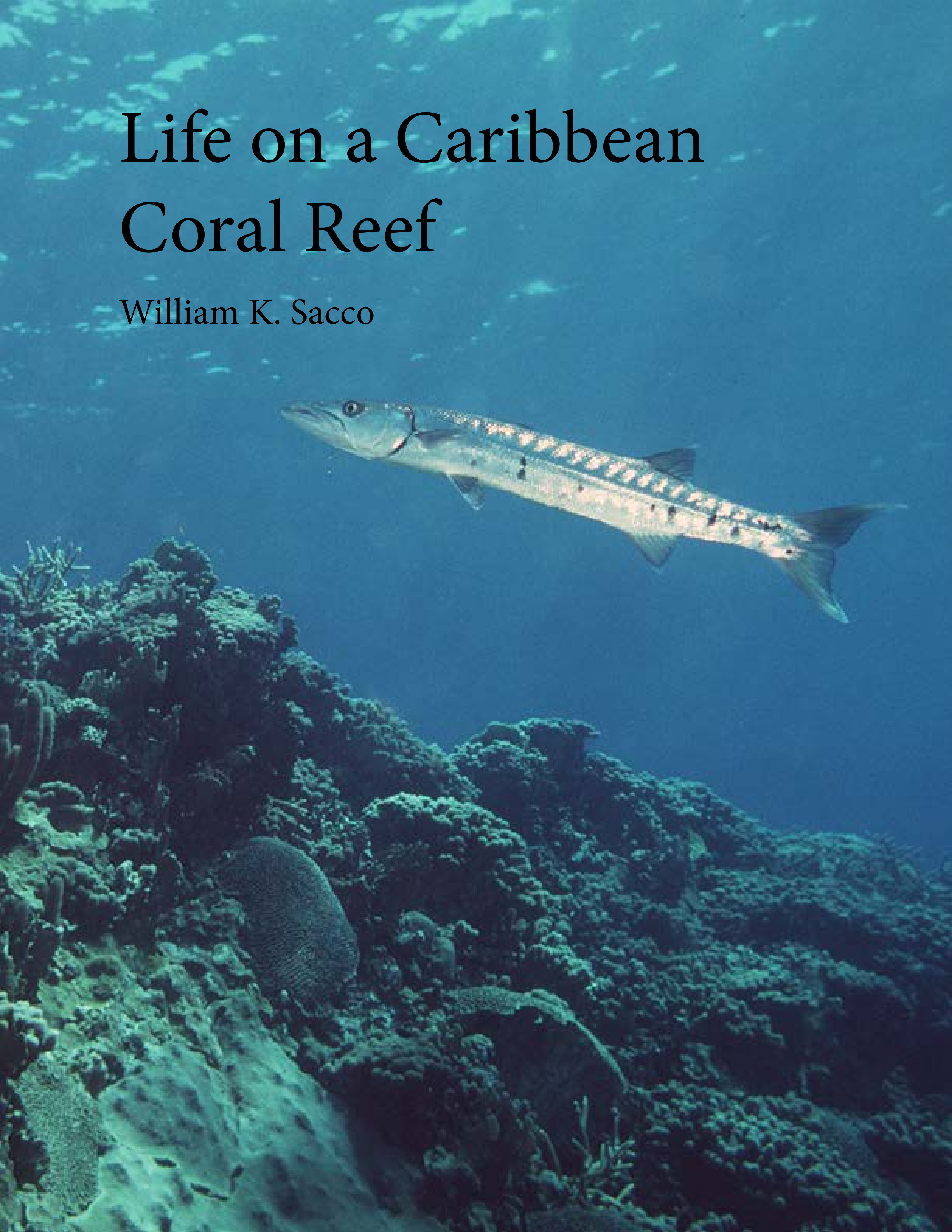
Life on a Caribbean Coral Reef

William K. Sacco



To the Yale Class of 1969:

This pdf is intended for viewing by members of our class, to see what a classmate is up to. I started diving for a summer job between our junior and senior years, and the photos were taken from 1968 through 1978.

I haven't a clue what the market for this sort of book, aimed at middle or high school readers, might be. Feel free to share it with grandchildren of that age. I welcome feedback.

Kids' book publishers have been remarkably unresponsive. Of 15 that I sent this to in August, only 2 bothered to reply.

This is a simpler version of *The Caribbean Coral Reef: A Record of an Ecosystem Under Threat*, to be published in March by CRC-Taylor and Francis Group.

–Bill Sacco (william.sacco@yale.edu)

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On the cover: A *Sphyraena barracuda*, commonly just called the barracuda, is a streamlined predator on smaller fish that swims above the reef. About four feet long, it is wary of divers that approach and no threat to humans. Notice that the corals cover 100% of the available surface, once common but now rare. The depth is about 30 feet.

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Like many natural environments on earth, coral reefs are threatened by global warming, increased storms, and pollution, to name just some of the problems they face. They are special and important environments, which we will take a look at in this book. I am going to put terms you may not already know in bold type, just to draw attention to them. Their meanings should be clear from the surrounding text, but you may want to look them up for more information.

Corals can take many different growth forms. Some species build thick and massive skeletons that stand up into the wave zone, where they need to stand up to a pounding sea. Also in shallow water others form large rounded masses – the so-called "brain" corals, named for the grooves and ridges covering their surface. In deeper water, sheltered from strong waves, corals can form thinner, delicate skeletons, and they often assume a flat form to capture light from above to benefit the plant cells that inhabit their soft tissues. More on that in a moment.

Speaking of names like brain corals, they are not very precise (there are three "brain" corals in the Caribbean), so I will use the scientific names for specific corals rather than the common names that some of them have. Besides, most of these creatures are not common to most people and don't even have common names. You may already know the scientific names for some dinosaurs, like *Tyrannosaurus rex*. Scientific names have two parts, a name for the **genus**, a higher level grouping, and one for the particular species within that genus. It is customary to capitalize the genus name, but not the species, and to put the whole name in italics. Sometimes the genus name is shortened to its initial, as in *T. rex*, which you probably have heard. Sometimes it is clear what genus we are talking about.

The big branching coral standing up above the others in these pictures is *Acropora palmata*. These two pictures show how the same species of coral can grow in different shapes. The other, more slender, branching coral in both views is a related species, *Acropora cervicornis*.

Imagine that your skin was filled with plant cells that can get energy from the sun and produce most of the food you need to live and grow, using the process called **photosynthesis**. Then imagine that you just had to sit and wait while bits of tasty food floated by, which are easy to grab because your fingers have cells that can harpoon those tiny bits of food. Also, imagine that you are surrounded by your identical twins. That will give you an idea of what it is like to be a coral, except that they don't have brains to think about such things like you do, only a network of nerve cells that allow them to sense and respond to food or contact with something.

Corals, at least the ones that build reefs so massive that they can be seen from space, have such plant cells in their soft tissues. These cells, called **zooxanthellae** (the x is pronounced like a 'z'), take the waste products of the coral cells and use them to produce nutrients and energy that the coral can use. The coral/zooxanthellae combination is so efficient that the coral can devote much of its energy to making a home to protect itself. It secretes a hard chemical, **calcium carbonate**, forming a little cup or tube to shelter the soft body, and the coral grows by dividing and budding off new individuals, expanding sideways while at the same time adding material so that the colony grows thicker as well. The hard part in which the coral sits is called its **skeleton**, though it is very different from our bony skeleton.

The single coral animal, called a **polyp**, is a very simple animal. It is essentially a bag with a mouth at the top end. The mouth is surrounded with a ring of **tentacles**, flexible structures that are armed with clusters of **nematocysts**, which are specialized cells that can harpoon or inject poison into the little swimming creatures that are its food. The coral then uses the tentacles to pass the food to its mouth.

Coral polyps come in different sizes, ranging from a couple of millimeters to a couple of inches across. Some corals remain solitary and others form huge colonies made up of thousands of individuals. Corals reproduce two ways. They produce sperm and eggs which meet in the water and combine to form a **larva** that may drift to a new location before it settles down in a favorable spot and starts to grow its skeleton. Once established, it forms a growing colony by producing new identical polyps at the edges or in between existing polyps.

Coral reefs form in warm, clear, shallow water. This water is so clear because it contains very little other than water, so reef-building corals are special in that they are so productive in an environment with so few nutrients available. The zooxanthellae provide nutrients and make this productivity possible. This is an example of a **mutualistic** relationship, where both species that live together get a benefit.

