Diving Kwajalein Atoll

Filmed and edited by Scott and Jeanette Johnson
Music by Cori Ashley and Ed Franks

Diving Kwajalein Atoll is a 60-minute diving tour of the underwater world of Kwajalein Atoll.

Lying 9 degrees north of the equator and roughly halfway between Hawaii and Australia, Kwajalein is part of the Marshall Islands, a group of 34 atolls (or 29 atolls and 5 isolated coral islands) that make up the eastern edge of Micronesia. Water temperature here varies from a winter minimum of 79º F to a summer peak of 86º F (26º to 30º C). With lots of rainfall but little land area for runoff, the water is clear and the lush coral reefs support a wide variety of fish and invertebrate inhabitants.

Irregularly boomerang-shaped, Kwajalein is the largest atoll in the world. Altogether, about 320 kilometers (200 miles) of perimeter reef enclose a lagoon of more than 2500 square kilometers (1000 square miles) that contains innumerable coral pinnacles and knolls that rise from its 45 to 60-meter (150 to 200-foot) bottom, some reaching right to the surface. The possibilities for underwater exploration seem limitless.

The majority of the scenes in this DVD were shot within about 25 kilometers of Kwajalein, most of those within the standard boating area for rental boats from Kwaj. Some, however, were filmed all the way out at the other end of the atoll, and a few scenes were taken at Namu, the next atoll south, about 56 kilometers from Kwaj.

Scenes were shot in a variety of atoll habitats both in the lagoon and on the seaward (oceanside) reefs. Habitats include coral reefs, steep walls, pinnacle reefs (sometimes locally called coralheads) reaching to the surface from the lagoon bottom, sand patches, beds of a calcareous alga called *Halimeda* that sometimes carpet a sandy bottom, shipwrecks, and more. Interesting creatures can be found in all these places, and we hope you'll agree after viewing this video.

One theme you'll notice running throughout this document is the preference for scientific names of marine life. If you are interested, there are some comments in the appendix at the end of this document regarding use of scientific names and their preferred use in place of common names. At this point, it need only be said that common names are rarely common, often varying from place to place, and that scientific names based on Latin is a means of standardizing names throughout the world.

However, on the subtitles we used mostly common names. This is simply to make it easy to find the description of the scene. Most DVD players allow you to turn on subtitles. Each separate scene is described in a paragraph below, and the title of that paragraph is the subtitle you can make visible on the screen. So if you want to know more about the animals or the scenes you are viewing, download this file and turn on the subtitles, using them to key into the proper paragraphs.

Surf on a windward Kwajalein reef
Surf crashes on a windward Kwajalein reef. The outer atoll reefs are exposed to ocean swells that pound over the edge of the shallow reef, throwing water up onto the reef and flowing across to the lagoon.

Diver drops into water
A diver drops into clear water from a boat anchored on the leeward seaward reef of southern Kwajalein Atoll. This area, usually referred to as "oceanside west reef" by local divers, has a gradual slope from the intertidal outward to a typical depth of roughly 5 to 10 meters. At this point, it abruptly drops over into a steep slope of about 60 degrees, sometimes even more and in a few small areas becomes even vertical or undercut. Often this area, washed by open ocean water and currents, can be very clear, sometimes with a visibility of 50 meters (maybe 165 feet) or more. Other times, visibility can be much reduced. Westerly swells or stiff trade winds out of the east or northeast can raise a chop on the lagoon intertidal reef, stirring up the shallow water. Couple this with a falling tide to carry the stirred up sediments outward

and visibility can drop significantly. But at times like that you can just hide behind one of the west reef islands to block the cross-reef tidal flow and you can usually find clean water.

Diver swims over seaward reef front
A diver is silhouetted swimming over the seaward reef front, or the knee of the drop where the gradual slope from the shallows abruptly turns downward. This is a rich area for different kinds of fish.

Diver passes under archway
A diver passes under a small archway on the leeward seaward reef. Parts of the seaward reef are cut by channels perpendicular to the dropoff. These are locally called surge channels, although they are not the same as the surge channels that cut through the shallow algal ridge at the edge of the intertidal reef on the windward side of the atoll. The channels out near the drop are sometimes interconnected with narrow caves or archways such as the one pictured here.

Diver photographs bluestreak fusiliers
A diver photographs *Pterocaesio tile* on a coral-encrusted lagoon pinnacle slope. Most species in this fish family often school in large numbers. *Pterocaesio tile*, commonly called bluestreak or neon fusiliers, are frequently seen both lagoonside and on the seaward reef. These fish, and others in the fusilier family (Caesionidae), often seem curious about divers, and will sometimes swarm around them.

Bluestreak fusiliers on lagoon pinnacle
Pterocaesio tile school on a lagoon pinnacle slope that is covered with mostly corals in the family Acroporidae.

Bluestreak fusiliers over staghorn coral
Pterocaesio tile school over the staghorn *Acropora* coral on the atoll's seaward reef. This fish is common on both lagoon and seaward reefs.

Scissortail & twinstripe fusiliers
A school of mostly twinstripe fusiliers (*Pterocaesio marri*) mingle with a few scissortail fusiliers (*Caesio caerulaurea*) on a pinnacle reef. The former has black tips on its tail fin and the latter has a dark line extending along the length of both lobes of the tail. The caesionids are often found in mixed schools. A yellow foxface rabbitfish (*Siganus vulpinus*) passes in background.

Yellowback fusiliers
Another of the schooling caesionids, *Caesio teres*, mill around in front of the photographer on the atoll's seaward reef. Depending on the book you read, this is called either the blue and yellow or the yellowback fusilier. The name yellowback is I think more appropriate for young individuals, since on those the yellow just in front of the tail extends farther back onto the dorsal surface of the fish. On these adults, the yellow is mostly near the tail. These fish swarmed around the photographer and stayed there swimming around and around for many minutes.

Threeline fusiliers & anemones
A school of the mostly lagoon dwelling threeline fusiliers (*Pterocaesio trilineata*) passes in front of two color forms of the magnificent sea anemone (*Heteractis magnifica)*. This particular fusilier is usually found only on lagoon reefs. In the nearer anemone, you can see a couple of apricot clownfish (*Amphiprion perideraion)*.

Two sea anemones on small coralhead
The camera approaches a small coralhead that supports two anemones, *Heteractis magnifica* (on top) and *Heteractis crispa*. The apricot anemonefish (*Amphiprion perideraion*) is usually found in *H. magnifica* while the orangfin anemonefish (*Amphiprion chrysopterus*) is often in *H. crispa*, and both can be seen in this scene if you look close. A few young *Pterocaesio tile* pass in front, and small cardinalfish mill about over and around the coralhead. Isolated reefs in sandy areas often attract large numbers of fish to take advantage of the shelter they offer.

Anemone with apricot clownfish
A striking magenta-based *Heteractis magnifica* with lavender tentacle tips contrasts starkly with its somewhat drab surroundings on a lagoon pinnacle reef. This anemone hosts the apricot clownfish (*Amphiprion perideraion)*. This clownfish is also called a pink anemonefish. Many fish people don't care much for the common name clownfish, preferring to use anemonefish. We've been using clownfish for so long it is hard to change.

Apricot clownfish in magenta anemone
This is a closer view of the previous scene. These anemones are usually yellow or brown in color due to the presence of single-celled algae called zooxanthellae within their tissues. These algae, like all plants, process sunlight and carbon dioxide to produce oxygen and carbon compounds. This relationship is beneficial to both anemone and algae; the algae uses the carbon dioxide produced as a waste product by the anemone to produce oxygen and food for its anemone host.

Apricot clownfish in-balled-up anemone
A balled-up pink-base *Heteractis magnifica* hosts *Amphiprion perideraion* while *Pterocaesio tile* swim by in the background. These anemones will frequently ball up like this. We've seen them do it after being fed fish scraps, so maybe it is a normal reaction to engulfing some solid food. Although they can get nourishment from the zooxanthellae algae they harbor within their tissues, these anemones will also eat chunks of food, including living fish, if they get too close. Sea anemones, like most other members of the large and diverse group of animals related to corals, may be armed with specialized stinging cells called nematocysts. The nematocysts can often be thought of as a harpoon on the end of a coiled up spring, which can be released upon the slightest touch. The sting from a nematocyst discharge is frequently accompanied with venom, which can be quite virulent in some species. While the venom from this anemone is not especially potent, at least to humans, it is enough to paralyze or kill small fish that blunder into the tentacles, and the fish can then be swallowed by the anemone. The various species of clownfish (four of which are found in the Marshalls) and one kind of damsel are immune to the anemone's sting; through careful and repeated exposure, these fish apparently develop a special mucus coat on their bodies that keeps the anemone's stingers from being triggered. Hiding among the stinging tentacles is a safe place for a small anemonefish, and it seems that the fish "pays" for this protection by cleaning the anemone and sometimes even by delivering food directly to its mouth. Also, the clownfish may drive off passing butterflyfish or other animals that may try to eat the anemone.

Apricot clownfish in pink-base anemone
This is the same anemone as in the previous scene but closer.

Redfin & Bartlett's anthias
A school of mostly redfin anthias (*Pseudanthias dispar*) with a few Bartlett's anthias (*Pseudanthias bartlettorum*) come out of hole, then go back in. These two similar-looking species share the same habitat, mostly right around the knee of the steep dropoff on parts of Kwajalein Atoll's western seaward reef. They primarily live near the southern tip of the atoll. Both are abundant along the seaward reef of the northern part of Namu Atoll, which lies south of Kwajalein. You can pick out the few *P. bartlettorum* in the group by their brighter yellow backs. There is a clear shot of one near the upper right corner of the frame at the end of the scene.

Redfin & Bartlett's anthias in coral
Here is a mixed school of mostly *Pseudanthias bartlettorum* and a few *P. dispar* around fire coral on the seaward slope on the west side of Kwajalein. *Pseudanthias bartlettorum* was first described as a distinct species in 1981, when it was named after two Kwajalein diver/photographers named Nathan and Patricia Bartlett who were among the early divers to photograph and try to identify the species. A scientific name ending in "orum" is generally used when an animal is named after more than one person, in this case, after more than one person named Bartlett. These fish are abundant around a reef outcrop at the edge of the dropoff off the west end of Kwajalein, but it is hard to get there nowadays. The area was put off limits a few years ago after an unexploded artillery shell was found nearby. The shell was subsequently destroyed by demolition divers, but a couple of others were found nearby, as might be expected from a place where an invasion and major battle took place in 1944. It is hard to imagine that ordnance under the

water on this shallow reef, exposed to more than 60 years of jostling wave action (occasionally with huge waves coming in), could possibly present a danger.

Male Randall's anthias
The brightly colored male Randall's anthias (*Pseudanthias randalli*) lives on the steep seaward slope of Kwajalein's west reef. Like other species of anthias, the males and females look a bit different, with the male typically larger, more brilliantly colored, and nearly always fewer in number. One or a small number of males usually have a harem of females. Occasionally, or if the male is lost, one or more of the females turn into males, a biological process known as protogyny.

Male Princess anthias
A male princess anthias (*Pseudanthias smithvanizi*) swims around some old dead black coral branches upon which are perched a couple of black and white crinoids. A couple of smaller, less ornate female *P. smithvanizi* are briefly visible in various part of the scene.

Girdled wrasses & neon damsels
Numerous fish investigate a small hole in the reef. Most are the girdled wrasse (*Cirrhilabrus balteatus)*, the males gray above and white below with a squarish red patch behind the pectoral fins and the females red brown above and white below. Like the anthias seen above, wrasses start out as female and may change to male later in life. Also, there are a few of the bright blue neon damsels (*Pomacentrus coelestis*). At the very end, a young cleaner wrasse (*Labroides dimidiatus*) darts in.

Bluegreen chromis over Turbinaria coral
A school of tiny juvenile bluegreen chromis damsels (*Chromis viridis*) swims over the yellow coral (*Turbinaria reniformis*). These fish are often seen in clouds over bushes of branch corals, into which they dive at the approach of potential danger.

Fish on isolated reef
A small reef in the midst of open sand sand offers shelter to a variety of reef fishes, including the blue neon damsels (*Pomacentrus coelestis*), the bright yellow cardinal fish (*Apogon luteus*), and various other damsels, cardinals, wrasses, and more.

Bluegreen chromis & other fish
In a wide sand patch, a large isolated colony of the branching coral *Pocillopora* provides refuge to innumerable fish, mostly the bluegreen chromis (*Chromis viridis*) and a smaller transparent cardinal fish. Also visible are a number of the bluestriped yellow snapper (*Lutjanus kasmira*), sapphire blue damsel (*Pomacentrus pavo*), a larger orange-shouldered tang (*Acanthurus olivaceus*) skirting along the bottom, mostly black 3-spot damsels (*Dascyllus trimaculatus*), and a couple of black and white banded humbug damsels (*Dascyllus aruanus*).

Bluegreen chromis & others over coral
This is the same scene a bit closer. Now in addition to the *Chromis* and cardinals, you can see a few three-striped fusiliers (*Pterocaesio trilineata*) and the grayish fish with a pale spot near the tail, the yellowspot emperor (*Gnathodentex aureolineatus*).

Steephead parrotfish over coral
A school of mostly steephead parrotfish (*Chlorurus microrhinos*) swims by over dense coral growth on a midlagoon pinnacle.

Female minifin parrotfish school
A school of mostly female minifin parrotfish (*Scarus altipinnus*) cruises over a cut in the shallow seaward reef near Gea Island. Like the anthias seen earlier, parrotfish are protogynous hermaphrodites, changing from female to male as they get older. In this species, the females are reddish brown to maroon, while the males turn green.

Mostly minifin parrotfish
A *Scarus altipinnus* school grazes on the algae-covered rocks near some living coral colonies. The large reddish brown parrots are female, and there are a few green males also in the group. Other fish in the mass are a couple of the lined surgeonfish (*Acanthurus lineatus*) and several ringtail surgeonfish (*Acanthurus bloch)*, the black tangs with a white ring around the caudal peduncle. Early in the scene, a black and white snapper (*Macolor niger*) swims past right to left in the lower part of the screen.

Parrotfish creating fine sand
Parrotfish graze on algae that grow on dead coral or patches of bare reef. Scraping the thin coat of algae from rocks as they do, parrotfish also ingest a fair bit of dead coral rock scrapings, which turn into fine sand particles after passing through their digestive systems. The sand is released, often more or less simultaneously by an entire school of the parrots. They have a habit of coming around divers to do the deed, especially if those divers are carrying cameras and would prefer to shoot through clear water. How do they know when a diver has a camera?

Pink whipray feeding
As long as we are talking about clouding up the water, the stingrays are champions at raising water turbidity. Here is a diver passing over a large pink whipray (stingray) (*Himantura fai*) digging in a sandy patch of *Halimeda* algae on an east reef lagoon slope. Its digging exposes prey items such as burrowing echinoids (also called irregular urchins or sometimes "sea mice"), worms, and mollusks.

Pink whipray feeding
These digging stingrays often lead an entourage of other predatory fish looking for an easy meal. A flapping and digging stingray frequently scares out small fish, crustaceans, or other prey that the freeloaders will dart in and grab whenever possible. This stingray has a small dark ulua, possibly *Caranx lugubris* (although it is hard to be sure in this light) and a lighter-colored greater amberjack (*Seriola dumerili*).

Porcupine ray feeding
Most of the stingrays dig in this fashion. This porcupine or thorny ray (*Urogymnus asperrimus*) has dug itself quite a depression, showing it is willing to go rather deep in the sand to get a meal. Most of the large depressions divers commonly see in sandy areas are dug out by various kinds of stingrays. This one has a couple of accompanying sharksucker remoras (*Echeneis naucrates*).

Porcupine ray swims away
Although sometimes you can get pretty close to a digging stingray if you move in very slowly and carefully, more often they are a bit shy and slip away at the approach of divers. This one takes off with its pair of sharksuckers when the cameraman approaches from above.

Whitetail whipray
Very rare at Kwajalein is the whitetail whipray (*Himantura granulata*). We have seen only two here so far, although they seem to be a lot more common a few hundred miles to the west at Pohnpei, Caroline Islands. This very large specimen was slowly cruising over the flat top of a large lagoon pinnacle just in from Gea Pass. In addition to digging in the sand, stingrays will grovel in rocky reef areas, picking up and crushing large mollusk shells. We have even seen them active in this way at night on the seaward reef slope, where they probably find and crush nocturnally active mollusks such as golden cowries.

Sand dollar
One of the probably prey items for stingrays digging in sandy areas is this burrowing echinoid or sand dollar, possibly a species of *Clypeaster*. On some lagoon sand flats these form dense populations of dozens of individuals per square meter.

Sand dollar digging into sand
The sand dollars live just beneath the surface of the sand. If exposed by currents or surges (or some klutzy diver's flailing fins), they dig back down by moving sand grains out from underneath them and pushing the sand over the top.

Burrowing echinoids
While the sand dollars seen previously are very flat, there are other burrowing echinoids that are more oval or egg shaped. These species of *Metalia* are covered with larger spines than those of most sand dollars, showing their relationship with sea urchins.

Burrowing echinoids digging
Like sand dollars, other burrowing echinoids do not like to be exposed as that makes them easy prey. They will emerge to move around at night, but if they find themselves exposed in daylight, they actively dig themselves back into the sand.

Carneola olive shell
Other sand burrowers that could get picked up by sand digging stingrays include a variety of mollusks, such as this small common carneola olive shell, (*Oliva carneola*). Olive shells live buried in the sand during the day and plow around through the sand leaving trails at night when searching for food. When exposed like this, they usually immediately try to bury themselves again. In 1995, specimens of this olive shell from Kwajalein were given the subspecific name *Oliva carneola kwajaleinensis* because the two white spiral bands are raised a bit above the surrounding yellow shell; typical *Oliva carneola* from other areas are mostly smooth. It is a variable characteristic, and some of the shells here are smooth as well, so it is likely that the subspecies distinction is not necessary.

Bert's olive shell
This is another of the sand burrowing olives, Bert's olive (*Oliva berti*). Like the *Oliva carneola* just seen, this exposed shell is quickly trying to hide itself under the relative safety of the sand. This is another species named from Kwajalein as a minor variation on a more widespread species. It is hard to see where *Oliva berti* differs from the common Indo-Pacific species *Oliva miniacea*, but they may be distinct enough to warrant the separate name.

Lance auger shell
All of the auger shells are also sand dwellers. The lance auger (*Hastula lanceata*) is common in shallow water in sand patches in both lagoon and seaward reef habitats. Although the shell is usually buried just under the surface of the sand both day and night, you can often tell where these and other auger shells are by following the trails they leave in the sand as they crawl along.

Affinis auger shell
Another common sand burrowing auger shells is *Terebra affinis*. Here two individuals dig into the top of a coarse sand ripples. Like most augers, they tend to dig along just under the surface of the sand. They are active at night leaving trails in the sand while they hunt for their worm prey.

