

2020

IMPACT REPORT







A WORD FROM OUR FOUNDERS

2020 was a year of adaptations across the world. During the dangerous global pandemic, Schmidt Ocean Institute was able to operate in new ways, under the leadership of our first Executive Director and with the help of our first formal Advisory Board. Our sea-going expeditions planned for Australian waters presented opportunities for innovation, as R/V *Falkor* remained one of the only research vessels in the world to operate throughout the year, leading to many notable discoveries.

We focused on bringing life to many stories of hope and wonder from the beautiful depths of Australia's waters during our first dedicated geographic campaign.

Among them were newsworthy sightings of the world's longest sea creature, a 45-meter siphonophore; a new coral reef standing taller

than the Empire State Building; more than 50 new potential species; and a rare video recording of the Ram's Horn Squid.

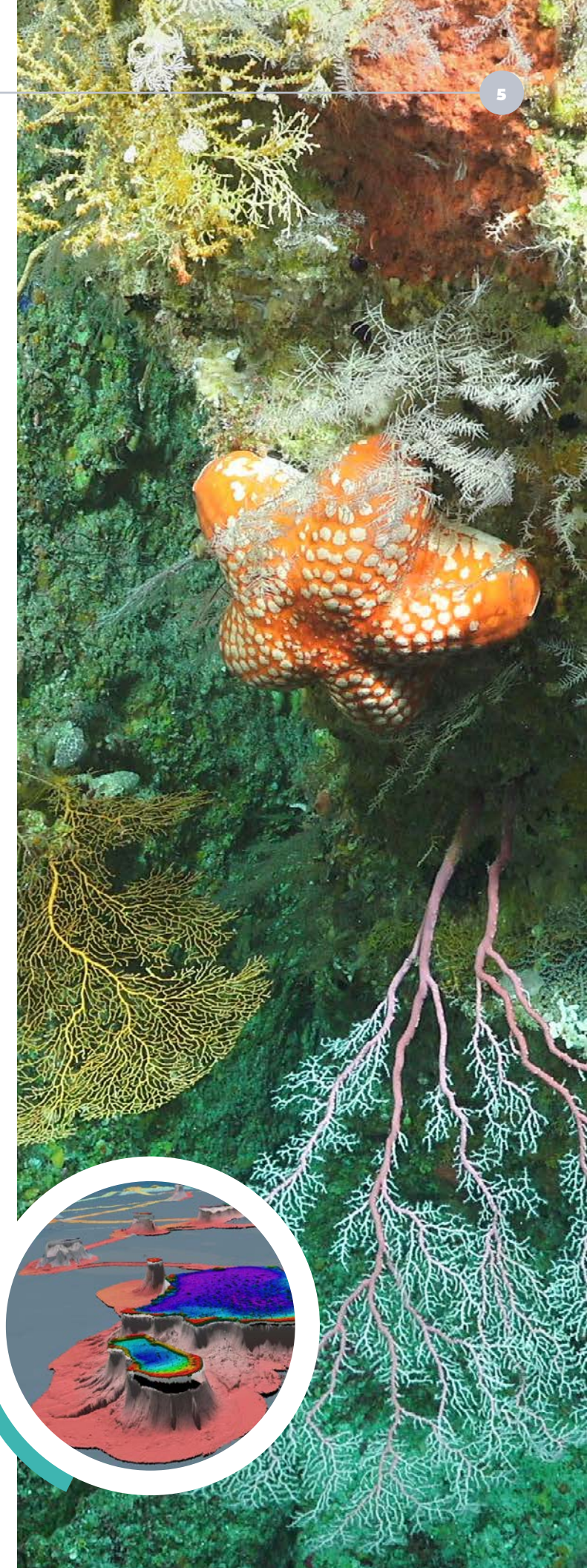
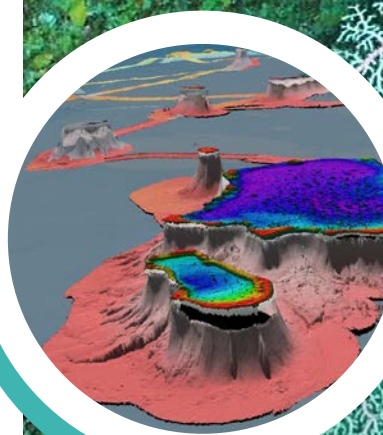
In a year where human interactions were restricted, these extraordinary moments filmed by ROV *SuBastian* were live-streamed for public audiences, making it possible for everyone with internet connectivity to experience the hidden treasures of the deep ocean.

We made connections with communities throughout Australia, sharing our findings using virtual events and our Artist-at-Sea program. Technology on *Falkor* allowed for our first completely remote expedition, with the science team joining virtually. Subsequent expeditions continued to connect scientists globally, providing expert input from living rooms around the world.

SOI continued to demonstrate our dedication to open data sharing by bringing novel and critical data to the world. The scientists and crew aboard *Falkor* mapped more than 153,500 square kilometers of previously unmapped seafloor and shared the new data with Seabed 2030 and AusSeabed, allowing almost real-time data of the seafloor. We were also the first external customer in 2020 to install the new Google Transfer Appliance (2.0) – a hardware used to securely migrate large volumes of data collected by *Falkor* to the cloud.

Expanding our commitment to advancing ocean knowledge, SOI launched our new grants program, first, funding student education through the National Ocean Science Bowl, and also important long-term measurements of the Ocean Keeling Curve. We strengthened our network of collaborators by convening philanthropically-funded marine science vessel operators to discuss our collective work at sea, and underwater vehicle operators to talk about the development and operations of scientific ocean technologies. Looking forward with optimism, SOI established new relationships in 2020, partnering with the Intergovernmental Oceanographic Commission of UNESCO to support the Ocean Decade for Sustainable Development and NOAA's Office of Exploration and Research.

We are about to embark on an exceptionally hopeful time for ocean science. The coming decade will be devoted to the rapid acceleration of ocean exploration, seafloor mapping, and equity of information and access, leading to management that will expand ocean protection for future generations. We intend to add to this momentum with our contributions using innovative technology platforms to aid in our discovery of our global Ocean.



AUSTRALIA

2020

1 Deep-Sea Coral and Canyon Adventure

January / February



Whale Fall

Bremer Canyon, Western Australia

A discovered whale fall (sunken whale carcass) was brought to the surface and contained numerous organisms, some of which may be new species.



Coral Graveyard Discovered

Leeuwin Canyon, Western Australia

Large coral graveyards such as this new discovery offer insight into environmental change over time, as well as the history of Earth's climate.

2 Illuminating Biodiversity of Ningaloo Canyons

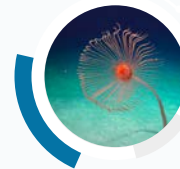
March/April



World's Longest Animal

Cape Range Canyon, Western Australia

This siphonophore - recorded by ROV SuBastian - is thought to be the longest organism in the world at 45 meters in length.



First Australian Deep Sea Hydroid

Cape Range Canyon, Western Australia

This giant hydroid, standing at over a meter tall, was the first ever documented in Australia.

3 Visioning the Coral Sea Marine Park

May/June



Pumpkin Star Range Extension

Lihou Reef, Coral Sea Marine Park

The "Pumpkin Star" was identified as a new genus and species in 2004. The collected footage substantially extends the species range.



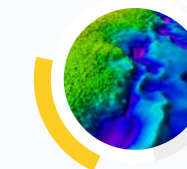
Tiny Find: Pygmy Seahorse

Ribbon Reef Canyons, Coral Sea Marine Park

Pygmy seahorses spend their adult life on a single gorgonian coral. They are one of the smallest seahorses and only grow to 3/4 of an inch.

6 Ice Age Geology of the Great Barrier Reef

November/ December



Capricorn Ridge Mapped

Capricorn Ridge, Southern Great Barrier Reef

Falkor mapped the Capricorn Ridge, thought to be the southernmost extent of the approximately 20 million-year-old foundation of the Great Barrier Reef.



Sykes Reef, Coral Sea

Sykes Reef

Mapping provided insight into what the Australian coastline looked like when the sea level was approximately 100 meters shallower during the last ice age.

4 Seamounts, Canyons & Reefs of the Coral Sea

August

Walking Scorpionfish

Tregrosse Reef, Coral Sea Marine Park

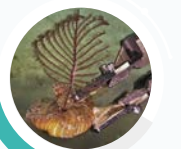
This rare species of walking scorpionfish is a range extension record for Australia.



New Black Coral Species

Herald Cays, Coral Sea Marine Park

Samples were taken of black coral thought to belong to the family schizopathidae, but DNA sequencing may reveal they belong to an entirely different family.



5 Northern Depths of the Great Barrier Reef

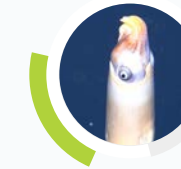
October/ November



New Detached Reef Discovered

Northern Great Barrier Reef

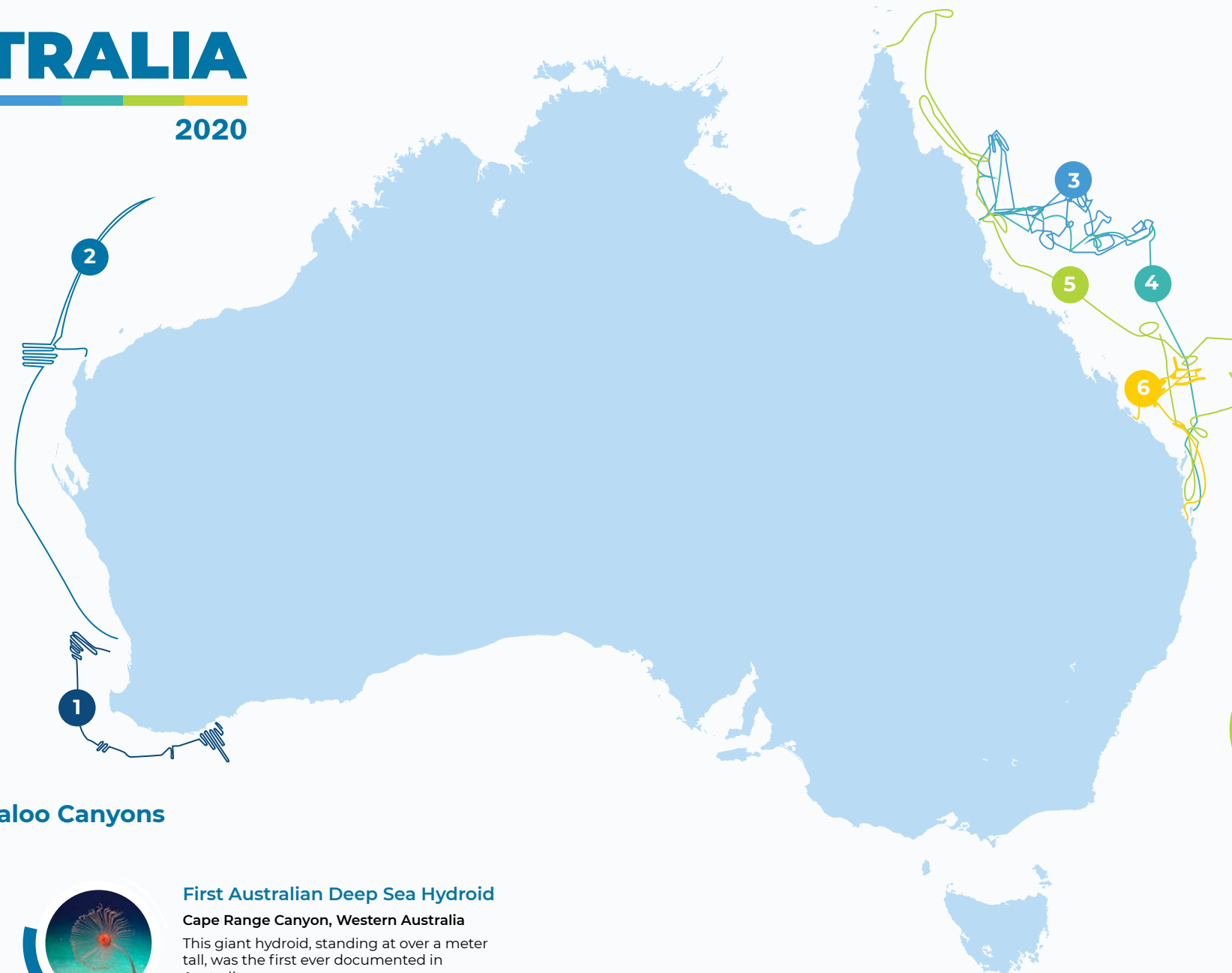
The 500-meter reef structure is taller than the Empire State Building. The last time a reef of this kind was found in the Great Barrier Reef was 120 years ago.



