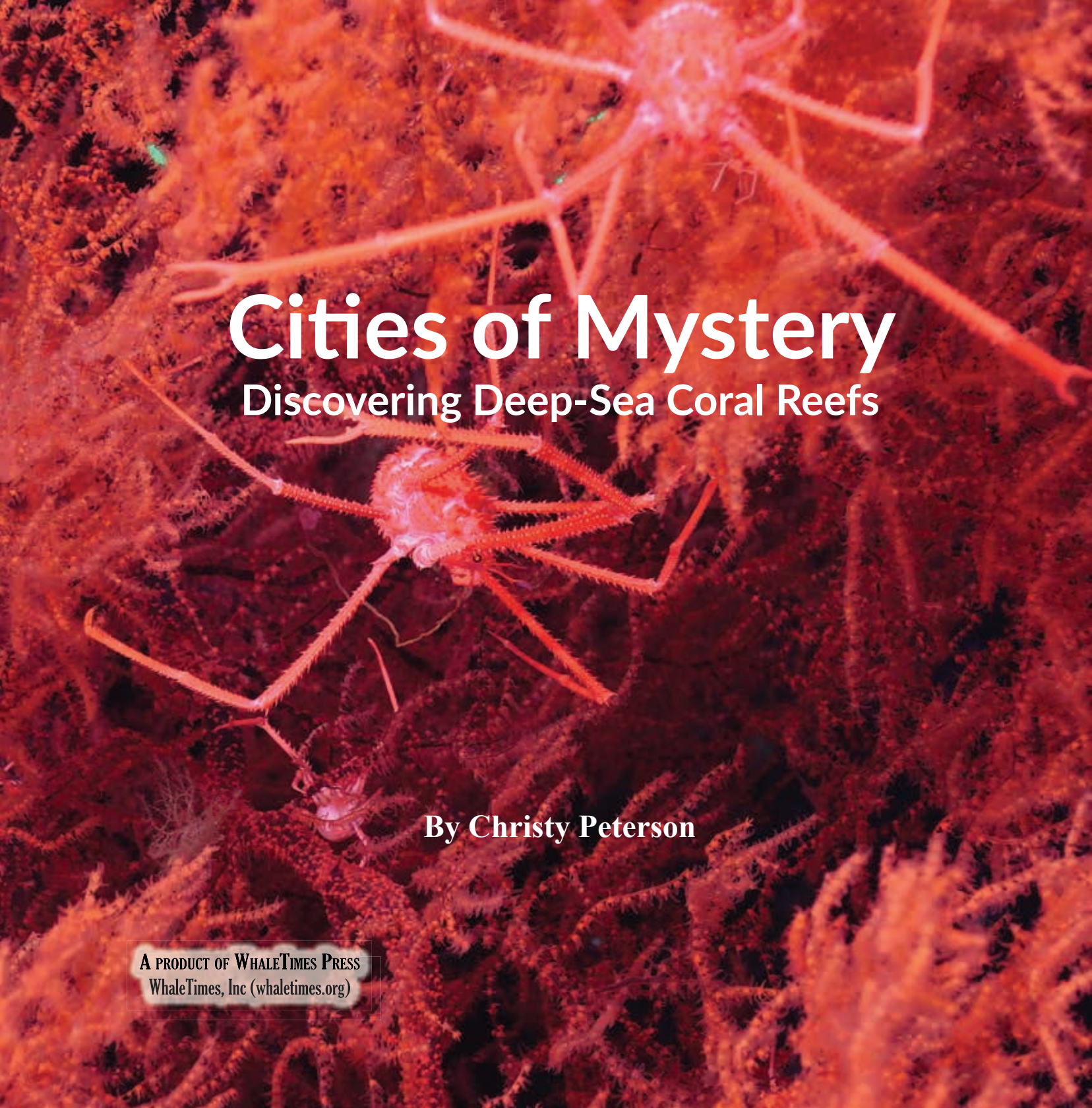

Cities of Mystery

Discovering Deep-Sea Coral Reefs

By Christy Peterson

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By Christy Peterson
Illustrated by Paul J. Lopez

