# What is this Reef Doing Here?

**By Christy Peterson**

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# What is this reef doing here?

## Solving a Deep-Sea Mystery

By Christy Peterson

*We respectfully acknowledge the Kanaāka Maoli, who have wisely stewarded the ocean and respect their infinite connectivity past, present, and future.*

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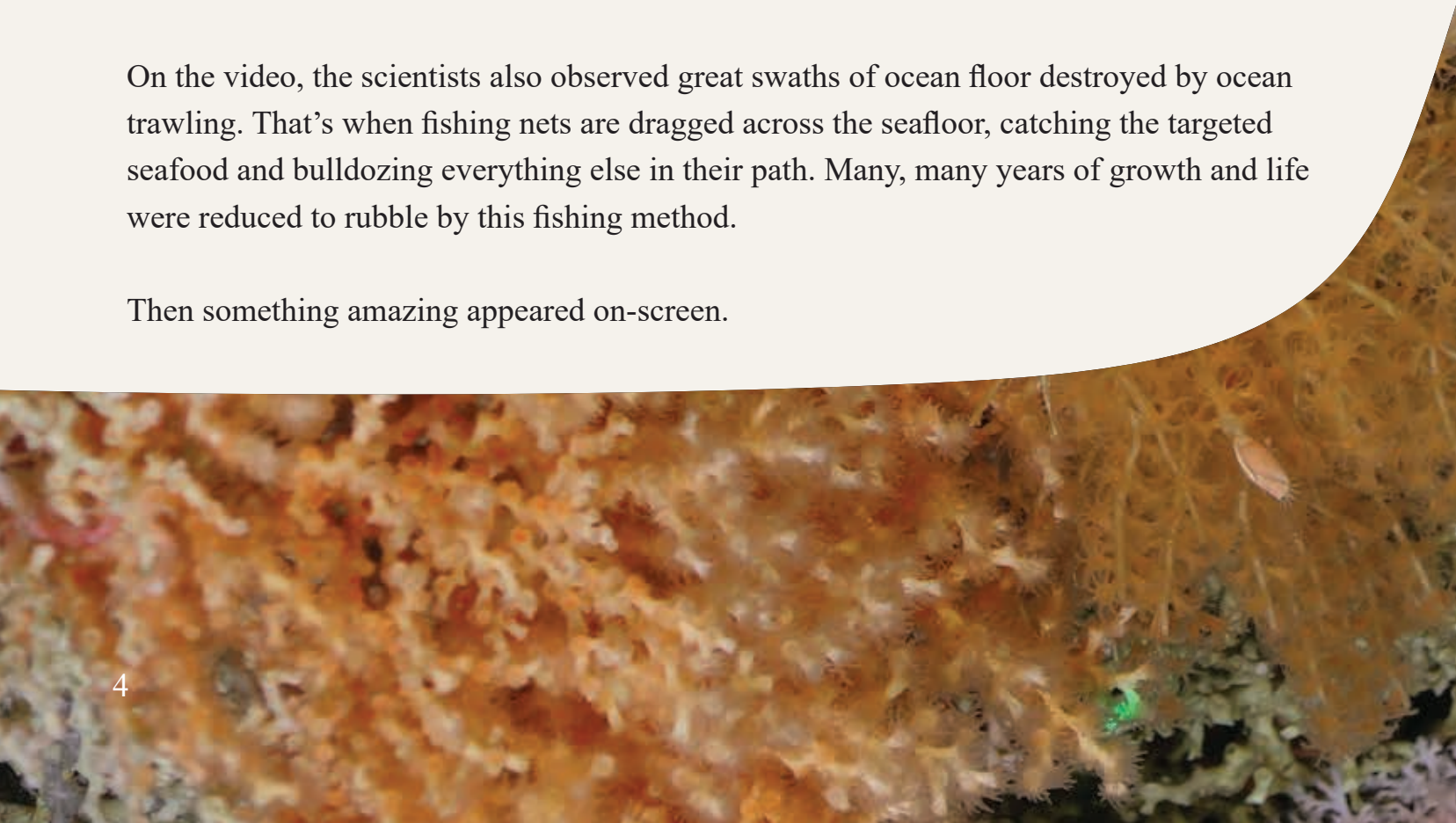
# A Typical Day—

**Dr. Amy Baco-Taylor** and **Dr. Brendan Roark** crowd around a computer screen. The ocean scientists study video footage recently collected by an Autonomous Underwater Vehicle (AUV). This pre-programmed robot explored where the scientists couldn't go without a submersible. The team's goal for this original research was to learn more about deep-sea coral and the effects of human activities on these habitats.