Variety in Coral Form

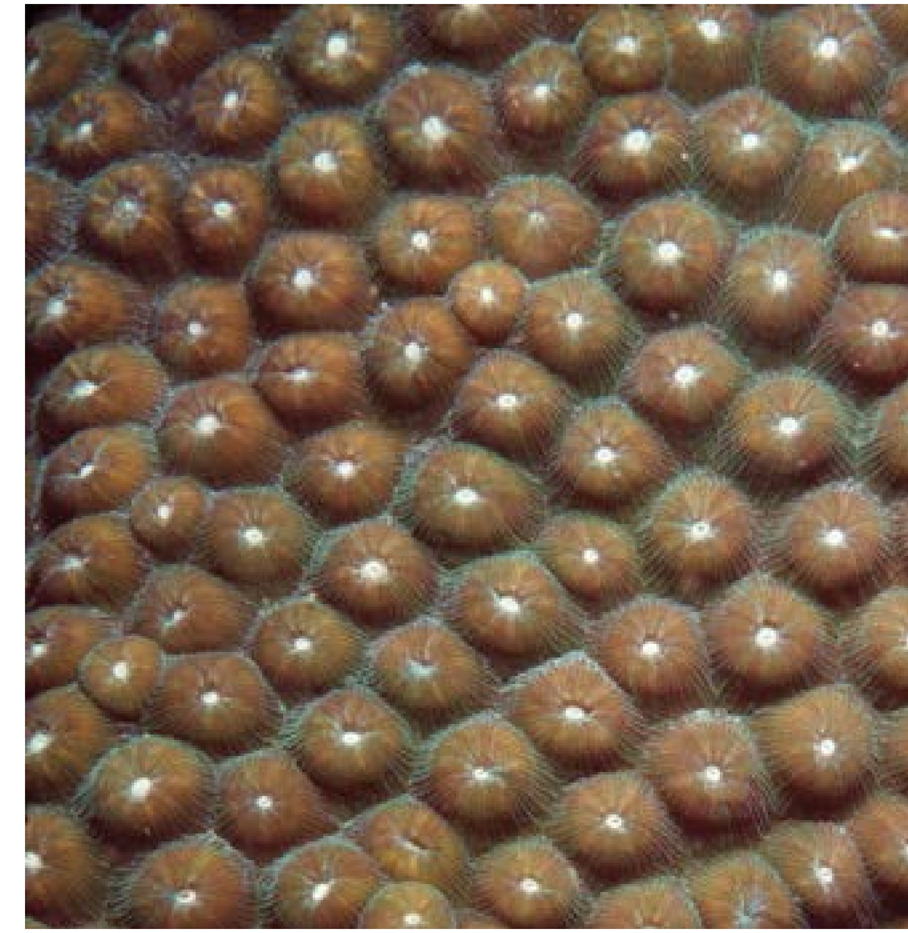
A close view of *Acropora palmata*. Each little coral polyp lives in a raised tube on the surface. They are dangerous to swim around unless the water is very calm. The little tubes are sharp and would tear a swimmer's skin very badly if a wave pushed the swimmer onto the coral.

Colpophyllia natans, one of the so-called "brain corals". Both of these are close to actual size.

Here are two related flat corals found slightly deeper on the reef. At the top is *Agaricia agarcites*, and at the bottom is *Helioseris cucullata*. These are slightly larger than actual size. The green dots mark separate polyps.

Dichocoenia stokesi is common in shallow water. This is slightly smaller than actual size. You can see polyps elongating before splitting into two new polyps and also small ones growing between existing ones.

Montastrea cavernosa has fairly large polyps, about actual size here.



Scolymia cubensis is a solitary coral that does not grow beyond a certain size and does not bud off new polyps. Here it is about two and a half times actual size.

When scientists want to study how corals settle from larvae and grow, they put clean surfaces out to see what settles on them. In this case the settling plates are pieces of plastic on a rope with a float at the top and a weight at the bottom so the plates are suspended in the open water over the reef. In the photo at right, a coral larva has settled and started to grow its skeleton. The green color indicates that it is probably *Agaricia agaricites*, seen here five or six times actual size.

A fisherman is about to place fish traps on the reef below his boat.

You may be wondering why, apart from their beautiful and interesting creatures, reefs are important. For one thing, the reef and the adjacent environments like the lagoon or back-reef area between the reef and the shore is where little fish can live protected and grow. Around the world many people depend on reef fish for their food, and without the reef to provide food and hiding places for fish, there would be far fewer available. In addition, the structure of the reef absorbs the energy of storm waves and lessens their damaging effects to coastal settlements. The money brought by tourists who visit tropical countries to see their reefs adds a lot to those countries' economies too. It has been estimated that the value of the ecosystem services provided by reefs to tropical countries around the world is almost ten trillion dollars a year.

With climate change warming tropical waters, corals are suffering from **bleaching**. The high temperature causes the zooxanthellae to produce toxins which cause the coral to expel them, leaving a white skeleton showing through the otherwise clear tissue. The coral can survive for a little while this way, and can acquire new zooxanthellae, but it will die if it doesn't. There are also coral diseases that were unknown when the reefs were less stressed. Dead coral is quickly overgrown with algae, which prevents new coral from settling and changes the reef ecosystem to something completely different, which no longer has the massive growing structure of a healthy reef. Scientists around the world are looking for ways to find and grow corals that are more resistant to high temperatures so that the reefs can be restored, but it is an enormous job to go from corals grown in a lab to fully restoring the reefs.

All the corals we have seen have had their tentacles withdrawn in the daytime, but *Dendrogyra cylindrus* extends them to feed in the daytime. The fish is a blue chromis, *Chromis cyanea*, seen here about life-size. Unlike the corals, the fish of the reef have common names that are widely used, so I will give both the common name and the scientific name for the fish.

This very large *Orbicella faveolata* shows two growth forms. At the top it is massive, but at the edges it grows thinner and extends out into the water so that it can get as much light from above as possible. This huge colony has thousands and thousands of individual polyps.

The fuzzy branching coral at the top of this picture, *Porites porites*, is very common on the shallow reef. Though most corals only extend their tentacles to feed at night, *P. porites* also extends them in the daytime. The small orange coral growing on the side of the old *porites* branches is *Tubastrea coccinea*. It does not have zooxanthellae and must meet all its food needs by feeding at night. Withdrawn in the daytime, it is active at night. This is about actual size.

Coral Relatives

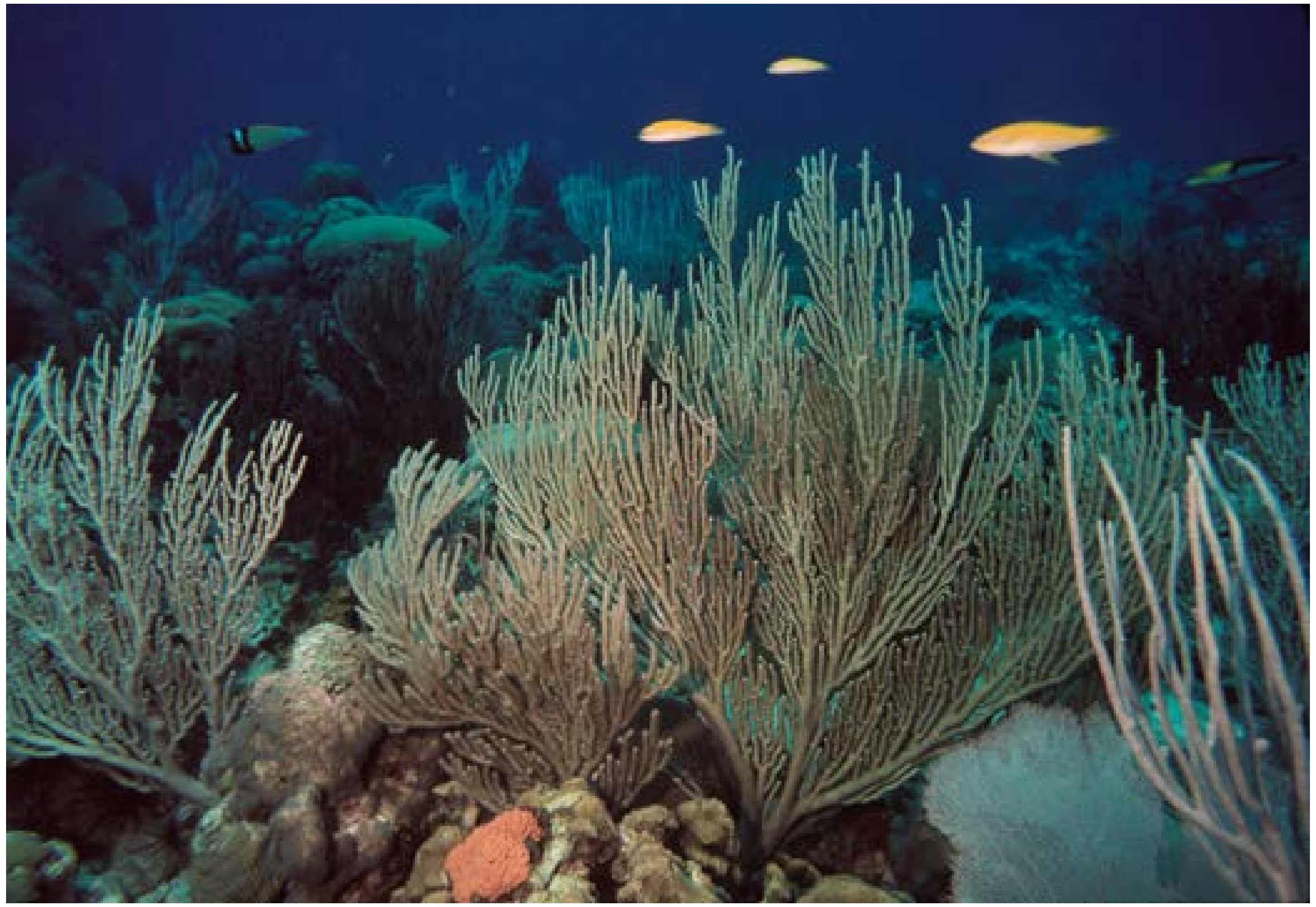
There are several groups of animals related to corals. They are all in the same **phylum**, the top level division of animals. In addition to the **stony**, or **scleractinian**, corals we have seen, the phylum **Cnidaria** also includes the so-called fire coral, the soft corals, the jellyfish, the anemones, and a couple of other groups. They all share variations on the same body plan and have stinging cells to catch prey.

Millepora alcicornis, which makes a calcium carbonate skeleton like that of the stony corals, is in the cnidarian group **Hydrozoa**. It has tiny polyps and stinging cells that can give a person a painful burning rash if they are touched. The tiny hairs that are visible in the picture are its stinging cells. About life-size.