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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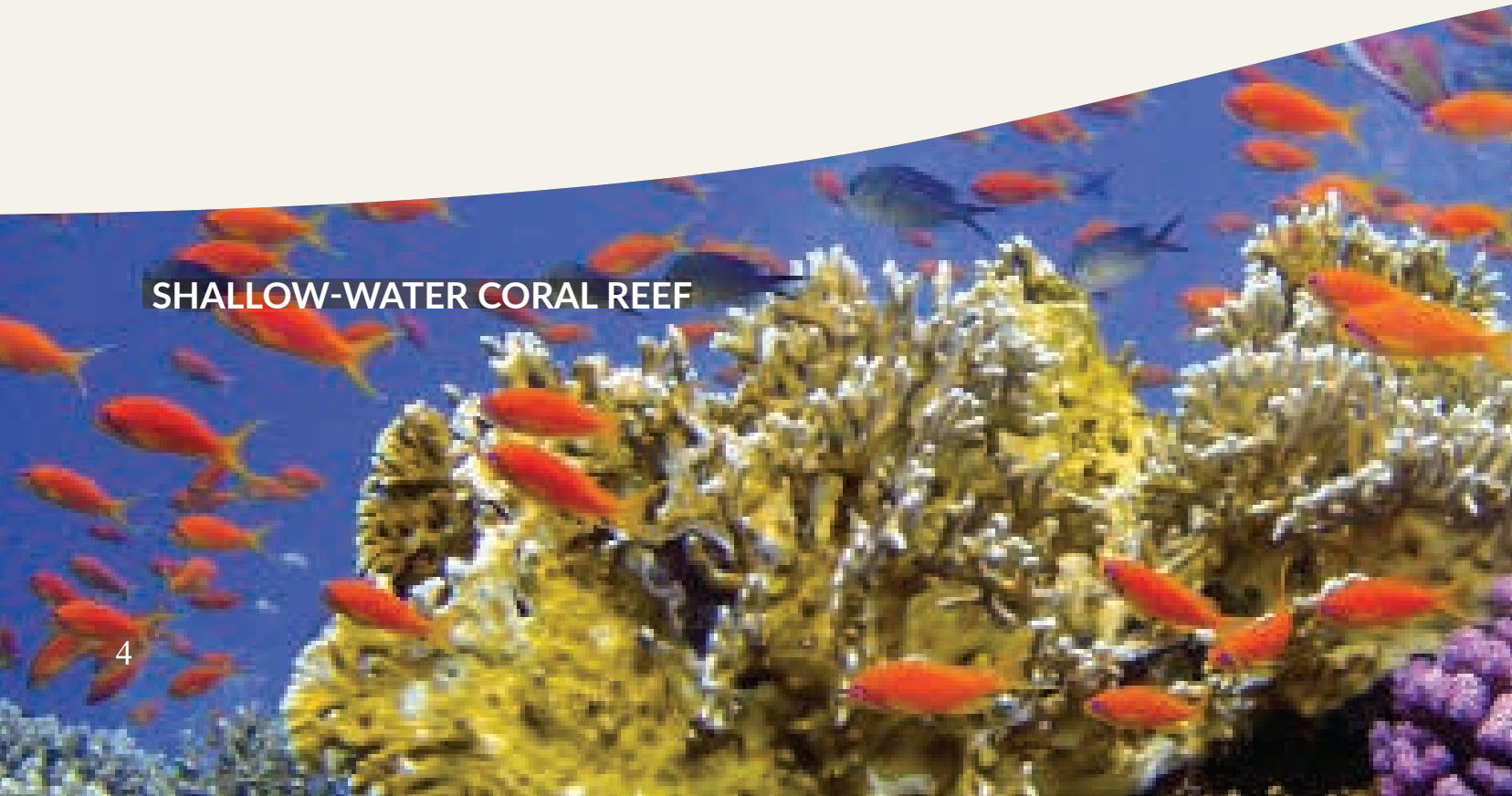
A City in the Sun

This is a coral reef. Sunlight filters through the bright blue water, decorating the reef with shadows and patterns. The reef is home to so many animals, it's like a city in the sea. Schools of brightly-colored fish swim past each other, like cars on city streets. Eels, crabs, and shrimp poke their heads out of holes in the reef, like apartment dwellers peering out their windows. Turtles and sharks glide in, like tourists from out of town.