Ram's Horn Squid First Footage

Northern Great Barrier Reef

The first Ram's Horn Squid footage in the wild provided insight into its behavior, solving a long-held mystery within cephalopod science.







OUR YEAR IN NUMBERS

2020

10


 Expeditions

270+

 Science Days

75+  TB
 Terabytes of Public Data

84 
 Blogs

46 
 Science Videos

43 
 Science Publications

1000+ 
 Press Stories

119 
 Scientists

28 
 Scientific Organizations | from Australia

21 


11 MILLION+

people reached through SOI's Facebook, Twitter and Instagram


17,977

Publicly available data files downloaded from Marine Geo-Science Data System Repository

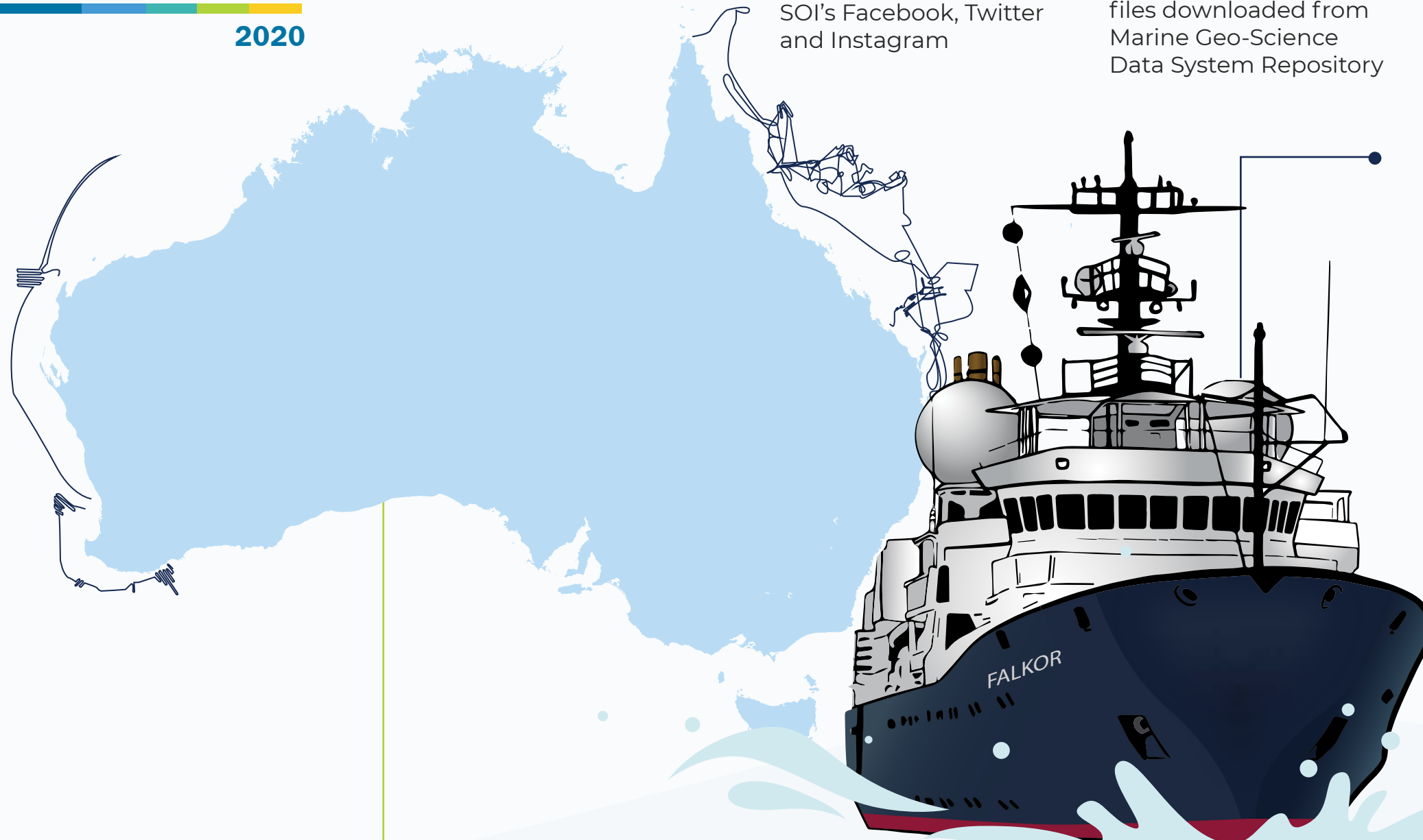

160,000

People attended virtual presentations, ship tours and ship-to-shore program

89 
 Underwater Robotic Dives

1809 
 Public Samples Collected

616 
 Hours Exploring Australia's Deeper Waters




74,894 KM SAILED
 The Equivalent of 3x the Entire Australian Coastline

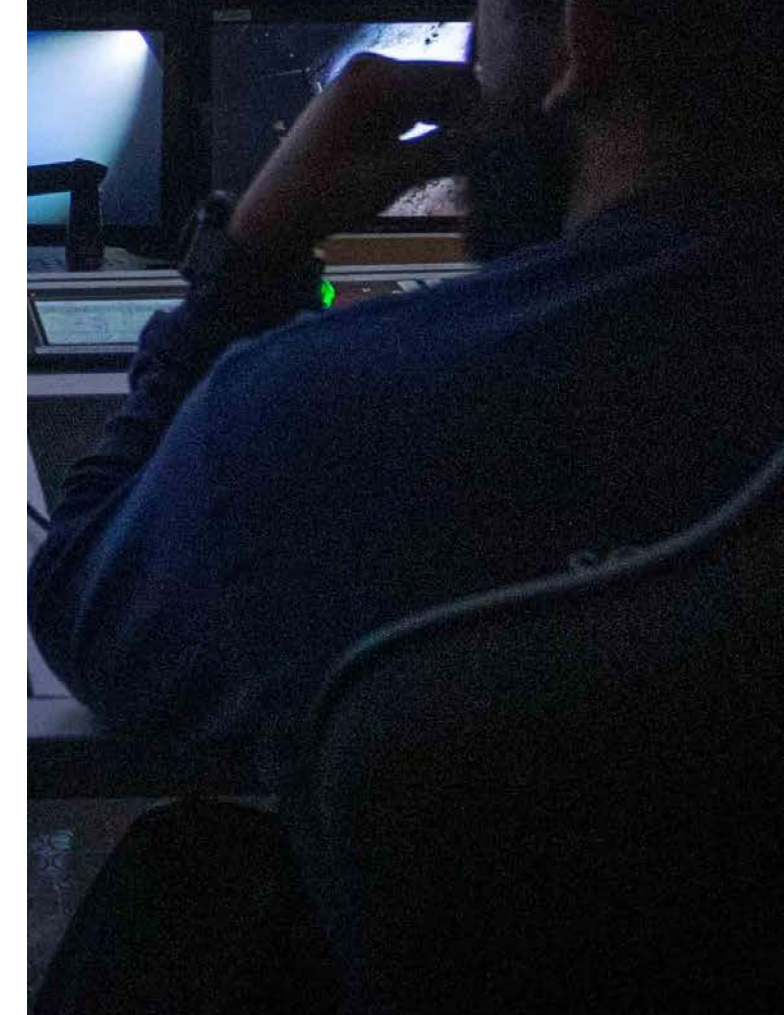

153,536+ KM²
 Of Australia's Seafloor Mapped



CONNECTING IN A VIRTUAL WORLD

This year, Schmidt Ocean Institute engaged with communities around the globe like never before. When R/V *Falkor* arrived in Australian waters at the beginning of 2020, nearly a thousand people came to the Welcome to Country ceremony and public ship tours in collaboration with the Australian National Maritime Museum. In February, SOI participated in the 2020 Ocean Sciences Meeting, introducing our first Executive Director and continuing our alumni event tradition, while also co-hosting the National Ocean Exploration Forum Town Hall and chairing other sessions and presentations.

SOI expanded outreach into the virtual realm in response to pandemic lockdowns, presenting plentiful opportunities for engaging with audiences. Virtual presentations reached almost 200,000 people, sharing knowledge at international assemblies such as the CogX Global Leadership Summit, UN Virtual Ocean Literacy Summit, Global Oceans 2020, World Economic Forum and Friends of Ocean Action Virtual Ocean Dialogues, and Australia Science Week. In the United States, we were proud to be a part of a series of the National Academies and Consortium for Ocean Leadership workshops and Capitol Hill Ocean Week.



In March, we launched our #SchoolsOutScience campaign to help support K-12 students with home learning. The campaign included lesson plans, videos, and interactive exercises. SOI also expanded our reach into communities with live virtual presentations to groups like The Ocean Race, Oceanic Institute, Sustainable Ocean Alliance, and Alta Sea. We were able to share our expeditions not only virtually, but also through film, print, and countless articles and productions.

SOI's footage was used by BBC's *A Perfect Planet*, two NHK documentaries, World Surf League, Parks Australia, and the United Nations. We graced two magazine covers and were featured in more than a dozen publications, including a partnership with *ECO Magazine* for a special issue on the deep sea. SOI was covered by over 900 media outlets, including BBC, the Guardian, CNN, Australian Broadcasting Corporation, and had three prominent features in the *New York Times*.

We completed the year with two awards recognizing our storytelling and digital outreach: The Maritime Foundation's Babcock International First Sea Lord's Award for Maritime Media and the Science Engagement Initiative of the Year as part of Western Australia Premier's Science Awards 2020. The amazing discoveries and imagery collected were the catalysts for connecting people to the ocean no matter their proximity to the sea.