Soft corals, known as **alcyonaceans**, are very common on the shallow reef. The familiar sea fan that you may have seen dried in a shell shop is one. In life *Gorgonia* is stiff but flexible, and stands up in such a way that it waves back and forth as the surging water from waves passes through it, allowing tiny polyps to catch food.

Soft corals do not make a hard calcium carbonate skeleton. *Gorgonia* and a few others make a flexible skeleton from a protein called **gorgonin**. Others make similar skeletons from different material.

There are three species of *Gorgonia*, but two can be distinguished from one another only by a specialist with a microscope, so we will use only the genus name. In these two pictures the same sea fan is moving back and forth in the **wave surge**, a back and forth movement of the water as waves pass by. On the shallow reef wave surge brings small particles of food to the many animals that filter it from the water. This is about 3 feet tall.



Plexaura flexuosa has many fine branches and stands up in the wave surge in shallow water as *Gorgonia* does.

Many soft corals form branching bushes with larger or smaller polyps extended into the water to trap food. Many of the soft corals also have zooxanthellae to provide extra nutrition, which accounts for them being very common in shallow water. Cnidarians have **radial symmetry**. That is, they have no front and back, no left or right sides, but instead have identical parts arranged around a center. Another difference between the stony corals (scleractinians) we have seen and the alcyonaceans is that the stony corals have six-sided symmetry and the soft corals have eight-sided symmetry. You can see the difference if you look at the coral skeleton up close (see the coral on the settling plate) and then at the polyps of a soft coral. The ones on these pages are between 3 and 5 feet tall.

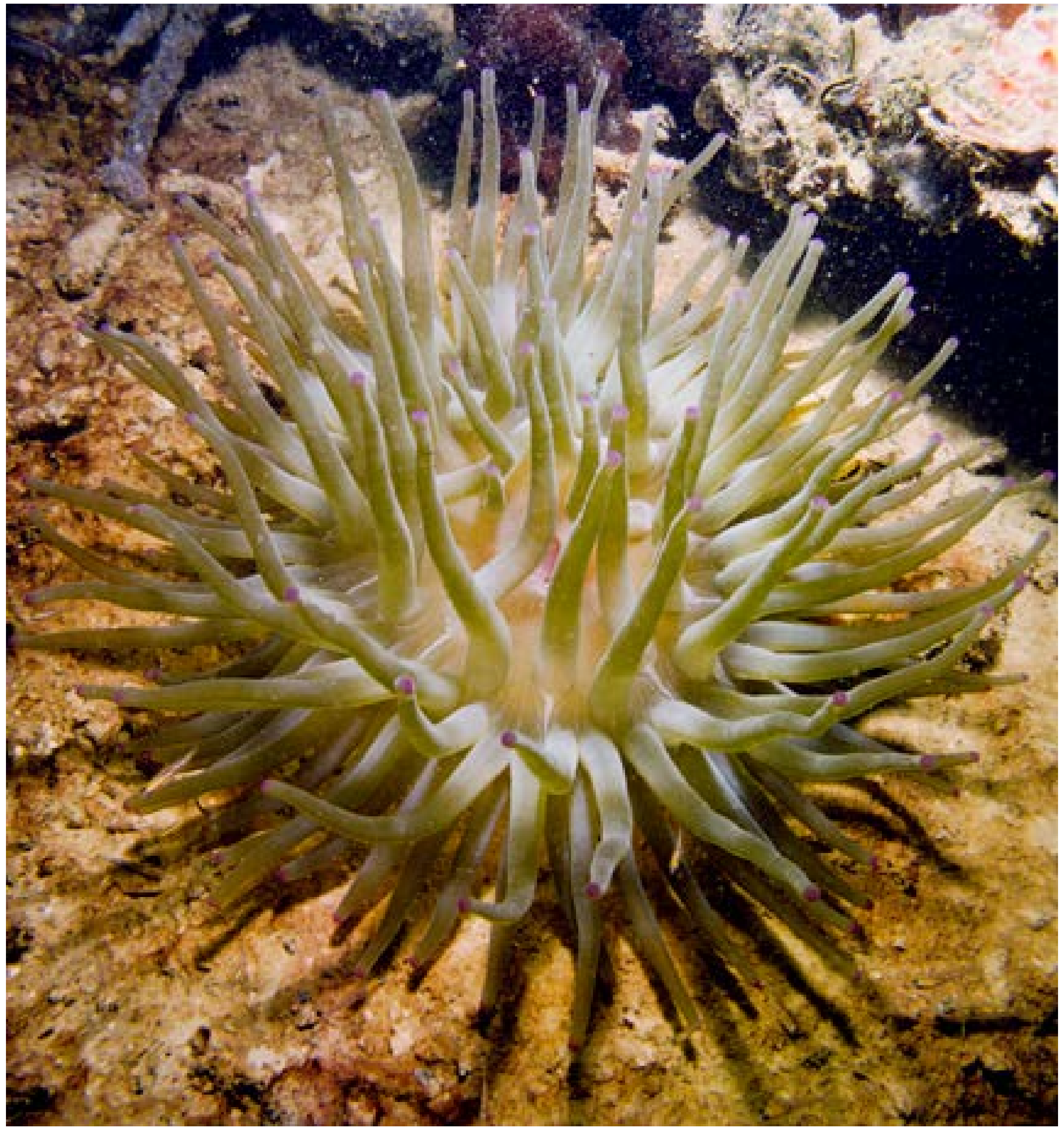
Plexaurella polyps have eight tentacles. About 3x actual size.

Plexaurella has thick, bushy branches. About 4 feet.

Plexaura homomalla has tan polyps, black branches.

Antillogorgia acerosa branches profusely.

Antillogorgia bipinnata has featherlike branches.



Condylactis gigantea is a large common anemone. This is about one third to half actual size.

Periclimenes yucatanicus is a shrimp that lives with the anemone but does not get stung.

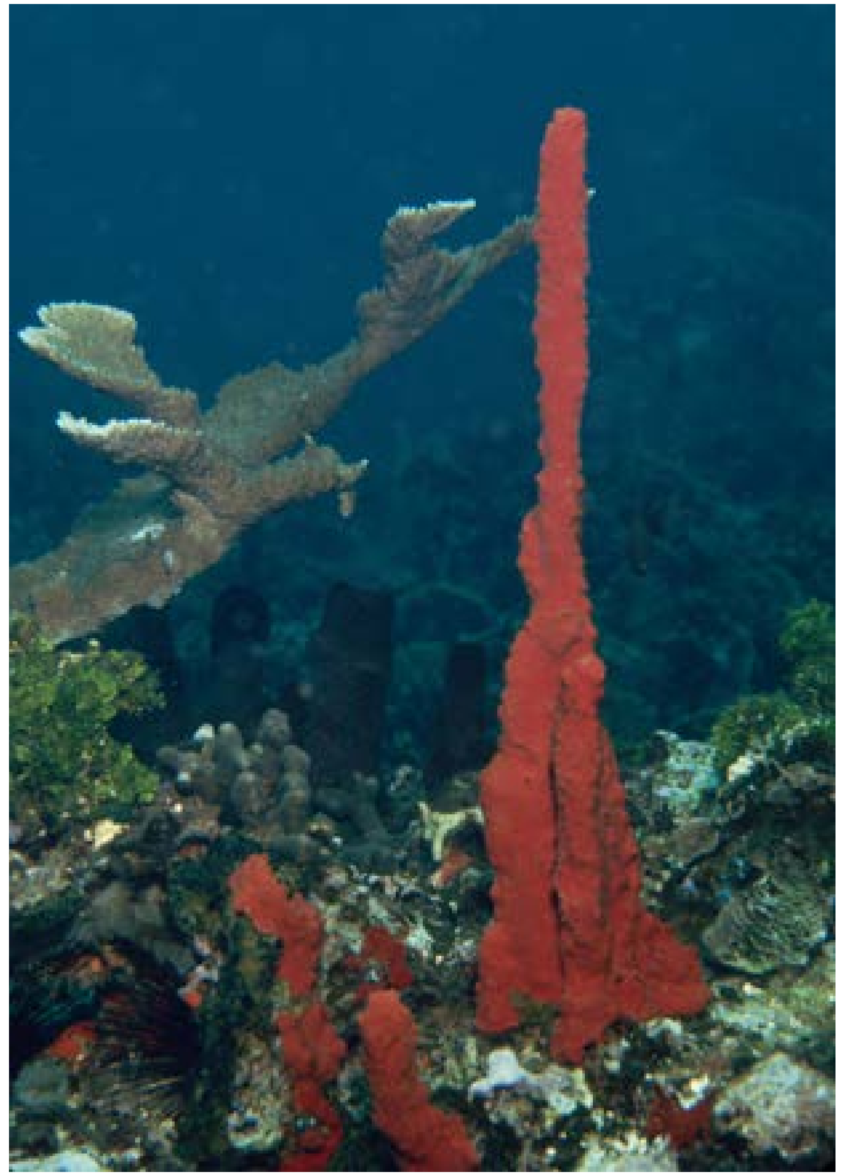
Anemones are another group related to coral. They are single large polyps that hold up numerous tentacles to catch everything from tiny animals floating in the water to small fish. There are some little shrimp and even a fish that lives in among the anemone's tentacles and do not get stung. This one is *Condylactis gigantea*, which is a big anemone with many tentacles, each of which is as thick as a finger.

The juvenile bluehead wrasse, *Thalassoma bifasciatum*, also can live among anemone tentacles.