Little love harp shell
Some of the sand burrowing mollusks tend to dig deeper in the sand by day, usually emerging at night to hunt. This fast moving little love harp shell (*Harpa amouretta*) is relatively common in patches of *Halimeda* algae growing on sandy lagoon slopes. Smaller specimens are found in and around sand patches on the seaward slope. This is the only common species of harp shell found in the Marshalls. A rare species here is shown in the next scene.

Large harp shell
Harpa harpa is several times larger than the small *Harpa amouretta*. We have seen only three living specimens of this mollusk in the Marshalls, although we occasionally see shell fragments from specimens broken up and eaten. All three living animals were seen at night in a *Halimeda* patch on a shallow lagoon reef. Two of the three were mating when discovered.

Admiral cone shell
A number of cone shells also live in the sand. A species with a most intricate pattern is the Admiral cone shell (*Conus ammiralis*), shown here crawling across the sand at night. By day they are usually buried in sand in *Halimeda* algae patches or under rocks. At the right side of the shell you can see the siphon, the

black and white banded tentacles with a red tip. This is used to draw water in to flow across the gills, which are located safely inside the shell. A smaller white tentacle below the siphon sports an eye near its end. The eye is primarily used for detecting light, so the animal can tell when it is dark and it is relatively safer to come out of hiding.

Admiral cone shell with egg mass
This specimen of *Conus ammiralis* was out during the day in a *Halimeda* algae patch. It appears to have just deposited an egg mass on the algae. The eggs are within those white capsules above the shell. This species does not tend its eggs after laying them, so it is possibly just too tired after laying them to dig down again right away.

Omaria cone shell
There are a number of species of cone shells with triangular "tent" markings. These are collectively referred to as tented cones. This one is *Conus omaria*. The tented cones all eat other species of seashells, and they kill or immobilize their prey with a venomous harpoon. In some cone shells, the harpoon, an adaptation of the standard mollusk radula (or tooth), can be dangerous to humans. Certain fish-eating (piscivorous) cone shells have caused human fatalities. Note that the coloration on the siphon of *Conus omaria* is similar to the *Conus ammiralis* shown previously.

Marble cone shell with egg mass
The cone shell here also has somewhat tent-shaped markings and it is also a mollusk eater. This cone, *Conus marmoreus* or the marble cone, has been reported to eat primarily other cone shells, although we have also observed it eating top (*Trochus*) and turban (*Turbo*) shells in the wild. This *Conus marmoreus* is perched on *Halimeda* algae adjacent to its mass of egg capsules.

Tiger cowry
Other mollusks that make good photo subjects are the cowries. This is the relatively common tiger cowry (*Cypraea tigris*). The highly glossy shell is typically white with dark spots although the extent and pattern of the spots are highly variable. Cowries keep their high gloss by extending a thin flap of tissue called a mantle over the entire shell, especially at night when they are active. The mantle is the part of the shell's animal that produces the shell, and by keeping the shell covered most of the time and continually depositing shell material, the shell maintains its shiny appearance. The mantle is usually ornamented with projections called papillae. In *Cypraea tigris*, the papillae are simple spikes, mostly with white tips. The tiger is one of the larger cowries, growing to a bit more than 100mm in length in the Marshalls; Hawaiian specimens can get quite a bit larger.

Deer cowry
The papillae on the mantle of the deer cowry (*Cypraea vitellus*) are branched at the tips. This was shot during the day and the shell is partly exposed. The mantle may have also retracted due to the irritation of the video lights. From the anterior end of the shell (the right side of the photo) you can see the long gray-brown tentacles that are mostly used for feeling their way around, and just above but difficult to see against the papillose mantle is the fringed siphon, the tube through which water is drawn into the shell to flow across the gills.

Labrolineata cowry, mantle rising
The cowry (*Cypraea labrolineata*) has a mantle that is extremely frondose with long branching papillae, camouflaging the shell very well when the mantle is fully extended. This is a small cowry, usually much less than 25mm in length. The little bit of shell you can see shows it is bluish or greenish gray in color with whitish spots. Hidden by the mantle are dark spots that surround the base of the shell. Like most cowries, these live hidden away under rocks or rubble, or in clumps of *Halimeda* algae, by day and are active at night to feed.

Nudibranch Ceratosoma tenue
The hard shells of mollusks such as cowries helps protect them from being eaten by a variety of predators, although there are some who can crush the shell or eat the animal out of an intact shell. Some snails have evolved away from shells altogether. Among these are the nudibranchs, such as the orange

Ceratosoma tenue shown here. Lacking the protection of the shell, nudibranchs have had to evolve a variety of more active defenses, including a cryptic appearance or habit, poisonous glands, or use of stinging cells provided from their food. *Ceratosoma tenue* is one of the poisonous ones and is apparently very distasteful to fish predators. In the Marshalls, this species is most often found in beds of *Halimeda* algae on sandy lagoon slopes.

Nudibranch Ceratosoma tenue
In a second shot of the same species of nudibranch, you can see the primary anatomical features of this nudibranch. On the right side are two tentacles called rhinophores extending upward. The rhinophores are used for chemical sense, probably for "smelling" its sponge food or others of the same species for mating. A bit to the left of midbody is a tuft of other tentacles. These are the gills and it is the exposed nature of the gills in many (but not all) nudibranchs that gives the group its name ("naked gills"). Just behind the gills (to the left) in this species is an upturned flap of tissue that contains a concentration of poison glands. Presumably the exposed location of this flap might entice potential predators to sample this area first, hopefully getting a heavy dose of distasteful chemicals, which might make them leave the rest of the body alone. Further left the foot stretches out into a rather elongate tail curving upwards in the screen.

Nudibranch Glossodoris atromarginata
Another nudibranch, *Glossodoris atromarginata*, is also found fairly often in lagoon slope *Halimeda* patches, but this is not its normal habitat. By choice, this species lives in the shallow groove and spur system on the windward seaward reef, where it is usually found on its prey sponge. This area can get extremely rough at times due to high winds or storm-generated swell. Occasionally the nudibranchs or even the entire sponge colonies they inhabit get ripped off the hard substrate and rolled across the intertidal reef, coming to rest on the lagoon slope. Unfortunately, the sponge they eat does not naturally occur here, so once the nudibranch eats up all the sponge that came across with it (if any did), it must find another chunk that similarly rolled across or it will starve. Note that on this species, the gills (a bit toward the right side of the screen in this scene) continually vibrate. Presumably this aids in keeping a constant flow of fresh water flowing over the gills, which may aid both oxygen uptake and removal of wastes. In this group of nudibranchs, the posterior end of the digestive system opens to the outside right in the middle of this circle of gills. The specific designation "atromarginata" refers to the waving black line that forms a rim around the dorsal surface.

Nudibranch Glossodoris rufomarginata
These two nudibranchs belong to the same genus as the previous scene, but these are both *Glossodoris rufomarginata*. This time the "rufomarginata" portion of the name is a bit of a misnomer. The actual edge of the margin varies from white to light orange to brown, but in the first one scientifically described it must have been yellow. Like the previous species, *Glossodoris rufomarginata* continually waves its gills. Also like the previous species, this is most common in the rough seaward reef groove and spur system, and rather frequently specimens and colonies of their prey sponge take trips across the reef when surge conditions rip the sponges and their nudibranch riders from the ledges within which it grows. These two specimens show how variable some species can be.

Cephalaspidean sea slug
Related to the nudibranchs is a group of sea slugs called cephalaspideans. Some members of this group possess thin shells, sometimes internally. This one is called *Chelidonura hirudinina* and lives in sandy and algae patches on lagoon reefs. Sometimes it is present in large numbers, generally when they get together for mating. Although these sea slugs, like the nudibranchs, are hermaphrodites (that is, each individual possesses both male and female reproductive organs), they do not fertilize themselves; instead the male organs of one fertilize the female organs of the other, and this is generally done reciprocally. Some of these cephalaspideans get together in mating clusters where it is impossible to tell who is mating with whom.

Paddle sea slug
Another group of mollusks related to nudibranchs is Sacoglossa, which contains mostly shell-less slugs with a variety of different body morphologies. Unlike nudibranchs, which are all carnivorous,

sacoglossans are all plant eaters. The animal shown here is *Cyerce elegans*, a species with crowded paddle-like appendages dorsally. The paddles detach easily and may function in part at least for defense. A predator attacking this animal may end up with one or a group of sacrificial paddles, allowing the important body to escape. The paddles seem to regenerate quickly.

Lobed sea slug
One of the sacoglossans that does possess a thin shell is this *Lobiger virdis*. We have been finding these on the algae *Caulerpa urvilleana*, usually within lagoon sandy slope *Halimeda* patches. The four elongate lobes of the animal resemble branches of the algae. This animal probably relies mostly on its cryptic appearance for protection against predation.

Fire sea anemone, powerful sting
Although it resembles a plant with its green stalks and bushy appearance, this is a kind of sea anemone in the genus *Actinodendron*. They live in lagoon sand and algae patches and can retract completely under the sand if disturbed. However, fish or divers that disturb them probably do not do so often; members of this group of anemones are commonly called fire anemones, and with good reason. They pack a very powerful sting. Anemones, like other relatives of corals (including such disparate creatures as jellyfish and hydroids) possess tiny stinging cells called nematocysts. A nematocyst can be thought of as a coiled spring; the slightest irritation can trigger it to uncoil, usually into the object that triggered it. These nematocysts are often associated with venom, and in some species, like our *Actinodendron* here, the nematocysts are large enough and the venom potent enough to do damage to divers. It hurts! Yet, some animals, in particular a few species of crab and shrimp, are immune to or able to tolerate the stings and live in and around the anemones.

Fire sea anemone, powerful sting
A closer view shows the erect green stalks and bushy branches.

Corkscrew sea anemone
The sand dwelling corkscrew anemone (*Macrodactyla doreensis*) lives on Marshall Islands lagoon sand flats and *Halimeda* patches. It often is inhabited by a symbiotic three-banded anemonefish (*Amphiprion tricinctus*), as well as by one or more small commensal shrimp. The anemone gets its common name from the corkscrew shape of some of its tentacles.

3-banded clownfish in anemone
A more common sea anemone in the Marshalls is *Heteractis aurora*. These live in sandy and rubbly areas, and are often in patches of *Halimeda* algae. This particular anemone is host to a number of small three-banded anemonefish (*Amphiprion tricinctus*). These anemones will retract completely under the sand when disturbed, leaving the anemonefish living with it unprotected until it comes back out. As noted earlier, anemones have stinging cells called nematocysts. These nematocysts discourage many predators from approaching, which helps protect the anemonefish and other symbionts that live with the anemone. Also as noted earlier, many people prefer “anemonefish” to “clownfish” for these fish, but here at Kwajalein they’ve always been referred to as the latter.

3-banded clownfish & 3-spot damsels
Another anemone usually found in and around lagoon *Halimeda* algae patches is *Stychodactyla haddoni*. The anemone comes in several color forms, most often whitish or brown, but sometimes pink or red like the one in the next scene. Usually these anemones are host to many three-stripe anemonefish (*Amphiprion tricinctus*) and three-spot damselfish (*Dascyllus tricmaculatus*). Also there are several kinds of shrimp and crabs that live in and around these anemones, benefiting from protection from predation provided by the anemone’s nematocysts.

3-banded clownfish in red anemone
Among the color forms of the anemone *Stychodactyla haddoni* found in the Marshalls is this striking but rare red one. This species of anemone often seems to act as a nursery for juvenile anemonefish. In addition to the numerous small *Amphiprion tricinctus* and *Dascyllus trimaculatus* anemonefish living here, there are several juvenile butterflyfish trying to use the anemone as a defense against predation.

However, they have to be careful to keep from touching the anemone's tentacles. Butterflyfish have no defense against the anemone's nematocysts, and would be stung and likely eaten by the anemone if they touched.

Young butterflies hiding near anemone
Moving in a bit closer, we can see up close the juvenile butterflyfish visible in the previous scene. The one with the orange rear is the threadfin butterfly (*Chaetodon auriga*) and the mostly brown ones with lighter bands are Klein's butterflyfish (*Chaetodon kleini*). You might notice that the orange color on the anemone so visible in the previous scene is a lot more subdued, more a light pink, in the closeup scene. This is a lighting issue. The previous scene was taken with available light, while the closeup was shot with bright video lights. Many marine animals produce low levels of chemical light of their own, which can be completely hidden when artificial light is used. This anemone is found at a depth of nearly 20 meters (about 60 feet). At that depth, orange is usually not visible under natural conditions, the orange color having been filtered out of sunlight in the upper 10 or so meters of water. By the time sunlight gets down to 20 meters, the red and orange colors are completely gone, so any orange seen down that deep comes from either artificial light brought along by the diver (e.g., a flashlight) or is produced in the object itself.

Juvenile surgeonfish near anemone
Here is another closeup shot of a more whitish *Stychodaclyla haddoni* anemone showing another fish that is not normally an anemonefish taking refuge near (but not touching!) the anemone. The grayish looking fish with the slivery head and black eye is a newly settled juvenile surgeonfish or tang. Many fish spend the early part of their lives floating in the plankton while they develop their fish shape and get larger. While in the plankton, it is advantageous for the developing fish to be hard for plankton-eating predators to see, so they are often transparent or have a mirror-like finish to reflect images of the surrounding dark water. When they are ready to begin life on the reef, they "settle out" of the plankton to the bottom. (Of course they have to be lucky enough to be close to a reef to settle on; many are not and do not survive.) Within hours of settling, they generally change color, losing the transparent or mirror-like appearance. This little tang must have just settled out of the plankton, since it is still mostly transparent. You can see the spine and blood vessels running down the middle of the body, and the opaque internal organs are coated with a mirror-like sheen. Very soon this fish will turn mostly black, like several other small tangs seen in the same scene.

Young stripebelly pufferfish
Another juvenile fish found in the lagoon *Halimeda* patches is this small pufferfish, *Arothron hispidus*. The juvenile is typically more distinctly lined on the underside than the adult seen in the next scene. Depending on whose book you read, this puffer is sometimes called the whitespotted or stripebelly puffer.

Adult stripebelly pufferfish
An adult *Arothron hispidus* swims over corals on the seaward reef. The common name stripebelly puffer is more appropriate for the juvenile, while whitespotted puffer seems a good fit for the adult.

Young map pufferfish
Another juvenile pufferfish, the map puffer (*Arothron mappa*) also spends some of its growing-up time living in lagoon algae patches.

Adult map pufferfish
As it grows, the coloration of *Arothron mappa* changes a bit, but the animal can still be recognized. This one is seen through schools of cardinalfish and blue damsels.

Gray blackspotted pufferfish
The most common pufferfish in the Marshalls is the blackspotted puffer (*Arothron nigropunctatus*). This gray specimen is in a small cave on the seaward reef slope. In the background you can see a pennant butterflyfish (*Heniochus chrysopterus*) and a couple of one of the lionfish (or turkeyfish) species *Pterois antennata*.

Gray & yellow blackspotted pufferfish
Arothron nigropunctata can also have some yellow pigment. The one resting on the bottom here has a yellow underside.

Yellow blackspotted pufferfish
This is a mostly yellow color form of *Arothron nigropunctata*. It still has the characteristic black spots, however.

Porcupinefish with cleaner wrasses
Another kind of puffer, this one is the porcupine puffer (*Diodon hystrix*). The porcupine is accompanied by a pair of the black and blue striped cleanerfish (*Labroides dimidiatus*), who are checking over the puffer for external parasites. The porcupine takes a bite of something from the bottom; it is hard to tell, but it looks like it could have been a seashell, possibly one with a hermit crab. Although not shown here, when disturbed this fish draws in water to puff up into a ball covered with hard and sharp spines.

Purple-brown sea urchin
Speaking of being covered with sharp spines, that is the typical form of most species of sea urchins. *Echinometra mathaei* is a common shallow water urchin found most commonly on intertidal reefs but also found occasionally in shallow subtidal areas. The tough spines of this species are used mostly to wedge the urchin into holes in the reef to withstand wave action in its normal shallow water habitat. The spines are not sharp enough to puncture skin easily, although it can happen with enough force. Between the spines you can see thin soft tentacles, which are the animal's tube feet.

Banded sea urchin
A sea urchin more dangerous to people handling them is *Echinothrix calamaris*. The thicker and longer spines are not a problem, but the thin spines between them definitely are. These are extremely sharp and brittle, and will easily penetrate skin and break off. The black and white spotted ball on top of the urchin's body is the called an anal bulb. In urchins, the mouth is on the bottom and is used to graze algae from rocks. The anus is on the top, so waste products are pushed out on top of the animal, and have to bounce their way between the spines to drop off the edges of the animal. Doesn't seem very sanitary. This urchin is usually found under rocks on the reef or nestled among *Halimeda* bushes in algae patches. I have "found" a number of specimens using the Braille technique while running my fingers through *Halimeda* algae patches looking for nudibranchs. I can attest to the fact that being spined by these urchins is not pleasant.

Red pencil urchin
Nobody will be spined by this urchin, *Eucidaris metularia*. The thick spines are not sharp at all and the animal can be safely touched. The spines still may help protect the urchin from being swallowed by predatory fish. This urchin lives under rocks on lagoon and seaward reefs. Note the small brown sea anemones attached to the rock right in front of the urchin.

Short-spined urchin
Not too commonly seen in the Marshalls is the short-spined urchin *Tripneustes gratilla*. It is most common in lagoon *Halimeda* algae patches, where it camouflages itself by holding clumps of algae and other debris over itself. The short spines of this species are not very sharp, but it is best to not handle it. The tube feet will adhere to your fingers and not let go; they will often break off when you try to release your grip. Also, there is a venom associated with other appendages called pedicellaria, but in the species those appendages and small and don't seem to be able to penetrate the skin of a human hand. I have handled many without being stung, but maybe they could do damage to more tender skin. Or perhaps they just haven't tried to sting me yet. The next urchin has much larger and very dangerous pedicellaria.

Toxic sea urchin, don't touch
One urchin that is certainly not safe to handle is *Toxopneustes pileolus*, but it is not the short spines you have to watch out for. Those crowded roundish features all over the urchin are appendages called pedicellaria. They are structures capable of closing down in sort of a three-pointed jaw shape. Sharp edges can penetrate the skin and a powerful toxin bathes the wound. Although I haven't tested it

personally, I hear it is very painful and has been reported to cause human fatalities, although another source suggested that any associated deaths have been due to drowning from the severe pain and muscular paralysis caused by the venom. The longer tentacles extending out well beyond the pedicellaria are the tube feet. This urchin is not often seen here in the Marshalls, but because of its secretive habitats it may be more common than it seems. Specimens in the Marshalls have been found in lagoon *Halimeda* patches, in shallow water along the lagoon shore of Kwajalein Island, and in shallow quarries blasted out of the reef for building materials. The urchin appears to live buried in sand or rubble and comes out to feed at night. Don't touch!

Toxic sea urchin, don't touch
This closer shot of the venomous sea urchin *Toxopneustes pileolus* shows the dangerous pedicellaria that clamp down in a sharp three-pointed jaw when disturbed. They don't look very dangerous, do they? But they are.