The AUV captured many wonderful and heartbreaking sights on its journey. The scientists watched as the robot floated past soft coral colonies that looked like little trees. The colonies stretched out across the sea floor in such numbers it looked like an ancient forest.

On the video, the scientists also observed great swaths of ocean floor destroyed by ocean trawling. That's when fishing nets are dragged across the seafloor, catching the targeted seafood and bulldozing everything else in their path. Many, many years of growth and life were reduced to rubble by this fishing method.

Then something amazing appeared on-screen.



# Meet the Scientists

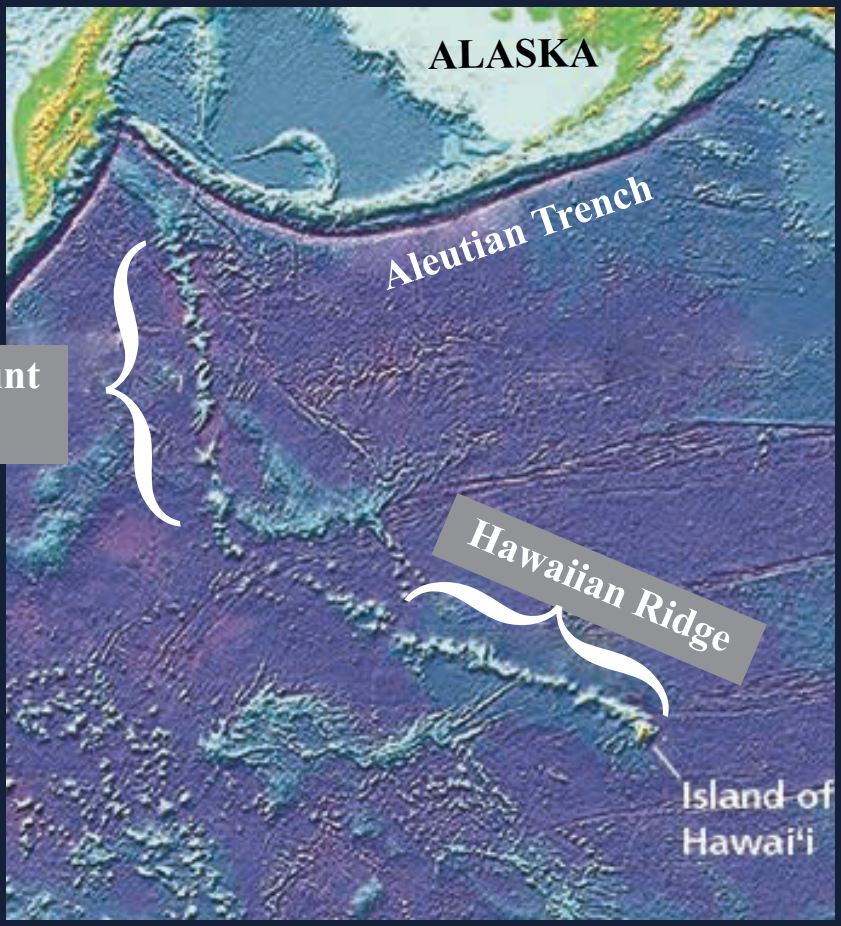
Dr. Baco-Taylor has explored the deep-sea inside a submersible more than 150 times.

**DR. AMY BACO-TAYLOR**
**PROFESSOR, FLORIDA STATE UNIVERSITY**

Dr. Baco-Taylor, marine biologist and the lead scientist for this research project, studies deep-sea coral and seamount ecology. She wants to discover the full extent of deep-sea coral reefs on seamounts in the North Pacific. She is also interested in understanding how the corals can live in an area where the seawater chemistry is all wrong for reef formation. She hopes her work will help us learn how to protect life in the deep ocean.

