamentally changed how the scientific community views microorganisms in Antarctica. Most notably, his work led to the recognition of strong biogeographical patterns in Antarctic soil microorganisms, which has had profound scientific and biosecurity implications.

A $1m Marsden grant in 2019, saw a group of researchers complete a world first mission inside the high-temperature soils on the summit of Mount Erebus, the most southern active volcano on the planet. The group was led by Craig and discovered some of the rarest and oldest living organisms on Earth.

In March last year, Craig also undertook a world first survey for bird flu, where he monitored a colony of one million Adelie penguins, trekking nine hours in and around the colony to look for signs of infection. He also developed a robot that can sample planktonic communities under the Antarctic ice shelf to help forecast the future impacts of climate change.

Craig's most famous discoveries centred on Alvinella pompejana, the Pompeii worm, which revealed its remarkable survival capabilities in extreme conditions – making it the most thermal-tolerant organism known to science. His findings not only expanded our understanding of extremophiles but also held potential applications in pharmaceutical production. In 2021, Craig was part of a group of international scientists that were awarded a $1.8m grant from the world-renown Human Frontier Science Program to study the evolution of the epsilonproteobacteria's powerful flagellum.

A dedicated family man

While he will always be remembered for the passion he had for science, he was most proud of his role as a devoted husband, father, and grandfather. His family describes him as a loyal, generous, and loving man, who inspired them, along with countless students, colleagues, and young people around the world.

He and his wife Amy shared a love that spanned 35 years, and together they raised two children, Ky and Robin, whom he adored, and a grandson Rio, who he loved deeply. He was a wonderful provider who took an active role in his children's life. He was very proud of them and the partners they had chosen.

Stanley Kim Juniper

Mar 23, 1954 – June 7, 2024

It was another great idea hatched somewhere off the west coast of Canada. They were always coming – some realistic and others, perhaps a bit far-fetched. After the rest of us had long retired to our bunks, Kim Juniper would continue to dream in the aft lab: we could set up cameras to film worms fighting at vents; we could ship the ROV across the Pacific to explore volcanoes; we could buy a support ship and power it by hydrogen…(and only one of those was a partial failure). Those ideas kept coming, inspiring his colleagues and students. Kim was the epitome of a positive thinker even in the face of hurdles that would overwhelm most of us.

Kim was raised in the middle of Canada in a mid-sized town in Saskatchewan. His formative years left a life-long appreciation for wilderness adventure, swimming and canoeing, moose meat and indigenous knowledge. Yet, it was the books and films of Jacques Cousteau that resonated most deeply. After receiving a Zoology degree from the University of Alberta, Kim sought an ocean experience and landed on the mudflats near Christchurch, New Zealand. His doctoral work focussed on the interactions between deposit-feeding snails and microbes and the die was cast: the role of microbes in marine ecosystems became the central theme of his subsequent research programmes.

A post-doctoral position at the Institute of Ocean Sciences on Vancouver Island brought Kim back to Canada in 1982, where he took part in a dive in the Pisces IV submersible and discovered vast mats of sulphide-oxidizing bacteria on the bottom of Saanich Inlet. Eager to find more microbe-dominated ecosystems, he joined an expedition to hunt for hot vents on the Juan de Fuca Ridge the next year. The Axial Seamount cruise with Pisces IV opened his horizon to the deep ocean and the intricate relationships between biological and geochemical processes. Kim developed a breadth of interests and of colleagues: microbes in symbiosis, in worm mucus, affecting mineral deposition, and in vent community development. He took up a research associate position at IFREMER in Brittany, France, where he developed skills using deep-sea imagery to examine chemosynthetic community spatial patterns. Here, Kim formed lasting connections to France, not least because he met and married Laurence Patris. Frequent visits thereafter renewed research and family ties throughout his life.

An offer of a faculty position from the Université du Québec à Rimouski soon introduced Laurence to Canadian winters and Kim to travel restricted by snowfalls. Nevertheless, he maintained his interests in west coast ecosystems, sponsoring students to study both seamounts and the expanding discoveries of hot vents in Canadian waters. In 1991, Kim moved

to the Université du Québec à Montréal where he stayed for 15 years. Two children were born: Glenn and Fiona. At UQaM, Kim assumed Directorship of GEOTOP – a provincial inter-university training and research centre focussing on geosciences with special expertise in stable isotopes. Here, he explored the seasonal changes of Arctic sea-ice microbial ecosystems and denitrification in sediments. The work at hot vents continued and benefitted from GEOTOP expertise as Kim and his students explored a wide array of techniques to unravel relationships in the community . During this time, Kim was also involved in Canada's contributions to the Joint Global Ocean Flux Study (JGOFS).