Sea urchin crawling
The attractive little urchin *Paraselenia gratiosa* is most common in rubble and under rocks on lagoon pinnacles. Here it moves around with its long tube feet waving around. Its spines are not especially sharp or brittle.

Long-spined sea urchin
Another potentially dangerous sea urchin is this *Diadema savignyi*. Its long sharp and brittle spines easily enter human flesh and break off in the wound. It usually just causes pain and swelling, but serious infection is possible. I once had tingling in my entire foot for months after being stung by on of these just below my ankle. I think an embedded spine was rubbing against a nerve. These live under dead coral rocks and in lagoon *Halimeda* algae patches.

Crown-of-thorns starfish eats coral
This beast is covered with sharp and dangerous spines, but it is a starfish rather than a sea urchin. The crown-of-thorns starfish (*Acanthaster planci*) is common on coral reefs, where it eats live coral by crawling over a coral colony, opening up its underside to extrude its stomach, and digesting the animal tissue right out of the coral skeleton. This one is eating the bush of branching *Acropora* it is resting upon. Typically they hide in holes in the reef by day and emerge at night to feed. However, you can usually tell one is in the area by the presence of a number of pure white coral skeletons; corals from which all the animal tissue has been extracted, leaving only the dead white skeleton. Periodically, these starfish seem to undergo population blooms that result in many specimens in a small area and much of the living coral on some sections of reef eaten and killed. Much has been written about these COTS (crown-of-thorns starfish) infestations, but their ultimate causes and whether or not they are natural periodic events remains uncertain. Normal or not, the sight of these coral-eating machines killing off many colonies of living coral usually prompts concerned divers to want to do something. I've seen people stab these starfish with dive knives, pull them out of their hiding places and swim them out over the wall to drop them down the reef into deep water, or even pull them out of the water altogether to let them die. Only the latter probably kills them; starfish are excellent at regenerating body damage. Further, some of their relatives among the sea urchins are known to spawn when stressed. And one individual spawning triggers others nearby to do the same. One of the things you learn in population biology is that one of the fastest ways to *increase* population size is to spawn earlier. I don't know if the crown-of-thorns does this, but if it does, then molesting them could be increasing their population rather than decreasing it. Kwaj doesn't seem to have a huge problem with COTS outbreaks, but I think it may have in the past. There are some areas with expanses of dead coral that do not look like they were caused by storms or any other factor. Corals in these areas could have been wiped out by starfish.

Crown-of-thorns starfish spines
This closeup shot shows the spines of *Acanthaster*. These spines are sharp and coated with venom that causes pain and interferes with blood clotting. A puncture wound not only hurts, but it seeps blood for a long time. I speak from experience.

Juvenile crown-of-thorns starfish
This is a juvenile specimen of *Acanthaster planci*, only about 40mm in diameter. Since small specimens are more susceptible to predation, they usually live hidden under rocks during the day, often in shallow water, and come out to feed on coral at night. This is not where they live as they get larger. I once had a biologist who studied crown-of-thorns tell me that no one really knew where the young ones were. He obviously hadn't spent many hours searching under rocks in shallow water for nudibranchs, as I had. Nowadays I have to admit to collecting any small ones I see. Their spines are too short to be dangerous, they're too young to spawn, and I figure that every one I take home and freeze will ultimately lead to a lot of coral colonies that do not get eaten. Does it do any good? Who knows?

Spiny brittle star
Another echinoderm with spiny appendages is this brittle star, a species of *Ophiothrix*. Brittle stars are usually able to move faster than the normal sea stars. They tend to hide under rocks and in caves during the day, and will rapidly try to crawl away when exposed. Even though some of them are covered with sharp spines, quite a number of fish will eat them if given a chance. The spines of some of these species cause considerable pain if they puncture your skin.

Superb brittle star
Some brittle stars are smooth and sometimes slower, such as this *Ophiolepis superba*.

Pointy cushion star
Moving back to the normal starfish, another coral eating species is the common cushion star, *Culcita novaeguinea*. Like *Acanthaster*, *Culcita* eats corals by opening up its underside, extruding its stomach over the coral, and digesting the tissue out of the coral skeleton. *Culcita* is also known to eat other coral relatives such as sea anemones and perhaps some other benthic invertebrates such as sponges. Generally it has not been considered as much of a threat to coral reefs as has the crown-of-thorns. *Culcita* is quite variable in color, and also comes in two forms that we suspect are different species.

Pointy cushion star
This closeup of the previous *Culcita* starfish shows the intricate coloration. Looking closely you can see the numerous hard and somewhat sharp points all over the star. These points distinguish the reef-dwelling form or species from the other form or species that is smooth and somewhat velvety to the touch. The other form can be seen in subsequent scenes and is usually found in lagoon *Halimeda* patches or on sandy bottoms. Because of the differences in appearance and habitat, we suspect they are different species. Both forms are figured in subsequent scenes.

Pointy cushion star
This is another of the standard pointy form of *Culcita novaeguinea*.

Smooth cushion star
Here is a shot of one of the smooth forms of *Culcita*. This form eats small corals and sea anemones that live on sand and among the *Halimeda* plants in lagoon algae patches.

Pointy cushion star
This is one of the pointy *Culcita* stars living in a ledge on the seaward reef.

Smooth cushion star
Here is the smooth form again, a mostly orange color form with the algae patch it lives in visible around it.

Smooth cushion star
Another smooth *Culcita* in an algae patch.

Smooth cushion star
Yet another smooth *Culcita*, this time in open sand.

Pointy cushion star
Now we are back to the pointy *Culcita*, this one mostly bright red.

Commensal shrimp on cushion star
This shows the underside of one of the *Culcita* starfish. Where the lines converge in the center is where the starfish opens up to extrude its stomach to feed on corals and anemones. Also visible in this scene are a number of commensal shrimp that are always found on *Culcita*. These shrimp, *Periclimenes soror*, come in a number of color forms and are usually well camouflaged on their host star.

Commensal shrimp on cushion star
Here are three more *Periclimenes soror* on a mostly red *Culcita* starfish.

Commensal shrimp on cushion star
This is another *Periclimenes soror* on a starkly colored pointy *Culcita*.

Commensal shrimp on whip coral
Another shrimp that always lives in association with another kind of organism is this one, which we think is *Pontonides unciger*. A similar species found in the same habitat is named *Dasycaris zanzibarica* and is more humped dorsally. These shrimp are always found living on black corals such as this whip coral *Cirripathes*. They are a bit hard to photograph, since when you approach too closely they tend to rotate around to the opposite sides of the coral.

Bumblebee shrimp
The little bumblebee shrimp (*Gnathophyllum americanum*) is reported in various books to live on echinoderms such as starfish, but around here they are usually near or under (but usually not on) the sea anemone *Stychodactyla haddoni*. While they always have the black lines, the background color on the shrimp can be yellow or white, the latter more common. These shrimp are small, usually 10mm or less in length.

Bumblebee shrimp
Another yellow *Gnathophyllum americanum* tries to escape from the video camera lights.

Male Saron shrimp
This long “armed” shrimp *Saron marmoratus* check lives back in holes and caves in the reef by day and emerges to feed at night. Only the *Saron* males have these extremely long appendages.

Female Saron shrimp
Female *Saron* shrimp, like this smaller species, have shorter anterior appendages. This one zips away, vanishing in a flash near the end of the scene.

Grouper darts away
Fish too often zip away when approached by the camera. This grouper, a species of *Epinephelus* (perhaps *tauvina*?), watches me approach, taking off when I get too close. It darts away so fast that the loose colony of *Pocillopora* coral it was next to falls over.

Specklefin grouper
Another grouper, *Epinephelus ongus*, hangs in a ledge containing some plating *Pachyseris* corals. This is sometimes called a specklefin grouper.

Honeycomb grouper
This small honeycomb grouper (also called a dwarf spotted grouper), *Epinephelus merra*, rests on rocks upon which a *Halimeda* alga is growing. This is one of many cases where referring to two different fish books, both written by knowledgeable and respected ichthyologists, gave two different common names for the same fish. Common names do, alas, very often vary from place to place. If you want to be more precise, the scientific name is greatly preferred.

Snubnose grouper
A snubnose grouper (*Epinephelus macrospilos*) rests in a seaward reef ledge.

Camouflage grouper
This scene of the camouflage grouper (*Epinephelus polyphekadion*) starts with a closeup of the head, zooming out to a nearly full view.

Camouflage grouper
Epinephelus polyphekadion hovers over a table coral, moving off as the camera comes closer.

Adult slenderspine grouper
The slenderspine grouper (*Gracilia albomarginata*) changes color greatly from juvenile to adult. This is an adult form and is common, especially on the seaward reef. The scientific name of this species is a bit puzzling. In Latin, albomarginata means white margin. It's pretty clear from the image here that the adult does not have a white margin. Let's look at some younger ones.

Intermediate slenderspine grouper
This *Gracilia albomarginata* is intermediate in color between juvenile and adult. No white margin here either. A cleaner wrasse follows.

Juvenile slenderspine grouper
This scene shows the juvenile color form of *Gracilia albomarginata*. Juveniles are usually fairly rare here, but occasionally a number will appear on the reef during a short period. When the fish turns and shows its right side, an external parasite is visible in the middle of the body. Of course, there's no way one could call the bright red margins of this fish white. Or is there? Some colors disappear quite readily in preservative. I suspect this fish was originally described from a juvenile specimen that had been pickled and lost its red marginal color. Underneath the red is likely a white base. Maybe.

Juvenile bicolor parrotfish
Here is another species that changes greatly in color as it grows. This is a juvenile bicolor parrotfish (*Cetoscarus bicolor*). The juveniles are usually found singly, often in ledges in seaward reef surge channels.

Adolescent bicolor parrotfish
As *Cetoscarus bicolor* grows, it begins to get dark spotting on its white scales and the red band through the eye becomes less distinctive. This shows the path to the adult female color form seen in the next scene.

Male & female bicolor parrotfish
Like other parrotfish, *Cetoscarus bicolor* changes its color and sex throughout its life. The first sexual organs to develop are female. This shot contains several female specimens along with a greener male, all feeding on algae on a living coral reef. The females have brown heads, and the rest of the body is mostly dark green on the lower half and yellow on the upper. A Moorish idol (*Zanclus cornutus*) feeds in the same area.

Male bicolor parrotfish
After being a female for a while, *Cetoscarus bicolor* may lose its female reproductive organs and change into a male. At the same time, it changes color to the pink and green seen here. In this scene, a cleaner wrasse (*Labroides dimidiatus*) examines the parrotfish for parasites.

Male festive parrotfish
The male color form of the festive parrotfish (*Scarus festivus*) swims over a living coral reef. Most of the coral it swims over here is the columnar coral *Acropora palifera*, a dominant species on the upper leeward seaward reefs along most of the middle portion of the atoll.

Male bridled parrotfish

A male bridled parrotfish (*Scarus frenatus*) is cleaned by a pair of cleaner wrasses (*Labroides dimidiatus*).

Male egghead parrotfish
This is the male color form of the egghead or dark-capped parrotfish (*Scarus oviceps*). Here is another case where two different books gave two different common names, proving that common names are often not common at all. Learn the scientific name.

Greencap parrotfish
The pygmy or greencap parrotfish (*Scarus spinus*) feeds on the thin layer of algae growing over dead coral rocks. Yet another species with at least two common names.

Yellowband parrotfish
This is another parrotfish, *Scarus schlegeli*, also called the yellowband or yellowbar parrot.

Redlip parrotfish
The redlip or ember parrotfish (*Scarus rubroviolaceus*) displays at another male that came too close. This is one of the largest (but not the largest) parrotfish found at Kwajalein. Obviously, the male color form does not have red lips. Hmm, two common names again. Have I mentioned that you should learn scientific names?

Steephead parrotfish
A school of the parrotfish *Chlorurus microrhinos* swims past a coralhead on a midlagoon pinnacle. These are usually called steephead parrots.

Coral on shallow midlagoon pinnacle
Many of the large shallow midlagoon pinnacles are topped with these large ball corals, which I think is a species of *Astreopora*.

Saddleback butterfly & elkhorn coral
A saddleback butterflyfish (*Chaetodon ephippium*) swims in front of some elkhorn coral and above several other coral species on a lagoon pinnacle reef.

Heavy live coral cover
On some reefs the coral growth covers every bit of the bottom. Here we pan the slope of the lagoon pinnacle known as Twin Peaks, formerly called Q Buoy, where we can see a number of different coral species in this one scene.

Turbinaria coral
Turbinaria reniformis coral is common on some lagoon pinnacles and parts of the seaward reef. It occasionally forms large rounded colonies like these. This is one of the larger stands we know.

Staghorn coral
A large field of staghorn *Acropora* coral. This fast growing coral sometimes seems to overgrow and choke out slower growing species and some other sessile animals. We have had to weed some of this coral out occasionally when it has overgrown and threatened to kill off giant clams.

Stalk coral overgrowing staghorn
Here a number of dome-shaped *Lobophyllia* coral colonies are growing up and engulfing staghorn *Acropora* coral, some spikes of which still protrude above the ever-expanding domes. Even corals fight and kill each other for space.

Massive Porites coralheads
Some parts of the upper edge of the steep seaward reef slope at nearby Namu atoll are crowded with colonies of the massive *Porites* coral.

Dense covering of hard & soft corals

A large flat-topped midlagoon pinnacle is densely covered with a variety of hard and soft corals.

Close up of coral polyps
A close look at a colony of branching *Acropora* coral reveals the individual yellow coral polyps extending from their depressions or calyces in the coral skeleton.

Close up of coral skeletal structure
This closeup shows another branching coral, *Acrhelia horrescens*. The polyps are not extended but the spike-edged calyces are clearly visible.

Coral close up shows wave pattern
A closeup of a *Pachyseris speciosa* plating coral looks like waves approaching a beach.

Close up of green coral polyps
Another plating coral, this *Mycedium elephantotus* has green polyps.

Hard coral with long polyps
Some hard corals have long soft polyps that mostly hide the hard skeleton underneath. This *Goniopora* coral can be distinguished from the similar *Alveopora* because each polyp has 24 tentacles rather than 12. The mouth of each polyp is in the white patch in the center of the disk surrounded by the 24 small tentacles.

Hard coral with long polyps
Here is a larger colony of *Goniopora* with the polyps waving in the slight water surge.

Hard coral with long polyps
The long polyps of *Goniopora* corals can be retracted into the hard skeleton. In the center of this image the polyps are mostly, but not completely, retracted.

Hard coral with long polyps
Because this one has only 12 tentacles on each polyp, it is a species of *Alveopora*. A mouth is visible as a dark spot in the center of each polyp.

Ball-tentacle coral
This one looks a bit like some kinds of sea anemones but it is actually a hard coral named *Euphyllia glabrescens*. Those tentacles can retract completely back into the hard skeleton.

Ball-tentacle coral
Euphyllia comes in a green form as well. The light surge keeps the tentacles moving.

Sausage coral
Euphyllia ancora is commonly called sausage coral. It is uncommon at Kwajalein, but can be found on a number of lagoon pinnacles.

Yellow cardinalfish & zoanthids
In a small ledge, a school of yellow cardinalfish (*Apogon luteus*) mills about in front of a colony of zoanthids, a relative of sea anemones.

Yellow & slender cardinalfish
Under a colony of living coral is a mixed school of two cardinalfish species, the yellow *Apogon luteus* and the transparent slender cardinal *Rhabdamia gracilis*.

Yellow & slender cardinalfish
The same two species of cardinalfish share a cave under a coralhead.

Orangelined cardinalfish

Orangelined cardinalfish (*Archamia fucata*) spend the day in the shelter of a coralhead cave. At the end of the scene, a striped cardinalfish comes into the camera's view. Most cardinalfish are nocturnal, wandering out at night to feed.

Cardinalfish
Here a cardinalfish hovers in front of plating coral in a reef ledge.

Shell blenny inside an empty seashell
On a lagoon reef, a shell blenny (*Petroscirtes xestus*) peeks out of its refuge inside an empty seashell *Casmaria ponderosa*.

Red-streaked blenny in vermetid hole
Many of the blennies live in small holes in the reef. The hole occupied by this *Cirripectes stigmaticus* was probably created by a vermetid mollusk. Different books give the common name of this fish as either the red-streaked or reticulated blenny.

Caterpillar blenny nodding in hole
We call *Blenniella chrysospilos* the caterpillar blenny. Like the previous species, it lives in holes in the reef. This species can often be seen with its nodding head in shallow water on the seaward reef. Other books call this one the red-spotted blenny, so we're adding to the confusion with our own common name here.

Tile blenny
The tile or comical blenny (*Escenius opsifrontalis*) is commonly found in ledges and caves of the seaward reef, where this individual was filmed.

Red-speckled blenny
Here is the red-specked blenny (*Cirripectes variolosus*), which is common on the top of the seaward reef. They are usually relatively shy and hard to approach.

Saddleback butterflyfish
A saddleback butterflyfish (*Chaetodon ephippium*) swims over a variety of living corals.

Oval butterflyfish
Two coral-eating oval butterflyfish (*Chaetodon lunulatus*) peck at a colony of *Pocillopora*. This butterfly eats only living coral so will starve in a home aquarium without corals. Live corals are not easy to keep alive in an aquarium. Special (and expensive) lights, special filtration, and a close eye on water chemistry are required to keep living corals.

Lined butterflyfish
A lined butterflyfish (*Chaetodon lineolatus*) swims in toward the camera.

Blacklip butterflyfish
Two blacklip butterflyfish (*Chaetodon kleini*) peck on a colony of *Lobophyllia* coral on a lagoon pinnacle reef.

Spotbanded butterflyfish
A spotbanded butterflyfish (*Chaetodon punctatofasciatus*) turns around several times to look into the camera.

Whitetip shark
A whitetip shark (*Triaenodon obesus*) comes up the reef and turns around over colonies of *Porites* coral on the seaward reef slope.

Whitetip shark
A *Triaenodon obesus* swims into the camera on a lagoon pinnacle.

Whitetip shark
A *Triaenodon obesus* passes over the camera up the slope on a lagoon pinnacle.

Whitetip shark
A *Triaenodon obesus* passes very close to the camera, giving a good view of its left eye.

Small whitetip sharks
Smaller *Triaenodon obesus* often live together under the shelter of large table corals. Looks like we are having a bit of a traffic jam here.

Bennett's butterflyfish
Bennett's butterflyfish (*Chaetodon bennetti*) passes over a colony of *Porites* coral.

Racoon & Bennett's butterflyfish
A couple of butterflyfish species, *Chaetodon lunula* (raccoon) and *Chaetodon bennetti* (Bennett's) show off for the camera.