# Where in the World?

**The coral reefs located and studied by scientists in this book are located in the Hawaiian and the Emperor seamount chains which are northwest of the Hawaiian Islands.**



# —Turns into an Unusual Day!

Instead of the “forest” of coral colonies Dr. Baco-Taylor and Dr. Roark had observed on most of their journey, a different formation appeared. They found a 3-dimensional structure. A coral reef. A coral reef where it did not belong!

Fish hid in the shadows. Squat lobsters and brittle stars wiggled and scuttled along. Soft corals, anemones, and other invertebrates clung to the hard coral.

The scientists were excited and perplexed. The existence of a reef this deep in the ocean is not what puzzled them. There are deep-sea reefs scattered across the globe. But a hypothesis shared by many ocean scientists says deep-sea reefs cannot exist in this part of the Pacific Ocean.

If the hypothesis is true, how could these coral be here?

# Why Not Here?

**It is not uncommon to find brightly-colored reef-forming corals in other parts of the deep ocean. But scientists were shocked to find them in this area of the Pacific Ocean.**

The water chemistry where the research team found these unexpected reefs isn't ideal for hard corals. In fact, research in other places suggested that the skeletons of these corals should be dissolving. But the images on the screen told a different story. The reefs were there. How could this be?

Reef-building corals use calcium carbonate from the water to build their skeletons. The balance of chemicals in the water must be just right for this to happen. There must be enough calcium carbonate for coral to grow and maintain their skeletons. The water also cannot be too acidic. If it is, the skeletons will start to dissolve.

# How Acidic is the Ocean?

**When we talk about ocean acidification, it might be easy to imagine that the ocean water is changing into something that is very acidic, such as vinegar or orange juice. That's not the case. Here's one way to think about it. Imagine you pour yourself a glass of water. You taste it—it's clean and crisp and tastes like, well, water!**

**Now, image you put a drop of orange juice into the water and stir it up. If you taste it, you probably won't be able to tell the difference. That's because the drop of orange juice is tiny compared to the full glass of water. But, the chemistry of the water has changed—it has become more acidic.**

**The changes in ocean water are a lot like our water and orange juice example. The changes in the water are small from our point of view. But for ocean life, even a small change might harm them.**

**TWO KINDS OF DEEP-SEA REEF-BUILDING CORAL**

# Meet the Scientists

**DR. BRENDAN ROARK**
**PROFESSOR, TEXAS A&M UNIVERSITY**

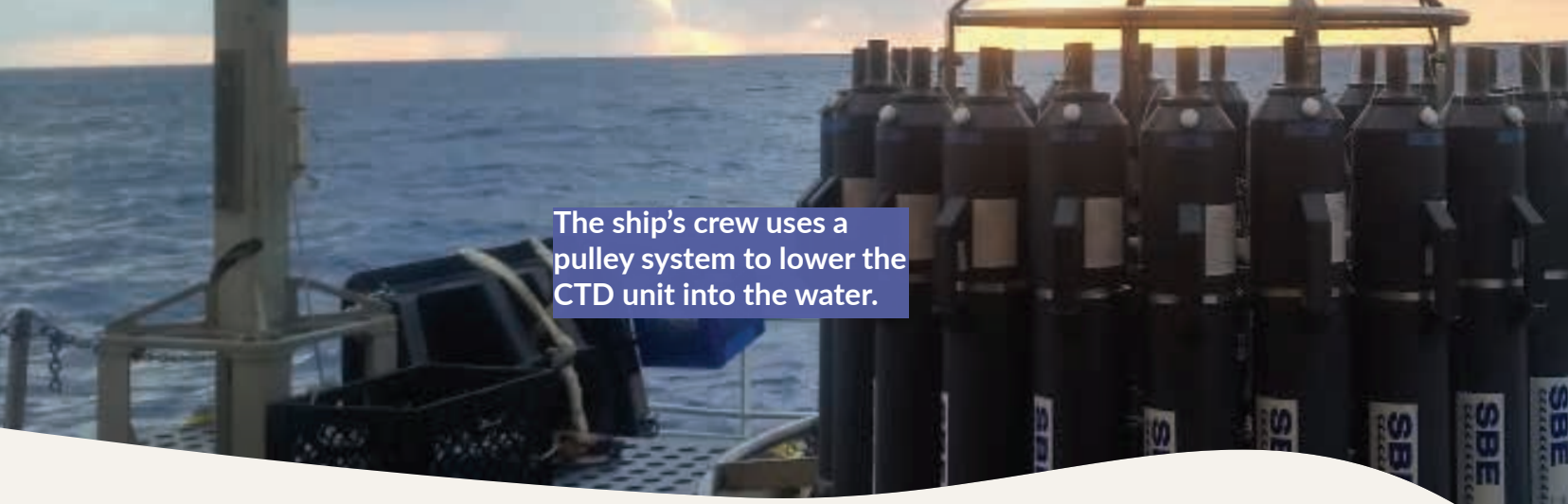
**Dr. Roark studies rocks and minerals on the ocean floor to understand what the climate of the earth was like in the past. This information can tell us how the earth has changed over time and the impact people are having on the ocean. He is especially interested in helping people understand how to keep the ocean and ocean animals healthy and thriving.**