2020 EVENTS

Ocean science is now available for public engagement - enabling a broader understanding of the ocean and building an informed appreciation. Listed below are just a few of the virtual events we hosted and participated in this year.

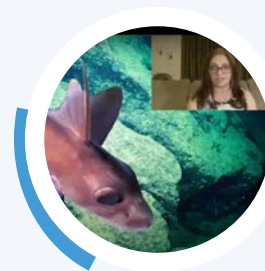


Celebrating ROV SuBastian 4th Birthday

April 24th, 2020

Schmidt Ocean Institute

A live event celebrating SuBastian's 4th birthday where we speak to ROV pilots and engineers.



Ocean Literacy Summit

June 8th, 2020

UN Decade of Ocean Sciences

Executive Director Dr. Jyotika Virmani participates in a panel discussion on the role of ocean literacy in transforming ocean knowledge into action as part of the Ocean Literacy Summit for World Oceans Day.



Capitol Hill Oceans Week

June 9th, 2020

National Marine Sanctuary Foundation

Executive Director Dr. Jyotika Virmani participates in the first virtual Capitol Hill Ocean Week in plenary session "A New Age of Ocean Exploration."



Women on the Water

August 12th, 2020

U.S. Habor

Executive Director Dr. Jyotika Virmani in conversation on mapping our deep seas, and the importance of the ocean and atmosphere to the health and well-being of coastal communities.



Virtual Ocean Dialogues

June 3rd, 2020

World Economic Forum

Executive Director Dr. Jyotika Virmani participates in the panel discussion: "The High Seas: Operating within the Global Commons."



Deep Sea Exploration and Stewardship

June 9th, 2020

Sustainable Ocean Alliance

Director of Communications Dr. Carlie Wiener participates in a panel discussion exploring the deep sea and what new discoveries have been made there recently.



Virtual Seabed 2030 Conference

June 11th, 2020

Marine Technology Society

Executive Director Dr. Jyotika Virmani participates in a panel discussion on partnerships and the marine industry role in Seabed 2030.

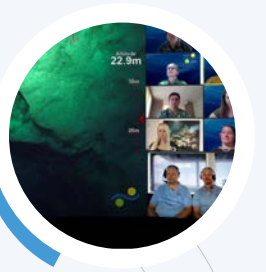


Exploring Unseen Oceans

August 25th, 2020

Australian National Maritime Museum

Director of Communications Dr. Carlie Wiener participates in a conversation with researchers on the ship and an audience in Australia as part of the Sydney Science Trail.



Celebrating World Ocean Day: SOI Brings the Ocean to You

June 8th, 2020

Schmidt Ocean Institute

This live event from R/V Falkor celebrates World Ocean Day by speaking with artists, students, and researchers that have sailed with us.



Understanding Deep Sea Exploration

June 9th, 2020

Cheddar/Curiosity Stream

Senior Research Manager Allison Miller is interviewed on news outlet Cheddar about SOI's new discoveries.



Teaching and Communicating Science in the Age of Social Media

June 26th, 2020

Goldschmidt2020

Director of Communications Dr. Carlie Wiener participates in a panel that explores ocean science messaging on social media platforms.



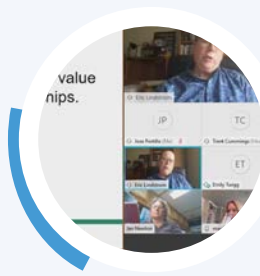
6th Marine Robotics Entrepreneurs Forum

August 26th, 2020

Woods Hole Oceanographic Institute's Consortium for Marine Robotics

Executive Director Dr. Jyotika Virmani participates in a panel discussion on entrepreneurs from labs to start-ups.

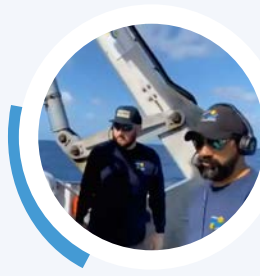
2020 EVENTS



NASEM Workshop on Sustaining Ocean Observations

September 16th, 2020
National Academies of Sciences, Engineering, and Medicine

Executive Director Dr. Jyotika Virmani participates in a panel that brings together diverse groups of stakeholders of ocean observations from multiple sectors.



Ship-to-Shore with MATE ROV

October 8th, 2020
MATE ROV

MATE ROV students connect with the science team and crew aboard R/V *Falkor* to talk about ROV SuBastian's capabilities, ROV team backgrounds, and the current expedition in the Coral Sea.



Ocean, Weather, and Climate Forum

November 4th, 2020
Esri

Executive Director Dr. Jyotika Virmani gives keynote presentation on "A New Golden Age of Ocean Exploration."



Three of the World's Top Female Ocean Explorers Talk Trailblazing Ocean Discovery and Conservation

November 11th, 2020
Alta Sea

Director of Communications Dr. Carlie Wiener joins a panel with other female explorers to discuss deep sea exploration and the path for women in exploration.



Race to Zero Dialogues

November 12th, 2020
World Economic Forum and Friends of Ocean Action

Executive Director Dr. Jyotika Virmani participates in a panel discussion on innovative and sustainable technologies be scaled to tackle climate change.



Unraveling the Mysterious Deep Sea, One Expedition at a Time - Dr. Carlie Wiener

November 14th, 2020
Geography 2050

Director of Communications Dr. Carlie Wiener presents on ocean exploration in Australia and finding new species.



Unraveling Australia's Deep Sea

November 18th, 2020
ARC Center of Excellence for Coral Reef Studies

Director of Communications Dr. Carlie Wiener presents on ocean exploration in Australia and finding new species.



Defend the Deep

December 10th, 2020
Sustainable Ocean Alliance

Director of Communications Dr. Carlie Wiener shares new footage of deep-sea biodiversity at this virtual event, while sharing voices from the frontlines likely to be directly affected by seabed mining.



Live with Taloi Havini and Chus Martínez: Artist-at-Sea Conversation

December 11th, 2020
TBA21-Academy

Live conversation with curator Chus Martínez and Bougainville-born artist Taloi Havini from R/V *Falkor* (sailing in northern Great Barrier Reef) as part of our Artist-At-Sea program.



In 2020, as a response to pandemic lockdowns, SOI expanded outreach into the virtual realm in an attempt to share science and research situations as opportunities for engaging with audiences.

The year's virtual presentations have reached almost 200,000 people, a testament for the hunger and power of sharing knowledge.



DOWN UNDER

For Schmidt Ocean Institute (SOI), 2020 held more surprises and discoveries than we could have imagined. SOI undertook a year-long initiative in Australia, conducting expeditions with interdisciplinary teams of scientists from partnering research institutions in Australia and around the world. Until *Falkor's* arrival, Australia did not have a dedicated science ROV for exploring deep waters. Our work allowed for some of the first visualizations of the continent's deep-sea environments. Astounding ROV footage unveiled gardens of glass sponges, massive gorgonia forests, and coral graveyards.

The collected imagery, samples, and data have important implications for protecting these underwater ecosystems and will aid in future management decisions within Australia's vast marine estate, including the Coral Sea, Gascoyne, and Great Barrier Reef Marine Parks. Alongside the underwater surveys, *Falkor's* mapping effort will help scientists better understand the Australian continent's history, its formation, and how ecosystems have responded to climatic shifts and tectonic movement in the geologic past.

THE GREAT AUSTRALIAN DEEP-SEA CORAL AND CANYON ADVENTURE



A large array of new habitats and ecosystems were documented in Australia for the first time.



#DeepCoralAdventure

1/26/2020 - 2/25/2020
Albany, Australia
Dr. Julie Trotter

University of Western Australia; Instituto di Scienze Polari (ISP); Instituto di Scienze Marine (ISMAR); Western Australian Museum

400
samples collected

32
days at sea

17
ROV dives

18
CTD casts

159
ROV dive hours

10,427
km² mapped

Expedition Objectives

ROV Expedition

Using high-resolution video imaging from the ROV SuBastian, deep-sea animals and their habitats were documented, as well as the biodiversity and distribution patterns of these unexplored ecosystems to depths of 4000 m.

Strategic Sample Collection

The ROV strategically sampled the benthos, specifically collecting dead/fossil coral skeletons. These collections will establish a unique reference collection for the Western Australian Museum and underpin post-cruise geochemical analyzes.

Physical & Chemical Environment Characterization

Comprehensive physical and chemical measurements of canyon waters will provide a present-day 'baseline' of environmental conditions and enable comparison with past records of environmental change extracted from the coral skeletons.

All of the data gathered during the cruise is new and reveals for the first time what occurs below the surface waters in these canyon systems.

Following the cruise, the skeletons of the collected corals and foraminifera will be analyzed at University of Western Australia's (UWA) state-of-the-art analytical facilities. The analysis will yield an understanding of the variables enabling these animals, like deep sea coral and sponges, to exist in such extreme environments.

The analysis will also aid in the quantification of deep-ocean warming and acidification over recent and potentially geological timescales (centennial to millennial).

Quantifying deep-ocean warming and acidification over longer time scales will provide an understanding of how deep-sea calcifiers (animals which produce a calcium carbonate shell, like coral) will likely be impacted in a high CO2 world.

By extending sampling into the deeper reaches of the Perth Canyon (4000 m) and re-sampling the fossil coral graveyards (~30-18 kyr) discovered in 2015, our collections and paleo records will be expanded within and beyond the Last Glacial Maximum period that occurred 20,000 years ago.

The outcomes of the research will inform the general public, authorities, and researchers about the existence of these unique and never before seen ecosystems, and will provide otherwise unavailable information about changing environmental conditions in the Southern Ocean, which plays a major role in regulating global climate. The immediate data collected during the cruise can be accessed and used by the Commonwealth Marine Park Authority (MPA). When the dive survey data, taxonomy, and canyon environmental conditions and geology are fully determined and integrated as habitat maps, these details will be provided to the MPA which the public will be able to access via the MPA website of the respective canyons.

NEW MAPPING OF CANYON DETAILS

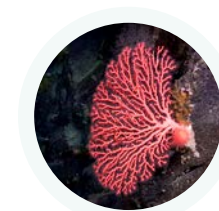
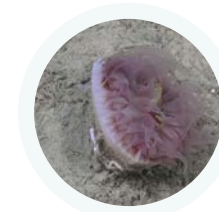
Maps will be created for the currently unmapped areas where data is poor and requires greater resolution.

A VARIETY OF NEW SPECIES

New species identifications are awaiting confirmation from taxonomists, but a variety of new invertebrate species were likely identified.

400 SAMPLES COLLECTED

Biological and Geological samples will aid in our understanding of these deep canyon ecosystems.





ILLUMINATING BIODIVERSITY OF NINGALOO CANYONS



The discovery of the (likely) longest animal on Earth, a 45m long siphonophore, *Apolemia sp.*



#NingalooCanyons

3/08/2020 - 4/08/2020
Fremantle, Australia
Dr. Nerida Wilson

Western Australian Museum, Curtin University, Geoscience Australia, Scripps Institution of Oceanography, Geraldton Senior High School, Macquarie University, Foundation for the WA Museum


32
days at sea


20
ROV dives


1018
samples collected

1ST 
high school student aboard *Falkor*

Expedition Objectives



eDNA Surveys

eDNA sampling was utilized to detect traces of animals left behind that may have not been encountered during surveys, which helped to expand the measurement of biodiversity in the region.