Meyer's butterflyfish
A Meyer's butterflyfish (*Chaetodon meyeri*) pecks on a colony of *Acropora* coral. This butterfly, like a number of others including *Chaetodon lunulatus* seen earlier, feeds exclusively on living corals and is not suitable for home aquaria. This is a rare butterfly at Kwajalein, although we hear it is more common at Majuro Atoll. After seeing one in 1975 to confirm they lived here, we looked for a number more years before seeing another. One El Niño year, a large number of juveniles appeared suddenly on reefs throughout at least the southern atoll. Like many other fish, these butterflies spend the first part of their development drifting in the plankton before settling out on the reef to begin a benthic existence. We suspect the eastward moving water masses associated with El Niño brought a large group of planktonic larvae into Kwaj right at the time they were ready to begin to settle out of the planktonic and begin life on the reef. We watched this generation of butterflies grow up on the reefs, pairing off with each other and sometimes with the closely related *Chaetodon reticulatus* (next scene) as they approached adulthood. As they grew, their numbers steadily dropped, probably succumbing to predation by larger fish and eels. Now the species is once again rare, although we still see an occasional specimen (as well as an occasional hybrid; see the next two scenes). I suppose we will need to wait for another El Niño to bring in another chance settling before we start seeing a lot of specimens again.

Reticulated butterflyfish
The reticulated butterflyfish (*Chaetodon reticulatus*) is another species that exclusively eats living corals.

Hybrid reticulated & Meyer's butterfly
Chaetodon reticulatus and *Chaetodon meyeri* are very closely related; so much so that they are able to interbreed producing hybrids that show characteristics of both species. The hybrid in this scene shows both the diagonal lines of *C. meyer* and the reticulated pattern of *C. reticulatus*, but both are somewhat faded. As noted a couple of scenes back, *Chaetodon meyeri* is usually rare at Kwajalein, so it may be hard for them to find mates. The common *Chaetodon reticulatus* must be close enough that they will suffice. During most of the years we've been observing them, the hybrids have been more common than full-blooded *Chaetodon meyeri* at Kwajalein.

Ornate butterflyfish
Another butterflyfish with diagonal lines is this ornate butterfly (*Chaetodon ornatissimus*). This is another of the corals feeders and is not suitable for keeping in aquaria.

Fourspot butterflyfish
The fourspot butterflyfish (*Chaetodon quadrimaculatus*) is rare at Kwajalein. The few specimens observed were in shallow water near the intertidal on seaward and lagoon reefs. This is one of the only pair we have seen in at least the last 10 years, but we have been able to return to the site near Omelek Island and visit them several times over several years. This is another species reported to eat only living coral.

Doublebarred butterflyfish
Chaetodon ulietensis is a common species usually found in pairs. A common name for it is the doublebarred butterflyfish.

Gray reef shark
A curious gray reef shark (*Carcharhinus amblyrhynchos*) swims in to look at the photographer. Gray reefs can be territorially aggressive, but when they are swimming straight and steady like this they are usually not a problem. However, it is easy to get nervous when one of these is swimming in toward you. I personally know several people who have been seriously bitten and two of them nearly killed by this species of shark.

Gray reef shark with pilotfish
A *Carcharhinus amblyrhynchos* escorted by a small school of pilotfish in front of its nose swims by on a lagoon pinnacle near a pass in the reef. Such pinnacles are usually good places to see a lot of sharks. On this pinnacle there is also a school of the yellowback fusiliers (*Caesio teres*) and many other fish.

Gray reef shark
A *Carcharhinus amblyrhynchos* swims quietly by on a coral-covered midlagoon pinnacle.

Gray reef shark
Another *Carcharhinus amblyrhynchos* comes up the slope of a lagoon pinnacle to look at the cameraman.

Gray reef shark
A rather small *Carcharhinus amblyrhynchos* swims by overhead through a group of the tang *Acanthurus thompsoni*.

Redbreasted wrasse
This is the wrasse *Cheilinus fasciatus*, which we call the chomper fish due to its tendency to eat up any unfortunate critters a careless diver might disturb and expose. Particularly on lagoon pinnacles, this species of wrasse has learned to follow divers in the hopes of scoring a free meal. The books call it a redbreasted wrasse.

Bandcheek wrasse
Another species of wrasse, Oxyc*heilinus digrammus*, comes in to take a close look at the camera lens. These guys can be quite fearless. In my early days of photography, I had affixed a short pole on my camera to show me how far away my close-up lens would focus. Once while easing in to get close enough to shoot one of these, the fish surprised me not only by not swimming away, but by swimming in and biting the end of the focusing pole! The books call this one either the bandcheek or the cheeklined wrasse.

Juvenile humphead wrasse
The largest wrasse is *Cheilinus undulatus*, commonly called the humphead or napoleon wrasse. This scene shows a small juvenile specimen hiding among the branches of the gorgonian *Rumphella antipathes*.

Humphead wrasse
Here is a medium large individual of *Cheilinus undulatus*. They can get quite a bit larger and turn dark green in color. We are lucky to still have a reasonable population of these here at Kwaj. I hear that most have been fished out of many reefs farther west in the Pacific. Although I'd love to be able to easily get close to them for photo purposes, it is probably better that the ones here are somewhat shy of divers; it keeps them away those who carry spears.

Sixbar wrasse
The sixbar wrasse (*Thalassoma hardwickii*) always seems to be moving.

Fivestripe wrasse
This *Thalassoma quinquevittatum* also spends most of its waking time actively swimming, so it is tough to get a good photo of it. Different books call this either the fivestripe or the redribbon wrasse.

Grayhead wrasse
This is an adult male of the grayhead wrasse (*Halichoeres leucurus*). Like parrotfish, wrasses change sex as they grow and also usually change color as well. I think the "grayhead" common name must refer to a younger specimen.

Female goldstripe wrasse
The fish with the orange stripe is a female goldstripe wrasse (*Halichoeres hartzfeldii*). These wrasses are relatively common in some lagoon *Halimeda* algae patches and rubble reefs. The white wrasse with the colored head visible early in the scene is *Halichoeres trimaculatus*.

Male goldstripe wrasse
This is the male of the *Halichoeres hartsfeldii* in the previous scene. Males are relatively scarce here.

Blackspot pygmy wrasse
The wrasse *Wetmorella nigropinnata* is pretty common, but its secretive habits keep it from being seen very often. It lives well back in ledges and caves on the seaward reef and hides quickly when approached by divers with lights. This one was visible for a surprisingly long time. It looks as though it was confused about which way to go to escape. Different books call this the sharpnose or blackspot pygmy wrasse.

Magenta wrasse
The magenta wrasse *Pseudocheilinus ocellatus* was named only a few years ago, but it is relatively common on the seaward reef, especially deeper than about 15 meters. The specific name ocellatus refers to the circled spot within the green patch near the tail.

Male Johnson's wrasse displaying
Johnson's wrasse (*Cirrhilabrus johnsoni*) was named after a Kwajalein fish enthusiast and photographer from the 1970s and 1980s named Dave Johnson. He first found the species swimming over *Halimeda* patches on the lagoon slope. The male *C. johnsoni* erects its fins as shown when courting females, which are the smaller peach-colored fish in the lower part of the frame.

Helmet shell buried in sand
The camera approaches a partly buried helmet shell (*Cassis cornuta*) on a lagoon reef sand flat. Helmets live on sandy flats along the reef and deeper into the lagoon. They often bury part way into the sand by day. At night, and sometimes during the day, they crawl about on the surface of the sand and feeding on burrowing echinoids like those seen earlier in this video.

Helmet shell
This *Cassis cornuta* is up on the sand's surface cruising along at full speed. We are looking at the anterior end. The upcurved tube in front holds the animals siphon, used to draw water in to pass across the gills, which are inside and protected by the shell. You can see by the layer of clean shell that this specimen typically buries itself about halfway in the sand. The upper part, always exposed to the elements, has a thicker growth of algae and debris on it.

Giant finger shell
This is the giant finger shell (*Lambis truncata*). Like the other members of this family, these mollusks can flip themselves upright using their muscular foot. Attached to the end of the foot is a hard brown operculum used to seal off the shell's opening when the animal retracts inside. The operculum and foot are used as a pole to allow the mollusk to hop along the bottom. This particular individual is not quite fully adult, as seen by the hollow fingers along the shell in the upper part of the picture. As the animal ages, these fill in and the shell thickens. These seem to be able to live quite a while; we've seen colonies of living coral growing on still occupied shells that much way more than the shell itself.

Fragile stromb
Other members of the same family of mollusks move the same way. Here is a *Strombus fragilis* quickly righting itself after having been turned up. Before it flips, you can see the two large black eyeballs, which are on the ends of long tentacles near the right side of the shell.

Pipus stromb
This is another stromb shell that was only recently found to live here at Kwajalein. Two specimens of *Strombus pipus* were seen on a shallow lagoon reef in the northern part of the atoll. Like the others, this one is capable of flipping itself over using its muscular foot.

Pipus stromb feeding
Strombs and finger shells are herbivores, and use their long proboscis to reach out and eat algae, as this *Stombus pipus* is doing here. We are looking straight into the anterior end of the shell, where there are two notches through which the eyes on their separate tentacles extend. Just below the eye on each tentacle is a smaller tentacle used primarily for feeling.

Triton's trumpet shell
The largest snail found in the Marshalls is Triton's trumpet, *Charonia tritonis*. Although they are popular collectors' items, they have been scarce at Kwajalein since at least the mid 1960s, and they are equally scarce on mid-lagoon reefs that we think we may have been the only ones to have ever visited, so it seems that there have never been many of them around. This mollusk eats starfish, including the coral-eating species *Acanthaster planci* and *Culcita novaeguinea*. The crown-of-thorns *Acanthaster* is well known for damaging coral reefs when populations of the starfish rise. While it is not known whether tritons can limit populations of these coral-eating stars under normal circumstances, it would be better to leave these alive and on the reef where they can do their thing. Far more important to leave these be, I would say, than worry about abundant herbivores such as *Lambis truncata*.

Comptum triton
Related to the triton is this *Cymatium comptum*. The shell of this species varies in color. This black form is unusual. With the shell tilted up, the colorful animal within stretches out to reach the substrate and pull it back to its normal upright position.

Map cowries
A pair of map cowries (*Cypraea mappa*) crawl across the undersurface of an overturned rock. This cowry lives on both lagoon and seaward reefs and like most cowries is active at night, hiding in dark caves or under rocks during the day.

Sieve cowry
The sieve cowry (*Cypraea cribraria*) crawls toward the camera. The red mantle, the thin sheet of tissue that creates the shiny shell, is partly covering the shell in this scene. Two long red anterior tentacles extend from the front of the shell, at the bottom of the scene. This cowry prefers living under rocks on shallow lagoon reefs, although there is a similar but smaller species that lives on lagoon pinnacles and seaward reefs. It eats an encrusting red sponge.

Punctate cowry, mantle over shell
Another red-mantled cowry is *Cypraea punctata*, shown here with the mantle covering nearly the entire shell. The shell itself is white with brown spots, which can be seen through the translucent red mantle. This cowry eats red sponges, most often on lagoon reefs and pinnacles.

Staphlaea cowry
Cypraea staphlaea usually has a black mantle, although sometimes it is a bit lighter reddish brown. This species usually lives under rocks on rubbly lagoon pinnacles, where it feeds on a black sponge. Most cowries are smooth and shiny; this one is shiny, but its surface is covered with small rounded bumps.

Isabella cowry
Another cowry with a black mantle is *Cypraea isabella*, a common species in both lagoon and seaward

reef habitats. It usually eats a light yellow sponge.

Isabella cowry with its egg mass
Here a *Cypraea isabella* moves across its egg mass. Each of those tightly packed dark maroon capsules contains a number of developing cowries. When ready, the larvae will escape from the capsules and float away in the plankton, where they drift for some time before they are ready to settle out and begin life on the bottom. The adult cowry remains with the eggs until they hatch, usually covering the egg mass with her foot to protect the vulnerable eggs from being eaten.

Forskal's leurobranch sea slug
This is a sea slug called *Pleurobranchus forskali*. Rare at Kwajalein most of the time, it appears to live in lagoon slope *Halimeda* patches, but they seem to occasionally move en masse into shallower water where they spawn and deposit their egg masses under rocks. For a few days one year, we saw dozens or maybe even hundreds of these on a lagoon reef north of Bigej; since then we have seen fewer than half a dozen specimens.

Orange pleurobranch sea slug
Related to the previous species, this orange pleurobranch is *Berthellina citrina*. It crawls across the undersurface of an overturned rock. The spiraled white object the slug crawls past is its egg mass. This species is common under rocks in shallow water on both lagoon and seaward reefs. It also comes in a yellow color form that some think might be a different species.

Pleurobranch sea slug
This sea slug has been tentatively identified as *Berthella africana*, a species originally described from the Atlantic Ocean.

Nudibranch Chromodoris aureopurpurea
The nudibranch *Chromodoris aureopurpurea* is known from Kwajalein from only one specimen found crawling on a detritus-covered sandy lagoon slope. This animal retracts its gills at the left on the dorsum, then extends them again.

Nudibranch Chromodoris elisabethina
Chromodoris elisabethina is one of the more common nudibranch species and is found on lagoon reefs, pinnacles, and seaward reefs, usually found in small ledges and under overhangs. This one was under a rock along with some red and yellow sponges.

Nudibranch Chromodoris fidelis
Another common chromodorid nudibranch at Kwajalein is *Chromodoris fidelis*, a small species generally measuring less than about 15mm long. These are usually seen on lagoon reefs and pinnacles under rocks and eat several different kinds of sponges. The two chemosensory rhinophores protrude from the dorsum on the right and the cluster of naked gills is near the tail on the left.

Nudibranch Hypselodoris decorata
Hypselodoris decorata is not commonly seen, and usually lives under rocks on both lagoon and seaward reefs.

Nudibranch Hypselodoris whitei
Hypselodoris whitei has been observed rarely at Kwajalein, but the species was more common at Enewetak Atoll. All so far were found on lagoon reefs and pinnacles, and the pair figured were feeding on sponge in a patch of *Halimeda* algae on a lagoon slope.

Nudibranch Thorunna purpuropedis
So far only one of these has been found at Kwajalein. It is *Thorunna purpuropedis*, named for its purplish foot, only the tail of which can be seen in this scene. This species was originally found and described from Enewetak Atoll here in the Marshall Islands. This is another species that continually vibrates its gills.

Nudibranch Thorunna australis
Thorunna australis is a small nudibranch occasionally found on lagoon reefs and pinnacles under rocks. The two lower individuals here are busy eating up a tan-colored sponge.

Cuming's starfish
This attractive little starfish is named *Neoferdina cumingi*. It is often found in ledges and small caves on seaward and lagoon pinnacle reefs. This one is crawling across a red sponge.

Cuming's starfish with 4 arms
This individual of *Neoferdina cumingi* is missing one of its arms. While stars can lose and regenerate arms, this one looks like it developed this way. There's no sign of damage or regeneration.

Hemprich's star
The name of this little prickly starfish may be *Ophidiaster hemprichi*.

Hemprich's star
This also may be *Ophidiaster hemprichi*. They are apparently variable in color.

Starfish
This is a common starfish on lagoon and seaward reefs. This one has an extra arm.

Red starfish
This bright red starfish may be a species of *Fromia*. Here it is seen crawling over a blade of algae on a lagoon reef.

Starfish
We have not yet identified this starfish. A bit difficult to see in this image, it had a five-pointed crown-like ring in the center of the dorsum.

Starfish tube feet
Tube feet extend from the underside of the star shown in the previous scene. Starfish, as other echinoderms, do much of their movement using a water vascular system. Basically, they bring water into a series of internal tubes and vesicles, and by muscular pressure on different parts of these vesicles force water into these tube feet, which are then equipped with suction cups to grasp the surface and can be used to pull the animal around.

Soft coral
This is a small colony of an unusual soft coral. The few we have seen were in small caves on lagoon reefs.

Soft coral
Here is closer shot of the soft coral from the previous scene. One characteristic of soft corals is that they have polyps bearing eight pinnate tentacles, which can be pretty clearly seen in this clip.

Xenia soft coral
Another soft coral, this is a species of *Xenia*. These soft corals continually grasp with their large soft polyps. At Kwajalein, they are common on some lagoon reefs but absent from many others. Here the colony is nestled among branches of a brown sponge.

Soft coral
This soft coral is in the genus *Scleronephthya*. This is uncommon, but can be occasionally found on pinnacle and seaward reefs. On reefs near passes through the atoll reef seem to be the best areas to find it.

Soft coral
This is a closer shot of the soft coral from the previous scene.

Soft coral
This *Dendronephthya* soft coral is growing on a dead branch of a gorgonian. To the right of the soft coral are some hydroids.

Soft coral
Here is another *Dendronophthya* soft coral growing against a colony of *Millepora* fire coral.

Soft coral
Dendronephthya soft corals come in a variety of colors. Unlike islands to the west, these soft corals are not common at Kwajalein, where they usually occur in small ledges or caves.

Soft coral with murex
Here is an orange *Dendronephthya* soft coral in a small cave with a murex shell, *Chicoreus torrefactus*, on the rock at its base.

Soft coral with fan
This small orange *Dendronophthya* soft coral grows at the base of a large orange fan gorgonian *Subergorgia mollis*.

Orange fan gorgonian
Here a *Subergorgia mollis* gorgonian hangs down in a coral cave.

Orange fan gorgonian
This is another colony of *Subergorgia mollis* on a slope bordering a pass in the atoll's reef. A couple of black crinoids rest on the top to filter the water for plankton. A couple of small colonies of yellow *Distichopora* coral grow on the gorgonian itself.

Yellow coral
This yellow *Distichopora* is found only in the northern half of the atoll; this color form is never seen in the southern part. In the north, it is found on seaward reefs and lagoon pinnacles, particularly those exposed to the swift currents that race back and forth through passes in the reef. Looking up we can see the glassy surface of the water on a very calm day.

Yellow and pink coral
Some yellow *Distichopora* coral shares a small cave with some of the pink coral *Stylaster*. The black damsel with a white tail that swims into the scene is *Chromis margaritifer*.

Purple coral
Related to the yellow *Distichopora* is this purple variety. This color form is found throughout the atoll. In some parts of the mid atoll, much of this coral is more of a muddy brownish purple color rather than this brighter purple.

Red coral
A third color form of *Distichopora* found in this area is this red colony. We have not found this color form at Kwajalein, but it is common at Namu Atoll about 35 miles south of Kwajalein, as well as in some other Marshall Islands atolls. This group of coral is in need of some serious study. Some suggest that all the color forms, including another orange one we have seen at Enewetak Atoll, are all color variants of a single species, while others think they all represent different species. Behind this coral on the left is a crinoid or feather star.

Blackfin barracuda
Four blackfin barracuda (*Sphyraena qenie*) swim past the camera. This is one of at least three species of barracuda found at Kwajalein.

Heller's barracuda

A school of smaller Heller's barracuda (*Sphyraena helleri*) passes by on the seaward reef.

Great barracuda
A large great barracuda (*Sphyraena barracuda*) gets annoyed at being followed by the camera. I have never seen one behave in an aggressive manner like this. This was on Victor buoy coralhead, where the numerous resident barracuda should be kind of accustomed to seeing divers. He must have been having a bad day.