Kim remained deeply committed to the development of access to Canada's deep ocean. After Pisces IV was sold, the Canadian government sponsored construction of an experimental ROV, ROPOS, in the late '80s . But it was a shaky start and ROPOS was soon passed to a nascent private organization: the Canadian Scientific Submersible Facility (CSSF). Kim and a handful of supporters raised money while a skilled team of technicians and pilots rose to every challenge – they were legends. Keith Shepherd, CSSF's General Manager, recalls that Kim was key in shaping the philosophy of support for science and for students. Kim was President of CSSF from 2001 to 2011 during which time securing funding for expeditions and upgrades was a constant challenge as the Facility strove to maintain a reputation for excellence. Kim developed business acumen as he helped to expand the user base to international clients, some of whom became research colleagues. To date, the ROV ROPOS has operated in four oceans.

The final move for the Juniper family came in 2006, when the University of Victoria offered Kim the prestigious British Columbia Leadership Chair in Ocean Ecosystems and Global Change. Here, he was appointed Professor in the School of Earth and Ocean Sciences and in the Department of Biology. Now, fieldwork was easier: the local mudflats, nearby Saanich Inlet, ROPOS and ships in the neighbourhood, plus the home base for the VENUS/NEPTUNE cabled observatories on campus. Born from the vision of John Delaney to cable the entire Juan de Fuca Plate, it was Canada that was able to move first. VENUS was the first test of concept as NEPTUNE Canada slowly gathered support to lay a cable loop to the hydrothermal vents 200 km offshore. Kim was deeply involved in proposals to fund science workshops in the late 1990s. He became co-Chief Scientist in the earliest days of NEPTUNE Canada. Later, he assumed the same role within Ocean Networks Canada. The Strategic Plan that Kim developed will guide ONC through to 2030. He was a tireless campaigner for the Observatory as his many travels raised awareness, gathered users, engaged partnerships and sought new tools to understand the changing ocean. Kim was particularly proud of the Indigenous Ocean Governance Forum at Ocean Observing '19 (Hawai'i) which he facilitated in many ways; he was very hopeful of growing relationships with indigenous communities around the Pacific. Due much to Kim's engaging approach to partnership, there are now observatories in the Pacific, Atlantic, Arctic and Antarctic oceans.

At the University of Victoria (UVic), Kim supervised another ten graduate students, the last of whom is set to graduate next spring. These students continued down some familiar research avenues—Saanich Inlet nitrogen cycling , mud flats, hot vent fauna and microbes—and, with his unwavering support, forged new research paths of their own (Arctic community research engagement, blue carbon, and symbiont population structure using CRISPR haplotyping). Kim always saw the value of Saanich Inlet as the "ideal natural laboratory" and supported two previous students in further research on nitrous oxide cycling by facilitating ship and lab access through the University. Even after his cancer diagnosis, he frequently asked about his remaining students to make sure they were well supported.

Kim was deeply proud of his students' accomplishments. He had a knack of playing to their strengths with humour and wisdom and opened many doors due to his extensive network of contacts. He also encouraged interests in social sciences and the arts (if you can write about it, then try performing it). When Paul Snelgrove of Memorial University hatched the concept of CHONe (Canadian Healthy Oceans Network) that would feature country-wide training of Canada's next marine scientists, Kim was all in. He served for 12 years in leadership and advisory roles as the network opened opportunities for more than 100 students and postdocs.

The great ideas continued to flow, even through the last year as Kim struggled with brain cancer; the positive view was still there. He dreamed of spending retirement writing a book about indigenous relationships with the sea in Hawai'i. He was ready: he had taken ukulele lessons. Kim's legacy lies in his research students (44 over his career), in 130+ publications, in formalized advice to several organizations, and in those ideas that still circulate.

Contributed by Verena Tunnicliffe, John Dower, Cat Stevens and Sheryl Murdock

Deep-Sea Biology Society News

First and foremost, the Deep-Sea Biology Society would like to express all its sympathy to Dr Erik Cordes, for the dedicated years he has spent supporting our community. His engagement as Development Officer to stir motivation and help find resources has been effective, proactive and always just. It was an honor to work and share ideas with you! Following Erik's departure, Dr Julia Johnstone, our recently appointed Non-Office Bearing Trustee, gracefully agreed to step up as Development Officer, temporarily.

"Temporarily", because the Society is imminently calling for nominations to renew the current pool of Trustees, which will be effective after a vote at DSBSoc's Annual General Meeting (AGM) planned for Tuesday, January 14th of 2025 - that is, during the 17th Deep-Sea Biology Symposium in Hong Kong (SAR, China). Yet, the call will be disseminated at the occasion of the upcoming DSBSoc's AGM of September 26th: you can already tell all your deep-sea research fellows!

