

Exploring Kwajalein's Living Reef

The movie Exploring Kwajalein's Living Reef is set entirely to music with no narration. We realize some people may be interested in understanding a little more about what they are seeing. This document is provided to provide a short explanation of each scene in the video, where appropriate including scientific and common names of at least the primary subjects and perhaps a little bit on what is happening in the scene. Most or all DVD players include an LED time counter in minutes and seconds on the front of the machine. The number in the left column below gives the minutes and seconds from the counter of the beginning of each scene. We suggest first watching the video without referring to this document. On a subsequent playing, you can pause the video at a scene, read off the counter and go down the left column until you are in the correct range. This document runs many pages, so we do not recommend printing it. However, you can access it through a computer or download it to a tablet for reference.

- 00:00 Ripples through the calm surface decorate the white sandy slope.
- 00:08 Looking up a steep slope of dense coral to a calm surface.
- 00:13 A stand of gorgonians and soft coral on the steep slope of an atoll pass. Regular swift currents through the pass promote soft coral growth.
- 00:19 A closer view of the previous scene.
- 00:25 A colorful scene consisting of a peach gorgonian (*Anella mollis*), soft coral (*Dendronophthya*) and yellow coral (*Distichopora*).
- 00:32 Yellow *Dendronophthya* soft coral in an area subject to swift currents.
- 00:38 Several layers of peach gorgonian and a red *Chironophthya* soft coral growing in an atoll pass.
- 00:44 This *Distichopora* yellow hard coral is common up around the western bend in the atoll. It is not present at all in the southern part of the atoll. It, like the pink *Stylaster* it is growing against here, often take up gaps in the coral where they can intercept passing water to filter out their planktonic food.
- 00:51 More yellow *Distichopora* coral on an outcrop. A plankton eating crinoid or feather star takes advantage of the height to reach farther out into the current to snag its passing food.
- 00:59 A crinoid spreads out to filter plankton from a red gorgonian.
- 01:06 Looking upward toward the sun through a field of red whip gorgonians (*Ellisella*) on the steep seaward slope.
- 01:14 Black Elongate Surgeonfish (*Acanthurus mata*) with Scissortail Fusiliers (*Caesio caerularia*) in the background.
- 01:20 Numerous Pyramid Butterflyfish (*Hemitaurichthys polylepis*) with other fish on a coral and algae slope.
- 01:30 Pyramid Butterflyfish and Thompson's Surgeonfish (*Acanthurus thompsoni*) with a few Purple Queens (*Pseudanthias pascalus*) on coral and algae slope.
- 01:38 Purple Queens school over coral above a sandy slope. One male with a red dorsal fin displays at left near the beginning of the scene. A Golden Damselfish (*Amblyglyphidodon aureus*) swims into the right side near the end of the scene.
- 01:46 Juvenile Purple Queens around a crinoid with a few juvenile Midget Chromis (*Chromis acares*) mixed in.

- 01:53 Looking down a coral drop with some crinoids on the coral. Golden Damsels are down near the coral with large gray Unicornfish (*Naso hexacanthus*) above.
- 02:01 Rainbow Runner (*Elagatis bipinnulata*) mill about over the edge of a seaward reef slope.
- 02:10 On a lagoon pinnacle a school of Double-lined Mackerel (*Grammatorcynus bilineatus*) swims past.
- 02:18 A small school of Heller's Barracuda (*Sphyraena helleri*) swims slowly above the edge of a lagoon pinnacle.
- 02:25 A large school of Heller's Barracuda passes overhead.
- 02:34 A large and dense school of Heller's Barracuda mills about overhead, suddenly darting to the right and upward.
- 02:47 Gray Reef Shark (*Carcharhinus amblyrhynchos*) swims past along dropoff with a rippling pattern of sunlight on its back.
- 02:57 A Nurse Shark (*Nebrius ferrugineus*) comes up slope into camera through red Goggle-eyes (*Priacanthus hamrur*), then zips away down the slope when he get close enough to see the size of the photographer. In the distance is a school of Bigeye Scad (*Selar crumenophthalmus*).
- 03:04 A school of Moorish Idols (*Zanclus cornutus*) swims past through a milling school of Purple Queens.
- 03:12 A school of Thompson's Surgeonfish around a table coral on the top of a steep slope.
- 03:17 A diverse bouquet of corals with a single Chevron Butterflyfish (*Chaetodon trifascialis*) swimming over the table in the center.
- 03:23 Purple Queens swim in front of a ruffled soft coral (*Sarcophyton*).
- 03:30 Two Magnificent Sea Anemones (*Heteractis magnifica*) sit next to each other with an assortment of Apricot Clownfish (*Amphiprion perideraion*) and 3-Spot Damsels (*Dascyllus trimaculatus*) sharing the protection of the anemones' stinging tentacles. These two anemones have vanished, possibly succumbing during the coral bleaching episode in the fall of 2013.
- 03:37 A healthy yellow Magnificent Sea Anemone with Apricot Clownfish on an interisland lagoon reef.
- 03:45 This is a close-up of the Apricot Clownfish in previous scene.
- 03:53 A purple base Magnificent Sea Anemone with Apricot Clownfish. The stalks of these anemones come in several colors. This anemone has retracted, possibly eating something that stuck to the tentacles. A couple of small groupers (*Epinephelus merra*) are just to the right.
- 04:01 Close-up of the previous scene.
- 04:09 A stark white Magnificent Sea Anemone with Apricot Clownfish. This anemone has bleached due to excessively warm water. When conditions get too warm, anemones and corals will lose the symbiotic unicellular zooxanthellae, a photosynthetic plant-like organism that gives the corals their color and also provide food and oxygen. The zooxanthellae get in return carbon dioxide and nitrogen produced by the coral's metabolism, which it uses to produce the food. Without this symbiotic give and take, the corals and anemones would have a hard time surviving in typically nutrient-poor tropical waters. At Kwaj, bleaching seems to start getting serious at about 30degC (86degF).

- 04:17 Magnificent Sea Anemone with Apricot Clownfish. This anemone is also bleached, although its background natural color is yellow rather than white. This is at about 25m depth on the slope of a lagoon pinnacle. Behind the anemone, numerous Fusiliers (*Pterocaesio marri* and *P. tile*) swim past.
- 04:25 A group of Apricot Clownfish in a bleached Magnificent Sea Anemone. Kwaj has seen serious coral and anemone bleaching episodes during the Fall months of 2009, 2013 and 2014.
- 04:33 Apricot Clownfish in a colorful bleached Magnificent Sea Anemone. Extracting the typically brown zooxanthellae plants allows the anemone's true and sometimes bright colors to show through, although most individuals turn out to be pure white without their symbiotic algae.
- 04:43 Bluegreen Chromis damselfish (*Chromis viridis*) swimming over some branching *Pocillopora* coral. The fish will dive between the branches of the coral for protection at the approach of danger. This was shot looking upward at a glassy calm surface on a windless day.
- 04:50 Mostly Bluegreen Chromis swimming over a colony of branching *Porites* coral. Partway through the scene, a Tripletail Wrasse (*Cheilinus trilobatus*) enters from the left swimming through the damsels over the top of the coral.
- 04:59 Some Bluegreen Chromis mixed with a number of Peacock Damsels (*Pomacanthus pavo*) and few other fish around a small colony of the branching *Pocillopora eydouxi*.
- 05:05 Large Peacock Damsel deciding whether to dive back into a hole in the reef, with a few smaller ones darting around.
- 05:10 Dick's Damsel scooting around between the pointed columns of a large colony of *Acropora* coral.
- 05:19 Dense coral growth on the edge of a lagoon pinnacle reef. Several green-banded Staghorn Damselfish hang around the coral as a female long-snouted female Bird Wrasse (*Gomphosus varius*) darts through the scene.
- 05:26 A small isolated patch reef on a shallow sand and rubble flat becomes a settling place for various coral colonies, attracting a variety of fish to the feeding opportunities and protection offered by the reef.
- 05:33 Numerous fish around a small colony of branching *Pocillopora* coral growing on other corals. Two species of black and white damselfish, the Humbug and Reticulate Damsels (*Dascyllus aruanus* and *D. reticulatus*) will dive between the coral branches at the approach of danger.
- 05:40 Nearly always wandering around the reef in pairs, Foxface Rabbitfish (*Siganus vulpinus*) peck at the algae growing on dead coral colonies. More territorial damsels and surgeonfish (like this *Acanthurus nigricans*) will try to chase the rabbits away to protect their food sources.
- 05:48 Another grazing rabbit, the Goldspotted Rabbitfish (*Siganus punctatus*) is easily recognized by the dense red circles covering its body. This one looks the photographer but seeing no apparent danger, returns to pecking at the algae on the bottom.
- 05:55 A third local rabbitfish is the Bluelined Rabbit (*Siganus puellus*). These two are grazing on a patch of algae-covered dead coral in the company of a couple of Foxface

- Rabbits, a Moorish Idol (*Zanclus cornutus*), a pair of smaller brown Klein's Butterflyfish (*Chaetodon kleini*) and a Regal Angelfish (*Pygoplites diacanthus*).
- 06:04 A rarely seen trio of Bluelined Rabbitfish (they're usually paired) swim past in a tight bundle.
- 06:10 Numerous fish on a shallow coral-rich reef. The school of bluish gray fish are Forktail Rabbitfish (*Siganus argenteus*). Other interesting fish are a trio of jacks (*Carangoides orthogrammus*) passing high in the frame and a couple of black-saddled Bigeye Emperors (*Monotaxis grandoculis*).
- 06:23 More fish swim over a coral-rich lagoon reef. Most of these are a couple species of parrotfish, with the whitish ones Longnose Parrots (*Hipposcarus longiceps*).
- 06:33 Various fish over a reef dominated by staghorn *Acropora* coral. Several Orangespine Unicornfish (*Naso lituratus*) with an orange band at the narrows in front of the tail swim from left to right. In the opposite direction, a couple of Orangespinner Tangs (*Acanthurus olivaceus*) pass a couple of Moorish Idols at lower right. The large green parrots mostly appear to be Steephead Parrots (*Chlorurus microrhinos*). In the last half of the scene, a single Coronation Grouper (*Variola louti*) swims through the middle from right to left.
- 06:42 A school of Minifin Parrotfish (*Scarus altipinnis*) swims over a clump of yellow branching *Porites* coral on the reef near Shell Islands. Parrots, like a number of other fish, often mature first into females and change to males later in life. The reddish brown ones are initial phase (probably mostly females) while the green ones are terminal phase males. Parrots provide a valuable service to the reef, using their hard fused teeth to scrape algae right down to the bare rock. Juvenile corals settling to the bottom out of the plankton generally cannot adhere to the bottom and start to grow if the rock is fully covered with algae. Parrotfish grazing opens up bare spots to which the coral larvae can attach if they can get there before the algae covers it again.
- 06:48 A small school of Purple Queens (*Pseudanthias pascalus*) swim over a colony of crinkly coral (*Porites rus*). A few dark juvenile Bettlehead Parrotfish (*Chlorurus spirulus*) swim over the coral from left to right, and a red Flame Angelfish (*Centropyge loricula*) keeps to the safety of the coral columns.
- 06:53 A female Bettlehead Parrotfish pauses in front of some Pacific Elkhorn coral (*Acropora rotumana*) to have her parasites picked off by a Striped Cleaner Wrasse (*Labroides dimidiatus*). The more green male Bettlehead is in the background and a couple of Foxface Rabbitfish swim through the coral. At the end, another female Bettlehead comes in for her turn with the cleaner.
- 06:59 A male Bettlehead Parrotfish having his parasites picked off by a Striped Cleaner Wrasse.
- 07:03 A male Egghead Parrotfish (*Scarus oviceps*) grazes algae off the reef rock.
- 07:10 Several wrasse species are attracted to what appears to be a patch of rust showing through the algae growing on a sunken landing craft on the lagoon side of the west reef just north of Kwaj. Participants appear to be the yellow female Sunset Wrasses (*Thalassoma lutescens*), a few white female Threespot Wrasses (*Halichoeres trimaculatus*) and dark green female Moon Wrasses (*Thalassoma lunare*). Toward the end, a couple of striped female Blunthead Wrasses (*Thalassoma amblycephalum*) show up.

