

# Wonders of the Living Reef

## The Invertebrates

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In-Depth Images

The living reef is a realm of wonders. With a first look at a living reef, one is overwhelmed with the diversity in color and shape of the corals and fishes. But beneath this surface is an even more wondrous world, one of bizarre, alien creatures, some of which hardly resemble living animals. These "aliens" are the invertebrates.

This tape will take us on a brief tour of this marvelous and diverse group of animals. But first, what do we mean when we say "invertebrate?"

Animals are divided into groups based upon factors such as similarities or differences in how their bodies are constructed or the stages they go through in development from eggs to adults. More is said about some of the different animal groups later, but one distinction used to segment the animals into two major groups is whether or not the animal has a vertebra, or backbone. Most of the creatures the average person thinks of as animals have backbones. All fish, amphibians, reptiles, birds, and mammals, with humanity included in that last group, are vertebrates. They all have vertebrae.

All the rest of the animals are invertebrates: corals, starfish, worms, snails, clams, lobsters, crabs, insects, plus a bunch of other groups of which most people have never even heard. No backbones.

All right, so what? Most animals are vertebrates, aren't they? No. Not by a long shot. Let's look at some numbers. Scientists think there are maybe 4500 different kinds of mammals alive today. Sure, there are probably some unknown to science yet. But not too many. We know the mammals pretty well. There are maybe 8600 kinds of birds, 6000 kinds of reptiles, 2500 different amphibians, and a whopping 20,000 or so different kinds of fish. That puts us up to less than 45,000 different kinds of vertebrates we're sharing the world with.

There are likely more snail species than that. There are at least 20 times and probably more kinds of insects than all the vertebrates combined. And there are scientists who think that some of the lesser known groups of small worms have even more species than insects.

If you consider the range of diversity of animal life on earth, the vertebrates are but a blip on one end of the spectrum. Most animal diversity occurs among the inverts.

All right, there are a lot of them. But are they important? Very much so. It is marine invertebrates that build up the reef. At the same time, other inverts are working to break down the reef. Inverts provide food for one another, as well as for many fish and other vertebrates as well. Invertebrates are down near the base of the food chain that supports just about all of the commercially valuable fishes farther up the chain. Inverts even constitute the primary diet for many of the largest animals on earth, the whales. Yes, invertebrates are important indeed.

Invertebrates live throughout the coral reef. Some may sit right out in the open. Others hide beneath rocks or in caves and ledges. Still others may bore into living coral or reef rock, live on or beneath the surface of the sand, or drift with the currents. If you get in the water, you cannot avoid them: you just might not recognize all of them.

The primary purpose of this tape, aside from simple entertainment, is to increase the average person's awareness of invertebrates by showing a variety of them from most of the major groups engaged in their normal activities on a tropical Pacific coral reef. While aimed at the interested layman, we hope that the presentation of interesting animal behaviors on tape and some of the observations recorded in this booklet will also be of interest to researchers or teachers studying or preparing lessons on the invertebrates.

### Scene Descriptions

The scene by scene discussion that follows begins each block of text with a four-digit number that represents the tape counter on your VCR. Most VCRs have a tape counter, or allow you to turn on a counter display on the TV screen itself. If you reset your counter to zero just as the movie starts, the numbers shown here should match up fairly close to those on your VCR. Since there may be some variation in play rates between different VCRs, the numbers may not match perfectly. We hope that enough descriptive information is given to determine your position even without the counter numbers. In particular, title scenes that separate different animal groups may help you locate what you are looking for in the booklet. Title scenes are printed in inverse color to help you locate your position.

The counter number is followed by the animal's common name (or the title of the section if it's a title scene). Occasionally a particular text block will discuss more than one scene, and if so, the number of scenes being discussed is shown next.

The rest of the paragraph contains a description of the scene and includes, if known, the scientific name (*in italics*) of the primary animals being shown.

#### **0000** Movie Title

A mixture of ripples: Light rays bending as they pass through the slightly undulating glassy water's surface focus to an ever-changing ripple pattern superimposed over the parallel sand ridges produced by larger waves.

#### **0010** Title: Stony Corals

Scientists often use the term "stony corals" to refer to a particular group of corals that possess hard, calcium carbonate skeletons, but not including all corals with such skeletons. For the purposes of this video, we've widened the definition slightly to include a few corals not usually considered part of the stony coral group.

Stony corals are certainly the most visible of elements of a Pacific coral reef; it's from them that the coral reef derives its name. In some areas, various branching, massive, plating, or spreading corals can cover virtually 100 percent of the available substrate; they crowd, shade, or overgrow each other for access to sunlight, a factor critical to the growth of most stony corals. From their appearance and requirements for sunlight, you'd almost think these corals were plants. Well, in one respect, they nearly are.

Corals themselves are definitely animals. Most of the corals you see are colonies of innumerable minute, thin, cup-shaped individuals with tentacles that surround a central mouth. Coral individuals, called "polyps," capture planktonic food with their tentacles and move it to the mouth, which is used both for eating and for getting rid of some undigestible material. The thin animal tissue of the polyps can be retracted right down to the surface of their porous calcium carbonate skeletons, making it look as though there's nothing there but rock. But the animal is there. Sometimes you can tell the animal is there with your naked eye only by its color; coral skeletons from which the animal has been freshly removed is usually pure white, and is soon covered by algae and other marine growths.

The color you see in living corals is often not the color of the coral animals, however. The color is often due the presence of single-celled plants that live within the coral tissue itself. These plants—called zooxanthellae—do in fact function as plants. They're the ones who require the sunlight that growing coral seeks.

Now why should the coral location and growth be determined by what their resident plants need? Turns out that these plants and their relationship with corals may be the primary factor that permits coral reefs as we know them to exist.

Animals such as corals require among other things food and oxygen to survive and grow. Plant requirements include sunlight, carbon dioxide, and various nutrients. In warm, tropical oceans, essential nutrients are often in short supply. Nutrients such as vitamins and minerals are present within plants and animals living in the top several hundred feet of the ocean. When plants and animals near the surface die, their bodies containing these essential nutrients sink. Often they're eaten by some other creature on the way down and brought back up. But some and eventually most sink down, far beyond the limits where sunlight can penetrate, down into the cold, dense, deep ocean. In the tropics, because the colder, deeper water is heavier than warmer water near the surface, once those nutrients sink, they stay down. And down there, beyond the reach of sunlight, plants can no longer use them. Where the ocean gets cold for part of the year, mixing can occur, bringing nutrients back up. Or in some areas, upwelling—currents from the bottom to the top—bring nutrients back up. But for the most part, where tropical coral reefs grow, the nutrients don't come back up, keeping the warmer surface waters nutrient and, in general, life-poor. You may have heard that tropical ocean waters tend to be a "desert"—this is the reason why.

Yet, coral reefs in tropical oceans are among the richest, most diverse of biological systems. How can this be, given the nutrient-poor waters in which they occur?

The primary reason coral reefs can exist is because of the relationship between corals and zooxanthellae algae. The carbon dioxide produced as a waste product by the coral is passed to the algae, which uses it plus the energy from sunlight to make carbon compounds (food!) and oxygen, some of which are passed to the coral in return for more carbon dioxide. This relationship—called symbiosis, meaning a close relationship between two different kinds of organisms—allows for extensive coral reef growth, which then provides a suitable environment for the myriad of other creatures that make up the coral reef ecosystem. Essential nutrients, once they get into such a system, tend to be retained within that system and are typically not lost by sinking beyond the reach of sunlight.

It seems like it could hardly have been better designed. There is one potential weakness, however, in its temperature sensitivity. Recent observations and studies have suggested that even slightly warmer water than the corals typically grow in can cause them to expel the algae from their tissues, causing a phenomenon called "coral bleaching." The initial result is that the coral without its algae loses its color, becoming mostly white. With no algae to provide food and oxygen, the coral can neither survive as well nor grow as fast, and this sometimes leads to coral death. The past few years, coral bleaching has been observed to be a considerable problem in parts of the Caribbean and western Pacific. So far, we haven't really seen its effects here at Kwajalein.

Many corals are difficult to positively identify without examining under magnification the fine structure of the animal or skeleton. Therefore, the identifications used here should mostly be regarded as tentative.

#### **0014 Table coral**

A rich coral reef contains a variety of different corals, each crowding each other for space. Here, various table corals (*Acropora clathrata*) spread out, trying to reach above their neighbors to gain exposure to the sunlight. Fast growing staghorn corals (*Acropora*) at left form a tangled network of branches.

#### **0019 Table coral**

Another large table spreads out over the bottom. This one makes up the territory of a pair of coral-feeding chevron butterflyfish, *Chaetodon trifascialis*. The butterflies guard their territory against other coral eating species, chasing them away if they wander too near "their" coral.

#### **0023 Table coral**

A table grows up against a dense stand of staghorn coral. On a growing reef, competition for space among the corals can be fierce. Again, a resident chevron butterfly grazes on his coral.

#### **0026 Table coral**

More fast-growing table corals spread out, shading several species growing between them. The massive spikes at lower right and in some other parts of the scene are *Acropora palifera*. There's kind of an odd-looking coral in the background, just to the left of center. This is a table coral that has fallen over. The edges of the colony have begun growing out horizontally again from its now vertical orientation. A couple of black surgeonfish (tang) swim over the corals.

#### **0029 Corals and fish**

Small table corals (*Acropora hyacinthus?*), branching corals (*Acropora*), and ball corals (*Astreopora?* at left) cover a rock as a school of small fusiliers (*Pterocaesio tile*) swarm around.

#### **0035 Corals**

A cluster of colonies of bluish branching *Acropora* corals grow up against a mass of columnar crinkly coral (*Porites rus*).

**0038 Branching corals**

A colony of blue tinged bushy *Acropora* grows near a stand of staghorn coral (also an *Acropora*).

**0041 Staghorn coral**

A branching staghorn *Acropora* grows from the edge of a cliff. The water's surface can be seen in the background.

**0044 Pan shallow coral reef**

A shallow reef is densely covered with various corals, including branching staghorns, dome-shaped crinkly coral, and a brown lumpy gonioporiid. This area is close to one of the lagoon passes that permits the regular inflow of a fresh supply of sea water, providing conditions that contribute to the growth of corals.

**0049 Coral**

Damselfish (*Chromis*) dart into the safety provided by a bluish branched coral (*Acropora*).

**0052 Coral**

A shallow water branched coral (*Acropora*?) is colored purple.

**0055 Coral**

A purple *Acropora* coral grows up against a yellow *Acropora palifera*.

**0057 Elkhorn coral**

The camera looks upwards through the branching patterns of a large elkhorn *Acropora* coral.

**0100 Corals**

Looking close, we can see the structure of the small branched *Acropora* against an encrusting *Montipora* coral. In the *Acropora* skeleton, branches are studded with and tipped by small rounded craters. These craters are called calices or corallites, and each houses a single coral animal or polyp. Each polyp has its own mouth, and the separate polyps are connected by tissue that spreads between the calices. A new coral colony starts out as a single polyp, which then reproduces by division to form colonies that can be made up of many thousands of polyps.

**0103 Spiky coral**

Another species of *Acropora*, possibly *A. palmerae*. This one prefers shallow water habitats where there is some wave action. Often the damselfish *Plectroglyphidodon dickii* guard colonies of this coral and fend off intruding coral feeders.

**0106 Branch coral**

A large colony of the branch coral *Pocillopora eydouxi* provides a home for a school of green damselfish (*Chromis viridis*). Several kinds of fish and invertebrates use these large branching corals as homes. Later we'll see a crab that lives its entire life between the branches of corals like these. Table corals are visible in front of the branching coral and in the background.

**0108 Coral**

A large colony of the crinkly coral *Porites rus* towers up the dropoff toward the surface. Numerous purple (actually magenta in the correct light) fairy basslets (*Pseudanthias pascalis*) school around such corals on the oceanside slope.

**0111 Lump coral**

A rounded lump coral *Porites lutea* adorns a reef as various snappers and tangs swarm around.

**0114 Corals**

Table *Acropora* and *A. palifera* grow next to a bottom encrusting blue *Montipora (hoffmeisteri?)* coral. *Chromis* damselfish swim overhead.

**0117 Corals**

A purple encrusting *Montipora* coral shares an outcrop crowned by a faviid coral (*Favites*). The depressions are the calices, each housing an individual coral polyp, and are large and easily seen in faviids.

**0119 Corals**

A faviid coral grows out of a substrate densely covered with small, flexible, bush-like branching soft corals.

**0122 Coral**

A smaller faviid coral encrusts the hard bottom. In some species, the color within the calices is brilliant green or yellow; unfortunately, film or videotape of the coral often does not do the colors justice.

**0125 Corals**

A pair of threadfin butterflyfish *Chaetodon auriga* pass over a large faviid coral colony. An elkhorn type of *Acropora* coral is behind the faviid.

**0130 Coral**

This rounded ball coral (*Astreopora*?) prefers shallow reefs where there is lots of water movement. In this scene, a yellow-band parrotfish (*Scarus schlegelii*) swims up and over the ball.

**0136 Corals**

Rows of ball corals form a range of "mountains" behind a stand of branching *Acropora* coral. Dick's damselfish (*Plectroglyphidodon dickii*) crosses the front mountain swimming forward.

**0138 Stinging coral**

Another kind of "ball" coral, this one packs a powerful punch. Corals and their relatives possess throughout their tissue stinging cells called nematocysts. These nematocysts are analogous to a coiled spring with a hair trigger. A slight touch against the trigger causes the spring to evert, forcing a pointed or even barbed harpoon into whatever touched up against it. The stinger is generally associated with some sort of venom, although the venom varies considerably in intensity from one species to another. In the ball coral

shown here, the intensity is great. Divers have been stung right through dive skins, leading to pain and bubbling blisters erupting at the site of the sting. This coral is mostly restricted to lagoon reefs and pinnacles; we rarely see it on the oceanside (seaward) reefs.

#### **0141 Stalk coral**

The stalk coral (*Lobophyllia corymbosa*) forms large rounded, sometimes interconnected domelike colonies on lagoon reefs and pinnacles. Like other corals, a colony starts off with a single polyp. As it gets larger, the first polyp divides into two. After a bit more growth, one or both of these two divide, and so on as the colony increases in size. The real growth takes place on the outer surface of the colony. In most species, the different segments formed by division remain firmly attached to one another and to the rest of the colony, forming one more or less solid mass. In the pictured species, the different polyps remain only loosely attached to each other; the colonies are somewhat fragile and can be broken apart into individual stalks by rough weather. When the colony is broken apart, each individual polyp has its growing end on the outer tip, and the remainder of the stalk going back down to what was the center of the colony is all old dead coral. The dead stalk represents the life history of that particular polyp; to get where it is today, the living tip had to grow through the entire length represented by that stalk.

#### **0144 Stalk coral field**

Stalk coral is very successful in sheltered lagoon areas, often forming large colonies that cover a large portion of the substrate. Here a couple of colonies of *Acropora* protrude from within or from the edge of the sprawling colony of stalk coral. This coral is growing on the top of the steep slope of the atoll's seaward reef. Purple fairy basslets mill around to the right of the coral.

#### **0146 Coral**

This coral may be *Lobophyllia pachysepta*. Its skeleton is more cemented together than that of its relative, the stalk coral.

#### **0149 Coral**

Some of the *Lobophyllia* corals possess a varying degree of red or orange coloration.

#### **0152 Coral**

*Lobophyllia*, this time with bright orange coloration. This was taken under natural lighting conditions at a depth of about 80 feet. By the time sunlight reaches this depth, the orange and red components of light have been filtered out of water. So how can this look so bright red? It must be generating some light of its own, a sort of natural chemical lighting. If you photograph it with artificial lighting from a strobe, the orange disappears, replaced on the film image by a dull brown.

#### **0155 Coral**

*Pachyseris speciosa*, like many of the other thin, plating corals, grows in areas of low light. This colony is in a shaded ledge. It grows in thin, wide plates to take full advantage of what little sunlight reaches it from reflection.

#### **0200 Lettuce Coral**

The delicate-looking lettuce coral, *Pavona cactus*, prefers sheltered, quiet lagoon habitats.

#### **0203 Razor Corals**

While most corals are colonial, some members of the razor coral family are individuals. Most species of *Fungia* form disk-shaped or elongate skeletons that are not cemented to the substrate. The common name razor refers to the sharp plates (called septae) that radiate outward from the usually central groove containing the polyp's mouth. The larger individual in this scene is a member of the same family but in the genus *Halomitra* instead of *Fungia*. It is a true colony, with numerous mouths to the separate polyps. Being loose on the bottom, razor corals can get rolled around by strong swells, or they can be flipped by some triggerfish or large wrasses searching for food hiding beneath. Since upside down razor corals make the reef look somewhat untidy, we like to flip them back upright. Also in this scene, at the left edge of the frame, is a finely branching coral called *Seriatopora*.

#### **0206 Razor Coral**

This shot of the razor coral *Fungia fungites* shows the polyp's tentacles extended at night.

#### **0208 Razor Coral**

Some of the razor corals are bright orange under natural light conditions at depth. Like some of the *Lobophyllia* corals, they seem to give off their own chemical light.

#### **0211 Razor Coral**

While the most common colors are tan and brown, some razor corals can range all the way to purple.

#### **0214 Razor Coral**

While many of the species of razor corals are round or oval, some are elongate, such as this *Herpolitha limax*.

#### **0216 Razor Corals**

These small razors belong to the genera *Cycloseris* and *Diaseris*. *Diaseris fragilis* comes in orange and brown, and is common in deep lagoon patches of *Halimeda* algae. One of this coral's normal means of reproduction is by breaking up into 2, 3, 4 or more segments, each regrowing into a full sized individual that will break up again.

#### **0219 Razor and Table Corals**

The large razors in the genus *Halomitra* can form what appear to be large (up to about 600mm across) mountainous masses, but it's all a shell. Upside down, the mountain is hollow, with the appearance of an irregular bowl. Although untidy in appearance, these corals are able to grow in an upside down position; their outer edges curl inward to get more exposure to light.

#### **0222 Coral**

Members of this coral family can be found on both lagoon and seaward reefs and are characterized by long stalked polyps capped with a circle of tentacles. Each of the hundreds of long brown stalks in this scene is a separate polyp, crowded together and waving in the surge. The two common genera that make up this family are easily distinguished by examining the tentacles at the end of the stalk: if there are 24, it is *Goniopora*; if 12, then it's *Alveopora*. In this scene, we're a little too far away to tell. A yellow wrasse (*Thalassoma lutescens*) and a brown damsel pass by as we watch.

**0226 Coral**

This is a close view of the polyps of a species of *Goniopora*; if you're quick you can count the 24 tentacles on each polyp. The whitish center of each disk is the location of a mouth.

**0230 Coral**

Here is another *Goniopora*, with its long polyps waving in the surge. The polyp tentacles on this one are much longer than those on the species in the last scene.

**0233 Coral**

This curious *Goniopora* forms small colonies interspersed in lagoon slope *Halimeda* patches. When the polyps are not extended, it is not an easy coral to find.

**0236 Coral**

This *Alveopora* (12 tentacles on each polyp) is living within a continually shaded ledge. In normal sunlight, the coral tissue is full of symbiotic algae called zooxanthellae. This algae uses some of the waste products of coral to photosynthesize and produce oxygen and carbon compounds—food—for the coral (see the discussion under 0043, Stony Corals, above). However, if there is not enough light to support efficient photosynthesis, the algae becomes not a producer but a consumer of oxygen. Not only can the algae not survive long in low light levels, but under such conditions the coral seems to actively expel the algae cells from their tissue. Since it is the algae that usually gives corals their color, in perpetually shaded conditions, corals (and some anemones) sometimes are pure white, as is this coral.

**0241 Ball Tentacle Coral****2 scenes**

Although it looks like an anemone, *Euphyllia glabrescens* is in fact a hard, stony coral. Those soft, waving tentacles capped with round balls can be completely retracted into a hard stony coral skeleton. The second scene shows a closer view of the crowded tentacles waving in the surge.

**0247 Bubble or Grape Coral**

The tentacles on bubble coral (*Pleurogyra sinuosa*) resemble a cluster of bubbles or grapes, and are kind of like water balloons. Each bubble is a coral polyp tentacle. They can completely deflate when the tentacles retract into the hard coral skeleton. Colonies of this coral are frequently found hanging at the edges of small caves on sheer walls, often in the vicinity of encrusting sponges such as the orange one in this scene. They seem to prefer quiet lagoon reefs, but can be found on seaward reefs as well.

**0249 Sausage Coral****2 scenes**

*Euphyllia parancora* gets its common name of sausage coral from the sausage-shaped tentacle extremities. It is most often found on lagoon pinnacles and patch reefs. In the close-up, the sausage-shaped tentacle ends are clearly visible. Like its relative the ball tentacle coral, these tentacles can completely retract into the coral skeleton.

**0255 Coral**

The bright yellow to yellow green coral named *Turbinaria reniformis* belongs to an offshoot group of the stony corals related to the tube corals to be shown shortly.

**0257 Coral**

This colony of *Turbinaria*, or cluster of colonies, forms a mass 5 to 6 meters across. The large parrotfish over the right side give an indication of the size of the colony.