Periclemenes pedersoni is another shrimp that can live among anemone tentacles without being stung.

Other Invertebrates

Sponges (phylum **Porifera**) hardly seem like animals at all. They get such a high-level classification because they are so different from other animals. They are permanently attached to one spot and do not have organs or even sensory cells or nerves. They obtain nutrition by pumping water through their tissue and removing microscopic particles of food. Often they grow in the form of a tube, with water being pulled in from the outside and coming out an opening at the top, called an **oscule**. Somehow they thrive and can grow to a large size. Sponge tissues contain chemicals that are irritating to humans, so it is best not to touch them. Some, like this red one, also produce chemicals that are of interest to drug companies, as do many reef animals.



Amphimedon compressa stands about three feet tall. The red color is a signal to fish that it contains a compound that is toxic to them.

Clathria curacaoensis is an encrusting sponge known only from the island of Curaçao. It draws water in from the areas between the openings, and sends it out the openings after filtering microscopic food from it. This is a little larger than actual size.

Niphates digitalis grows over a foot tall, and pumps water through the wall and out the large opening.

Worms are a common sight on the reef. The fire worm, *Hermodice carunculata*, roams in search of food, protected by clusters of sharp bristles that give it its common name. It is also best not touched. Other worms never move once their larvae settle. One group, the **sabellids**, or feather duster worms, keep their bodies protected in a paper-like tube, extending feather-like structures from their heads into the water to gather food and also act as gills to absorb oxygen from the water. Another group, the **serpulids**, live in a tube of calcium carbonate that usually becomes overgrown with coral. If you see a pair of little spiral tree-shaped feathery structures that are quickly withdrawn if you stir up the water near it, you are looking at the Christmas-tree worm, *Spirobranchus gigantea*, a serpulid.

Bispira brunea buds like a coral when young and grows as clusters of identical individuals. About life-size.

The red color of *Hermodice carunculata,* seen here about twice actual size, says not to touch it.

There are three *Spirobranchus gigantea*, with their tubes overgrown by coral, in this picture. Each individual has a pair of spiral tree-shaped structures called **radioles**. Normally extended, as at the top of this view, they are withdrawn to the safety of the tube at the slightest provocation. The worm is protected by a hard door, or **operculum**, that closes the opening. The operculum has two spines, also visible in the upper individual, and the tube itself also has a pointed thorn, visible in the lower middle part of the picture, where another worm is fully withdrawn. At the bottom, a third worm is slowly extending its radioles again. About twice life-size.

The color of *Spirobranchus gigantea* is highly variable. They are slightly larger than actual size in these three pictures.

Molluscs are a big phylum that includes snails and clams (**gastropods** and **bivalves**) and also squids and octopuses (both are **cephalopods**). The most easy to spot is the flamingo tongue cowrie, *Cyphoma gibbosum*, usually seen on a sea fan or other alcyonacean, on which they feed, stripping away the soft tissue. The shell itself is not spotted. Instead the spots are on tissue that the snail extends to cover its shell. The conch is a large snail that can be found on the sandy patches of the reef, feeding on algae and other plants.

Another gastropod, but one without a shell, (an **opisthobranch**) is *Elysia crispata*. It feeds on algae, and some of the **chloroplasts** in the algae, the parts of its cells that use sunlight to make food through the process of photosynthesis, end up migrating to the frilly structures on its back. So this animal is like the corals in using sunlight for some of its needs.

Squids are active swimmers that cruise just over the reef, often in pairs. They hold their tentacles together to swim forward using fins on the sides, but they can also jet backward to escape from danger if they need to. They have big eyes, good eyesight, and, like octopusses, are very intelligent.

Cyphoma gibbosum feeding on the soft tissue of a *Gorgonia*, about one and a half times actual size.

Macrostrombus costatus, the milk conch, covered with algae and reef sand, is about 7 inches long.

Elysia crispata feeds on algae. The head end is at the top of the picture. About life-size.

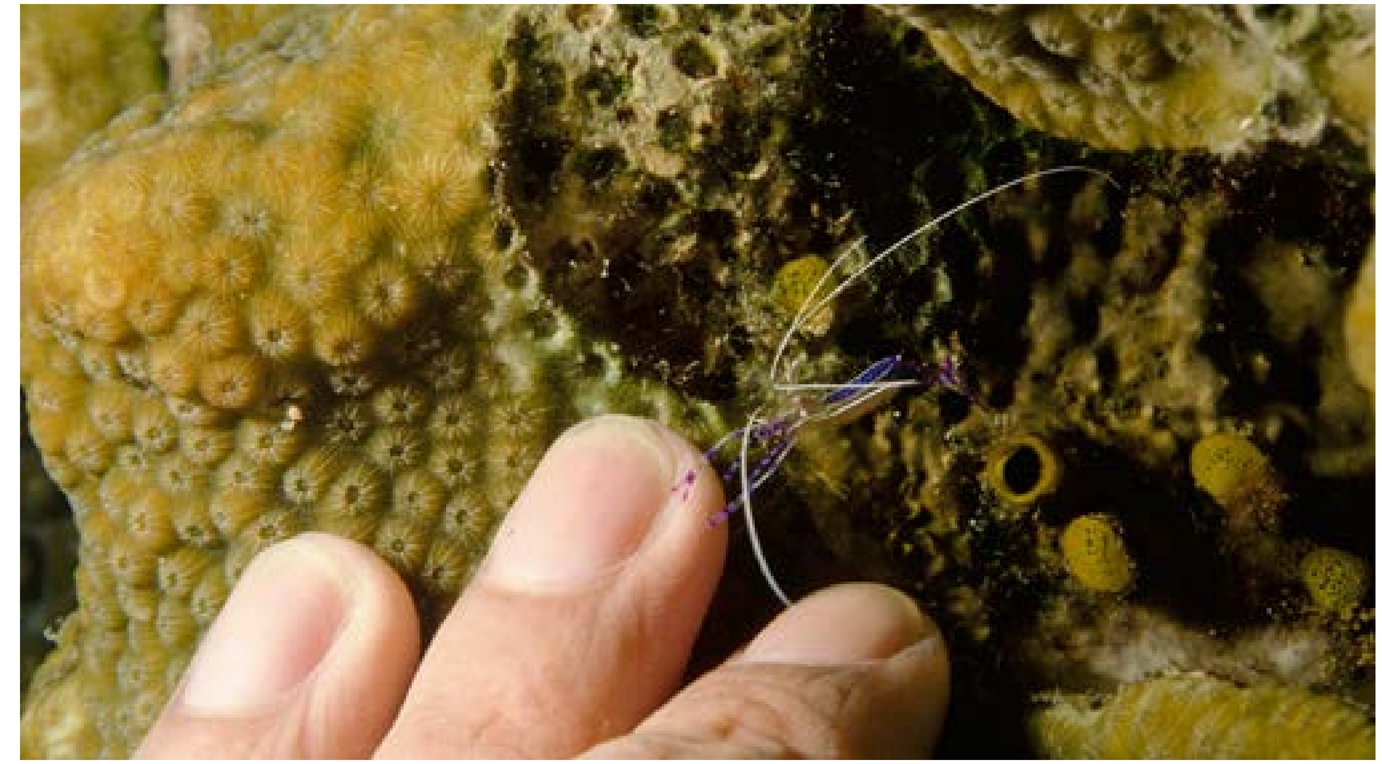
Two *Sepioteuthis sepioidea* squids cruise above the corals and alcyonaceans of the shallow reef. They are very wary of people and hard for a diver to approach. These are about 15 inches long.

Crustaceans include the lobster, crab, and shrimp. Most are active only at night, but some shrimp are visible in the daytime. A few are **cleaners**, which wave their white antennae to attract fish that want to have parasites or dead skin removed more than they want a little shrimp for a meal. Some little fish, as we will see, also provide cleaning services for bigger fish.

The slipper lobster, *Parribacus antarcticus*, is related to clawed and spiny lobsters. Though found on Caribbean reefs, the same species occurs in the tropical Pacific and Indian oceans. About half life-size.

The red and white bands on the body and claws of *Stenopus hispidus* and the long white antennae advertise to fish the cleaning services the shrimp provides. About life-size here, it is larger than the *Periclimenes* cleaners.

Stenorhynchus seticornis, the arrow crab, with its triangular body, elongated forward projection, or **rostrum**, in front of its eyes, and its long spidery legs is another unmistakable reef crustacean. Here it appears a little smaller than actual size.



The little cleaner shrimp, *periclimenes pedersoni*, can be coaxed to see if there is anything on my hand for it to clean. Normally it would clean dead skin or parasites from fish. About twice actual size.

Lacking a strong shell, the *Calcinus tibicen* hermit crab uses an empty snail shell for shelter. For more defense it puts anemones on its shell. When it grows too big for its shell, it finds a new one. About actual size.

Echinoderms are a phylum containing sea stars and other related groups. Although like cnidarians, they have radial symmetry (five-fold) instead of bilateral (left-right) symmetry like that of mammals and fishes, their larval stages are bilateral, so they are grouped with other bilateral animal groups, to which they are probably more closely related than the cnidaria are. There are several groups of echinoderms that live on the reef, and we will take a close look at each group in more detail than we have for other groups, because they are quite common on the reef and quite distinctive in their appearance and lifestyle.

