

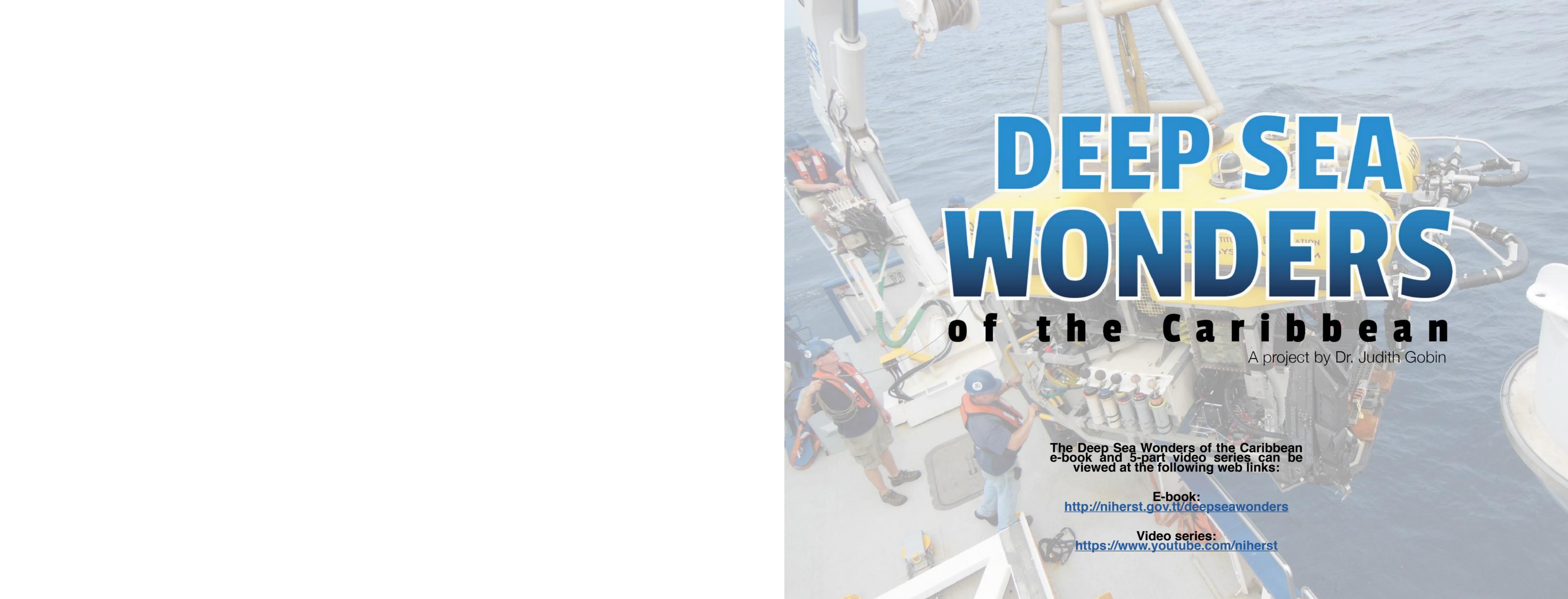


DEEP SEA WONDERS

of the Caribbean

A project by Dr. Judith Gobin



An aerial view of a research vessel's deck. A large yellow ROV (Remotely Operated Vehicle) is being lowered into the water. Several crew members in blue hard hats and orange life jackets are visible on the deck, working with the equipment. The ocean is visible in the background.

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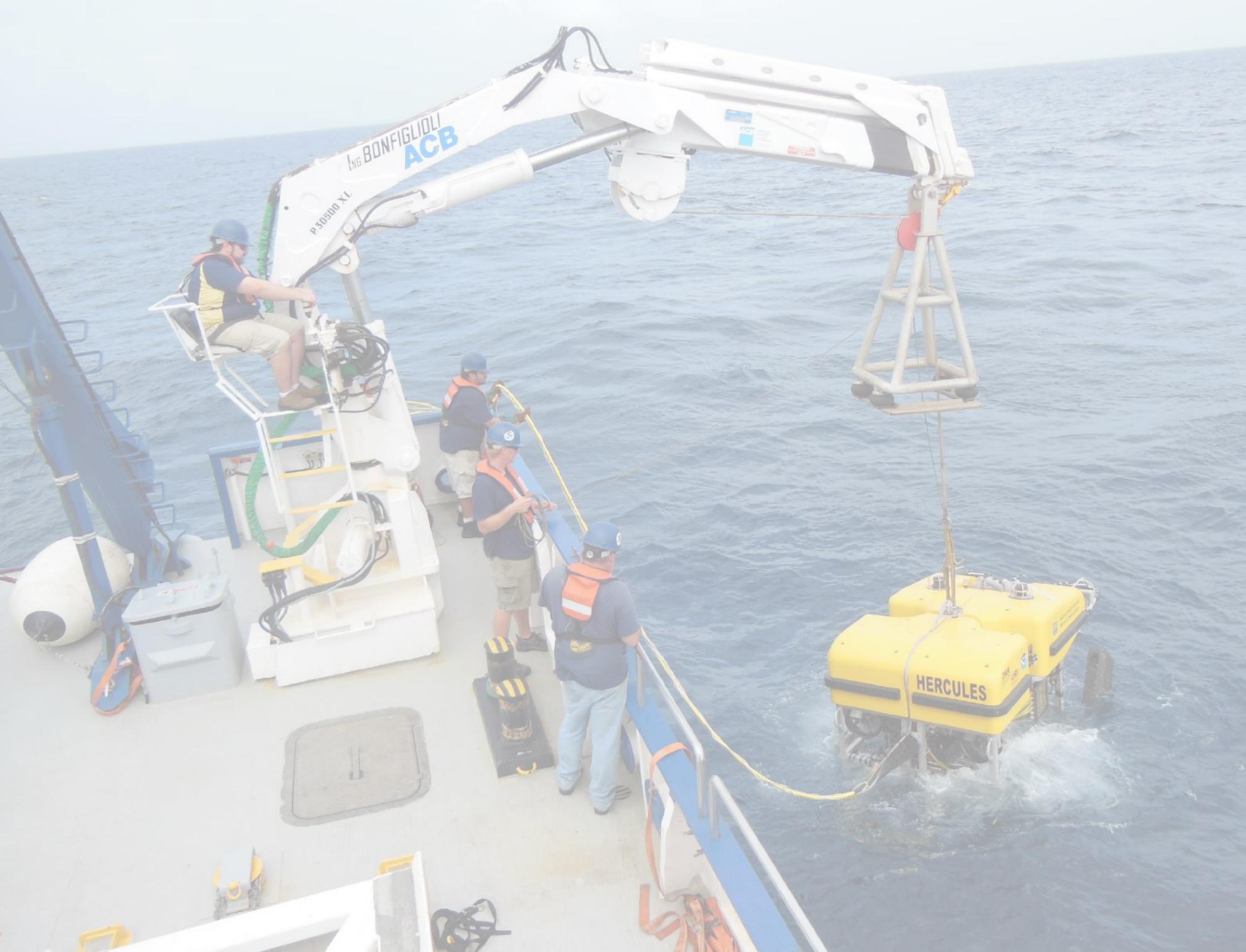
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e-book and 5-part video series can be
viewed at the following web links:

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<http://niherst.gov.tt/deepseawonders>

Video series:

<https://www.youtube.com/niherst>



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We are deeply appreciative of valuable inputs from the various scientists, who were instrumental in allowing us to develop the story of the most detailed deep-sea exploration in the southern Caribbean waters. In particular, we wish to acknowledge the support of pioneering deep-sea scientist Professor Robert Ballard.

We also wish to acknowledge the support of our international scientists — Professor Lisa Levin, Dr. Sandor Mulsow, Dr. Adrian Glover, Dr. Erik Cordes, as well as our local and regional scientists, Professor Richard Robertson, Dr. Frederic Dondin and Dr. Diva Amon.

A debt of gratitude is owed to The Ocean Exploration Trust's expedition in the Caribbean waters near Trinidad and Tobago and Grenada, aboard the Exploration Vessel (E/V) Nautilus. The captivating photos used in this publication are some of those taken during this scientific exploration.

We acknowledge the various academic, professional, governmental and scientific bodies who supported this project, especially the Ministry of Education, The University of the West Indies (UWI), Caribbean Council for Science and Technology (CCST), Massy Foundation and Sagicor Life Inc.

A very special thank you is dedicated to the project team, namely the lead scientist, Dr. Judith Gobin; writer and editor, Roslyn Carrington; project manager, Joanne Chin Sang, and other team members, Lovaan Superville, Stacey-Ann Sarjusingh, Jamie Lee Yuen and Graeme Araujo.

Finally, NIHERST wishes to express sincere gratitude to diamond sponsor, Shell Trinidad and Tobago Limited and platinum sponsor, the Embassy of the Federal Republic of Germany in Port of Spain, who made this valuable and educational publication possible.

Foreword

Biodiversity discovery in the deep ocean has entered a new era. There are many more eyes on the deep due to the increasing numbers of remote and autonomous underwater vehicles, to the growing interest in fish, energy and mineral resources and to telepresence that reaches scientists and the public alike.

This book, Deep Sea Wonders of the Caribbean and the associated five-part video series are timely and the first of its kind promoting such awareness of the Caribbean's deep oceans. This work is based on the superb ROV footage shot during expeditions by the E/V Nautilus.

With this revelation of the deep oceans, we are now better able to understand the Caribbean's deep-sea environment and how organisms there have adapted to it. Exploration of the unique ecosystems associated with the submarine volcano Kick 'em Jenny off Grenada and the methane seeps off Trinidad will help us understand the processes that shape biodiversity.

Even as we are still discovering them, deep-sea environments are changing globally, thanks in part due to the effects of rising carbon dioxide

emissions. These include but are not limited to increased water temperatures, reduced oxygen, increased acidity and reduced food supply.

In the Caribbean, there are additional direct human disturbances such as from exploration drilling and fish trawling. New knowledge such as reflected in this beautiful book combined with intensified observation and study of the ocean environments is critical in our pursuit of humanity's harmony with nature.

These are key to the management and protection of Caribbean deep-sea biodiversity and the functions and services it provides to humanity. Priority must be placed on identifying and enacting Caribbean policy that can mitigate the cumulative impacts of climate change and human-induced global change.

Future generations in the Caribbean will thank Judith Gobin for shining a light on their amazing deep world; the first step in recognizing and conserving the ocean wonders that help the planet survive.

Professor Lisa Levin
Scripps Institution of Oceanography
University of California San Diego

Introduction

The years 2013 and 2014 were perhaps the most rewarding for me as a Caribbean marine biologist. Indeed, it was the unrivalled highlight of my career to be invited to join world renowned Professor Robert Ballard on his Exploration Vessel (E/V) Nautilus (www.nautiluslive.org), as it explored deep-sea areas off Trinidad and Tobago and Grenada.

These incredible adventures led to amazing revelations of our Caribbean deep-ocean beds which are special oases of species diversity. The large *Bathymodiolus* mussels off Grenada and the numerous methane seeps off the east coast of Trinidad were exciting finds, as were the hundreds of thousands of deep-sea mussels, tubeworms, crabs, shrimp, snails and fishes.

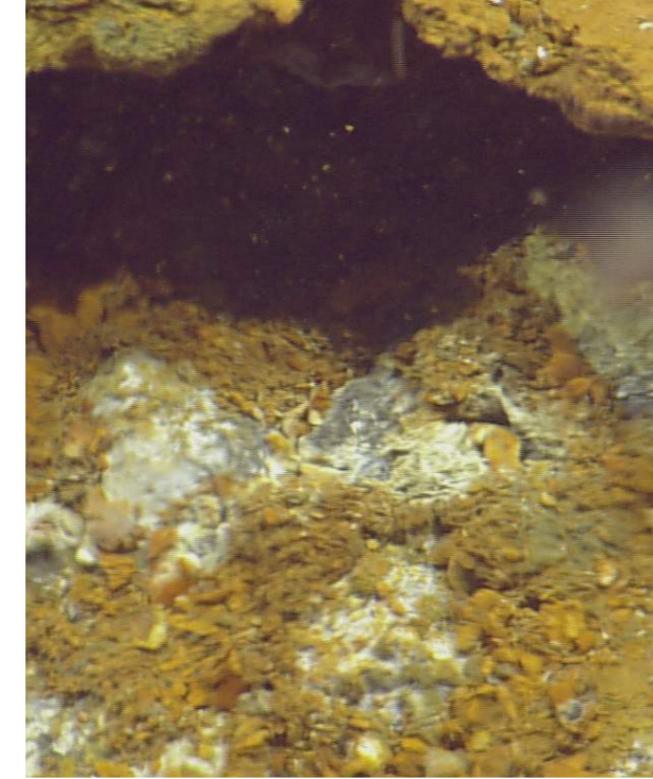
One of my aims of this Deep Sea book and the associated DVD series was simply to share with all Caribbean people for the first time, the wonderful deep-sea life and unique communities that is our heritage. The Ocean Exploration Trust (OET) has made this possible by allowing us to showcase the amazing pictures and videography captured on those explorations.