Twinspot snapper
A large and curious twinspot snapper (*Lutjanus bohar*) swims close to the camera. Look at that fang! These large snappers often seem curious and approach quite close to divers. Fortunately for them, most spearfishermen know they are usually quite toxic, being one of the worst offenders for causing ciguatera poisoning, which is something you do not want to get. It can be fatal, but it is usually not. However, it is not pleasant. This is a little long, but I can't help quoting one story of a case published by Loison (1955) (a quote I actually pulled from Wiens, 1962):

> I diagnosed the cause of my own particular case on the very first day, when I got up and washed my hands. It was certainly the cold tap I had turned on, and yet I started at the excruciating burning pain experienced. This sensation was to last for several weeks. Similarly drinking a cold beverage caused an unbearable impression of agonized burning.
>
> Gastro-intestinal troubles were of minor importance, and ended after 48 hours, leaving me to cope with a far more unpleasant symptom: a general itching that continued constantly for a fortnight, forcing me to contort my body into the most grotesque positions and scratch without stopping. Moreover, I would wake up every night, not because of the spasmodic twitching of my legs, but because I had the impression my teeth had become loose and were about to fall out of their sockets.
>
> The final and most difficult effect to bear was the ensuing state of exhaustion which lasted some three or four months. My thighs in particular were weak and painful as though they had been given a thorough beating. Those familiar with fish poisoning tell me I was lucky to get away with few and such slight symptoms: I might have suffered from vomiting, abdominal pains, fever, excessive perspiration, pains in the joints, numbness of the lips and tongue, motility incoordination, various paralysis of the motor and vegetative systems, temporary blindness, and other similar troubles.

In addition to these large snappers, you need to avoid large groupers, large ulua (particularly the black ulua (*Caranx lugubris*), barracuda, and all moray eels. And maybe some other fish from particular reefs at particular times. One thing about ciguatera is that it can get into all sorts of different fish.

Fish on coral slope
A coral-covered seaward reef slope supports a dense community of reef fish, including schools of the humpback snappers *Lutjanus gibbus*, rabbitfish *Siganus argenteus*, and anthias *Pseudanthias pascalis*, along with smaller numbers of several other species.

Humpback snappers
A school of *Lutjanus gibbus* passes over *Porites* coral on the seaward slope of Namu Atoll. The greenish wrasse going in the opposite direction is *Anampses caeruleopunctatus*.

Bluestriped snappers
A school of the bluestriped snappers (*Lutjanus kasmira*) swarm around *Acropora* coral colonies on the slope of a lagoon pinnacle.

Orangefin emperor
The orangefin emperor (*Lethrinus erythracanthus*) usually steers clear of divers. These fish are known to eat echinoderms and mollusks, including cowry shells.

Blue-spotted large-eyed bream
This *Gymnocranius microdon* is found on both lagoon and seaward reefs. This one is looking for bits of food in the sand. One book gives a rather long common name of blue-spotted large-eyed bream.

Spotted sweetlips
During the day, a spotted sweetlips (*Plectorhynchus picus*) usually stays around or underneath ledges or large table coral colonies. At night it wanders away to hunt. In the background in the early part of this scene is the camouflage grouper (*Epinephelus polyhphekadion*).

Juvenile spotted sweetlips
This is a juvenile of the sweetlips seen in the previous scene. Juveniles are rarely seen; this one was out at the knee of the double drop in the atoll's seaward reef near Mian Island.

Adult black & white snapper
This is an adult snapper, probably *Macolor macularis*. This is a curious species that often swims right in to take a close look at divers.

Yellowspot emperors
The yellowspot emperor (*Gnathodentex aureolineatus*) can be found in schools on both lagoon and seaward reefs. This group was on the seaward reef slope at a depth of about 30 meters. This is also sometimes called the goldlined emperor.

Yellowspot emperors & more
Here are more *Gnathodentex aureolineatum* on a lagoon reef along with a few staghorn damsels (*Amblyglyphidodon curacao*) and numerous spotfin squirrelfish (*Neoniphon sammara*) in the background.

Spotfin squirrelfish
This is a closer view of the *Neoniphon sammara* from the previous scene. These fish usually dive into holes in the reef when approached too closely.

Spotfin squirrelfish
A closeup shot of the spotfin squirrelfish (*Neoniphon sammara).* The common name spotfin comes from a dark spot on the forward part of the dorsal fin, which is not visible in these photos because the fin is folded down against the body.

Blackfin squirrelfish
The blackfin squirrelfish (*Neoniphon opercularis*) lives in a cave on a seaward reef. A soldierfish (*Myripristes*) swims by in front and in the background is the bronze or copper sweeper (*Pempheris oualensis*).

Sabre squirrelfish
This is the sabre squirrelfish (*Sargocentron spiniferum*) living in a seaward reef cave. At left is one of the bronze or shadowfin soldierfish (*Myripristes adusta*), shown closer in the next scene.

Shadowfin soldierfish
A group of shadowfin soldierfish (*Myripristes adusta*) occupies a seaward reef cave.

Goggle-eye
Here we zoom out from a head shot of a sleepy goggle-eye (*Priacanthus hamrur*). This is a nocturnal species that lives either near reefs holes or in large schools during the day. We often refer to this by its Hawaiian name aweoweo.

Goggle-eye school
Many lagoon pinnacles are home to schools of *Priacanthus hamrur*. This species can change color quickly from red to silvery.

Goggle-eye school
A school of *Priacanthus hamrur* moves over a coral reef out of the way of an approaching diver.

Moorish idol school
A school of large Moorish idols (*Zanclus cornutus*) swarms around a diver on the seaward reef. These fish are usually found paired or in very small schools, but sometimes will form larger schools like this one.

Bluestreak fusiliers & diver
A diver passes overhead, past a school of bluestreak fusiliers (*Pterocaesio tile*).

Yellowback fusiliers & diver
A school of yellowback fusiliers (*Caesio teres*) swarm around a diver on a midlagoon pinnacle.

Yellowback fusiliers with diver
A school of *Caesio teres* along with a few *Pterocaesio tile* swim past a diver concentrating on photographing a sea anemone.

Barcheek jack
A barcheek jack (*Carangoides plagiotaenia*) swims rapidly past.

Yellowspotted trevally
The yellowspotted trevally (*Carangoides orthogrammus*) swims past at a more leisurely pace. This is also called an island jack.

Black ulua
The black ulua (*Caranx lugubris*) is most often seen rather deep on the seaward reef. This species is well known for often causing ciguatera poisoning in people who eat it. As noted earlier, ciguatera is a toxin in certain dinoflagellate algae that gets into benthic feeding herbivores and concentrates in predatory fish tissues as it moves up the food chain. Upper level carnivores like these black ulua, along with some groupers, snappers, and moray eels, are often dangerous to eat because of ciguatera. (There is more on ciguatera about 25 scenes back under twinspot snapper.) In most places, a member of this family is called a “jack” or a “trevally” but I’m used to calling them by their Hawaiian name ulua.

Bluefin ulua
The bluefin ulua (*Caranx melampygus*) is common on lagoon and seaward reefs.

Bluefin ulua school
Sometimes *Caranx melampygus* occurs in large schools that race along the seaward reef. Years ago these ulua seemed a lot more curious and would often swirl around divers. This seems pretty rare now. Perhaps they have learned that divers sometimes carry spearguns.

Golden trevally
These uncommon golden trevally (*Gnathodon speciosus*) are feeding on sand and algae-dwelling organisms in a lagoon *Halimeda* patch.

Dot-dash goatfish
Goatfish also dig in sand for burrowing worms and shrimps to eat. This dot-dash goatfish (*Parupeneus barberinus*) is being followed by the checkerboard wrasse (*Halichoeres hortulanus*) in case any tasty tidbits get past the goat.

Multibar goatfish
A multibar goatfish (*Parupeneus multifasciatus*) digs in the sand around a rock for buried food items. The boat uses its barbels, two tentacles attached to the bottom of its chin, to probe for crustaceans or worms under rocks or in the sand.

Goldsaddle goatfish
This goldsaddle goatfish (*Parupeneus cyclostomus*) must have spotted an escaping prey and zipped after it. It kind of looks as though the prey got away. A bigeye emperor (*Monotaxis grandoculis*) attracted by the activity swims over to see if it can get in on the feeding.

Dragon wrasse
The dragon wrasse (*Novaculichthys taeniourus*) doesn't wait for prey to show itself. Dragons hunt for prey by digging in the rubble.

Dragon wrasse moving rocks
Not only do the dragon wrasses dig in rubble, they are also capable of turning over good-sized rocks. The books call these rockmover wrasses, an appropriate name. However, I've called them dragon wrasses since I used to chase them for my aquarium more than 40 years ago.

Dragon wrasse moving rocks
Another scene of the dragon wrasse moving a large rock to scare out some prey.

Mustache triggerfish breaking coral
The large mustache triggerfish (*Balistoides viridescens*) breaks its way into a colony of branching *Acropora* coral to get at the crabs and small fish living among the branches. The triggers use their strong jaws and teeth to break off the branches one by one until the prey is exposed. Notice how they twist around to get the best angle at which to attack a certain coral branch. These fish are also called titan triggerfish, but I like the name mustache trigger instead; the fish has a wavy black band right above its upper lip that looks just like a mustache. These large triggers can be somewhat dangerous to divers. Most of the time, they are pretty shy and will retreat when approached. However, their behavior changes when they are defending a nest. These triggers put their eggs in a little nest they create out of sand and rubble, and they guard the eggs the whole time they are there. If they leave, neighboring fish will readily eat all the eggs. So the trigger spends all its time chasing intruders away. And these intruders could include divers. While some will retreat from their nests when approached, many will charge the intruder. Divers have been bumped hard enough to bruise, and in some cases even bitten by the wicked-looking teeth of one of these triggers.

Coral broken by mustache triggerfish
Here is a shot of the bush of coral the trigger in the previous scene was breaking apart. The entire side of the colony is broken away with the branches scattered on the bottom below. There are a lot of these triggers out there always looking for a meal, so this species is probably responsible for a fair bit of the reef damage a diver might see.

Guard crab
This is a guard or coral crab (*Trapezia bidentata*). This little crab is one of several species that live between the branches of living corals and is among the prey items for the big mustache triggers that break up those corals. But the crabs do try to defend their homes. Sometimes if you put your finger right down between or right at the edge of the coral branches, the crabs will come out and pinch you, making the common name of guard crab appropriate. I'm afraid it is not too effective against a mustache trigger, however.

Tarantula crab
Here is one of the large decorator crabs *Camposia retusa*. These crabs have various items such as sponges, tunicates, and algae growing on their shells, which helps camouflage them from potential predators. With their long legs and slow and deliberate movements, they remind me of a tarantula, so we often call these tarantula crabs.

7-11 crab
This *Corpilus maculatus* is commonly called the 7-11 crab. It sports seven brown spots on the top of the shell with another four on the underside. They hide during the day and come out on the reef to feed at night. This footage was shot on a night dive on the western seaward reef.

Laevis swimming anemone crab
This small attractive crab is *Lissocarcinus laevis*. It tends to live around large sea anemones but is rarely seen at Kwajalein. It is one of the swimming crabs, and has rear appendages that are flattened and used

almost like fins or paddles to help the crab move through the water. This one appears to bear a pugnacious attitude towards the photographer. “You want a piece of me? Just come and try it!”

Halimeda crab
This *Halimeda* crab (*Huenia heraldica*) is well camouflaged in its normal habitat in clumps of *Halimeda* algae.

Halimeda crab
Another camouflaged *Huenia heraldica* crab sits in a clump of algae and appears to be picking at its own leg.

Redbanded crab
This redbanded crab (*Carpilodes cinctimanus*) is trying to hide again after being exposed on the underside of an overturned rock. Many predatory fish find crabs quite acceptable prey, so the crabs usually hide away under coral and rocks during the day. If exposed to light, as this one was, they high-tail it to cover as quickly as they can.

Redstriped hermit crab
This small hermit crab is peeking out from an old empty *Cerithium* shell.

Haig's hermit crab
A hermit crab *Calcinus haigae* emerges from an old *Cerithium* shell.

Hidden hermit crab
Another hermit *Calcinus latens* occupies an old drupe shell.

Bloody hermit crab
This hermit *Dardanus sanguinocarpus* is in an old *Nassarius papillosus* shell.

Flattened hermit crab
Here a pair of the cone shell dwelling hermits *Ciliopagurus strigatus*. These crabs have flattened bodies and are among the few hermits that will fit in the narrow apertures of empty cone shells.

Blue-legged hermit crab
This blue-legged crab is a fast one. This appears to be a species of *Pagurixus*, possibly a color form of *P. nomurai*.

Gorgonian crab
This *Xenocarcinus conicus* crab lives on the brown gorgonian *Rumphella antipathes*.

False black coral
Here is a large colony of the brown gorgonian *Rumphella antipathes*. This is sometimes locally called “black coral” due to its internal skeleton, which is shiny black. It is not, however, what is usually called black coral elsewhere; in fact, it is not too closely related to the real black corals. These grow in shallow and deeper water throughout the atoll, particularly on the seaward reef and on lagoon pinnacles. However, it is much less common around Kwajalein Island than it used to be. In the early days of diving at Kwajalein, mostly in the 1960s and 1970s, this gorgonian was heavily collected by hammer-and-chisel-wielding divers who apparently figured they’d make a fortune collecting black coral for the jewelry trade. Alas, it turns out the black skeleton of this gorgonian, while attractive in itself, it not dense enough to be polished into jewelry and is worthless. It has taken a while for some colonies to come back. Fortunately, there are many isolated lagoon pinnacles and seaward reef slopes well up the reef from Kwajalein where the gorgonian is still abundant. A black tang with a white tail, *Acanthurus thompsoni,* swims across the scene.

Red fan gorgonian
This red fan gorgonian lives on the seaward slope.

Red fan gorgonian with white polyps
Here is another seaward reef red gorgonian. On this one, the white polyps of this colonial animal are extended in feeding mode. They filter plankton out of the passing water currents.

Red fan gorgonian with white polyps
This is a closer shot of the red gorgonian with white polyps.

Whip coral
One of the black corals grows as a single lengthening strand. Sometimes long colonies of this *Cirripathes* black coral take a corkscrew shape. This particular colony was at least 4 meters long and was relatively deep on the seaward reef.

Pink coral
This hard pink coral *Stylaster* lives in ledges and caves in a variety of lagoon and seaward reefs. Here it shares a cave with sponges, gorgonians, and a lot of small anthiid fish.

Pink coral
Here is some more *Stylaster* in a seaward reef cave. The *Stylaster* colony in the center of the scene is being held up by a colony of sponge. If the sponge breaks or dies, the coral will fall and likely die on the bottom.

Pink coral at Namu Atoll
Although *Stylaster* coral is common at Kwajalein, it is even more abundant on parts of the seaward reef of Namu Atoll, where this photo was taken.

Rock oyster
Here a few small coral colonies, including some *Stylaster*, grow on the shell of a living rock oyster, which may be *Hyotissa hyotis*.

Pearl oyster
A pearl oyster (*Pinctada margaritifera*) rests in the sand in a lagoon *Halimeda* algae patch. These oysters are relatively uncommon here. Don't bother checking these out for pearls. Pearls are extremely rare in these, and the relative scarcity of the oyster itself would pretty much ensure you'd never find one.

Cliff oyster
This rock or cliff oyster, probably *Spondylus violacescens,* usually lives cemented to the undersurface of a rock. The shell of this individual and the surrounding area are coated with a thin layer of red sponge.

Large rock oyster
This large living *Spondylus varians* lives in ledges and caves on lagoon reefs, and sometimes on the steel hulls of shipwrecks. The color of the animal is somewhat variable between specimens. This clam is surrounded by a variety of corals and sponges.

Large rock oyster at night
Here is another *Spondylus varians* in a small cave at night. The orange cup corals *Tubastraea* around it are extended and feeding.

File shell
Lima is a clam commonly called a file shell. The animal has numerous tentacles that extend from the shell. This clam is capable of moving around by flapping its valves and jetting water out its openings. We are not sure of the exact name of this species.

Electric clam
This is another kind of file shell named *Lima ales*. We call this the electric clam since it looks like there are flashing electric arcs within the animal. The electric arc is probably just a white edging to the clam's

animal that flashes in and out of view. Note that there is a second *Lima ales* behind the first in the cave they are living within. They are usually seen at relatively deeper depths on the seaward reef.

Fragile file shell
Here is another species of file shell. It could be *Lima fragilis*. Sometimes this one or a related species has bright orange tentacles. This one was out swimming after being disturbed from its usual habitat under a rock.

Crambione jellyfish
Several kinds of jellyfish live in the waters around Kwajalein. This is *Crambione mastigophora*, a species that can be found either in small numbers or in large aggregations of thousands of individuals. Its short but powerful stinging tentacles pack quite a wallop.

Transparent jellyfish
Here is another jelly, probably *Aequorea australis*, a mostly transparent species with very long tentacles. We often see these while doing safety stops after deeper dives on lagoon bottom shipwrecks.

Moon jellyfish
The moon jelly (*Aurelia aurita*) has long tentacles that will contract if the animal is disturbed. Recent research suggests that there may be a number of similar but different species in the Pacific.

Crown jellyfish
This is one of the crown jellies *Cephea*, one of the largest species found in this area.

Crown jellyfish backlit by sun
Here is another shot of the previous species backlit by the sun.

Spotted garden eels
These worm-like creatures are actually eels called spotted garden eels and are the species *Heteroconger hassi.* They stretch from their burrows in the sand, feeding on plankton drifting past in currents. These eels are very shy and retract into their burrows when divers approach. It takes much patience waiting for them to come out to get a good photo. When you are too close, every time you exhale, it scares them back into their burrows. It would probably be easier to photograph them if you were using a rebreather. At this distance, you cannot see that they are covered with many fine small dark spots and a few larger black spots.

Highfin snake eel
Here is one of the sand dwellers, the highfin snake eel (*Ophichthus altipennis*). They seem to spend all their time under the surface of the sand, often with their head sticking out to catch passing prey. The small shrimp passing in front of the lens show the scene was shot at night.

Barred moray eel
This barred moray eel (*Echidna polyzona*) was left in the open when the rock it was hiding underneath was overturned. It is quickly trying to get under cover again.

Whitemouth moray eel
The whitemouth moray eel (*Gymnothorax meleagris*) is here extending from a colony of a *Turbinaria* coral. It's easy to see where it gets its common name.

Snowflake moray eel
One of the prettier little eels, the snowflake moray (*Gymnothorax nebulosa*) is found on shallow lagoon reefs, usually living under rocks.

Snowflake moray eel
Here is another individual of *Gymnothorax nebulosa* on a lagoon reef. This one's a bit twitchy, probably a threatening display at the cameraman.