Geological Evolution Insight

Enhanced mapping of the area provided new data for Gascoyne Marine Park.



ROV Expedition

Twenty ROV dives resulted in 181 hours of footage and aided in the collection of specimens and deployment of gear. The deepest dive was 4,439 meters.

The deep-sea expedition was focused on discovering the biodiversity in two marine canyons in Gascoyne Marine Park off the mid-coast of Western Australia, in the eastern Indian Ocean. The main aim of the work was to better understand the biodiversity in the Cape Range and Cloates Canyons. The region is known for its extensive karst system and network of subterranean water bodies, which support an incredible diversity of evolutionarily significant fauna in the surface waters. The deeper waters were unexplored until this expedition. Investigating the deeper regions with ROV surveys yielded a stunning array of marine biodiversity.

The science completed during this expedition will allow the research team to formally describe many of the new species of animals that were found, develop ROV methodology for monitoring Marine Parks in Australia, and screen deep-water samples for environmental DNA in the Indian Ocean. The footage and specimens collected are important records within the Gascoyne Marine Park, and will aid in future management of the park.



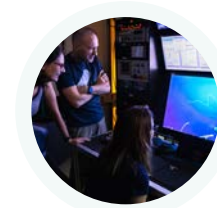
+30 NEW SPECIES

Specimen collections include the deepest fish records for Western Australia (4470m), first giant hydroids collected in Australia, and significant communities of glass sponges discovered in Cape Range Canyon. Along with new distribution and depth records of known species, this research also led to the discovery of up to 30 new species of marine animals.



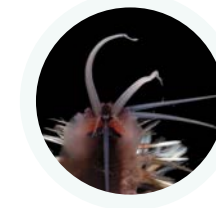
DEPLOYMENT OF ARMS

The deployment of five Autonomous Reef Monitoring Structures (ARMS) in the Cape Range Canyon was noteworthy as it was the first time that the ARMS had been deployed at abyssal depths.



11,218 KM² OF SEAFLOOR MAPPED

The new mapping data is necessary for continued management of the Gascoyne Marine Park.



UNPRECEDENTED FISH CAPTURES

The capture of fish using nets held by the ROV arm was unprecedented and resulted in 10 significant specimens collected.



VISIONING THE
CORAL SEA
MARINE PARK

We celebrated World Ocean Day during the expedition with a livestream bringing together Falkor's crew with scientist, students, and athletes to share their ocean experiences.



#VisioningCoralSea

04/29/2020 - 06/15/2020
Cairns, Australia
Dr. Robin Beaman

James Cook University, The University of Sydney, Geoscience Australia, Queensland Museum, Museum of Tropical Queensland, Biopixel, Coral Sea Foundation, Parks Australia

+13K 
km travelled

14 
ROV dives

1ST 
fully remote science team

4 
new drowned reefs found

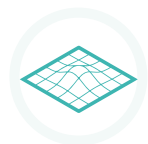
Expedition Objectives



Geological Evolution Insight

To collect visual data to allow the understanding of the physical and temporal changes that have occurred historically on the Queensland Plateau.

Within Australia's largest marine reserve, the recently established Coral Sea Marine Park, lies the Queensland Plateau, one of the world's largest continental margin plateaus at nearly 300,000 square kilometers. Here a wide variety of reef systems range from large atolls and long banks to shallow coral pinnacles. This region is virtually unmapped.



Mapping Seafloor

To map, in detail, the steeper reef flanks using high-resolution multibeam mapping.

This project addresses a range of priorities of the Australian Government in terms of mapping and characterizing a poorly known frontier area of the Australian marine estate.



ROV Expedition

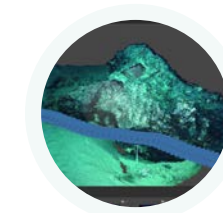
To document deep-sea faunas and their habitats, as well as the biodiversity and distribution patterns of these unexplored ecosystems. Additionally, the ROV dives will help to determine the extent and depth of coral bleaching.

The seabed mapping of reefs and seamounts in the Coral Sea Marine Park is a high priority for Parks Australia, the managers of Australia's Commonwealth Marine Parks. The new multibeam data acquired will be added to the national bathymetry database hosted by Geoscience Australia and released through the AusSeabed Data Portal.

Information from the ROV imagery, such as new species or range extensions, will be added to the living resources databases managed by the Australian Government and made publicly available. Parks Australia will utilize the derived information to communicate the important environmental values of the Coral Sea Marine Park to the broader community.

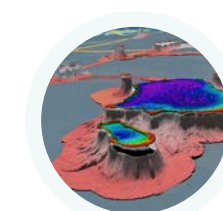
The information from this research is likely to be of great interest to the general public, who were widely consulted on the zoning and activities prior to the nearly 1 million square km Coral Sea Marine Park being declared in 2017 – the largest Marine Park in Australia.

Having 4K-resolution underwater video imagery of the deeper reef environments of the Coral Sea, allows us to tell the full story of the interconnected environments of the Coral Sea. This vision is invaluable for educational, social and mainstream media platforms.



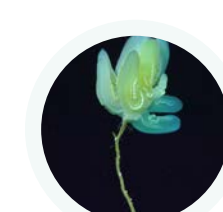
+35,554 KM² WERE MAPPED

with high-resolution multibeam depth data, an area larger than half the size of Tasmania. The depths mapped ranged from 2800m to 80m.



NEW MAPPING REVEALS COMPLEX SEAFLOOR

including submarine canyons, dune fields, submerged reefs, underwater landslides, and huge debris blocks scattered around the periphery of the reefs.



10 NEW MARINE SPECIES

were observed, as well as new significant range extensions for fishes in the genus *Odontanthias* *Hollardia* *Bodianus* *Roa*.



SEAMOUNTS, CANYONS, AND REEFS OF THE CORAL SEA



At least 3 new coral species were discovered.



#VisioningCoralSea

8/02/2020 - 8/30/2020
Cairns, Australia
Dr. Brendan Brooke

Australian Government, James Cook University, The University of Sydney, University of Tasmania, Queensland Museum, Parks Australia, Biopixel, Marine Biodiversity Hub, University of Wollongong, JAMSTEC



30
days at sea



21
ROV dives



114
ROV dive hours



226
samples collected



14,572
km² mapped



At least **3**
new coral species

Expedition Objectives



Mapping Seafloor

High resolution maps of the seabed revealed new detail about the geomorphic processes operating within canyons and around the edges of reefs and seamounts.



Characterize Seabed & Affiliated Communities

By acquiring biological data and samples and comparing them with seabed geomorphology and geology, jellyfish communities and oceanographic data, we can reveal the features and processes driving biodiversity patterns in deep-water settings around the Queensland Plateau.



Epibenthic & Plankton Communities Survey

Surveying reef margins along the Queensland Plateau will indicate their potential to provide refuges for communities impacted by a rapidly warming marine environment, and reveal the influence of past lower sea levels on reef morphology and the present-day spatial patterns of biodiversity.

The overarching goal of this research was to identify the influence of long-term environmental processes on the present-day characteristics and distribution of seafloor biological communities in an important but poorly known region of Australia's marine area-- the northern Great Barrier Reef (GBR) and adjacent Queensland Plateau. We vastly improved our knowledge of seafloor environments in this unexplored region, by identifying seafloor community relationships for predictive modeling of communities, and helping to develop an integrated understanding of Australia's Coral Sea ecosystem through highly interdisciplinary research.

The combination of high resolution seabed mapping, ROV observations and samples provides us with robust data sets from which we can build models of habitat distributions for the Coral Sea Marine Park and canyons in the Great Barrier Reef Marine Park. Importantly, models can be built to represent patterns across depths and across geomorphic features like reefs, canyons, seamounts, which will aid in our understanding of these deep sea habitats. These new maps, samples and images, give us a new understanding of the geological diversity and biological wealth contained in different zones of the Coral Sea Marine Park. This information can support implementation of management plans for the marine parks.



AN UNBLEACHED REEF

Imagery was captured of a huge extent of mesophotic (deep) coral reef in the Coral Sea Marine Park, with no evidence of bleaching from recent events that impacted the Great Barrier Reef in 2020.



BETTER UNDERSTANDING OF LAND/SEA CONNECTIONS

Improved understanding of the link between the Great Barrier Reef lagoon and outer reefs, with data collected that maps the pathways of sediment transport from reefs to submarine canyons and the deep sea.



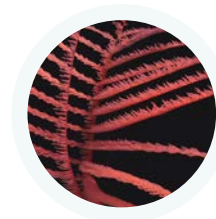
ANCIENT REEFS REVEALED

Multibeam mapping reveals ancient reef platforms submerged in hundreds of meters of water. A sample of 40-50 million-year-old mudstone was collected, which is what the reef sits on top of. This is the first collection of its kind.



FIRST EVER PHOTOGRAPHY

First ever photography and samples of deep water seabed habitats in the Great Barrier Reef Marine Park, with cameras taken down to 1800 m in the Ribbon Reef submarine canyons.



NEW SPECIES OF CORAL AND JELLIES

Several undescribed species of jellyfish and corals were collected for taxonomic and genetic analysis.



RARE FISH SPOTTED

First recorded observation for Australia of an extremely rare fish, *Rhinopias agroliba* – located in the deeper waters of the Tregrosse Reefs (Coral Sea). The extent of its range was thought to end in Hawaii.

NORTHERN DEPTHS OF THE GREAT BARRIER REEF



#EdgeGBR

09/30/2020 - 11/17/2020
Brisbane, Australia
Dr. Robin Beaman
Dr. Mardi McNeil

James Cook University, Queensland University of Technology, University of Queensland, University of Sydney, Geoscience Australia, Queensland Museum, Museum of Tropical Queensland, CSIRO, Biopixel, Coral Sea Foundation, Parks Australia, JAMSTEC, University of Grenada


49
days at sea


10
ROV dives


1
CTD cast


158
samples collected


70
ROV dive hours


28,248
km² mapped

The Ram's Horn Squid was recorded in situ for the first time and confirmed previously held suspicions around its swimming orientation and behavior.



Expedition Objectives

Exploring a Frontier

The northern range of the Great Barrier Reef was poorly mapped prior to this expedition and no ROV surveys had been conducted in the region.

Understanding the Past

The mapping aimed to prove the existence of any possible fossil fringing reefs and wave-cut caves that might indicate where sea level was shallowest during the Last Glacial Maximum.

ROV Expedition

Using ROV SuBastian, we gained a better understanding of the depth trends and habitat preferences of deep and cold water coral communities and mesophotic coral ecosystems of the far northern Great Barrier Reef.