- 07:17 An adult Axilspot Hogfish (*Bodianus axillaris*) hangs around a ledge on the seaward slope.
- 07:22 Juvenile Axilspot Hogfish look very different from the adults (previous scene). These usually live in dark caves or ledges, but this individual was swimming in the open on the top of the seaward reef.
- 07:27 Juvenile Dragon Wrasse (*Novaculichthys taeniourus*), sometimes called a Rockmover Wrasse due to the propensity of larger adults to pick up with their teeth quite large rocks to move them aside in the hunt for prey beneath. Juveniles like the one figured tend to drift around the coral looking like floating bits of debris.
- 07:36 The strikingly black and white banded male Barred Thicklip Wrasse (*Hemigymnus fasciatus*) swims past chewing on a mouthful picked up from the bottom. After some mastication, he spits out the indigestible portion, taking one last look at it for anything tasty he might have missed.
- 07:44 Another "spitter," the Blackeye Thicklip Wrasse (*Hemigymnus melapterus*) takes a bite of algae and rubble from the bottom. Primarily a carnivore, the wrasse is taking a chance there might be small animals like shrimp or small shells in the algae he chews.
- 07:53 The wrasse may swim along chewing away for some time before spitting the remnants. Again, he takes another look to make sure he did not miss anything. At the last minute, he decides to again chew up part of what he just spit out.
- 07:58 This dark wrasse with a central yellowish band and long pelvic fins is a male Tubelip Wrasse (*Labrichthys unilineatus*).
- 08:02 Twinspot or Clown Wrasse (*Coris aygula*). Like many wrasses, this species changes greatly in color as it matures from a juvenile to a female and finally to a terminal male. The name twinspot obviously refers to the juvenile with its pair of red and black spots on each side.
- 08:05 Female Twinspots lose the twin spots and begin to darken posteriorly.
- 08:12 Terminal male Twinspots look nothing like the earlier stages, becoming large fish with a distinct forehead hump, like this one swimming over a stand of Pacific Elkhorn coral.
- 08:18 Even the largest wrasses start out small. This juvenile Napoleon or Humphead Wrasse (*Cheilinus undulatus*) has a nice yellow tail margin and an elongate dark spot on each scale.
- 08:24 Larger but still not fully grown Napoleon Wrasses turn more green in color.
- 08:31 Large males become darker green and develop a humped forehead. Even this one is not fully grown. Largest specimen ever reported is 2.29m (or about 7.5 feet), but others have questioned that measurement.
- 08:35 This grasping soft coral (*Xenia* sp.) used to be more common but now is hard to come by in the southern part of Kwajalein Atoll. In recent years, we've seen only a few colonies on the seaward reef off Legan and a large stand of separate colonies on one reef near Meck, which is where this clip was shot. The large polyps on the ends of often long stalks spend a lot of time grasping with its tentacles, like a hand opening and closing repeatedly.
- 08:44 Occasionally one or a pair of *Xenia* eating nudibranchs (*Phyllodesmium hyalinum*) can be found living on or around colonies of their grasping coral prey. Here a nudibranch approaches a colony of grasping coral on the seaward reef at Legan.

- 08:55 Another nudibranch was already on the colony of grasping coral, the slug's dorsal tentacles (called cerata) closely resembling the polyps of the coral to help camouflage it from the eyes of carnivorous fish.
- 09:03 An as yet unnamed species of nudibranch in the genus *Flabellina*. The single Kwaj specimen was found crawling in algae debris at the base of a sandy lagoon slope near Gugeegue.
- 09:10 This sponge eating nudibranch named *Reticulidia fungia* is seen only occasionally, usually fairly deep, 30m or more, on the seaward slope.
- 09:16 Certainly one of the most striking of nudibranchs is *Nembrotha kubaryana*, ornamented with round or elongate green spots on black with a fiery, almost florescent red trim to the foot, rhinophores and usually the gills. Sometimes the green spots are darker and seem to suck up the light, making it hard to get a picture of how attractive the animal is. These live on a variety of lagoon and seaward reefs, usually near their food, a dark green colonial tunicate.
- 09:23 The nudibranch *Hypselodoris whitei* crawls across algae debris at the base of a sandy lagoon slope. The two white tipped orange tentacles at the front (right side) are called rhinophores and are used for chemical sensing to find food or mates. The orange tuft near the left end are the naked gills that give the group its common name of nudibranch.
- 09:30 The nudibranch *Hoplodoris estrelyado* crawls across a blade of green algae on sand on a lagoon reef.
- 09:37 So far known at Kwaj from only one specimen, this *Dendrodoris krusensternii* nudibranch was on a small rock in an algae patch in the lagoon near North Loi.
- 09:41 Also known at Kwaj from only one specimen, this *Plocamopherus maculapodium* was under a small rock near Gugeegue.
- 09:46 Commonly found on one or two sites on the lagoon side of Bigej, this species of *Cyerce* may not yet be named.
- 09:51 This slug appears to be *Elysia punctata*. It is common on quiet lagoon pinnacles in the vicinity of Kwaj, and must be distasteful, since it is often exposed during the day.
- 09:57 Rarely seen here at Kwaj, most individuals of this attractive bubble shell (*Hydatina physis*) have been in algae patches at North Loi.
- 10:04 Crown-of-Thorns starfish (*Acanthaster planci*). This is a very small individual of this coral-eating seastar.
- 10:11 This is a larger but still fairly small Crown-of-Thorns on branching *Pocillopora* coral. The spines covering the star are sharp and venomous. Puncture wounds cause quite a bit of pain, and an anti-coagulant in the venom keeps the blood flowing out of the puncture for some time.
- 10:16 The star *Asteropsis carinifera* is not rare but is not often seen during the day, when it hides in dark ledges and caves. It comes out at night.
- 10:23 Sometimes called the Barf Star, *Echinaster callosus* is usually seen well in ledges and small caves on seaward reefs and pinnacles. It is more often seen at night, when it is more active. This scene shows it in a cave with some pink *Stylaster* coral.
- 10:29 A juvenile individual of *Echinaster callosus* was under a small rock.
- 10:36 Also nocturnal, *Leiaster speciosus* can sometimes be seen during the day under rocks or back in dark ledges.
- 10:42 The brittle star *Ophiolepis superba* is one of the slowest moving brittlels.

- 10:49 Several kinds of spiny brittle stars in the genus *Ophiothrix* live in algae patches or on sponges or gorgonians. In some species, the sharp spines are apparently venomous.
- 10:58 This is a different *Ophiothrix* brittle star usually found in large numbers with their arms wrapped tightly around gorgonians.
- 11:04 An especially long-spined *Ophiothrix* brittle star living on a gorgonian. The spines of some of these brittles produce painful puncture wounds if you accidentally brush against them.
- 11:12 Here the common peach fan gorgonian *Annella mollis* has some of the green algae *Caulerpa* growing over it.
- 11:19 Gorgonians such as *Annella mollis* often have other animals associated with them. Here the ovulid *Pellasmimnia annabellae*, a shell in the egg cowry family, lives and feeds on a large gorgonian. These are not common and rather difficult to see, and have mostly been seen here at Kwaj on fans at depths of 30m or more on the seaward reef.
- 11:25 Here a *Pellasmimnia annabellae* has retracted the peach-colored mantle, a thin layer of tissue that covers and actually produces the shell, revealing the off-white shell beneath. You can see the head tentacles, one with a small black eye at the base, just under the upper right end of the shell.
- 11:32 Another rare inhabitant of the large peach fan *Annella mollis* is this Denise's Pygmy Seahorse (*Hippocampus denise*). We have seen only one here, and it was found by accident while we were photographing one of the *Pellasmimnia* ovulids in the previous scenes. Only about 15mm tall with the long tail stretched out, its tiny size and resemblance to the gorgonian makes it very hard to distinguish. Frequent searches for additional specimens have not been successful.
- 11:38 Another view of Denise's Pygmy Seahorse after it had moved out to the edge of the gorgonian.
- 11:44 The only other seahorse we have found at Kwajalein is this single Spiny Seahorse (*Hippocampus histrix*). It was in a lagoon algae patch along an interisland reef. This species is known to sometimes live pelagically, floating along with debris across the open ocean. Since no other individual has been seen in many years of diving here, we think it may have drifted in with something floating and decided to stop on the reef.
- 11:55 A relatively common inhabitant of lagoon sand flats and algae patches is the large Horned Helmet shell (*Cassis cornuta*). This one has an unusually clean shell; most are encrusted with coral, algae or sand. They are often seen partially or even mostly buried in sand, sometime with only the dorsal horns sticking out of the sand. They eat the burrowing urchins sometimes called "sea mice," leaving behind often surprisingly intact urchin skeletons.
- 12:05 In the same family as the Helmet shells are these Bonnet shells (*Casmaria ponderosa*). These are common in some sandy areas and algae patches, but usually come out only at night, when they chase down their small burrowing urchin prey. They also often turn into prey themselves, as we have seen piles of freshly emptied shells in some lagoon sand or algae patches. While we have not yet seen it happen, we envision a sand octopus gathering up a bunch of these at night and carrying them all with its tentacles to its dinner site, where it proceeds to pluck out the animals and leave the empty shells.

- 12:10 Another nocturnal sand dweller, this is one of many species of Moon snail (*Natica euzona*) found in the sand and algae reefs in the lagoon.
- 12:15 Another Moon snail, this one is *Natica onca*.
- 12:19 Related to a sought-after delicacy on the US west coast, the species of Abalone (*Haliotis*) we have here in the Marshalls are way too small to eat. Only about 25mm long, these fast moving snails can be seen occasionally on rocks at night, usually near the top of the seaward reef.
- 12:24 The longest, although maybe not the most massive, cowry found in the atoll is without a doubt the Tortoise (*Chelycypraea testudinaria*). They typically live on lagoon pinnacles or the shallow seaward reef. Live ones are not often seen except at night, but based on the number of dead shells observed on the reefs, they seem to come and go over the years. As I write this, they seem to be rather scarce, although in other years fresh empty shells have been pretty common. On the right side of the shell, the grayish wrinkled-looking skin bearing soft spikes is the mantle, the portion of the animal that creates the shell, and in cowries, maintains their high gloss.
- 12:29 Another large cowry is the Eyed (*Arestorides argus*), whose shell is marked with distinct brown circles. In this scene, the semi-transparent mantle bearing branched projections called papillae extends out over most of the shell.
- 12:35 The Golden Cowry (*Lyncina aurantium*) hides well back in dark holes on the seaward reef during the day, but at night may come out in search of mates or new food sources. The irregularly patterned mantle with branching papillae helps camouflage the solid orange shell.
- 12:45 The Mole Cowry (*Talparia talpa*) is a relatively common inhabitant of lagoon and seaward reefs. These too come out only at night. The mantle on these shells ranges from the figured black with greenish spots to solid black with rounded papillae, and usually covers the entire yellow dorsum.
- 12:49 The medium sized Chinese Cowry (*Ovatipisa chinensis*) has a shell with a spotted light brown to greenish dorsum, purple spots along the sides, and orange between the ridges (“teeth”) that line the aperture. The mantle is bright red, speckled and streaked with white.
- 12:54 Chinese cowry with the mantle extended over most of the shell.
- 13:00 One of the most rarely seen cowries at Kwaj is the small *Palmadusta asellus*, a species much more common in the Pacific farther to the west.
- 13:04 Sporadically common under rocks and in algae patches on some lagoon and seaward reefs is the small cowry *Erosaria labrolineata*, whose variably colored mantle densely covered with branching papillae effectively hide the shell.
- 13:09 Mostly unique to Kwaj is this reddish brown color form of the Stolid Cowry (*Bistolida stolidia*), which in other parts of the Pacific is mostly bluish. Here the semi-transparent mantle with fine branching papillae cover most of the shell.
- 13:16 A young, very small Cuttlefish (*Sepia* sp.) emerges from between the branches of a bush of dead coral and slips away.
- 13:23 A normal sized individual of this small species of Cuttlefish was spotted scooting among *Halimeda* plants in a lagoon algae patch. The not yet positively identified Cuttlefish species at Kwaj is small and secretive, rarely seen during the day. It is unknown whether there is only one species or multiple similar ones, although it does seem there are very different egg masses that could represent different species.