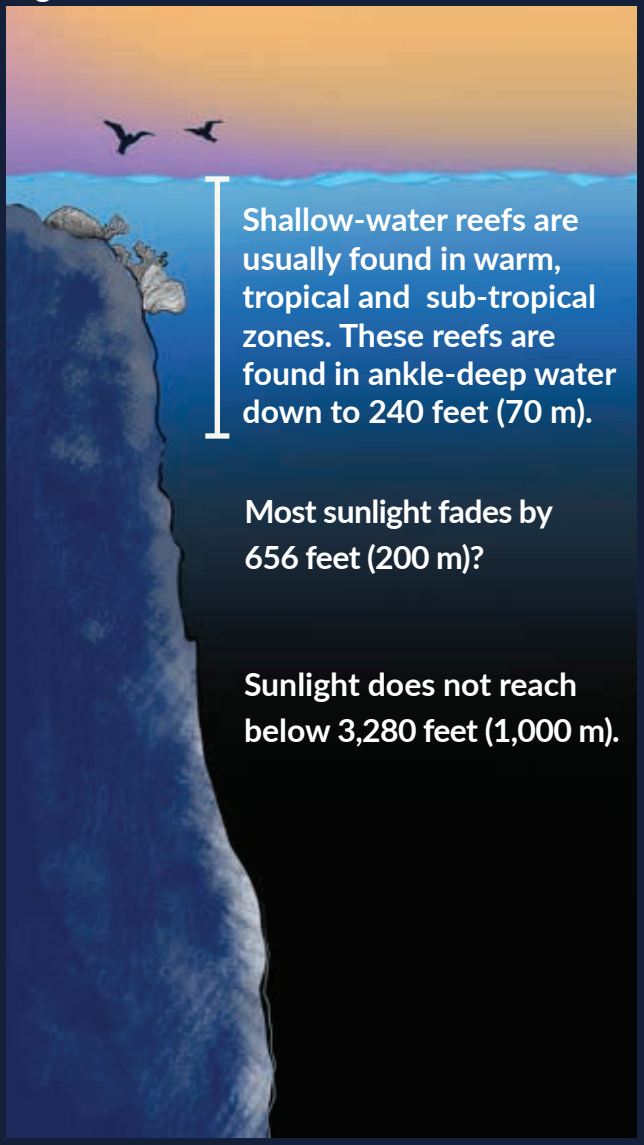
SHALLOW-WATER CORAL REEF

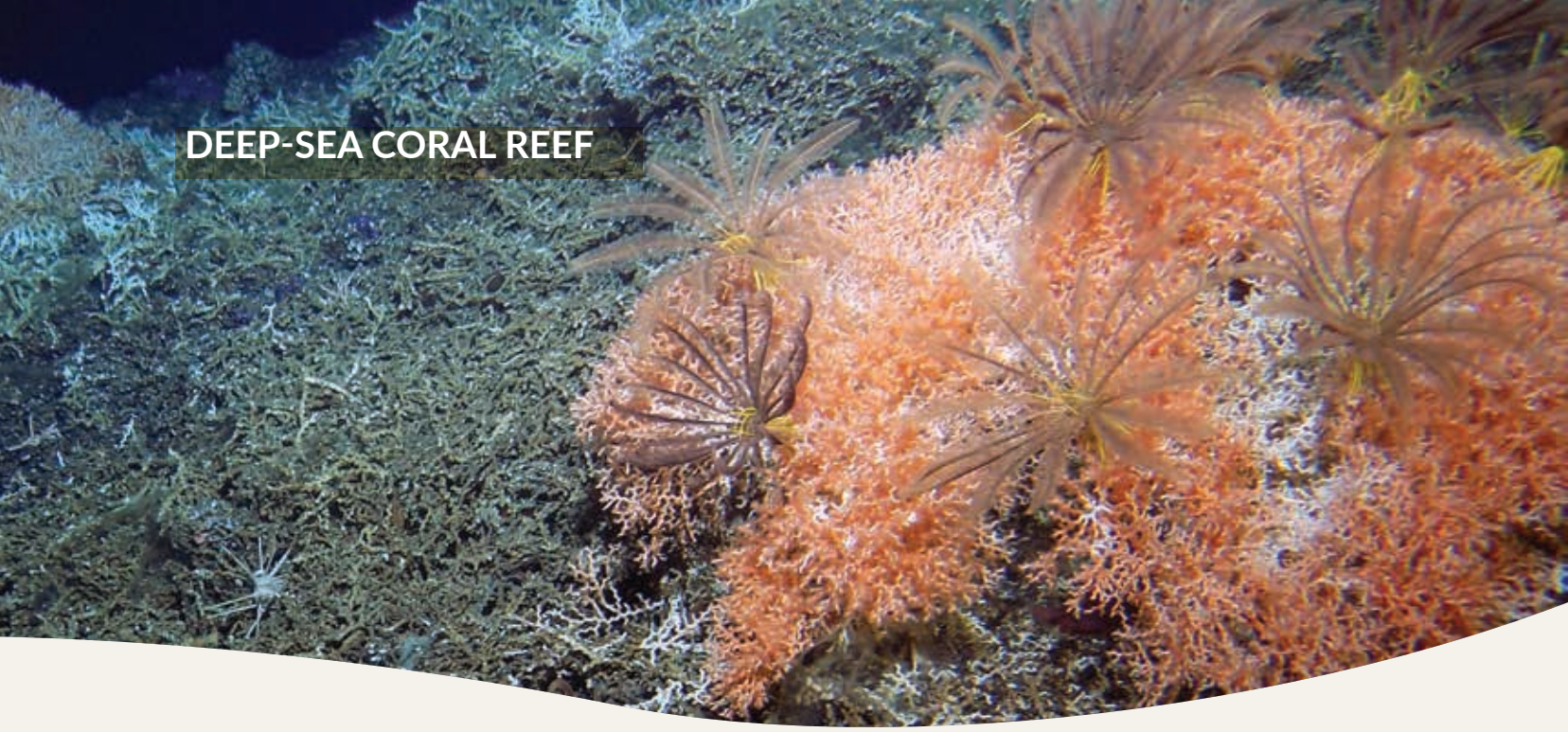
SEA TURTLE

MORAY EEL

BLENNY

This illustration shows a shallow-water coral reef. These reefs live where the sun lights the sea.