While we enjoy these fascinating revelations, we must also be mindful of their potential destruction from mining and other exploration activities. In addition to minerals and oil and gas, our deep seas provide critical marine genetic resources, some of which are used in pharmaceuticals, including medicinal drugs. At the same time, the deep ocean is a carbon trap that helps to regulate climate change.

My other aim, therefore, is to urge our decision and policy makers to work with us scientists, towards sustainable management of our Caribbean deep seas in order to conserve our biological resources in these obviously unique areas.

Dr. Judith Gobin
Lead Scientist
Deep Sea Wonders of the Caribbean Project
and Marine Biologist
The University of the West Indies

Mysteries of the DEEP WILDERNESS



What is it about the deep that fascinates us, enthrals us, and even scares us so much? Is it the mystery? The inaccessibility? Or just our natural curiosity?

The oceans are the largest habitat on Earth, and yet we know the least about them, even less than we know about the moon and distant planets. While 71% of the Earth is covered by the oceans, only 5% has been thoroughly explored.

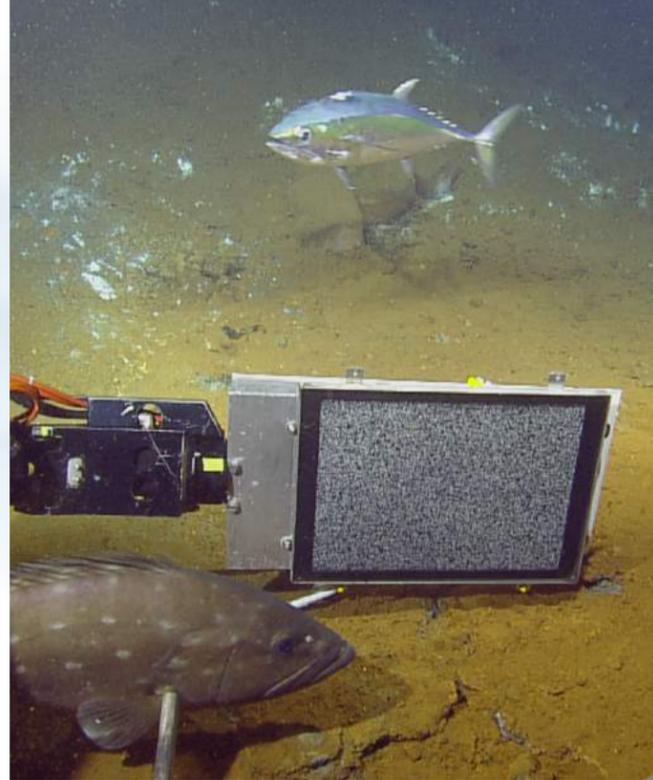
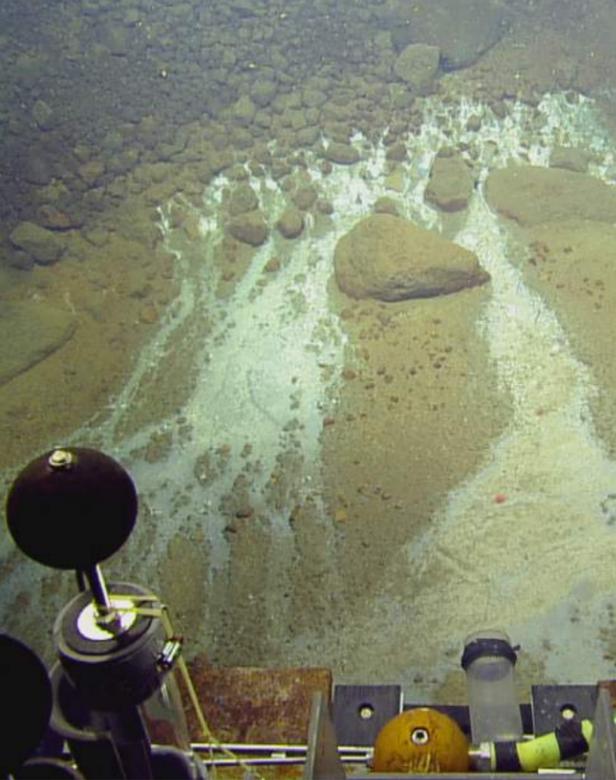
Approximately 230,000 marine species have been identified around the world, with an estimated 1 to 10 million yet to be discovered. The Caribbean region is particularly diverse.

Thanks to technology, humans are now able to plunge deeper, explore farther, and learn more about the deep seas than ever before.

“The abyssal wilderness is modest neither in
measure nor in mystery.”

Professor Cindy Lee Van Dover
Chair of the Division of Marine Science and Conservation
Duke University