- 13:31 These clusters of small balls found frequently under rocks are the egg masses of what appears to be a small species of cuttlefish or squid. This mass is apparently being attacked and eaten by the banded triton shell *Gyrineum gyrinum*, which may be what is causing the little cephalopods to hatch and swim away.
- 13:35 A pair of common reef squid (*Sepioteuthis lessoniana*) hover over a shallow coral reef. Squid are usually found in small groups called shoals, although we think “squid squad” sounds a lot better.
- 13:42 Squid, like their cousins the octopus, are masters at changing color.
- 13:54 A small octopus hides on the underside of a small rock. It is uncertain whether this is just a juvenile of a larger species or is a tiny species of its own.
- 14:00 There are several different, mostly unidentified octopus species at Kwaj, including this nocturnal long-legged one usually found in lagoon sand and algae patches.
- 14:11 The coloration and relative short tentacles of this small octopus resemble those of the Coconut Octopus (*Amphioctopus marginatus*), a species we think has not yet been reported from the Marshalls. It could, however, just be a young individual of our common *Octopus cyanea*. This one happened to be hanging around a large sea cucumber (*Thelenota ananas*) on a sandy lagoon reef.
- 14:19 The common large octopus at Kwaj, *Octopus cyanea*. Intelligent invertebrates, they will often both curiously and warily watch a diver from the relative safety of dens, holes they often build themselves by excavating rocks out of gaps in the reef.
- 14:28 Octopus can also often be seen exposed on the reef, sometimes moving between coralheads, hunting or even mating. Here an angry little damsel pesters one as it glides across the bottom.
- 14:41 Looking down between coralheads and schooling Neon Fusiliers (*Pterocaesio tile*), a gray reef shark (*Carcharhinus amblyrhynchos*) can be seen coming up the sandy lagoon slope.
- 14:51 Numerous Neon Fusiliers swim about in front of the camera. While the swimming appears chaotic, the apparent lack of fish crashes suggests they are more organized than they appear. The various species of Fusiliers often seem to be attracted to divers and will swarm around them rather than swim away.
- 14:56 Neon Fusiliers swim over the top of a coral pinnacle ornamented with not one but two knocked over or bent marker poles. On two different occasions, medium sized inter-atoll ships have run up on this pinnacle at night, crushing a good deal of coral and bending or knocking over the marker pole. The reef is now marked with a buoy that sits 50 to 100m off the pinnacle itself.
- 15:03 A mixed school of two different Fusiliers, the more numerous Neon Fusiliers and the slightly larger Marr’s Fusilier (*Pterocaesio marri*) with black tips at the upper and lower tips of its tail fins, passes over a large colony of *Turbinaria* coral.
- 15:13 More mixed up Neon and Marr’s Fusiliers swim uncharacteristically slowly past on the edge of a large midlagoon pinnacle.
- 15:20 More Neon and Marr’s Fusiliers pass right to left in front of a rounded colony of *Porites rus* coral, while a school of mostly Lined Unicornfish (*Naso brevirostris*) move left to right in the background. This was filmed during the 2009 coral bleaching episode, as seen by the stark white colony of *Goniopora* coral on the right side.

- 15:25 A school of mostly Threeline Fusiliers (*Pterocaesio trilineata*) mills around close to the reef.
- 15:32 A mixed school of Threeline and Neon Fusiliers feeds on plankton at the edge of the lagoon slope.
- 15:40 A pair of Dogtooth Tuna (*Gymnosarda unicolor*) cruises past on the slope of a lagoon pinnacle. A school of Fusiliers in the background.
- 15:48 Dogtooth Tuna being cleaned of parasites by a pair of large Bicolor Cleaner Wrasses (*Labroides bicolor*).
- 15:59 The Dogtooth returns to the slope of the lagoon pinnacle and stops to give a trio of large Bicolor Cleaner Wrasses a chance to pick its parasites. Dogtooth will sink if they stop swimming, so to maintain position it assumes this head up position and swims upward just fast enough to stay in one place.
- 16:15 Fast-moving Bigeye Scad (*Selar crumenophthalmus*) stream past left to right on the slope of Troy's coralhead, while predatory Gray Reef Shark, Rainbow Runner (*Elagatis bipinnulata*) and Dogtooth Tuna swim around watching for a feeding opportunity.
- 16:26 A school of Goggle-eyes (*Priacanthus hamrur*), stream past on the slope of a lagoon pinnacle. This is a popular eating fish called Aweoweo in Hawaii.
- 16:35 Aweoweo range from red to silvery, and individuals can change color almost instantly. Here a small Gray Reef Shark winds its way through a large school.
- 16:43 Aweoweo are nocturnal plankton feeders. During the day, they may aggregate in schools as in the previous scenes or hover alone or in small groups over coral, into which they retreat at the approach of possible danger.
- 16:54 Two different species of Soldierfish (*Myripristis* spp.) hover over the seaward reef. These big-eyed fish are nocturnal plankton feeders. By day, they hover in small schools over or in holes in the reef, into which they retreat when danger approaches. They are called Menpachi in Hawaii and are a popular eating fish.
- 17:03 A Blackfin Squirrelfish hovers over a hole in the reef, diving into it as the camera approaches. Like their cousins the Soldierfish, the various Squirrelfish species are nocturnal predators, although they tend to eat benthic invertebrates such as shrimp.
- 17:07 A group of Spotfin Squirrelfish (*Neoniphon sammara*) hover over a lagoon reef by day, waiting for night when they disperse to feed.
- 17:14 Spotfin Squirrelfish hover over a lagoon reef when they are joined by a mixed school of Goldlined Emperors (*Gnathodentex aureolineatus*, with the yellow spot on the back a bit in front of the tail) and Yellowfin Goatfish (*Mulloidichthys vanicolensis*).
- 17:22 A large school of Goldlined Emperors approaches the photographer, with the fish splitting to go both directions as they get too close.
- 17:31 Usually shy Humpback Snappers (*Lutjanus gibbus*) mill about on a steep lagoon slope, while a couple of black saddled Bigeye Emperors swim through the scene.
- 17:40 Bluelined Snappers (*Lutjanus kasmira*) seem to flow over the coral on a rich lagoon reef.
- 17:46 Juvenile Bluelined Snappers and Threeline Fusiliers dart around a small coral head, along with several species of damsels.
- 17:52 The early part of the scene focuses on some Goldlined Emperors and Yellowfin Goatfish. The camera pans up over some staghorn *Acropora* coral to show more Yellowfin Goatfish swimming above.

- 18:02 More small Yellowfin Goatfish hovering above a rich living coral reef.
- 18:13 Lots of fish gather around an interisland lagoon reef. Included are Yellowfin Goatfish above, Goldlined Emperors mostly low in the scene, and several female parrotfish right over the coral in the middle of the frame swimming right to left.
- 18:19 An isolated reef on a sandy interisland lagoon reef, capped with staghorn *Acropora* and with various fish species swimming around over the top.
- 18:23 A Goldsaddle Goatfish (*Parupeneus cyclostomus*) swims up the reef and passes the camera before turning around at the end of the clip.
- 18:33 A Dot-Dash Goatfish (*Parupeneus barberinus*) swims up a sandy slope using the barbels on its chin to dig in the sand for worm or crustacean prey.
- 18:38 Fluted Giant Clams (*Tridacna squamosa*) are the medium sized members of the giant clam family in the Marshalls. Shells are distinctly fluted. While the animals vary considerably in color, the patterns usually consist of colored ovals or elongate streaks. The next few clips show just a few of the many variations.
- 18:44 Fluted Giant Clam.
- 18:49 Fluted Giant Clam.
- 18:54 Fluted Giant Clam.
- 18:59 Fluted Giant Clam.
- 19:05 Fluted Giant Clam.
- 19:10 Fluted Giant Clam.
- 19:15 This is a soft coral named *Pachyclavularia violacea*. The eight-tentacled polyps extend from a purple mat that covers hard surfaces, often in shaded areas on shallow reefs. We know of one pinnacle reef near Legan where this is a dominant bottom cover, and even seems to be growing over and perhaps smothering living hard corals.
- 19:20 This branching soft coral called *Dendronephthya* comes in a variety of attractive colors. Relatively uncommon at Kwajalein, it seems most prevalent in passes where there are swift currents carrying their planktonic food. At islands west of the Marshalls, such as Pohnpei and Chuuk, *Dendronephthya* corals are abundant and large. In this clip, a small colony occupies a small hole in the reef. Sponges and pink *Stylaster* coral cover the ceiling of the small cave.
- 19:26 Another soft coral similar to the last, this appears to be a species of *Chironephthya*. Also usually not common at Kwajalein, a few colonies can be seen fairly deep on the seaward reef or in current swept reef passes.
- 19:30 This was, for Kwaj, a very large stand of *Dendronephthya* at about 25m on the slope of a lagoon pinnacle near Onemak Island on the west reef. We saw it on several trips to this pinnacle, after which the soft coral nearly completely vanished. From this and other short-lived colonies we have seen, we suspect this soft coral may grow fast but not live too long.
- 19:42 Another color form of *Dendronephthya* soft coral.
- 19:46 Another color form of *Dendronephthya* soft coral.
- 19:49 Gorgonians constitute another group of soft corals but usually have a somewhat stiff, often branching skeleton. They reach out into the water forming a network of branches enabling the individual eight-tentacled polyps to capture passing plankton.
- 19:54 An orange gorgonian with elongate white polyps. It is easy to see that passing plankton would have a hard time making it through the gauntlet of feeding polyp tentacles.

- 19:59 Another densely branched gorgonian that looks as though it is covered with a field of flowers.
- 20:04 Another gorgonian.
- 20:08 A small yellow gorgonian, probably *Acabaria bicolor*, that lives back in dark ledges and small caves. The same species comes in other colors.
- 20:14 More of the yellow gorgonian, this time mixed in with a lot of pink *Stylaster* coral and hard yellow *Distichopora* coral over on the right side.
- 20:18 A large, fragile pink *Stylaster* coral hanging from the ceiling of an overhang on the seaward reef.
- 20:23 More pink *Stylaster* coral growing in a ledge with yellow *Distichopora*.
- 20:28 Looking toward the surface past some colonies of yellow *Distichopora*. This coral has an unusual distribution in this area. In the southern part of the atoll, all of the *Distichopora* is purple and tends to live in overhangs and caves. As you move northward on the west reef, you start to see the purple turn to a kind of muddy brown and then to bright yellow, which is the predominant color form along both seaward and lagoon pinnacle northwestern reefs. South of Kwaj, across the approximately 50km gap, Namu Atoll has large colonies of a bright red *Distichopora* growing out in the open on the seaward reef. The red color appears not to be present at Kwaj at all.
- 20:32 The purple *Distichopora* common in the southern Kwajalein Atoll
- 20:35 *Distichopora* and sometimes pink *Stylaster* occasionally support small ovulid snails called *Pedicularia pacifica* that feed on the coral polyps and take on the color of the coral. This purple *Distichopora* has a purple *Pedicularia* that looks sort of like a little cap shell in the center of the frame.
- 20:41 Several gorgonians and soft corals also sometimes host similar almost parasitic predators. This ovulid shell, *Noviculavolva kurziana*, is one of the more common ovulid gorgonian predators at Kwaj. It lies on the gorgonian named *Rumphella*, locally referred to as “black coral,” although it is not in the real black coral family. Clusters of these little *Noviculavolvas* can sometimes be found, usually near the base of the branching gorgonian, often hidden by algae growing up around the base.
- 20:48 Here is a colony of the *Rumphella* gorgonian preyed upon by *Noviculavolva*.
- 20:53 Another ovulid shell that can be found here is what appears to be *Aclyvolva lanceolata* or a related species. It lives on the red whiplike or sparsely branched gorgonians often seen deeper than about 30m on the seaward reef. The little rounded papillae on the shell’s mantle resembles the retracted polyps of the host gorgonian, making the small shells somewhat difficult to see.
- 20:57 This is one of the red whip gorgonians where *Aclyvolva* can be found.
- 21:02 Known so far from Kwaj from only a single sighting is this *Phenacovolva subreflexa*, found on a real black coral at about 40m on the seaward slope. All the color you see on the elongate shell is actually on the animal. The shell under the mantle is light brownish white.
- 21:08 A reasonably common ovulid here at Kwaj is the Warty Egg shell (*Calpurnus verrucosus*). It lives on the leathery soft coral *Sarcophyton*, usually hiding under the outer curled edge of the soft coral by day and emerging at night to feed on the soft coral polyps. The shell is nearly pure white, with a tinge of lavender on both ends just below a light brown-edged wart that can be seen in this clip. the brown circles over the shell and black spots around it are all on the animal, not the shell.