**0300 Orange Tube Coral****2 scenes**

The typical form for tube coral *Tubastraea* is this: small clusters often growing from the ceilings of ledges and small caves. It is difficult to tell the species and sometimes even the genus without a close examination of fine details of skeleton morphology. In the first shot, the orange polyps are retracted right up to the hard skeleton, which turns pure white after the coral animal dies. In the second, the polyps are extended. This is the way you usually see them at night. Unlike most of the reef building corals, tube corals do not carry symbiotic zooxanthellae in their tissue.

**0305 Orange Tube Coral****2 scenes**

These two scenes show larger clusters of tube corals extended at night. Colors can vary from peach to pink to orange and even to dark brown, but a particular colony, since it is made up of clones of the single initial founder, are usually all the same color. In the second scene, tube corals and sponges encrust a sunken buoy.

**0311 Green Tube Coral****2 scenes**

The green tube coral (*Tubastraea micrantha*) is a common sight throughout most of Micronesia. It is abundant as least as far east as Pohnpei, but fades out in the Marshalls, where it is very rare. In daylight, it appears dark green. Under artificial lights, it can look dark brown. Photographers call it a "light eater" since it seems to suck up the light from a strobe and not give any back, causing the coral to often appear black in pictures. In the first scene, some purple fairy basslets, *Pseudanthias pascalis*, have taken refuge around a colony of green tube coral.

**0317 Organ-Pipe Coral****2 scenes**

Bright red skeletons of the organ-pipe coral (*Tubipora musica*) are common sights on many beaches. In the living state, however, it looks quite different. The coral's stacked column structure is invisible beneath the living polyps shown in the second scene, and the color turns bright red only after it has been sunbleached a bit. Organ-pipe coral is actually not closely related to the other stony corals; its animal characteristics lump it with the soft corals seen later in the video (scene 0656 and later). It is included here since it has a hard calcium carbonate skeleton similar to the true stony corals. The brown, elongate bubbles waving under the coral colony in the first scene is a kind of algae.

**0325 Title: Sea Anemones**

Like several other groups we're covering, the animals lumped together here under "Sea Anemones" are not all strictly sea anemones. The first few scenes show a related group of sea anemone-like soft corals called zoanthids. Within the sea anemones

themselves, there are several somewhat distantly related groups including the typical anemones, the stalk anemones, and the ball-capped-tentacle or plate anemones (or corynactids).

Anemones, like other corals and their relatives, possess stinging cells called nematocysts (see "Stinging coral" at 0138). These stingers vary in virulence from coral to coral (or anemone to anemone); some are potent even to human skin while others are too mild to even be noticed. Depending on the coral and the situation, these nematocysts might be used by the coral (or anemone) for capturing prey for themselves or for defense against potential predators. Even mild nematocysts are probably able to sting and capture planktonic prey, and more powerful stingers can even kill fish.

Yet, there are some fish that appear to be immune to the sting of certain sea anemones. All of the clown fish (about 28 known species worldwide) live nestled among the tentacles of certain sea anemones throughout their lives, and juvenile individuals of a related damselfish live with the anemone until they grow up and wander off.

How do these fish withstand the sting of the nematocysts? Researchers believe that the clown fish produces a mucus coat over its body that inhibits the firing of the stinging cells. This coat is something that develops gradually. It has been observed that anemonefish, if kept away from contact with anemones (for example, in an aquarium), lose their immunity. When reintroduced to an anemone, a fish at first appears susceptible to being stung. The fish gradually "reacquaints" itself with the anemone by briefly touching the tentacles over and over, and this seems to help the protective mucus coat redevelop.

Most anemones do not play host to anemonefish. Most of the different kinds that do here in the Marshall Islands are shown in this video.

### **0329 Leathery Sea Anemones**

#### **2 scenes**

These scenes show one of the long-tentacled sea anemones named *Heteractis crispa*. I'm not sure where the common name comes from, since the anemones are always very soft. In the first scene, the anemone coloration is typical, usually yellow or brown, sometimes with purple tips on the tentacles. In the second, parts of the anemone are pure white, indicating it may have lost its symbiotic algae in those areas. Here in the Marshalls, *Heteractis crispa* is usually inhabited by a pair of adult 2-stripe anemonefish, *Amphiprion chrysopterus*, and maybe two or three juveniles as well. There also may be several of the black and white damsels, *Dascyllus trimaculatus*, in or around the anemone.

### **0338 Magnificent Sea Anemone**

#### **2 scenes**

The large anemone called *Heteractis magnifica* varies in color from brown to yellow to white with tentacles that can be tipped with blue or green. In addition, the stalk can be from light orange to pink to magenta, although under normal daylight conditions it often looks bright blue. The anemone is usually inhabited by two to about 10 (sometimes more) apricot anemonefish (*Amphiprion perideraion*, sometimes called the pink anemonefish). These anemones can be either on the seaward reefs or lagoonside; they seem most plentiful on lagoon pinnacles. These two scenes are different views of the same individual, which is resting on top of an isolated lagoon reef surrounded by sand. Numerous fish swarm around the reef.

### **0348 Magnificent Anemone**

This anemone was photographed on the deeper slopes of a lagoon pinnacle with a school of blue fusiliers (*Caesio teres*) swimming behind. There are also several damselfish swimming immediately above the anemone.

### **0351 Magnificent Anemone**

This anemone has an unusually large number of the apricot anemonefish and a few 3-spot Damsels living among its tentacles. The largest fish seems to be guarding the anemone's mouth, a behavior seen frequently in this species.

### **0357 Magnificent Anemone**

#### **4 scenes**

The first two scenes show an anemone with white tentacles bearing blue tips. In the third, the white tentacles are tipped with green, while in the fourth, even the tips are white. The pale coloration of the tentacles of these anemones suggests that they may have lost their symbiotic zooxanthellae, the single-celled plants live symbiotically with corals and their relatives. A few months later, the tentacles of these particular anemones were brown, indicating the return of the plants.

### **0410 Magnificent Anemone**

An anemone with a blue stalk and yellow tentacles is attached to a rock on the slope of a lagoon pinnacle. Some anemones prefer sandy substrates, but this species is nearly always in rocky areas.

### **0413 Magnificent Anemone**

The blue stalk of this anemone has unusual white band on its side. A separate anemone, colored more brown, is visible at the left side of the screen.

### **0419 Magnificent Anemone**

#### **2 scenes**

These two scenes are different shots of the same individual. In the first, natural lighting shows the anemone's stalk color the way it normally appears. In the second, artificial lighting reveals the true pink color of the stalk. In both scenes, the anemone's tentacles and oral disk are kind of retracted within itself. In aquaria, this behavior is sometimes observed when the anemone is given a chunk of food. Perhaps this one recently caught a fish who carelessly ventured too close to the stinging tentacles.

### **0425 Magnificent Anemone**

Again, the video lights show off the brilliant pink coloration of this waving anemone's stalk.

### **0432 Magnificent Anemone**

A school of 3-lined fusiliers, *Pterocaesio trilineata*, pass in front of cluster of anemones.

### **0435 Beaded Sand Anemone**

#### **2 scenes**

The Beaded Sand Anemone (*Heteractis aurora*) is generally attached to a rock buried several inches or more down in the sand. The stalk protrudes upward, and the tentacles and mouth (the "oral disc") expand out at the surface. In the Marshall Islands, it is often inhabited by young specimens of the 3-stripe Anemonefish, *Amphiprion tricolor*. This anemonefish is restricted to the Marshalls, so in other areas, other species of anemonefish take over. The anemone usually retracts completely into its hole in the sand if disturbed, leaving the anemonefish out in the open to fend for themselves. The anemone in the first scene is a particularly large

individual of the species. In addition to its resident anemonefish, several yellow cardinalfish and a dense school of transparent cardinalfish hover nearby. The second scene shows a smaller individual of the anemone, and is inhabited by only the single juvenile anemonefish.

**0441 Bulb Tentacle Sea Anemone 2 scenes**

Young specimens of the anemone *Entacmaea quadricolor* form aggregations that often peek out through branches of coral or rubble. The tentacles of different anemones nestled together may be of different colors, as shown in the first scene. At this stage, these anemones are usually inhabited by colonies of the anemonefish *Amphiprion melanopus*, locally called the tomato clown but more widely referred to as the black and red anemonefish. When the anemones get older and larger, they seem to strike out on their own. Large specimens, which typically form a bubble or bulb near the tip of each tentacle, are usually solitary, and are most often occupied by adult three-striped anemonefish.

**0447 Corkscrew Tentacle Sea Anemone**

*Macrodactyla doreensis* is another anemone capable of withdrawing most of the way into the sand. Usually a few tentacles and part of the oral disk still show at the surface when the animal is retracted. This anemone was only recently found to live here in the Marshall Islands; previously it was thought to occur only to the west. It usually contains a few juvenile 3-stripe Anemonefish and perhaps couple of 3-spot Damsels, *Dascyllus trimaculatus*, as well.

**0450 Carpet Anemone**

*Stichodactyla mertensii* is usually called the carpet anemone, but elsewhere is often called Mertens' anemone. It is one of the larger anemones found in the Marshalls. It is usually inhabited by a pair of large 2-stripe anemonefish, *Amphiprion chrysopterus*, although there are often one or two small juveniles as well. Carpets are generally found in rocky reef areas, with the base adhering directly to the rock. The stalk is ornamented with rows of orange dots, only slightly visible in the video, making this species easy to identify when seen up close.

**0454 Haddon's Anemone 6 scenes**

*Stichodactyla haddoni* lives almost exclusively in sand or lagoon *Halimeda* algae patches. It resembles the carpet anemone but tends to have more regularly undulating margins. These anemones vary in color from white to brown to pink to orange, and seem to function as nurseries for numerous juvenile 3-stripe anemonefish and 3-spot damsels. Also, there are nearly always several kinds of crustaceans (shrimp and crabs) that live associated with these anemones. Some of these are shown later in the sections on shrimp and crabs.

**0515 Sticky Sucker or Adhesive Sea Anemone**

*Cryptodendrum adhaesivum* well deserves its common name of sticky sucker. Its tentacles are very small but extremely adhesive to the touch. Further, when touched, it rapidly sucks back into its hole in the reef. Why? Not sure. But it is conceivable that it uses this technique to capture fast moving prey. By sticking to, for example, a fish and quickly sucking back, the anemone would entrap and immobilize the prey more effectively by completely enfolding it within its sticky, stinging tentacles. Yet, in some areas, although not here in the Marshalls, a species of anemonefish may occasionally inhabit sticky suckers. The tentacles, by the way, pack a powerful sting. The photographer inadvertently brushed his finger, which was sporting an abrasion from an earlier encounter with a jagged rock, against one of these one day and suffered from the sting for several hours.

**0521 Sticky Sucker Anemone 4 scenes**

Sticky suckers come in various colors; sometimes it seems there are no two alike. The next four scenes show different color forms. In the first and last scenes, commensal shrimp can be seen on the sticky tentacles.

**0531 Hemprich Anemone 2 scenes**

*Heterodactyla hemprichii* is a low, flat anemone that, like the sticky sucker, also occurs in a variety of colors. These two scenes show two color forms.

**0537 Tree Anemone**

This unknown species is occasionally spotted on apparently solid rock at night. Where it goes in the daytime is unknown.

**0540 Fire Anemone**

This anemone, possibly *Actinodendron arboreum*, extends from a hole in sand. When disturbed, it rapidly retracts completely into its hole. True to their common names, these have quite powerful nematocysts capable of producing painful stings. Don't touch. Yet, several kinds of shrimp can live among the tentacles with no problems.

**0543 Fire Anemone**

This anemone was disturbed at the approach of the camera and swiftly retracted into its hole. If you look closely, you can see the resident shrimp riding down into the hole on top of the retreating anemone.

**0549 Green Fire Anemone 2 scenes**

These two scenes show some of the animals living with a green-stalked tree anemone (*Actinodendron?*). In the first, a small commensal shrimp, *Periclimenes holthuisi*, rests on the tentacles. In the second, a trio of small cardinalfish hide among the anemone's branches. Probably not immune to the anemone's sting, the fish must be careful not to accidentally bump into one of the branches.

**0556 Fire Anemone**

The camera approaches a highly branched anemone.

**0559 Anemone**

This nocturnal anemone is perched on rock coated with the purple calcareous alga *Porolithon*.

**0602 Anemone**

This species is usually found attached to the undersurface of chunks of dead coral rock. They extend their tentacles and mouth out to the edge for feeding.

### 0605 Tube Anemone

*Arachnanthus oligopodus* anemones extend from holes in the sand at night. They are often sensitive to a diver's light and may retract quickly into their tubes.

### 0608 Ball Anemones

#### 2 scenes

The next two scenes show ball anemones, or corynactids (*Pseudocorynactis*), which are characterized by round balls on the ends of their tentacles. In this way, they resemble some corals in the genus *Euphyllia* (see scene 0241). The corals, however, have a hard skeleton into which the tentacles can be retracted. The ball anemones are completely soft. The corynactids and the plate anemones shown in the next two scenes are not generally considered true anemones. Both of these species are completely nocturnal; during the day they are completely retracted.

### 0615 Plate Anemone

These large plate anemones (*Amplexidiscus fenestrafer*) are usually found on lagoon reefs and pinnacles. This cluster happened to be covering a small rock out in the sand.

### 0618 Plate Anemone

Possibly the most abundant anemones on lagoon reefs and pinnacles hardly look like anemones at all. In some areas, these small plate anemones in the genus *Discosoma* literally cover the rocks. On some lagoon reefs, they may even choke out the corals. Pinnacles that used to be quite abundantly overgrown with corals now seem to be almost entirely coated with these anemones. Some of these reefs are downwind from overpopulated islands, so it is tempting to blame pollution, but there is so far no evidence to support this.

### 0620 Zoanthid

Zoanthids are anemone-like animals that typically have polyps with a single row of tentacles around a central mouth. Usually colonial, some species can form a coat over the reef that can be 4 meters across or more. Certain species of zoanthids have been found to contain a toxin that can be dangerous to humans. It is probably not wise to handle them with bare hands, especially if you have any cuts or abrasions on your fingers.

### 0624 Zoanthid

This scene shows that the individual polyps in a zoanthid colony are typically attached through the bases of their stalks. Some of the individuals in this scene were disturbed, causing them to contract. Sometimes, a small disturbance will cause a wave of contraction that propagates across the entire colony.

### 0627 Zoanthid on sponge

Some zoanthids grow on other organisms, such as this species of *Parazoanthus* growing over a clump of orange sponge.

### 0630 Zoanthid

This attractive unidentified zoanthid is growing over some dead coral on a lagoon pinnacle. Orange pigment surrounds the mouths of the polyps.

### 0633 Zoanthid

This relatively large zoanthid, probably a species of *Protopalythoa*, seems to prefer sheltered waters in the lee of islands.

### 0636 Title: Black Corals

Corals in this group range from finely branched to unbranched, whip-like species. A thin layer of animal tissue overlays a black and hard but flexible skeleton. The skeleton of some species has been used in making black coral jewelry, although not all species are suitable. In the Marshalls, black coral is most common on deep reefs and on shipwrecks.

### 0639 Black Coral

This branching species of *Antipathes* grows from the reef's seaward slope. It was a large colony, measuring about two to three meters in height. Often these colonies support pairs of the long-nose hawkfish, *Oxyrrhites typus*.

### 0642 Black Coral and Pink Coral

Another branching black *Antipathes* grows next to a colony of the pink *Stylaster* coral.

### 0645 Whip Coral

These whip corals (*Cirrhopathes*) growing out of an isolated reef on the sandy lagoon slope are close to 3 meters long.

### 0648 Whip Coral with gobies

Whip corals are often homes to a pair of small gobies in the genus *Bryanopsis*. Frequently, one or more kinds of shrimp also live out their lives attached to the whip.

### 0653 Title: Soft Corals

Some of the corals that do not produce hard calcium carbonate skeletons, and there are many, are called soft corals. These include such creatures as leather corals, tree corals, and many fan corals. As a group, they are often referred to as octocorals; the polyps of the true soft corals possess eight pinnate tentacles around the central mouth.

### 0656 Red Gorgonian

Most of the fan corals belong to a group called gorgonians. Here a tall, reddish gorgonian grows from the seaward slope at a depth of about 100 feet.

### 0659 Red Gorgonians

The camera pans through a field of another kind of red gorgonian, *Ctenocella*, on the seaward slope.

### 0706 Orange Gorgonian

An orange gorgonian forms part of a dense tangle in a shaded ledge, along with a black coral (at left) and sponge (below).

**0712 Orange-Brown Gorgonian**

With the video lights, this normally rather dull looking gorgonian (*Semperina?*) reveals an orange brown coloration.

**0714 Red Gorgonian**

This small red fan (*Astrogorgia?*) shares a hole with some pink coral.

**0717 Orange gorgonian**

This gorgonian is common in ledges along the seaward slope. Here it shares the ceiling of a small cave with some pink coral and roundish clumps of yellow calcareous sponge.

**0720 Yellow and Maroon Gorgonians**

These small gorgonians, as their name *Acabaria bicolor* implies, come in two (or more) color forms. They remain small and live in dimly lit caves and ledges.

**0723 Red Gorgonian**

On another red gorgonian, the white polyps are the individuals that make up the colony, and seem to form a frost over the reddish skeleton. It waves in the surge.

**0726 Orange Gorgonian**

Another orange gorgonian resides in a seaward cave in a dense tangle of branches.

**0728 Red Gorgonian**

This bright red gorgonian lives on the seaward slope. You need a flashlight to see its color at its normal depth of 80 to 100 feet.

**0731 Orange Gorgonian**

This small fan is growing from the side of a small cave. Clumps of brown sponge adhere to the cave walls and ceiling behind.

**0735 Orange Gorgonian**

This orange gorgonian (*Subergorgia mollis*) is often seen growing out in the open on the seaward slope. Left to grow, it can form bushes 3 meters or more across. They have occasionally been collected as souvenirs—a wasted effort as well as the unfortunate loss of an impressive animal, since they tend to become very brittle and break apart when dried. A black tang passes in front of this medium sized colony.

**0740 Orange Gorgonian**

A large colony of *Subergorgia mollis* looks bent over. Growing in an atoll pass, it faces swift currents in both directions for much of each day. Black crinoids are perched on top.

**0742 False Black Coral**

*Rumphella* has been called the false black coral. A layer of brown coral tissue covers an internal black skeleton. The skeleton is not dense enough to be made into jewelry the way “real” black coral is. True black coral, seen earlier, is only distantly related. Many colonies of *Rumphella* are inhabited by a group of small snails (scene 3143) that eat away the brown outer covering of the coral.

**0746 Digitate Leather Coral**

There are a number of species of leather corals in the Pacific. They lack hard skeletons and tend to be soft or leathery to the touch. It is often difficult to distinguish different species just from appearance. This species of *Sinularia* is waving gently in the surge.

**0750 Lobed Leather Coral**

Another common species of leather coral is *Lobophyton*. This is the typical food source of the Egg Shell (*Ovula ovum*, scene 3146).

**0753 Leather Coral**

Another leather coral that may be *Sinularia* or *Lobophyton* grows on a shallow reef as striped wrasses and damsels swim by above it. Its softer, more flaccid texture suggests it is *Sinularia*.

**0756 Mushroom Leather Coral**

This wavy leather coral *Sarcophyton* is often preyed upon by a snail, the warty egg shell (*Calpurnus verrucosus*, scene 3140), which hides under the ruffled edges of the coral during the day. Here, a group of colonies cover a rounded rock. Most have their coral polyps retracted and appear smooth; on others, the polyps are extended.

**0800 Mushroom Leather Coral**

This is probably a small colony of *Sarcophyton*. Each of the “flower” bearing stalks is a coral polyp with its own eight tentacles surrounding a central mouth. The individual polyps connect to the rest of the colony through their bases.

**0803 Mushroom Leather Coral**

**2 scenes**

These two scenes show colonies of *Sarcophyton*. The first is a side view against blue water. In the second, three colonies grow on a rock in the sunlight.

**0808 Grasping Soft Coral**

**3 scenes**

*Xenia* is one of the most active soft corals. Except when disturbed, its polyps continually grasp at the water, presumably randomly capturing planktonic prey. Sometimes, as in the second scene, movements in the surrounding water mask the continual grasping of the polyps. In the third scene, a disturbed colony stops grasping and folds its polyps into fists. As suggested earlier in this booklet, one of the ways to tell a soft coral from other coral groups is by the polyps. Soft corals, including gorgonians and leather corals already seen, possess polyps with eight pinnate tentacles; that is, eight tentacles that bear small branches along their lengths. In most soft corals, you have to look pretty close to see even the tentacles, and even closer to see the smaller branches. In *Xenia*, however, the polyps are large and the pinnate tentacles easy to see. There are several nudibranchs that eat this soft coral, and they all bear tentacles that resemble the coral's polyps.

**0820 Orange Soft Coral****2 scenes**

The soft coral *Minabea aldersladei* extends its long tentacled polyps only at night. It retracts into a small orange blob during the day.