# Planning a Scientific Study

Dr. Baco-Taylor and Dr. Roark, along with another scientist, Dr. Katie Shamberger, began to plan another study. This research would help answer their big question—how are these reefs surviving where we thought they couldn't? But first, they need to answer many other questions. Questions like:

- What is the water chemistry like around each reef?
- What species of coral live in these reefs?
- What other living things make these communities home? Are they helping the corals survive?
- What is the environment like around the corals–sandy, muddy, rocky?
- Can we predict and find more reefs in these seamounts?

To help answer these questions, Dr. Baco-Taylor, Dr. Roark, and Dr. Shamberger assembled a team of scientists who study many different things: biology, chemistry, geology, paleoceanography, and more. With their team of science detectives, they set out to solve the mystery of the coral reefs in the "wrong" place. The science team made two trips aboard research vessels to study the reefs and collect samples as part of their quest.



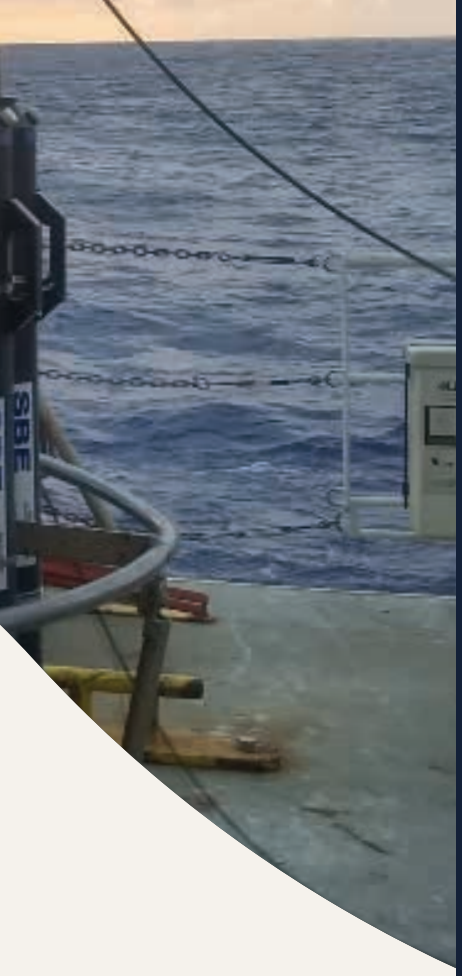

The ship's crew uses a pulley system to lower the CTD unit into the water.

# The Search for Answers: Chemistry

The scientists want to understand how these corals are surviving in water they thought had the wrong chemistry.

First, the science team needed to know everything about the water that surrounds the reefs. At each study site, the team lowered a tool called a CTD into the water. The CTD records temperatures, depth, and other information, while the tubes collect seawater. The pre-programmed tubes open and close at different depths. This way the scientists know exactly where the water was collected. The data is used to understand the water chemistry in different locations.

