THE BENTHOS

INTRODUCTION

As a scuba diver, you have a remarkable capability. Unlike most of the planet's inhabitants, your ability to breathe underwater gives you a front-row seat to explore a largely unknown world. Of Earth's population of 8.1 billion, fewer than 10 million are certified divers and thus blessed with the unique privilege of understanding why Earth has been called the "Blue Planet."

Still, there is an obstacle to gaining a full appreciation of the underwater world. The emphasis during your scuba training was almost entirely on the knowledge and skills required to dive safely. Yet, learning the theory and practice of scuba diving was probably not why you chose to become a diver. After all, learning to dive is just a means to an end – a way to get there – not the end itself. For most people, the real motivation to dive is to explore the 71 percent of the Earth that most others cannot experience and to observe creatures and phenomena most people only see in movies and social media.

The lack of emphasis on the environment during scuba training means that most divers graduate without a clear understanding of the underwater world and are therefore unable to fully appreciate what they see around them. As a result, many divers quit diving once the excitement and adventure of simply being underwater begins to wane.

The Reef Smart Guides Ocean Explorer program is designed to enhance your underwater experience. The contents of this program include waterproof handheld cards and guided activities provided by a Reef Smart-trained dive professional, as well as optional online reading materials that provide additional context. The program's goal is to provide an intimate understanding of how coral reef ecosystems function, the challenges they face, and the action that is being taken to protect them.

The Reef Smart Guides Ocean Explorer Program is ideal for any avid diver or snorkeler who wants to learn more about the marine environment, particularly coral reefs, irrespective of their age or educational background. The Ocean Explorer Program consists of several individual modules that are designed to provide insight into a particular facet of the marine environment. Each module listed below is designed to complement the others in the program and can be completed in any order:

THE BENTHOS
This experience familiarizes divers and snorkelers with critical environmental aspects of coral reefs and the key benthic species that form the basis of this incredibly productive and diverse ecosystem. The objective is to hone observational skills and gain an understanding of subtle yet vital indicators of coral reef health.

THE FISH COMMUNITY
This experience familiarizes divers and snorkelers with coral reef fishes, but it involves so much more than "fish ID." The objective is to introduce the concept of how fish morphology (form) drives their behavior and role (function) in the coral reef ecosystem.

THE REEF AT NIGHT
This experience familiarizes divers and snorkelers with various phenomena that can be observed on coral reefs at night, such as bioluminescence and biofluorescence. The objective is to raise awareness of how the

coral reef community's "night shift" differs from its "day shift" and some of the behaviors that can be observed.

While each module covers the background material required to enhance your dive experience, it does not include many in-depth aspects of coral reef ecology. For a more thorough treatment of the topic, we suggest purchasing a copy of *Beneath the Blue Planet: A Diver's Guide to the Ocean.*

THE BENTHOS

Marine scientists use the term "benthos" (from the Greek meaning "depth of the sea") to describe the sea bottom or substrate. The term also encompasses the various organisms, such as plants, algae and corals, which are attached to it. Most divers and snorkelers focus primarily on mobile reef life, such as fishes, mollusks and crustaceans, but the organisms that make up the seafloor of a coral reef represent an incredibly diverse and fascinating system. Moreover, they are of great consequence to the general health of coral reef ecosystems.

This module of the Reef Smart Guides Ocean Explorer Program is designed to familiarize divers and snorkelers with the physical and biological aspects of the benthos, and how these factors can be indicators of the health and resilience of the entire ecosystem. Understanding the creatures that make up this part of a reef is crucial to genuinely appreciating the wonders of any reef anywhere in the world.

LEARNING OBJECTIVES

1. Understand and evaluate the physical requirements of coral reefs.
2. Understand how the benthos (seafloor) of a coral reef is important in determining its health status.
3. Identify coral types.
4. Identify signs of competition between corals and other sessile (attached) organisms.
5. Identify signs of stress on coral reefs involving predation, disease, and bleaching.
6. Identify common forms of algae and differentiate those that contribute to reef health versus those that can weaken it.
7. Identify common marine invertebrates.

WHAT MAKES A HEALTHY CORAL REEF?

As with any ecosystem, coral reefs can only thrive under the right environment. In the case of corals, they require a stable environment with the following conditions:

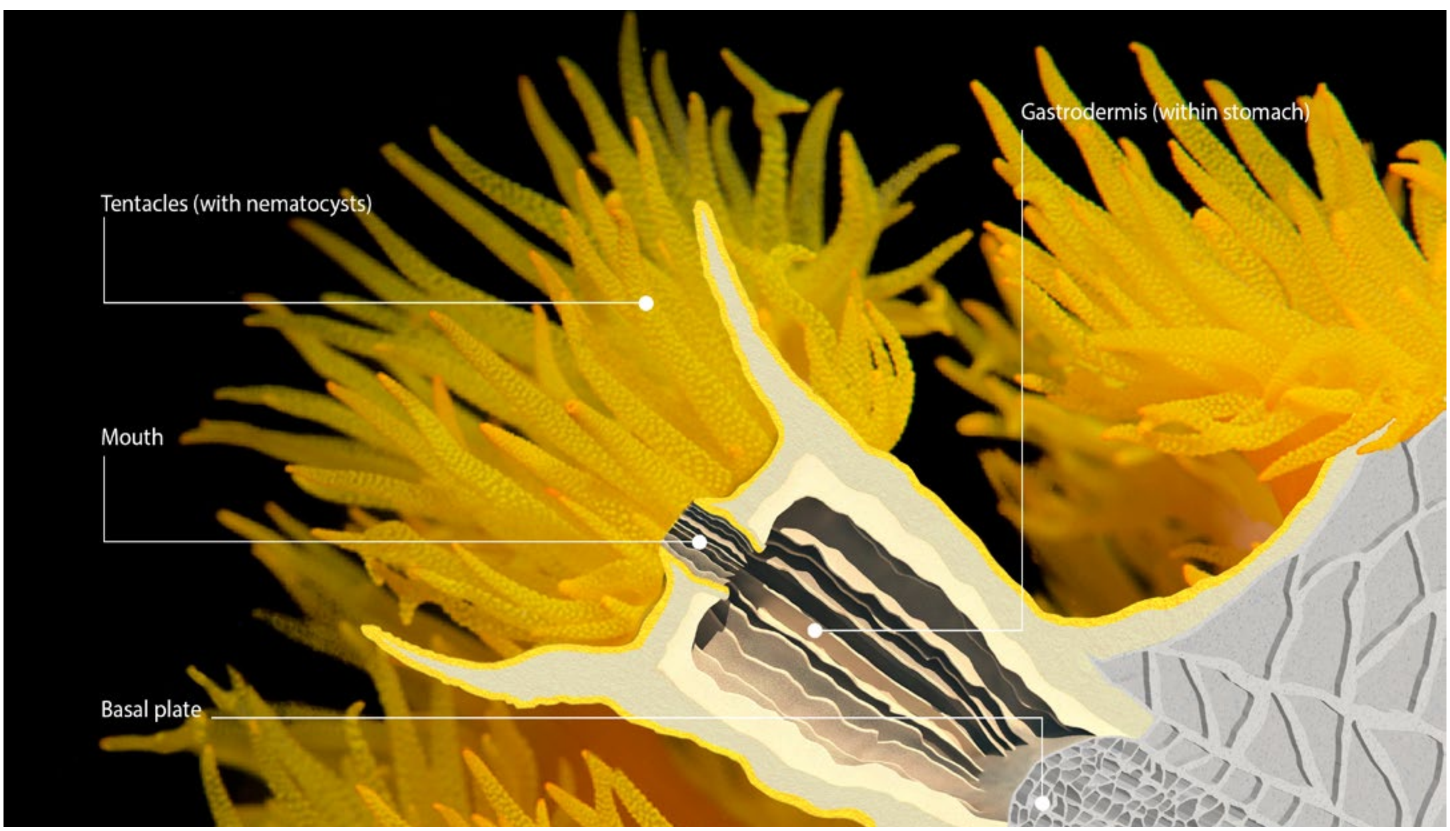
- A temperature range between 25 and 29°C or 77 and 84°F – not too hot and not too cold.
- A salinity (salt content of the water) range of 32 to 42 0/00 (parts-per-thousand).
- A pH range of 8.0 to 8.4 – pH is a measure of whether a solution is acidic or alkaline, where 7 is neutral, so 8 represents water that is slightly alkaline.
- Clear, low-turbidity water that allows sunlight to penetrate so that corals can photosynthesize.
- Low levels of nutrients in the water – nutrients (including nitrogen and phosphorus), usually originate from land-based sources, such as sewage and fertilizers used for crops and lawns. Unlike plants and algae, corals do not like nutrients. In fact, coral reefs thrive only in low-nutrient conditions, which may seem counterintuitive, given their high biological productivity.

Although reefs can survive outside these environmental ranges for short periods of time, they cannot thrive in the absence of their ideal conditions. The reason why these environmental conditions are so important to the coral reef ecosystem is that they have a significant effect on the survival of reef-building corals. And reef-building corals are arguably the most important organisms in the entire reef ecosystem – they are what give the ecosystem its name, after all.

Corals are tiny animals that resemble plants and algae in many ways. For example, corals attach themselves to the seabed and use sunlight to produce energy through a process known as photosynthesis, much like plants and algae. Except corals are actually animals. They eat small organisms such as bacteria and plankton found in the water, and they rely on microscopic algae that they shelter in their tissues to develop their photosynthetic abilities.

Rich Carey/Shutterstock©

A healthy coral reef often contains a wide range of coral species.