The Cape York Peninsula lies in the far northern Great Barrier Reef Marine Park. The peninsula is one of the most isolated regions of the Australian continent and prior to this expedition, little was known about what was beneath the offshore deeper waters. Sparse information from previous mapping expeditions indicated complex deep sea canyons, massive landslides, and seven detached mesophotic reefs rising up from 500 meters below the sea surface. Mapping revealed complex undersea bathymetry and an eighth detached reef was discovered. Subsequent ROV surveys documented thriving new reef ecosystems, significantly expanded the ranges for multiple species, and captured live footage of rare organisms for the first time.

The 49-day project focused on the offshore Cape York Peninsula area through multibeam mapping of the shelf edge and upper continental slope adjacent to the barrier reefs, and around the seven detached reefs in the Great Barrier Reef Marine Park. The expedition was split into three legs and there were ten ROV dives. The Leg 1 transit northward from Brisbane to Cairns mapped the newly-discovered 'Swain Slide,' a 20 km long underwater landslide that was partially mapped. Mapping the debris field to completion provided understanding of the entire slide area, and was important for understanding the natural hazards which shaped the Great Barrier Reef edge in the geological past.

The offshore Cape York Peninsula area was the focus of Leg 2. The upper continental slope and shelf edge was thought to preserve a record of drowned reefs that now represent a key habitat for

modern mesophotic reef communities. The expedition also mapped around the seven detached reefs to better understand the platform they sit on. A new 500 meter detached reef was uncovered during this leg of the expedition. ROV dives took place in the midwater and along multiple geologic habitats including an undersea landslide area, deep plunge pool environments, contrasting submarine canyons, and drowned reefs. Several dives demonstrated a variety of mesophotic reef habitat with different ecological communities based on how steep or gentle the slope was. Potential new species were documented, many species ranges were extended, and several other species were recorded alive for the first time.

The Leg 3 transit from Cairns to Brisbane provided an opportunity to map a long (~70 km) section of the Swain Reefs shelf edge and upper slope that had no previous multibeam data. The location was important because we did not know where the edge of the Great Barrier Reef was in the very remote Swain Reefs area. Leg 3 was also an opportunity to map around the steeper flanks of the Coral Sea Marine Park's Saumarez, Frederick, Kenn, Wreck and Cato Reefs. These coral reefs grow upon the remains of extinct volcanoes: the Tasmantid Seamounts. Visits to several of the reef's islands were conducted to provide visual records of their present condition for Parks Australia marine managers. Overall, the project addressed knowledge gaps for the Great Barrier Reef Marine Park Authority (GBRMPA) in terms of mapping and characterizing a poorly known frontier area of the Great Barrier Reef Marine Park.



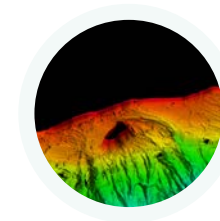
NEW 500-METER TALL DETACHED REEF

A ~500 m tall detached reef was discovered, the first in over 100 years, bringing the total number of detached reefs in the Cape York area to eight.



HEALTHY REEFS & NEW CORAL SPECIES

There was no evidence of mass bleaching in the corals observed within the mesophotic zone to ~50 m and at least three suspected new black coral species were collected.



AUSTRALIA'S GEOLOGIC PAST

High definition mapping of seafloor features and rock/sediment samples provide data for understanding the formation of the Australian continent and the Great Barrier Reef.



A YEAR LIKE
NO OTHER

There are predicted to be millions of unknown species whose function and contribution to the ocean, global ecosystem, and human health are still unrevealed. Understanding goes hand in hand with technology, but we have not had the tools to enable a complete view of the ocean until very recently.

Advances in technology have allowed for groundbreaking discoveries, including new species and behaviors like those recorded this year in Australia. *Falkor's* multibeam sonars uncovered exciting new seafloor features, including a massive drowned waterfall basin and a 500-meter tall detached reef in the Great Barrier Reef - the first discovered in this area in the last 120 years.

ROV SuBastian aided in discovering over fifty suspected new species and recorded several known species in the wild for the first time, including the Ram's Horn Squid and the Short-tail Catshark. Footage of what is thought to be the longest animal on Earth- a 45-meter long siphonophore- was recorded, among other exciting finds; including new species of coral, massive range extensions for species like the pumpkin star, and the discovery of giant hydroids in Australian waters for the first time. The achievements of SOI and the scientists who joined us this year from institutions in Australia, Japan, Italy, and the United States made more than 50 top scientific discovery lists for 2020, including in National Geographic and Smithsonian Magazine.

2020 DISCOVERIES

In high-risk, high-reward science and exploration, we do not know what we may discover. This year certainly proved rich with findings. Here are a few of our favorites:



New Deep-Sea Coral Ecosystems

Overall Expedition | Dive 312-331
Perth, Bremer, & Leeuwin Canyons
Multiple new types of deep-sea coral ecosystems were uncovered in Western Australia throughout the expedition.



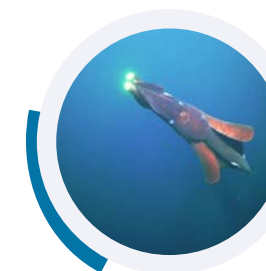
Solitary Cup Coral

Feb 8, 2020 | Dive 318
Bremer Canyon
Originally found in the Southern Ocean around Antarctica, the discovery of this coral off the West Coast of Australia demonstrates the influence of the Southern Ocean in some of Australia's deep marine ecosystems.



Siphonophore (Apoemia sp.)

Mar 16, 2020 | Dive 336
Cape Range Canyon
This siphonophore had never been previously seen and is thought to be the longest seacreature in the world at 45 meters in length.



Taning's Octopus Squid (Taningia danae)

Mar 21, 2020 | Dive 343
Cape Range Canyon
This was the first observation of the species in Western Australia.



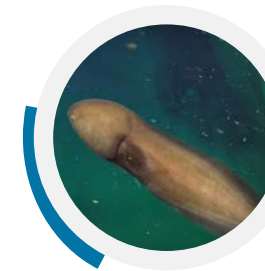
Whipnose Anglerfish (Gigantactinidae sp.)

Jan 27, 2020 | Dive 312
Bremer Canyon
The recording of this fish was the first time the genus was reported in Australia.



Pedestal-Shaped Coral Graveyard

Feb 18, 2020 | Dive 327
Perth Canyon
Large coral graveyards like this pedestal-shaped one offer insight into environmental change over time and the history of Earth's climate.



Faceless Cusk Eel (Typhlonus nasus)

Mar 20, 2020 | Dive 341
Cape Range Canyon
The sighting of this eyeless fish was the deepest record of it, as well as the first time it was observed outside of Queensland and on the western side of the continent.



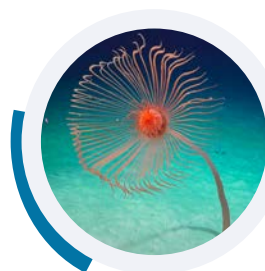
Leptoseris Coral Fields

Jun 2, 2020 | Dive 365
South Diamond Islet
Leptoseris Coral Fields are well characterized in Hawaii but had never been observed in the Coral Sea until these dives.



Natural Whale Fall

Jan 31, 2020 | Dive 315
Bremer Canyon
A discovered whale fall (sunken whale carcass) was brought to the surface and contained numerous organisms, some of which may be new species.



Giant Hydroid (Branchiocerianthus sp.)

Mar 15, 2020 | Dive 337
Cape Range Canyon
This giant hydroid, found at 2497 meters depth, was over a meter tall. Giant hydroids have never been observed in Australian waters before, so this one might be a new species.



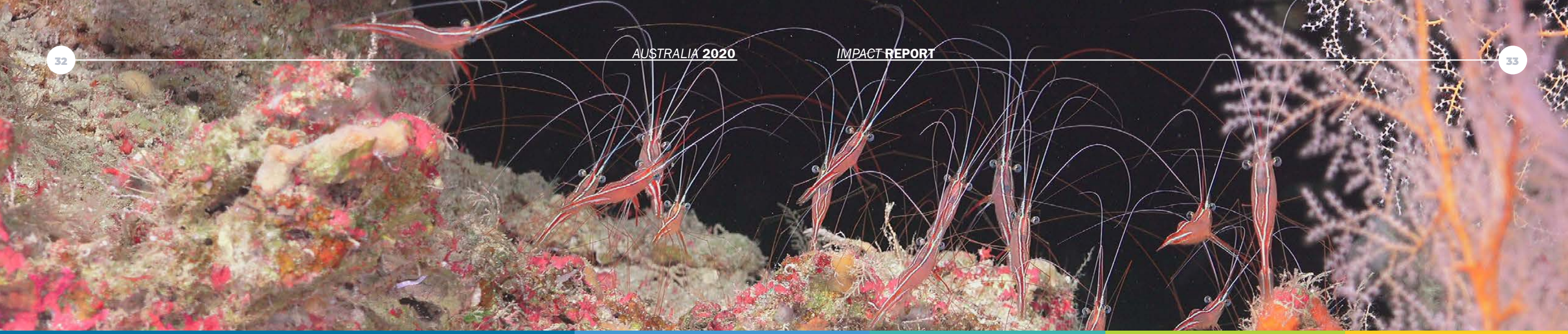
Glass Sponge Communities

Mar 20, 2020 | Dive 342
Cape Range Canyon
Many old and new sponges were found, indicating a rich diversity and history in the area.



Pumpkin Star (Astrostarkus)

Jun 6, 2020 | Dive 336
Lihou Reef
Identifying this particular species of "pumpkin star" (first described in 2004) during an ROV dive resulted in a substantial range extension for the species.



Deepwater Spike Fish (*Hollardia goslinei*)

Jun 6, 2020 | Dive 368
Lihou Reef

This deepwater spike fish was thought to be native to Hawaii, but footage of the fish in Australian waters extended its significantly further from its original "home range."



Deep-Sea Scleractinian & Soft Corals

Aug 21, 2020 | Dive 390
Osprey Reef

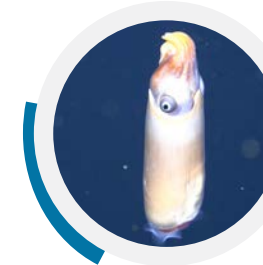
The deepest specimens of soft and stony corals ever collected in the Coral Sea.



Dumbo Octopus (*Grimpoteuthis sp.*)

Oct 5, 2020 | Dive 395
Noggin Canyon

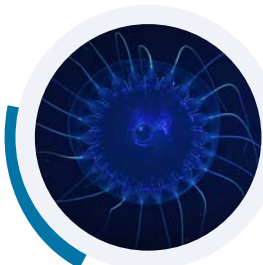
The team spotted a dumbo octopus that was displaying highly unusual behavior. Researchers are still unsure what was happening, though many speculate it could have been predated upon another octopus or holding onto a mate.



Ram's Horn Squid (*Spirula spirula*)

Oct 26, 2020 | Dive 402
Wreck Bay Plunge Pool

The Ram's Horn Squid is well known for its spiral shell, that washes up on beaches around the world. However, no scientist has seen this animal alive in its natural environment until ROV SuBastian recorded footage of it during a midwater dive.



Midwater Jelly Survey

Aug 6, 2020 | Dive 374
Cairns Seamount

The first survey conducted of midwater jellies in the South Pacific.