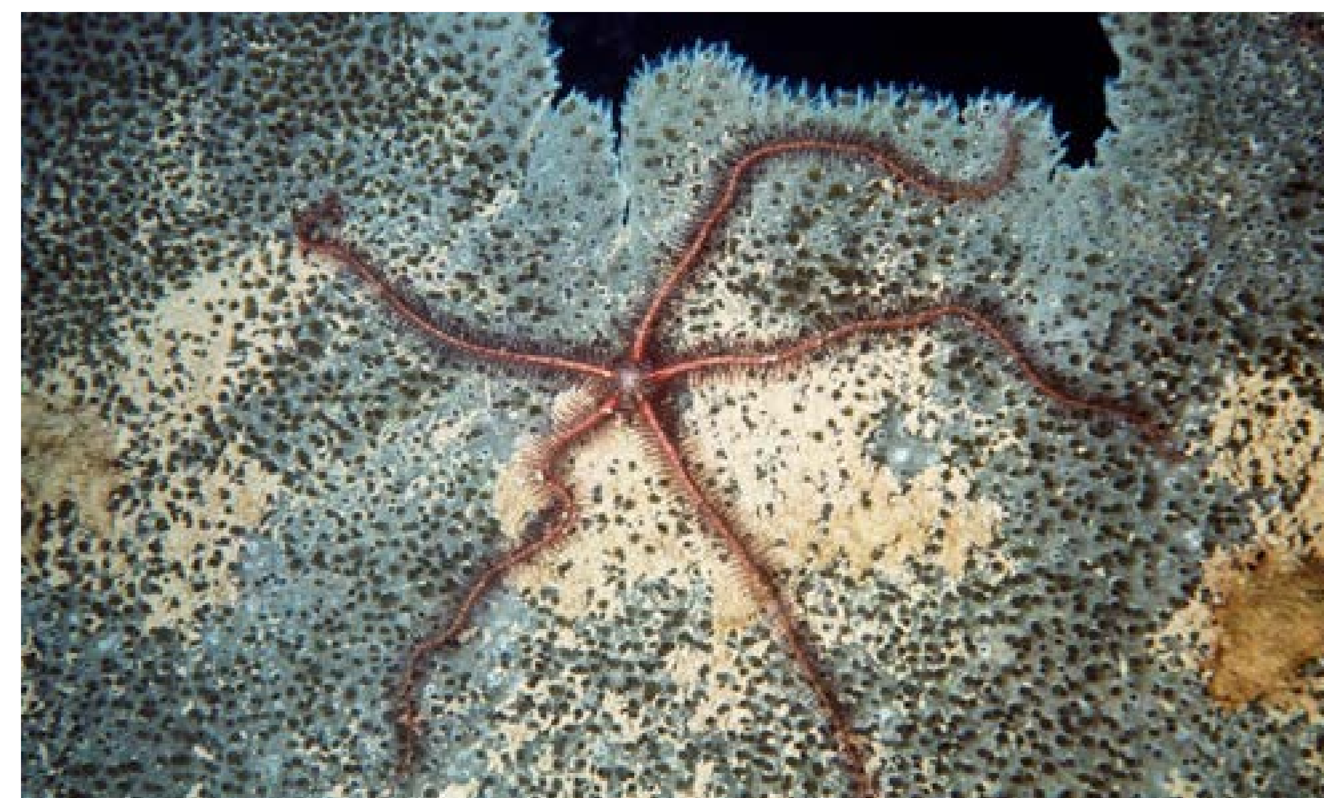
Asteroids (not the kind in space) are the familiar sea stars. They have a body that blends with its five arms. If they lose an arm, they can regrow it.

Linckia guildingii grazes on the film of algae and bacteria that grows on coral rubble. This is about the actual size.

Oreaster reticulatus has a thick body and five tapered arms that blend with the body. These two are on the sand behind the reef. These are about 10 inches across, but they can be larger.

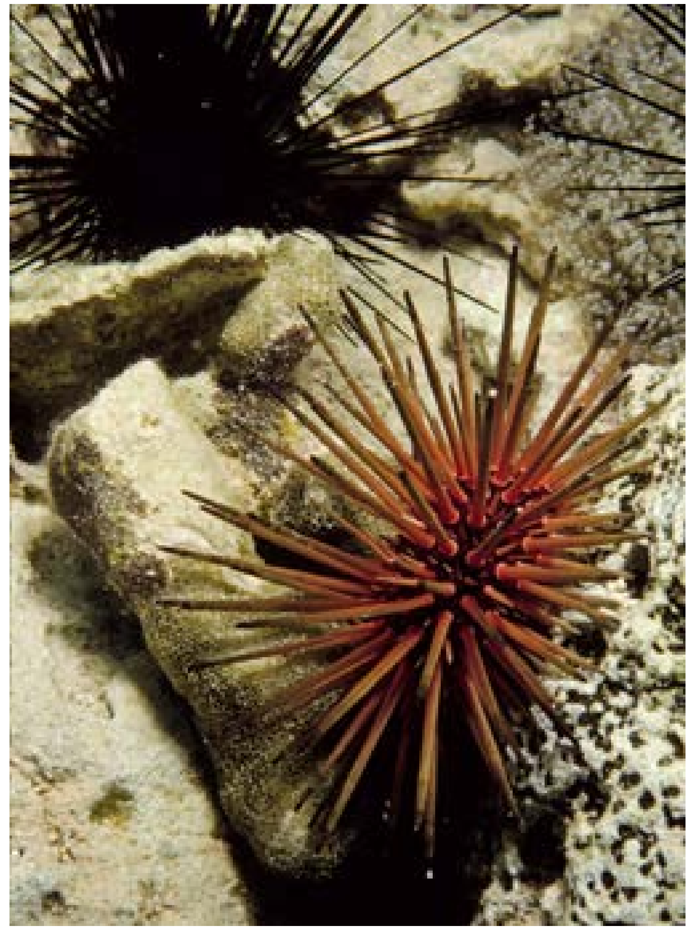
Ohiuroids, or brittle stars, have a central body that is disk-shaped and have five slender arms radiating from it, which may be smooth or spiny. Some, the basket stars, have arms that branch.

Ophioderma appressum has arms that are scaly rather than spiny. The tan color and banded arms identify this species. These ophiuroids forage on the abundant organic debris of the reef. About two thirds life-size.

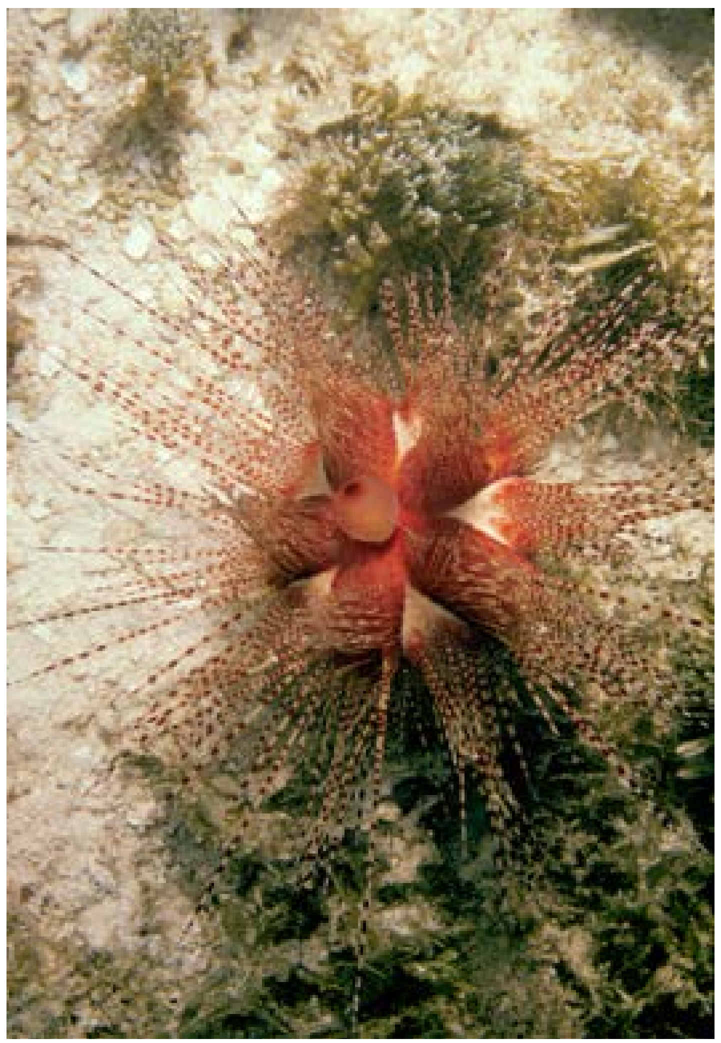


Ophiothrix suensonii is almost always seen in association with sponges. The long, thin spines and black stripe on the arm are characteristic features. This is a little smaller than life-size.

Echinoids are the spiny sea urchins and the smooth sand dollars. Like all the echinoderms they have a system of hydraulic "**tube feet**" that are filled with fluid and are used to move the animal about.



Echinometra viridis has a deep red body and stout spines, red at the base and green at the tip. It grazes on algae growing on coral rubble on most of the shallow reef. The black urchin in the background is *Diadema antillarum*. This is about life-size.