The team also wants to understand how the water chemistry affects the reefs over time. Dr. Shamberger and her team designed an experiment to test this. They cut coral skeletons into small blocks. They weighed and measured them. They even scanned them with a machine that could see all the nooks and crannies inside the coral. On the first research cruise, they placed the blocks in locations near the deep-sea reefs. One year later, they retrieved the blocks, and the science team studied them to see if there were any changes.



# Meet the Scientists

**DR. KATIE SHAMBERGER**
**PROFESSOR, TEXAS A&M UNIVERSITY**

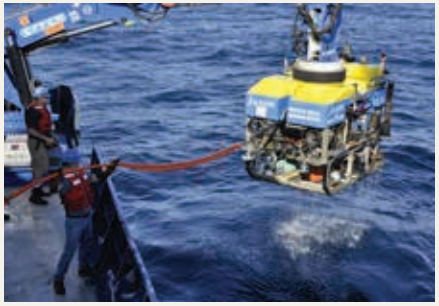
**Dr. Shamberger studies the chemistry of seawater. Her research includes finding out how humans are changing the seawater chemistry and how those changes affect the health of coral reefs. For this research project, Dr. Shamberger will investigate how these newly-discovered reefs exist where the water chemistry suggests they should not. Are the coral skeletons that form the reef dissolving? If so, how fast? If not, why not?**

# The Search for Answers: Technology

Scientists don't know the specific coral species that live in these newly discovered reefs. It's not just the corals that are mysterious. Scientists need to know what else lives in the habitat the corals create.  But it's not easy. They need to get up close and explore the reefs. They need samples to study. They need so much more information. To do all that, they need the help of technology!

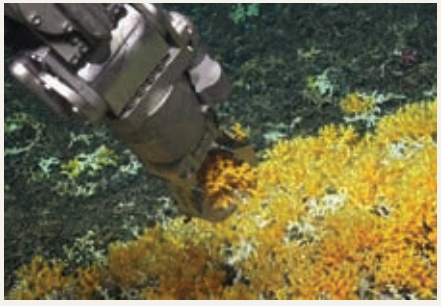
Since the science team can't simply put on scuba gear to explore these reefs, they use a Remotely Operated Vehicle (ROV).

Pilots aboard the research ship operate the ROV with the direction of the Science Team. The ROV's robotic arms collect coral samples or pick up long-term experiments left by the science team.