**0827 Soft Coral**

This fan-like soft coral is probably a species of *Chironophthya*. It seems to prefer steep slopes with swift currents.

**0830 Tree Soft Coral****11 scenes**

The tree soft coral called *Dendronephthya* comes in a variety of colors and forms. It is likely that several different species are represented in the next 11 scenes. Many species live in caves and ledges, but many others prefer walls with some current flow, from which they can filter their planktonic food. Tree soft corals are a far more conspicuous element of the shallow water benthic fauna in the high islands of the west and west-central Pacific than in the low atolls of the Marshalls.

**0910 Title: Jellyfish and Hydrocorals**

The taxonomic group that constitutes the corals, called Cnidaria, is divided into three subgroups based on the anatomy of the animals. One of these subgroups contains most of the hard corals, soft corals, anemones, and black corals. One of the others is made primarily of jellyfish. The third contains some jellyfish, the hydroids (or stinging feathers), and some kinds of hard corals. The next few scenes start off showing some of the true jellyfish, then a couple of feathery hydroids, and finally the hard fire and "precious" corals that make up the hydrocorals.

**0913 Jellyfish****2 scenes**

*Crambione mastigophora* is one of the larger jellyfish seen in the Marshalls. It is generally observed drifting around the lagoons in groups, sometimes large groups that seem to extend for miles and contain many thousands of jellyfish. This species is reported to have a pretty powerful sting, so keep your bare skin away from its trailing tentacles, visible in the second scene as the animal turns around.

**0923 Jellyfish**

This unidentified jellyfish is slightly damaged around the margin of its bell. Jellies are sometimes eaten by sea turtles and by some fish, such as the large leatherjacket file fish *Aluterus scriptus*, when they venture too close to reefs.

**0926 Crowned Jellyfish**

Although the jellyfish *Cephea cephea* typically lives far out to sea, sometimes they drift across the reefs. This one has had some damage to its bell.

**0929 Spotted Jellyfish**

*Mastigias papua* occasionally shows up in the Marshalls. We've observed the leatherjacket file fish leaving the reef to swim up and eat these as they drift by.

**0933 Hydroids****2 scenes**

There are a number of different kinds of these stinging feathers in the Marshalls. Some cover rocky surfaces out in the open as in the first scene, while others tend to live in shaded ledges or caves. They are also common on pier pilings or on shipwrecks. Many species contain relatively potent nematocysts (stinging cells) that can irritate human skin.

**0940 Fire Coral****3 scenes**

Although they form a calcium carbonate skeleton similar to stony corals, fire corals (*Millepora*) are anatomically more closely related to the hydroids. Like hydroids, and as their common name implies, fire corals possess powerful nematocysts that cause burning stings on skin that happens to rub up against it. These three scenes show three different growth forms of what may be the same species of fire coral.

**0950 Pink Coral****6 scenes**

Related to the fire corals are the pink corals in the genus *Styaster*. The nematocysts in pink corals, however, are very mild and are not capable of perceptibly stinging humans. The mostly delicate pink corals tend to live in overhangs and small caves, and range from very shallow to very deep water. There are a number of different growth forms or species, several of which are illustrated in these six scenes. Despite the common name, some *Styasters* are not pink at all but pure snow white.

**1009 Purple Coral****3 scenes**

Purple coral, shown in the first scene with some pink *Styaster*, is one of several different species or color forms of the genus *Distichopora* found in the Marshalls. All of the color forms grow in fan shaped colonies and have white-tipped branches. Distributions of the different color forms are sporadic. In the southern part of Kwajalein atoll, only the purple color form is found, and it is common in shallow ledges and caves on seaward and lagoon pinnacle reefs. In the second scene, a colony grows next to some encrusting red sponge at the base of a colony of fire coral. In the third scene, the purple is subdued, almost blending toward the yellow of the color form shown in the next few scenes.

**1019 Yellow Coral****3 scenes**

These three scenes show the bright yellow form or species of *Distichopora*. This form is abundant in the northern half of Kwajalein atoll, but is not found at all near the southern end. It seems to become more orange near the western tip of the atoll. A similar form, even more orange in color, is common at Enewetak atoll, northwest of Kwajalein. The bright yellow form also inhabits seaward and pinnacle reefs, and is more likely to be found growing exposed on the rocks than is the purple form shown previously. In the first scene, one yellow and several black crinoids or feather stars perch atop the yellow coral colonies.

**1029 Red Coral****3 scenes**

Yet another form or species of *Distichopora* is bright red. The red form is not present at Kwajalein, but is abundant along parts of the seaward reef of Namu atoll, south of Kwajalein, as well as at Enewetak atoll to the northwest. It forms the largest colonies of the three colors, and is often found growing exposed in the open.

## 1039 Title: Sponges

Sponges are usually considered among the simplest of multicellular animals. Most are sessile, meaning that they live firmly attached to the bottom and do not move around under their own power. While it's true they lack many of the specialized organ systems present in more highly developed animal groups, sponges are highly successful, living throughout the world's oceans and to some extent in fresh water as well. To be so successful, they've had to evolve solutions to the problems of a sessile existence, two of the most notable being how to catch your food and how to avoid becoming food for someone else.

Sponges are filter feeders; they suck water into usually multiple openings through the colony wall, extract from it the plankton upon which they feed, and pump the filtered water back out through one or more other openings. The sponge cells lining the walls of these openings are equipped with small tentacles called flagellae, which all beat in the same direction to set up and maintain the plankton-carrying water currents through the colony.

Sponges range from large globular or elongate massive colonies to thin sheets of cells encrusting rocky surfaces to species that bore into coral reef rock. They can be firm bodied or very soft. The colony can be given support by a network of protein fibers or by various kinds of hard skeletal elements called spicules. The kind of skeletal material is one of the characteristics used to divide sponges into three main groups. One group has a skeleton of protein fibers or small siliceous spicules or both. This is by far the most abundant group. The ones with only the fibers and no spicules are the ones used by people as cleaning sponges—it's important to get the right ones, since washing your skin with a sponge full of sharp spicules would not be pleasant. Another group has a skeleton of spicules made of calcium carbonate; these sponges are usually somewhat firm bodied and have a brittle texture. The third has siliceous spicules with six rays; these tend to live in deep water and are rarely seen by divers.

Many sponges can be variable in coloration, size, or shape. One of the characters often used to distinguish between different species is the morphology of the hard spicules. Consequently, it is often difficult to positively identify different species of sponges until you dissolve away the flesh and expose the skeleton, which then has to be examined under a microscope. The sponges shown in this video are tentatively identified with names drawn largely from several books of color photographs now available. See the references at the end of this book for details.

The spicules probably function in defense against predators as well as in providing structural support for the colony. While some animals can prey upon sponges, for most the mouthful of sharp spicules is probably an effective deterrent. But some sponges have a potentially even more effective defense. Many produce toxic organic compounds that render them quite unpalatable—often downright poisonous—to predators. These organic compounds have drawn the interest of researchers who are studying the chemistry of sponges in hopes of finding new drugs for, for example, the treatment of cancer or AIDS.

While most sponges are not harmful to divers (as long as you don't try to eat them!), there are a few that can produce burning stings similar to fire coral. Others, because of their sharp spicules, can irritate bare skin that comes in contact with them. One of the biggest dangers might be to your home aquarium. Sponges are NOT recommended for most aquariums. They tend to not do well in closed systems, usually dying fairly quickly and often releasing various toxins into the water, which then proceed to kill everything else you have in your tank. If you bring in fresh rocks from the reef for your fish tank, avoid those that bear sponges (for example, patches of colorful encrustations).

## 1042 Blue Vase Sponge

One of them most easily recognized sponges in the Marshalls, *Cribochalina olemda* is common on lagoon reefs, usually attaining its largest sizes on deeper reefs or shipwrecks. Water being filtered for food is drawn in through innumerable tiny openings all over the outside of the colony and expelled through a large tube-like opening in the top. Here, three tubes are fused along their edges, forming a compound vase. The sponge is growing up against a colony of *Porites* coral, and numerous fish, including damselfish and squirrelfish, mill around.

## 1045 Cup Sponge

2 scenes

This soft, thin, cup-like sponge in the genus *Kallypidion* grows out in the open. In the first scene, a goatfish (*Parupeneus multifasciatus*) swims over the top. In the second, the sponge grows from a colony of *Porites* coral. Some *Chromis* damselfish swim around the coral at the base of the sponge.

## 1051 Yellow Sphere Sponge

This round yellowish massive sponge is found sporadically on lagoon pinnacles. The colony measures about 300mm in maximum width.

## 1054 Brown Calcareous Sponge

This reddish brown sponge grows in ledges in lagoon areas and has calcareous spicules, giving the sponge a hard, stiff texture. Damselfish live around the sponge colony and a small group of cardinalfish swims by.

## 1057 Walking Sponge

These small spherical sponges live on the undersurfaces of rocks. They can slowly move around by extending their tendrils and pulling themselves along.

## 1100 Blue-gray Sponge

This sponge, probably a *Haliclona*, forms small colonies along rock walls.

## 1103 Purple Sponge

This thin, purple, encrusting sponge known as *Nara nematifera* grows over the surfaces of dead coral in still lagoon habitats. Here it covers a rock nestled within a colony of the sea anemone *Entactmaea quadricolor*.

## 1106 Red Sponge

This is a thin sponge named *Clathria mima* that encrusts the surfaces or undersurfaces of rocks. The distinct channels visible funnel filtered water out of the colony.

## 1109 Encrusting Sponges

Several species of thin, colored sponges encrust a shadowed rock wall.

### 1112 Encrusting Blue Sponge

This thin, blue-gray encrusting sponge grows over a coral colony, covering the dead coral skeleton with a thin blue crust, but not obscuring its shape. We suspect that the sponge grows only over that portion of the coral colony that has died from other causes; however, it is conceivable that the sponge growth itself is choking out the coral.

### 1118 Title: Flatworms

The term “worm” is used for a lot of very different animals. To illustrate, a bit of taxonomic background is necessary.

Scientists (who always need to categorize things) divide life on earth into Kingdoms. There are two big ones: Plant and Animal. Aside from viruses, bacteria, and a few single-celled creatures, anything you might think of as “animals” are in the Animal Kingdom. The kingdom is subdivided into a score or more of major animal groupings called Phyla (singular phylum), which are further subdivided several times until you get down to separate animal species.

Phyla separate groups of animals that differ considerably in their body structure, development, and evolutionary history, but species that share a single phylum can be quite diverse in appearance. For example, all the corals we’ve seen so far—the stony corals, soft corals, gorgonians, anemones, black corals, jellyfish, hydrocorals—all of these are part of a single phylum called Cnidaria. All of the mollusks—seashells, nudibranchs, clams, and octopus and squid—are all part of a single phylum called Mollusca. Even all the vertebrates (animals with backbones)—you, me, all other mammals, reptiles, amphibians, birds, and fish—belong to a single phylum, the Cordata. Not only that, we vertebrates share our phylum with as unlikely looking a group of animals as the tunicates, seen later in this tape.

Yet, things that we call “worms” belong to a half dozen or more different phyla. Some of these worms—the flatworms, roundworms, segmented worms, acorn worms, etc.—are very different in morphology and in evolutionary history. But they’re all kind of “worm-like” so we tend to refer to them all as worms.

We’re starting off with the simplest of the worms, the flatworms. You’ll see some other kinds of worms later.

Many flatworms, such as tapeworms and flukes, are parasitic animals and not shown in this video. But there are quite a few frequently colorful free living species that inhabit coral reefs.

Flatworms are among the simplest non-sessile animals. Their bodies are extremely flat, only a few cells thick. They completely lack any sort of specialized respiratory or circulatory systems; that is, they have no gills, lungs, or blood vessels. That’s one reason they’re so flat. With no gills to acquire oxygen, an element necessary for metabolism, and no blood vessels to move it around, all the cells in the body have to be close enough to the surface to pick up their oxygen simply by diffusion from the surrounding sea water.

Also, in typical flatworms, there is only one opening into the digestive system. All undigestible wastes have to come out the same way they go in—through the mouth.

In our look at the flatworms, we’re actually covering two phyla of worms: the true flatworms and the ribbon worms. The latter are anatomically somewhat similar to flatworms, but tend to be much more elongate and have a flow-through digestive system; the wastes have a rear end to go out through instead of having to come back out through the mouth. The last two scenes in this group depict species of ribbon worms.

### 1122 Flatworm

*Pseudoceros dimidiatus*, with its orange margin and yellow markings on black, is an easy species to recognize. This scene was shot at night. A planktonic shrimp, attracted to the camera’s lights, runs into the front end of the flatworm, causing it to momentarily draw back. It is sometimes difficult to tell which is the “front end” of a flatworm. Many species have a pair of folds in their margin at the very front; these folds are probably more sensitive to touch and used by the animal to feel its way along. Looking even closer at some flatworms (although not visible in this scene), you might see a cluster of dark dots—light sensitive cells (it seems hard to call them “eyes”) that detect the presence or absence of light.

### 1127 Orange Margin Flatworm

A small hermit crab runs into the side of this large, ruffle-edged flatworm.

### 1131 Banded Flatworm

*Pseudobiceros gratus* is a common species usually found under rocks in the daytime. The green things the flatworm is crawling over are colonial tunicates. We’ll discuss tunicates later, but we’ll see them in quite a few scenes in this video, since colonial tunicates commonly encrust the undersurfaces of rocks.

### 1135 Bedford’s Flatworm

*Pseudobiceros bedfordi* can occasionally be found crawling in the open during the day.

### 1138 Spotted Flatworm

Although not common, this flatworm (a species of *Acoela*) can occasionally be found living in the darkness beneath chunks of dead coral. Most flatworms hide during the day, but a few can be found active and exposed in daylight. This one flows almost like a liquid as it crawls along.

### 1142 Spotted Flatworm

This species of *Pseudoceros* flatworm is most often found under dead coral rocks in shallow water. Although simply the inverse in coloration from the previous species, they are not closely related. The margins ruffle vigorously around small obstacles as this animal crawls across the rock.

### 1146 Flatworm

Flatworms in this group come in a large variety of colors. This speckled species is here crawling over an orange encrusting sponge sculpted with large channels for drawing in water.

### 1150 Flatworm

**2 scenes**

This flatworm (*Maiacoon orsaki*) like a number of other species, is capable of swimming through the water by undulating its lateral margins.

**1158 Swimming Flatworm****2 scenes**

Some flatworms, such as this *Pseudoceros fulgor*, can cover considerable ground by swimming. This species swam many meters over 5 to 10 minutes while being photographed. In the first scene, it undulates low over *Porites* coral; in the second, it paddles itself upward into the water column.

**1205 Yellow-spotted Flatworm**

Members of a group of related flatworms bear warts over the dorsal surface. Many of these are in the genus *Thysanozoon*. This striking species, *T. nigropapillosum*, has black warts tipped with yellow.

**1209 Warty Flatworms****2 scenes**

These two scenes show other species of *Thysanozoon*. These species are usually hidden beneath rocks during the day. On the red species in the first scene, you can see the cluster of black eyespots at the base of the anterior folds in the margin (right side of the animal).

**1217 Flatworm**

This large species of *Acanthozoon* can often be found out crawling in the open during the day.

**1221 Flatworm**

This fast moving species (possibly *Aquaplana pacifica*?) eats a variety of invertebrates, including small mollusks.

**1225 Flatworm**

This colorful specimen of *Pseudoceros fulgor* is resting on orange sponge on the underside of a rock. Note the tiny crustaceans that resemble black spots moving around on the sponge.

**1229 Flatworm**

The same species of *Pseudoceros* as in the previous scene. These two individuals are reared upon their “tails” and appear to be engaged in a battle. In fact, they are mating. Flatworms are hermaphrodites; that is, each individual is both a male and a female, so in this scene each of them is trying to fertilize the other. However, another anatomical feature these primitive worms lack is a female reproductive opening. They mate by essentially spearing one another with their male organs, leaving embedded in the body a portion of the male reproductive system containing sperm, which make their way to the eggs in the female part of the reproductive system. If you look close, you can catch a glimpse of the paired “spears” extending from the underside of the worms’ bodies.

**1237 Ribbon Worms****2 scenes**

These two scenes show two of the species of ribbon worms or nemertineans. The first scene shows a dark colored *Notospemus tricuspoidatus*; the second shows what is probably *Baseodiscus delineatus*. We’re only seeing the anterior portion of each of these individuals. Nemertineans, like flatworms, possess a very primitive and simple body morphology. They differ from flatworms in their generally much more elongate bodies, sometimes a meter or more in length. More importantly, the nemertineans are the most primitive animals that possess a “flow-through” digestive system. Food is taken in through the mouth, but leaves the body through a separate opening, the anus—quite a significant evolutionary development.

We’re going to skip several phyla of animals that are somewhat intermediate in complexity between the simple coral, sponges, and flatworms and the two lines of “higher” invertebrates we’re going to start showing next. These intermediate phyla, including groups such as the nematode worms and the rotifers, consist of very tiny animals that you’d want to look at with a microscope. Their small size does not make them unimportant; some of these animals live just about anywhere—and in large numbers. I remember reading somewhere that there could be many thousands of nematodes, for example, in a single rotting apple. But they’re too tiny to be easy to videotape, so we’ll jump over these groups and into the higher invertebrates.

Biologists often draw a tree-like structure to illustrate the relationships between animal groups. Although sometimes an oversimplification, such trees are useful for representing the evolutionary relationships between animals. Overgeneralizing somewhat, animals seem to follow a single evolutionary line from the simple sponges near the bottom through the flatworms, nemertineans, and intermediate groups mentioned in the previous paragraph. At this point, however, the tree branches into two major lines distinguished primarily by a few important differences in the way adult animals develop from eggs. One of these branches leads to most of the worms, the crustaceans, and the mollusks. The other goes to the echinoderms, tunicates, and vertebrates, including all fish, amphibians, reptiles, birds, and mammals. We’ll start off with the echinoderm branch.

**1245 Title: Sea Urchins**

Sea urchins are one of the five different classes of animals that make up the phylum of echinoderms. The echinoderms are a diverse group, consisting of urchins, sea stars, feather stars, and sea cucumbers—animals that at first glance are not clearly related to one another. They do, however, share important developmental and anatomical characteristics that prove them to belong to the same phylum.

Most sea urchins are pretty easy to recognize. They tend to have more or less rounded bodies and are covered with spines. That being said, there is actually quite a lot of variation in this pattern. We’ll see some of this variation in the scenes that follow.

Sea urchins are important components of coral reefs in the tropics. Most species are grazers, using a complex, bony tooth structure called Aristotle’s Lantern to scrap algae from rocks. In the process they erode down the calcium carbonate substrate, producing fine sand from what appears to be hard rock. This process, a form of bioerosion (that is, life processes wearing away the reef), is one of the destructive forces continually operating on coral reefs.

Urchins can be an important component of temperate and cooler shores as well. Species in California, for example, eat away the holdfasts of giant kelp plants, causing the plants to lose their connection to the bottom and float away.

**1248 Long-spined Urchin**

*Diadema savignyi* bears long, sharp spines that easily penetrate human skin, then break off in the wound. These spines are often equipped with numerous minute barbs, making a broken-off spine difficult-to-extract from a wound. Sometimes the only way to remove the spines is by surgery, or by soaking the injury in a mild acid such as vinegar for several hours. Some species are

venomous, and injuries are painful and susceptible to infection. This species lives under rocks and in holes during the day, coming out at night to graze on algae.

### 1252 Sea Urchin

### 3 scenes

All three of these scenes show different color forms of *Echinothrix calamaris*. Urchins in this genus are deceptive. The long spines appear blunt and non-threatening. Look closer, however, at the finer, short, sharp spines between the longer blunt ones. Needle sharp, these spines easily penetrate human skin and cause painful wounds. Yet, certain fish, such as large trigger fish, consider these urchins very tasty. A trigger fish may spend several minutes biting off the spines until it gets them short enough that it can safely eat the entire urchin. I've seen triggers and some wrasses hurry the process, munching down an urchin spines and all, often leaving numerous spines embedded in their lips. You'd think that would hurt. The third scene is a close shot of the dorsal surface of the urchin, showing the blunt and sharp spines as well as a balloon-like structure called the anal bulb or anal sac. In sea urchins, the mouth is on the "bottom" of the animal, making it easy to scrap algae from the rocks it crawls across. Waste products come out through an opening on the top.

### 1304 Globular Urchin

The spines of this small urchin named *Mespilia globosa* are short and arranged in rows running down the sides of the body. Also visible here are numerous fine, waving tentacles. These tentacles possess small jaws called pedicellaria on the tips capable of nipping at anything that comes close. In most species, these jaws are too small to cause humans any harm. There are some species, however, that possess large and venomous jaws that can inflict a painful wound. Although present at Kwajalein, the venomous species are rare and not illustrated in this tape.

### 1308 Urchin

*Paraselenia gratioiosa* possesses sharp spines, but they are not brittle and do not easily break off. It can be handled safely as long as you do it carefully. Note the tentacles bearing pedicellaria are also present here.