Walking Scorpionfish (*Rhinopias agroliba*)

Aug 24, 2020 | Dive 392
Tregrosse Reefs

The first-ever recording of this rare species of walking scorpionfish in Australia significantly extended its range.

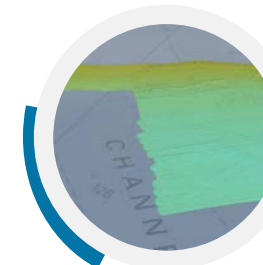


Short-Tail Catshark (*Parmaturus bigus*)

Oct 17, 2020 | Dive 399

Southern Small Detached Reef

The short-tail catshark is one of the rarest species of sharks in the world, known from a single specimen collected from the southern Coral Sea. We documented three new specimens of this shark throughout the year.

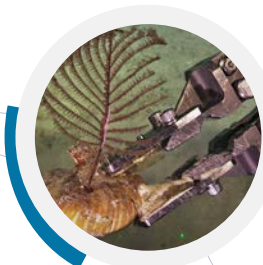


Capricorn Ridge

Nov 2020

Capricorn Ridge

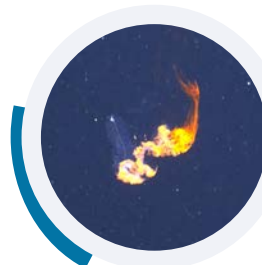
R/V *Falkor* and team fully mapped a distinctive cliff feature at approximately 200 meters depth; it is thought to be the southernmost extent of the ~20 million-year-old base of the Great Barrier Reef.



New Black Coral Species

Aug 7, 2020 | Dive 376
Herald Cays

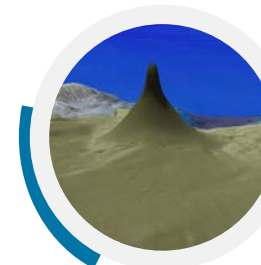
Samples were taken of black coral and may reveal they belong to the family schizopathidae, but DNA sequencing may reveal they belongs to an entirely different family.



Fiery Siphonophore

Sept 30, 2020 | Dive 393
Northeast Fraser Island

This brilliant, bright orange siphonophore is thought to potentially be a new species.



500m Detached Reef

Oct 25, 2020 | Dive 401
Southern Detached Reef

A geologic structure of this kind and size had not been discovered in the Great Barrier Reef for the past 120 years.



Presence of Ooids

Nov 2020

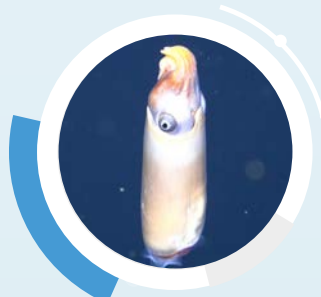
Capricorn Channel

The presence of ooids (a sediment grain made from calcium carbonate) in deep water provides insight into the ancient geological makeup of the Great Barrier Reef and gives insight into historic sea levels.



IN PERSPECTIVE

Life varies greatly in size, shape, and appearance throughout the ocean. Likewise, Schmidt Ocean Institute's 2020 findings came in all shapes and sizes, from the tiny one-centimeter pygmy seahorses to the lengthy 45-meter siphonophore, proving that there is so much left to explore in the global ocean.



Ram's Horn Squid
Spirula spirula
4.5 cm



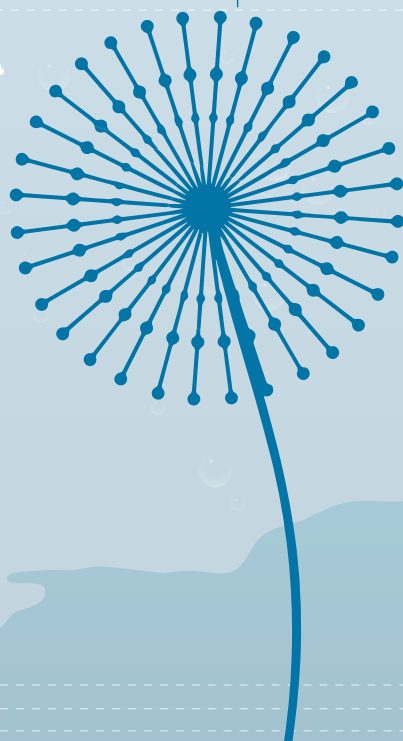
Giant Hydroid
Branchiocerianthus sp.
1 m



Pygmy Seahorse
Hippocampus bargibanti
1.4 cm



Walking Scorpionfish
Rhinopias agroliba
15 cm



100 cm

15 cm
4.5 cm
1.4 cm



Newly Discovered Detached Reef
500 m

Measuring more than 500m, it is taller than the Empire State Building, the Sydney Tower, and the Petronas Twin Towers

Giant Hydroid
Branchiocerianthus sp.
1 m



Siphonophore
Apolemia sp.
45 m

500 m

380 m

45 m

1 m





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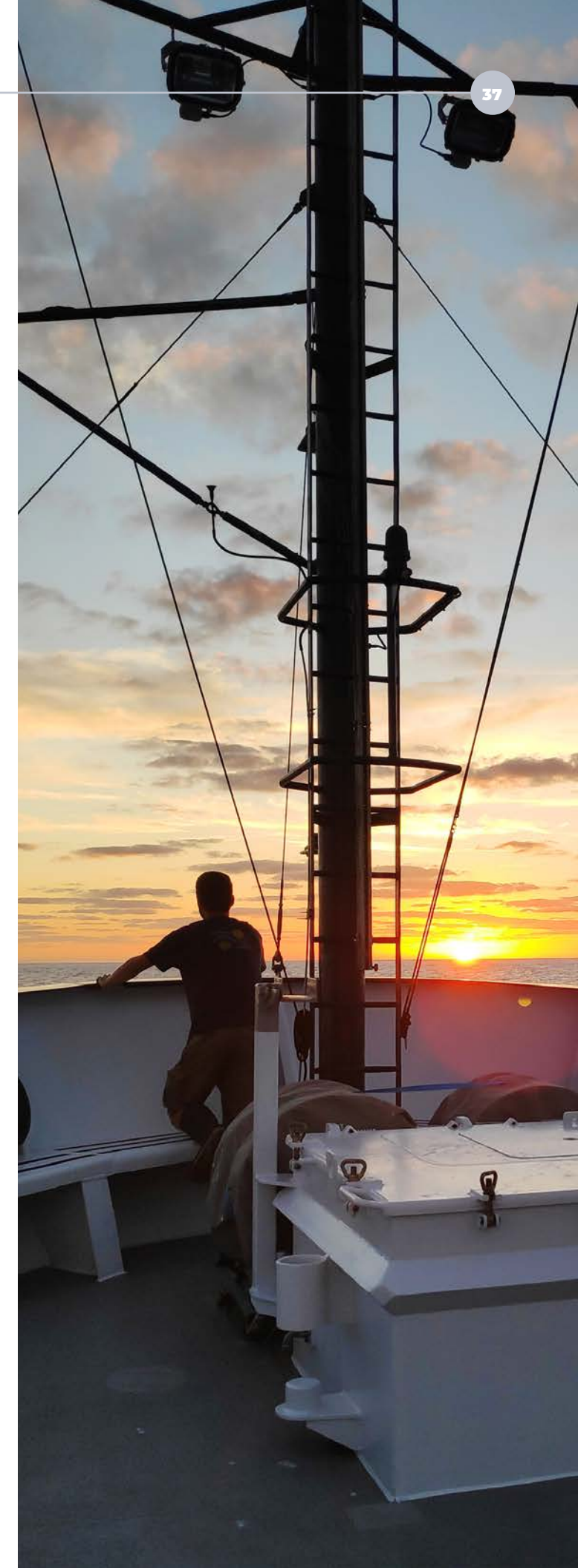
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Wolf, M., Goodell, M., Dong, E., Dove, L., Zhang, C., Franco, L., et. al. (2020). A Link between the Ice Nucleation Activity and the Biogeochemistry of Seawater. *Atmos. Chem. and Physics*, 20(23), doi: 10.5194/acp-20-15341-2020.

Yamada, T., Prugel-Bennett, A., and B. Thornton. (2020). Learning Features from Georeferenced Seafloor Imagery with Location Guided Autoencoders. *Journal of Field Robotics*, doi: 10.1002/rob.21961.

Zappa, C., Brown, S., Laxague, N., Dhakal, T., Harris, R., Farber, A., and Subramaniam, A. (2020). Using Ship-deployed High-endurance Unmanned Aerial Vehicles for the Study of Ocean Surface and Atmospheric Boundary Layer Processes. *Front. Mar. Sci.* 6:777, doi: 10.3389/fmars.2019.00777.

Zhang, Y., Kieft, B., Hobson, B., Ryan, J., Barone, B., Preston, C., et. al. (2020). Autonomous Tracking and Sampling of the Deep Chlorophyll Maximum Layer in an Open-ocean Eddy by a Long Range Autonomous Underwater Vehicle. *IEEE Journal of Oceanic Engineering*, 45(4), doi: 10.1109/JOE.2019.2920217.



Student Dissertations from SOI-supported work

Weber, S. (2020). Nitrogen fixation in the Monsoon Impacted Mekong River Plume, PhD Dissertation, University of Rostock.

Scientific Presentations in 2020 resulting SOI-Supported work

Ashford, O., Guan, S., Capone, D., Rigney, K., Rowley, K., Cordes, E., et. al. (2020). A Chemosynthetic Ecotone- 'Chemotone'- Surrounds Deep Sea Methane Seeps. Oral Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Baker, I., Girguis, P., Michel, A., and Wankel, S. (2020). Characterizing the Role that Iron-oxidizing Bacteria Play in Iron and Carbon Biogeochemical Cycling at Deep-sea Methane Seeps. Poster Presentation, Gordon Research Conference on Geobiology, Galveston, TX, USA.

Barlett, D. (2020). Microbial Life at the Greatest Ocean Depths, Guest Lecture, Montana State University, Bozeman, Montana, USA.

Billings, G. and Johnson-Roberson, M. (2020). Visual Methods Towards Autonomous Underwater Manipulation, Oral Presentation, Underwater Intervention, New Orleans, LA, USA.

Blum, J., Drazen, J., Johnson, M., Popp, B., Motta, L., and Jamieson, A. (2020). Contrasting Hg Isotope Ratios from the Kermadec and Mariana Trenches, Oral Presentation, Goldschmidt Conference, Virtual.

Borges de Sousa, J. (2020). Exploring Dynamic Features of the Ocean with Coordinated Multi-domain Vehicle Systems. Oral Presentation, Underwater Intervention, New Orleans, LA, USA.

Borges de Sousa, J. (2020). Systems and Technologies for Multi-domain Synoptic Ocean Observation. Oral Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Borges de Sousa, J. (2020). Exploring the Pacific Subtropical Front with Coordinated Ship-robotic Surveys. Oceanology International, Virtual.

Brooke, B., Nichol, S., Huang, Z. (2020). Submerged Coasts on the Australian Continental Shelf & Offshore Islands. Oral Presentation, Submerged Paleoshorelines of the Southern Hemisphere Webinar, Virtual.