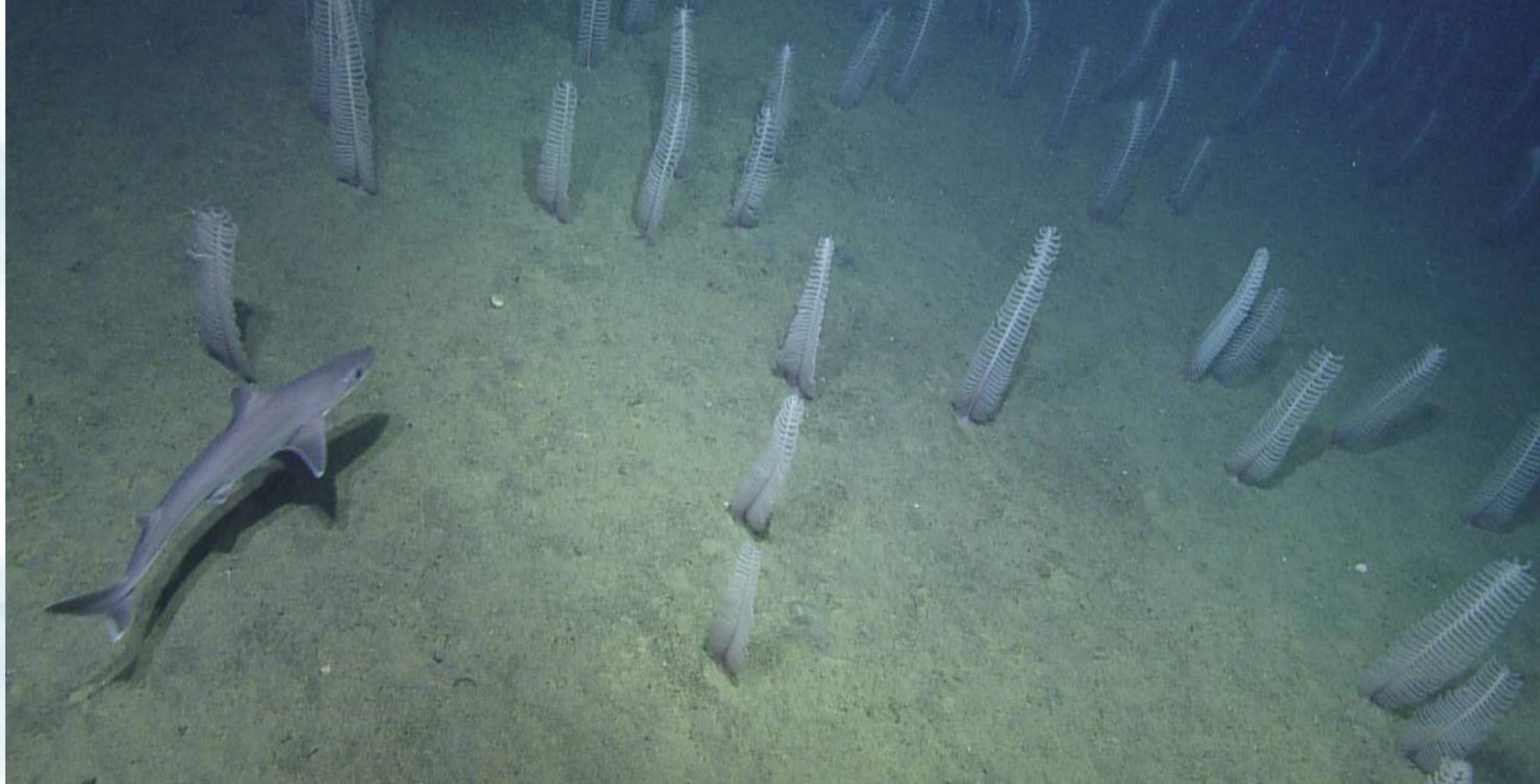




In 2013 and 2014, Trinidadian scientists, Dr. Judith Gobin and Dr. Diva Amon, took part in scientific expeditions aboard the E/V Nautilus, one of the most famous exploration vessels in the world.

The Nautilus is owned by the Ocean Exploration Trust, which was founded by Professor Robert Ballard —best known for his discovery of RMS Titanic’s final resting place.

Using the Remotely Operated Vehicles (ROVs) Hercules and Argus, the teams brought back footage of the deep seas to depths of 2,100 metres, off the coast of Grenada and Trinidad and Tobago, that had never been explored before.



“Our expedition into the Caribbean, particularly where we were, was really just the beginning. There’s more unexplored than explored. We humans have better maps of Mars than of our own world!”

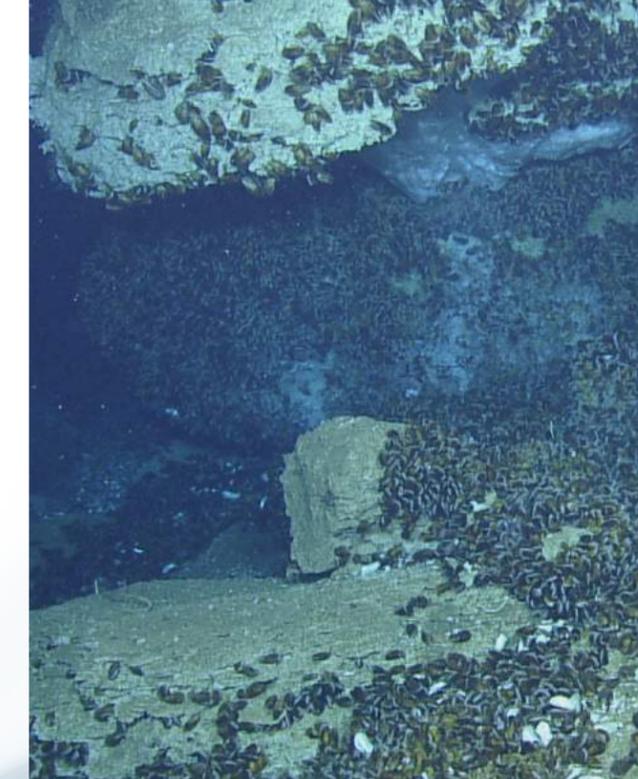
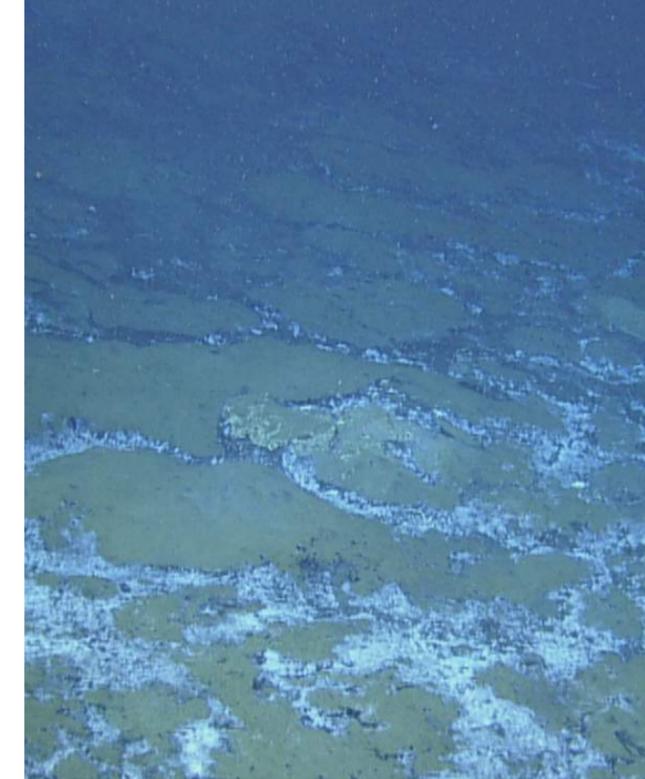
Professor Robert Ballard
President, Ocean Exploration Trust and Discoverer of the RMS Titanic



“Some of the most fascinating questions are in the deep sea. This is an area that is the largest habitat on Earth, and yet we know least about it. It’s really fundamental research, and really exciting research.”

Dr. Erik Cordes
Associate Professor, Ecology and Integrative Biology
Temple University, Philadelphia

Life Beneath THE WAVES



The deep-sea environment differs from shallower waters in several ways. Beyond a depth of 300 metres, sunlight struggles to penetrate, so we need the powerful lights of the ROVs to see our way.