Giant moray
A giant moray (*Gymnothorax javanicus*) twitches a bit at the approach of the camera. These eels get quite large, having been definitely reported in other areas up to at least 2.5 meters long (more than 8 feet) with unmeasured specimens estimated more than 3 meters (10 feet). That's a big eel! Studies from Johnston Island indicate that they often eat parrotfish, and one large specimen even had in its stomach a whitetip shark (*Triaenodon obesus*)! Fortunately, these giant morays tend to be less overtly aggressive towards divers than some of there smaller relatives. In some places, members of this species have been trained to take food from the hands of divers. However, we do NOT recommend this practice. It doesn't take much of a mistake to lead to a large injury. We have been nipped by smaller morays, and the deep and bloody cuts inflicted by those long sharp teeth are easily infected and take a long time to heal.

Banded moray
The banded moray (*Gymnothorax rueppellii*) is exposed on the reef and hunting at night. We used to call these yellowheaded morays in Hawaii, where we saw them frequently while night diving. It is an aggressive eel and often appeared threatening if approached too closely. Note how these eels are not restricted to the forward gear; they seem to be able to move quickly in reverse as well.

Zebra lionfish
Here is one of the five species of lionfish found at Kwajalein. The lionfish are also frequently referred to as turkeyfish, and we use both names in the next few scenes. This one is typically a shallow lagoon dwelling species named *Dendrochirus zebra*. Like the other lionfish, the dorsal spines of this species are venomous and capable of causing painful wounds. The fish often hide against rocks and in algae on shallow reefs, so divers need to be careful to watch where they put their hands. Dr. John Randall, ichthyologist at the Bishop Museum, writes in Reef and Shore Fishes of the South Pacific (a book we highly recommend), that he was spined by a specimen that had been dead and on ice for several hours, and even so, "the severe pain was alleviated by immersion in hot water for 2.5 hours before it could be barely tolerated with the hand out of the hot water."

Zebra lionfish
This is a closeup of the animal in the previous scene. These fish wait until prey, usually small fishes or shrimps, come close enough to be quickly engulfed.

Antenna turkeyfish
Another kind of lionfish is this *Pterois antennata*, which is common in ledges and caves on lagoon and seaward reefs. This has been called the antenna turkeyfish or spotfin lionfish. Like its relative the zebra lionfish, it has venomous spines that can inflict a very painful sting. While common, these fortunately usually occupy caves where it is not easy to run into them. However, at night they often emerge from the caves and may be much more exposed; under these conditions, it would be easy for a diver to inadvertently put his or her hand or leg down right on top of the spines. If that happens, get out of the water right away. It is said that venom from lionfish can cause paralysis of the diaphragm, which would interfere with breathing.

Clearfin turkeyfish
Another common lionfish is *Pterois radiata*, shown here in a seaward reef cave. This species is called a clearfin lionfish or turkeyfish. One of us has been stuck by a related species in Hawaii, with three spines perforating the right thumb. The pain was immediate in the thumb, and over the next couple of hours it jumped first to the rest of the hand, then to the lower arm, then to the upper arm and around the shoulder before gradually fading away.

Juvenile turkeyfish
The largest lionfish is *Pterois volitans*, but this is a very small juvenile.

Turkeyfish
This is a somewhat larger specimen of *Pterois volitans*, although it is still much smaller than the large adults.

Turkeyfish
Here is an adult *Pterois volitans* out hunting. Like other lionfish, this one has highly venomous spines making these fish dangerous to touch. The venom is apparently in the thin fin tissue surrounding the spines. When the spine enters a wound, it tears the tissue allowing the venom within to bathe the open wound, causing intense pain. All the lionfish and turkeyfish are predators, mostly feeding on fish and shrimp. This specimen is out hunting fish during the day. Since this is the lionfish most likely to be out during the day, I suspect it could have the most potent venom. I have not yet managed to get myself stung by this species, and I think that is an experience I would like to avoid.

Devil scorpionfish
Scorpaenopsis diabolis is known as the devil scorpionfish. Although it is well camouflaged and looks like a rock, this is not the well-known venomous stonefish, which will be seen later. The scorpionfish is also venomous, but its venom is not as virulent.

Devil scorpionfish
This is a larger *Scorpaenopsis diabolis* slowly moving down among some rocks and blending in against its background. These are ambush predators. They lie still on the bottom most of the time, blending in with their surroundings. When an inattentive fish wanders too close, the scorpion's large mouth opens and the prey is virtually inhaled.

Stonefish, extremely venomous
This is the highly venomous stonefish (*Synanceja verrucosa*). Although it does sport some bright colors, it is also very well camouflaged under normal conditions. All its spines are capable of injecting a highly virulent venom that causes at least intense pain and has caused a number of human fatalities, fortunately none at Kwajalein that we know of. However, this species does live in shallow water and at least one person was stung at the local swimming beach, Emon beach. As a child many years ago, I was stung on the finger by one of these after accidentally picking it up on the Kwaj reef; it looked just like a rock! Fortunately, the spine only lightly penetrated the skin and no venom was injected. The venom is in bulbs near the base of the spine, and it takes some force to push the skin surrounding the spine down enough to squeeze the bulbs and cause venom to be pushed up the spine and injected into the wound. It was extremely painful, but most of that could have been in my mind. I knew what these fish were supposed to be able to do!

Buried stonefish parasitized by seashell
One of the ways the stonefish hides itself is by nearly completely burying itself under the sand. Here only the mouth (on the left), eyes, and dorsal surface (containing its venomous spines) are visible above the surface of a sandy cave. They lie in wait until a prey fish comes close enough. The stonefish can engulf large fish with a sudden ambush attack. Later in this scene we pan to a seashell, *Colubraria muricata*, partly buried in sand next to the stonefish. This mollusk lives by parasitizing immobile fish. Under the sand, this shell has stretched out its long proboscis and cut into the flesh of the stonefish. It is feeding by sucking the blood of the stonefish. Usually these shells parasitize sleeping parrotfish at night, but obviously can also do their feeding during the day if they find a suitably inactive host.

Parasitic seashell Colubraria
This is the parasitic seashell *Colubraria muricata* that was seen with the stonefish in the previous scene.

Shells parasitize fish at night
These parasitic *Colubraria muricata* can also parasitize sharks. These four were found underneath a large nurse shark resting in a cave and were left behind when the shark swam off at the approach of a diver.

Nurse shark resting in cave
This is a nurse shark (*Nebrius ferrugineus*) much like the one that was parasitized by the *Colubraria* in the previous scene. These sharks are often found resting in caves by day. We have seen them actively hunting benthic invertebrates such as small clams at night.

Nurse shark coming out of cave
This nurse shark is coming out of its cave.

Nurse shark freaks out
Another nurse shark kind of freaks out, swimming rapidly around after possibly being disturbed by the approaching photographer.

Gray reef shark
Troy's coralhead is a well-known spot to see gray reef sharks, *Carcharhinus amblyrhynchos*. This is a double coralhead, and down one slope on the south side are two long-standing schools of fish that hang out there. Whenever you go there, you can see up to a dozen or more gray reefs swimming around and through the schools of fish. Here a gray reef with a small pilotfish passes by as some fish from both schools dart away the opposite direction. The darker fish in the foreground are goggle-eyes *Priacanthus hamrur* while the silvery fish above appear to be bigeye scad *Selar crumenophthalmus*. A diver can be seen at the end farther down the slope.

Gray reef sharks
Here several gray reef sharks circle or swim through their school of fish.

Gray reef shark
A gray reef shark swims through the schools of fish.

Gray reef sharks
The gray reef sharks at Troy's coralhead are accustomed to seeing divers and do not usually act aggressively when divers are present. This is not the case on some other lagoon pinnacles farther up the reef. The gray reef sharks here are on a reef just in from an atoll pass halfway up the atoll where they are not used to seeing people. These sharks are a bit more active and agitated than those usually seen on Troy's.

Akibasan Maru shipwreck smokestack
The next few shots are on the shipwreck Akibasan Maru. Here we fade into an eagle ray (*Aetobatis narinari*) passing the smokestack. Kwajalein lagoon has a number of shipwrecks, mostly Japanese freighters sunk prior to and during the invasion of the atoll by American forces during World War II. Many of the shipwrecks are relatively deep, resting on the lagoon bottom that is often 40 through 60 meters deep. These wrecks, in addition to being interesting historically, are often loaded with marine life attracted to the artificial reefs. As the scene proceeds, a school of bluestreak fusiliers (*Pterocaesio tile)* rains down onto the wreck from above.

Akibasan fantail
We approach the fantail. In the front is a ladder that leads down to the main deck. The deck is coated with more than 60 years of sediment covered here and there with patches of *Halimeda* algae. Corals, sponges, and algae grow on the remaining metal beams and railings.

Akibasan fantail structure
This shows the fantail from above. The structure remaining is all that's left of the cabins that once stood here. Wooden walls and the ceiling have rotted away, leaving only the corroding steel beams now coated with sponges and corals.

Akibasan batfish by railing
As we drop down to the deck, three batfish (*Platax orbicularis*) swim past along the railing.

Akibasan longfin bannerfish
Next to a winch on the fantail, two longfin bannerfish (*Heniochus acuminatus*) take a look at the photographer.

Akibasan cabins
Swimming forward along the starboard side of the ship, we pass through a doorway into a room from which the ceiling has rotted away. Cables hang down from above. The floor is covered with sediment and algae. In the past, divers dug through this often fine sediment to seek buried artifacts. When done in a mostly closed room, this could stir up enough fine silt (called "muck") making it impossible to see. People often carried lifelines tied onto something outside to find their way back out.

Akibasan cabins
Continuing forward, we pass through another doorway with a doorway going inside to the left.

Divers on Akibasan
A diver swims over the engine hatches past some large funnels that once carried air down into the engine room.

Akibasan cargo hold
We swim over the opening to one of the amidship cargo holds. Lots of *Halimeda* algae grows on the beams.

Inside Akibasan cargo hold
The holds are often connected in the ship. Here we have dropped into one hold and are looking forward towards another, where a ladder leads down from the deck.

Akibasan map puffer
A large map puffer (*Arothron mappa*) passes through a doorway.

Akibasan map puffer
Following the puffer further, it slips out an empty porthole. The brass rims and portholes were mostly salvaged back in the 1960s shortly after the time when most of the wrecks were discovered by sport divers.

Akibasan bathtub
Here we look down through the roof into cabins of the superstructure. On the port side near the rear of the superstructure, an old bathtub can be seen in a corner of what was thought to be the pharmacy. Years ago, there was an unexploded 500-pound bomb lying right next to this tub, no doubt dropped from one of the attacking American planes in 1944. Although that bomb was a dud, the ship still went down from other causes. The bomb was removed as a potential safety hazard in the 1980s.

Akibasan bathtub
A photographer shoots the bathtub.

Akibasan 3-banded clownfish
Shipwrecks also often support sea anemones that are occupied by anemonefish. This *Amphiprion tricinctus* is in the anemone *Entacmaea quadricolor* on the deck of the Akibasan Maru.

Akibasan 3-banded clownfish
A very orange *Amphiprion tricinctus* lives in another anemone on the shipwreck. Bright red sponge encrusts some of the surroundings.

Akibasan 3-banded clownfish
A large and small *Amphiprion tricinctus* occupy a pure white *Entacmaea quadricolor* anemone. Most coloration in anemones is due to symbiotic zooxanthellae algae living within the tissue of the anemone. In this case, it appears as though the anemone has lost its symbiotic zooxanthellae. This can happen if the anemone is in a position where it receives too little sunlight for the algae to survive.

Akibasan Moorish idols
Two Moorish idols (*Zanclus cornutus*) pass each other over the deck of the ship. In the background to the

right is a threadfin butterflyfish, *Chaetodon auriga*.

Akibasan bluestreak fusiliers
Bluestreak fusiliers (*Pterocaesio tile)* swarm over the port side of the wreck.

Akibasan bluestreak fusiliers
Pterocaesio tile mill around one of the large funnels on the shipwreck.

Akibasan great barracuda
A great barracuda (*Sphyraena barracuda*) being cleaned by a *Labroides dimidiatus* passes over the port side of the wreck.

Akibasan great barracuda & divers
Two more barracuda pass a couple of divers rising past the stern mast on their way back up the mooring line to the boat.

Akibasan diver at mast
A diver photographs some of the abundant fish living around the shipwreck's stern mast.

Parker-Wallace wreck propeller
The Parker-Wallace shipwreck is a small, unidentified ship named for the two divers who found it. It lies on its side in about 50 feet of water near Kwajalein. This is a shot of the propeller.

Parker-Wallace minnows
Swarms of small baitfish gather around an obstruction like a shipwreck. Here the fish are being chased by several predatory ulua.

Parker-Wallace minnows
Fish swarm around structures on the deck.

Parker-Wallace minnows
More fish swarm around a lifeboat davit.

Asakaze Maru forward mast
Here we jump to another large Japanese freighter sitting upright on a 45-meter bottom. This is the Azakaze Maru, locally called K5 upright after the nearest navigation buoy. Old time Kwaj divers might remember this as K2 upright, which is what it was called before the Coast Guard changed the buoy numbers. This scene shows the forward mast.

Asakaze port rail
We swim forward along the railing along the port side of the superstructure.

Asakaze bow gun with diver
A diver swims around the front of the bow gun.

Asakaze bow gun
The bow gun sits on a platform on the bow of the ship. Sponges grow on the railing in front of the gun.

Tateyama Maru superstructure
The mooring cable is seen leading up toward the surface from the superstructure of another Kwajalein shipwreck, the Tateyama Maru, also called K5 side. This ship lies on its port side on a bottom of approximately 45 meters.

Tateyama superstructure
Here is another shot of structures in the main cabin area on the Tateyama.

Tateyama doorway
Doorways lead inside the wreck.

Tateyama portholes & door
In some parts of the superstructure, the wooden ceiling has rotted away, permitting easy access to some of the inside. Panning the camera up what was the wall facing aft we see a line of open portholes running up to a doorway on the starboard side of the ship.

Tateyama green turtle past gun mount
Moving out to the stern we see a green turtle (*Chelonia mydas*) lazily swim past an old gun mount. The gun itself is missing, having probably fallen off while the ship was sinking.

Eller wreck divers at stern
A shallow water wreck lies at Eller Island about a third of the way to the other end of the atoll. This unidentified wreck was apparently run aground while under attack during the invasion in 1944. Much of the wreck is really a wreck, having been pounded by near continual wave action along this reef. The stern, which we see with a couple of divers exploring, is relatively intact. The bow is completely in pieces.

Eller wreck diver at stern
A diver hovers above the stern to take some photographs.

Eller wreckage
Here is a view from the bottom looking up toward the surface across the wreckage.

Eller wreck fantail
This would have been the fantail of the ship.

Eller wreck bluegreen chromis
The very top of the wreck is only a meter or two below the surface of the water. The bluegreen chromis (*Chromis viridis*) are common around the branch corals growing on the wreck.

Palawan diver at bow
Jumping to another deep-water wreck, a diver swims over the bow of the Palawan near the island of Bigej. This wreck sits upright on a bottom of about 50 meters.

Palawan cabins
Here we look through the superstructure of the Palawan.

Palawan diver along starboard rail
A diver swims along the starboard rail.

Palawan spoked steering wheel
On the stern of the Palawan, a school of *Caesio teres* swims over a spoked steering wheel.

Palawan black coral on mast
A large bush of black coral grows on the top of one of the Palawan masts.

Fish schools on seaward reef
Returning to the reef, schools of fish above hover over the edge of the seaward slope.

Seaward reef surge channel
In many places along the seaward reef, steep-walled channels run from the outer slope in towards the shallow reef.

Seaward reef surge channel
Sometimes these seaward reef channels form caves or near tunnels.

Seaward reef sandy channel
Often white coral sand fills the bottom of the seaward reef channels.

Diver swims through minnows
A diver swims through a school of minnows over a shallow lagoon reef.

Minnow school
A minnow school up close.

Forktail rabbitfish feed on algae
A school of forktail rabbitfish (*Siganus argenteus*) feeds on a small patch of algae growing among colonies of the coral *Porites rus*.

Goldspotted rabbitfish
Two goldspotted rabbitfish (*Siganus punctatus*) swim close together.

Bluelined rabbitfish
Four *Siganus puellus* stay close together as they swim along the reef. Different books call these masked or bluelined rabbitfish.

Longnose filefish bickering
A group of six longnose filefish (*Oxymonacanthus longirostris*) interact with each other as they feed on living coral. We've also heard these called orange-spotted filefish, but longnose is more appropriate; after all, that is what the name "longirostris" means. Although this looks like it would make a cute aquarium fish, it will eat only polyps of living coral. In aquaria without living coral, they will starve.

Picassofish
Three Picassofish *Rhinecanthus aculeatus* wait near holes in rocks they can hide in if the photographer moves in any closer. This is also called a lagoon triggerfish.

Clown triggerfish displaying
A pair of clown triggerfish (*Balistoides conspicillum*) display at each other.

Juvenile yellowmargin triggerfish
A couple of juvenile yellowmargin triggerfish (*Pseudobalistes flavimarginatus*) interact.

Juvenile yellowmargin triggerfish
Juvenile triggerfish *Pseudobalistes flavimarginatus* change a bit in color as they get larger. The yellow margins on the fins that give this species its name are beginning to show up here.

Adult yellowmargin triggerfish
This adult yellowmargin trigger (*Pseudobalistes flavimarginatus*) looks at the camera as it swims past.

Anglerfish
A small anglerfish (*Antennarius*) props itself between a couple of rocks as it waits for prey fish to swim within striking distance. These anglers can eat surprisingly large fish. The mouth opens wide and the gut can expand dramatically.

Anglerfish
This is a head-on view of the anglerfish from the previous scene.

Anglerfish
Anglerfish use jet propulsion for swimming. Although they can use their fins, they often swim by drawing water into their large mouths and expelling it backwards through small gill openings just behind their pectoral fins.

Cuttlefish
Kwajalein has at least one species of *Sepia*, or cuttlefish, found in lagoon rubbly areas and *Halimeda* patches. It is a small species, usually around 75mm (3 inches) in length or less. These animals are capable of rapidly changing colors, which can be seen during the course of the scene.

Octopus
An *Octopus cyanea* sits on top of a lagoon coralhead surrounded by a school of cardinalfish

Octopus
Octopus hunt by probing under rocks and in holes with their long arms to drive out crustaceans and small fish. Often they flare out a thin sail-like balloon of tissue between their arms to catch prey that try to escape. This one is not ballooning very much because it is probably watching the photographer a bit too closely to be too concerned about feeding, even though it is going through the motions.

Octopus
A small, long-armed octopus species crawls across the sand in search of a hiding place. This species is certainly different from the common and larger *Octopus cyanea*, and is mostly seen in sandy or algae areas.

Octopus
Another small octopus walks across the sand to escape from the photographer. It kind of looks like it has two of its arms up with the tips curled into fists in front of its face.

Astropecten starfish
The spiny starfish *Astropecten* is a nocturnal species that buries in the sand during the day. It can move quite quickly across the sand when it wants to. The purple spots along the sides of the arms and orange blotches on top, coupled with the numerous sharp white spines make for quite a sight. This one is a large specimen, about 100mm across.

Astropecten starfish digging
Note how *Astropecten* folds its spines up or against the arms to make it easier for it to dig straight down into the sand.