### 1311 Pencil Urchin

Many urchin species, such as this *Eucidaris metularia*, bear only blunt spines. While they do not protect the urchin by their ability to puncture potential predators, they may be even more effective protection; since they are thick and strong, fish such as wrasses or triggers may have more trouble breaking them away to get at the animal inside. This small individual is moving across a small colonial tunicate, which closes its opening as the urchin poles its way across.

### 1315 Lumpy Spined Urchin

*Chondrocidaris gigantea* is much larger urchin than the previous species. Hiding in caves and holes during the day, it emerges at night to graze.

### 1319 Pencil Urchin

Like the last species, *Phyllacanthus imperialis* is nocturnally active. Here it crawls across some razor corals in its search for algae covered rock.

### 1323 Red Pencil Urchin

*Heterocentrotus mammillatus* is another of the pencil urchins. It uses its hard thick spines to wedge itself into holes in the reef and can be extremely difficult to dislodge. Such behavior keeps the animal from being rolled around by wave surges in its shallow water habitat.

### 1327 Sea Mouse

### 2 scenes

Also included in the sea urchin group are what are called the "irregular" urchins, including the sea mouse, heart urchin, and sand dollar. They typically live beneath the sand, emerging at night to graze on the surface or on nearby rocks. When exposed during the day, they immediately move their thin spines in a pattern that causes them to sink downward in the sand. The process may take a few minutes, but the animal completely disappears beneath the sand surface. This one may be *Maretia planulata*.

### 1336 Title: Brittle Star

The second group of echinoderms we'll examine is one of the two that make up the starfish. Brittle stars differ from sea stars in several ways. The brittles typically have a distinct central disk from which the arms extend; in sea stars, the line of demarcation between the central body and arms is not as distinct. Brittle stars also tend to move more rapidly, usually by flexing their long arms. Sea stars usually move more slowly, generally by dragging themselves around with their tube feet. Many species eat detritus or anything they run across on the bottom, but some are filter feeders on plankton.

### 1339 Brittle Star

This species, *Ophiolepis superba*, is relatively short armed and slow moving for a brittle star. Like many species, it lives beneath rocks and slowly crawls away when exposed to light.

### 1343 Brittle Stars

Different species of brittles may be found together under the same rock. These all appear to be species of *Ophiocoma*.

### 1346 Brittle Star

*Ophiarachnella gorgonia* runs away to escape the light when the rock it was hiding under was overturned.

### 1350 Brittle Star

Many species have spiny arms. In this one (*Ophiomastix variabilis?*), the spines are rather blunt.

### 1354 Brittle Star

Another brittle runs away to hide. Many fish would readily gulp down an exposed brittle star.

### 1358 Long-arm Brittle Star

This species, possibly a *Macrophiothrix*, is found under rocks in shallow water. It has extremely long arms. Brittle stars get their common name from their easily broken arms, but in this species, the arms are even more fragile than normal. It is difficult to capture one without losing parts of some or all of the arms.

### 1402 Spiny Brittle Star

About the only brittle stars that are commonly exposed on tropical coral reefs during the day are those that live with corals. Here, numerous long armed spiny brittle stars spread out among the branches of a gorgonian, where they compete with their host for planktonic food drifting by.

### 1405 Brittle Stars

In this scene, it is not easy to see individual brittle stars. There are several specimens, each with their long arms wrapped around and around branches of the red gorgonian. I'm sure it would be just about impossible to peel one away from its host without breaking it apart.

### 1409 Spiny Brittle Star

This spiny brittle (*Ophiothrix purpurea*) rests on a soft coral at night. Several of the coral-associated brittles are armed with very sharp spines that easily penetrate skin and cause quite painful wounds. I don't know if any kind of venom has ever been found associated with these spines, but the level of pain a spine wound produces convinces me that there must be some venom there somewhere.

### 1413 Basket Star

#### 3 scenes

One interesting member of the brittle star group is the basket star, *Astroboa nuda*. These animals have highly branched arms and a tangled mass of tentacles used to hold onto the coral substrate. They emerge from hiding at night, perch on top of rock outcrops or coralheads, and expand their curling tendrils out into the water column to capture drifting plankton. Often seen facing the current, they kind of resemble radar dishes up to nearly a meter in height. The third scene is a close up of the tangled tentacles at the base.

### 1426 Title: Sea Stars

Sea stars are a common component of many marine habitats, from tropical to temperate to even colder locales. There are even species living on the deep ocean floor. On tropical reefs, species are diverse and abundant, but often are hidden among the corals and are less prominent or easily observed as those in temperate areas. Sea stars are typically predators on such animals as bivalve mollusks or corals, but many species will also eat dead fish or anything else they can come across. Like other echinoderms, they use water pressure and a hydraulic system for mobility. Water is drawn into a water-vascular system (a system of water tubes and vesicles within the body), and pressure on these vesicles extends or retracts tube feet, which are used to pull the star across the substrate.

### 1429 Crown-of-Thorns Starfish

#### 2 scenes

Probably the most famous—or infamous—of the tropical sea stars is the crown-of-thorns, *Acanthaster planci*. This armored beast is a voracious predator on living corals. It eats these corals by crawling over a helpless coral colony and everting its stomach completely out of its mouth, covering part or all of the colony. Digestive enzymes from the stomach dissolve the soft coral tissue, which is then absorbed by the stomach wall. When the star is done, it leaves behind a pure white, empty coral skeleton from which the animal has been completely digested. Occasionally, numbers of these stars increase to the point where much of the coral on a reef is killed. In some places, groups of divers have organized programs to try to kill off the crown-of-thorns before populations get out of control. Whether or not such programs work, or even are advisable, is uncertain. It is possible that molesting the stars could simply cause them to reproduce sooner, thereby increasing the population. Besides, handling the stars is not especially safe. The sharp spines that cover the body are venomous; the venom not only causes pain, but also contains a substance that inhibits blood coagulation, causing even small puncture wounds to bleed for quite a long time. The first scene here shows a crown-of-thorns on live coral with several white, already eaten coral skeletons nearby. The second is a close up of the end of one of the arms, with tube feet reaching out as the star crawls along.

### 1437 Cushion Star

#### 7 scenes

The cushion star, *Culcita novaeguineae*, is an odd starfish. The arms and the central body are essentially one. Only by looking at the underside, where five lines mark the openings from which extend the tube feet, can one truly recognize this as a five-armed star. Although all the variably colored individuals in this set of scenes is generally considered to belong to one species, there is some evidence that there are in fact two similar but different species. Specimens found on most reefs and generally throughout the atoll are rough in texture, covered with mostly rounded but sometimes sharp close set bumps. Specimens found in the *Halimeda* algae lagoon slopes are smoother with a velvety feel and slightly raised patches over the dorsum. In this set of scenes, the first two individuals show the bumpy reef variety. In the first scene, the cushion is eating a soft coral growing on a reef outcrop. In the second, a small black and white damselfish (*Chromis margaritifer*) swims in front of the star. The remaining five scenes show the velvety algae patch dweller. These individuals that live in algae patches seem to prey mostly upon small razor corals in the genus *Cycloseris* and *Diaseris* (scene 0216).

### 1458 Cushion Star (Sheriff's Badge)

Young cushion stars are pentagon-shaped and are sometimes referred to as sheriff's badges. Juveniles such as this one tend to hide beneath rocks; this one is on red encrusting sponge.

### 1501 Granulated Star

*Choriaster granulatus* is a medium sized star common in the west central Pacific, but less common eastward. These two were filmed at Kwajalein Atoll, and are the only ones we've ever seen there.

### 1505 Sea Star

*Asteropsis carnifera* usually inhabits small caves or lives under rocks during the day. Here it is crawling over a black colonial tunicate as it tries to get out of the daylight.

**1510 Red Velvet Star**

The red velvet Star *Leiaster* has a smooth, velvety feel to it. It hides during the day, emerging onto lagoon pinnacle and seaward reefs at night.

**1512 Spotted Sea Star**

One of the most abundant stars is *Linckia multiflora*. It is found in ledges, under rocks, and exposed on the substrate. In the Marshalls, it seems to be the favorite food of the harlequin shrimp (scene 2517).

**1515 Sea Star**

*Thromidia catalai* is a large star found rarely in ledges and small caves on the seaward reef.

**1518 Sea Star****2 scenes**

This large star, *Mithrodia clavigera*, is shown here crawling across *Halimeda* algae. The second scene is a closer shot of two of its spiked arms.

**1524 Sea Star**

The spikes on the arms of this star, *Gomophia egyptica*, are pointy and sharp. The species is usually found hiding beneath rocks during the day.

**1527 Sea Star**

This small spike-armed species is on a greenish colonial tunicate on the underside of a rock.

**1530 Sea Star**

This sea star, *Neoferdina cumingi*, is crawling up the wall of a small ledge with hydroids at upper left.

**1532 Sea Star**

The common sea star *Fromia milleporella* ranges from bright to dark red but usually bears the small black spots. Here it crawls across colonial tunicates on the undersurface of an overturned rock.

**1535 Sea Star**

This star, most likely a species of *Fromia*, rests on a single dead polyp of stalk coral surrounded by living polyps.

**1538 Sea Star**

This sea star crawls along the wall of a cave near tube corals at night.

**1541 Sea Star**

Here, a sea star named *Fromia nodosa* rests on orange sponge in a small cave during the day.

**1544 Barf Star****2 scenes**

An odd-looking star, *Echinaster callosus* is usually observed on the oceanside slope at night, often back in small ledges and caves.

**1552 Title: Sea Cucumbers**

Even though they don't look much like sea urchins or sea stars, sea cucumbers are related by also belonging to the echinoderm phylum. The similarities are mostly evident in the way sea cucumbers develop and in their internal anatomy.

Most species of sea cucumbers filter sand. They take it in one end, run it through their gut where anything edible is digested out, and deposit packages of mucus and sand out the other end.

Sea cucumbers often have other animals living along with them. A small fish or a pair of crabs may live inside the mouth or the anus of some cucumbers. Certain kinds of worms or seashells may live on the outside of the body, some of them acting as parasites on the cucumber itself.

**1554 Eyed Sea Cucumber****2 scenes**

One of the more strikingly patterned sea cucumbers is *Bohadscia argus*, the eyed cucumber. At Kwajalein, it seems to be more common on lagoon pinnacles in the middle to northern atoll.

**1604 Wrinkled Sea Cucumber**

The wrinkled cucumber *Holothuria fuscopunctata* lives on lagoon sand flats in relatively shallow water. Here, one blows water out of its rear end on the right side. Another individual can be seen in the background. Between them are a few garden eels protruding from their burrows in the sand.

**1607 Sea Cucumber**

This sea cucumber buries itself in the sand during the day, emerging to roam the surface at night. Many sea cucumbers when disturbed will eject a tangled mass of tentacles from one end. These tentacles, called Cuvierian organs, are extremely sticky. If you get some on your skin, you'll have a hard time getting it off. This is just one of the defensive tactics employed by sea cucumbers. Some species will eviscerate; they expel their internal organs when attacked by a predator, hoping the predator will be satisfied eating them while the cucumber gets away. You'd think this would be a pretty drastic technique—how could the animal live without its internal organs? But like the sea stars, cucumbers are very good at regenerating; they simply grow a new set. Another defense seen in a few species is to shed their skin, leaving a predator to eat a tough chunk of hide while the now naked cucumber gets away. Again, they can readily regrow their skin.

**1610 Red-Lined Sea Cucumber**

*Thelenota rubrilineata* is more common on the oceanside slopes at depths exceeding 100 feet. At this depth, its bright red color is not evident; you need artificial light to see its fine network of bright red lines.

**1615 Sea Cucumber**

This is a juvenile, probably of one of the large rectangular or lumpy species of *Thelenota* (either *T. anax* or *T. ananas*).

### 1618 Godeffroy's Sea Cucumber

This is *Euapta godeffroyi*, one of a group of odd sea cucumbers. Very long and snakelike, they are very soft, as if they were little more than water-filled plastic bags. Their thin skin is filled with small, hook shaped spicules that make their bodies feel slightly sticky. They feed by continually grasping with several feeding tentacles and drawing anything caught into the mouth, as shown in the next scene of a different but related species.

### 1621 Sea Cucumber

In a close view, the feeding tentacles of the sea cucumber *Synapta maculata* appear effective for capturing the small plankton-sized animals upon which these sea cucumbers feed.

### 1627 Title: Feather Stars

Feather stars, or crinoids, come from an ancient group of marine animals. According to the fossil record, hundreds of million years ago crinoids were an abundant and diverse group in the oceans. Most of these are now extinct, but the species that are left are still often a common component of coral reefs.

Several of the common species are active during the day, but several others come out only at night. The nocturnal species seem to be the most abundant; in some areas dozens may emerge from a single coralhead. Day or night, they typically crawl to the tops of coralheads or gorgonians and extend their many branching arms out into the passing current, from which they pluck drifting plankton. Most of those in this show were filmed during the day.

Several of the species are somewhat variable in coloration, and are sometimes difficult to tell apart.

### 1630 Schlegel's Feather Star

2 scenes

In the first scene, this individual *Comanthus schlegeli* is perched upon a coralhead for feeding, and, along with the coral, is also providing a refuge for a school of small damselfish. In the second, another individual hangs down from the ceiling of a small cave.

### 1635 Schlegel's Feather Star

Although the same species as the previous two, this one is colored more in black and white. It is hanging down from some pink and yellow hydrocorals.

### 1638 Orange Feather Star

2 scenes

Day or night, only the arms of this species (*Comaster gracilis?*) are generally seen. It often extends its long arms out from holes or ledges, or from behind plating corals such as in the first of these two segments.

### 1644 Feather Star

This Feather Star climbed up some red whip corals to find a better position for filter feeding.

### 1647 Feather Star

Gorgonians are a favorite perch for many crinoids, including this *Cenometra bella*, which has climbed up the side of the gorgonian away from the camera.

### 1650 Bennett's Feather Star

Even a small increase in height, such as this *Comanthus bennetti* perching on a small purple hydrocoral, can be useful for feeding success.

### 1652 Feather Star

Another feather star chooses a gorgonian as a perch. It sways in and out with the surge.

### 1655 Bennett's Feather Star

2 scenes

*Comanthus bennettii* comes in several color forms, the most striking of which is this pure yellow. The first scene shows one resting on top of a colony of the blue coral, *Heliopora*. In the second, a feather star perches on top of a fire coral colony in front of a small school of the plankton-feeding pyramid butterflyfish (*Chaetodon polylepis*), with a spotted eagle ray (*Aetobatis narinari*) passing by at lower left.

### 1703 Title: Tunicates

Tunicates are also often called sea squirts. Most adults are sessile, living firmly attached to a hard substrate and not moving throughout most of their lives. Some species grow as individuals, while others are colonial. The solitary ones generally have two openings in a bag-like body. Water is drawn into the bag through one of the openings. Inside, it is filtered and all planktonic food items removed, and the filtered water is then pumped out the other opening. Most tunicates, then, are basically just water filters.

Colonial species typically are composed of numerous fused tunicates. Each segment or individual in the colony generally has a single large excurrent opening but often with numerous tiny incurrent holes.

Surprising as it seems, tunicates are our nearest relatives among all the invertebrate animals we're covering in this tape. Although the adults are mostly sessile, the larvae are not. In fact, the larvae resemble minute fish, even to the point of having a structure somewhat analogous to a backbone, which is the defining characteristic of vertebrates; fishes, amphibians, reptiles, birds, and mammals are related in that all share the trait of having a backbone.

### 1706 Yellow Tunicate

By virtue of its bright yellow color, *Phalusia julinea* is one of the more easily recognized tunicates in the Marshalls.

### 1709 Translucent Tunicate

Usually living in the darkness beneath rocks, this tunicate's translucent body allows us to see some of its internal structure. It appears to be a species of *Ascidia*.

### 1712 Tunicate

This tunicate, a species of *Rhopalaea*, is growing on the shell of a giant clam, *Tridacna gigas*, in between lobes of the clam's mantle hanging over the edges of the shell.

### 1715 Orange Tunicate

This bright orange species is typically found on lagoon reefs. This one is attached among the polyps of stalk coral.

### 1718 Pink Colonial Tunicate

Many of the colonial tunicates live encrusted over the undersurfaces of rocks. In this pink species of *Didemnum*, a number of the larger excurrent openings are easily visible. The minute incurrent openings look like small dark spots.

### 1721 Purple Colonial Tunicate

This purple colonial tunicate also appears to be a species of *Didemnum*. Like the previous one, it lives on the undersides of rocks.

### 1724 Green Spot Tunicate

#### 2 scenes

Although not colonial in the sense of the previous two species, these tunicates tend to grow clustered, sometimes thickly, over rocks and dead coral on lagoon pinnacles. Named *Didemnum molle*, it is one of the more common tunicates in the tropical Pacific.

### 1730 Salp

One odd group of tunicate relatives are called salps. They are planktonic and, although quite variable in morphology between different species, typically appear as some sort of jelly string composed of repeating segments.

### 1736 Title: Worms

Worms form an extremely important part of the marine ecosystem. They live in sand, under and on rocks, among mats of algae, and even inside what appears to be solid reef. Many species live in symbiotic relationships with unrelated animals. They eat a wide variety of food items on the reef, and they themselves constitute a meal of choice for many other reef organisms.

Most of the worms we're going to be looking at here fall into the phylum Annelida, or segmented worms. Two scenes at the end of the worms belong to a related phylum, Echiura.

Among the segmented worms shown, some are wandering species, able to crawl around in search of food and mates. Others spend their entire lives in tubes, from which they extend specialized feeding structures to capture plankton.

### 1740 Long Brown Worm

This long, brown species of *Eunice* lives under rocks

### 1744 White Curling Worm

In its haste to get away, this worm apparently touches something it doesn't like, causing it to curl up in a ball.

### 1748 Bristle Worm

Many of the annelid worms possess clusters of sharp, pointed bristles along each side of their body. These shouldn't be handled. Sometimes these bristles can easily penetrate human skin; often they detach from the worm and remain in the wound. A common name for some of the bristle worms is "fireworm" for the pain their bristles can cause. This one appears to be a species of *Chloëia*

### 1752 Bristle Worm

#### 3 scenes

These three scenes show long bristle worms out moving around. The segmented nature of the body is easily seen in the second scene. The first two of these scenes show *Eurythoe complanata*; the animal in the third is unknown.

### 1806 Christmas Tree Tubeworm

#### 9 scenes

These pretty little worms come in a wide variety of colors and patterns. They live in holes (tubes) in live coral or rock, and extend their paired, spirally branching feathery gill structures, which function both for respiration and to capture drifting plankton. In the first two scenes, the worms are in the process of extending their gills out of their holes. Note the sharp spine defending the hole in the first scene; the worm creates that spine to help keep predators away. Sometimes, however, the spine breaks off, as in the second scene. The next four scenes show the gills of different worms, while the last three scenes show the worms retracting into their tubes at the first sign of potential danger. As you can see, they retract very quickly. The name given these animals is *Spirobranchus giganteus*. While they are not particularly gigantic, the generic name is appropriate, referring to the spirally arranged branchiae (meaning gills).

### 1843 Spaghetti Tubeworm

Like the previous species, these worms, *Loimia medusa*, live in tubes in the substrate. Usually these are in sandy or rubble habitats. Instead of a feeding crown of gills, these worms extend numerous sticky tentacles, colored white in this particular species, in all directions from their holes. Periodically, they draw the tentacles, to which potential bits of food or small organisms have stuck, into their mouths. Sometimes, the worms are quite sensitive, and a light touch on one of the tentacles will cause all the tentacles to be sucked in, like someone slurping a mouthful of spaghetti noodles.

### 1849 Echiuran Worm

Echiuran worms are not as obviously segmented as the annelids shown previously. They typically live under rocks or in holes and most species are not often seen.

### 1850 Bonellid Worm

The echiuran worm most often seen by divers is *Bonellia*. It too hides its body deep in a hole, but extends its long feeding tentacle out into the open. The tentacle is easy to recognize; it always branches in two at the very end. When disturbed, it will quickly draw back into its hole.

### 1856 Title: Hermit Crabs

Hermit crabs are the wandering vagabonds of the reef. Unlike most crabs, they have a soft abdomen and, unprotected, would fall easy prey to a large number of reef predators. They protect themselves by claiming squatter's rights in abandoned mollusk shells, which they lug around until the crab's body grows too large to properly fit. As a crab gets larger, it must look for a larger shell into which it can move—not an easy task, since most shells on the reef are already occupied, either by the mollusk that produced it or by another hermit crab, who is generally unwilling to give up occupancy when another crab comes along. Sometimes you can see crabs battling for possession of a particular shell.

### 1859 Giant Red Hermit

One of the larger species of hermits is this big hairy red one, *Dardanus megistos*. Large individuals need large shells; this one is in a broken specimen of a giant finger shell, *Lambis truncata*. Often hiding during the day, the red hermit emerges at night to wander the reef in search of food or mates.

### 1905 Anemone Hermit

The fast moving hermit *Dardanus gemmatus* has a large powerful claw. It uses the claw to break up the shells of mollusks to reach and eat the animal. The claws can also serve as an effective defense. Divers need to exercise care when handling these crabs; they can easily break the skin on the hands of a careless diver.