Cordes, E. (2020). Exploration of Hydrocarbon Seep Ecosystems and their Ties to the Deep Ocean and the Blue Economy, Oral Presentation, NOAA Seminar Series, Virtual.

Cordes, E. (2020). Exploration to Inform Management of the Blue Economy and to Protect Hydrocarbon Seep Ecosystems, Oral Presentation, iAtlantic Webinar Series, Virtual.

Cordes, E. (2020). Deep-sea Exploration for Research, Assessment, and Management. Invited Lecture, University of Rhode Island, Narragansett, RI, USA.

Daniels, J., Khan, A., Lord, J., Katija, K., Barry, J. (2020). Characterizing Animal-fluid Interactions in the Deep Sea Benthos using Combined DeepPIV and Respiration Measurements. Oral Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Ganguly, U. and France, S. (2020). Role of Depth and Substrate in the Evolution of Sea Pens (Pennatulacea, Octocorallia): a Phylogenetic Study. Poster Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Gerringer, M., Yancey, P., Tikhonova, O., Vavlov, N., Zgodá, V. and Davydov, D. (2020). Evolving Pressure-tolerance in Enzymes of Abyssal and Hadal Fishes. Oral Presentation, Deep-Sea Biology Meeting, Virtual.

Gerringer, M., Yancey, P., Tikhonova, O., Vavlov, N., Zgodá, V. and Davydov, D. (2020). Evolving Pressure-tolerance in Enzymes of Abyssal and Hadal Fishes. Oral Presentation, Society of Integrative and Comparative Biology, Austin, TX, USA.

Goffredi, S. (2020). Extreme Alliances: Relationships between Deep-sea Animals and Bacteria. Southern California Academy of Sciences Spotlight Speaker Series, Virtual.

Goffredi, S. (2020). Establishing Interactions in a Dynamic Environment, Keynote Speaker, University of Vienna, Virtual.

Huber, J. (2020). Part I: Microbes, Fluids, and Rocks. Oral Presentation, iBiology Research Talks, Virtual.

Karolewski, J., Oldham, V., Michel, A., Hansel, C., and Wankel, S. (2020). Manganese and Iron Support Anaerobic Oxidation of Methane at Cold Seeps, Poster Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Katija, K. (2020). Novel Imaging Tools to Illuminate Life in the Deep Sea. Invited Lecture, University of Washington, Virtual.

Katija, K. (2020). Novel Imaging Tools to Illuminate Life in the Deep Sea. Invited Lecture, Moravian College, Virtual.

Katija, K. (2020). Technological Challenges and Potential Solutions for Exploring the Ocean's Midwaters, Invited Lecture, University of Washington, Seattle, WA, USA.

Katija, K. (2020). New Laser-imaging Technology (DeepPIV) Informs Ecomechanics of Deep Sea, Giant Larvaceans. Invited Lecture, Friday Harbor Laboratories, Virtual.

Katija, K. (2020). New Laser-imaging Technology (DeepPIV) Informs Ecomechanics of Deep Sea, Giant Larvaceans. Invited Lecture, Western Washington University, Bellingham, WA, USA.

Katija, K. (2020). Searching for Inspiration in the Deep Sea. Invited Lecture, Moore Foundation, Virtual.

Katija, K. (2020). New Laser-Imaging Technology (DeepPIV) Informs Ecomechanics of Deep Sea Animals. Panelist, Advances in Oceanographic Research and Technology Development at Sea Panel, IEEE Global Oceans, Virtual.

Katija, K. (2020). Technologies for Studying Biological Phenomena in the Deep Sea. Panelist, Exploring and Mapping Unseen Worlds Panel, Smart Oceans, Virtual.





Katija, K. (2020). Developing Technologies to Discover Life in the Ocean's Midwaters. Panelist, United States Frontiers of Engineering Symposium, National Academy of Engineering, Virtual.

Katija, K. (2020). Searching for Life in the Deep Sea. Panelist, Joy Panel, PlayFest, Virtual.

Katija, K. (2020). Searching for Inspiration in the Deep Sea. Panelist, Eyes in the Sky, Eyes in the Seas Panel, Tektite 2020: Women of Sea and Space, Virtual.

Katija, K. (2020). Searching for Bioinspiration (with a LOT of Friends) in the Ocean's Midwaters. Panelist, Exploration Technology Panel, Ocean's Week: California Academy's Breakfast Club, Virtual.

Katija, K. (2020). National Science Foundation's Frontiers of Ocean Sciences Symposium, Panelist, National Science Foundation, Virtual.

McCulloch, M. (2020). Great Southern Science, National Science Week, Perth, AUS.

Michel, A., Johnson, A., Fauria, K., Preston, V., Nicholson, D., Hoer, D., et. al. (2020). From the Seafloor to the Surface: In situ Chemical Analysis of Rising Bubbles along the Cascadia Margin, Poster Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Negrete-Aranda, R. (2020). Modern Perspectives on Marine Heat Flow Measurement and Interpretation: A Look at the Past, Present, and Future Work of CICESE's Heat Flow Team. Oral Presentation, CICESE Weekly Seminar Series, Virtual.

Orphan, V. (2020). Extreme Microorganisms: Living at the Energetic Edge. Oral Presentation, CIFAR Earth 4D Symposia, Virtual.

Pereira, O., Le, J., Gonzalez, J., Ashford, O., Cordes, E., Orphan, V., et. al. (2020). Ecotones at Methane Seeps: Understanding the Seepage Sphere of Trophic Influence for Carbonate Macrofauna, Poster Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Rahlff, J., Khodami, S., Voskuhl, L., Humphreys, M., Stolle, C., Arbizu, P., et. al. (2020). Impact of Ocean Acidification on Microbial Eukaryotes from the Timor Sea. Oral Presentation, Annual Meeting of Microbiologists, Leipzig, Germany.

Richards, K., Natarov, A., Jia, Y. (2020). Enhanced Turbulent Mixing in the Equatorial Thermocline. Oral Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Speth, D. (2020). Comparative Metagenomics of the Pescadero Basin and Guaymas Basin Hydrothermal Vent Fields & Broader Applications of Environmental DNA Sequencing in Biology. Oral Presentation, Caltech Geological and Planetary Sciences Geoclub Seminar, Pasadena, CA, USA.

Speth, D. (2020). Genomes are Everywhere, but What to Make of Them? A 2-Part Story of Mud and Matrix Wrangling. Oral Presentation, Revelling on Microbial Processes Seminar, Virtual.

Speth, D. (2020). How does Life Conquer, and Thrive in, Extreme Environments? Oral Presentation, CIFAR Earth 4D Trainee Day, Virtual.

Speth, D. (2020). Comparative Metagenomics of the Microbial Community at Pescadero Basin: A Recently Discovered Hydrothermal Vent Field in the Gulf of California. Poster Presentation, Gordon Research Conference on Geobiology, Galveston, TX, USA.

Tokuda, A., Gerring, M., Popp, B., Wallsgrove, N., Grammatopoulou, E., Mayor, D., and Drazen, J. (2020). Food Web Structure in the Mariana and Kermadec Trenches from Stable Isotope Analysis. Poster Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Vega-Ramirez, L., Spelz, R., Contreras, J., Caress, D., Clague, D., and Paduan, J. (2020). A New Method for Fault-scarp Detection Using Linear Discriminant Analysis (LDA) in High-resolution Bathymetry Data from the Alarcón Rise and Pescadero Basin, Gulf of California, Oral Presentation, AGU Fall Meeting, Virtual.

Vega-Ramirez, L., Spelz, R., Negrete-Aranda, R., Neumann, F., Peña-Domínguez, J., Contreras, J., et. al. (2020). A New Method for Fault-scarp Detection Using Linear Discriminant Analysis (LDA) in High-resolution Bathymetry Data from the Alarcón Rise and Pescadero Basin, Gulf of California, Annual Meeting of Mexican Geophysical Union, Guadalajara, Jalisco

Watling, L., Baco-Taylor, A., Bingo, S., Carter, G., Dulai, H., France, S., et. al. (2020). Finding Biogeographic Boundaries in the Deep Sea: Alaska, Hawaii, and the Emperor Seamount Chain. Oral Presentation, Ocean Sciences Meeting, San Diego, CA, USA.

Wilson, N. (2020). Exploring the Deep-sea Canyons off Ningaloo. Invited Lecture, Royal Society of Western Australia Symposium, Perth, AUS.



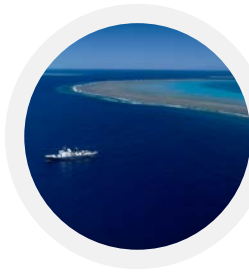


OUR COLLABORATORS

We could never do this alone, these are the institutions and organizations that we have collaborated with this year:



CAPTIONS



Cover

R/V *Falkor* holding position on the outside of Ribbon Reef #5 as ROV SuBastian works its way up the shelf, researching the origins of the Great Barrier Reef.



Cover and Page 17

An aerial image of ROV SuBastian launching from R/V *Falkor* near the Ribbon Reefs, where long, thin strips of reef form the outer edges of the Great Barrier Reef around 50-100 km off the northern Queensland shore.



Cover

Marco Taviani investigates rock samples on board R/V *Falkor*. Collecting and studying fossils can contribute to understanding the history of the ocean.



Cover

Galacantha rostrata, commonly known as a squat lobster, is a species with global spread. However, this is the first time that one has been collected in Western Australia.



Cover and Pages 12-13

As ROV SuBastian makes its way up the slopes of seamounts and canyons around the Great Barrier Reef, the changes in light, temperature, pressure, and other environmental factors are remarkable. These changes lead to a whole gradient of habitats suitable in different ways for many different species.



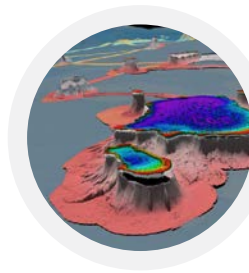
Pages 2-3

R/V *Falkor* experiencing a beautiful day at sea while on station at the Herald Cays in the middle of the Coral Sea Marine Park.



Page 4

Co-Founders Wendy and Eric Schmidt.



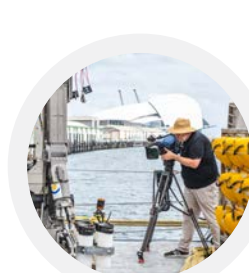
Page 5

A view of North and South Flinders reef mapped by R/V *Falkor* during the "Visioning the Coral Sea" expedition. North Flinders reef is a large scale feature of the Coral Sea Marine Park.



Page 5

A variety of life, including corals and a very rare *Astrosarkus* (commonly called a "Pumpkin Star"), cling to a scarp face at 120 meters depth near Lihou Reef in the Coral Sea Marine Park. *Astrosarkus* is a newly identified genus and species first described in 2004. This particular sighting of the Pumpkin Star was a substantial range extension to what was previously known.



Page 10

During a busy day on R/V *Falkor*, a crew from 7 News Australia visits to record footage and film interviews before the ship departs Fremantle on her next expedition off Australia's west coast.