- 21:13 With the mantle mostly down now, you can see the white shell with lavender tips and brown-edged wart. The shell has emerged from under the edge of the soft coral at night and has extended its white proboscis on the right side. The proboscis clearly pumping as it sucks out the soft coral polyps.
- 21:19 A long siphoned triton shell *Cymatium gutturnium* stretches out its colorfully spotted foot to try to flip itself completely upright. Common farther west in the Pacific, Kwajalein must be on the northeastern edge of its range, and it is very rare here.
- 21:26 The Rosy Triton (*Gyrineum roseum*) stretches out its maroon foot to grasp the substrate.
- 21:31 Once it pulls itself over, the Rosy Triton crawls along.
- 21:38 This tiny and rarely seen miter shell, *Thala exquisita*, was spotted in a cave on a lagoon pinnacle at night. Both the shell and the foot of the animal possess attractive coloration.
- 21:44 Another miter, *Vexillum acupictum*, lives buried in the sand by day, coming out at night to hunt. The animal's foot is stretched out in front of the shell, below the siphon, a tube that stretches out from the channel at the end of the shell and is used to draw in water to pass over the gills hidden under the shell.
- 21:50 An as yet unnamed species of small *Vexillum* that lives in lagoon pinnacle caves at night.
- 21:57 The common miter *Vexillum unifascialis* comes in a variety of colors and patterns. This is one of the more attractive ones.
- 22:03 Another small *Vexillum* species that still lacks a specific name. These too are seen only rarely in lagoon pinnacle caves at night. This clip illustrates the siphon, stretching upward and to the right to channel water to the gills, as well as the two anterior tentacles near the bases of which are the animal's small eyes.
- 22:09 The shell *Colubraria obscura* crawls up a rock. The brown disk, called an operculum, used to close off the aperture of the shell when the animal retracts inside, can be seen attached to the top of the rear of the white foot under the shell. This mollusk belongs to a group popularly called vampire shells. They emerge from hiding at night to suck the blood from sleeping fish.
- 22:15 This small active snail is called *Prodotia ignea*. Its animal is more colorful than the shell. A black eye at the base of one of the anterior tentacles on the right side is clearly visible.
- 22:22 A family of local mollusks that forms elongate shells to streamline burrowing through the sand is the Terebridae, or auger shells. Most augers eat various kinds of sand dwelling worms. The Crenulate Auger shown (*Terebra crenulata*) is reported to eat exclusively the Acorn Worms, a large burrowing worm that processes sand for digestible materials and extrudes the mucus-lined undigested sand upward, where it forms what resemble piles of thick, tangled spaghetti. This auger is digging into a mound to get to the worm.
- 22:27 The Acorn Worm being hunted by the previous Crenulate Auger does not yet suspect its danger. If you watch carefully, you can see the tube of extruded sand still being pushed up and out the top of the mound.
- 22:35 These burrowing worms live buried in the sand. They cement together sand grains to form living tubes and extend their feeding apparatus out the wide end. We call it the Gold-Tooth Worm because of the shiny gold color of what appears to be the digging

- structure on the worm. The worm on the left is using its golden shovel to start digging back down into the sand. These were carefully and safely reburied once the photo session was complete.
- 22:44 This is a cluster of white feather duster worms that are sometimes found in lagoon algae patches. As the scene opens, one in the lower part of the middle of the screen is slowly emerging from its leathery tube. The white feather dusters are used for both respiration and for feeding on plankton and falling detritus.
- 22:56 A true bouquet of corals consisting of columnar Fire Coral (*Millepora*), branching *Acropora* and *Pocillopora*, and massive *Porites* and *Pavona* species.
- 23:02 Another coral bouquet artfully arranged by Mother Nature and consisting of leafy yellow *Turbinaria* coral and various kinds of branching *Acropora* and *Pocillopora*.
- 23:08 Colonies of *Turbinaria* on the right and *Acropora palifera* on the left share a rocky outcrop on the slope of a lagoon pinnacle.
- 23:13 A robust stand of Pacific Elkhorn Coral, thought to be *Acropora rotumana*. This coral made the news a few years following its rediscovery at Arno Atoll in the Marshalls by a team from Australia. News reports speculated it might be the world's rarest coral. It happens to be very common in much of the Kwaj Atoll on shallow interisland reefs, pinnacle reefs and the seaward reef where there is some water movement.
- 23:18 Some of the shallow Pacific Elkhorn colonies have grown very thick to withstand exposure to regular currents and occasional swell.
- 23:24 A patch of bluish branching *Acropora* coral grows between overlapping mounds of columnar Crinkly Coral (*Porites rus*).
- 23:30 In the center of the frame, a purplish encrusting *Montipora* coral is surrounded by the smoothly branching tan or yellow *Porites* and a few bushes of the more roughly branching *Acropora*.
- 23:37 A leggy bush of sharply pointed staghorn *Acropora* extends upward through surrounding flatter *Acropora* colonies.
- 23:43 Many lagoon reefs have richly diverse reefs with high coral cover. Here one of a couple of Threadfin Butterflyfish (*Chaetodon auriga*) pass in front of a rounded Ball coral.
- 23:47 Some wrinkled looking columnar stalks of Fire Coral (*Millepora*) reach upward.
- 23:52 Some bluish colonies of branching *Acropora* appear to form a stairway up the sides of some rounded and multicolored Stalk Coral colonies (*Lobophyllia*).
- 23:57 Massive lumpy *Porites* coral colonies ranging from yellow to blue are scattered over this shallow lagoon reef.
- 24:01 A Regal Angelfish (*Pygoplites diacanthus*) passes in front of an *Acropora* coral, pausing to look into the camera.
- 24:09 The medium sized Regal Angel is a common inhabitant of most lagoon and seaward reefs at Kwaj.
- 24:22 Small but brightly colored, the Flame Angelfish (*Centropyge loricula*) is common around the knee of the seaward reef dropoff. Bright red with black vertical bars, this angel is easy to spot as it darts in and out of reef holes and coralheads.
- 24:29 About the same size but less often observed than the Flame, this Coral Beauty Angel (*Centropyge bispinosa*, which gives it its sometimes used common name of Two-spine Angel) is sporadically common on some reefs and in some parts of the atoll.

- Those shown in this clip were just three of many occupying a small lagoon pinnacle near Mann Island.
- 24:36 Another sporadically observed angelfish, the Bicolor Angel (*Centropyge bicolor*) is nonetheless not uncommon if you go to the right places. There are many, for example, along the lagoon side of Ennylabegan Island. Closer to home, you can nearly always see a few on the top of North Loi Coralhead.
- 24:43 This angel is a hybrid whose parents consisted of two species, the Lemonpeal Angel (*Centropyge flavissima*) and the Pearlscale Angel (*Centropyge vrolikii*). The Lemonpeal is abundant at Kwaj while full blooded Pearlscales are rare. But apparently they are closely enough related that they can successfully breed, forming hybrids with varying characteristics of both species. In this clip, the primarily yellow body takes after the Lemonpeal parent, while the black tail and caudal peduncle are more like the Pearlscale. This particular hybrid we have been watching on an occasionally revisited reef for at least 15 years. It shares the coralhead and is apparently paired up with a typical Lemonpeal, which can be seen on the right side of the screen in the middle of the clip.
- 24:49 Another mostly yellow angelfish is Herald's Angel (*Centropyge heraldi*). These are nearly all yellow with a light to dark gray patch right behind the eye. They are fairly common on some lagoon pinnacles and deeper on the seaward slope. On pinnacles they share the habit with the Lemonpeals, but on the seaward they rarely overlap, since the Lemonpeal is on the top of the slope while the Herald's is deeper on the slope.
- 24:56 The adult Emperor Angelfish (*Pomacanthus imperator*) is the largest angel at Kwaj. Usually solitary inhabitants of the reef, they will of course occasionally pair up for breeding. They make a loud, easily heard grunting sound when disturbed.
- 25:03 The juvenile Emperor Angel looks drastically different from the adult, having curved or even semicircular white lines on a dark blue background.
- 25:10 The Pacific Doublesaddle Butterflyfish (*Chaetodon ulietensis*) usually wanders over the reef in pairs pecking at algae and benthic invertebrates. These two were swimming up in the water column feeding on a day when the drifting plankton were particularly thick.
- 25:17 A pair of Oval Butterflyfish (*Chaetodon lunulatus*) peck at the polyps of a living *Porites* coral. This butterfly is strictly a live coral eater. Toward the end of the clip, a cleaner wrasse rises up but then an aggressive Dick's Damselfish darts up to chase the interloping butterflies away from his territory.
- 25:26 Usually paired, the Racoon Butterfly (*Chaetodon lunula*) occasionally gathers in small groups, possibly for mating.
- 25:32 Rather rare at Kwaj, the Dotted Butterfly (*Chaetodon semeion*) is usually spotted singly or in pairs on southern lagoon pinnacles.
- 25:39 The Teardrop Butterfly (*Chaetodon unimaculatus*) gets its common name from the shape of the black spot on each side, which looks like an upside down teardrop.
- 25:46 The Black-backed Butterfly (*Chaetodon melannotus*) is usually seen singly or in pairs and seems most common on southern atoll lagoon pinnacles, where it feeds primarily on soft corals, as this one is doing in this clip.

- 25:43 A pair of Saddleback Butterflies (*Chaetodon ephippium*) peck at bits of algae growing out of small dead spots on this plating *Montipora* coral. Possibly they are looking for tiny crabs or shrimp hiding in the small clumps of algae.
- 26:01 The strictly coral eating Chevron Butterfly (*Chaetodon trifascialis*) defends a specific territory consisting of one or more coral colonies from any other wandering coral feeders of any species. This one is investigating a patch of bleached coral on a large table coral that constitutes his territory. A dead and empty shell had been sitting on that spot probably for some time, and the lack of sunlight caused the coral animals in the shadow beneath it to lose the symbiotic algae that give most corals their color. In darkness in the shadow of the shell, the algae cells could not survive and were lost, turning the coral in that area white. I moved the shell off the coral, exposing the spot, so the coral could eventually regain its algae symbionts. That is, if the resident Chevron Butterfly doesn't peck out all the coral first. Perhaps he was sampling the taste of algae-free coral tissue.
- 26:09 The Vagabond Butterfly (*Chaetodon vagabundus*) is somewhat uncommon here, but can be seen on a variety of lagoon and seaward reefs.
- 26:16 A variety of butterflies, including a small school of Threadfin Butterflies (*Chaetodon auriga*) and one or two each of Racoons, Saddlebacks, Lined (*Chaetodon lineolatus*) and even a pair of the related Masked Bannerfish (*Heniochus monoceros*) gather around the edge of an outcrop on a shallow lagoon reef.
- 26:23 A school of Convict Tangs (*Acanthurus triostegus*) grazes algae from the relatively barren top of a shallow midlagoon pinnacle.
- 26:29 The Lined Surgeonfish (*Acanthurus lineatus*) seems to rarely slow down, erratically swimming back and forth over shallow reefs grazing algae.
- 26:35 Rare at Kwaj is the Achilles Tang (*Acanthurus achilles*). The blood red spot near the tail is hard to miss, but we have seen only a few individuals down here in the southern part of the atoll. This one was filmed on a lagoon pinnacle past Gellinam on the east reef. We did see a good number at the very shallow top of the reef on the ocean side of Ebadon the one time we were up there. In this scene there are also a couple of coral eating Reticulated Butterflies (*Chaetodon reticulatus*).
- 26:43 The striped one here is a juvenile Striped Bristletooth (*Ctenochaetus striatus*). As an adult, this is an abundant mostly black (but indistinctly lined) tang. The black one may be a color form or possibly a different juvenile species. We might go years without seeing any juveniles, then suddenly the reef is flooded with them, as seen in the next clip.
- 26:49 A massive settling of juvenile Striped Bristletooth tangs.
- 26:57 Juvenile Sailfin Tang (*Zebrasoma veliferum*) pecking at algae on a lagoon reef.
- 27:04 A couple of adult Sailfin Tangs along with several other fish grazing algae from dead coral.
- 27:11 Some large dark Elongate Surgeonfish (*Acanthurus mata*), several Lined Unicornfish and a couple of other species on the edge of a lagoon pinnacle.
- 27:20 A pair of Moorish Idols (*Zanclus cornutus*).
- 27:28 A Bignose Unicornfish (*Naso vlamingii*) stops over a stand of *Porites rus* coral so a Cleaner Wrasse can pick its parasites. The unicorn has his body paled to make the darker parasites easy to see. After turning around, he returns in darker form to reveal the lighter colored parasites.