The ocean floor is as varied as dry land, with mountains, canyons, and trenches. Most of the sea floor is covered with a layer of ooze made up of mud, sediment, and decomposing organic matter.

It's a difficult place to live. There is extreme pressure, caused by the tremendous weight of the water pressing down from above. At great depths, the pressure is enough to kill a surface-dwelling creature, or even to crush a submarine!

Creatures eat differently here. On land and in shallow waters, most organisms benefit from photosynthesis. In the absence of sunlight, photosynthesis can't take place.



Instead, most animals rely on a process called chemosynthesis to produce food.

Hydrothermal vents and cold seeps emit hydrogen sulphide and methane, among other substances. Bacteria use these compounds, along with oxygen and water, to produce the organic matter that other organisms feed on.



Other food sources for deep sea communities include organic matter from the sea surface, microscopic plants and animals called zooplankton and phytoplankton, and carcasses from large aquatic animals such as whales, which may drift to the ocean floor.



Creatures of THE DEEP



“In the deep sea many animals are red or purple, since red is the first wave length of light to dissipate with depth, so they are well hidden from predators. There’s no reason for them to have markings because there’s no light to see them.”

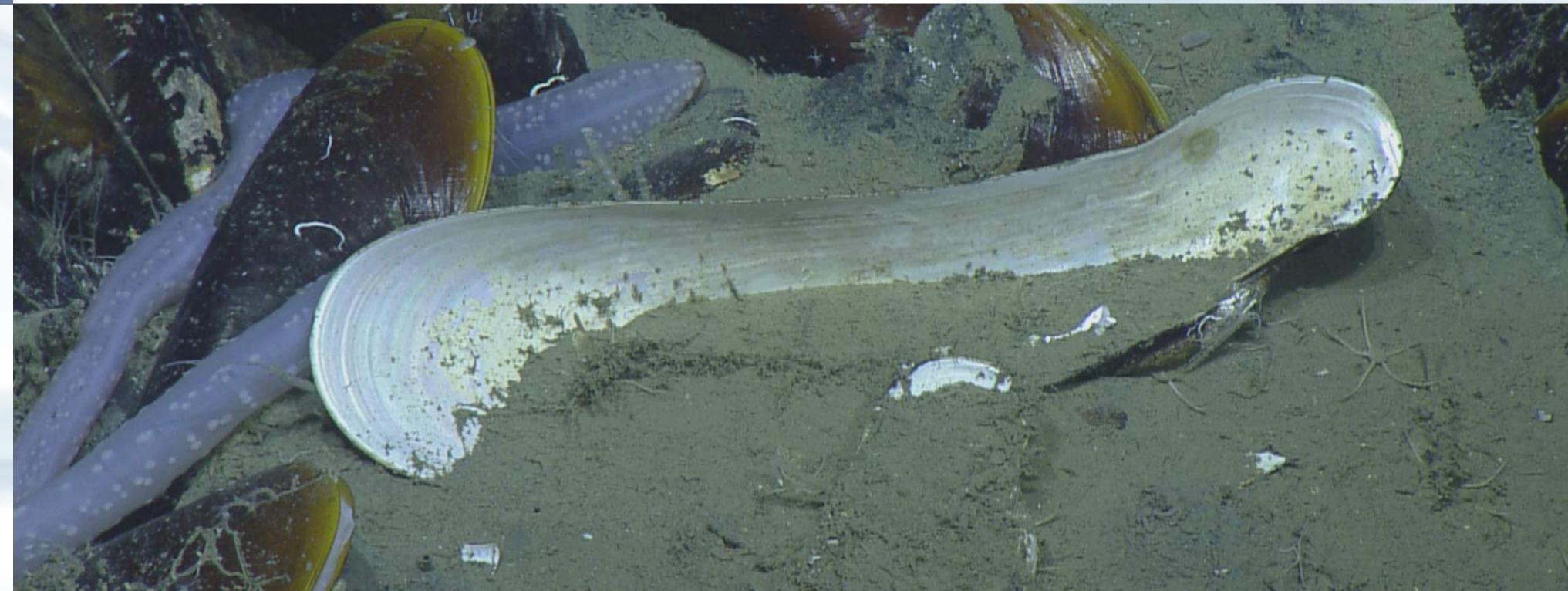
Dr. Diva Amon
Deep-Sea Biologist



Some creatures display gigantism, or the tendency to become truly enormous. During the 2013 and 2014 voyages, Dr. Gobin and her colleagues discovered giant tubeworms, and very large *Bathymodiolus* mussels, including the world's largest, found during the expedition in Grenada's waters.

Many organisms are bioluminescent—they have the ability to produce light. Some glow to attract mates, while others create light to lure prey or avoid predators.

Deep-sea creatures have adapted their methods of reproduction to suit their environment. Some reproduce similarly to corals, spawning their gametes into the water, where fertilisation happens. Others use internal fertilisation, like mammals do.