Dwarf starfish
Aquilonastra anomala is a tiny starfish commonly found under rocks on some lagoon reefs. This species often appears to be regenerating arms after being broken or split; it would seem that dividing is a normal means of reproduction for this species.

Sea cucumber feeding
There are a number of soft elongate sea cucumbers. This one is *Synapta maculata* and it is relatively common on some lagoon reefs. There are a few other sea cucumbers with this body form. All are long and thin, with bodies that almost seem to consist of thin skin surrounding little but water. This is not recommended, but if you hold one by the middle of its body out of the water, the body mostly collapses with most of the water running down to pool up in both ends, almost like a water balloon. Here we are seeing just the anterior end, from which extend these pinnate feeding tentacles. It constantly grasps ahead of itself, gathering and pushing anything that sticks to the tentacles into its mouth. Anything organic is digested, while sand and other undigestibles pass through the body come out the other end.

Eyed sea cucumber
Some sea cucumbers, such as this *Bohadscia argus*, can extrude white tentacles as a defensive response. These tentacles are extremely sticky and are quite difficult to remove if a diver happens to get any on his or her skin. The specific epithet “argus” refers to the “eyespots” scattered over its skin. It is an attractive and variable species.

Red-lined sea cucumber

Many sea cucumbers are rather drab in coloration, but there are a few exceptions. One of the most brilliantly colored species is this deep water *Thelenota rubrilineata*. These are usually found only at depths greater than about 35 meters on the seaward reef slope. At that depth, the red color is not visible and the animal is actually rather easy to overlook despite often being about 500mm or more long.

Red-lined sea cucumber
A closer look at *Thelenota rubrilineata* shows the brilliant red lines that cover the body.

Wrinkled sea cucumber
This wrinkled sea cucumber *Holothuria fuscopunctata* is usually found on lagoon sand flats. This one is crawling from right to left with a subtle inchworm-like wave traveling along the body.

Cucumber crab on wrinkled sea cucumber
The sea cucumber from the previous scene, like many other species, is often occupied by commensal crabs (*Lissocarcinus orbicularis*). These crabs hide out in the mouth or anus of the sea cucumber, sometimes coming out to wander around on the cucumber's body. You can sometimes see these if you gently turn the sea cucumber over on its back; the crabs are usually on the underside, often near one end or the other.

Cucumber crabs on wrinkled sea cucumber
Here are a couple more of the commensal crabs *Lissocarcinus orbicularis*. These crabs can either be white with dark spots like these, or dark with white spots as in the previous scene.

Darth Vader crab (box crab)
Calappa calappa is one of the box crabs. They are nocturnal, spending their days buried in sand and emerging at night to feed. This species comes in several color forms ranging from white to orange. Note here how it uses its legs and claws to dig straight down in the sand. Once it is far enough down it stops digging, leaving just the crab's eyes at the surface. We also call these crabs "Darth Vader crabs." The shell kind of looks like the evil Jedi's helmet.

Box crab eyes
Here are the eyes and a couple of small appendages left at the surface of the sand after the crab in the last scene buried itself.

White box crab
Here is a white and slightly lumpy *Calappa* digging down. It is probably also a variety of *Calappa calappa* seen previously.

Katherine's gobies & bulldozer shrimp
Shrimp gobies live in holes that are created and maintained by different kinds of alpheid shrimp. The shrimp, *Alpheus ochrostriatus* in this case, spends the day pushing sand out of the hole that both the shrimp and fish can hide in when danger approaches. The shrimp, however, has rather poor eyesight and keeps coming out of its hole with bulldozer loads of sand it dumps outside. A predatory fish that sees this could easily wait for the shrimp to show up and grab it when it appears. This is where the goby comes in. Several kinds of gobies sit outside the hole and keep a lookout for danger. At the approach of potential danger, the goby dives into the hole, blocking the shrimp and keeping it from coming out. While the goby is outside and acting as lookout, when the shrimp appears, it keeps an antenna on the goby; if the goby suddenly dives into the hole the shrimp knows to retreat as well. In this case, a pair of the goby *Amblyeleotris katherine* are the watchfish.

Arcfin goby with pearlscale dartfish
Here are two individuals of another shrimp goby, *Amblyeleotris arcupinna*, peeking out of a hole. It seems that a smallscale or pearly dartfish *Ptereleotris microlepis* is also using this hole as a refuge. Near the end of the scene, the bulldozer shrimp (*Alpheus bellulus*) doing the job of keeping up the burrow in this case comes out of the hole with a load of sand.

Randall's shrimp goby
One of the most striking shrimp gobies is *Amblyeleotris randalli*, which is rather rare here and so far found only relatively deep on the seaward slope.

Firefish
This is *Nemateleotris magnifica*, commonly called a firefish or fire dartfish. Firefish hover over the bottom and dive into small holes at the approach of danger. These typically live on lagoon and seaward reefs. On seaward reefs, they tend to live on the top of the reef and a short ways down the steep slope, usually shallower than the next species, *Nemateleotris helfrichi*. There is some overlap in their depth ranges. A third species, not shown in this video, is *Nemateleotris decora*; it is rare at typical scuba depths at Kwajalein, usually overlapping with *Nemateleotris helfrichi* on the deeper slope.

Helfrich's dartfish
This is Helfrich's dartfish *Nemateleotris helfrichi*. Like *Nemateleotris magnifica*, it dives into holes when approached. These live on the seaward slope typically deeper than the zone occupied by *Nemateleotris magnifica*.

Zebra dartfish
Ptereleotris zebra occurs in large numbers on some shallow lagoon and seaward reefs. They swim up in the water column, dropping down near the bottom at the approach of divers and other potential danger. When danger comes too close, they dive into holes in the bottom. Sometimes many fish will dive into a single hole.

Shallow lagoon reef corals
This shallow lagoon reef is covered with different corals. At very low tide, some of these would be right at the surface of the water.

Fish over corals
A school of fish in the distance passes over a field of staghorn *Acropora* coral.

Pyramid butterflyfish
A school of pyramid butterflyfish (*Hemitaurichthys polylepis*) gathers around corals on the seaward reef. Unlike most butterflies, this species is nearly always found in schools. They are often seen rising above the bottom feeding on plankton.

Latticed butterflyfish
A latticed butterflyfish (*Chaetodon rafflesi*) swims over a field of dome coral *Lobophyllia*.

Threadfin butterflyfish
The threadfin butterflyfish (*Chaetodeon auriga*) is usually found singly or in pairs. On this particular lagoon reef, a large group has been present for at least a year.

Vagabond & double-saddle butterflies
Here are a couple of different butterflyfish interacting somewhat. The single is the vagabond butterflyfish (*Chaetodon vagabundus*) and the pair is the doublebarred or double-saddle butterflyfish (*Chaetodon ulietensis*).

Blackback butterflyfish
This blackback butterflyfish (*Chaetodon melannotus*) feeds on gorgonians and soft corals.

Flame angelfish
The flame angelfish (*Centropyge loriculus*) lives mostly at the upper edge of the seaward reef dropoff, but they are also found on some lagoon pinnacles. Species of *Centropyge* are sometimes referred to as pygmy angelfish.

Herald's & bicolor angelfish

This scene shows two different pygmy angelfish, the yellow Herald's angel (*Centropyge heraldi*) and the blue and white bicolor angel (*Centropyge bicolor*). Herald's can be found on both lagoon and seaward reefs, but the bicolor is mostly found in the lagoon.

Multicolor angelfish
This pygmy multicolor angelfish (*Centropyge multicolor*) is mostly found deeper than 20 meters on seaward reefs.

Lemonpeel angelfish
The lemonpeel angelfish (*Centropyge flavissimus*) is common on lagoon and shallow reefs. It is similar to *Centropyge heraldi* but has blue around the eye instead of a grayish patch beneath it.

Young lemonpeel angelfish
Young *Centropyge flavissimus* often have a black or blue spot on the side.

Lemonpeel/pearlscale angelfish hybrid
A rare pygmy angelfish here is *Centropyge vroleki*. *Centropyge vroleki* is apparently very closely related to *C. flavissimus*, and they hybridize frequently. At Kwajalein, you see a lot more hybrids than real *C. vroleki*. The hybrids come in a variety of color forms. This is an individual we have watched for several years. It is always around one small coralhead on a shallow lagoon reef.

Lemonpeel/pearlscale angelfish hybrid
This is another hybrid between *Centropyge flavissimus* and *C. vroleki*. Color of the hybrids varies, but is usually manifested by a yellowish body and black tail, often with blue spots scattered about, particularly on the head.

Lemonpeel/pearlscale angelfish hybrid
Yet another hybrid.

Lemonpeel/pearlscale angelfish hybrid
And one more hybrid.

Regal angelfish
A pair of regal angelfish (*Pygoplites diacanthus*). These can be seen on most reefs and are usually alone or paired.

Juvenile emperor angelfish
This is a young specimen of the emperor angelfish (*Pomacanthus imperator*). They change a lot as they grow, as you can see in the next two scenes. There are also a few yellow cardinalfish (*Apogon luteus*) and a host of pygmy sweepers (*Parapriacanthus ransonneti*) off to the left.

Intermediate stage emperor angelfish
Here is an emperor angelfish (*Pomacanthus imperator*) that has nearly finished developing its adult coloration. Out-of-focus cardinalfish dart by in the foreground.

Adult emperor angelfish
And this is an older, fully adult emperor. A longnose butterflyfish (*Forcipiger flavissimus*) tries to get out of the emperor's way.

Emperor angelfish through hole
Here an emperor angelfish is visible through a hole in the reef.

Elongate surgeonfish being cleaned
A couple of elongate surgeonfish (*Acanthurus mata*) have their parasites picked by a couple of cleanerfish (*Labroides dimidiatus*). The can rapidly change color between light and dark, and will do so often when being cleaned. Different colors apparently make different kinds of parasites stand out better

for easier spotting by cleaner wrasses.

Bignose unicornfish displaying
A male bignose unicornfish (*Naso vlamingii*) displays at another male. The lighter-colored front of the body and blue band between the eyes and the mouth are generally visible only in males that are courting or in an aggressive display. Erecting the dorsal fin is another sign of the display.

Sailfin tangs
A pair of sailfin tangs (*Zebrasoma veliferum*) peck at algae-covered rocks.

Yellow tang
The bright yellow tang (*Zebrasoma flavescens*) is rare at Kwajalein (although there are other species of common tangs that are yellow at least when young.) *Zebrasoma scopas* (next scene) is a close relative here that is common, but mostly black and brown. Occasionally you see yellowish-brown hybrids between the two.

Brushtail tang
The brushtail tang (*Zebrasoma scopas*) is closely related to the yellow *Zebrasoma flavescens* seen in the previous scene; some think they are color forms of the same species. This is a juvenile pecking on the algae growing on a dead coral rock. One fish enthusiast at Kwaj used to call these the "Abraham Lincoln fish." Can you see a resemblance to Honest Abe?

Goldrim surgeonfish aggression
A common surgeonfish is *Acanthurus nigricans*, found on reefs throughout the atoll. The books call these either the goldrim or the whitecheek surgeonfish. Usually they seem to get along pretty well, but it is not uncommon to witness what appears to be aggressive behavior in this twirling dance.

Blunthead batfish school
This is a school of the blunthead or longfin batfish (*Platax tiera*), one of at least two species of batfish found at Kwajalein. These are most often found on lagoon reefs and pinnacles, as well as around lagoon shipwrecks. You can distinguish this species from the other local batfish, *Platax orbicularis*, by the yellow pectoral fins and the black spot at the base of the second gray vertical band. Neither of the books I referenced called these "batfish," no doubt because there is a very different kind of bottom-dwelling fish that is also called batfish. One book uses "platax" as a common name, while the other goes with "spadefish." However, we here at Kwaj have always referred to them as batfish, so will continue to do so here.

Orbicular batfish
This is a younger specimen of the orbicular (or circular) batfish (*Platax orbicularis*). This species has mostly or all black pectoral fins and no black spot at the base of the vertical bands.

Orbicular batfish comes close
Batfish are often very curious and unafraid and may swim in very close to take a look at a diver. This orbicular practically nibbles the front port of the camera lens.

Orbicular batfish investigates diver
The orbicular bat from the previous scene comes over to investigate a diver's fins. How, it probably wonders, can a creature possibly swim with those maladjusted appendages? No wonder they're so klutzy in the water.

Diver over giant clam
A diver passes over a reef containing a large living giant clam (*Tridacna gigas*). Unfortunately, this clam, probably at least 50 years old, is no longer among the living. Local islanders eat these whenever they find them, and they found this one. Now the empty shell is nothing more than a chunk of substrate for other things to grow on. While the islanders have been eating these things for many years, it still seems quite a waste to kill such a magnificent animal for the sake of a few calories. The only part eaten is a chunk of

muscle, small compared to the overall size of the animal: a meal or two at most. Now these slow-growing creatures are virtually absent from the vicinity of inhabited islands. In the lower 16 kilometers or so of the atoll, we know of only a few specimens of these giants remaining. However, the clams are a bit fortunate here in that much of Kwajalein Atoll is leased by the US government as a testing range, and people cannot live on most of the islands, including nearly half of the atoll. While people can fish this mid atoll zone, the distance from inhabited islands has somewhat protected many reefs from extensive fishing, so the clams in much of the atoll are doing pretty well.

Giant clam
A *Tridacna gigas* more than a meter long lives amid corals on a lagoon pinnacle reef.

Giant clam
Tridacna gigas coloration is variable, this one being more yellow than green or blue. The base coloration of these clams comes from dinoflagellate algae called zooxanthellae that grow within the tissue of the coral itself. This is another case of symbiosis, or organisms living together in close association. The clam, an animal, uses oxygen and food to grow and produce energy, generating carbon dioxide as a waste product. The zooxanthellae, which are plants, use the carbon dioxide produced by the clam plus sunlight to produce oxygen and carbon compounds. The clam then can use the extra oxygen, and use the plants' carbon compounds for food. So both clam and algae gain an advantage from working together. The clam can also filter planktonic food from the water, as well as draw any additional oxygen it needs from the water through its gills. So if the clam loses its zooxanthellae, it can still survive, although probably not as well. If the clam is overly shaded, for example if a piece of coral grows over and blocks the sunlight from reaching it, the zooxanthellae are no longer advantageous to the clam. Plants deprived of light use up oxygen rather than produce it. In such a case, the plants from the shaded part of the clam vanish—I don't know if they are expelled or if they die off, but when this happens the shaded portion of the clam's animal loses its color.

Giant clam
Here is another large, very green *Tridacna gigas* on the slope of a lagoon pinnacle. Clam animals have two openings, one for water to be drawn in and the other for it to be pushed out after passing through the gills, which function both to extract dissolved oxygen from the water and to filter planktonic food to supplement what they get from their farmed zooxanthellae. The little green spots you see are iridescent rings of green (or sometimes blue). These iridescent rings are a telltale characteristic of *Tridacna gigas*. The other members of the giant clam family do not have these.

Giant clam & bannerfish
This is another *Tridacna gigas* with a bannerfish (*Heniochus varius*) swimming by in front.

Fluted clam
The medium sized giant clam at Kwajalein is *Tridacna squamosa*, sometimes called the fluted clam for the flutes on the sides of the valves. *Tridacna squamosa* is also variable in color, but always has spots of streaks of color, both of which are present in this individual.

Fluted clam
In this *Tridacna squamosa*, the spots are small and confined to the outer edges of the animal. This species is also a popular food item for islanders and is also in some jeopardy. They are far more common in areas far from habitation than they are around islands were people live.

Maxima clam
The third species of *Tridacna* at Kwajalein is *Tridacna maxima*. It is the smallest of the three, so the name "maxima" must refer to their numbers, as they are by far the most common. These seem to not be collected in great numbers for food, or they are sufficiently abundant to not be too affected yet by population pressures. However, they are not completely safe. Diving around Pohnpei island in the Caroline Islands you see very few *Tridacna maxima* and no living *Tridacna gigas* or *T. sqaumosa* even though empty shells are not uncommon. They have been fished completely or nearly completely out.

Maxima clam
Tridacna maxima is the most variable in color of all the Kwajalein species. But you can always tell them from *T. gigas* and *T. squamosa* in that they bore depressions into the rocks where they live and the animal invariably has a row of black spots near the ruffled edges.

Maxima clam
Tridacna maxima comes in a variety of colors that include black, brown, tan, green, and blue.

Maxima clam
In this specimen the row of black spots on the edges of the animal seem to be incorporated into the outermost black line around the edge of the mantle. This is a very small young specimen. It may change color a bit as it grows.

Bristleworm
There are many different kinds of annelid worms on Kwajalein reefs, but the vast majority hide quite well during the day and can be difficult to find. This striated bristleworm (*Pherecardia striata*) was roused from its hiding place under a rock and is now looking for another place to hide. The tufts of bristles sticking out from each side of each segment in the body are extremely sharp and penetrate skin easily. Some of these worms are appropriately called fireworms for the burning sensation that comes from getting clusters of these bristles stuck in your skin. Often bristleworms will swim up in the water at night. In my younger days, I dove just with a wet suit jacket and a pair of cutoff jeans. One night I had a bristleworm land on my upper leg, and from there it crawled up into my shorts. At the time, all I felt was a tickle, so I reached down to scratch. Bad move. I can tell you that the "fireworm" designation is not an inaccurate one.

Spiny scaleworm
Here is spiny scaleworm (*Iphione muricata*) that was living underneath a rock.

Collared worm
This very elongate worm is a species of *Eunice*, possibly *E. australis*. It too lives hidden away under rocks during the day and moves quickly to escape predators when exposed to light.

Nemertinean worm
This is not an annelid worm. Rather it is a member of a small group called Nemertinean worms, which are closer to the flatworms than to the annelids. This one is *Baseodiscus hemprichii*, one of a number of species that can be found here under rocks, buried in sand, or sometimes in patches of *Halimeda* algae. They are very long for their diameter; this one is at least a meter long and might be well over that if you could pull it out straight and measure it. But don't try. They are rather delicate and would probably break.

Nemertinean worm
This black worm with the white M (or W) on its head is another nemertinean worm known as *Notospermus tricuspidatus*. Note how it moves with peristaltic action, or waves of contraction moving along the body.

Flatworm
Here is one of the many flatworm species found at Kwajalein. In one sense, one wants to refer to flatworms as "simple" or "primitive" in their construction. They lack tissue types that are present in the more "advanced" animals. They have no special respiratory system (no gills) for pulling oxygen out of water; they're so thin that oxygen can simply diffuse in through the top and bottom of the worm. They have no special circulatory system to distribute the oxygen or their digested food; they're so thin that oxygen diffusing through the skin can easily reach all their cells, and in many species their gut branches to all parts of the body distributing the food directly. They have no anus; undigested wastes come back out the mouth. But they are fascinating and successful animals. Different species eat a variety of other animals, including sponges, tunicates, and even mobile mollusks. Many apparently produce toxic or distasteful substances, since there are many species that are brightly colored and live out in the open during the day. If they were edible, they'd certainly be eaten. And many make great photo subjects, as we hope you will see in the next few scenes. This first one is probably a species of *Buloceros*.