- 27:47 A young Orbicular Batfish (*Platax orbicularis*), sometimes called a Spadefish, around some lagoon wreckage. Young ones like this are usually found around piers and buoy lines, but they move out to the reefs as they get larger.
- 27:53 A somewhat larger Orbicular Batfish on a shallow lagoon reef. Younger ones have much taller fins compared to the body size than old large individuals.
- 28:00 Another pair of medium sized Orbicular Batfish on the deck of the shipwreck at North Loi.
- 28:07 Also around the North Loi shipwreck were several large Batfish, giving more credence to the common name Orbicular.
- 28:15 A young Humphead Bannerfish (*Heniochus varius*) on a lagoon reef.
- 28:21 A young Pennant Bannerfish (*Heniochus chrysostomus*) swims over columns of *Porites rus* coral. Juveniles of this species have a black “eyespot” at the base of the anal fin near the rear end of the fish. This is presumably to fool predators who tend to home in on a prey’s eye, and the juvenile can momentarily fool the predator by going in an unexpected direction, giving it just enough time to get to cover. They lose the eyespot as they grow and become too large for many predators.
- 28:28 A rich reef of Table *Acropora*, branching *Pocillopora* and *Acropora*, and a somewhat crumpled looking *Pavona* over on the right side.
- 28:33 A large Giant Clam (*Tridacna gigas*) nestled down in coral and algae on a lagoon pinnacle. We visit this one periodically and often have to do a little “weeding,” moving to other areas some of the staghorn *Acropora* on the right that keeps trying to overgrow and choke out the clam. We have seen several old giants die after being covered by this fast growing coral.
- 28:38 Another Giant Clam on the slope of another lagoon pinnacle. There are few of these in the southern part of the atoll now near Kwaj and Ebeye. Nowadays, virtually all the pressure on giant clam populations is from Marshallese fishermen, who harvest the animals for food. None (that I know of) have been collected by Kwaj divers for quite a number of years, although that was not always the case. When I started diving here in the 60s, it was not unusual for giant clams to be collected and brought back from scuba club Sunday dives. I recall watching one diver walking across a sandy bottom back toward the boat with a clam in his arms while his buddy trailed behind carrying the diver’s flippers. I also have seen a Skin Diver magazine article from 1957 telling the tale of a dive club on Kwajalein formed of Navy personnel who called themselves the Reef Raiders; the article describes (with accompanying photos) how they hunted for and recovered the "Giant Killer Clams." Definitely not politically correct today!
- 28:44 Like their smaller relatives, Giant Clams vary somewhat in color. This is a large greenish yellow one on a shallow lagoon reef. For some years it had as a neighbor a large *Heteractis magnifica* sea anemone and associated clownfish, but these vanished a couple of years ago. The clam, however, still remains. It has not yet been found by clam harvesters from Ebeye.
- 28:51 Another pretty green Giant Clam. The small green spotting seen here is made up of little green or turquoise iridescent rings decorating the animal are a way (other than sheer size) to distinguish the real Giant Clam from other members of the giant clam family Tridacnidae.
- 28:57 Another large greenish yellow Giant Clam. Alas, this one is no more. When we last visited it, its empty shell was coated with algae. It probably died of natural causes,

- however. Just a couple of meters away (outside the frame of view here) is another Giant Clam nearly as large that is still OK. Fishermen harvesting clams for meat would have taken both.
- 29:03 A nicely colored Giant Clam in a relatively precarious position on the edge of a short lagoon pinnacle slope.
- 29:09 Kwaj is home to just over 60 different kinds of cone shell snails. This elongate species named *Conus aureus* is one of several bearing tent-shaped markings. It is seen only rarely, usually on night dives on lagoon pinnacles. Like all the other tented cones, it feeds on the animals of other snail shells, which it stings with a venomous harpoon to immobilize before stretching its mouth into the aperture of the prey snail's shell to engulf and digest out the animal. The red-tipped tube at the right side is the siphon, used to bring water in to flow across the gills. Just below and to the left of the siphon, a small white tentacle bearing a black eye peeks out from under the edge of the shell.
- 29:16 Another intricately patterned tented cone shell is *Conus ammiralis*, the Admiral Cone. This is a small, young individual, so the white tent markings are proportionately larger compared to the shell size than they are on fully adult shells, but the finely woven tented pattern in bands around the shell is similar. These live along shallow lagoon reefs, often near patches of *Halimeda* algae, and emerge at night to hunt snails.
- 29:22 A Marble Cone (*Conus marmoreus*) approaches a trio of potential prey strombs (*Gibberulus gibbosus*). The cone's light colored tentacle that delivers the venomous harpoon can be seen behind and slightly under the stretched out siphon. One active stromb detects its approach and uses its muscular foot to hop away. Ultimately, all three escaped, but there were plenty more around for the cone to chase.
- 29:31 Red Cone (*Conus pertusus*), a usually small cone shell sometimes seen at night in ledges and small caves on the seaward reef.
- 29:35 This medium sized cone is called the Circumsized Cone (*Conus circumcisus*). It is nocturnally active on lagoon pinnacle reefs, where it feeds on sleeping fish, stinging them with a paralytic venom and stretching out its mouth to engulf the entire prey. The mouth can be seen as the pucker between the white eye-bearing anterior tentacles and below the siphon tube.
- 29:44 Since cone shells tend to have elongate but narrow apertures, most hermit crabs are not able to use empty cones. A couple of hermit species, however, including this Turquoise Kneepad hermit (*Dardanus guttatus*), have evolved flattened bodies to take advantage of an otherwise mostly unused housing market.
- 29:50 The other hermit with a flattened body that can use cone and other narrow aperture shells is this red and orange banded crab (*Ciliopagurus strigatus*). This one occupies a vacated miter shell mostly encrusted with a pinkish coralline algae.
- 29:57 This large-clawed, striped-legged hermit with yellow eyes has made his home in an old murex shell *Naquetia cumingi*.
- 30:02 Certain hermit crabs, like this *Dardanus deformis*, form symbiotic relationships with sea anemones that always decorate their shells. The anemones possess stinging cells to help prevent the hermit from being eaten by octopus, while the mobility of the hermit keeps the anemones safe from being eaten by anemone-eating starfish such as

- the Cushion Star (*Culcita novaeguineae*). Both parties clearly benefit from the relationship.
- 30:07 Probably the largest hermit at Kwaj is this red *Dardanus megistos*. I especially like the rapidly moving maxillipeds, small appendages in front of the mouth modified for food manipulation.
- 30:13 A pair of Harlequin Shrimp (*Hymenocera picta*), also called Paddle Shrimp, backing up toward the protection of a hole in the reef. These attractive, pink spotted shrimp feed exclusively on starfish, which they cut apart using their scissor-like claws hidden within those large anterior paddles. The larger is the female. I have seen reports stating that these are monogamous pairs and mate for life, but I'm not aware of any studies that confirm this.
- 30:21 At night you can often see these burrowing sand shrimp (*Trachypenaeopsis* sp.). We have seen them swimming up off the bottom, but at the approach of diver lights, they usually settle back down on the sand and use their legs to bury themselves, like sinking into quicksand.
- 30:29 Occasionally a diver may be surprised by an erupting sand volcano. Eruptions are so sporadic it was sheer luck that I was able to get this filmed. These sand volcanoes are created by aptly named Volcano Shrimp, species of mud shrimp (*Callianassa* sp.). The shrimp burrow into soft sediment, forming ramifying tunnels as much as a meter or more beneath the surface of the sand. They feed by filtering through sand that they take in through holes from the surface. Processed sand from which the food has been removed is periodically pumped up to the surface through paddling actions of some of the shrimp's appendages. The pumped sand erupts from the bottom and after a few sessions, creates the volcano mounds that densely cover some lagoon bottoms of fine sand.
- 30:37 Related shrimp include the alpheids or snapping shrimp (*Alpheus* spp.), sometimes called Pistol Shrimp. Many of these can use their large claws to make loud snapping noises, loud enough that some aquarium keepers who have accidentally introduced one of these shrimp think the glass of their tank might be cracking. Different snapping shrimp occupy many different habitats under rocks, hidden in algae, in burrows they construct in the bottom, and even on or inside some other animals.
- 30:46 A shrimp living inside a translucent tunicate has the look of a snapping shrimp, although it is possible it belongs to another family.
- 30:53 The undersides of some crinoids (feather stars) are often occupied by a pair of alpheids called *Synalpheus stimpsoni*.
- 31:01 *Thor amboinensis* is usually called a Squat or Sexy Shrimp, but we often refer to them as popping or popcorn shrimp because of their habit of repeatedly flicking their tail up and down. These small shrimp are most common around but usually not nestled within the tentacles of sea anemones. The anemone in this scene is a species of *Actinodendron* and is out of focus in the background. One large and at least a couple of small shrimp can be seen in this clip.
- 31:09 Living among sea anemone tentacles is another shrimp, *Periclimenes brevicarpalis*. Females like this one are larger than the males and are often carrying eggs tucked under the abdomen.

- 31:16 Another species of anemone-dwelling shrimp, probably *Periclimenes holthuisi*, is usually seen hovering in the water just above the anemone or grasping one of the anemone's tentacles.
- 31:24 This shows a pair of the bright red and white Emperor or Imperial Shrimp (*Periclimenes imperator*). These some areas, these are sometimes found riding the larger nudibranchs such as Spanish Dancers, but here at Kwaj they are usually on sea cucumbers, most often the large knobby *Thelenota ananas*. The tentacles these two shrimp are traversing here are the tube feet from the ventral surface of a large *Thelenota*.
- 31:32 A shrimp living commensally on starfish is this small *Periclimenes soror*. Usually on Cushion Stars (*Culcita novaeguinea*), they are sometimes on Crown-of-Thorns or Blue Stars as well. The shrimp is usually either transparent (probably younger individuals) or they match the color of their host fairly well for camouflage. This one is on a mostly yellow Cushion with red spots.
- 31:40 Here is a full shot of the Cushion occupied by the shrimp in the previous clip.
- 31:43 Another *Periclimenes soror*, this one yellow on a yellow Cushion.
- 31:51 And here's the yellow Cushion next to a purple *Montipora* coral. Cushion stars, like their cousins the Crown-of-Thorns, prey upon live coral and anemones by extruding their stomach over the coral colony and digesting the living tissue.
- 31:55 Another *Periclimenes soror* on a smooth *Culcita* starfish described in more detail below. Watch closely for three slightly smaller, completely transparent shrimp that move away a bit above and to the right of the colored shrimp as it walks along. It is easiest to see the pair of white eyes of the young shrimp.
- 32:06 A large red and white Cushion Star in a lagoon *Halimeda* algae patch.
- 32:11 Another Cushion, yellow with lighter and darker brown patches, also in a lagoon algae patch. The Cushion Stars we find on coral reefs are always hard and a bit rough to the touch because they are rather densely covered with rounded or slightly pointed hard bumps. The Cushion Stars that live on sand and in algae patches are smooth and velvety to the touch, lacking the rounded bumps. While both varieties are currently considered *Culcita novaeguinea*, we think the morphological and habitat differences might indicate that they are separate species. Some DNA analyses of these would be useful to see how closely they are related.
- 32:14 Also a round echinoderm usually living in lagoon algae patches is this short spined sea urchin *Tripneustes*. *Tripneustes* use their tube feet to carry bits of algae and debris up over the urchin to hide it from urchin eaters.
- 32:20 *Tripneustes* urchins come in various colors.
- 32:25 A close view of the previous animal shows waving purple tipped tentacles. These are called pedicellariae and are tipped with small three-part jaws, and are possibly used for defense, feeding or cleaning up the urchin's exterior. In this family, the pedicellariae possess rather virulent venom, although in *Tripneustes* the jaws are too small to puncture human skin.
- 32:29 Also living in lagoon and seaward reef sand patches are a number of species of burrowing sea urchins, including several kinds of sand dollars. This one is probably a species of *Peronella*. When exposed, they sink back into the sand through the action of tiny spines that cover their surfaces.
- 32:33 Another *Peronella* sinking into the sand.