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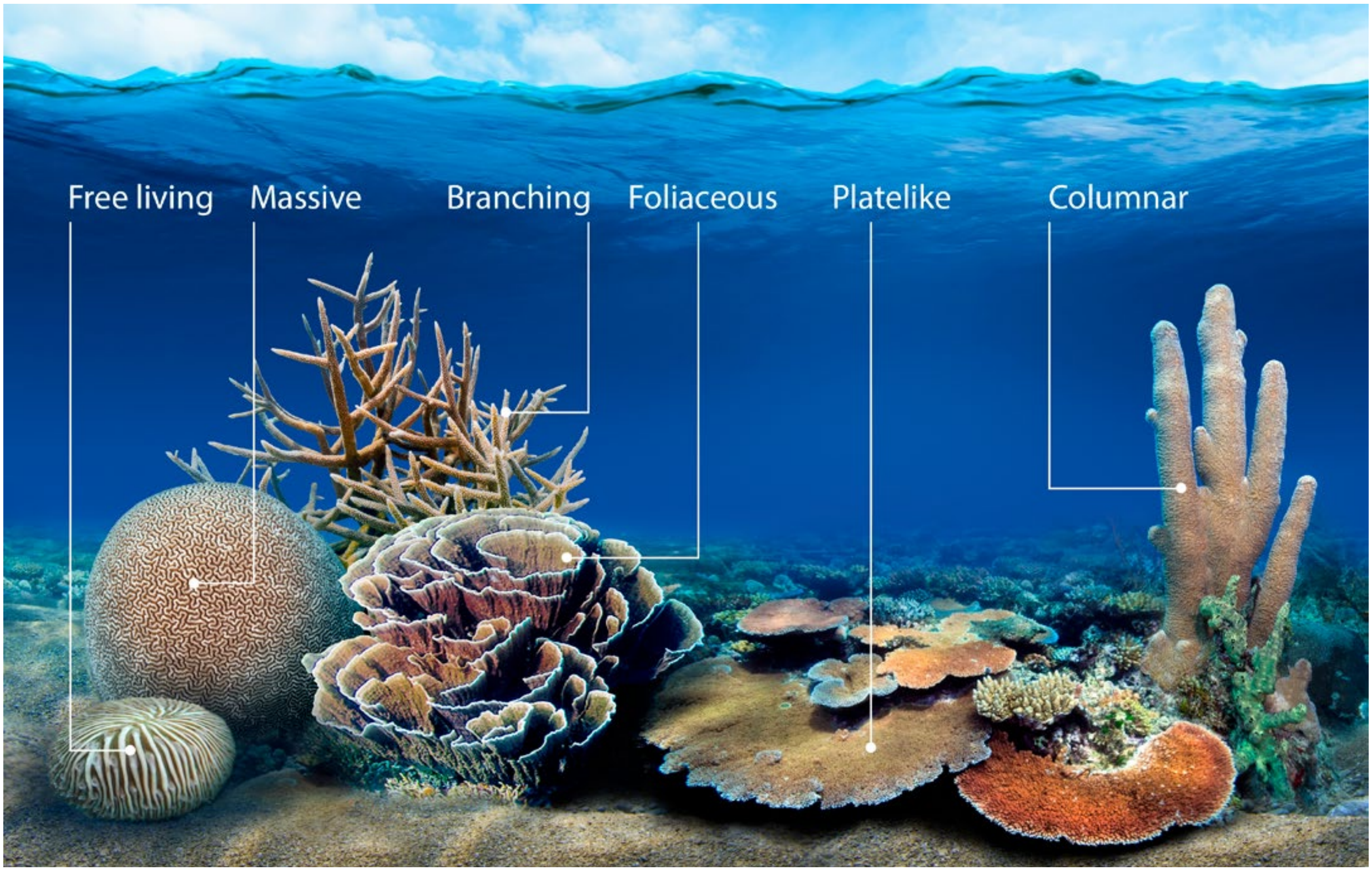
The irony of a coral reef is that such a complex ecosystem is based on such an anatomically simple animal.

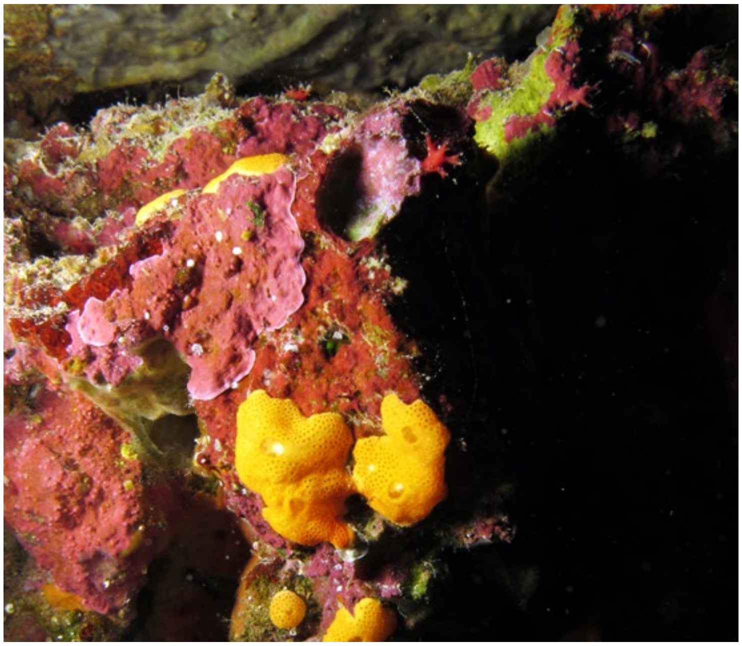


The first step in learning to identify corals is learning their general growth forms, as species of a particular form are often related.

When physical conditions are pushed outside of the ideal ranges for corals, they are less able to compete with other benthic organisms, such as plants and algae, which can quickly take over the seafloor to the detriment of the broader system.

Morphology describes the structure and form of an organism. There are approximately 80 species of hard corals in the Caribbean. Regardless of the large number of different coral species that exist, they all occur in one of several growth forms, often referred to as morphology. Species of a particular form are often related, so the easiest way to start identifying corals is to first determine their morphology.