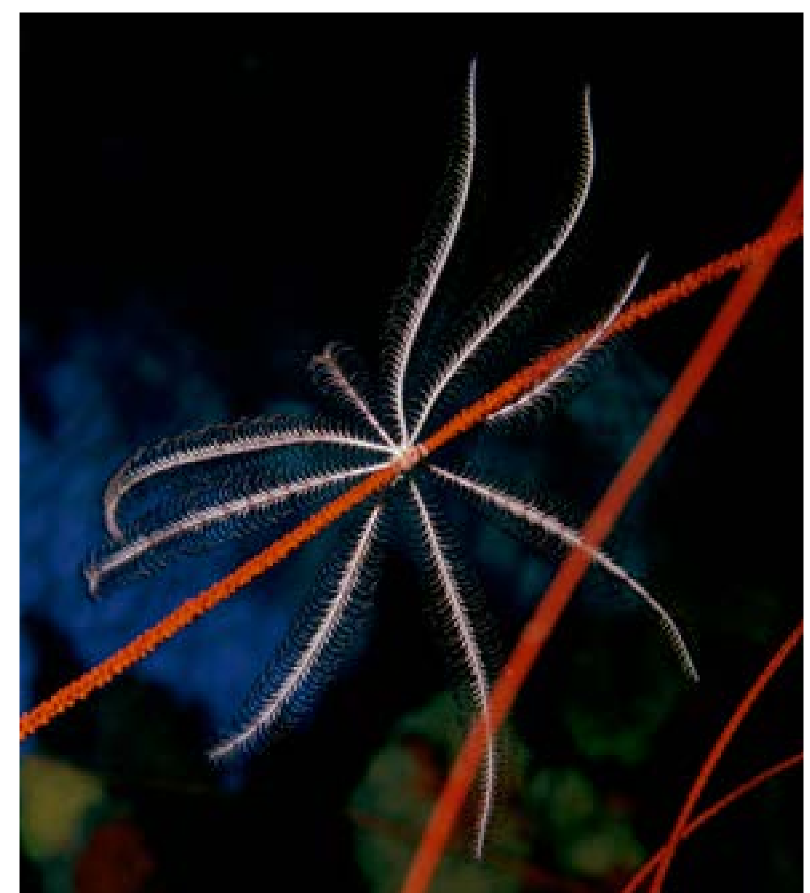


Astropyga magnifica closely resembles the long-spined *Diadema antillarum* except for its unmistakeable red and white coloration. They are both members of the family Diadematidae. This one is about half life-size.

Diadema antillarum spines are barbed, break off easily, and contain an irritant, making them a hazard to snorkelers or divers who enter the water from the shore. An unexpected mass die-off of Diadema occurred in the early 1980s, and they are now quite rare. About 12 inches across.

Crinoids have many feathery arms that are held up in the water to catch plankton, which is why the group are called feather stars. Their tube feet are used mainly for filtering food from passing water currents. Unlike echinoids, opiuroids, and asteroids, crinoids have the mouth on the upper surface of the central disk.

Crinoids catch plankton by extending their arms from crevices in the coral where the body is hidden. *Davidaster rubiginosa* ranges from orange to solid black. They can move, but slowly, and only when absolutely necessary, once they have found a good place to live. This is about half life-size.



With ten red and white banded arms, *Analcidometra armata* is nocturnal, normally climbing onto something like this alcyonacean to feed at night, but this was seen in the daytime in a deep canyon between two tall patch reefs. If it is disturbed, it can swim by beating alternate sets of arms up and down. This is about two-thirds actual size.

Holothuroids (or **holothurians**) are "**sea cucumbers**", a name that makes no sense except that the animals lay on their sides and are longer than they are wide. They find food by swallowing sand and extracting whatever nutrients may be in it, then passing it out the other end.

Holothuria thomasi can be up to six feet long, and never ventures out completely, instead keeping part of its body sheltered under the coral. There are short tentacles around the mouth. It is brown, sometimes mottled with white.

Holothuria mexicana looks for sand to swallow amid coral rubble and live coral in shallow water. It has a gray to black body, which has creases around the circumference. It is around a foot and a half long.

Reef Fish

All of the animals we have seen so far have been **invertebrates**, meaning that they have no backbone like **vertebrate** animals like fish, reptiles, birds, and mammals, including humans, do. There isn't a specific group for invertebrates. They are just all the many kinds of animals which are not vertebrates. With the exception of the squid and octopus, and perhaps some crabs, all of the invertebrate dwellers on the reef are slow moving, if they move at all. What gives the reef its feeling of being an active place are the fish, often brightly colored, that dart in and out of the spaces provided for protection by the coral or swim above the reef in search of food.

There are a lot of fish species on the reef, and a good reference will show you all of them, but we will look at a few with different approaches to surviving and finding food on the reef.

Angelfish and damselfish are related and very common reef fish, with tall, thin bodies. They mostly feed on algae. The threespot damselfish, *Stegastes planifrons*, protects its own patch of dead coral with algae growing on it, on which it feeds. If an intruder or diver gets too close, the little fish will swim out and challenge the trespasser. About half actual size.

Pomacanthus paru, the french angelfish, has a rounder body when seen from the side. Like many fish, it changes its appearance as it grows. It starts out solid black with bright yellow stripes, but loses the stripes and develops yellow edges to its scales as it becomes an adult.

The bright yellow and blue markings of the adult queen angelfish, *Holacanthus ciliaris*, make it a spectacular sight on the reef. They occur singly or in pairs, and feed on sponges. Juveniles are dark blue with blue to white bars and are cleaners. This is about two-thirds actual size.

Juveniles of the rock beauty, *Holacanthus tricolor*, are entirely yellow except for a small black spot on the upper body which expands into a large black area as the fish grows. This is a little smaller than actual size.

The banded butterflyfish, *Chaetodon striatus,* has a long snout to get food from crevices. Juveniles have a false eye at the base of the tail, but it fades with maturity. The eye is hidden by a black stripe to confuse predators. This is about life-size.

Chaetodon capistratus, the foureye butterflyfish, as the common name suggests, has a large spot just in front of its tail that may fool predators by resembling a big eye, making this small, thin fish look bigger. This is a little smaller than actual size.

Myripristus jacobus, the blackbar soldierfish, can be seen in the daytime in small caves under coral, but it comes out on the reef and forages at night. They are seen here at about actual size.

The trumpetfish, *Aulostomus maculatus,* feeds on small fish. It hides near sponges or this *Antillogorgia*, moving back and forth in the surge until its prey is close enough to catch. This is about half life-size.

The bluehead wrasse, *Thalassoma bifasciatum*, is common swimming about on the shallow reef and does not flee when approached by divers. It swims with its **pectoral fins**, the ones just behind the head, and appears to drag its tail behind. This is a **terminal phase male** or **supermale**, which is only about 4% of the population. This is about life-size.

Blueheads have complicated coloration and development. Juveniles and younger males and females can all exhibit three different color patterns, and they can change from one to another quickly. The most commonly seen pattern is shown here: yellow above, white below, with a black spot on the **dorsal** fin, the one on its back. There may also be a black stripe on the side. (See p. 17.) Both females and younger males can turn into supermales.

A Reef Cleaning Station

Juvenile blueheads are the major cleaner fish of the reef, establishing cleaning stations and advertising their availability by doing a little 'dance' to attract clients. Fish wanting to be cleaned will assume a head-down position in the water to indicate that they want cleaning more than to eat the cleaner, and the little blueheads then nip off external parasites and dead tissue from the skin and scales. Here the client fish are creole wrasses, *Clepticus parrae*. These are about half actual size.

Other prominent cleaners are several *Elacatinus* species that are just called cleaning gobies. These are about actual size.

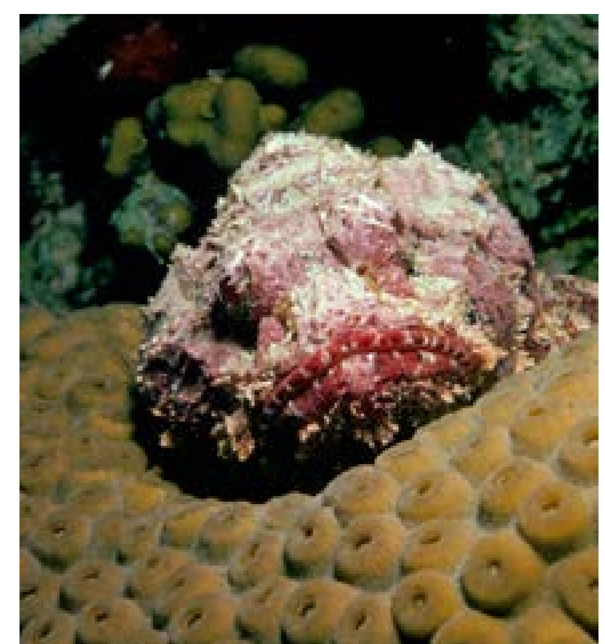
Like the *Periclimenes* shrimp, cleaning gobies can be coaxed to check out a human.

Here a cleaning goby attends to a wound on a spotted moray eel, *Gymnothorax moringa*.

A green moray eel, *Gymnothorax funebris*, its long body mostly concealed within the coral, is attended by a cleaning goby while four more sit on a nearby coral. Green morays can be over six feet long

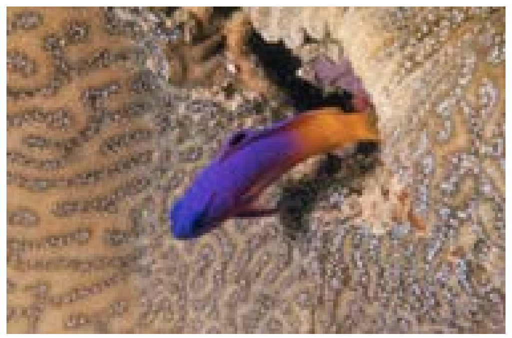
There are many kinds of parrotfish, and many color variations within a species. The yellow stripe behind the mouth and yellow spot on the gill cover mark this as *Sparisoma viride*, the stoplight parrotfish. They feed on algae and coral by nipping with teeth fused into beaks. The hard part of the coral passes through the fish and is eliminated as sand. This is about two thirds actual size.