- 32:37 This sand dollar appears to be a species of *Clypeaster*.
- 32:42 Another *Peronella*, with a small goby scooting past.
- 32:46 This sea urchin with long, all sharp spines is probably a species of *Diadema*. This one is on a clump of odd-looking brown algae called *Hydroclathrus clathratus*, which is usually loose on the bottom or tangled up in other algae plants. The urchins are commonly hidden among the plants in algae patches. I have a habit of running my bare fingers through the algae to scare up slugs or other invertebrates to photograph, so I end up frequently “finding” these urchins the hard way. The spines are sharp and brittle, and easily and painfully enter human flesh and break off. Shafts of the spine are usually barbed, making them impossible to pull out like a splinter. Generally, if you get spined, you can let your body dissolve it, although it often takes days or weeks.
- 32:51 Another, often larger, urchin common in algae patches has longer blunt-looking spines, between which are shorter, very sharp and very painful spines. Sometimes the urchins are host to a small group of Urchin Cardinalfish (*Siphamia versicolor*) that hide among the spines during the day for protection. The fish disperse to feed at night. In this scene, a few juvenile Humpback Snappers (*Lutjanus gibbus*) are also swimming around.
- 32:58 A closer shot of the Urchin Cardinalfish among the spines. These fish can change color to a silvery background with longitudinal black stripes. Note the shorter, narrow and much sharper spines among the larger dull ones.
- 33:05 A young individual of the large Lionfish (*Pterois volitans*), sometimes called a Turkeyfish. The long radiating pectoral fins give it the look of an octopus, but of course one with too many arms. Young Lionfish of this species may be either light colored like this one or mostly black. The waving dorsal spines are highly venomous: probably not deadly, but capable of causing extreme pain.
- 33:10 Another young *Pterois volitans* lionfish.
- 33:16 A similar but different species from the previous is the Antenna Lionfish (*Pterois antennata*). Its long radiating pectoral fin rays are simple white tentacles for more than half their distance, and a pair of short antennae just above the eyes (pointing down in this photo) are ruffled and banded. Also, the transparent webbing between the pectoral fin rays closer to the body usually bear a bluish spot. These lions are usually seen hanging upside down in ledges and small caves. That their dorsal spines are also painfully venomous, I can attest to from personal experience.
- 33:20 The third member of this genus at Kwaj is this Clearfin Lionfish or Turkeyfish (*Pterois radiata*). Like the previous lion, these hang upside down in ledges and small caves and bear venomous spines. Usually a darker reddish brown than the Antenna Lion, they can also be distinguished by the antennae just above the eyes (on the right side of the animal in this clip). In the Clearfin Lion these antennae are not ruffled or horizontally banded but instead are smooth and red or brown with a single white line running from base to tip.
- 33:24 Also called lionfish but in a different genus is the Zebra Lionfish (*Dendrochirus zebra*). The two different kinds of *Dendrochirus* lionfish (the second is not shown here) have webbing between the pectoral fin rays that extend nearly or all the way out to the ends of the fin rays, so it looks like they have a pair of gliding wings. The Zebra Lion is more of a lagoon dweller, usually found around rocks and in algae

- patches along lagoon reefs. If you run your fingers through the algae the way I do, you need to be very careful not to run into one of these. The dorsal spines contain a powerful venom that I can confirm is quite painful.
- 33:33 Related to the lionfish but much less flamboyant are many of the scorpionfish such as this Devil Scorpion (*Scorpaenopsis diabolis*). You have to be careful if you put your hand or knee down on the bottom because these fish are usually very difficult to see, they will not move out of your way, and like the lionfish they have highly venomous dorsal spines. Usually they do not swim, but just slowly walk along the bottom on their pelvic and pectoral fins.
- 33:41 An interesting but still unidentified scorpionfish is this one with the long branching growths from its head.
- 33:48 This scorpion with the chin whiskers is either *Scorpaenopsis oxycephala* or *S. papuensis*, a pair of species whose scales you have to count to distinguish between them. As I have certain objections to manhandling a squirming fish that has venomous spines in order to count anywhere from about 50 to 75 tiny scales running along a line on the side of the fish, I did not get a positive ID. But if I were to guess, I'd say it is the former; they are reported to get larger and this was a pretty good sized one.
- 33:56 This is the real bad boy, a Stonefish (*Synanceia verrucosa*). These have highly venomous dorsal spines capable of delivering a lethal wound. Fortunately, as I can again attest to personally, it takes a fairly strong spining to get any of the dangerous venom. The venom is stored in a sac near the base of the spine, and is delivered up through a channel in the spine into a wound by the pressure of the victim's flesh pushing the fish tissue surrounding the spine down and squeezing the sac. A light prick of the spine on your finger and you're not likely to get any venom. But step on it or put your hand down on it hard? Watch out! They frequently partly or almost completely bury in sand, often just leaving their eyes and mouths exposed waiting for hapless fish to approach close enough to be swallowed. This one is digging his way down into the sand a little more once he figured out I could see him.
- 34:08 Slightly resembling in shape a stonefish but a lot more benign and non-venomous are the frogfish or anglerfish. This one is called the Reticulated Frogfish (*Antennatus tuberosus*). It is small and rare, or at least rarely seen, around here. It is probably more common than it seems, but likely lives down in loose coral rubble or among the branches of dead *Pocillopora* coral clumps, where I have found them in Hawaii. The few we have seen here, such as this one, were hidden in patches of *Halimeda* algae. He first offers us a profile view, then turns head on.
- 34:16 Another angler, the Painted Frogfish (*Antennarius pictus*) comes in various colors and is also most often seen, although rarely, in lagoon algae patches. This one resembles the clump of sponge he is perched upon.
- 34:23 A closer view of the previous frogfish. Frogfish are called anglers because most species have an anterior dorsal spine modified into a long filament with a clump of tissue on the end of it. When hunting, the frog sits nearly motionless but waving this fishing pole with bait out in front of its mouth. When a fish comes close to investigate the bait, the frog, without moving from its perch, opens wide its huge mouth, literally sucking the prey in. Nature's own slurp gun, and one that works a lot better than those

- cheap knockoffs they used to sell budding aquarium fish collectors. Those things never worked.
- 34:27 Another color form of the Painted Frogfish we found in the algae one time is this small white one.
- 34:33 Yet another Painted Frogfish, this one nearly all black. This was the largest frog we have yet seen at Kwaj, maybe 100mm in length.
- 34:42 Not seen often at Kwaj is the Longsnout Flathead (*Thysanophrys chiltonae*). It is often partially buried in rubbly sand and blends in very well with its surroundings.
- 34:50 We covered some alpheid shrimp earlier, but there is one group of snapping shrimp called Bulldozer Shrimp that form symbiotic associations with several different species of gobies. The shrimp lives in a burrow and spends all day maintaining it, carrying or plowing sand or small rocks out of the burrow to drop them outside. It takes a lot of work, since the shrimp collapses the entrance each night to keep marauding eels out. However, shrimp are nice and tasty, and these Bulldozers don't have the best eyesight, being more adapted to the low light inside the burrow. If they made a habit of emerging from the burrow carrying a load of sand to drop outside, clever predator fish would learn to wait next to the burrow for an easy meal. Here's where the goby comes in. He sits next to the burrow as a lookout. If danger approaches, first the fish wiggles his tail at the mouth of the burrow to warn the shrimp to stay inside. But sometimes the shrimp ignores the wiggle, especially if it lasts too long, and he comes out anyway. So if danger gets too close, the goby dives into the hole, blocking the shrimp inside. Another case of a mutually beneficial symbiosis. The shrimp gets a lookout to help keep him from being eaten and the fish gets a safe refuge to hide in as needed. In this first clip, a Yellowspotted Shrimpgoby (*Amblyeleotris guttata*) is standing guard for the Bulldozer *Alpheus ochrostriatus*, seen here carrying out and dropping a load of sand and calcareous algae flakes.
- 34:59 A different goby and shrimp pair, this Arcfin Shrimpgoby (*Amblyeleotris arcupinna*) watches out for Bulldozer *Alpheus bellulus* half carrying and half pushing out a load of sand. What, you might ask, if the goby dives into the hole while the shrimp is outside dropping its load? If you look carefully at this scene, you will see that the shrimp always keeps one of its long antennae resting on the fish the entire time it is out of its hole. If the fish moves suddenly, that is the signal for the shrimp to retreat at once.
- 35:10 A pair of Arcfin Shrimpgobies appear to argue over who has the right to this shrimp hole.
- 35:19 Rarely seen at Kwaj is this Sea Moth (*Eurypegasus draconis*).
- 35:28 This is one of the ghost pipefish hanging around some red whip gorgonians on the slope of a lagoon pinnacle. This one appears to be a variation of the Robust Ghost Pipe (*Solenostomus cyanopterus*) although the different species seem to share a number of characteristics and there is some overlap.
- 35:35 This shows the only example we've seen in the Marshalls of the Ornate Ghost Pipefish (*Solenostomus paradoxus*). It was hanging around some *Halimeda* next to the wall of a surge channel on the seaward reef off Ninni. It always amazes me how they maintain their position in the surge. The tail goes back and forth, but the mouth seems to stay in about the same place.

- 35:48 This is the pipefish some people identify as *Corythoichthys conspicillatus* but others think is a form of *C. flavofasciatus*. Pipefish, including the ghost pipes above, exclusively eat live food, usually very tiny shrimp and other crustaceans they snatch with their elongate mouths. Although cute, they are not suitable for aquaria, and will usually live only a few days.
- 35:54 These three are Scribbled Pipefish (*Corythoichthys intestinalis*). These prefer very shallow water and can be seen along the shoreline of Kwaj or on tops of some shallow lagoon pinnacles.
- 36:03 A close-up of the head of the Yellowbanded Pipefish (*Corythoichthys flavofasciatus*).
- 36:09 This odd looking pipefish with the sharply angled body appears to be a white form of the Twospine Pipe (*Phoxocampus diacanthus*). It also comes in black. These have been found among loose rocks and rubble in the shallow ends of seaward reef channels.
- 36:15 These elongate, dark colored Duncker's Pipefish (*Halicampus dunckeri*) are found occasionally slithering between the plants in lagoon algae patches.
- 36:21 The Shortbodied Pipefish (*Choeroichthys brachysoma*) is rarely found at Kwaj. We have seen only two individuals, both on the atoll's seaward reef.
- 36:28 A large individual of the Orangefin Clownfish (*Amphiprion chrysopterus*) in a Carpet Sea Anemone (*Stichodactyla mertensii*). The clownfish are also often called anemonefish, a name preferred by some.
- 36:36 At least two adults and one juvenile Orangefin Clownfish inhabit this long tentacle anemone *Heteractis crispa*. The white tentacles of this anemone indicate it has suffered some bleaching (see the discussion at 04:09). Nearly all individuals of this anemone species have disappeared from Kwaj reefs over the past few years.
- 36:44 A *Heteractis crispa* anemone with pink tentacles, occupied by two large and at least two small Orangefin Clownfish. Generally, there will always be only two adults of this Clown species in an anemone. There might be a few juveniles, but once they start to get near adulthood, the adults chase them off and they have to go find another anemone. Most of those chased away probably die. However, it is advantageous for an anemone to have one or more juveniles as backups, waiting in the wings in case one of the adults dies or gets picked off by a predator.
- 36:52 Another kind of clownfish at Kwaj is locally called the Tomato Clown (*Amphiprion melanopus*), but most books refer to it as the Dusky Clown to distinguish it from a similar species, *Amphiprion frenatus*, also called the Tomato Clown but not found at Kwaj. This species is usually associated with aggregating colonies of the Bulbtentacle Anemone (*Entacmaea quadricolor*). The larger, solitary form of the anemone is usually inhabited by a different clown, the Threestripe (*Amphiprion tricinctus*). This scene shows a young Tomato.
- 37:00 Here is a larger adult of the local Tomato Clown.
- 37:06 This small unidentified Slipper Lobster is probably a species of *Scyllarus*.
- 37:12 We call this a hairy xanthid crab.
- 37:17 This light orange spiky beast appears to be one of the purse crabs. He has a very alien look.
- 37:29 This red crab may be a species of *Liomera*.
- 37:34 This is called the Thorny Round Crab (*Actaea polyacantha*).
- 37:40 One of the decorator crabs with its carapace covered with red sponge.