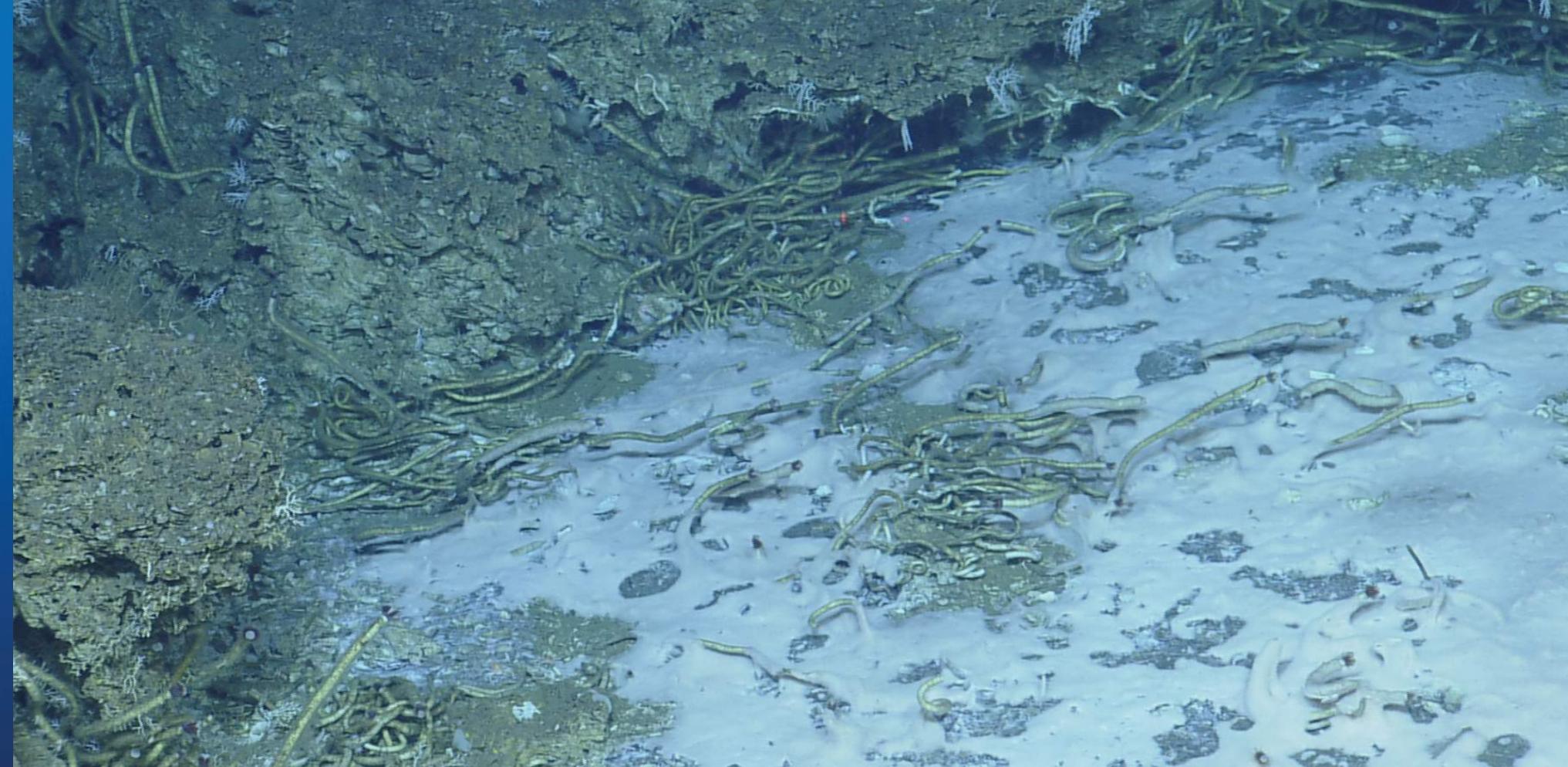


“In the deep-sea environment there are a lot of very bizarre looking creatures and organisms that are adapted for that specific environment, which is not a very conducive one.”

Dr. Judith Gobin
Marine Biologist
The University of the West Indies



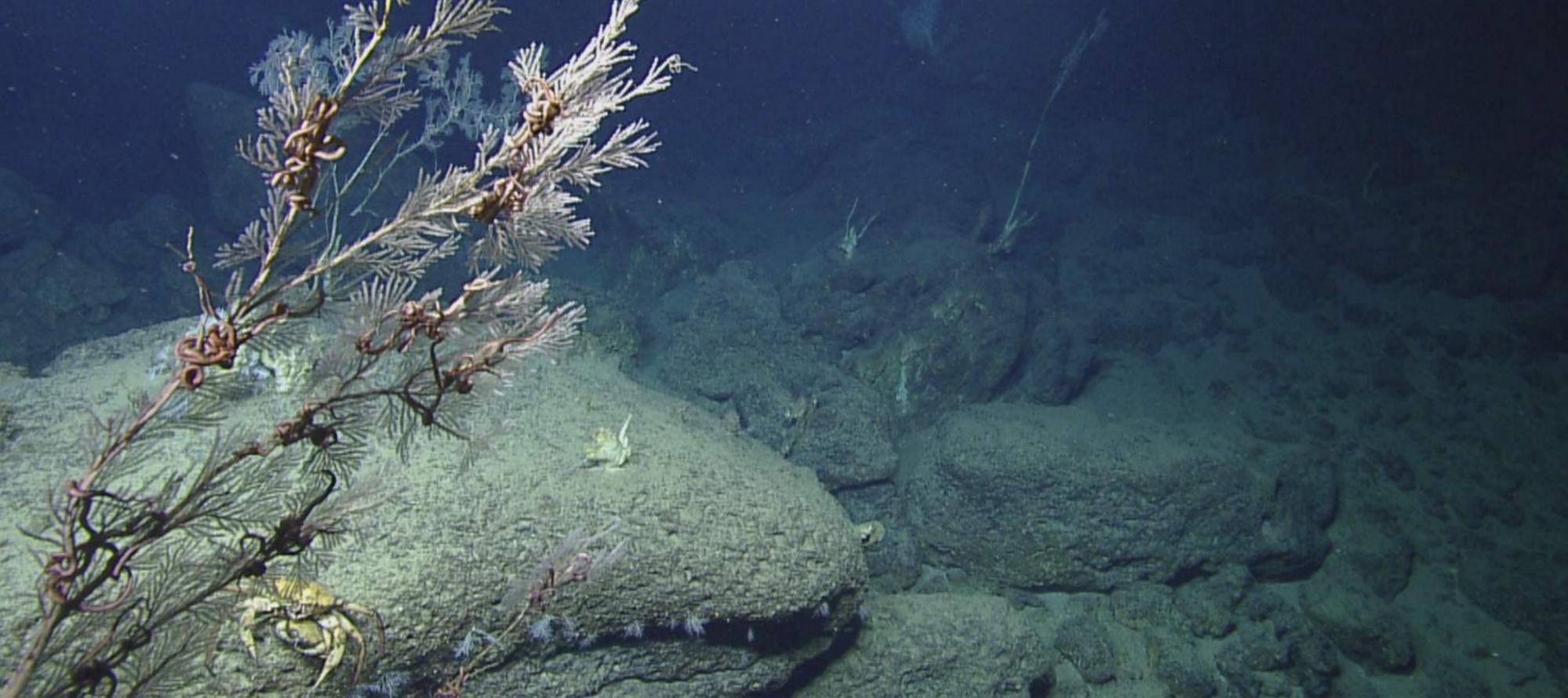
Ecosystems of a SUBMARINE VOLCANO



Kick 'em Jenny is an active submarine volcano, situated just eight kilometres north of Grenada. Its summit lies approximately 180 metres below the sea. This volcano has erupted 14 times since 1939.

The area around this submarine volcano is thriving with bacteria, which are the primary producers in a food web that includes a host of creatures such as tubeworms, mussels, shrimp, crabs, lobsters, fish and octopus.





“I really fell in love with Kick ‘em Jenny, because it’s a unique underwater volcano that had a lot of surprises for us.”