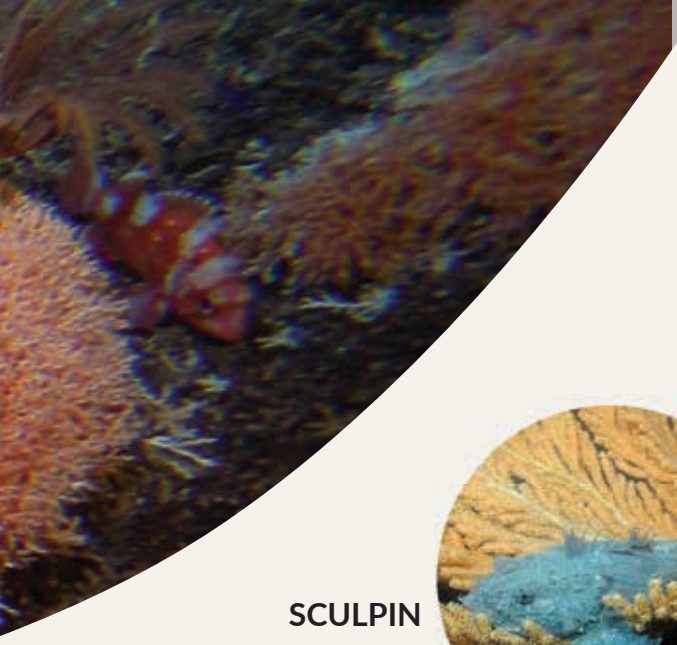




A City in the Dark

This is also a coral reef. This reef lies deep in the ocean, far deeper than sunlight can reach. Squat lobsters, brittle stars, and fish wander along, just like people in a city park. Strangely-shaped sponges, anemones, and other creatures attach themselves to the reef and reach out into the water, like flower pots on balconies and porches.

But there are many more living things here that we have never seen. Why are these places such a mystery?



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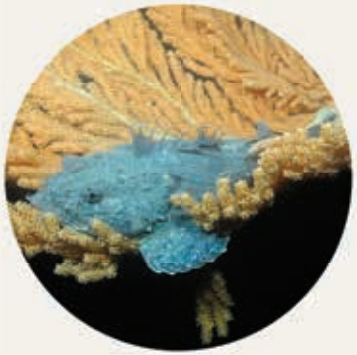
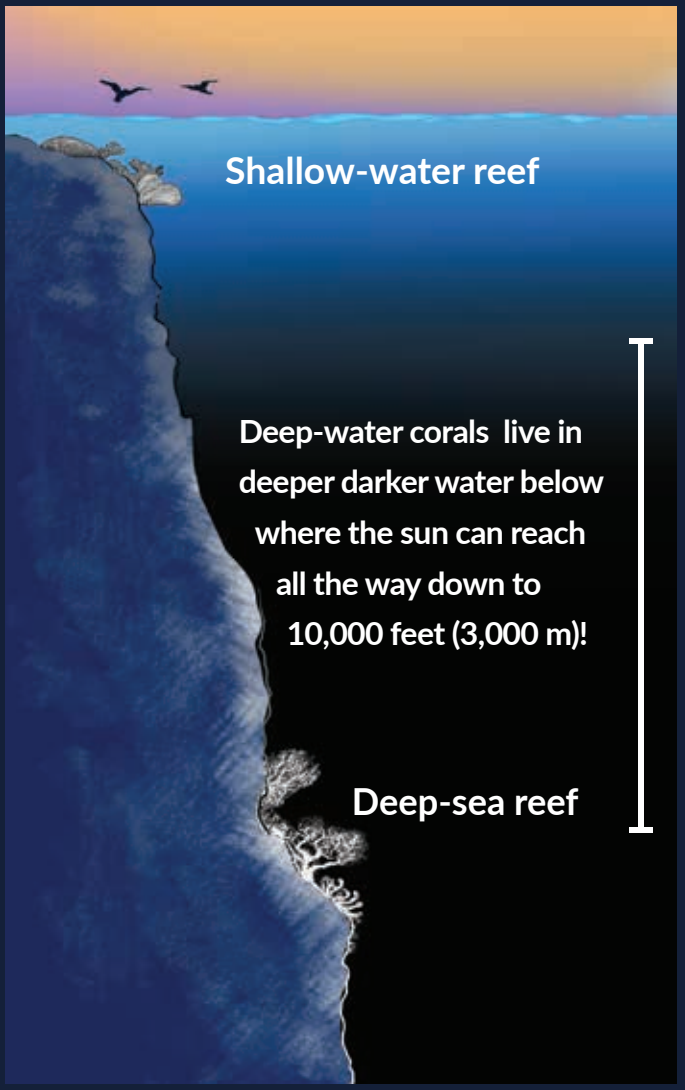