This crab forms a close knit symbiotic relationship with a couple of species of sea anemone, particularly *Calliactis polypus*. Individuals of this sea anemone are never found living alone. They always live attached to the shell inhabited by one of these hermits (or sometimes on shells of other, closely related, hermits). And in turn, these particular hermits are almost never found in shells that lack their external decoration of sea anemones. Far from being upset by having to carry around excess baggage, the crab welcomes these riders. In fact, when a crab changes to a larger or better shell, it takes the time to tickle the anemones in just the right way to cause them to release their hold on the old shell. The crab then carefully positions the anemones on its new shell until they adhere to it. What gives?

It turns out that this symbiotic relationship is beneficial to both crab and anemone. The stinging cells in the anemone's tentacles help protect the crab from being eaten by octopus. The rapid mobility of the hermit crab keeps the anemone from being eaten by crown-of-thorns and cushion starfish.

The anemones release pink threads called acontia when disturbed. Those shown here are obviously disturbed; their tangled pink threads trail the crab as he runs away.

### 1910 Hermit Crab

This hermit occupies a tapestry turban shell, *Turbo petholatus*.

### 1913 Hazlett's Hermit Crab

The shell here once belonged to the mollusk *Cantharus undosus*. The name of the new tenant is *Calcinus hazletti*.

### 1917 Hermit Crab

This pretty species of *Calcinus* with the red, black, and white banded legs is in a very long dead horn shell (*Cerithium*).

### 1920 Haig's Hermit Crabs

The two hermits here are both *Calcinus haigae*.

### 1924 Hermit Crab

This *Calcinus* is in a red triton shell, *Cymatium rubeculum*. The small greenish balls scattered about are tunicates (scene 1724).

### 1927 Hermit Crab

This appears to be a dark colored individual of *Dardanus lagopodes*. It is in an old dead frog shell, and is in the process of eating something and spitting out fragments.

### 1930 Minute Hermit Crab

This *Calcinus minutus* is busy grazing on the bottom. Many of these hermit crabs are grazers on anything that happens to be on the rock in front of them. You can often watch one picking stuff off the rock the way this one is and putting it into its mouth.

### 1933 Hermit Crabs

These specimens of *Dardanus* inhabit shells of the sand dwelling snail *Strombus gibberulus*. The shells are coated with symbiotic sea anemones, similar to those on the shell of the anemone hermit in scene 1905. One of these apparently punches the shell of the other with his claw, causing the other's shell to flip over.

### 1940 Hermit Crab

This small *Calcinus* is on a colony of the branch coral *Pocillopora*.

### 1943 Hermit Crab

A striped legged hermit inhabits a *Colubraria* shell.

### 1946 Hermit Crab

*Aniculus aniculus* is one of the more abundant large reef and shallow water hermit crabs in the Marshalls. This specimen is living in the spindle shell *Fusinus undatus*. While this sand dwelling seashell has never been found alive at Kwajalein (that is, occupied by its original mollusk inhabitant), empty shells are occasionally found carried around by these hermit crabs.

### 1949 Cone Shell Hermit Crab

One of the most strikingly colored hermits, this small *Ciliopagurus strigatus* has a very flattened body, making it one of the few hermits suited to occupy empty cone shells, which have long, narrow apertures. Here it carries a netted cone, *Conus retifer*.

### 1956 Blue Knee Hermit Crab

### 2 scenes

*Dardanus guttatus* grows rather large, allowing it to occasionally take large shells such as that of the giant finger shell, *Lambis truncata*. It also has a somewhat flattened body similar to that of the previous species, so it too can often fit into shells with narrow apertures, such as the tortoise cowry, *Cypraea testudinaria*, shown in the second scene.

### 2002 Hermit Crab

Studies suggest populations of hermit crabs are limited by the number of available shells. If a growing hermit cannot find a suitable home by the time he outgrows his previous one, he generally winds up as dinner for some predator. Some ingenious hermits will occasionally use something other than an empty mollusk shell; this one grabbed the shed-off portion of the end of a larger crab's claw. Hopefully he'll find something better by the time he gets too big for this substitute home. Other hermits have occasionally been found in small glass bottles.

### 2007 Yellow Eyed Anemone Hermit Crab

This yellow-eyed *Dardanus deformis* retracts quickly to escape the photographer. Like its cousin, the anemone hermit (scene 1905), this one usually carries sea anemones on its shell. Curiously, this relatively fresh frog shell lacks the symbiotic passengers.

### 2010 Title: Crabs

Crabs occupy a wide variety of habitats and niches on shallow coral reefs. Some live in sand, among clumps of algae, under rocks, or buried in rubble. Some live symbiotically (in close association with) certain corals, soft corals, gorgonians, anemones, sea cucumbers, urchins, or numerous other organisms. Different species eat many different things; for example, some eat algae or small invertebrates, some break open mollusk shells, and some capture planktonic prey with net-like appendages. The variety you can see among the crabs is tremendous; this section of the tape can barely do more than give you a hint of this incredible variety.

### 2013 Red Crab

These large red crabs (*Etisus dentatus*) live hidden away in holes during the day and emerge at night to feed. Its large pincers are not pointed at the ends like those of most crabs; these are flattened or even spoon-like. They have been observed carrying mollusk shells, which they may break open to eat the animal inside.

### 2017 Seven-Eleven Crab

### 2 scenes

*Carpilus maculatus* is a large nocturnal crab that gets its common and scientific names from the large round spots that decorate the carapace (the dorsal shell). The "seven-eleven" refers to the pattern of the spots; there are always seven large spots across the front and top of the carapace, and four more usually smaller ones toward the back. This species often eats the animals that inhabit seashells by first breaking up the shell with its powerful pincers. In the first of these two scenes, the crab is carrying off a shell of the netted cone, *Conus retifer*, that it plans to crack and devour when it escapes the light of the camera. In the second scene, the close up shows moving antennules between the eyes. Both scenes were shot at night, which is easily detected in the latter by the planktonic shrimp being attracted in to the video lights. We often refer to these swarming nocturnal shrimp as "sea fleas." Some nights, there are so many that if you stop moving, they swarm so thickly around your light that you're left in the dark.

### 2025 Redeye Crab

This small crab (*Carpilodes cinctimanus*) is occasionally found under rocks.

### 2027 Purple-eyed Crab

Many crabs prefer to hide during the day. When exposed in the open, as this one is, they immediately run for cover. Many predatory fish will greedily devour small crabs they find out in the open. Keep this in mind if you sometimes turn rocks over to look for shells underneath. There will be fish tagging along after you to try to slip in and grab crabs and other exposed creatures. Try to get the rocks turned back to their original positions as soon as possible.

### 2031 Orange-lined Crab

Another crab runs for cover when exposed during the day.

### 2035 King Kong Crab

This is probably a species of *Daldorfia*. The common name is derived not from the crab's resemblance to a giant ape, but rather its large pincers, covered with rounded bumps and projections, sort of look like heavily muscled arms, which it may wave up and outward in defiance when approached by a diver at night.

### 2038 Orange Crab

Look at the armor on this one; not only does it have vicious-looking pincers, they're equipped with sharp spines.

### 2042 Sponge Crab

Crabs in this family have a peculiar morphological trait that helps hide them from predators. The rear pair of legs operate in the opposite direction of the others. Instead of bending downward to walk on the bottom, those legs bend upward and are used to hold something, usually a clump of sponge, over the top of the crab. The sponge acts both as camouflage to hide the crab and as an active deterrent to predation, since most predators that would like to eat a crab would probably not like to eat a sponge. Many sponges are filled with toxic, unpalatable chemicals while others are loaded with sharp hard spicules; some sponges carry both. This crab, a species of *Dromia*, runs over live *Goniopora* coral to present its protective sponge toward the camera.

### 2048 Potato Chip Crab

The potato chip crab (*Aethra scruposa*) derives its name from its flattened shape, kind of visible here in a side view, resembling a thin curved potato chip. The sharp claws are strong and can be used to break up hard mollusk shells to get at the animals inside.

### 2052 Halimeda Crab

This crab (*Huena*) quite closely resembles the flake-like *Halimeda* algae among which it always lives. In addition to resembling the flakes of algae, it often waves back and forth like a loose piece of algae swaying in the surge.

### 2059 Red-Spotted Guard Crab

These crabs (*Trapezia tigrina*) are always found between the branches of live corals, usually those in the *Pocillopora* family. In addition to using the coral as protection against most predators, they may help provide much the same function to corals. If you place your bare hand over a small colony of live *Pocillopora* coral, the crabs will likely come out and pinch your flesh. (This may not be a good idea in most cases; some scientists believe even minor abrasions of live coral tissue may be detrimental to coral health and growth.) In this scene, you can see the coral's polyps, the small brownish circles scattered around and on the bumps of coral skeleton.

### 2103 Pom Pom Crab

The pom pom crab (*Lybia tessellata*) derives its common name from the pom poms it always carries in its pincers. These pom poms are actually juvenile sea anemones of the species *Triactis producta*. Somehow, the crabs are able to always acquire two of these little anemones (you never see them without their pom poms), and can always get more when the anemones grow too large and have to be dropped. Why do they do this? Remember, anemones have stinging cells. Presumably, if approached by a predatory

fish, the crab could use its pom pom boxing gloves to punch the fish in the lips, and the stings of the anemone tentacles may startle it away. The red on the underside of the crab is a clutch of eggs. Many female crustaceans carry their egg masses underneath their abdomen this way. When they are ready for hatching, the mother will often break up the mass with her legs to facilitate escape of the free-swimming, planktonic larvae.

### **2109 Orange Box Crab** **4 scenes**

Crabs in this genus, such as this *Calappa calappa*, are generally called box crabs. Keeping up with modern culture, however, suggests we should change the common name of this species to the “Darth Vader crab.” The carapace and large pincers held flat against the “face” makes one think of the evil jedi’s helmet. Box crabs are among the most interesting and amusing of all the crabs. Usually living buried in sand, you can catch them out wandering around at night in search of live mollusks, whose shells they can tear apart with their strong, cutting pincers. In the first scene, the crab seems to wink its right eye at the camera. The second shot provides a clear view of the pincers held up against the front of the body. In the third, the crab gallops across sand to escape the photographer. But the real method of escape is shown in the fourth scene; digging with legs hidden beneath the carapace and his big flat pincers, the crab simply sinks into the sand.

### **2133 Spotted Box Crab** **2 scenes**

Scientists believe this crab is the same species as the orange one shown previously, even though the two are colored quite differently. It buries itself the same way, giving a final puff of sand out from its mouth area as the only indication that something is buried here.

### **2143 Box Crab**

This lumpy box crab (*Calappa gallus*) is related to the previous ones, but has a bumpy carapace. It can bury the same way. Its dancing orange legs in this scene are apparently testing the bottom to make sure it is a suitable spot for sinking into the sand.

### **2149 Swimming Crab**

There are many species of swimming crabs. They are characterized by rear appendages that are flattened into paddles that can be used for rapidly swimming through the water. In order to swim, they have to be fast, so most species of swimming crabs can race across the bottom quickly as well. Sensitive to light, they usually do not let divers too close at night; this one remained steady for a few seconds since it was in the act of mating. If you look very closely, underneath this specimen of *Charybdis* you can see parts of another crab in the darkness.

### **2152 Swimming Crab**

The subdued coloration and spiny shell of this crab suggest it might be a juvenile specimen. It was small and camouflaged on the bottom at night. Right after this scene, it rapidly swam off to the side and disappeared.

### **2157 Cucumber Crab**

*Lissocarcinus orbicularis* is a somewhat atypical swimming crab. It does not swim (or rarely, if it does) and is not particularly fast moving. It lives inside sea cucumbers, usually just inside the mouth, although they’ve been spotted inside the other end as well. Occasionally, you can find them out crawling about on the exterior of the sea cucumber. They feed on the stuff caught on the cucumber’s body or on food particles extracted from what the cucumber is itself running through its digestive system. Also sometimes commonly called the harlequin crab, they come in a variety of colors—black with white spots and bands as shown here, but also white with brown or black spots.

### **2200 Handnet Crab** **6 scenes**

Handnet crabs (*Neopetrolisthes maculata*) always live in association with species of sea anemones. These scenes show crabs on sticky sucker (first and fourth through sixth scenes) and pink Haddon’s anemones (second and third). Their large pincers are apparently used strictly for defense, since these crabs have another means of feeding. Other appendages around the mouth branch into fine filaments at the end, forming a kind of handnet with which it scoops plankton out of the water and directs it into its mouth. The thin filaments of the net are hard to see, but if you look close you can see them in action in the fourth and fifth scenes. Many Haddon’s and sticky sucker anemones play host to a pair of these crabs, but they are often hidden underneath the anemone out of sight. Look closely at the next ones you see.

### **2220 Crab**

This crab, a species of *Percnon*, is a fast mover and is difficult to get close to. Here it feeds on the ceiling of a small ledge, beneath which extend upward the tentacles of a sea anemone.

### **2023 Decorator Crab**

A number of species of crabs permit (or even probably encourage) the growth of sponges and algae on their carapaces, helping to camouflage them from predators. Like all crabs, the carapace does not grow with the crab. When the flesh starts to overfill the shell, the crab sheds it and grows a new one. More precisely, as the crab fills up its old shell, it grows a new, soft one under the old one. When the new one is ready, the crab crawls out of the old shell, even pulling its thin antennae, eyeballs, and legs out of the interior of the old shell. It then immediately swells up its body as much as possible with water, and permits the new shell to harden on the swollen body. Once the new shell hardens, it releases its excess water, and the animal shrinks down leaving some room for growth under the new hard external carapace.

### **2228 Tarantula Crab** **4 scenes**

The crab *Camposcia retusa* can be well camouflaged, to say the least. In the first scene, the crab is difficult to see until it starts to move. In the second, the crab was caught in the act of spawning. Female crabs carry their eggs under their abdomen as they develop. When they are ready to be released, the mothers use their appendages to break apart the egg mass and release the larval crabs out into the plankton, as this one is doing here. The larvae will float around in open water for a variable length of time before settling down to life on the bottom. The last two segments show a tarantula crab wearing its Sunday best—a fancy suit of sponges growing on its legs. Usually referred to as another kind of decorator crab, I prefer to think of these as the tarantulas they resemble.

### 2254 Red Spider Crab

Backing away from the camera, the crab disappears over the far side of a rock.

### 2258 Spider Crab

This spider crab (*Hyastenus bispinosus?*) is almost always found in association with gorgonians and soft corals. This one is trying to crawl its way down the branches of a gorgonian at night, while the tendrils of a basket star above keep tangling up its legs.

### 2304 Title: Lobsters and Shrimp

Related to crabs are the lobsters and shrimp. On shallow coral reefs, you're likely to see spiny lobsters, slipper lobsters, and if you look close, perhaps a few kinds of red or clawed lobsters. On tropical reefs, the spiny lobsters are the best known; those are the ones people most often seek out for food. Slippers are more cryptic and usually smaller, and the red lobsters, while common, are small and hard to catch.

Shrimp are abundant in a variety of habitats on coral reefs. While most are nocturnal, they can often be found during the day in dark areas, such as in small caves, under rocks, or on shipwrecks. I once forced open the door of a metal locker that had apparently fallen from a boat on a bare sandy bottom and was amused to note that the locker was packed with various shrimp, a different species occupying each shelf. Like crabs, shrimp also often form symbiotic relationships with other kinds of animals, including fish, corals and sea anemones, and starfish.

### 2307 Spiny Lobster

### 3 scenes

*Panulirus versicolor* is the most common spiny lobster observed by scuba divers in the Marshalls. They live on coral slopes in holes and caves during the day, usually emerging at night to wander over the reef in search of food. The first scene shows one backed into a cave during the day. A closer view shows off the pink coloration on the carapace. In the third scene, a small lobster races over the bottom to escape the camera lights.

### 2319 Slipper Lobster

*Parribacis antarcticus* is inappropriately named; they live in the tropics, not the Antarctic. Also nocturnal, they have flattened bodies, often with a camouflage color pattern, and are sometimes hard to spot on the rocky substrate. This scene shows a pair of lobsters.

### 2322 Slipper Lobster

*Scyllarus* is a very small species of slipper lobster, usually less than 50mm long. It can be seen at night crawling on the walls of ledges on the seaward reef.

### 2325 Bullseye Red Lobster

*Hoplometopus holthuisi* is probably the most often observed of several red lobsters found in the Marshalls. It is large, as red lobsters go, and is common at night looking out of holes and caves on the oceanside slope. This species can be distinguished from other red lobsters by the white circles, or bulls-eye shapes, on the sides of the body. Sensitive to light, the animal quickly backs into its hole.

### 2328 Spotted Bulldozer Shrimp

Several kinds of shrimp form symbiotic relationships with certain fish in the goby family. Both shrimp and fish use a burrow in the sand for protection from predators. The shrimp's job is to dig and maintain the burrow, so it spends its entire day hauling out loads of sand from the burrow and dumping it outside. Unfortunately, it does not see very well, and would make an easy meal for a passing predator. But fortunately for the shrimp, its goby partner has pretty good eyes. The fish acts as a lookout. If it sees something approaching that might constitute danger, it dives into the hole. If the shrimp is in the burrow, the fish prevents it from coming out. That might not help the shrimp if he's outside at the time, but when out of the burrow, the shrimp keeps one of his antennae on the fish at all times. If the shrimp feels the fish dive for cover, it knows immediately to return to the burrow. The bulldozer here is *Alpheus rubromaculatus* and the black and white goby is *Lotilia graciliosa*.

### 2332 Yellow Bulldozer Shrimp

This common bulldozer, *Alpheus ochrostriatus*, is associated with several kinds of goby, including this banded *Amblyeleotris fasciata*.

### 2336 Bulldozer Shrimp

The same species of shrimp may also live with the orange spotted goby *Amblyeleotris guttata*. The shrimp tries to move a rock to the other side of the goby's tail, but it rolls back down.

### 2340 Bulldozer Shrimp

The bulldozer shrimp shown here (*Alpheus bellulus*) is associated here with the goby *Amblyeleotris steinitzi*.

### 2344 Banded Coral Shrimp

This common shrimp (*Stenopus hispidus*) usually lives in pairs. They can often be seen back in small caves and ledges, sometimes visible only by their white antennae protruding out from behind a rock. They emerge somewhat at night to feed. They are popular aquarium inhabitants, but you cannot keep them with juvenile bicolor parrotfish (*Cetoscarus bicolor*); the fish chew the long white antennae down to the nubs!

### 2347 Marbled Shrimp

*Saron marmoratus*, male. The males and females of this species are quite different in appearance. The males have long antennae and extremely long appendages with small claws on the ends. In the females, these appendages are shorter and look like they are covered with hair. The males stretch their long claws outward in what appear to be aggressive displays against other males.

### 2352 Marbled Shrimp

*Saron marmoratus*, female. This short-armed female *Saron* is crawling across the spiny back of a crown-of-thorns starfish. Her rapid disappearance upward shows how fast they can move when the need arises. Usually hiding during the day, these shrimp are active at night, when these scenes were filmed.

### 2356 Saron Shrimp

This striking yet unidentified species of *Saron* is generally found only at night on seaward slopes.

### 2359 Eyespot Shrimp

Members of this smaller species, *Saron neglectus*, usually live beneath rocks during the day. It scurries toward the edge of the rock when exposed. The common name comes from black eyespots on the upper part of the abdomen, not visible in this scene.

### 2402 Hinge Beak Shrimp

These shrimp (*Cinetorhynchus*) hide away in holes during the day and emerge at night to feed. They can dart quickly away when disturbed. They are sometimes called the black pearl eye shrimp for their round black eyes.

### 2405 Shrimp

Another nocturnal shrimp wiggles a bit as it moves away from the camera lights.

### 2409 Candy Cane Shrimp

The common nocturnal shrimp *Parhippolyte mistica* is frequently seen in caves and inside shipwrecks.

### 2415 Cleaner Shrimp

These shrimp (*Lysmata amboinensis*), which usually live in pairs, spend much of their time acting as cleaners, picking parasites from some cave dwelling fish and moray eels, such as the one in this scene. They rarely emerge from the small caves and holes in which they live. Not particularly common in the Marshall Islands, they can occasionally be found on the seaward reef slope, or a bit more frequently in small isolated reefs surrounded by lagoon bottom sand. The one in the foreground of this scene is on top of a yellow tunicate (scene 1706).

### 2420 Bumblebee Shrimp

Here in the Marshalls, the small shrimp *Gnathophyllum americanum* are usually found around the large sand sea anemones such as *Styrodactyla haddoni* (scene 0454). Although not living among the anemone's tentacles as some shrimp do, they usually hide beneath the anemone's ruffled skirt.

### 2424 Sea Star Shrimp

2 scenes

*Periclimenes soror*. These small shrimp live in association with some echinoderms, such as the cushion seastar (scene 1437). They can usually be found hiding on the underside of the star, but will sometimes dart away when the star is overturned. They seem to take on the color of their host, but I'm not sure if they actually acquire the pigment from the host or if shrimp that contrast with their host colors are picked off more easily by predators.

### 2430 Clear Shrimp

A small mostly transparent shrimp (*Periclimenes tenuipes*) jerkily moves away from the video lights. Note the tiny hermit crab moving around in a small shell at left.