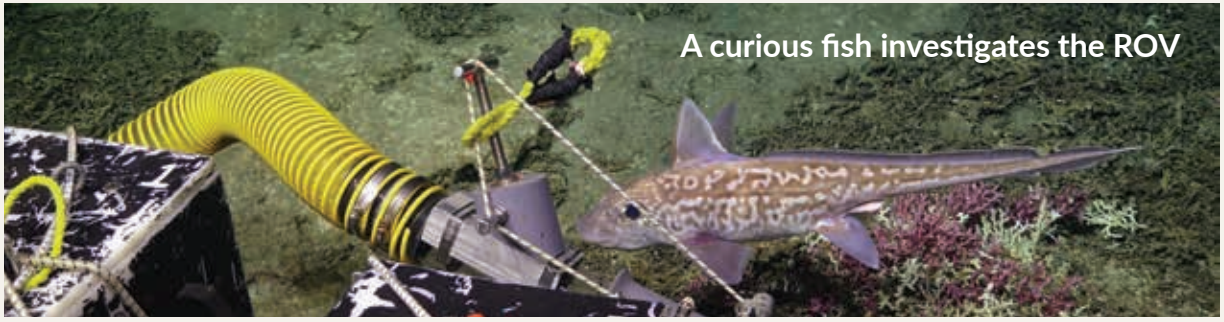


**ROV lowered into the sea**

**Pilots and scientists direct the ROV's exploration**



**The robotic arm collects a coral sample**



**A curious fish investigates the ROV**

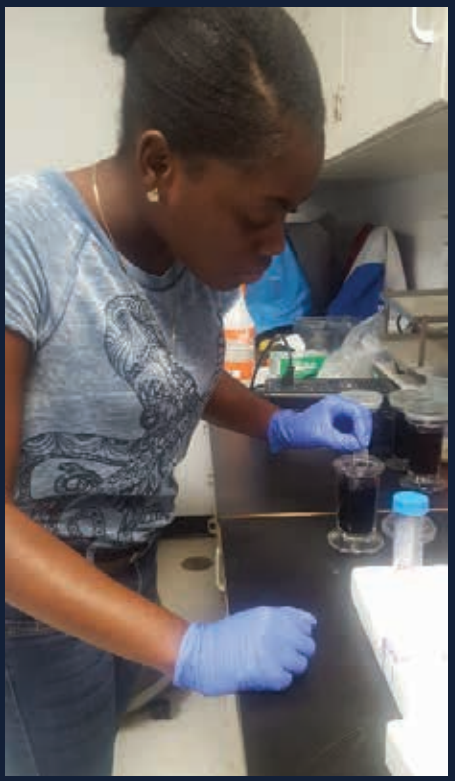
# Meet the Scientists

**LAURA ANTHONY**
**PHD STUDENT, FLORIDA STATE UNIVERSITY**

**PhD student Laura Anthony studies coral larvae. Unlike adult corals, larvae move around in the water for a while before they attach themselves to rocks, sponges, or other coral. Then they begin to build their skeletons. Laura wants to know if the larvae stay near their parents' reef or whether they float further away before settling down.**

**In addition, Laura and other science team members assist with the CTD containers before and after dives.**

# Meet the Scientists



**MAKEDA MILLS**
**GRADUATE STUDENT, TEXAS A&M UNIVERSITY**

**Makeda grew to love corals while studying how they get tissue loss disease. She said, "When I hold coral I think, I get to make a difference!"**

**For this research project, she will study bacteria that live in deep-sea corals and the reefs. Makeda will also investigate how they might help corals survive in the difficult and unexpected areas throughout the Emperor and Hawaiian seamounts.**

# The Search for Answers: Ecology

Another challenge is that many of the organisms that live on coral reefs, both shallow and deep, are too tiny to see without a microscope. Reef-building corals in shallow water rely on tiny algae that live inside their tissues. These algae photosynthesize. That means they get energy from the sun. The algae share that energy with the coral. The science team wonders if deep-sea corals have similar relationships with bacteria or other microorganisms. But we don't even know which bacteria live in the reefs.

The science team is working to solve this mystery, too. When the ROV returned with coral samples, the scientists cut up the coral up and prepared them to study back at their labs. Some are used for DNA sampling to figure out the species of coral. Some samples are used to discover how the coral reproduces. And some will be used to investigate the kinds of bacteria that live in and around the coral and reefs.

**Deep-sea coral**

**Cutting up the coral**

**Samples ready for further study**

# The Search for Answers: Computer Modeling

Some of the scientists working on this study spend more time in front of the computer than in a lab. Their work is vital to the research, too.

These scientists collect and enter data into the computer. Then they create or modify a program to tell the computer what to do with all this information. These programs are called computer models. For this research, it helps form a picture of the underwater environment. This can help scientists determine where they might find more deep-water reefs in the Pacific Ocean.

Other scientists on the project will use computer modeling, too. They hope to predict where or if deep-water reefs might be able to survive as the ocean chemistry and coral communities react to changing sea temperatures.

# Meet the Scientists

**DR. MAURICIO SILVA AGUILERA**
**SCIENTIST, FLORIDA STATE UNIVERSITY**

**Dr. Mauricio Silva Aguilera is a scientist who taught himself how to program computers and create computer models. Though challenging, he didn't give up . Now he is a specialist in this area. This aspect of his work allows him to work in many different areas of science.**

**For this study, Dr. Silva Aguilera is creating a model that will predict what kinds of habitats these coral like best.**

# What Are Scientists Learning?

If this book were a television show, this is the part where the detective would reveal the answer to the mystery. Everything would be solved, and the show would end.

But science doesn't work that way. Scientists go out to sea on research cruises to collect data—lots of data. Then they return to their labs and offices where they sort the data and try to understand what it means. It can take months or even years to figure things out.

But now Dr. Baco-Taylor, Dr. Roark, Dr. Shamberger, and the rest of the science team know a little bit more than they did before. Remember the blocks of coral they left on the seafloor? A year later when they pulled them up, the coral looked exactly the same. They still need to study them with the special scanning machine to peek inside, but the coral did not dissolve as they thought it might.