- 37:46 This hairy long-legged crab is probably a species of *Oncinopus*. We call it the Orangutan Crab for the way it waves around its long “arms.” Could also be the Conductor Crab, as this one seems to be conducting an orchestra.
- 37:58 The Pompom Crab (*Lybia tessellata*) takes part in an interesting symbiotic relationship. All individuals carry in each claw a juvenile of the sea anemone *Triactis producta*, a species reported to have powerful nematocysts or stinging cells. While the anemones are reportedly used by the crab for feeding, they are likely also defensive. When exposed to light, the crab waves the anemones over its head like a mini cheerleader waving pompoms. It seems likely that using these stinging anemones to punch a potential predator in the mouth might startle it and gain time for the crab to escape.
- 38:09 This may be another kind of purse crab.
- 38:14 We call this the King Kong Crab (*Daldorfia horrida*). They look tough, and can get quite large with a carapace width of at least 100mm. Nocturnal, you see them out mostly at night.
- 38:20 Another fairly large crab sometimes seen out at night. This one is *Zosymus aeneus*. It is reported to be poisonous if eaten.
- 38:26 Guard crabs live within bushes of live branch coral. Supposedly they are able to use their pinching claws to keep coral predators away, including even the Crown-of-Thorns starfish. I have had some of these crabs reach out and pinch my fingers if I have left them too close to the coral for too long. This one appears to be the Spotted-leg Guard Crab (*Trapezia guttata*). He’s doing quite a dance with those spotted legs.
- 38:31 An adult male Spotted Parrotfish (*Cetoscarus ocellatus*) swims over a reef with a female of the same species in the background. This used to be called a Bicolor Parrot (*Cetoscarus bicolor*) but that is a closely related species from the Red Sea.
- 38:38 A Bluebarred Parrotfish (*Scarus ghobban*) swims over a reef while being serviced by a Cleaner Wrasse.
- 38:47 A terminal phase male of the Yellowbar Parrot (*Scarus schlegeli*) grazes on algae.
- 38:53 A Palenose Parrot (*Scarus psittacus*) grazes algae from a seaward reef. The hard parrotlike bill of a parrotfish enables them to scrap algae off the rock down even to the top layer of the rock itself, which they later release out the other end as clouds of fine coral dust. The rigorous grazing helps the reef in other ways, particularly by opening up spots of bare rock where coral larvae can successfully settle to start forming new coral colonies. If the rock is covered with even a fine layer of algae, a coral larva has a hard time finding even a place to attach.
- 38:59 Bleeker’s Parrot (*Chlorurus bleekeri*) is not common but usually seen on quiet lagoon pinnacles. Toward the end of the scene, a school of rabbitfish come in from the left behind the parrot.
- 39:08 A couple of male Bridled Parrots (*Scarus frenatus*) in a brief battle over turf.
- 39:13 This is thought to be a color form of the flatworm *Pseudoceros dimidiatus*. It is usually found out in the open, so its bright color pattern probably warns predators it is not good to eat.
- 39:22 One of the larger flatworms at Kwaj, *Pseudobiceros fulgor* is also most often seen crawling in the open.
- 39:28 This flatworm may be a species of *Pseudoceros*.

- 39:34 Another unknown species of *Pseudoceros*. We see these mostly in lagoon *Halimeda* algae patches.
- 39:40 This appears to be an unknown flatworm in the Acotylean group.
- 39:44 We have found only a couple of these flatworms, both in lagoon algae patches. It appears to be a species of *Paraplanocera*. Unlike most flatworms, this one “walks” by lifting up its margin and taking steps.
- 39:53 Another *Paraplanocera* flatworm that moves in a manner similar to the previous one. Flatworms are extremely flat animals with all cells in the body relatively close to the surface. Consequently, they have no need of specialized respiratory or circulatory systems; that is, lungs or gills to remove oxygen from the water and blood and vessels to move it around. All the oxygen cells need can be absorbed directly from the water through the skin. With no circulatory system to move digested food around, polyclad flatworms have evolved with branches of the gut ramifying throughout the body to distribute food to all parts. You can see the branches clearly in this animal.
- 40:02 This is one of the small bubble shells, *Haminoea cymbalum*. It lives on intertidal and very shallow subtidal reefs, usually in algae. All the color in this creature is in the animal itself; the thin oval bubble shell completely transparent.
- 40:08 This is a species of *Philinopsis*, a dweller of sand and algae patches in the lagoon. *Philinopsis* species tend to be variable in color, and this one could be a form of *P. reticulata*. We have seen this form only about half a dozen times so far. It seems to glide right over the tops of the thin strands of algae.
- 40:15 This is the side-gilled sea slug *Pleurobranchus forskalii*. Although we have not seen any for some time now, for a while they were relatively common in algae patches along the lagoon interisland reef. Before that, for a few weeks in in 1988, we saw several dozen or more of these in one small area just off the north end of Bigej, mostly under rocks and laying eggs. They vanished a few weeks later and after a few years, that area and all the loose rocks were buried in sand being washed from a sandbar that used to extend for a hundred meters or more north of Bigej. The species varies considerably in color.
- 40:22 This is a large, flat, rather stiff nudibranch called *Platydoris cruenta*.
- 40:28 Related to the previous species is this reddish brown *Platydoris sanguinea*.
- 40:34 This active multicolored nudibranch covered with small rounded bumps is *Discodoris cebuensis*. We have seen several in lagoon algae patches.
- 40:47 A tiny chromodorid nudibranch named *Thorunna purpuropedis*. This one was originally described from Marshall Islands specimens. It is on the undersurface of a rock, feeding on a light tan sponge. This species, like a few others, continually vibrates its red tuft of gills.
- 40:52 The nudibranch *Miamira sinuata* is occasionally seen in small caves or under rocks on the seaward reef.
- 40:59 The nudibranch *Ceratosoma tenue* is an inhabitant of lagoon algae patches. Three individuals can be seen in this clip.
- 41:04 A Green Turtle (*Chelonia mydas*) comes in to take a close look at the photographer before turning away.
- 41:24 Kwaj’s other sea turtle, the Hawksbill (*Eretmochelys imbricata*) swims past on a seaward reef slope.

- 41:32 The large Moon Jelly (*Aurelia aurita*) pulses past. More can be seen in the background.
- 41:48 A Crown Jelly (*Cephea cephea*) on the seaward reef.
- 42:05 This very large jelly seems similar to the Crown, but differs in the lack of long tentacles and in the shape of the bell and crown. This was over the top of a midlagoon pinnacle.
- 42:22 Probably the most common of the larger jellies is this *Crambione mastigophora*. While there are usually none around, if you see any at all, you might see a bunch.
- 42:29 More *Crambione mastigophora*.
- 42:35 A large swarm called a “smack” of *Crambione mastigophora* jellyfish have invaded an algae-covered lagoon slope. The tentacles of these jellies pack a pretty powerful sting, so swimming through a smack requires some care.
- 42:41 An even more dense smack of *Crambione* off one of the sand spits near North Loi.
- 42:47 Looking upward toward the sun through hundreds of jellies.
- 42:55 A large colony of the blue coral *Heliopora* on a shallow reef, surrounded by columnar and branching Fire Coral (*Millepora*).
- 42:59 More Fire Coral growing upward as wrinkled-looking platelike columns.
- 43:05 A colony of Pacific Elkhorn Coral (*Acropora rotumana*) among other corals on a shallow interisland reef.
- 43:11 Multicolored Stalk Corals (*Lobophyllia*) on a lagoon reef. Like other corals, a Stalk Coral colony starts as a single polyp settled from the plankton. In Stalk Coral, the coral grows outward, dividing into other separate stalks as it grows and the polyps divide. In areas where this coral has been damaged by swell, or even where part of it has fallen away by its own sheer weight, you can see each of those many puckered oval disks is the living tip at the end of a long straight now dead skeleton—a “stalk” of coral. As they grow, colonies close together seem to merge, with low valleys between the original colonies, and this may be why the parts of this mass of Stalk Coral have the color pattern they do. The color of most coral comes from the symbiotic zooxanthellae within its tissue. The original polyp of each separate colony acquires an initial algae cell. Zooxanthellae vary in color, but once one is in the tissue of the original coral, it reproduces itself and goes along with the coral as new polyps are produced by fission, so all the coral stalks produced by the original polyp are all colored the same. However, a neighboring coral larva that settled out might have incorporated an algae cell of a different color. If several coral larvae settled in a small area and each acquired a different colored algae, when the colonies grow and merge you would expect to see a pattern like this develop.
- 43:17 Many kinds of coral home to many kinds of fish on the edge of the seaward slope.
- 43:24 Earlier we saw examples of the two larger species of giant clams. The third and smallest species, *Tridacna maxima*, is the most abundant and also seems to be the most varied in color. These clams live embedded in the reef, and with their bright colors are sometimes referred to as the eyes of the reef. Here’s one with several shades of blue and gray to start.
- 43:27 Another *Tridacna maxima*, black and yellow with an orange trim.
- 43:31 Green and black.
- 43:35 Black with blue deep inside and scattered yellow specks.
- 43:39 Dazzling blue.

- 43:42 Purple.
- 43:46 Blue dots on black with a green trim.
- 43:50 Brown speckled with black.
- 43:54 Cannot even describe this one.
- 43:59 Often different colored ones will settle out and grow up together.
- 44:03 A small yellow and black *Tridacna maxima* next to an *Entacmaea quadricolor* anemone.
- 44:07 Here at Kwaj, we rarely see more than one kind of Clownfish in a single anemone. But it does happen. Here a small orange Threestripe Clown (*Amphiprion tricinctus*) has moved into a colony of *Entacmaea quadricolor* anemones occupied by a bunch of Tomato Clowns (*Amphiprion melanopus*).
- 44:13 For a long time, this Carpet Anemone was occupied by one large Orangefin Clown (*Amphiprion chrysopterus*) and an almost as large dark Threestripe Clown. Twice when we visited, the Threestripe was tending an egg mass seen here as the silvery grayish bubbles on the underside of a small ledge near the left side of the screen. The Threestripe can be seen fanning the eggs with his pectoral fins. Male clownfish tend to be the ones who tend the eggs, and females tend to be larger. So is this a male Threestripe with a female Orangefin? Did they mate to produce the eggs? We know of no other clownfish closer than about 50 meters away. Alas, last time we visited this anemone, the large Orangefin was gone and there were a couple of young up and coming Threestripes to join the larger one, who will probably now turn into a female.
- 44:25 Here is a Threestripe Clown with a yellow Magnificent Anemone, a species it usually does not live in. There is already at least one Apricot Clown in the anemone. I guess you take what you can get. A clownfish without an anemone is just food for some predator.
- 44:32 Haddon's Anemones (*Stichodactyla haddoni*) vary in color and live in lagoon sand or algae patches. They are usually home to a number of young Threestripe Clowns and Threespot Damsels (*Dascyllus trimaculatus*). Generally, the clownfish do not get very large in these anemones; as they get larger, they may move off looking for other kinds of anemones.
- 44:38 Another Haddon's Anemone with several Threestripe Clowns and Threespot Damsels. The striping pattern on this anemone is unusual.
- 44:44 Haddon's Anemone with the usually clownfish and damsels, along with a number of blue damsels, yellow cardinalfish and even a young Threadfin Butterfly seeking shelter near (but not in) the anemone.
- 40:50 This Haddon's Anemone lost its symbiotic zooxanthellae algae during a warm spell.
- 44:56 Bulb Tentacle Anemones (*Entacmaea quadricolor*) will also lose their color when the water gets too warm. Anemones turning white are often the earliest signs of a warm water coral bleaching episode. This anemone is host to several Threestripe Clowns.
- 45:02 Another kind of clownfish hosting anemone is the Sand Anemone (*Heteractis aurora*). The stalks of these anemones reach well under the sand, and the entire anemone will pull down if disturbed. These usually host juvenile Threestripe or Orangefin Clownfish—the juveniles of both species look very much the same.
- 45:08 One more anemone that occasionally supports one or two small Threestripe Clowns is the Corkscrew Anemone (*Macroactyla doreensis*). These sand and algae patch dwelling anemones more often support several *Periclimenes* shrimp.