SEA STAR

SEA URCHIN



This illustration shows coral on a underwater mountain. Of course, coral grows on the seafloor in shallow or the deep sea, too.

The Construction Crew

Stony corals, also called hard corals, build reefs.

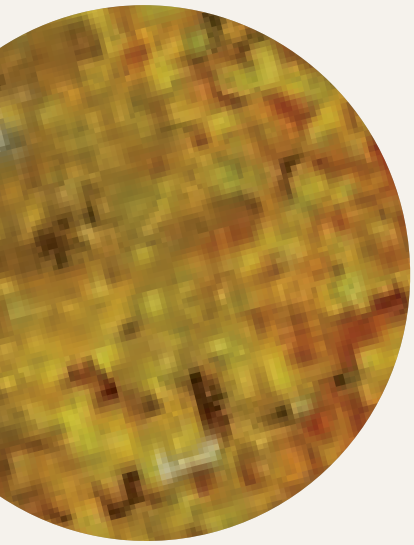
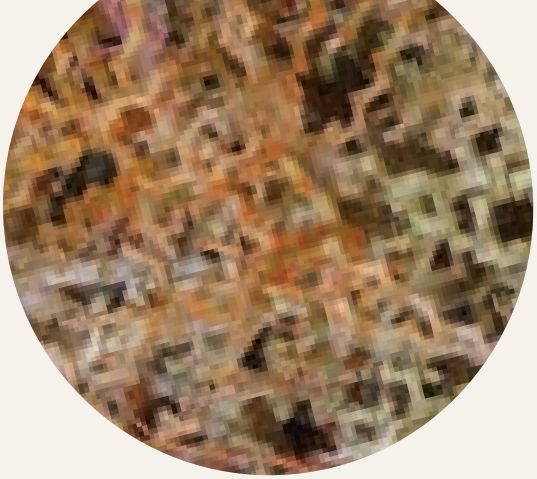
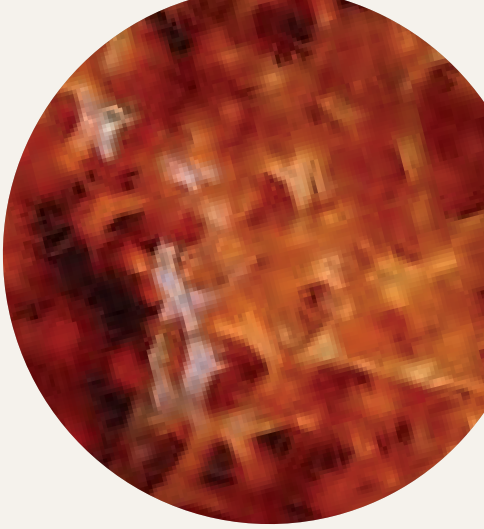
Corals are tiny animals. Each individual animal is called a polyp. When coral polyps are larvae, they swim freely in the ocean. When they get a little older, they attach to hard surfaces like other coral, rocks or the seafloor. Then they form their first polyp. Some corals will be one polyp their entire lives. Others will form multiple polyps, creating a colony.

As the stony coral polyps grow, they ooze a rock-like substance around their bases. The substance hardens and forms a cup-like skeleton. This is the first layer of a new reef. Each new layer makes the reef bigger.

By itself, a single polyp can build a tiny reef. But a colony of corals, with thousands of polyps building layer after layer, can create a huge structure. Reefs become as big or bigger than a city full of people!

Why the name Stony Coral?

There are many species of coral in all shapes, sizes, and colors. Some species build reefs and some, called soft coral, do not. We call coral species that build reefs stony or hard coral because the reefs they create are hard, just like stone.