Other community members also play a vital role in the ecology and health of coral reefs, some of whom play integral roles in the structural integrity of the reef. In some ways, coral reefs can



Crustose coralline algae (CCA) is vital in helping to maintain the structural integrity of coral reefs and providing a cue for coral larvae settlement.

be likened to the structure of a concrete wall. The main framework of any concrete structure is the cement blocks themselves, just as the major components of a coral reef are the reef-building hard corals. However, stacking concrete blocks in the shape of a wall would be very unstable unless mortar is used to help bind the blocks together into a cohesive structure. The same is true for the reef. And any organism that helps bind the reef together can be considered a kind of mortar. On coral reefs this role is usually filled by sponges and fleshy coral relatives called zoanthids.

Concrete is often fortified with aggregate (e.g. sand and gravel) to give it more strength. On coral reefs, this aggregate is provided by sedimentary infill such as urchin spines, shell fragments, and remnants of calcareous algae. Over time, this calcareous material will bind together through natural chemical processes to further strengthen the reef. Then, much like adding a stucco veneer on a concrete block building, the outer surface of the reef is often bound and fortified by a vital group of limestone-producing algae called Crustose Coralline Algae (CCA). In deference to our building analogy, CCA is sometimes called "pink cement" and, as pictured below, it is often mistaken for coral. It is abundant on healthy reefs.

Healthy coral reefs also depend on nearby ecosystems such as seagrass meadows and mangrove forests, as well as a diverse assemblage of reef-dwelling organisms, such as fishes and invertebrates. Together, the organisms across all these associated ecosystems interact at a finely tuned level that supports an incredible amount of diversity and a startling level of production.

THE BENTHOS AS A HEALTH INDICATOR

Coral reef health can be quantified in multiple ways. One way is by determining the amount of substrate (or seabed) that is living versus non-living. In the non-living category are sand, silt, rubble, rock, and dead coral. The living category is more diverse and includes seagrass, algae, sponges, various encrusting organisms, and coral.

Of course, the most critical factor is how much hard coral is present, and the parameter for quantifying this variable is termed *percentage of hard coral coverage*. Consider this real-world example: As late as the 1970s, the percentage of hard coral cover in Florida and the Caribbean was about 50 percent, meaning half of the sea bottom was covered with living coral. Today, that percentage averages just 10 percent, although it can vary widely from location to location – for instance, it is a mere one or two percent in Florida. This just serves to demonstrate the significant degradation experienced by Caribbean coral reefs over the last five decades. In that time, many reefs have undergone a "phase shift" from the dominance of hard coral to fleshy macroalgae. Many factors have contributed to this decline, including poor water quality, disease, rising acidity and temperature, and predation, each of which is explained in more detail below.

WATER QUALITY

Water quality plays a crucial role in the health and survival of coral reef ecosystems. Coral reefs are highly sensitive to changes in their surrounding environment, and so water quality directly affects their overall well-being. There are many factors affecting water quality, such as agricultural runoff, sewage discharge, and coastal development.

Coral reefs have evolved to exist in low-nutrient conditions, so high nutrient levels in the water are detrimental to coral health as they cause algae to rapidly outcompete corals for space on the reef. Excessively high nutrient levels, known as eutrophication, can smother corals, preventing them from receiving sufficient light for photosynthesis. It can also serve as a food source for microbes.

Excessive sedimentation, often due to coastal construction projects and deforestation, can create high turbidity in coastal waters. These sediments can block sunlight while in the water column as well as suffocate corals as they settle on the reef, preventing corals from obtaining oxygen and food from the water. Sediments can also carry pollutants and pathogens that can directly harm corals, while sewage and runoff of industrial pollutants can do the same.

Pictured are two forms of nutrient-indicator macroalgae: Y-branched or Dictyota, covered by a form of cyanobacteria.

Poor water quality generally increases the stress on corals, making them more vulnerable to diseases caused by bacteria, fungi, and viruses. Overall, maintaining good water quality is essential for the resilience and survival of coral reef ecosystems. Efforts to mitigate the impacts of climate change, reduce pollution, and protect coral reefs from human activities are critical for preserving these unique and biodiverse marine ecosystems.

CORAL DISEASE

Since the 1970s, about two dozen infections have been identified in hard and soft corals across the Caribbean, many of which led to significant disease outbreaks that spread far and wide. Unfortunately, the various causes of these outbreaks are only known for about a quarter of the total number of cases. There is limited funding available for this kind of research and culturing these pathogens in the laboratory is challenging. Even so, scientists can point the finger at climate change and other human impacts as essential drivers in many coral diseases. As we just learned, poor water quality facilitates many coral diseases either through direct or indirect effects on corals.

Coral diseases involve many organisms, including bacteria, fungi, ciliates (a common group of protozoans), and sometimes a consortium of cyanobacteria-dominated microbes (sometimes referred to as blue-green algae). Another oddity is that some of the bacteria found on diseased corals are terrestrial species that are generally not considered pathogenic. Complicating matters even further is that at least one disease is not caused by one pathogen alone but by multiple pathogens working in concert with environmental factors such as high temperature, acidity, and abnormally high nutrient levels.

Coral diseases often form a narrow band of diseased tissue separating the living tissue from the bare skeleton. The bands move across the colony's surface at a rate sometimes as high as an inch (several centimeters) per day, leaving behind bare skeletal material rapidly colonized by algae.