Professor Robert Ballard
President, Ocean Exploration Trust and Discoverer of the RMS Titanic

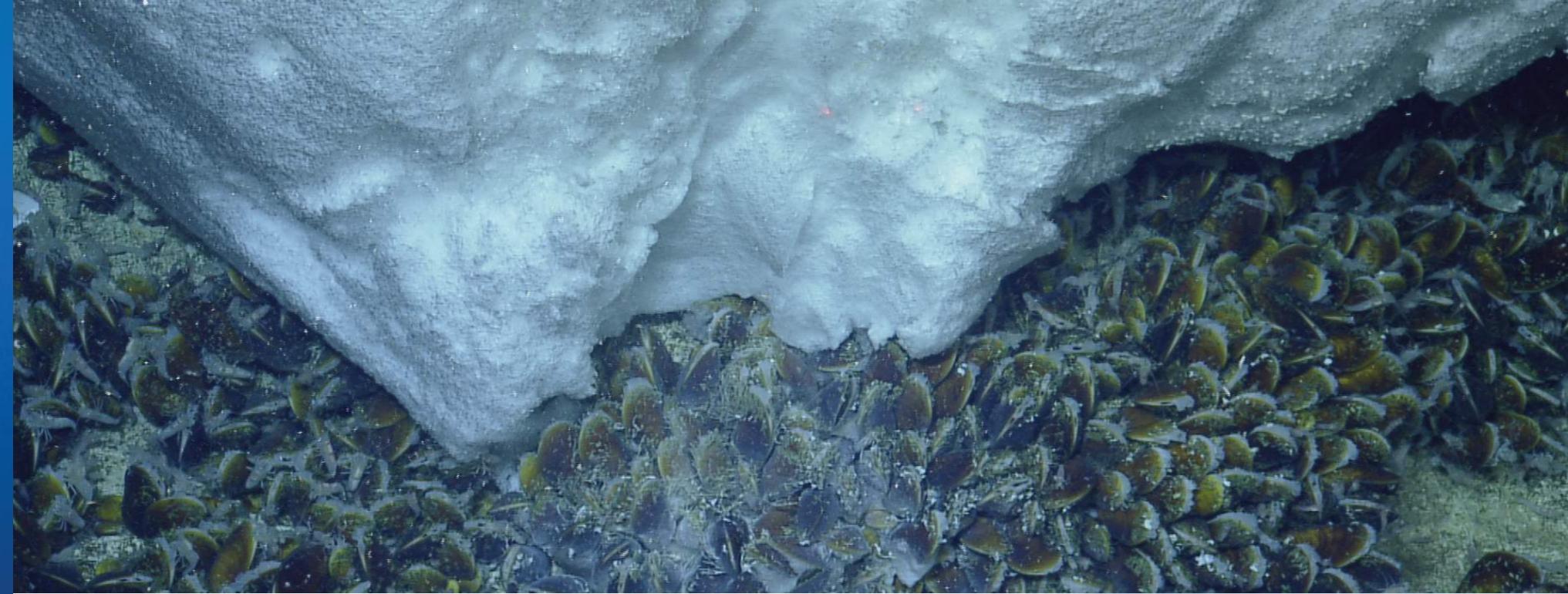
A volcanic eruption can temporarily chase away or kill nearby life forms, but they always return, lured by the chemical rich fluids generated by buried organic matter, which provides the energy that sustains life at these vents, through the process of chemosynthesis.



“It’s a multi-stage process, where you have less evolved biological forms that settle, and more evolved forms come back once the physical environment is more comfortable.”

Dr. Frederic Dondin
Volcanologist, Seismic Research Centre
The University of the West Indies

The World of COLD SEEPS



“The most exciting discovery for us off the Trinidad and Tobago waters was the methane seeps. They’re frozen because of the extreme temperatures. It actually looks like a snow cone mountain.”

Dr. Judith Gobin
Marine Biologist
The University of the West Indies

The seeps are a thriving and varied habitat for many creatures. Shrimp, sea cucumbers, crabs, jellyfish, fish, brittle stars, worms, mussels and more live around the seeps, and will remain here as long as the seeps are active, which can be thousands of years.



“Methane seeps are oases of life forms. They are hotspots of biodiversity, sources of food and production for surrounding organisms, and a source of material for genetic research.”

Professor Lisa Levin
Scripps Institution of Oceanography
University of California San Diego



“With Trinidad and Tobago developing their oil and gas and exploration in the area, it’s important that the scientists have a chance to explore, to map out these areas and find these sensitive communities in advance of oil and gas activity on the sea floor.”

Dr. Erik Cordes
Associate Professor, Ecology and Integrative Biology
Temple University, Philadelphia University of California San Diego

The Depths of OUR RESPONSIBILITY



In order to maintain the integrity of the deep-ocean ecosystems we must balance the use of its resources.

We need to devise strategies to engage stakeholders and integrate science, technology, policy and economics within and beyond national jurisdiction.