More Questions Than Answers

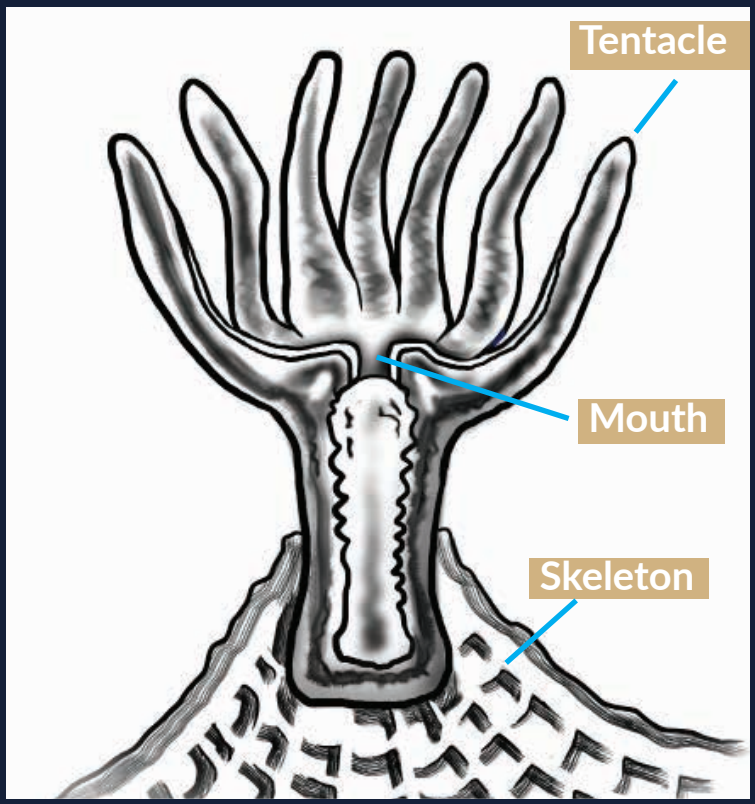
Most reef-building corals have similar bodies. Tentacles surround the coral polyp's mouth. The tentacles collect food and then move it to the mouth. Many shallow-water corals eat tiny ocean life called plankton.

Shallow-water corals also get their energy from algae that live within their cells. Algae get their energy from the sun, like a plant, and then share that energy with the polyp.

But, what does deep-water coral eat? Do they eat plankton or microscopic marine debris that sinks from the surface? Scientists don't know for sure.

There are many other questions about deep-sea corals. How fast do they grow? How do they reproduce, make babies called larvae? What other animals live in the reefs? Where are all the deep-sea reefs in the world? More research will help answer these questions and tell us more about these cities of mystery. Let's take a closer look at what it's like to study deep-water reefs.

These photos show coral from different species.



This drawing shows parts of a reef-building coral. The mouth leads to where the coral digests its food.

How to Travel to the Sea Floor

Scientists answer questions by gathering data and making observations. But that's a huge challenge if you're a scientist studying deep-sea coral reefs. To better understand, let's observe a team on a research mission.

Dr. Amy Baco-Taylor, Dr. Brendan Roark, and **Dr. Katie Shamberger** study deep-sea reefs in the Pacific Ocean. Their first challenge is to get to the reefs. A research ship takes them far out onto the ocean, miles and miles away from land. But that's only part of the journey.

The corals are 7,000 (2,100 meters) feet below the ocean surface. That's more than a mile under water. Humans cannot dive that far down, unless they are in a submersible. But for this research trip, the scientists use an ROV called *Jason.* It has lights and cameras that allow the scientists to see the reef and the animals that live there.

HOVs, ROVs, and AUVs

Since people cannot swim to the deep ocean, scientists use three kinds of machines to help them observe underwater life and to collect data. The machines have lights and instruments, such as cameras, robotic arms, water testers, and other special equipment to do research.

A human-operated vehicle (HOV), or submersible, is a thick-walled vehicle that can carry people to the deep ocean.

Pilots aboard the ship operate a remote-operated vehicle (ROV). ROVs , like *Jason*, can stay down many hours at a time.

An autonomous underwater vehicle (AUV) operates without direct human guidance, usually with a combination of computer programming.

The ROV passes many strange-looking animals as it sinks to into the deep.