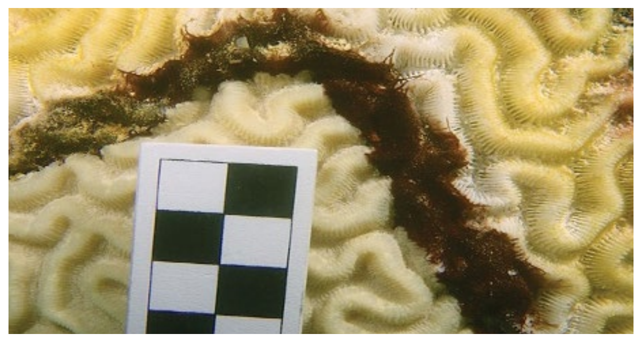
Coral diseases are not evenly distributed across the world. The Caribbean and tropical Western Atlantic reefs are particularly affected by diseases, possibly because of how closely together the islands are grouped in this part of the world, the linked nature of the oceanic current systems in this region, and the high concentration of the surrounding human population. By comparison, the Indo-Pacific Ocean encompasses an enormous area and the resulting greater distances between reefs may help insulate this region from the widespread diseases found in the Caribbean.

The many faces of coral disease

White pox

Dark spot

White band



Black band

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Yellow band

A recent coral disease deserving special mention has been dubbed stony coral tissue loss disease (SCTLD). Often referred to as "skittle-d" by divers. The reason for such special attention is its recent appearance, virulence, and potential to wreak widespread damage on what remains of Caribbean coral reefs. Unlike previous disease outbreaks that might only kill part of a colony, SCTLD typically leaves no survivors. In addition to being one of the most widespread disease outbreaks on record, it is also one of the most lethal and infectious once established.

While coral disease has been common for the past several decades, SCTLD is different due to its extended duration, rapid progression, high rates of mortality, and the number of species it affects. Colonies infected with SCTLD can display multiple lesions and die at an alarming speed. Complete mortality can result after mere weeks in the case of smaller colonies or occur over one or two months in the case of larger colonies.

So far, this disease has been documented in 22 of the approximately 45 reef-building species found in the Caribbean (although branching corals, such as staghorn and elkhorn corals, appear to be immune). Tragically, five species affected by SCTLD are also listed as threatened on the U.S. Endangered Species list.

SCTLD is believed to be a bacterial disease, although there is some evidence that a virus may be involved. What is known, however, is that SCTLD is transmitted through water circulation and direct contact. Researchers are working to identify potential pathogens and any relationships with environmental factors. They are also working to develop strategies to treat diseased colonies and identify genotypes of corals that might be resistant to the disease.

If there is any good news about SCTLD, it is the fact that the disease has sparked a united effort among scientists across the region to both identify the pathogen and respond with treatment options. Moreover, recognizing the potentially disastrous consequences of SCTLD, the State of Florida and various U.S. federal agencies have committed serious funding to assist scientists in their task. Initially detected in late 2014, SCTLD was considered a Florida problem because it seemed to occur nowhere else. However, the disease has since been reported in roughly 20 countries throughout the Caribbean.

RISING ACIDITY AND TEMPERATURE

While many factors affect the health of coral reefs, scientists now agree the most severe impact currently is the result of global warming. The significant increase in carbon dioxide levels in the atmosphere due to the burning fossil fuels affect coral reefs in two ways. First, extra carbon dioxide has increased the ocean's acidity (decreased the pH) by nearly 30 percent since the beginning of the Industrial Revolution. With this increase in acidity, corals are literally beginning to dissolve, and the higher acidity also makes it more difficult for them to form the limestone (calcium carbonate) skeleton they need to grow. This is also the case for other organisms that build calcium carbonate shells and skeletons, such as sea urchins and conch.

The other problem with global warming is that the ocean has absorbed most of the excess heat trapped in the atmosphere. This has made the ocean warmer. But because water can absorb much more heat than air before changing temperature, this increase has been gradual and largely unnoticed until recently. The consequences

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Stony Coral Tissue Loss Disease (SCTLD) is, so far, the most virulent disease to occur in the Western Tropical Atlantic.

are only now becoming apparent and have been termed marine heat waves (localized regions of abnormally high sea temperature).

You may recall that the optimal temperature range for tropical corals is between 77 and 84°F (25 and 29°C). Corals in some extreme locations such as the Red Sea and Persian Gulf have adapted to higher-than-normal temperatures, but for most corals, too much time spent outside of this ideal range in water temperature can be dangerous.

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Bleached corals turn white with the loss of the symbiotic zooxanthellae from their tissue.

Corals react to heat stress with a phenomenon known as bleaching, a condition where their symbiotic algae (zooxanthellae) are ejected from the tissues of their polyp host. Since coral tissue is transparent, a colony without its zooxanthellae appears bleached due to the white limestone skeleton found beneath the living tissue. Bleaching is not necessarily a death sentence, depending on how long the condition persists and the colony's ability to withstand heat stress. However, zooxanthellae provide most of the polyps' energy in tropical corals through photosynthesis, so the colony will gradually starve if too much time elapses before the bleaching event ends. If any remaining zooxanthellae not expelled can regenerate fast enough or new planktonic dinoflagellates of the correct species can be drawn from the surrounding water column, the colony can recover.