Two Annual General Meetings within a year? Yes, you are not dreaming, we made it! Well… in fact the September AGM is meant to fulfill our legal obligation. The accounts of the year 2023 (due October) must be presented to the members and hopefully, approved by the members. A voting platform will remain open until the end of September for all members unable to attend this AGM to vote: an email with a link will be sent forth. At this first AGM, the agenda will also include remarks and an overview of our activities, reports from the Trustees, presentation of awards, the call for new Trustees nominations, and before discussion and Q&A for members, most exciting updates on the 17th Deep-Sea Biology Symposium.

The Local Organization Committee at the Hong Kong University of Science and Technology (HKUST), chaired by Prof. Pei-Yuan Qian (DSBSoc's Conference Officer), in collaboration with the Society, have attained key milestones for a promising 17th edition of the Deep-Sea Biology Symposium (17DSBS). More than 300 persons have already registered, mostly in person: we will propose fun solutions to offer an immersive experience to the 10% of registrants who opted for online participation. While held in Asia for the first time, most of the participants will come from Europe (40%). Nonetheless, 30% will represent Asia, including two third from China and Hong Kong, 20% will cross the Pacific Ocean from North America, but still too few of us will make the trip from southern areas, incl. Oceania or Latin America (3% each) and a single participant from Africa. But, registrations are not yet closed, and travel awards generously offered by HKUST, DOSI and DSBSoc surely will help increase diversity for our gathering! However, on September 1st the abstract application period ended. The LOC has received 230 requests for a talk and 80 for posters. The 12 sessions received between 7 and 45 oral communications proposals. Chairs have been notified and difficult decisions are currently carried out. Good luck, everyone.

With DSBS - our main, triennial event - the number of DSBSoc members increases and this year is no exception. In 6 months, during which 17DSBS was announced, a 23% increase was recorded and we now form a 431-strong group of deep-sea biology professionals. Of note, our "One-year Researcher from Developing Nations" membership level jumped from only 6 to 17 members (+183.33 %), and DSBSoc also attracted 17 new students for the next 3 years (+48.6%). Our largest group remains the "One-year Researcher or Professional" but yet has increased to a total 106 members (+19%). We are excited to welcome new faces at 17DSBS: please remember that new faces are welcome to populate our Hall of future Fame: on the "Meet the Next-Generation of Deep-Sea Research" and "Life After PhD" sections of the DSBSoc website: dsbsoc.org. Please contribute!

DSBSoc develops on the web, with archives from previous partner conferences, recollections of early-career Seminar

Series hosted (currently in private) on a new YouTube channel (youtube.com/@DSBSoc) and resources (currently curated), and the profiles of a fresh new group of diverse Artists inspired by life in the deep ocean. Indeed, DSBSoc offered 36 free "Artist" memberships to promote works of art and bridge Arts & Science. Currently, 25 DSBSoc Artists have provided art and we are working on activities gathering artists and scientists. A call has been sent to registered Artist members, for them to exhibit and value their art for our great delight and inspiration at 17DSBS. To join as a DSBSoc Artist, share your vision through art, and work with deep-sea scientists, please visit dsbsoc.org/art-science.

The Communications and Media Offices, with the help of tech-savvy volunteer members, are working at setting up a DSBSoc Server on Discord, a platform that is very similar to Slack. The DSBSoc Slack was created in 2018 after 15th DSBS in Monterey, CA, but out of the 900+ members that joined for this occasion and the following 16th DSBS in Brest, less than 100 are still active, and the channels are pauperized. Moreover, all messages and most useful shared links and engaging initiatives are now hidden behind a paywall that DSBSoc cannot afford. Discord does not have such limitations: we will slowly migrate to Discord, where 17DSBS participants will be invited to communicate online - stay tuned and tune in to our thriving social media news feeds on BlueSky (bsky.app/profile/dsbsoc.bsky.social), Instagram (instagram.com/dsbsoc), Mastodon (mstdn.science/@dsbsoc), and Twitter/X (x.com/DSBSoc).

Last but not least, the Deep-Sea Biology Society is proud to count amongst the many collaborators of the European "REDRESS" project: "Restoring deep-sea habitats to rebuild European Seas". Please visit the official website or contact our President, Dr. Michelle Taylor for more information and about involvement: redress-project.eu.

Our Society is as strong and useful as its members are active, communicating, and diverse in ideas and personalities. In the next months, we will do our best to stir engagement, and invite all - especially the many new members joining us for the first time at 17DSBS - to feel the good vibe of understanding and fun that characterizes the deep-sea research community. Look up for announcements!

On the behalf of the Trustees of the Deep-Sea Biology Society,

Franck Lejzerowicz - Communications Officer

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): 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): 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, Dr. Julia Johnstone (USA): development@dsbsoc.org
Communications Officer, Dr. Franck Lejzerowicz (University of Oslo, Norway): communications@dsbsoc.org
Media Officer, Janet Ferguson-Roberts and: socialmedia@dsbsoc.org