### 2435 Clear Cleaner Shrimp

2 scenes

Groups of these small shrimp can be found during the day in dark, sandy bottom caves and ledges, or sometimes inside shipwrecks. At night, they are often seen cleaning parasites from sleeping fish. They are similar in appearance to the next species but are nearly entirely transparent.

### 2444 Clear Cleaner Shrimp

2 scenes

*Urocaridella antonbruunii* is a small cleaner shrimp that is mostly transparent with red spots on its body and red and white banded appendages. It too is nocturnal, often seen cleaning fish or moray eels at night. In the second scene, a pair are on the head of the large moray *Gymnothorax javanicus*.

### 2451 Holthuis' Shrimp

3 scenes

This small, attractive, mostly transparent shrimp (*Periclimenes holthuisi*?) lives in association with various sea anemones and corals. In the first and second scenes of this set, the shrimp is on the tentacles of the corkscrew tentacle anemone (see scene 0447). In the second, the shrimp appears to be scrubbing its face and grooming with its little feeding appendages. In the third, a pair of the shrimp move across the orange tentacles of Haddon's anemone (scene 0454). Another individual of this species can be seen in scene 0549 of the Green Fire Anemone.

### 2502 Anemone Shrimp

3 scenes

These anemone-associated shrimp (*Periclimenes brevicarpalis*) are easily recognized by the large opaque white patches on a transparent body. They also have some orange pigment on their tails. These three scenes all show females, which are larger and stouter than the males of the species. In the first two scenes, the shrimp is on the pink tentacles of a Haddon's anemone (scene 0454); in the latter of these two, a couple of other mostly transparent shrimp appear around the edges of the frame. In the third scene, the large female shrimp is on the surface of a sticky sucker anemone (scene 0515).

### 2513 Squat Anemone Shrimp

These minute shrimp (*Thor amboinensis*) are usually found near, but not among the tentacles, of sea anemones. They frequently rhythmically pop their tails as seen here.

### 2517 Harlequin Shrimp

2 scenes

*Hymenocera picta* is one of the most interesting shrimp, both in appearance and behavior. Usually in pairs, it feeds solely on starfish, which it chops up with its appendages and devours. Here in the Marshall Islands, they are usually found eating *Linckia multiflora*, but they will eat other stars as well, including the crown-of-thorns. In Hawaii, this shrimp has brighter purple colors and is frequently found out in the open; here in the Marshalls, it is more pink than purple and shuns light, hiding beneath rocks. We suspect the greater numbers of grouper and snapper predators in the Marshalls forces these shrimp to remain hidden.

### 2526 Mantis Shrimp

4 scenes

These four scenes show what appear to be two different kinds of mantis shrimp (*Lysiosquilla*). Mantis shrimp, or stomatopods, have forward appendages that fold up similar to those of a praying mantis (although their joints cause the appendages to fold up in the opposite direction). These folded appendages can be extended and withdrawn extremely fast. In some species, the forward edge of these appendages is sharp and in others, it's blunt and club-like. The shrimp use these appendages to lash out and cut or

lobber prey or potential enemies. Some of these shrimp are commonly known as "thumb splitters" for their effect on the person who handles them carelessly. The four scenes depict a species that sports yet another way the folding appendages are constructed. In these, the outer segment of the appendage creates a wicked-looking comb-like structure with long, curved, sharply pointed spines. These are apparently used to skewer prey; when the appendages are retracted, the impaled prey is held right against the shrimp's mouth. These species spend most of their time living in holes in the sand, sometimes poking their oblong eyeballs out the hole and wobbling their eye stalks to look in different directions at the same time. In the first scene, a mantis pops to the top of its hole to see what's going on outside. In the last, another sinks back down into its tunnel.

#### **2543 Title: Clams**

Clams, or bivalves, constitute one of the major divisions of the phylum of mollusks, a diverse and highly successful group of animals that also includes snails, chitons, squid, and octopus. Clams are found in all oceans of the world, including hot deep sea vents and cold arctic waters. They have successfully invaded fresh water, but never made the push onto the land. The tropical Pacific has a wide variety of bivalves living buried in the sand, exposed on rocks, cemented to reefs or wrecks, attached to whip corals, and so on. Clams, like most sessile or mostly sessile animals, are typically filter feeders. They spend their time sucking water in, filtering out any planktonic food items, and pumping the filtered water back out. There is some variation in this pattern, which we discuss later. The most conspicuous bivalves on tropical Pacific reefs are members of the so-called killer clam or giant clam family Tridacnidae. Some species in this family have variably colored and brilliant animals whose vivid blues and greens seem to jump out of the reef at you. Other species are the giants among clams, growing to lengths of one and a third meters and more. The killer clam family also has the dubious distinction of being among the few marine mollusks whose continued existence is considered at risk. All members of this family have been put on the CITES list. The acronym stands for Convention on International Trade in Endangered Species. Their presence on this list means that by law, they or their remains cannot be traded or transported between nations who have signed the convention. While these clams have not reached the truly endangered status yet, it is true that they are heavily harvested in some areas for food, and in those areas, their numbers have diminished drastically. Even here at Kwajalein, giant clam abundance has greatly decreased in the southern part of the atoll. In the 60s and 70s, I knew of dozens of giant clams on the reefs around Kwaj; now I am aware of only three large individuals within several miles of the island.

#### **2546 Bear Paw Clam**

#### **2 scenes**

The Bear Paw (*Hippopus hippopus*) is one of the members of the Tridacnidae or killer clam family. This species typically lives in sandy or rubbly areas, just resting on the bottom and not attached to the substrate in any way. They are more common in quiet lagoon areas. This individual is in a *Halimeda* algae patch on a sandy lagoon slope. The second scene is a close-up view of the animal coloration. The yellowish streaks in this one are unusual.

#### **2552 Maxima Clam**

#### **11 scenes**

Despite its specific name of *Tridacna maxima*, this species is the smallest of the killer clam family in the Marshalls. Maximum shell size is perhaps 250 to 300mm. Shells of this species are always embedded within solid reef rock. They apparently wear their way into a reef depression and keep enlarging it as they grow simply by opening and closing their shell; although both calcium carbonate based, the material that makes up the shell is stronger than the reef rock in which the clam lives. As can be seen from this set of scenes, the clam's animal can vary considerably in color from one species to the next; it almost seems as though no two are alike. One consistent aspect of the coloration, at least in the Marshalls, is the presence of a close-set row of squarish black spots around the edge of the mantle, the colored portion of the animal visible between the valves. In addition to filter feeding, this species and the other *Tridacna* clams are farmers. Within their tissue are innumerable single-celled plants called zooxanthellae, the same kind of microscopic plants that live in coral tissues. Like all plants, the zooxanthellae use sunlight and carbon dioxide (the latter conveniently provided as a waste product of the clam's metabolism) to produce oxygen and carbohydrates, both of which are useful to the clam. All animals including clams require oxygen for metabolism, and the carbohydrates are food. Interestingly, it is these zooxanthellae that are responsible for much of the coloration in the giant clams. If deprived of sunlight, the plants will die. We have seen clams that had portions of their animals in continual shadow from a fallen chunk of coral; within this shadow, the clam's mantle was pale and colorless, while the portion still exposed to sunlight was bright and vivid.

#### **2628 Fluted Clam**

#### **7 scenes**

The medium-sized giant clam in the Marshalls, adult Fluted Clams (*Tridacna squamosa*) typically live simply resting on the bottom or attached to the substrate by byssal threads. Externally, the shells are characterized by wide flutes in rows that extend from the base to the lip of the shell, although these can be worn down and resemble the smaller flutes on both *T. maxima* and young *T. gigas*. The animal coloration does not include the black squarish spots around the edge of the mantle, nor does it include the iridescent blue or green rings seen in *T. gigas*. Instead, the mantle of the Fluted Clam is usually adorned with round or oval, sometimes ocellated, spots that occasionally stretch into bands. In a few cases, the spots are small and close set, giving the animal a variegated appearance. Individuals in the scenes show some of the variations. The last scene shows a close up of one of the clam's siphons.

#### **2650 Giant Clams**

#### **10 scenes**

The giant of the killer clam family is *Tridacna gigas*. Specimens over one and a third meter long are known, and others have been reported even larger. Juvenile specimens live embedded in the reef and are often confused with *T. maxima*, but the larger ones are free living with the large and heavy shells simply resting on the bottom. Sheer size is often enough to positively identify an individual as a Giant, but it can be confirmed by animal colors; the mantle of this species varies in background color but is nearly always scattered with iridescent blue or green rings (see the fourth scene of this set). Unfortunately, these impressive giants are at some risk. While they, like all the *Tridacna*, are on the CITES list and may therefore not be transported between countries, they are still heavily collected for food in many areas where they occur. Anywhere near populated islands, a living giant clam is somewhat of a rarity. Fortunately, scientists have worked out methods for raising them in captivity, and several *Tridacna* clam hatcheries now exist in the tropical Pacific. In the last scene of this set, a school of fusiliers (*Pterocaesio tile*) pass over the clam.

#### **2724 Tellin Clam**

*Tellina staurella* is a member of a family of sand-dwelling clams. Generally, only empty shells are ever seen, but digging beneath the surface of a sand patch can bring up this and a number of different species.

**2727 Pearl Oyster****2 scenes**

The pearl oyster (*Pinctada margaritifera*) has a flattened shell that appears scaly in young specimens or simply solidly encrusted with growth in most older ones. The black animal, visible in the second scene, lays down mother-of-pearl on the inner surface of each shell, as well as on occasional sand grains that might get inside. But wait! Before you head out to find and chop open oysters to make a fortune in pearls, you should know that very very few oysters contain pearls, and these reef dwelling pearl oysters are not all that common to begin with. You'd most likely never find a pearl. Forget it.

**2732 Zigzag Clam****2 scenes**

These zigzag clams (*Hyotissa hyotis*) are a kind of rock oyster, living with one shell valve cemented to the substrate. Shells are often coated with red sponge. Fairly sensitive to motion, these clams will usually close up at the approach of a diver.

**2736 Rock Oyster**

Similar to the zigzag clam, these rock oysters grow with one valve cemented to a substrate. In this case, the substrate is the steel hull of a sunken ship. Again, the shell and surrounding areas are covered with colorful encrusting sponges.

**2739 Zigzag Clam**

Some of the rock oysters attach to various corals. These three sponge covered individuals of *Lopha cristagalli* are on the skeleton of a dead whip coral.

**2744 Rock Scallop****2 scenes**

These large rock oysters (*Spondylus varians*?) have shells that grow up to 250 to 300mm in diameter. They too live with one valve firmly cemented to the rock, making a complete intact shell nearly impossible to collect. Like most clams, they are filter feeders, drawing in water to filter for planktonic food. They are usually sensitive to the approach of a diver, probably feeling the vibrations through the water as the diver moves closer; usually, the clam will snap shut as seen in the second scene.

**2751 Spiny Rock Scallop**

Many of the clams in the rock scallop family, such as this *Spondylus linguafelis*, are covered with spines, some long and dense as shown here. Clams, especially those cemented to a hard substrate, are vulnerable to predation. Just about all they can do to try to avoid being eaten is to close up and hope the predator goes away. Some predators, however, get at the clams by drilling holes right through their shells. Presumably, an outer shell covered with spines would help prevent a drilling predator from finding a suitable spot to try to dig a hole through the shell.

**2755 Rastellum Scallops****2 scenes**

One of these scallops opens its valve wide momentarily before closing it again. Shells of *Mirapecten rastellum* come in a range of attractive warm colors, from pale pink through yellow, orange, bright pink, red, or any combination thereof. Empty shells are found frequently, many of them intact and unbroken, suggesting that there is a predator out there that is capable of handling the shell gently while devouring the contents. Living specimens can sometimes be found beneath dead coral rocks, usually attached to the substrate by byssal threads. Like most other scallops, they are able to release their attachment and swim away by quickly flapping their valves open and closed. The second scene shows a closer view of an open scallop. A number of light-sensitive eyes are distributed along the edges of each valve and tentacles extend from the opening.

**2804 Coral Scallop**

The scallop *Pedum spondyloideum* lives deep within crevices in massive coral colonies such as *Porites*. The scallop's blue mantle is easily seen, and a closer look reveals the reddish eyes that line the mantle edges.

**2806 Scallop**

*Chlamys limatula* is a rather small scallop species that usually hides beneath rocks during the day. When exposed to light, it makes an effort to escape by swimming up and out of the picture. The yellow mass just to the lower left of the clam is a calcareous sponge.

**2810 Irregular Scallop****2 scenes**

Another rather small scallop, this *Chlamys irregularis* shell is covered with sponge growth. It too tries to swim away before a predator catches sight of it. Notice the sensory tentacles extending out all the way around the opening.

**2818 Scallop**

A common larger scallop in the Marshall Islands, *Gloripallium pallium* seems to prefer lagoon reefs and pinnacles. The shell is often heavily encrusted with sponges, sometimes making the shell difficult to see. They usually attach to the undersurfaces of rocks using threads known as a byssus, but can let go at a moment's notice when it there is a need to try to swim away.

**2821 White File Clam**

Scallops are not the only clams that swim. Many of the file clams in the genus *Lima* are quite mobile as well. Most file clams have long tentacles and can swim by flapping their valves open and closed. Many file clam species have thin, fragile shells and live hidden away under rocks during the day.

**2826 Banded File Clam**

This species of *Lima* has banded tentacles. It is common in shallow under rocks that are partly buried in fine silty sand, and usually lives in groups of three or more. The circular objects to the upper left of the clam are pieces of the alga *Padina*.

**2833 Red File Clam**

This red-tentacled file clam may be *Lima orientalis*. Usually solitary, it lives under rocks on sandy lagoon reefs.

**2840 Electric File Clam**

*Ctenoides ales* is a file clam that has a more substantial shell than the others seen previously. They live in holes and caves on the steep seaward reef slope. The "electric arcs" you see in the scene are in fact just flashes of white color as a bright white edging on the animal flashes in and out of view, reflecting the video lights back at the camera. Somewhat sensitive to water movement, the clam jerks backward farther into its hole at the approach of the camera.

**2846 Title: Seashells**

Even though the clams we've been looking at so far are also sea shells, this segment of the video focuses on snails bearing shells. All of these animals belong to a group within the phylum of mollusks called gastropods, which basically means stomach foot; they kind of look like they're crawling around on their stomachs. The gastropod class also includes nudibranchs and other sea slugs, which are covered in the following segment of the video.

The mollusks inhabiting seashells are quite diverse in structure, habitat, diet, and activity. These scenes barely touch on the range of variation present on most tropical reefs.

**2849 Abalone**

Abalone make up a large and important component of many temperate coastlines, such as those of California and New Zealand. Around tropical coral reefs, abalone tend to be smaller and less common. The most common species in the Marshalls, *Haliotis crebisculpta* is typically little more than 25mm long. The species is nocturnal, coming out of hiding at night to graze on algae. It is frequently found on purplish encrusting coralline algae *Porolithon*, where it is difficult to see. The abalone has a large foot and is capable of crawling fast when necessary.

**2853 Giant Finger Shell**

*Lambis truncata* is the largest of the finger shells, sometimes measuring up to 300mm in length. Here it rests on a mat of calcareous *Halimeda* algae.

**2857 Spider Conch**

The spider conch *Lambis chiragra* is a common finger shell that can reach nearly 200mm in length. They are usually found paired, one large and one small, the larger one generally the female. Like all of the members of this family, spider conchs move by "poling." Each animal possesses a muscular foot attached to a hard, elongate operculum, which is the trap door that closes off the aperture of the shell when the animal retracts completely inside. To move, the animal forces this foot and operculum into the ground and pushes, causing the shell to hop forward, as shown in this scene.

**2900 Scorpion Finger Shell**

Like the spider conch seen previously, the scorpion shell (*Lambis scorpius*) has a muscular foot with attached operculum it uses to hop along the bottom. The foot is also used to flip the shell upright if it happens to fall over and land upside down. The foot can reach way out around the curve of the shell and push against the bottom, causing the shell to flip over. It does not always work, though. Sometimes one of the shell's fingers gets caught in coral in such a way that it prevents the shell from flipping over. In such case, the animal generally cannot survive very long. This scene also shows how difficult it can be to see some of these shells. The aperture side is bright and shiny, but when the animal flips over, the back of the shell, which is encrusted with algae and other growth, is very difficult to see.

**2903 Silver Conch****2 scenes**

Although in the same family as the finger shells seen previously, the silver conch (*Strombus lentiginosus*) lacks fingers, as do many others in the family. In the first scene, the animal is extending its proboscis to feed on algae. The proboscis is the elongate green and black banded tube extending downward from the right side of the scene. In the end of that tube is the mouth. Just above the proboscis, the eyes extend outward on the ends of long thin tentacles. The banded proboscis of a second Silver Conch can be seen at the left side of the screen. The second scene is a view right down the anterior end of the shell. The eyes peek out of separate notches in the shell, and there is a small tentacle used for feeling beneath each eye. Each on its own stalk, the eyes can look in any direction.

**2910 Tooth Conch****2 scenes**

The toothed conch (*Strombus dentatus*) is also related to the finger shells and the silver conch. Although lacking fingers, the outer lip of the shell is armed with three sharp projections referred to as "teeth." These mollusks generally live beneath coarse flaky sand during the day and emerge at night to graze on algae. Their eyes are similar to those of the Silver and other conchs, and like them, it can use its muscular foot and operculum to hop around. As a response to escape from potential danger (in this case, a huge creature approaching at night and bearing bright lights), the Tooth Conch can extend its foot rapidly and repeatedly, causing it to hop away.

**2916 Spotted Bonnet**

The Spotted Bonnet shell (*Phalium bisulcatum*) hides deep under the sand during the day, emerging at night to search for food and mates. The presence of numerous planktonic crustaceans reveals that this sequence was shot at night. The animal here is pure white, causing the jet black eyes to stand out. Although common in the western Pacific, this species is rarely seen in the Marshalls.

**2923 Apple Tun**

Like the bonnet shell, the apple tun (*Malea pomum*) lives deep under the sand by day and comes out to hunt at night.

**2928 Horned Helmet****2 scenes**

The horned helmet shell (*Cassis cornuta*) is one of the larger snails found around Pacific reefs. Strictly sand dwellers, they can bury down so that only the horns of the shell are exposed, or they can rest on the surface of the sand. They eat burrowing urchins similar to the one shown in scene 1327.

**2935 Partridge Tun Shell**

The partridge tun (*Tonna perdix*) has a rather thin shell with a very large aperture, and it needs that large aperture to fit all of its huge animal inside. Nocturnally active, it emerges from the sand at night to search for sea cucumbers, which it can devour whole by extending its large, flexible proboscis (mouth) out around the entire sea cucumber.

**2941 Pear Triton**

This pretty, orange pear triton (*Cymatium pyrum*) has an equally attractive animal living inside. Here the orange animal spotted with dark extends out of the shell to pull it back to an upright position.

**2946 Triton's Trumpet****3 scenes**

Triton's trumpet (*Charonia tritonis*) is one of the largest snails in the tropical Pacific. The shell can grow up to a half a meter, although the first scene here shows a small specimen. When the animals are young, the shells are typically shiny and clean. Over the years, as the animal grows, the growing shell becomes encrusted with algae and calcareous deposits, often to the point where no shell color is visible. Tritons feed exclusively on sea stars; although they seem to prefer the cushion star (scene 1437), they also feed on the crown-of-thorns starfish as seen in the second and third scenes in this set. While it is controversial, some scientists have suggested that removal of tritons may contribute to population blooms of the crown-of-thorns, which may then aggregate and eat much of the live coral on some reefs, practically denuding them. Although it seems unlikely that the triton, uncommon as it is on many reefs, could keep the coral-eating sea stars in check, it has been shown in some other situations that small numbers of a predator high in the food chain can have what would seem to be a disproportionately large impact on the populations of animals lower down in the chain. Perhaps this is also the case with the tritons and the crown-of-thorns.

**2956 Clandestine Triton****2 scenes**

The clandestine triton (*Linatella succinta*) deserves its common name. Its shell is hidden beneath a fluffy brown coating called a periostracum that the animal lays down over its hard shell. The periostracum, which here looks like a clump of algae, makes it almost impossible to see the shell. The shell itself, only barely visible through the fluff, is light brown with close set, darker brown ridges spiraling around the shell. The animal too is attractively colored, seen here as it reaches out to pull the shell's aperture back down to the rock.

**3006 Black Blob**

The black blob (*Coriocella nigra*) is another snail that hides its shell, in this case buried beneath the thick, tough, lumpy black tissue that extends over its back. Only if the animal decomposes is the thin, translucent shell exposed. Black Blobs tend to wander about in the open during the day. This habit, plus the obvious lack of any protection by its shell, suggests that the animals are not edible. In fact, these black blobs have been observed apparently eating a jet black sponge that grows exposed on shallow seaward reefs and is known to be toxic, so the blobs may be picking up some protective defensive chemicals from their prey. The blobs also lay their wispy gray black egg masses on these sponges.