This result led to more questions. Why? Why didn't these corals show obvious signs of dissolving? The research team will study the rest of their data to try to figure that out. But one investigation won't answer all the questions. The team, as well as other scientists around the world, plan more studies to keep looking for answers.

THE *R/V KILO MOANA*

# Science at Sea

**Scientists who study the ocean spend days, weeks, or even months aboard research ships. The ships have sleeping quarters, bathrooms, eating areas, laundry facilities and rec rooms to play games or watch movies. Ships even have Wi-Fi! Cranes and pulleys raise and lower ROVs, submersibles, or CTDs. ROV pilots control the equipment from special control rooms. Scientists process their samples in laboratories outfitted with microscopes, refrigerators, freezers, and other essential equipment.**

# Why should people care?

Scientific research has shown that shallow-water coral reefs are very important. Thousands and thousands of ocean species rely on reefs for food, nurseries, and shelter. They keep the ocean healthy.

Reefs also provide food for people. They protect coastal communities from harmful waves. And they attract tourists who provide jobs for many people.

Even though deep-sea coral reefs aren’t fully understood, we know that these habitats are also important. They provide food and shelter for many other creatures. Understanding how these corals survive in this newly discovered and unexpected ecosystem might help us protect other reefs as the ocean temperatures change.

Perhaps you can be part of a science team in the future - and discover more!

# Glossary

**Calcium Carbonate**

A material that animals use to build shells and bones.

**Chemical**

A substance that is made up of a specific group of atoms. Everything is made of chemicals, including us!

**CTD**

An instrument that measures Conductivity, Temperature, and Depth. Conductivity is how well the water conducts electricity, which is related to how salty the water is.

**ECOLOGY**

The study of living things and their environment. For example, corals and the deep-sea.

**ROV**

Stands for Remotely Operated Vehicle. ROVs are used by scientists to explore places people cannot safely or easily reach or locations that need long dives.

**Microbe**

A tiny lifeform that we cannot see without the help of a microscope. Microbes includes bacteria, algae, or fungi. Also called a microorganism.

**DNA**

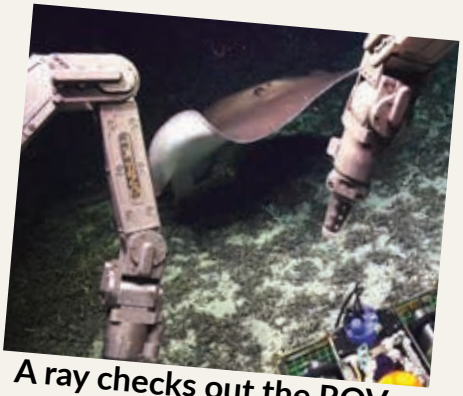
The part of a living thing that contains a set of instructions for how an organism is made and how it functions. (DNA stands for deoxyribonucleic acid.)

# Home Sweet Reef: Fun photos from the exploration

Squat lobster climbs coral

A crab on the seafloor

Brisingida star and basket star on coral



A ray checks out the ROV

Pretty coral on seamount

Sea star with coral

Bubble gum coral

**More questions than answers surface when ocean scientists Dr. Amy Baco-Taylor and Dr. Brendan Roark discover a deep-sea coral reef where it doesn't belong! Hard-corals rely on seawater to help build their skeleton. The must live somewhere with an ideal chemical balance, otherwise their skeleton – and the entire reef would dissolve. The seawater in the Northern Pacific is not the right mix for a reef to grow. So how do scientists explain these deep-sea reefs thriving where they shouldn't exist? Join the team of scientific detectives who begin to unravel the mystery.**

**WHAT IS THIS REEF DOING HERE?** is part of WhaleTimes Inc's E*xploring Deep-sea Coral series.* These books highlight the important research of ocean experts **Dr. Baco-Taylor** (Florida State University), **Dr. Brendan Roark** (Texas A&M University), and **Dr. Katie Shamberger** (Texas A&M University).

**Christy Peterson** has written more than 50 books and articles for students. Her book, *Into the Deep: Science, Technology, and the Quest to Protect the Ocean* (Twenty First Century Books) was a Washington State Book Awards finalist. Christy and her family live in Vancouver, WA.

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