- 45:14 A pair of large Orangefin Clownfish in a Carpet Anemone.
- 45:20 In Carpet Anemones, the Threestripe Clownfish nearly always turns much blacker than usual, losing all its orange and sometimes even the third white stripe at the base of its tail.
- 45:27 A Haddon's Anemone in a lagoon *Halimeda* algae patch. A school of young Sidespot Goatfish (*Parupeneus pleurostigma*) swim by from left to right.
- 45:36 A towering colony of Crinkly Coral (*Porites rus*) is infested with small *Entacmaea quadricolor* anemones growing between its branches, which support a group of Tomato Clowns.
- 45:42 Parrotfish swim through a rich coral reef on the edge of a lagoon pinnacle.
- 45:48 Bluegreen Chromis damsels mill around a colony of branching *Porites* coral. Colonies of the soft coral *Sarcophyton* are on the right, and a small school of small dark parrotfish approach from the background.
- 45:53 More Bluegreen Chromis around a colony of branching *Pocillopora eydouxi*. A Goldrim Surgeonfish (*Acanthurus nigricans*) swims in from the right.
- 45:58 A Spotted Eagle Ray (*Aetobatis narinari*) approaches from above.
- 46:09 Three Spotted Eagle Rays put on a little dancing performance for the camera on the seaward slope.
- 46:28 A Pink Whiptail Stingray (*Himantura fai*) wings its way up an algae-covered lagoon slope, accompanied by several jacks.
- 46:48 Sand streams from the back of a Porcupine Ray (*Urogymnus asperrimus*) as it lifts up off the bottom and swims past.
- 46:59 A Porcupine Ray digs for burrowing echinoids and mollusks while a couple of freeloading jacks wait for the ray to scare up something they can steal.
- 47:09 The large Blackblotched Stingray (*Taeniura meyeni*) usually dines on fishes. I think here the ray is humped up over a small coralhead, trying to literally suck out the fish hiding within. We have seen this humping behavior twice.
- 47:16 A close shot of the venomous spine on the tail of the Blackblotched Stingray. Spines of this species have been known to kill at least two people, one apparently a diver who grabbed the edge of the ray, thinking it was a manta and wanting to take a ride.
- 47:23 A Blackblotched Stingray swims past over a sandy bottom.
- 47:34 A Flowery Flounder (*Bothus mancus*) swims across a lagoon algae patch.
- 47:43 Another Flowery Flounder swims away across rubble.
- 47:50 A small Threespot Flounder (*Samariscus triocellatus*) is hard to see on a background of *Halimeda* flake sand and shell bits. A transparent longarm shrimp (*Periclimenes tenuipes*) comes into the scene from the left side.
- 48:01 A lateral view of the Threespot Flounder as it slowly eases over a rock.
- 48:10 A young Stripebelly Puffer (*Arothron hispidus*) among small branching corals in a lagoon algae patch.
- 48:17 An adult Stripebelly Puffer feeds in a lagoon algae patch.
- 48:29 A Guineafowl Puffer (*Arothron meleagris*) in a small ledge on the seaward reef.
- 48:35 Guineafowl Puffers use their hard, fused teeth to scrape the polyps from live coral. This one takes a couple of bites of *Porites*, leaving scars where his teeth scrape off the top layer of coral. Other bite marks show he's been doing that for a while.
- 48:49 A large Bluespotted Puffer (*Arothron caeruleopunctatus*) is serviced by a young Bicolor Cleaner Fish before rising up to pass close to the photographer.

- 49:00 Common farther west in the Pacific, the Striped Puffer (*Arothron manilensis*) is rare at Kwaj. We have seen it only three times, once in Kwaj harbor, once in shallow water at Emon Beach and this photographed one on the sandy lagoon slope near Gugeegue.
- 49:07 The Map Puffer (*Arothron mappa*) is a large species with a distinctive maze-like pattern of lines across the back and radiating out from the eyes.
- 49:13 The largest puffer at Kwaj is the Stellate Puffer (*Arothron stellatus*). This is a small juvenile that has been digging for food in the sand.
- 49:18 A somewhat larger but still small Stellate Puffer occupies the mouth of a fire coral encrusted sunken pipe.
- 49:25 A larger Stellate Puffer hunts for food in a lagoon algae patch.
- 49:31 The curious Stellate Puffer then comes over to investigate the camera.
- 49:37 A pair of large Stellate Puffers drift past like overhead dirigibles on the seaward reef.
- 49:44 A rather small Blackblotched Porcupinefish (*Diodon liturosus*) rests in a small seaward reef ledge. To avoid being eaten by large predators, these Porcupinefish can suck in water to puff up into a hard, round ball covered by sharp, tough spines pointing in all directions.
- 49:52 A large Scrawled Filefish (*Aluterus scriptus*), also sometimes called a Netted Leatherjacket, passes by on a lagoon pinnacle reef.
- 49:58 Three coral-eating Longnose Filefish (*Oxymonacanthus longirostris*) hover next to a colony of *Porites rus* coral.
- 50:03 A Picasso Triggerfish (*Rhinecanthus aculeatus*) watches the camera while deciding if he needs to dive into a hole to hide.
- 50:10 A gaudy Clown Triggerfish (*Balistoides conspicillum*) attacks a crinoid feather star. There is not much to eat on crinoids, so I suspect he was after the commensal crabs or shrimp that often live with crinoids (see 30:53).
- 50:16 The Clown Trigger pauses with a sticky crinoid arm still stuck to his lips.
- 50:20 A Blacktip Grouper (*Epinephelus fasciatus*) hovers in front of a gorgonian on the seaward slope.
- 50:25 A fat Peacock Hind (*Cephalopholis argus*) swims to the right in front of the camera. It appears that this carnivorous fish has recently had a good meal.
- 50:33 A Redmouth Grouper (*Aethaloperca roga*) keeps an eye on his school of feeder fish, the Pygmy Sweeper (*Parapriacanthus ransonneti*).
- 50:39 A large school of mostly transparent cardinalfish hover over a stand of *Acropora* coral on the lagoon slope.
- 50:46 More cardinalfish and damsels on the side of a coralhead bearing a cluster of the blue tube sponges *Cribochalina olemda*.
- 50:53 A small bait ball of cardinalfish darts around on the edge of a coralhead.
- 51:05 A small stomatopod or Mantis Shrimp (*Pseudosquilla ciliata*) flips around next to a clump of algae and looks over its tail back at the photographer. Mantis Shrimp are so named because their forward appendages fold up similar to those of a praying mantis and are used for capturing or disabling prey.
- 51:13 Another stomatopod battles with a small crab destined to be dinner.
- 51:22 The larger stomatopod *Lysiosquilla* inhabits deep smooth-walled holes in the sand. It often sits at the opening, its bizarre cylindrical eyes rotating independently of one another, watching for passing prey that could be grabbed and eaten.

- 51:29 A similar but darker colored *Lysiosquilla* Mantis Shrimp. This and the previous Mantis are called spearers. The last segment of their folding mantis-like feeding appendages bear a row of long, sharp spines. When a prey passes close enough, the Mantis whips out its folding appendages and impales it, then folds its appendages back up, putting the speared prey right up against the shrimp's mouth.
- 51:36 A small orange stomatopod curls up between branches of coral and watches.
- 51:40 An elongate species of *Eunice* worm crawls across a rock.
- 51:49 A large bristleworm (*Pherecardia striata*) crawls across a rock. those whitish clusters of bristles along both sides are sharp and easily penetrate skin, where they burn for some time and itch for much longer. It is not called a fireworm for nothing.
- 51:57 Another bristleworm.
- 52:06 A small banded worm crawls across orange sponge.
- 52:14 A Yellowmargin Moray Eel (*Gymnothorax flavimarginatus*) looks out of its hole in the reef.
- 52:20 This moray eel is not yet positively identified, although some have suggested it is a form of the previous species, the Yellowmargin. We'd probably have to pull out a specimen to try to verify it, and so far we have not been willing to do so. To me it looks a little too sharp nosed and aggressive for it to be the relatively laid-back Yellowmargin.
- 52:27 The Giant Moray (*Gymnothorax javanicus*), an eel that has been measured in some areas as long as 2 and a half meters. We have not seen any near that size at Kwaj, but they do get quite large nonetheless. Fortunately, they do not appear to be especially aggressive.
- 52:32 The attractive Snowflake Eel (*Echidna nebulosa*) is not common at Kwaj but can sometimes be seen in rubble and rock piles on shallow lagoon reefs. This one gets a bit twitchy, probably annoyed by my bright video lights.
- 52:38 The Whitemouth Moray (*Gymnothorax meleagris*) is a relatively common species that often stretches out of its holes in the reef to look around. This shows a typical color pattern. Notice the bright white color inside the mouth, which gives the species its common name.
- 52:43 A Whitemouth Moray of an overall lighter color due to the white spots elongating into streaks.
- 52:48 On this Whitemouth Moray, the white streaks have elongated farther. This is an unusual color pattern for this eel.
- 52:54 A Gray Nurse Shark (*Nebrius ferrugineus*) resting in a shallow, sand bottom cave. This shark gets quite large, but is usually not aggressive unless unduly bothered.
- 53:01 A Reef Whitetip Shark (*Triaenodon obesus*) cruises through numerous fish along the steep seaward slope.
- 53:09 A Reef Whitetip with a nipped dorsal fin comes in for a close look before passing on. Whitetips are not aggressive to divers except perhaps in the presence of speared fish, but are curious and will often come close.
- 53:17 Small Whitetips often congregate under large table corals, where they usually rest by laying on the bottom. These three (this and the next scene) under this large table were swimming about, possibly disturbed by my presence and lights shining in.
- 53:22 A Whitetip parade.

- 53:30 Another shark with white tips to its fins is the Silvertip (*Carcharhinus albimarginatus*), a much larger and usually deep water shark with white trailing edges to its dorsal, pectoral and tail fins. This is a relatively small 7 footer that came up shallow to take a look at us. Normally these are seen only deeper than 35m or so.
- 53:39 A shallow water Blacktip Shark (*Carcharhinus melanopterus*) comes over to check out the bubbling interlopers entering her domain.
- 53:47 A Gray Reef Shark (*Carcharhinus amblyrhynchos*) comes up the sandy slope to investigate divers. This is on a reef rarely dove, so the sharks were a bit uneasy and curious.
- 53:54 A smaller female Gray Reef swims up the side of a steep reef on the edge of the lagoon accompanied by a small pilotfish.
- 54:02 Another small female Gray Reef comes up the reef.
- 54:10 A Gray Reef passes off the reef out into the deep blue water.
- 54:16 Another Gray Reef comes over a coralhead to take a closer look.
- 54:21 A large black Manta Ray (*Manta birostris*) cruises slowly over a coral encrusted bottom, probably looking for a large cleaner wrasse willing to come up and work him over.
- 54:32 A white bellied Manta glides along the edge of a coral mound while having its parasites picked by a cleaner wrasse.
- 54:48 A small all black Manta cruises past.
- 54:56 Another white bellied Manta with feeding flaps extended and mouth open cruises past the reef, gathering plankton into its mouth.
- 55:03 A small black bellied Manta does a couple of somersaults through a cloud of plankton at the edge of the lagoon slope.
- 55:24 A large white bellied Manta hovering at the edge of a reef for cleaning services performs an up and over somersault before falling back to the same position.
- 55:34 A large black bellied Manta accompanied by four sharksucker remoras glides slowly past as the scene fades out.