**3009 Worm-like Shell**

Even though this looks like it should be called a tubeworm, it is in fact a snail called a vermetid (*Dendropoma maxima*) that lives in that tube. Imagine a coiled shell uncoiled and somewhat straightened. Then cement that uncoiled shell down onto a rocky substrate or into a coralhead and you have a vermetid mollusk. Being cemented to the bottom, they obviously cannot wander around in search of a meal, so vermetids make their living by setting traps. As seen here, a vermetid extends sheets of sticky mucus out of its shell. This mucus entraps small crustaceans and other tiny organisms. Periodically, the vermetid draws in the mucus sheet, digesting off any critters that happened to get stuck.

**3012 Saul's Murex**

The attractive murex shell *Chicoreus saulii* is most often seen at night exposed on the seaward reef slope. The red color here, however, is not the color of the shell. The shell is orange brown to dark brown. The red is a kind of slimy, protective coat called a periostracum that the snail lays down over its shell as it grows. This is the same sort of stuff, but in a very different form, that the clandestine triton (scene 2956) lays down to hide its shell. The periostracum on this murex probably helps prevent the settling of cap shells that could eventually dig through the murex's shell and expose the soft animal within.

**3016 Pele's Murex**

Pele's murex (*Homolocantha pele*, or possibly *Homolocantha anatomicus*) can be extremely difficult to see most of the time; the shell is usually encrusted with algae and blends in well against the bottom. This individual only recently completed its growth of the last shell whorl, which is still rather clean and unencrusted.

**3020 Red Spindle Shell**

The red spindle (*Fusinus filamentosa*) has a dark maroon animal decorated with white spots. The animal is a predator, generally feeding on other snails.

**3023 Smooth Colub Shells****2 scenes**

*Colubraria nitidula* typically live in groups of three or more, and generally spend the daylight hours secreted beneath rocks or buried within sandy caves. These three were disturbed in daylight and are running away to try to escape back to darkness. This species, along with most other members of its genus, are parasites upon sleeping fish, as shown in the second scene. At night they emerge from hiding and find a fish asleep on the bottom. Usually they find parrotfish, although other kinds will also suffice. When it finds a sleeping fish, the shell approaches as close as it can, sometimes coming right up to the fish or sometimes crawling up the mucus bag that parrotfish create to sleep in. The colub then extends its long proboscis through the bag and into a soft part of the fish—into the gill opening, the eye, the anus, or even under a loose scale. In this scene, the colub's proboscis stretches into the fish's mouth. There, it painlessly cuts into the unsuspecting fish and drinks its blood. The fish is apparently not harmed by this parasitism; presumably these little vampires cannot drink enough blood in a night to cause any serious damage. Again, the swarms of plankton attracted to the video lights reveal this to be a night dive.

**3033 Bent Colub Shell**

The bent colub (*Colubraria tortuosa*), like its smooth cousin, makes its living by drinking the blood of sleeping fish. Here two juvenile snails crawl on a parrot's mucus bag to feed. If you look closely, you might be able to see the feeding proboscis of the lower shell extending through the bag into the fish's mouth.

**3037 Marginella Shell**

This unidentified marginellid shell is another parasite upon sleeping parrotfish. Often clusters of ten or more can be seen crawling on an unsuspecting fish at night. A marginellid appears to stick its proboscis through the skin, probably sucking up blood or other body fluids.

### 3040 Little Love Harp

These harp shells (*Harpa amouretta*) typically live buried deep in the sand beneath rocks. They emerge at night to feed or to lay their egg masses on the undersurfaces of rocks.

### 3045 Pimpled Basket Shell

The basket shell *Nassarius papillosus* spends its day buried in sand underneath rocks. At night, they emerge to search for food. Scavengers, they will take just about any dead animals they find. They are capable of detecting food nearby quickly. If several of these shells are buried in the sand in an aquarium, introducing a small chunk of dead fish to the tank will usually cause the shells to almost immediately erupt from the sand and go off in search of the food.

### 3050 Bert's Olive

This species of olive shell (*Oliva berti*) lives in fine lagoon sand in the Marshall Islands. Some scientists consider it a form of *Oliva miniacea*, which is more widespread in the Pacific and Indian Oceans. The shells move around at night to feed. Rarely do they actually come to the surface of the sand as seen here, however; usually they dig right through the upper layers of sand, leaving a trail in the sand behind them.

### 3055 Annulate Olive

#### 2 scenes

Like Bert's olive, the annulate olive (*Oliva annulata*) lives in sandy habitats. In the Marshalls, Bert's olive lives in fine sand in inshore lagoon areas. The annulate olive prefers coarser sand on seaward reefs or mid-lagoon pinnacles, so the two species are rarely seen together. In these two scenes, the olive, brought to the surface of the sand, is quickly trying to dig back down again.

### 3103 Kitten Auger

All of the different kinds of auger shells are sand dwellers. Usually, they live just beneath the sand's surface, leaving trails behind them as they dig through the sand in search of their worm prey. This kitten auger (*Terebra felina*) is attempting to dig back down after being brought to the surface.

### 3107 Dimidiate Auger

This close up shot of *Terebra dimidiata* briefly shows the small eyes and tentacles of the auger's animal as it starts to dig down into the sand.

### 3110 Spotted Auger

This auger (*Terebra subulata*) digs down into the sand.

### 3112 Fenestrate Miter

These miters (*Pterygia fenestrata*) are sand dwellers, usually living in soft lagoon sand flats.

### 3117 Episcopal Miter

The episcopal miter (*Mitra mitra*) is a common sand dwelling species that grows quite large, although a typical size is about 75mm. An episcopal miter has a long, white proboscis that it extends down into the sand to feed on worms.

### 3121 Vulpecula Miter

This sand dwelling miter (*Vexillum vulpecula*) lives in fine lagoon sand flats. Buried by day, it emerges to the top of the sand at night to feed. The siphon, which draws water in and across the gills, extends from the anterior end of the shell on the right side of the scene. Like many miters, those that live in white coral sand have much lighter colored shells than those that live in darker volcanic sand.

### 3123 Varicose Wentletrap

Most of the different kinds of wentletraps feed on various corals and sea anemones. The varicose wentletrap (*Cirsotrema varicosum*) is an anemone eater. Large specimens and their eggs (both shown in this scene) are frequently found with the leathery sea anemone, *Heteractis crispa*. The shells eggs are mixed into the round balls of sand piled up right below the shell.

### 3126 Ulu Wentletrap

#### 2 scenes

The ulu wentletrap (*Epitonium ulu*) is usually found underneath its food source, various species of fungiid razor corals. In these scenes, a small group of wentletraps and their eggs are exposed when a razor coral is turned upside down. This may be why razor corals are so frequently observed flipped over. It is likely that certain carnivorous fish, such as large wrasses or triggerfish that are capable of turning fair-sized rocks, have learned that they might find a tasty meal if they flip over a razor coral.

### 3133 Wentletrap

These two wentletraps (*Epitonium*) were exposed when the razor coral they were hiding under, *Herpolitha limax*, was overturned. Their egg masses are those clusters of oddly shaped structures above the shells in the scene.

### 3140 Warty Egg Shell

The warty egg (*Calpurnus verrucosus*) is always seen in association with its food source, the soft coral *Sarcophyton* (scene 0756). Generally, the shells hide under the curled edges of the soft coral colony during the day, moving to the top of the soft coral at night to feed on the coral's polyps. The shell is pure white with a brown-edged wart and lilac tip at each end, but the animal's foot is spotted with black dots and the mantle, not seen in this scene, is crowded with brown circular spots.

### 3143 Deflexa Egg Shell

Like most other egg shells, *Phenacovolva deflexa* feeds on a soft coral, in this case the gorgonian *Rumphella* (scene 0742). Here four of the small egg shells are strung out along a branch of the gorgonian. They will eat the soft outer covering off the jet black coral skeleton.

### 3146 Egg Shell

#### 2 scenes

The largest of the egg shells, *Ovula ovum*, eats the soft corals *Sarcophyton* (scene 0756) or *Lobophyton*, shown here. The shell is pure white and oval, with the only color a dark purple tint in the interior of the shell. The black outer covering seen here is the animal's mantle, which actually creates the shell from calcium carbonate picked up from the water or from the animal's diet.

**3153 Tiger Cowry****4 scenes**

The tiger (*Cypraea tigris*) is one of the largest and most variable of the cowry shells. The first scene shows a typically spotted tiger with its mantle, the thin layer of skin that covers and produces the shell, halfway covering the shell. The second shows a shell with more white and fewer spots. The third shows a relatively darkly spotted shell halfway covered by the mantle. In the last shot, the mantle is covering the entire shell. The mantle's ability to cover the entire shell is what keeps cowry shells so shiny and smooth. Tigers live on lagoon and shallow seaward reef flats, as well as on some large lagoon pinnacle and patch reefs. They can also be found intertidally. Nocturnally active, they spend the day with their mantles down, usually in a reef depression or underneath a rock or overhang.

**3206 Mole Cowry**

The mantle coloration, black with minute green spots, of the mole cowry (*Cypraea talpa*) contrasts sharply with the yellow to brown banded shell. Here the animal is crawling over a clump of algae (*Galaxaura marginata*) moving away from the camera. Mole cowries live in both lagoon and seaward reef habitats; it is common, but cryptic in the living state when the mantle covers the entire shell.

**3210 Eroded Cowry**

This eroded cowry shell (*Cypraea erosa*) is shown covered about half way with the mottled and branched mantle, which provides excellent camouflage when fully extended. This species prefers intertidal and shallow lagoonside reefs under rocks.

**3213 Caurica Cowry**

*Cypraea caurica* lives in lagoon habitats, usually hiding beneath rocks during the day.

**3216 Porous Cowry**

The porous cowry shell (*Cypraea poraria*), which is maroon to purple with lighter colored spots, is here completely hidden beneath the reddish purple mantle. Cowry mantles are usually covered with sometimes branched projections called papillae; these are thought to break up the shell's smooth outline and make it harder to see, and possibly also to increase the surface area of the animal for absorption of oxygen from the water. The shell here is crawling over *Halimeda* algae at night.

**3221 Jester Cowry**

The cylindrical shape of the jester cowry (*Cypraea scurra*) distinguishes it from other species that have the same color pattern. In the Marshalls, large specimens live under dead coral on lagoon pinnacles, while small ones inhabit ledges and caves on the seaward reef. The anterior end of this animal is on the right side of the scene, where you can see the two sensory tentacles and fringed siphon extending from the shell.

**3226 Eglantine Cowry****2 scenes**

*Cypraea eglantina* prefers shallow quiet lagoon reefs, where it lives under rocks. It emerges at night to graze. In this close up view, the frilled half tube like structure in the notch in the front of the shell is the siphon. Through this the animal draws in water to flow over the gills. The translucent gray mantle ornamented with small pointed spike-like papillae is partly visible. In the second scene, a cowry crawls away past some waving hair-like *Lyngbya* algae.

**3233 Isabella Cowry**

This cylindrical, light brown cowry (*Cypraea isabella*) is shown half covered by its black, smooth mantle. It lives in intertidal, lagoon, and seaward reef habitats, under rocks and in caves. Nocturnally active, its primary diet appears to be sponges.

**3238 Map Cowry**

The map cowry's (*Cypraea mappa*) most characteristic feature is the undulating line running across the top of the shell from the front to the rear end. The line is highly variable in form from one cowry to the next. Maps live under rocks and in holes on subtidal lagoon and seaward reef, as well as on shipwrecks. The largest individuals tend to be on seaward reefs, while the smallest are usually on the deep, lagoon bottom shipwrecks. Again, we're looking at the anterior end, where the fringed siphon extends from the shell and the two tentacles are barely visible just below.

**3242 Stolid Cowry****2 scenes**

Stolid cowries (*Cypraea stolida*) live under rocks along shallow subtidal lagoon reefs and pinnacles. The first scene shows an adult with mantle partly extended. The dorsal dark brown blotch on the shell is clearly visible. The second scene shows a juvenile, which lacks the brown dorsal blotch. The juvenile is also completely covered by its mantle. Stolid cowries from Kwajalein differ from those found in other parts of the Pacific in that the background coloration is light brown rather than bluish gray. Kwajalein specimens have even been given a subspecific name, *kwajaleinensis*.

**3251 Lynx Cowry**

The lynx cowry (*Cypraea lynx*) lives intertidally and on shallow lagoon reefs under rocks. This specimen is resting on its egg mass. Cowries sit on their egg masses until hatching to help keep other animals from eating them.

**3255 Tortoise Cowry****2 scenes**

The tortoise cowry (*Cypraea testudinaria*) has a large, cylindrical shell and prefers living on the tops of lagoon pinnacles and on top of the oceanside seaward slope. Hiding by day in caves and under large rocks, they emerge at night to graze. The mantle, partly covering the shell in these two scenes, is gray-brown with spike-like papillae.

**3303 Eyed Cowry****2 scenes**

The eyed cowry (*Cypraea argus*) has a most distinctive shell of brown circles on a tan or gray background. These two scenes show a more distant and a closer shot of the shell, which is partly covered by the translucent mantle. Eyeds live on lagoon pinnacles or on the seaward reef, hiding in caves or under rocks during the day and emerging at night to feed. Notice the branched papillae that help to obscure the smoothly rounded outline of the shell.

### 3311 Maria's Cowry

This small, round, bubble-like cowry (*Cypraea mariae*) lives deep in caves and ledges on the seaward reef slope and in surge channels. Rarely seen alive during the day, they crawl about on the ceilings of caves at night. The mantle, not visible in this scene, is nearly transparent, permitting the yellowish-brown circles on the shell to show through.

### 3317 Children's Cowry

2 scenes

*Cypraea childreni* is one of the few cowry species that does not have a smooth or bumpy shell. Instead, it is covered with close-set ridges that circle the entire shell. Rarely seen alive during the day, it emerges from deep seaward reef and surge channel caves at night, crawling around on the ceilings in search of food. It probably eats sponges growing on the cave's ceilings. The first scene shows the shell with animal retracted; in the second, the animal's translucent mantle covers the entire shell, and its siphon is well extended to draw water in over the gills. Reacting to the video lights, the animal turns around to retreat into the cave.

### 3327 Sieve Cowry

Two sieve cowries (*Cypraea cribraria*) are together on the underside of a rock. The one in front moves away. The one behind, with its mantle fully extended over the shell, remains motionless. These cowries live under rocks intertidally and on shallow subtidal reefs, and can also be seen in ledges and caves on lagoon pinnacles and the seaward reef at night.

### 3332 Tapering Cowry

The red mantle of this cowry (*Cypraea teres*) covers a bluish gray shell that's flecked and spotted with brown.

### 3336 Chinese Cowry

The chinese cowry (*Cypraea chinensis*) is another species with a bright red mantle, but only a small part of it is visible in these scenes. The cowry typically lives under rocks on intertidal and shallow subtidal seaward reefs.

### 3339 Punctate Cowry

In this small species, *Cypraea punctata*, a red mantle partly covers a white shell scattered with brown spots. Here it is seen on a pinkish sponge. These cowries live under rocks on shallow lagoon and seaward reefs, and are generally active at night.

### 3342 Zigzag Cowry

The shell of the zigzag cowry (*Cypraea ziczac*) has chevron-shaped red brown lines within lighter bands set in a reddish brown dorsum. In this scene, the cowry is almost completely covered by its orange mantle, but a small portion of the shell is visible near the anterior end. This animal had been hiding under a rock; when exposed to light, it immediately began crawling away. Many carnivorous fish would have readily taken this cowry as a meal if given the chance.

### 3351 Carnelian Cowry

The carnelian cowry (*Cypraea carneola*) has an orange shell with alternating lighter and darker bands. In this scene, shot at night, the cowry is trying to get away from the video lights by retreating back into a hole in the reef.

### 3355 Golden Cowry

5 scenes

The golden cowry (*Cypraea aurantium*) is a large shell that varies from yellowish orange to bright, deep orange, almost red. They live primarily on oceanside seaward reefs, hiding in holes and caves during the day and becoming active at night to feed on sponges and possibly algae. The mantle covering the shell is a combination of white, black, and translucent patches through which the orange shell can be seen. The mantle is also covered with large, branched papillae, looking like minute leafless trees. The first scene shows a golden upside down on a cave ceiling with its mantle partly extended over the shell. Night-time plankton swim around the lights. In the second, a young specimen is viewed head on, giving a good view of the sensory tentacles and small black eyes. The third scene shows a cowry with its mantle mostly extended, and a small harp shell crawling quickly away in front of it. Next is a shot of a golden with its mantle fully extended and completely covering the orange shell. Finally, a group of three goldens in a single cave was filmed on a night dive.

### 3415 Nussatella Cone

This cone shell (*Conus nussatella*) seems to prefer living in the vicinity of patches of fine sand near reefs. The anterior end is to the right, where we see the siphon extending out of the shell. Below that is the front of the foot, where the small sensory tentacles and eyes are located. Cone shells are predators. Many, such as the nussatella cone, eat worms. Some others eat other mollusks such as small tritons and cowries. A few species eat fish. Most cones catch their prey using a poisoned harpoon delivered by a tentacle that extends from the mouth, which lies below the siphon and is not visible in this scene. In some species, especially those that eat fish, the venom delivered with the harpoon can be dangerous to humans.

### 3421 Circumcised Cone

*Conus circumcisedus* lives on lagoon pinnacles and deep on the seaward reef slope. Its shell, like that of many other cones, is covered in life by a reddish brown to brown periostracum, a tough skin-like layer that can hide the true coloration of the shell. In this species, the actual shell color is usually white to very pale purple, often spotted with small brown spots. Through the periostracum, this shell color is not evident. Unlike the mantle that covers the shells of cowries, the periostracum is not part of the animal; rather, it is deposited by the cone animal while the shell is being created. Below the shell, we can see the mottled brown, white, and black foot. The circumcised cone is a fish eater. Its venom is powerful enough to quickly immobilize a fish, so it must be considered dangerous to humans. The venomous stinger would extend from beneath the siphon on the right side of the scene.

### 3425 Striated Cone

2 scenes

*Conus striatus* is another fish eater, and is therefore likely to be dangerous to humans. These cones prefer shallow subtidal lagoon reefs. They hide buried in the sand underneath rocks during the day, emerging at night to hunt for sleeping fish. In the second scene, a Striated Cone is shown with her clutch of eggs. Each of the white egg capsules contains many eggs. The eggs are not brooded or protected by the cone; once deposited on the rock, the cone may leave.

### 3432 Obscure Cone

The small, thin-shelled *Conus obscurus* lives in ledges and caves on the seaward reef slope. It becomes active at night to hunt for sleeping fish. As a fish eater, it is potentially dangerous to humans.

### 3436 Geography Cone

Another fish eating cone, the geography cone (*Conus geographus*) is probably the most dangerous to humans. Several deaths have been attributed to its sting. Also, it is a very active cone. Many species will retract back into their shells when disturbed; not so the Geography. At the risk of being anthropomorphic, picking up the shell seems to only annoy the animal inside. Often when a Geography Cone is picked up, it immediately extends its proboscis with its venomous harpoon. Worse yet, there is no way a person can safely hold the shell; the stinger is capable of stretching out all the way to the far end of the shell and beyond. If you ever have occasion to pick up a living specimen of one of these cones, watch it very carefully all the time. Drop it at the first sign of a long tentacle coming out from below the siphon. Better yet, don't pick it up without very good reason.

### 3441 Legate Cone

This pair of small pink or orange tented cones (*Conus legatus*) was observed under a rock with their clutch of eggs. The Legate Cone is a molluscivore, eating the animals out of other kinds of seashells. They live under rocks and rubble on the seaward reefs and on lagoon pinnacles.

### 3445 Episcopal Cone

The episcopal cone (*Conus episcopatus*), like most of those with shells bearing tent-shaped markings, is a mollusk eater. It stings prey seashells, slowing them down enough to eat them. A molluscivorous cone eats its prey by extending its mouth into the aperture of the prey's shell to surround the animal. It maintains this position until it digests enough to pull the remainder out and retract into its own shell. Mollusk eating cones have venom that is probably not as dangerous to humans to that of fish eaters, but is dangerous nonetheless. Human fatalities have been reported from the sting of at least one molluscivorous species, and others may be equally dangerous. It is wise to treat all cone shells as dangerous unless you have reason to know it is not.

### 3450 Auratus Cone

The large, tented *Conus auratus* lives on lagoon pinnacles and on the seaward reef. It is seldom seen in the living state, but is apparently a favorite meal of some sharp-jawed predator. Quite a few shells are found empty, with the shell broken in much the same way in each case. These shells look as if something with a strong, sharp jaw bit through the middle of the ventral side of the shell, breaking a narrow hole in the shell through which the cone animal was extracted.

### 3456 Netted Cone

#### 2 scenes

The netted cone (*Conus retifer*) lives on intertidal reefs, lagoon pinnacles, and seaward reefs. It hides in rubble or under rocks by day and emerges at night to eat mollusks. In the second scene, a cone is stretched out between pieces of coral to eat a vermetid mollusk; the scene ends with the cone extracting the vermetid from its tube-like shell.