Flatworm
We've found this flatworm mostly in lagoon *Halimeda* algae patches. It is possibly a species of *Pseudoceros* but is as yet not positively identified. Many flatworms remain unidentified, but there is now a very nice book on worldwide flatworms by Newman & Cannon (2003) listed in the references.

Flatworm
This black species, possibly a *Thysanozoon*, is covered with small crowded black papillae and occasional bright white spots.

Flatworm on red sponge
This one is rapidly crawling over a bright red sponge. Note the wave action along the lateral margins as the animal moves along. This one may be *Pseudoceros lactolimbus*.

Bedford's flatworm
This *Pseudobiceros bedfordi* is crawling over a sponge encrusted rock.

Flatworm
This is a closeup of the anterior end of *Pseudobiceros fulgor*. While it can be hard to distinguish the head of these animals, there is usually a concentration of sense organs in the front. Often the anterior margin folds up into two tentacular folds that can almost look like the rhinophores of a nudibranch. Flatworms and nudibranchs are not, however, related.

Flatworm
This large and spectacular flatworm is *Pseudobiceros gloriosus*. These are rare here, but often when we find one, we also find others at the same time.

Flatworm
Similar to the previous species is *Pseudobiceros periculosus,* externally differing in having an orange rather than a magenta margin.

Flatworm
Pseudoceros dimidiatus is a strikingly colored species.

Flatworm
This is a species of *Thysanozoon*. Although not too visible in the image, the yellow dots are at the tips of black papillae that cover the dorsum. The bottom it is crawling across is studded with sea anemone-like disks called zoanthids.

Sacoglossan sea slug
Nudibranchs and their relatives can look similar to flatworms, but they are not so flat and have a lot of other anatomical differences. This is a not actually a nudibranch but instead belongs to a related group called Sacoglossa. This one is a species of *Elysia*, possibly a color form of *Elysia ornata*. They are most often found on lagoon reefs and pinnacles, usually exposed on algae during the day.

Carlson's sacoglossan sea slug
Here is another sacoglossan, this one called *Thuridilla carlsoni*. One of the ways sacoglossans differ from nudibranchs is because they are all herbivores while nudibranchs are all carnivores. Sacoglossans typically feed by puncturing individual algae cells with a tiny tooth to drain out and consume the cell contents. From this cell juice, they harvest individual chloroplasts, which are the organelles in plant cells responsible for producing food and oxygen from carbon dioxide and sunlight. Sacoglossans store these chloroplasts within their tissue, where the organelles continue their production of food and oxygen for a while. The sea slug continues to replenish them by feeding on algae.

Halimeda sacoglossan sea slug
This is a very odd and as yet unique individual of *Elysia*. The sole specimen was found on a clump of the

common algae *Halimeda cuneata* f. *undulata.* Considerable searching has so far revealed no more.

Formosa dorid nudibranch
One of the true nudibranchs is this *Platydoris formosa*. It lives under rocks by day and feeds on sponges. It is a fairly large nudibranch, growing to well over 100mm.

Scabra dorid nudibranch with eggs
Related to the last nudibranch is this *Platydoris scabra*. It is more common and usually lives under rocks on shallow lagoon reefs. Here it has just laid down a couple of ruffled orange egg masses.

Tuberculose nudibranch
This lumpy well-camouflaged nudibranch is *Dendrodoris tuberculosa*. I am careful when touching these ever since the time I handled one in Hawaii and subsequently rubbed my eyes. Their skin secretes a defensive compound, possibly acidic, that does a number on the sensitive tissues around the eye.

Phyllidia nudibranch
Another highly toxic nudibranch is this *Phyllidia* species. Their distinct coloration and normally exposed habits suggests they are protected from predation and this is indeed the case. Experiments, intentional and otherwise, have shown that if these nudibranchs secrete their toxins in an enclosed aquarium, everything in that aquarium will die and the water will smell bad enough to permeate even the air. For more information on this nudibranch and others that mimic it, see http://www.underwaterkwaj.com/nudi/porostomes/varicosa-group.htm.

Bilas eolid nudibranch
Most nudibranchs in one large groupf, the eolids, do not protect themselves using toxic chemicals. Instead, many of these species eat relatives of corals that possess stinging cells called nematocysts. The nudibranchs are somehow able to eat their prey without setting off the nematocysts. Undischarged stinging cells are transported to the tips of tentacles called cerata that run along the back of the nudibranch. There they are stored and are quite as capable of stinging nosy predators as are the coral relatives from which they were taken. This nudibranch is *Flabellina bilas* and it eats and stores the nematocysts of featherlike stinging hydroids.

Bilas eolid nudibranch closeup
Here is a closer shot of the anterior end of *Flabellina bilas*. The cerata are the tentacles banded with red and white near their tips.

Blue dragon eolid nudibranch
This is another hydroid-eating eolid nudibranch named *Pteraeolidia ianthina*. This species is not uncommon on seaward and some lagoon reefs. The nematocysts it gathers from its hydroid prey are capable of stinging careless divers.

Madrella nudibranch
Although this nudibranch named *Madrella ferruginosa* in the center of the frame has dorsal tentacles, it is not an eolid but belongs to another nudibranch grouping called arminaceans. At Kwajalein these are found in lagoon *Halimeda* algae patches where they eat a dark-colored bryozoan growing on the algae. This animal is on a patch of its prey bryozoan, which is extending its little flower-like cups of tentacles on the algae stem above and below the nudibranch.

Golden cowry partly hidden by mantle
You can't do a movie on Kwajalein marine life without including a living *Cypraea aurantium*, more commonly known as the golden cowry. Goldens live on the seaward reef slopes, although we have seen traces—empty shells and fragments—on some lagoon pinnacles. Nocturnal, they hide well back in caves and holes in the reef by day and emerge at night to feed and look for mates. Their primary food seems to be a lumpy gray species of sponge that is common in the caves and ledges. In this scene the mantle of the golden, the thin sheet of tissue that can cover the shell and is responsible for actually laying down the calcium carbonate that makes up the shell, is partly covering it, hiding much of the orange shell from view

under the mottled and camouflaged cover.

Golden cowry with mantle extended
When the mantle fully covers the golden, it can be hard to see.

Beck's cowry
This tiny cowry is called *Cypraea beckii*. The translucent reddish mantle covers part of the shell. These are usually seen in rubble on the seaward reef, or crawling along the walls and ceilings of ledges at night.

Children's cowry
Another cowry seen most often on seaward reefs at night is *Cypraea childreni*. This has a ridged rather than the typical smooth shell. It lives in seaward reef channel caves and ledges and dead and empty shells can often be found on the channel floors.

Chickpea cowry
One of the chickpea cowries is this *Cypraea cicercula*. These are most often found on lagoon pinnacles and are active at night.

Martin's cowry
Another nocturnal cowry found most often on lagoon pinnacles is *Cypraea martini*, although it can also be found in deeper seaward reef caves.

Clandestine cowry
Cypraea clandestina is a relatively common small cowry found under rocks and in *Halimeda* algae patches on shallow lagoon reefs. This one has its mostly brown mantle completely covering the shell, which is more or less off white with thin zigzagging brown lines.

Dillwyn's cowry
An extremely rare cowry here is this *Cypraea dillwyni*, which is found on the seaward reef at night.

Kurz' ovulid shell
Related to the cowries is the family of egg shells, most of which feed on gorgonians or soft corals. We have long called these shells *Cymbovula deflexa*, although an expert on the group recently told us it is more likely *C. kurziana*. They are on their sole food source, the gorgonian *Rumphella antipathes*. Usually they are found in groups of at least five or six specimens and always on the gorgonian. By day they hide themselves away in crevices or in debris surrounding the base of the gorgonian colony, and crawl out on the branches at night to feed.

Lance ovulid shell
We identify this egg shell as *Aclyvova lanceolata*, although it might be a new species. It is eating a red whip-like gorgonian that may be a species of *Ctenocella (*or *Ellisella*). Near the right side of the shell, you can see it actually sucking at the gorgonian, feeding on the coral's tissue. Our experience has been that these usually live with one specimen to a gorgonian colony, but where there is one, surrounding gorgonian colonies are more likely to host specimens as well.

Yellowbanded pipefish
Switching back to fish, here are a couple of the pipefish *Corythoichthys flavofasciatus*.

Schultz's pipefish
Here is a closeup of the head of another pipefish, *Corythoichthys schultzi*. Early in the scene it uses its long mouth to peck at something, then spits it out. These pipefish typically eat small crustaceans hiding among the tiny tufts of algae.

Black pipefish
This was an unusual black pipefish we found in a seaward reef channel. There is a chance it is *Halicampus brocki*.

White pipefish
This white pipefish was found in a lagoon *Halimeda* algae patch. Our best guess on this one is *Halicampus spinirostris*.

Ringed pipefish
The ringed pipefish (*Dunckerocampus dactyliophorus*) is usually found in seaward reef caves. Their shy habits make them a bit hard to get close to. You'll probably need a flashlight and look in a lot of caves and holes to spot one of these.

Ghost pipefish
Related to the pipefish and seahorses are the ghost pipefish, such as this *Solenostomus* species. They tend to float over the bottom and resemble drifting pieces of algae or debris. It looks a lot like *Solenostomus cyanopterus*, but we have been told it might be a new and undescribed species instead.

Halimeda ghost pipefish
Another ghost pipefish is *Solenostomus halimeda,* named for its close resemblance to the *Halimeda* algae it usually hangs around. In this scene, it attacks a small goby sitting on the reef, possibly going after the goby's eye.

Trumpetfish & gorgonian
A trumpetfish *Aulostomus chinensis* tries to hide against a large orange fan gorgonian (*Subergorgia mollis*).

Sea anemones
Dead whip coral and gorgonian skeletons on the seaward slope sometimes get colonized by these small sea anemones, *Nemanthus annamensis*.

Sea anemone
This sea anemone (*Telmatactis decora*) usually lives hidden under rocks.

Swimming sea anemone
The sea anemone *Boloceroides mcmurrichii* gets around by swimming.

Sea anemones
Here are a couple of large sea anemones living close together. The mostly white one is *Heteractis crispa* and the larger brown one is *Stychodactyla mertensii*. Both are occupied by a number of orangefin anemonefish (*Amphiprion chrysopterus*).

Orangefin clownfish
This is a closer view of *Amphiprion chrysopterus* in a carpet anemone (*Stychodactyla mertensii*).

Dusky clownfish
A large and a tiny dusky clownfish (*Amphiprion melanopus*) occupy the anemone *Entacmaea quadricolor.* As the fish grow, they lose their second stripe. Often commonly called a tomato clownfish locally, this common name is more frequently used for a similar but separate species that does not occur in the Marshalls.

3-banded clownfish & damsels
A large number of *Amphiprion tricinctus* and *Dascyllus trimaculatus* swarm over a sea anemone *Stychodactyla haddoni*. These anemones are typically found on sandy lagoon slopes and *Halimeda* patches.

Crabs & shrimp in sea anemone
Stychodactyla haddoni is also usually occupied by a number of kinds of crabs and shrimp. The crab is *Neopetrolishthes maculatus*. There are two shrimp species, including a couple of popcorn shrimp (*Thor*

amboinensis) and one bumblebee shrimp (*Gnathophyllum americanum*).

Popcorn shrimp
Here five popcorn shrimp (*Thor amboinensis*) gather next to the anemone *Stychodactyla haddoni*. Harder to see are a couple of transparent *Periclimenes* shrimp. *Thor* is usually found in small groups around, but usually not on, one of these large anemones.

Anemone shrimp
The shrimp *Periclimenes holthuisi* hang around a number of anemones, including this stinging *Actinodendron*.

Anemone shrimp & crab
Here's another mostly transparent *Periclimenes holthuisi* along with some anemonefish and a *Neopetrolishthes* crab on a *Stychodactyla haddoni* anemone.

Commensal shrimp on crinoid
The shrimp *Periclimenes amboinenis* lives on crinoids (feather stars) such as this *Comanthus bennetti*.

Bluestreak fusiliers pass crinoid
Another *Comanthus bennetti* crinoid sits up on colony of coral as a school of bluestreak or neon fusiliers (*Pterocaesio tile)* swims past.

Yellowback & bluestreak fusiliers
Schools of *Pterocaesio tile* and *Caesio teres* mix it up on a lagoon pinnacle.

Sea turtle through fusiliers
A sea turtle approaches through a school of *Caesio teres*. When it notices the photographer, it darts quickly away.

Hawksbill sea turtle
A hawksbill sea turtle (*Eretmochchelys imbricata*) swims in close to the camera. This turtle is missing its front right flipper, probably bitten off by a shark. Sea turtles use their front flippers for most of their propulsion, so this one is a bit clumsy, but it still seems to be surviving well enough.

Green sea turtle
A green sea turtle (*Chelonia mydas*) swims past on the dropoff.

Eagle ray with sharksuckers
An eagle ray (*Aetobatis narinari*) swim in accompanied by a couple of sharksuckers (*Echeneis naucrates*).

Eagle rays
Three eagle rays (*Aetobatis narinari*) swim around a sand bottomed channel.

White-bellied manta ray
A white-bellied manta ray (*Manta birostris*) comes up the lagoon slope past the camera. Mantas can be seen both in the lagoon and along the seaward reefs. Along some reefs in the lagoon, they frequently come in to cleaning stations, as in the next scene.

Black-bellied manta ray
A black-bellied manta ray hovers over a coralhead to have its parasites picked by cleaner wrasses. Most authors consider the white-bellied and black-bellied manta rays to both be the same species.

Whitetip shark
A white tip shark (*Triaenodon obesus*) swims up the slope to check out the photographer.

Silvertip shark
Another shark with white tips on its fins is the silvertip (*Carcharhinus albimarginatus*). This is a much larger shark usually seen in deeper water on the seaward slope. This one is more than two and a half meters long. Some years ago, one of these injured a spearfisherman on Kwajalein's seaward reef, but sharks cannot be expected to behave non-aggressively in the presence of speared fish. Fortunately, the ones we have seen with no spearfishing going on have not acted aggressively, but they are reported to be potentially dangerous. Among the things they are known to eat are gray reef sharks, and anything that can eat a gray reef deserves to be treated with respect.

Gray reef shark
A gray reef shark (*Carcharhinus amblyrhynchos*) charges over a coralhead to check out the photographer.

Gray reef shark
The shark comes in for a close look, then darts away.

Gray reef shark
Another gray reef shark swims through a school of *Pterocaesio tile*.

Diver swims back toward boat
At the end of the dive, a diver swims back towards the boat.

Credits roll across a sunset at Kwajalein Atoll.

Musical Selections are all by Cori Ashley and Ed Franks, selected from their CDs Naturcise I, Naturcise II, and Forest Dreams:

Country Fair
New Beginnings
Amore
Follow
Reflections
Paradise
Path of the Sun
Serene
Hidden Creek Shuffle
Rain Forest
Woodland Lullaby
Rejuvenation
Emerald Trail
Camino de Cielo

References:

As color printing gets cheaper, we are seeing an abundance of great color guides to various kinds of marine life. The books referenced below contains only a few of many that are now available. We'd like to be able to list many more, but then the list would get too long to be easily used. These happen to be ones we use frequently, specifically to identify the animals and plants in this video but also just generally to figure out what we are seeing underwater. (A couple of the list entries are not identification books but are works referenced in the text above.) One good place to get marine life books is from Sea Challengers at http://www.seachallengers.com.

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Reasonably inexpensive and easy-to-use digital cameras in housings have led to an explosion of underwater photographs, and the internet has opened the way for many of these to be seen and shared. Here are some of the many excellent web sites that I have found particularly useful.

Sea Slug Forum http://www.seaslugforum.net
Slug Site http://slugsite.tierranet.com/
Kwajalein Sea Slugs http://www.underwaterkwaj.com/nudi/nudi.htm
Fish Identification http://www.fishbase.org/search.php
Marine Flatworms http://www.rzuser.uni-heidelberg.de/~bu6/index.html

Appendix

Naming Conventions

Scientific nomenclature is based on a multilevel hierarchy that reflects how the animals are related to one another. For example, the full position within this hierarchy of one species of nudibranch is the following:

Kingdom Animalia (the animal kingdom)
Phylum Mollusca (all snails, clams, octopus, and so on)
Class Gastropoda (snails, literally “stomach foot”)
Subclass Opisthobranchia
Order Nudibranchia
Suborder Doridoida
Family Chromodorididae
Genus *Chromodoris*
Species *fidelis*

Other levels may be placed in between some of these to further subdivide groups. Note that the last two levels, the genus and species, constitute the actual name of the species. The genus is always capitalized while the species is always lower case. Both are italicized, but none of the other levels are. In some publications you might see the genus and species underlined instead of italicized.

Scientific names are based on Latin, because it is, in theory at least, a “dead” unchanging language. By agreeing to use a language that is no longer used on a day-to-day basis, the worldwide scientific community was able to avoid regional bickering about whose language should be used to name species. Can you imagine the French accepting the use of standardized names based on American English, for example? But the Latin nomenclature is a worldwide standard; each country or area may and often does have its own common names, but any scientific work must use scientific nomenclature.

But why should we be using scientific names in what is primarily a work of entertainment? Well, we hope that some of the observations detailed here might be of some use to working biologists. But mostly we use scientific names because they are consistent and accurate. If we use a scientific name, then as long as we have made the identification correctly, people who view the video or read these notes should be able to determine exactly what species we mean. You cannot do that using common names. For one thing, common names are rarely common. We used several books extensively to identify fish, for example. Two of our favorites, both excellent books by extremely knowledgeable fish biologists, frequently give different common names for the same fish, even when they nearly always agree on the scientific names (and where they do not is usually due to new research turning up a new name to a particular fish). If two such experts in the field, both studying reef dwelling fish in the tropical Pacific, don’t use the same common names, how can we expect agreement from fish enthusiasts in Australia, Asia, Europe, and so on? Common names don’t even match up on the big animals. What we call the gray reef shark in these notes would be called a “gray pointer” in Australia.

Then of course, many animals do not even have common names. Among the nudibranchs, for example, there are only a few species with common names even sporadically used. True, some recent picture books have tried to put common names on all the species, but to do so, the authors generally had to make up most of them. How common is that?

If you’re going to be interested in these animals enough to learn their names, it is best to at least be familiar with the scientific names.

Unfortunately, even the scientific names are not completely stable. New names are added if animals once considered part of another species are determined to be fully separate species. Animals may be put in different genera (the first part of the binominal Latin name) if further research indicates relationships are different than previously thought. And names might be changed when older names for the same species are discovered. Scientific names are subject to a law of priority that says the first name used is the real one. Often animals named particularly in the 1700 and 1800s were either forgotten after being named, were named in obscure or rare publications that are not widely known, or were so insufficiently described that it has been hard to re-identify them. Consequently, many species have been given more than one

scientific name, and generally if an earlier name for a particular species is found, the name must change.