The spotted scorpionfish, *Scorpaena plumieri,* uses excellent camouflage to wait for prey to come close. It is brown to red and may have branched plumes resembling algae above the eyes. Poisonous dorsal, anal, and pelvic fin spines should be avoided. There are three dark bands on the tail. This is about half actual size.

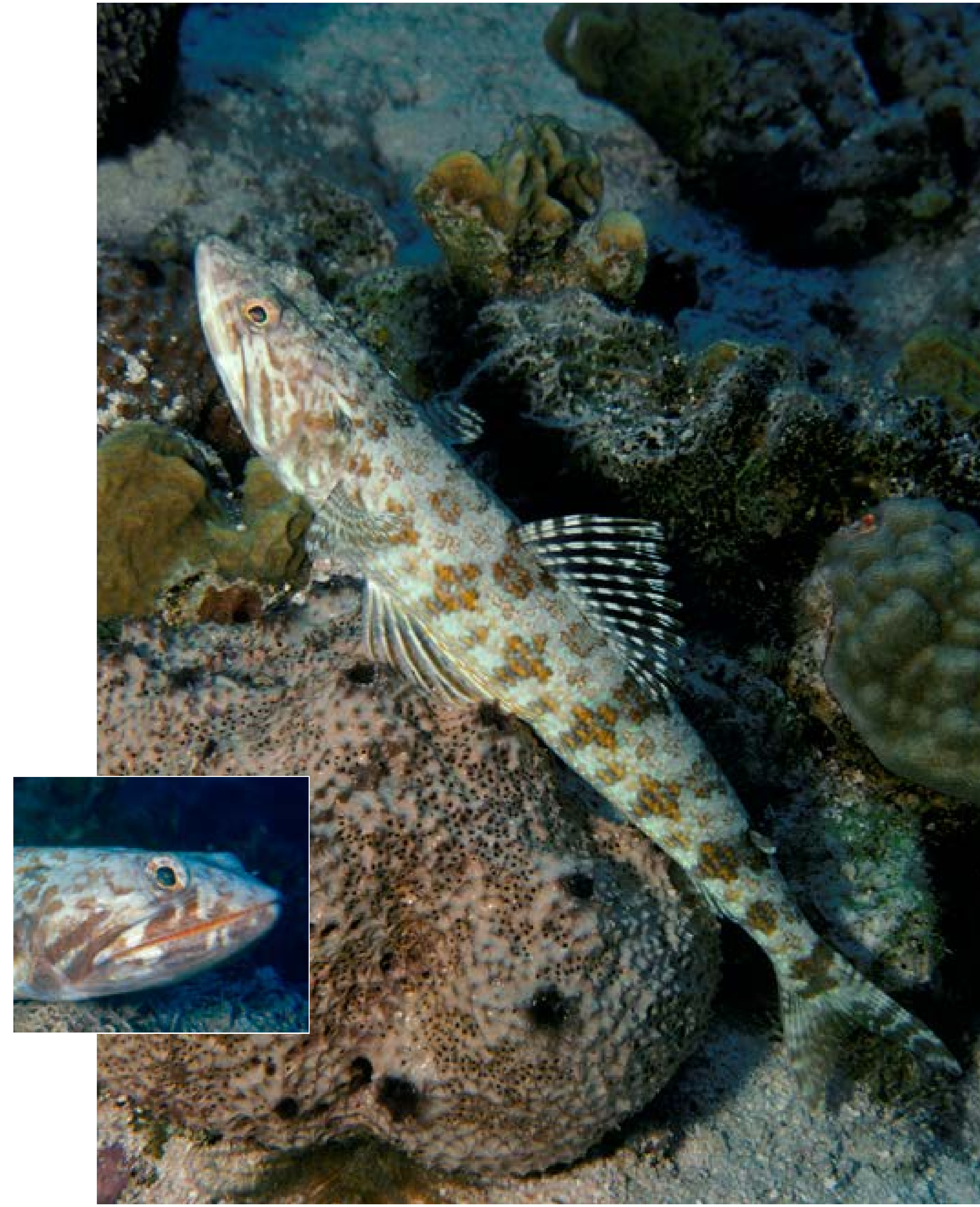


This photo is not upside down. The fairy basslet, *Gramma loreto*, swims with its **ventral**, or bottom, surface toward whatever is nearby, no matter what the orientation. Here it is under a coral overhang. This one is about three quarters actual size.

This one is in a more normal position.

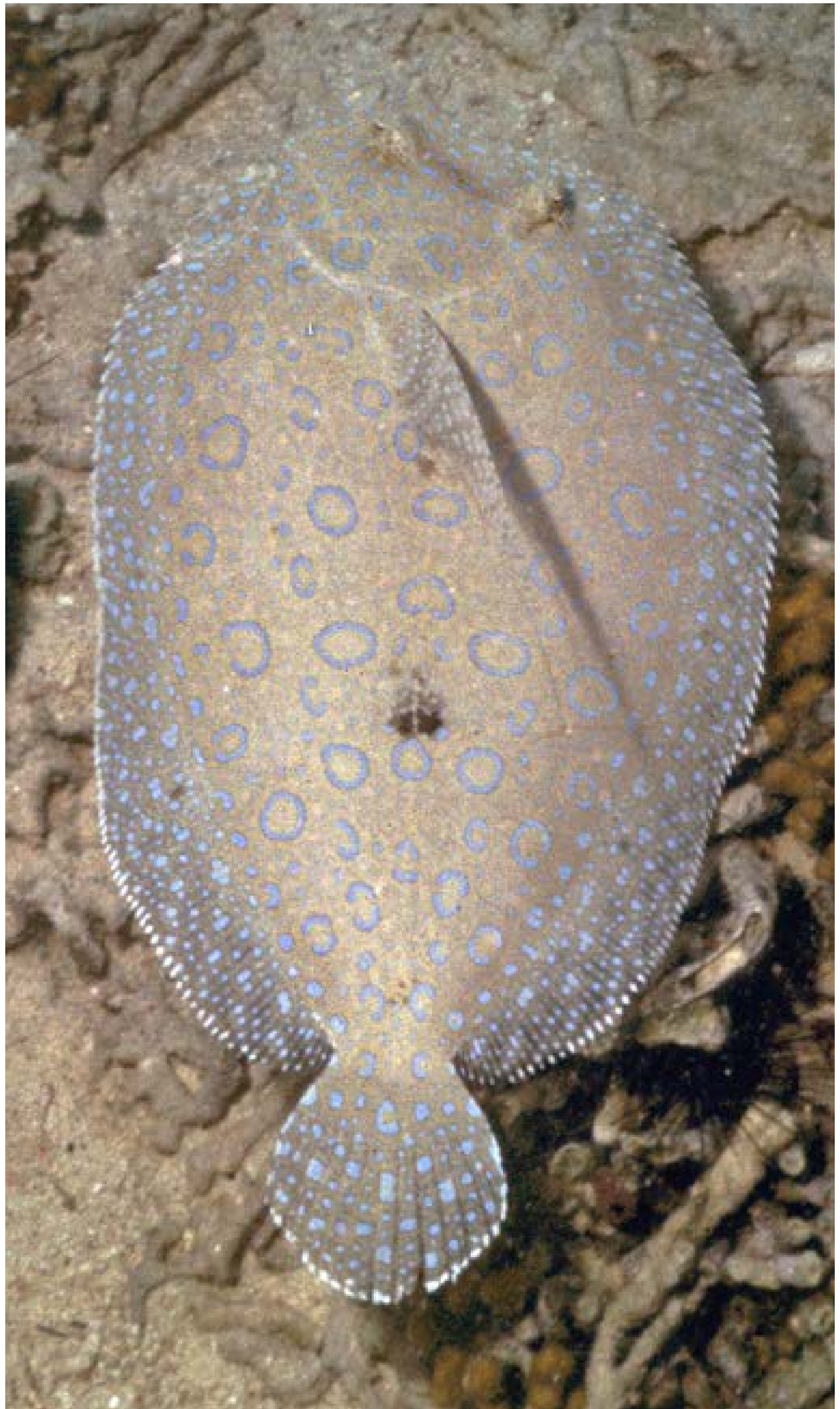


Diodon holocanthus, the ballonfish, can inflate its body and make its spines stand erect if it feels threatened, though it can also raise its spines without inflating. The strong mouth easily crushes molluscs, urchins, and crabs that it hunts at night. This is about two-thirds actual size.



The lizardfish, *Synodus intermedius*, is a torpedo-shaped bundle of muscle that waits patiently for smaller fish to pass. It has a large mouth full of sharp teeth and can dart forward quickly to catch its prey. It is also called the sand diver because it may also burrow and wait half-hidden in the sand. Near actual size.