### 3504 Textile Cone

#### 5 scenes

One of the best known cones is *Conus textile*. While it has been reported that its sting is dangerous to humans, the textile is a mollusk eater. From these sequences, however, you almost have to wonder how it ever gets enough to eat. In the first four scenes, the textile is attempting to sting and eat a granulated frog shell, *Bursa granulata*. In the first, the long red tentacle that delivers the venomous harpoon extends from the cone in search of the prey. In the second scene, the cone finds its target; the stinger enters the aperture of the *Bursa* and stings the animal. As it stings, a cloud of white venom is released. The *Bursa* then extends its own proboscis to try to fight back. In the third scene, the textile is trying to deliver another harpoon, but the *Bursa* will have none of it. It finds and pushes away the cone's stinger as it fires milky venom harmlessly into the water. Finally, the *Bursa* rights itself and starts to crawl away. To give itself time to escape, it once again extends its proboscis, physically pushing the cone's animal back into its shell. The *Bursa*'s fight was successful; it did not become a cone meal that day. In the last scene, a pimpled basket shell, *Nassarius papillosus*, stumbles upon a textile cone. As soon as the basket shell senses the cone is there, it begins its escape response of twisting its large foot, causing the shell to flip away from the cone. The basket also lived to crawl another day.

### 3537 Title: Sea Slugs

Sea slugs are related to the seashells, but for the most part lack a thick heavy shell. Some have thin, delicate shells or small internal shells, but others lack shells completely. The best known of the sea slugs are the nudibranchs, completely shell-less snails that are often brightly and extravagantly colored. Other sea slugs include bubble shells and their relatives, sea hares, pleurobranchs, and others.

A good, hard, thick shell can be a pretty effective defense for a soft bodied animal. However, shells do have some disadvantages. They are heavy, slowing down the movement of the mollusk inside. Also, shells are inflexible, preventing the animals from going into narrow openings, perhaps making them more conspicuous to predators. It would seem that in some cases, it might be best to develop without a shell for increased mobility and hiding ability. Sea slugs have done essentially that. Although their ancestors did possess shells, and their larvae still have very tiny shells, most slugs during development drop their larval shells or keep them small and thin. Lacking thick, heavy shells, most soft bodied sea slugs would seem to make an easy meal for any predator who could find them. In fact, in dropping their shells, most slugs have been forced to evolve some other means of protection. For some, it is a cryptic appearance or habit. Other pick up something in their diet that makes them unpalatable. Some of these possibilities are discussed below.

### 3540 Inornata

*Chelidonura inornata* is a relatively common species can be found on shallow lagoon reefs crawling about in the daytime.

### 3544 Amoena

Similar to the previous species, *Chelidonura amoena* is less common.

### 3546 Gardiner's Sea Slug

Gardiner's sea slug (*Philinopsis gardineri*) usually buries in sand during the day. It can most easily be found by looking for its egg mass, which is a small gelatinous balloon generally attached by a small stalk to the surface of the sand. If you see these, you can often find Gardiner's or related sea slugs buried in the sand nearby.

### 3549 Pilsbry's Sea Slug

Like the Gardiner's slug, Pilsbry's sea slug (*Philinopsis pilsbryi*) is usually buried in fine sand during the day, and it too often leaves its balloon-shaped egg masses, seen here waving around in the background, at the surface.

### 3553 Long-tailed Sea Hare

*Stylocheilus longicauda* is named for its very long tail. It is found pretty much exclusively as part of the drift community, living on floating masses of algae and other debris. Sometimes it can be found on the underside of floating docks, or, as in this case, on buoy lines left in place for considerable time. This one was found living on the buoy line marking a sunken shipwreck at Kwajalein, Marshall Islands. Formerly called *Stylocheilus citrina* for its yellow color, it has been shown that the earlier name of *longicauda* should be applied to this species. A more common species that lives on the bottom and used to be called *Stylocheilus longicauda* is now known as *Stylocheilus striata*.

### 3557 Sea Hare

2 scenes

Since they are plant eaters, most sea hares such as this *Aplysia* live in areas with lots of algae. This species is capable of swimming when disturbed.

### 3605 Sea Hare

2 scenes

The large sea hare *Dolabella auricula* is shaped like a triangular wedge. Like many of its relatives, it is capable of spurring purple or maroon ink when disturbed.

### 3615 Mertens Sea Slug

This slug, *Berthella mertensi*, belongs to a group called pleurobranchs, characterized by the location of their gills under the side margin of the animal.

### 3619 Forskal's Sea Slug

2 scenes

*Pleurobranchus forskalii* is a highly variable species that comes in a number of color forms. Two of these color forms are shown in these two scenes. It lives under rocks on shallow lagoon reefs.

### 3627 Elysia

*Elysia (ornata?)* belongs to a group of sea slugs that use a single finely pointed spear-like tooth to puncture individual plant cells to suck out the contents.

### 3631 Eastern Paddle Slug

*Polybranchia orientalis* has paddle-like processes growing out of its body that make the animal look kind of like a clump of algae. The processes detach from the body easily, which may confuse or distract a predator that tries to attack the slug.

### 3635 Nudibranch

*Phyllidia tula* is a common species found exposed on hard substrates. The nudibranchs in this family are frequently observed out in the open during the day. They are relatively immune to predation, since all species are highly poisonous. When disturbed, they can secrete a milky fluid from their skin that drives potential predators away. This characteristic also makes them not very suitable for maintaining in a home aquarium. If disturbed, they will secrete the toxins that can kill off everything in the aquarium and in the process, stink up the entire room.

### 3640 Nudibranch

*Fryeria menindie* is similar in color to the previous one, and the two species, along with several other similarly colored species that are not shown in this film, exhibit a phenomenon biologists call Mullerian mimicry. Here's a generalization on how it's thought to work. Once a predator knows that a particular kind of animal is poisonous, it will learn to refrain from trying to eat that animal. But what if there are lots of predators and relatively few prey? Does each predator have to learn not to eat this kind of animal by trying one? If the prey is killed or severely damaged in the encounter, the species would suffer from attempted predation even though it is inedible. But what if several different species, all poisonous, evolved over time to look like each other? If a predator cannot tell the difference, it is as though there were suddenly lots more of this kind of potential prey. Fewer members of each of the poisonous species would be damaged or killed "teaching" predators not to eat them.

### 3643 Pustulose Nudibranch

*Phyllidiella pustulosa* is another of the poisonous nudibranchs feeding on its prey sponge. Under natural light at depths greater than about 10 feet, those pink pustules covering the nudibranch look green.

### 3646 Elegant Nudibranch

Like the other phyllidiid nudibranchs seen in the last three segments, *Phyllidia elegans* secretes toxins that make it both inedible and foul smelling.

### 3651 Ocellate Nudibranch

*Phyllidia ocellata* is quite variable in color throughout its Indo-Pacific range. The form shown here comes from the central Pacific Marshall Islands.

### 3655 Tuberculate Nudibranch

This is a rather small individual of *Dendrodoris tuberculosa*, a nudibranch that can grow to at least 250mm long. They move slowly and have a hard, rubbery texture. Like the phyllidiids seen before, they protect themselves with chemical defenses. A slimy secretion from their body is apparently toxic; it certainly causes irritation if you handle it and then rub your eyes. Generally, this species hides during the day, sometimes coming out into the open at night.

### 3700 Longspot Nudibranch

This elongate *Dendrodoris* nudibranch is a bit softer and faster moving than the previous species. These are most often found underneath rocks during the day.

**3705 Red Dendrodorid**

The red dendrodorid (*Dendrodoris rubra?*) is found at least from Hawaii through the Marshall Islands. In the Marshalls, it lives in caves and moves around at night in search of its sponge prey. The two white tipped, red tentacles extending from the dorsum on the left are called rhinophores. They are used in the nudibranchs chemical detection system (essentially, its sense of smell). The red tuft near the opposite end are the gills, also called branchiae. It is from these exposed “naked” branchiae that the word nudibranch—naked gill—is derived.

**3709 Spanish Dancer****3 scenes**

The spanish dancer (*Hexabranhus sanguineus*) is one of the largest nudibranchs, in some areas growing to more than 500mm long. The first scene shows a small individual in a cave at night. The second shows one with its pink, flowery egg mass, which it deposits on exposed rocky surfaces. The final scene shows a medium sized individual swimming up off the bottom; the flaring of its marginal “skirts” gives the Spanish Dancer its common name.

**3723 Nodulose Nudibranch**

This small, relatively hard nudibranch (*Hoplodoris?*) is covered with rounded warts. They live under rocks and eat sponges.

**3727 Nudibranch**

*Platydoris cruenta* is a relatively large, somewhat flattened nudibranch with a rough, sandpapery texture. They too usually hide beneath rocks during the day.

**3731 Bohol Nudibranch**

This large, attractive nudibranch, *Discodoris boholensis*, is found in the Indian and Pacific Oceans from East Africa through Micronesia. The single specimen found in the Marshalls was crawling through a patch of *Halimeda* algae on the lagoon slope.

**3735 Nudibranch**

*Kentrodoris funebris*. The black and white colors on this nudibranch contrast sharply with the blue sponge it normally eats. This specimen was found not on its prey sponge but under a rock, with a pycnogonid sea spider clomping by in the background.

**3740 Nudibranch**

*Kentrodoris rubescens* is a large soft nudibranch that lives in shallow water on the seaward reef, sometimes hiding between the branches of dead coralheads.

**3744 Nudibranch**

A small species that rarely exceeds about 25 mm long, *Halgerda albocristata* is most often found on lagoon reefs and pinnacles under rocks.

**3747 Nudibranch**

A sponge feeding nudibranch, this *Halgerda* is active at night in small caves and ledges on the seaward reef.

**3752 Nudibranch**

*Ceratosoma sinuata* is an uncommon species that lives under rocks on lagoon reefs and pinnacles.

**3755 Elisabeth’s Nudibranch**

*Chromodoris elisabethina* lives on lagoon pinnacles and on the seaward reef. It is found under rocks or in small caves. Here it crawls over various sponges on the undersurface of a rock.

**3800 Coleman’s Nudibranch**

Less common than the previous species, *Chromodoris colemani* lives under rocks and in small caves on lagoon pinnacles. In this scene, it crawls around the edge of a small sponge clump.

**3806 Purple-spotted Nudibranch**

*Chromodoris aspersa* lives under rocks on shallow lagoon reefs and pinnacles.

**3809 Geometrical Nudibranch**

*Chromodoris geometrica* is often found crawling about in the open during the day. It often waves its front margin up and down as it moves along.

**3814 Red-horned Nudibranch**

This may be an unnamed species, although it is very close to *Chromodoris rubrocornuta*, which has a pure white rather than a yellow body. It lives under rocks on shallow lagoon reefs and pinnacles, and so far, the yellow form is known only from Kwajalein Atoll in the Marshall Islands.

**3818 Seto Nudibranch**

*Chromodoris setoensis* crawls over red sponge that encrusts the undersurface of a rock.. Many scientists consider this a form of another nudibranch, *Chromodoris decora*.

**3823 Nudibranch**

*Thorunna australis* is a small sponge-eating nudibranch that lives under rocks on shallow lagoon reefs and pinnacles.

**3826 White-pustule Nudibranch**

This pair of *Chromodoris albopustulosa* is under a rock on a shallow lagoon reef. Nudibranchs align themselves in this position, facing opposite directions, for mating. Although nudibranchs are hermaphrodites (that is, each individual has both male and female reproductive organs), they cannot fertilize their own eggs. During mating, each individual functions both as a male and a female, and afterwards, each will go off to deposit its own egg mass.

**3829 Nudibranch**

*Glossodoris rufomarginata* prefers areas with lots of water movement, where it feeds on its prey sponge, the dark gray species it is crawling on in this scene. In the Marshalls, it is most often found in shallow water ledges and caves along the windward reef. Most of the year, this area is pounded by surf and strong trade winds, and it is a rare day that is calm enough to get into the area to see them. The individual in this scene was attached to a large sponge colony that had been ripped from the reef by the surge, rolled across the intertidal zone, and deposited on the lagoon slope at a depth of about 60 feet. The nudibranch has to be able to hold on extremely well to survive not only the pounding surf but also being rolled several hundred yards across a rocky reef.

**3834 Nudibranch**

*Glossodoris hikuerensis* is an uncommon nudibranch usually found beneath rocks on lagoon or seaward reefs. Here a very small individual nestles up against a much larger one. Like some related species, this one continually wiggles its gills.

**3839 Tom Smith's Nudibranch**

*Glossodoris tomsmithi* is a sponge eating nudibranch common in Hawaii and found occasionally in the Marshall Islands. Like the previous species, it continually wiggles its gills.

**3843 Black Margin Nudibranch**

Here a *Glossodoris atromarginata* is crawling across colonial tunicates attached to the underside of a rock.

**3849 Tryon's Nudibranch****2 scenes**

*Risbecia tryoni* is a relatively large nudibranch usually found in pairs on lagoon reefs. Nudibranchs in this genus exhibit what is called trailing or queuing behavior as they crawl along. The trailing individual follows the leader by keeping the front edge of its crawling foot on the tail of the one in front.

**3856 Nudibranch**

This long slender *Hypselodoris maculosa* usually hides under rocks during the day.

**3900 Green Spotted Nudibranch****3 scenes**

These three scenes show different individuals of *Nembrotha cristata*. This species feeds upon small dark green tunicates. In the third scene, a large individual crawls through a colony of pink Stylaster coral.

**3910 Nudibranch**

*Nembrotha kubaryana*, although related to the species just seen, differs in having flaming red edges to its gills, rhinophores, and foot margin.

**3915 Nudibranch**

This small *Flabellina exoptata* is part of a group of nudibranchs that defend themselves using stolen weapons. Many of the nudibranchs covered with these tentacles, which are called cerata, eat corals and relatives of corals such as hydroids or sea anemones. Remember from early in the tape that many of the coral relatives defend themselves using stinging cells called nematocysts (for example, see scene 0138, Stinging Coral). Not only can these nudibranchs eat the various stinging prey safely, they manage to keep the stinging cells intact while they eat the coral animal. The intact stinging cells move along the gut of the nudibranchs and out into the cerata tentacles, where they are placed at the cerata tips. In this way, the nudibranch, using the coral's own defenses, become just as capable of stinging as their prey, thus protecting themselves from many other kinds of predators.

**3921 Black Nudibranch**

Like the previous species, *Protaeolidia atra* eats hydroids. But unlike the previous one, it blends into its normal food source background, the hydroid it is on in the scene, very well. This kind of nudibranch is almost never found anywhere but on its prey hydroid.

**3924 Chooch Nudibranch**

This scene just shows the front end of a *Pteraeolidia ianthina*, a long, slender nudibranch with many rows of curved cerata tentacles. Often this species is blue in color; this individual is more brown. These nudibranchs eat hydroids (similar to those in scene 0933), and store the stinging cells from those hydroids in the tips of their cerata, and the sting from the nudibranch can even be felt by divers.

**3929 Nudibranch**

A *Bornella stellifer* is crawling across the undersurface of a rock towards a yellow scallop, *Chlamys coruscans*.

**3933 Eel Nudibranch****2 scenes**

*Bornella anguilla* has unusual swimming behavior for a nudibranch. A number of species are able to "swim" by laterally or dorso-ventrally bending their entire bodies one way, then the other. Unlike these, the Eel Nudibranch swims just like an eel or blenny fish. The swimming behavior is observed when the animal feels threatened or falls from its normal habitat of seaward reef cave walls and ceilings. In the second scene, the swimming is briefly shown.

**3940 Green Triton Nudibranch****2 scenes**

These two scenes show the full body and then a close up of the head of a green triton nudibranch.

**3948 Orange Triton Nudibranch**

*Tritoniopsis elegans*, like other species in this group, eats soft corals.

**3952 White Triton Nudibranch**

This is the same species as the orange one shown previously. Their coloration may depend on the colors in the soft coral they have been eating.

**3958 Title: Octopus and Squid**

The most highly developed and intelligent of the mollusks, and indeed of all the invertebrates, are probably the cephalopods, which include the octopus, cuttlefish, and squid. Their well developed eyes are similar in design and function to eyes of mammals, although they arrived at that similarity through very different paths of development. It is mostly the eyes, which stare back at you while you watch them, that give these animals their look of intelligence. Looking at them, one gets the feeling that, if given enough time to evolve, they could even develop higher intelligence. Many of the attributes we associate with higher intelligence are there: the tentacles are capable of manipulating their surroundings and their excellent vision and astonishing ability to change color could form the basis of an elaborate communication system. Who knows what could happen if humanity does not kill them all off first.

**4001 Squid****2 scenes**

While most octopus are solitary, some squid, such as these *Sepioteuthis lessoniana*, tend to form groups and live up in the water column. They are often colored so that they are hard for predators to see both from above and from below.

**4008 Cuttlefish in water column****2 scenes**

Cuttlefish give the impression of being sort of half-way between squid and octopus. They are shaped more like squid, but they tend to live on or near the bottom. This species of *Sepia* from the Marshall Islands has a body texture and coloration that more resemble the common octopus. These first two cuttlefish scenes show an individual who has swum up off the bottom but is now trying to get back down to hide.

**4014 Cuttlefish**

Cuttlefish lay their eggs as clusters of balloons attached to the undersurfaces of rocks. Here, the tiny cuttlefish are visible within their egg capsule balloons, and one hatches out, squeezing free and getting away while we watch.

**4025 Cuttlefish****3 scenes**

Cuttlefish are most comfortable near the bottom. This small species lives beneath rocks during the day, emerging a short ways out at night to forage. A close-up shows the bizarre eyeball of a cuttlefish.

**4041 Octopus**

The next ten scenes show the common octopus, *Octopus cyanea*, in pretty typical poses. They can often be seen stretching up out of a hole in the coral or rocks to look at a passing diver. When approached, they usually pull back down to hide.

**4047 Octopus**

This one is out in the open, crawling over dead coral.

**4051 Octopus**

Octopus are capable of rapid and drastic color changes.

**4100 Octopus**

Another interesting octopus behavior is what we call ballooning. Occasionally when octopus are seen moving about in the open, they will quickly reach their eight arms around a rock, causing the thin tissue connecting the arms to puff out like a balloon or parachute. Why do they do this? Possibly displaying at another octopus as part of courtship behavior. Possibly they are using their arms to scare shrimp or crabs out from under the rock and catching them in the balloons. Or possibly they are just making themselves look larger to deter possible predators. When octopus are moving around in the open like this, you will often see them shadowed by groupers such as the one hovering nearby in this scene. The grouper might grab at one of the thin arm tips if given the chance. Or maybe the grouper is just hoping some of the small fish, crabs or shrimp the octopus scares from under the rocks will escape and become grouper food.

**4109 Octopus**

Octopus can either walk across the bottom or swim over it.

**4118 Octopus**

This one makes a quick color change as it lands.

**4125 Octopus**

Walking over the bottom, an octopus pales out. Notice how it keeps its thin tentacle tips curled up. It may do this to help prevent opportunistic small predatory fish from nipping at and biting off the fine tips.

**4135 Octopus**

This octopus retreats into its hole at the approach of the camera. Curiosity gets the better of it, though, and it has to come back out for a closer look.

**4143 Octopus**

As an octopus moves onto an old dead table coral, it instantly changes color to match its surroundings.

**4149 Octopus**

An octopus flashes at the photographer several times before swimming away.

## 4215 Credits

This video was filmed, produced, and edited by Scott Johnson and Jeanette Johnson. Most of the scenes were filmed at Kwajalein Atoll in the Marshall Islands. Filming was done using Sony or Nikon Hi8 camcorders in an underwater housing produced by Light & Motion Industries of Monterey, CA. The tape was produced using non-linear editing. Footage used in the video was captured to computer disk, edited using Adobe Premiere, and put back out to tape.

### Music

The music in this video comes from the CD *Sea Dreams* by Ashley and Franks. This and other "Dreams" titles by the same artists are distributed by Holborne Distributing Co. Ltd., PO Box 309T, Mt. Albert, ON L0G 1M0 Canada.

### Acknowledgements

Special thanks to Scott Finkel, who assisted greatly in cover design and execution, and acted in our behalf in getting the sleeves and tape copies produced. Thanks also to the many dive buddies who helped us find creatures to videotape: Bess Buchanan, Kathy Campbell, Karen DeGross, Kent DeGross, Kathi Hammon, William Ince, Stan Jazwinski, Norm Lariviere, Becky Mathews, Rob Ramsey, Al Vaccaro, Madelain Westermann, and others.

### References

There are several books available that offer color photos of marine invertebrates. The three recent volumes that we use most often are the following:

Colin, Patrick L. & Charles Arneson. 1995. *Tropical Pacific Invertebrates*. Coral Reef Press. 296pp.

Gosliner, Terrence M., David W. Behrens, and Gary C. Williams. 1996. *Coral Reef Animals of the Indo-Pacific*. Sea Challengers, Inc. 320pp.

Hoover, John P. 1999. *Hawaii's Sea Creatures – A Guide to Hawaii's Marine Invertebrates*. Mutual Publishing. 396pp.

These books, and many others on marine life and other natural history subjects, are available from Sea Challengers at [www.seachallengers.com](http://www.seachallengers.com).

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