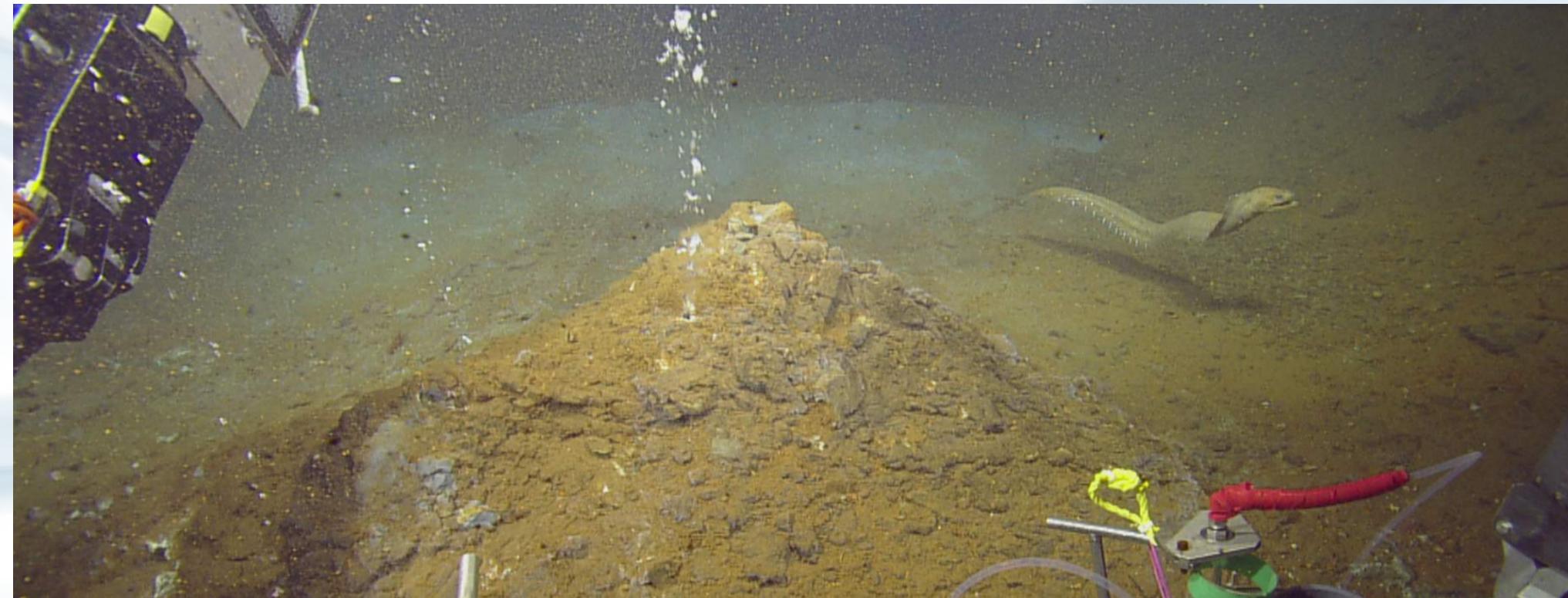


Greater study of these oceanic habitats can lead to scientific breakthroughs that will provide us with new sources of medicines, foods, minerals and energy, as well as a new understanding of the geology and biodiversity of our region.

As we admire the beauty of the deep sea and recognise its value, it is up to us as humans to honour our responsibilities of stewardship.

“The deep sea is incredibly important. It performs functions such as sequestering carbon and regulating our climate. It detoxifies our oceans and cycles nutrients. But more tangibly, we are running out of land and many resources like minerals, food, and energy, so we’re pushing into our deep oceans for those.”

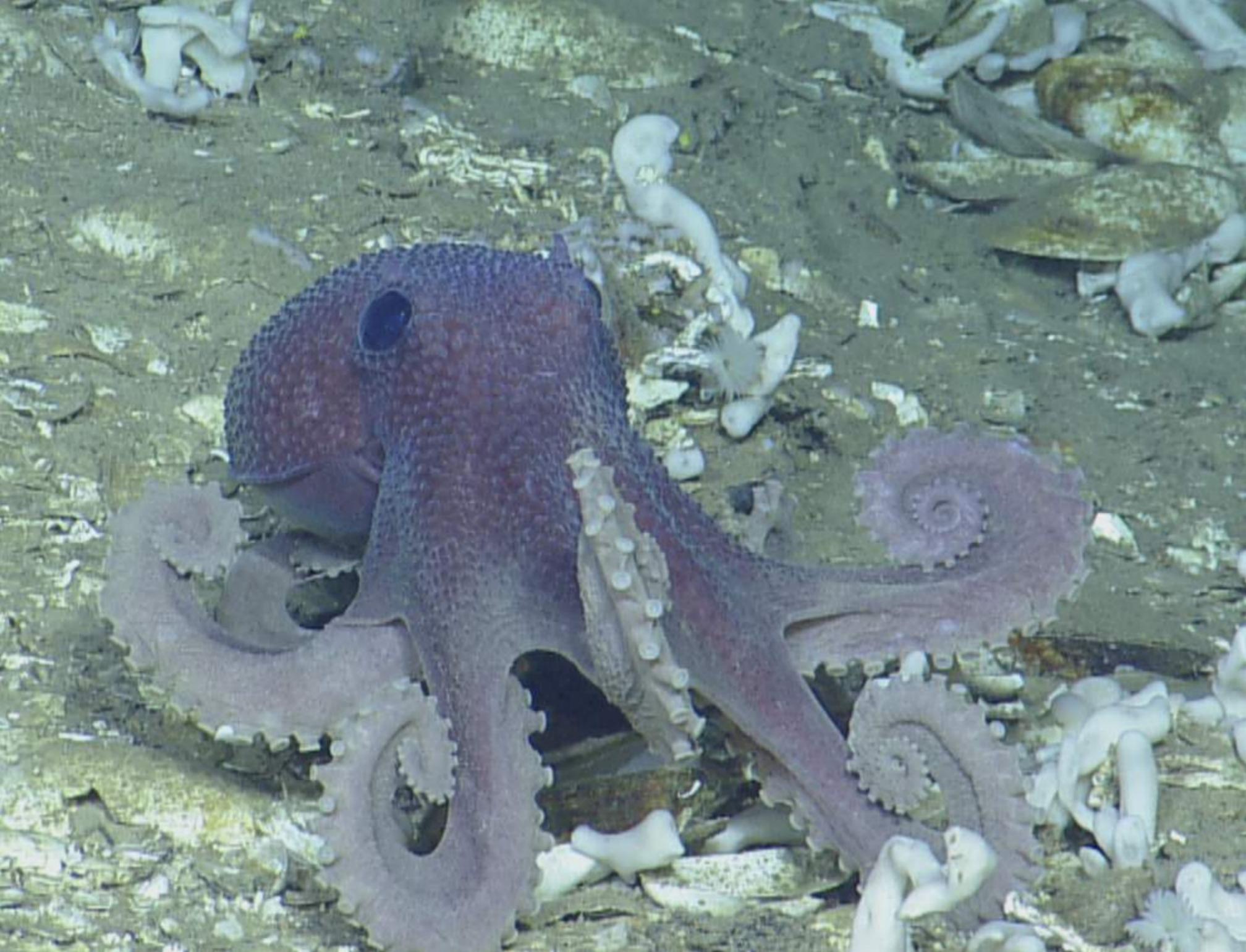
Dr. Diva Amon
Deep-Sea Biologist



“The deep ocean is one of the last frontiers on this planet,
and an exciting area of study for young scientists. There are
many opportunities.”

Professor Lisa Levin
Scripps Institution of Oceanography
University of California San Diego





“Think of the earth as a living creature. We’re studying a thing we live on that’s actually alive. Your job is to figure out how to live in harmony with it.”

Professor Robert Ballard
President, Ocean Exploration Trust and Discoverer of the RMS Titanic



The Government of the Republic of Trinidad and Tobago
MINISTRY OF EDUCATION



“Armed with this new knowledge we can now work towards improved conservation and management of our deep-sea ecosystems.”

- Dr. Judith Gobin, Senior Lecturer, UWI



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