Even so, bleaching is physiologically stressful, so colonies are often highly susceptible to disease after a bleaching event. And even if a colony survives bleaching and avoids diseases after a bleaching event, the experience can still negatively affect colony health. For instance, research has shown that bleaching can impair reproduction in surviving corals for years after a bleaching event.

The prevailing hypothesis explaining why corals bleach is that both high temperature and light conditions overpower the photosynthetic process of the zooxanthellae, resulting in oxidative stress. The one-time ally is no longer capable of providing food and instead creates harmful oxygen radicals, and so the coral polyp expels its zooxanthellae. Still, not all scientists are convinced. Some believe the zooxanthellae control the process themselves. More research is needed, which is a pattern that repeats across many aspects of our knowledge about coral threats.

Global mass bleaching events are a result of elevated water temperatures. Surprisingly, the temperature increase required to trigger a bleaching event appears small – just 2°F (1°C) above the average summertime temperature. Recent evidence shows that bleaching events have become five times more frequent than they were just 40 years ago.

At a local level, bleaching can be caused by other factors beyond high temperatures. For instance, increased solar irradiance (UV radiation), excessive sedimentation, bacterial infection, changes in salinity, and toxicity from various chemicals have all been shown to trigger bleaching, as have abnormally low water temperatures.

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*The growth of a branching coral, such as staghorn (*Acropora cervicornis*), occurs at the terminal tips. Because this is a fast-growing species, limestone is deposited before the zooxanthellae can take up residence, so the tips typically appear white. In this case, it is not the result of bleaching but a normal growth condition.*

Alex Brylske©

*Not all corals appear white when they are bleached. Some species display a range of colors due to the presence of fluorescent pigments within their tissues. In the Caribbean, this occurs in massive starlet coral (*Siderastrea sidereal*).*

Alex Brylske©

*Blushing coral (*Stephanocoenia intersepta*) is often mistaken for being bleached, but this blushing phenomenon is just a reaction to disturbance, and it can quickly restore its normal coloration.*

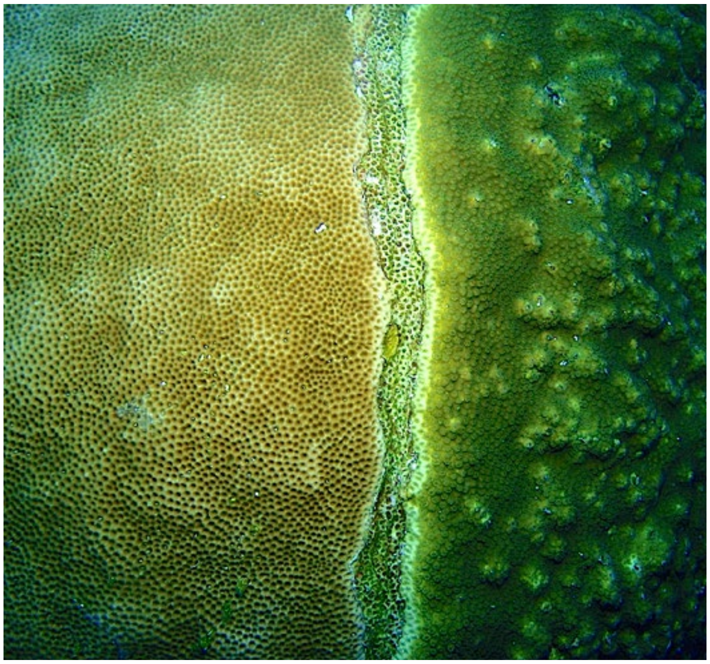
Because of their similarity in appearance, it is often challenging to distinguish bleaching from disease. One way to determine the difference is by observing the transition between the affected and unaffected tissue. In diseased corals, the border between the white and healthy tissue is often sharp and abrupt, while in bleached corals, the borders are often more gradual and less discernible.

PREDATION

The term predation is usually associated with predatory species such as sharks, which actively hunt down their mobile prey. Predation on corals, however, is not always an intentional act. For instance, some organisms such as fireworms and some Coralliophila snails directly consume coral tissue while others, such as parrotfish and urchins, might inadvertently remove coral tissue as they work to scrape algae off the surface of the reef. In either case, what is left behind is the coral's bare limestone skeleton, which is quickly colonized by macroalgae. A healthy reef can accommodate this damage. In fact, this disturbance can help enhance diversity by creating habitat for other organisms. But if predation is excessive, or the community structure of the ecosystem gets out of balance due to overfishing, disease, or other environmental stress, the health of the reef can be compromised by supporting algae growth at the expense of coral growth.

Surprisingly, another form of predation comes from the corals themselves. The reef is a community bent on aggression, like a city rife with gang warfare. To the casual observer, there are few signs of dispute, let alone war. Indeed, the evidence of aggression on a reef can be subtle. But it is visible everywhere if you look close enough. Corals are constantly battling for resources, particularly space and light. Few divers witness these coral wars because they occur primarily at night and at such a slow pace that they can barely be perceived in real time.

Fireworms (shown above), and some Coralliophila snails, directly consume coral tissue.