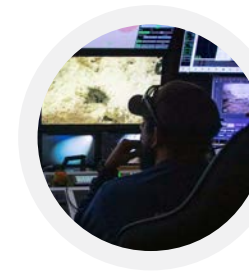
Page 10

Artist-at-Sea Taloi Havini during the Ice Age Great Barrier Reef Expedition. Taloi is SOI's first Indigenous artist and her work produced on *Falkor* will be showcased in the 2021 Biennale.



Page 11

The Bremer Canyon is larger than the Grand Canyon and multibeam maps allowed the team to safely explore it for the first time. Deep in the canyon, ledges teeming with life reveal how interlinked geology and biology are in the deep ocean.



Page 11

The ROV crew assessing and piloting SuBastian on a test dive to ensure all systems are functioning properly.



Pages 14-15

A crew from 7 News Australia visits the ship to capture footage and film interviews before the R/V *Falkor* departs Fremantle for the "Illuminating Biodiversity of Ningaloo Canyons" expedition.



Page 16

Gemma Galbraith of James Cook University with one of the many coral samples that were collected from the "Seamounts, Canyons & Reefs of the Coral Sea" expedition. These samples will help researchers understand ranges and taxonomies of many species.



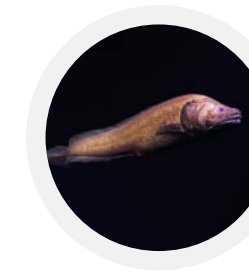
Page 17

Bringing AUV Sirius alongside the R/V *Falkor* can be tricky, as any wave action means both machines move in different directions. All hands are on deck to safely bring it aboard so its valuable data can be downloaded and the AUV prepared for its next mission.



Pages 18-19

Benthic animals on rocky substrate, including black corals, stalked barnacles, and urchins, are seen on ROV SuBastian Dive 314 in Bremer Canyon, Australia.



Pages 20-21

An ophidiiform swims in the depths of Ningaloo Canyon. The exact species has not been identified yet, but this order of ray-finned fish includes cusk-eels, pearlfishes, and others.



Pages 22-23

Some gently-sloping habitats were seen to have fields of hard coral dominated by the genus *Leptoseris* - never observed in the Coral Sea until ROV SuBastian's dives this year.



Pages 24-25

R/V *Falkor* holds position on the outside of Ribbon Reef #5 as ROV SuBastian works its way up the shelf, researching the origins of the Great Barrier Reef.

CAPTIONS



Pages 26-27

A *ctenophore* seen on Dive 393 during a Mid-water Survey near Northeast Fraser Island, Australia.

Page 28

While the Ningaloo Canyons expedition was happening off the coast of Australia, the rest of the world was locking down due to the looming threat of Covid-19. Here, crew and researchers demonstrate the "new normal" of social distancing for when they depart the ship.



Page 29

ROV SuBastian being moved into deployment position with *Falkor's* aft deck A-frame crane.



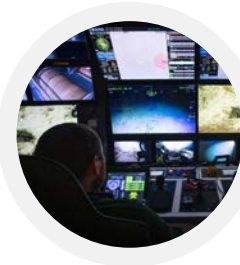
Page 29

Jeremy Horowitz from James Cook University excitedly holds up two perfect black coral samples from below 1000 meters on Cairns Seamount in the Coral Sea.



Pages 30-31

The ROV crew assessing and piloting SuBastian on a test dive to ensure all systems are functioning properly.



Pages 32-33

A group of shrimp on substrate at 134 meters depth, as seen on Dive 384 in the Ribbon Reef Canyons, Australia.



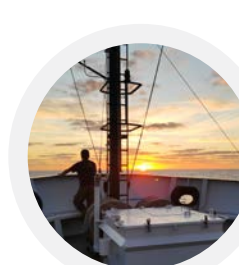
Page 36 / Back Cover

Andrew Hosie (Curator, Western Australian Museum) photographs a beautiful specimen during a busy evening in the wet lab. The moment ROV SuBastian lands back on deck, the science team jump into action to process their finds as quickly and efficiently as possible.



Page 36

After a busy first week of science, the team researching the Ningaloo Canyons amassed an impressive collection of organisms that will help to shed new light on the biodiversity of Cape Range Canyon and Cloates Canyon off Ningaloo. (Image is an illustration – a collection of photographs – and specimens are not to scale).



Page 37

Markus Niinemets (deckhand) on *Falkor's* foredeck during a brilliant sunset.



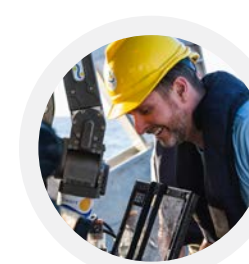
Page 38

Black coral photographed in detail by ROV SuBastian at 1200 meters depth on Cairns Seamount. This close-up view shows the delicate structures of this poorly understood coral.



Page 39

A basket star perches high on a bamboo coral, seen off of the Southwestern Australian coast in January, 2021.



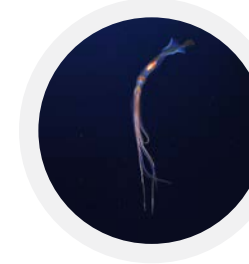
Page 41

Upon the ROV's return to the aft deck, Andrew Hosie (Curator, Western Australian Museum) looks into SuBastian's bioboxes, where samples and specimens are stored.



Page 42

Michael Utley (Bosun) works a deployment on *Falkor's* aft deck, with a nautilus plushie made by one of ROV SuBastian's loyal livestream fans tucked in his PFD.



Page 43

A *Chiroteuthidae* deep-sea squid is observed at 1000 meters depth, just as the team was about to commence ROV dive #355 at North Horn on the northwestern tip of Osprey Reef.



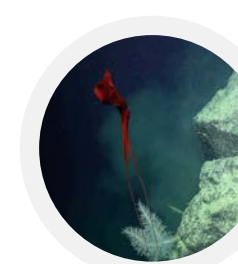
Page 44

Brittle stars and other creatures often use corals to get off the seafloor: being higher in the water column delivers better access to food. This was observed at ~600 meters depth off the Magdelaine Cays, Queensland Plateau, Australia.



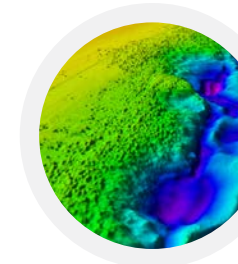
Page 44

ROV SuBastian is recovered onto R/V *Falkor's* aft deck after a dive during the "Seamounts, Canyons & Reefs of the Coral Sea" expedition.



Pages 50-51

A beautiful whiplash squid (*Mastigoteuthis*) seen at 1100 meters during Dive 399 off a Southern Small Detached Reef.



Back Cover

Bathymetry of Capricorn Ridge is shown here; a drowned reef that has contourite drift deposits.



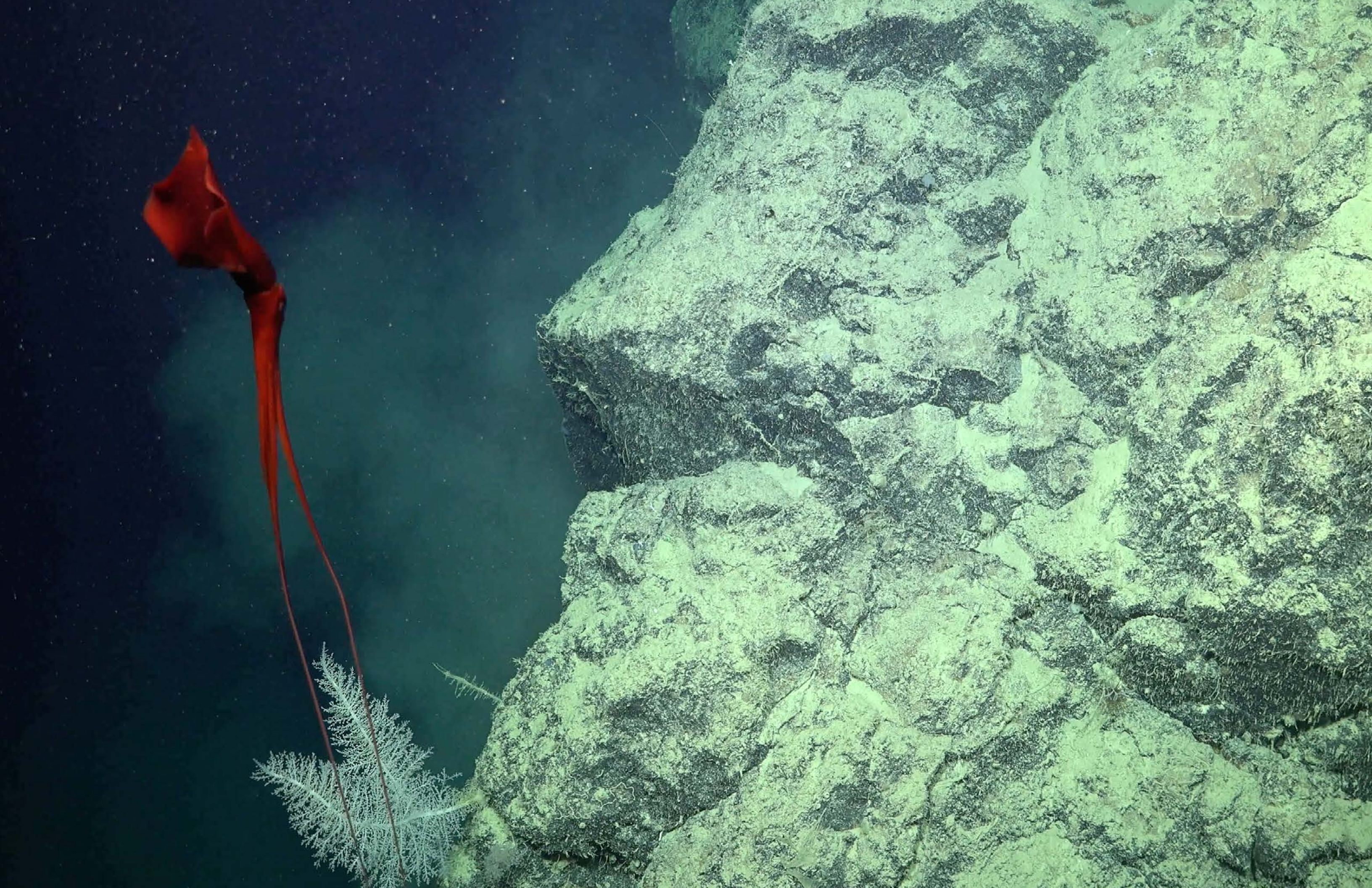
Back Cover

Scientists onboard *Falkor* discovered a large, detached coral reef while mapping the seafloor off the coast of North Queensland, in the Great Barrier Reef Marine Park. The reef measured over 500 meters (1,640 feet) in height. A detached reef has not been discovered in the area for the past 120 years.



Back Cover

Georgia Nester (Student Opportunities Participant, Curtin University) processes water samples from the CTD for eDNA (environmental DNA) analysis.



2020

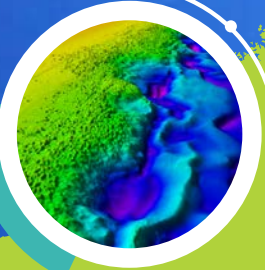
IMPACT REPORT

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