DEEPSEA SQUID

VELVET WHALEFISH

An Amazing Journey

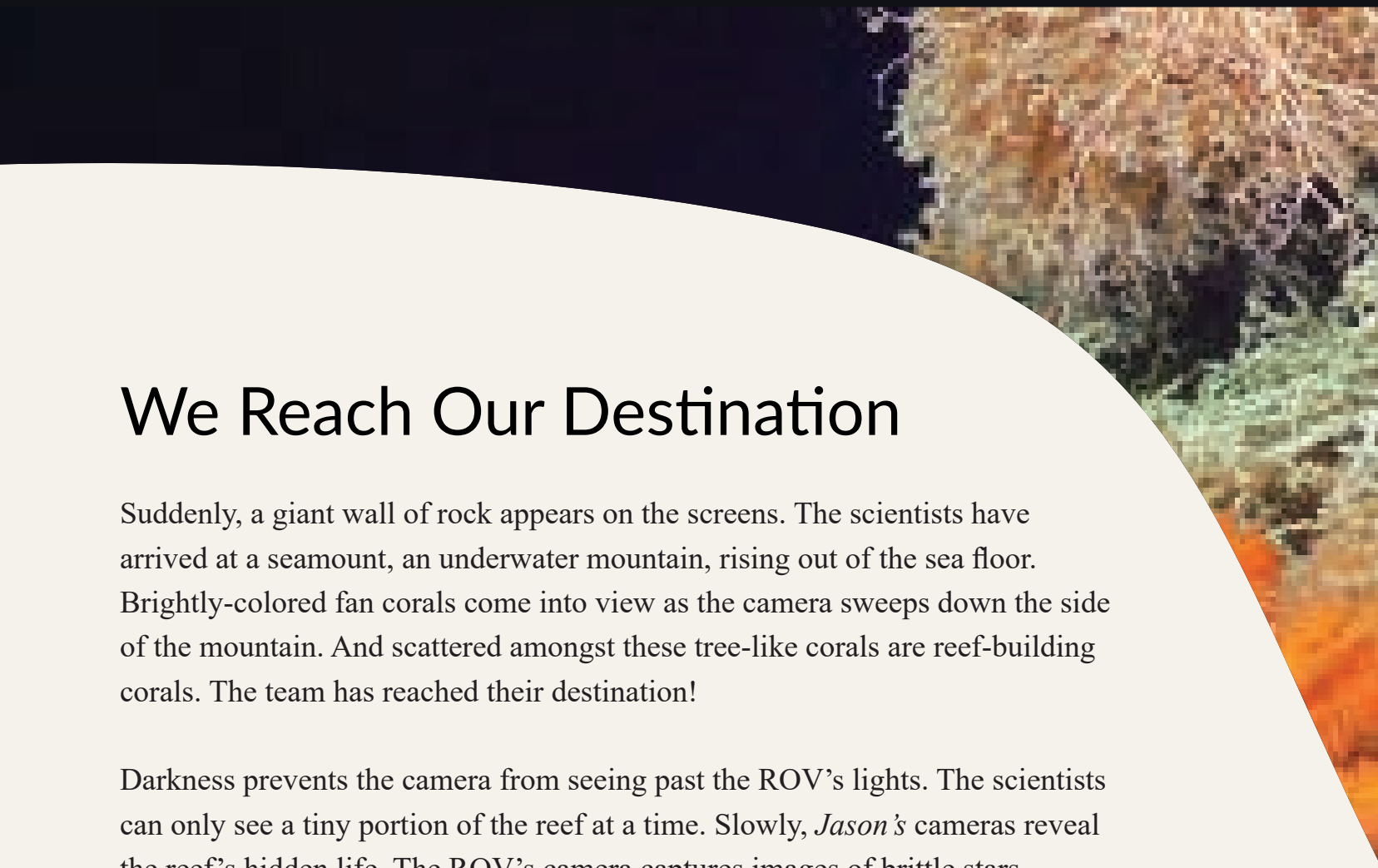
ROV Jason has a long journey in search of deep-sea coral reefs. A special crane lifts the ROV off the deck. It carefully swings the *Jason* above the water. Then the crane gently lowers *Jason* into the water.

As *Jason* disappears under the waves, its cameras are switched on and the scientists gather around computer screens. At first, the images are lit by sunlight. A school of fish darts by and a jellyfish floats gently past.

The light dims as Jason travels deeper. Soon it is so dark the scientists can't see a thing. *Jason* has reached the depth where sunlight cannot reach. In the smothering blackness, the ROV camera spots bioluminescent animals. Those are animals that make their own light. And still the ROV sinks deeper and deeper.

Once the ROV is lowered into the water, it is released from the ship. Pilots in the control room begin to send it instructions, such as telling it how fast to go and which direction to turn.

CONTROL ROOM



We Reach Our Destination

Suddenly, a giant wall of rock appears on the screens. The scientists have arrived at a seamount, an underwater mountain, rising out of the sea floor. Brightly-colored fan corals come into view as the camera sweeps down the side of the mountain. And scattered amongst these tree-like corals are reef-building corals. The team has reached their destination!

Darkness prevents the camera from seeing past the ROV's lights. The scientists can only see a tiny portion of the reef at a time. Slowly, *Jason's* cameras reveal the reef's hidden life. The ROV's camera captures images of brittle stars climbing the coral branches. Different kinds of fish swim past. A crab wanders among the stony corals—its purple color matches the coral polyps. And here or there, a spiky urchin hides.

As they explore, the scientists also collect samples of different kinds of coral to bring back to the ship. When the exploration for the day is complete, *Jason* begins its long journey back to the surface.

The pilot aboard the ship carefully and precisely uses the ROV's robotic arm to collect samples for scientists to study.