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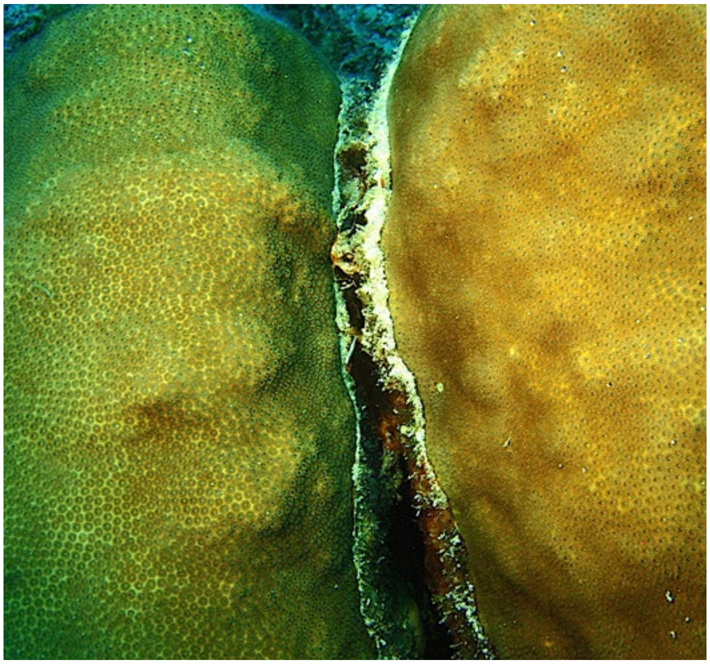
*Two different species – Massive Starlet Coral (*Siderastrea siderea*) on the left, and Boulder Star Coral (*Orbicella franksi*) on the right – battle for real estate. The margin between them is a no-man's land of bare rock, which is the result of a turf war fought between the two colonies.*



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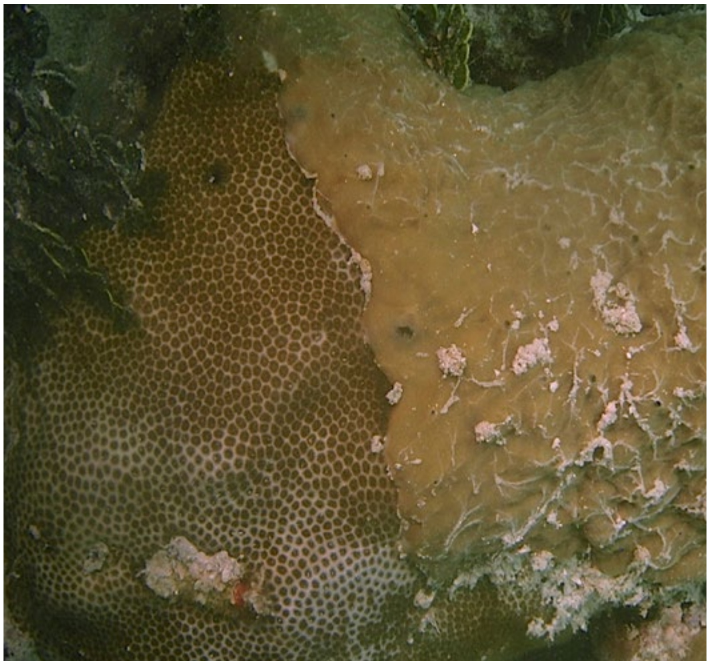
*A battle between two colonies of the same species, mountainous star coral (*Orbicella faviolata*), but different genotypes (individuals). Even though they are the same species, as they are not from the same original colony, they will not merge but will instead fight. Note the no-man's land margin in between.*



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*Corals and sponges are competitors, too. They often overgrow each other in a constant battle for space. Pictured here is a colony of blushing star coral (*Stephancocoenia intersepts*) and, on the right, an encrusting sponge (*Halisarca caulea*).*

Some coral species can extrude their stomach tissue (known scientifically as mesenterial filaments) over neighbors that grow too close, literally digesting them alive. Other species fight using their stinging tentacles. Branching corals have the competitive advantage of being able to shade out nearby colonies in much the same way as trees do in a forest.

Of course, it is not just corals that need living space. As the image below shows, sponges compete for space, too. Unlike corals, sponges lack the offensive armament of tentacles and nematocysts. Their weapons include a wide array of potent toxins that can kill or dissolve a coral colony.

THE REEF'S LAWNMOWERS

As mentioned, algae can grow much faster than can coral, even under healthy conditions. So, a healthy reef must have mechanisms that prevent algae from getting out of control. Fortunately, there are enough algae-eating creatures on healthy reefs to do just that. Keeping algae at bay is important for established corals, but it is also important for the recruitment of new coral colonies. When coral larvae settle out of the water column, they need to be able to attach to a clean substrate free of fleshy macroalgae to successfully grow into new colonies. This only happens when there is a sufficient population of grazing herbivores, including fishes and invertebrates, inhabiting the reef.

Alex Brylske©

A reef that has been completely overgrown by macroalgae.