Different Fish, Similar Lifestyles

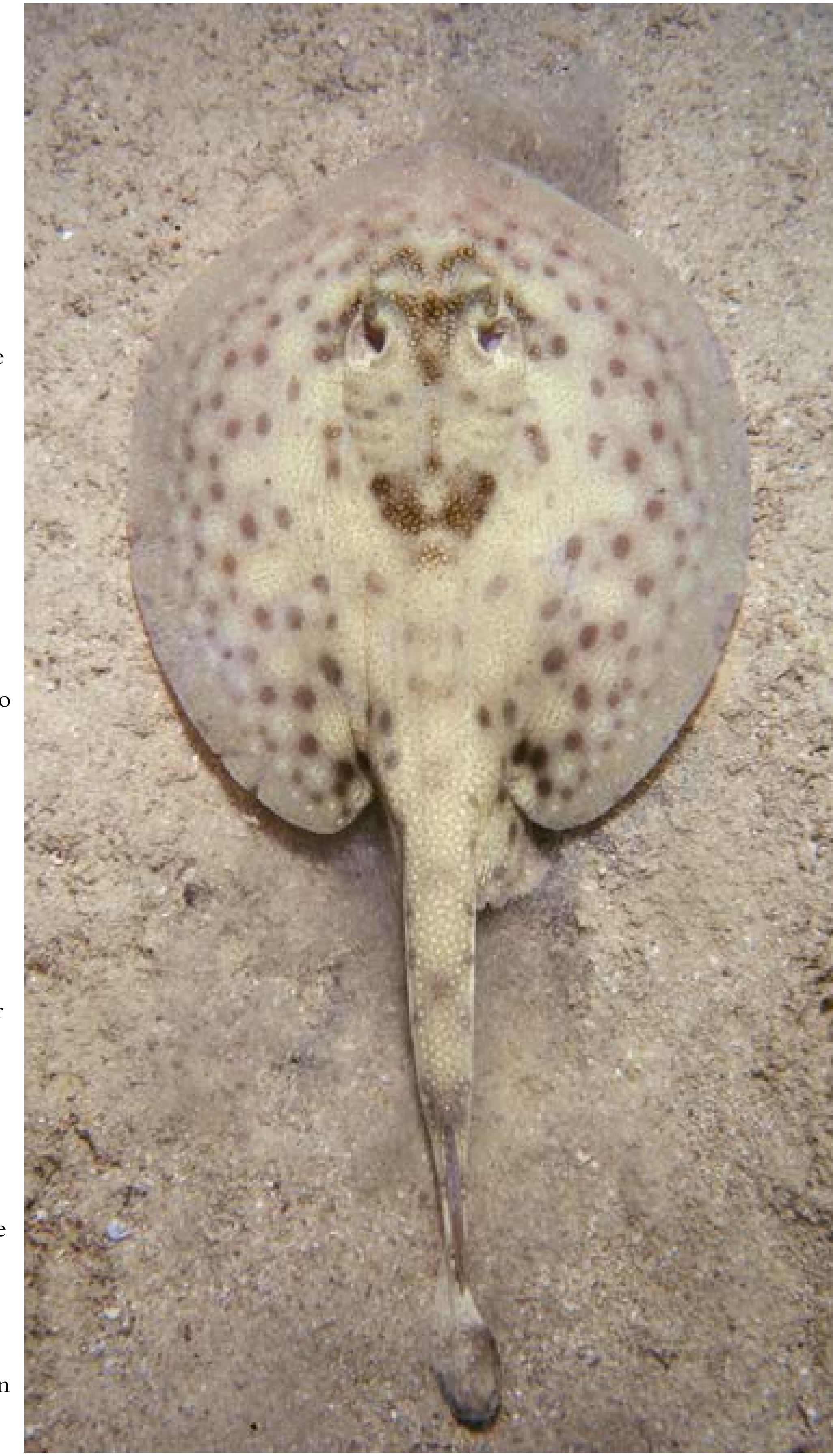


Bothus lunatus, the peacock flounder, has blue rings on the body and blue spots on the fins, tail, and head, though it can change color quickly, darkening when swimming over darker coral and turning pale to match the sand. It swims by undulating the dorsal and anal fins which encircle almost the whole body. The eyes protrude on bumps raised above the body.

The peacock flounder and the yellow stingray opposite show both different and similar ways of adapting to life on a sandy bottom. The flounder begins life as a typical fish with an upright profile, but as it grows, one eye migrates to the other side of the body and it begins to swim on its side, with the eyes on the upper side. Since the fish is on its side, the mouth at the front end, which is difficult to see here because of the excellent match with the color of the bottom, opens side to side rather than up and down, and the tail is horizontal rather than vertical. This is about two-thirds actual size.

Urolobatis jamaicensis, the yellow stingray, is pale yellow with dark spots, though like the peacock flounder it can change its coloration to better match the bottom. The rounded snout and pectoral fins give an overall rounded shape to the flattened disk, which undulates to propel the ray forward. There is a venomous spike between the tapered rear end of the body and the tail fin. This is about half actual size.

These two fish show how two unrelated species can evolve similar form and behavior, a phenomenon known as **convergent evolution**. The flounder and the stingray belong to two very different groups of fish. The flounder has a bony skeleton, while the stingray, like sharks, has a skeleton of **cartilage**, a softer substance. (The cartilaginous fish are in the class Chondrichthyes, the bony fish in the class Osteichthyes.) In order to live primarily on sandy bottoms, they behave in much the same way. Beside matching the bottom, both fish flutter their fins to partially bury themselves in the sand, and both have eyes that are raised up to see well when they are buried.



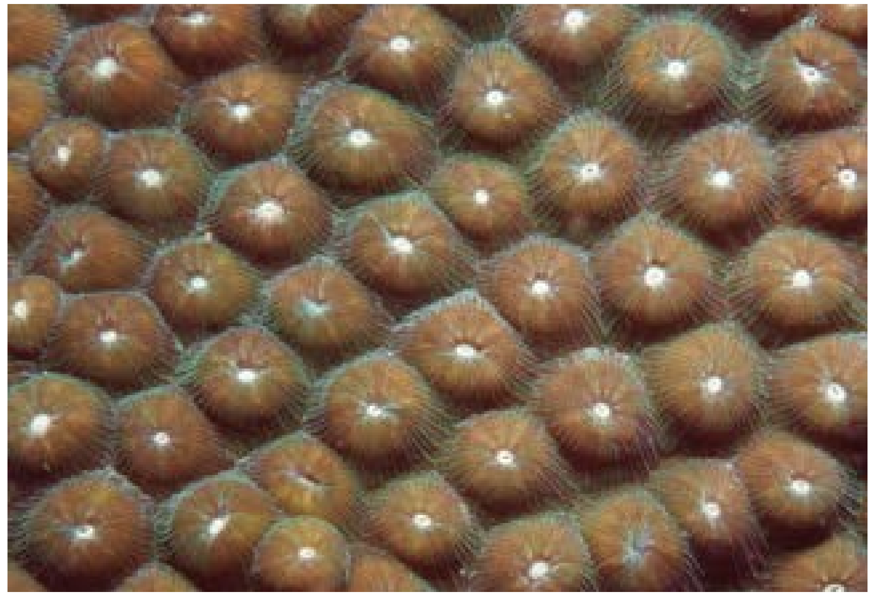
The Reef at Night

We have looked at the corals that build the reef, at the other invertebrate animals that live there, and at the fish that it provides shelter and food for. But almost everything we have seen is what you will find if you visit the reef in the daytime, as most people do. But, just as on land, night brings out different reef dwellers while the others sleep or are less active.

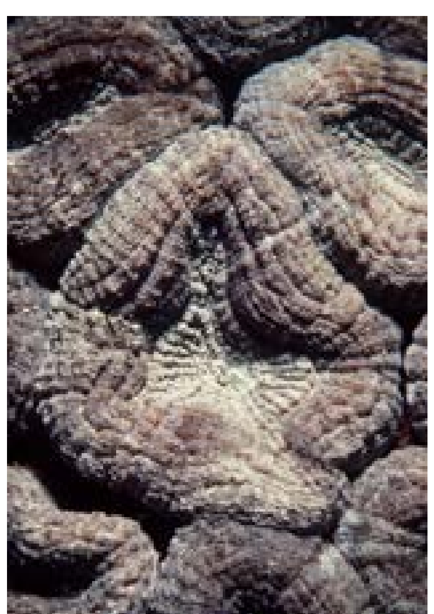
A fundamental change occurs on the reef each night. As the light dims at sunset, an upward migration of tiny animals, collectively called **zooplankton**, begins. Most of them avoid the light and predators by retreating to deep water during the day, but at night they rise to feed on the tiny drifting plants, or **phytoplankton**, that live only in the upper water where the sunlight they need for photosynthesis penetrates in abundance. The zooplankton are in turn eaten by corals and many other reef animals.

Though some corals also feed in the daytime, night is the primary feeding time because of the greater abundance of zooplankton in shallow water. Though usually withdrawn and hidden in the daytime, at night the tentacles are extended out into the water to catch tiny prey passing in the current.

Some fish are out and active at night, while others sleep in protected spots on the reef. Many other animals come out only at night and hide in the daytime. The change from day to night makes more environments available to the reef's creatures.



Montastrea cavernosa in the daytime and at night. Actual size.



Mussa angulosa in the daytime and at night. About half actual size.

Tubastrea coccinea does not have zooxanthellae and must extend its polyps to feed on plankton at night, looking very different from its daytime appearance (right). (Also see p. 11.) The ones at the top left are about one and a half times actual size.

Above, an unidentified parrotfish sleeps under a coral overhang. It has secreted a mucous bag for protection. At right, another parrotfish and a creole wrasse, *Clepticus parrae*, sleep in crevices in fire coral. 1/3 and 1/4 actual size.

The red banded lobster, *Justitia longimanus,* hides effectively within the reef during the daytime, only emerging to feed and be seen at night. This is about half actual size.

Mithrax spinosissimus will follow a fleeing urchin, breaking off spines until it clears an area big enough to reach and break the fragile shell. This one has just finished a meal. This is about one third actual size.

A Caribbean reef octopus, *Octopus briareus*, forages freely at night. During the daytime it will squeeze into the smallest of spaces on the reef. This is a little smaller than actual size.

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