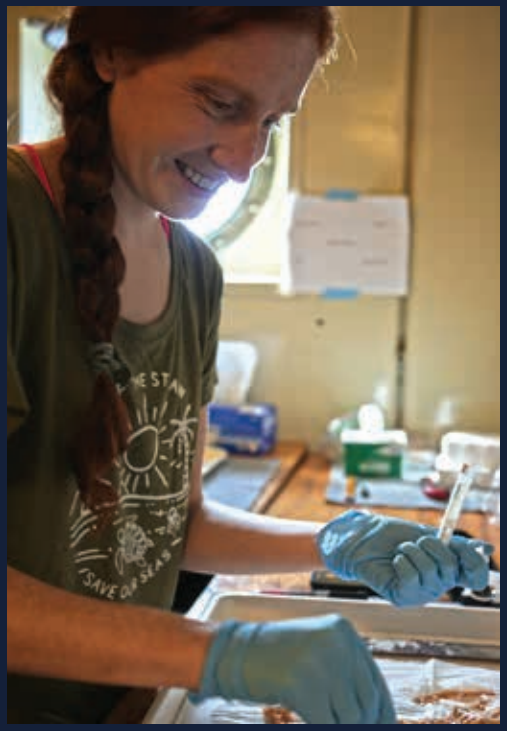
The Real Work Begins

The science team swings into action as soon as the ROV returns to the surface. They carefully process the samples the ROV has collected. Some pieces of coral go into a liquid that will preserve the cells to be studied in different ways. Scientists will be able to determine the different species they've observed. Other samples will help scientists understand how these corals reproduce. A few samples go into the freezer. And some may even make it into a museum!

Days pass. The scientists travel from one reef site to another, gathering data and more samples as they go. Before they know it, it's time to head back to shore. The data they've collected will help them learn much more about these mysterious habitats.

Back in their labs, the science team will spend months studying the data. They examine coral samples to learn more. They also look at water samples and the ROV's images of the whole coral reef landscape. All this data will help them crack the mystery of how deep-sea reefs survive and thrive.


TRIPP-LITE



The ROV's robotic arm stops to let the crab move out of the way.

Why We Need To Know More

Why work so hard to learn more about deep-sea coral reefs? We know that thousands of species depend on the shallow-water reefs to live. People also depend on these reefs. The reefs are home to fish people eat. Reefs protect shorelines from big waves. And people visiting the reef bring income to local communities.

Deep-sea reefs are important as well, in ways we don't fully understand. They support species of animals we haven't even discovered yet. Unfortunately, deep-sea corals are threatened by human activities like fishing, mining, and rising sea temperatures.

By learning more about deep-sea corals, we can work hard to protect them. Because when we protect reefs, we are really protecting entire "cities" in the sea. And when we protect the cities, we protect the entire ocean community.

Meet the Scientists!

Dr. Amy Baco-Taylor - Professor, Florida State University
Dr. Baco-Taylor is a marine biologist who studies life on seamounts. Seamounts are just like mountains on land, except they are underwater! She is especially interested in deep-sea corals, which often live on seamounts. She hopes her work will help us learn to protect life in the deep ocean.

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 the animals that live there healthy and thriving.

Dr. Katie Shamberger - Professor, Texas A&M University
Dr. Shamberger studies the chemistry of seawater. She wants to know how humans are changing this chemistry and how the changes are affecting ocean life, especially corals and coral reefs. She has studied coral reefs all over the world in places like Hawaii and Australia.


RESEARCH
VESSEL

Glossary

Autonomous Underwater Vehicle (AUV)

A machine that travels underwater and is guided by a computer program rather than direct control of people.

Colony

A collection of coral polyps that are interconnected and genetically identical.

Corals

Animals related to jellyfish and sea anemones that attach to hard objects on the sea floor and live in large groups.

Deep Sea

The term used for the ocean below 656 feet (200 meters).

Human-Operated Vehicle (HOV)

A thick-walled ocean vessel that allows people to safely travel to the deep sea.

Polyp

The term used to describe an individual unit of coral.

Remote-Operated Vehicle (ROV)

A machine that can be operated via remote control from a distance.

Tentacle

A long, flexible extension that some animals, like sea anemones and coral, use to find food.

Scientists recently discovered a city full of creatures that are mostly tentacles and mouths. Creatures from deep space? No, coral. They build complex reefs, like cities in the sea. Reefs provide food, shelter, and even nurseries for fish, sharks, crabs, dolphins, octopus, and more. But what is coral? Where do they usually live? And, why they are important? Dive into the deep and learn about coral reefs and the scientists who study these newly discovered cities of mystery.

CITIES OF MYSTERY is part of WhaleTimes Inc's *Exploring 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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