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*In the Caribbean, blue tangs (*Acanthurus coeruleus*) commonly form schools with ocean surgeonfish (*Acanthurus bahianus*) and doctorfish (*Acanthurus chirurgus*)*

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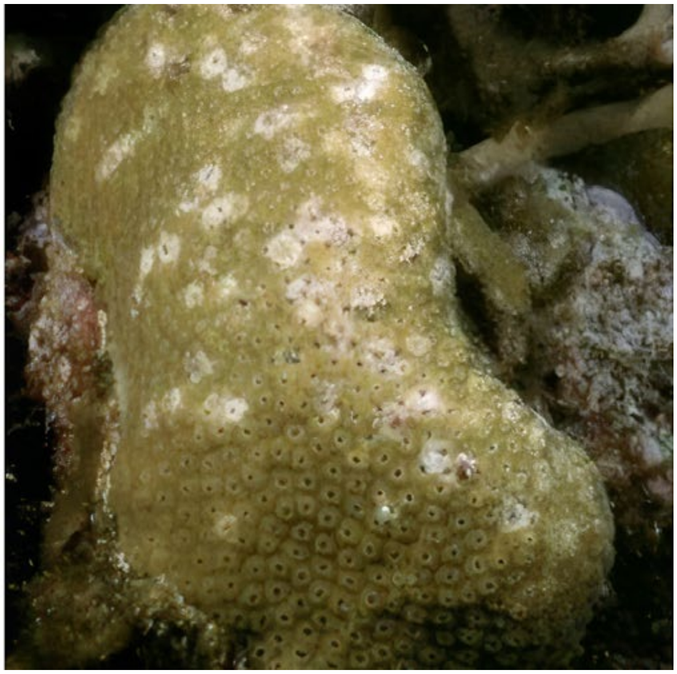
With their well-designed beak-like teeth, parrotfish are excellent at harvesting algae.

François Libert (Creative Commons Attribution-NonCommercial-ShareAlike 2.0 Generic)©

*The threespot damselfish (*Stegastes planifrons*) is one of several algae eaters in this family that bites coral to remove the tissue. This open space promotes the development of algal "gardens," which are then consumed as a food source.*



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Corals damaged by parrotfish (above on the left) often bear linear scrape marks from the parrotfishes' large and specially adapted teeth. Damselfish lack the robust jaws and teeth of parrotfish, however, so their bites (above on the right) appear more circular. Use the rulers on your Reef Smart Guides waterproof card to measure the size of bite marks.

The primary vertebrate herbivores on reefs originate from three families of fishes: parrotfish (Scarids), surgeonfish (Ancanthurids), and some species of damselfish (Pomacentrids). There is a fourth family found only in the Indo-Pacific, namely rabbitfishes (Siganids). Parrotfish, with their beak-like fused teeth, are especially effective lawnmowers on the reefs. Unfortunately, parrotfish are heavily targeted for food in many parts of the tropical world. Their overfishing is a major cause of coral decline on many coral reefs.

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*Long-spine sea urchins (*Diadema antillarum*) are important algal grazers. Just how important was not fully realized until after their devastating die-off in the 1980s.*

One of the primary invertebrate grazers on healthy reefs are sea urchins. The importance of their role in managing reef health – or rather the impact of the absence of this important algal grazer – is very much on display on Caribbean reefs today. A mass mortality in the Caribbean of more than 98 percent of long-spine sea urchins *(Diadema antillarum)* occurred between 1983 and 1984 from a disease that struck the Western Atlantic. It has left many Caribbean coral reefs still struggling under a state of algal overgrowth decades later.

Currently, efforts are underway to find other herbivores that might replace some lawnmowing functions left vacant from the sea urchin die-off. One highly innovative approach is working to increase the number of another algae-loving invertebrate naturally found on Caribbean coral reefs: the channel clinging crab *(Mithrax spinosissimus).*

THE UPSIDE OF ALGAE

Algae is, of course, not all bad. As we have already shown, turf algae is highly nutritious and is an important food source for a number of reef herbivores, such as sea urchins, parrotfishes, damselfishes and surgeonfishes.

In addition, we owe a debt of gratitude to algae for some of the stunning beaches we enjoy when on vacation—these largely consist of the ground-up calcium carbonate contained in some species of green macroalgae, particularly Halimeda. Some of this "Halimeda hash" eventually washes up onshore and, when combined with a sprinkling of parrotfish poo (which is also largely calcium carbonate), forms the stunning beaches that typify tropical regions.

Finally, as previously mentioned, not all the algae on coral reefs are harmful. Some are essential to reef health. You may recall that calcareous (calcium-forming) algae help maintain the structural integrity of the reef. Meanwhile, crustose coralline algae (CCA) act much like mortar in a concrete block wall, helping to hold the "blocks" (coral) together.

Much of the sand around a coral reef consists of ground-up "Halimeda hash." Eventually, some of it washes ashore and makes up a large portion of tropical beaches (along with some parrotfish poo).

DIVE/SNORKEL PREVIEW

The open water dive with your Reef Smart-trained dive leader will be an opportunity to observe some of what has been discussed here. Using the Reef Smart Guides Benthos waterproof cards, you will:

1. Record the environment parameters of the reef you explore
2. Assess the coral reef community health in terms of benthic biodiversity
3. Identify certain key species of coral and sponge
4. Identify and categorize "good vs. bad" algae
5. Identify algae-eating marine life
6. Determine the amount of damaged coral due to bleaching, predation, and disease
7. Identify other reef invertebrates.

Afterward, you will debrief and discuss the observations made on your waterproof cards with your dive leader to gain a sense of the health status of the reef at the dive site you visited.