

Kwajalein's Living Reef

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Kwajalein: it means something different to different people. To scientists, it's the largest coral atoll in the world. To some World War II veterans, it brings back memories of bloody violence or, after the invasion, excruciating heat and boredom. But to many who have passed through here during the last 45 years, Kwaj is an experience not to be forgotten, especially for those who took advantage of the opportunity to become acquainted with the underwater world.

Kwajalein's underwater experiences can range from peaceful, coral-encrusted, fish-filled lagoon reefs to World War II shipwrecks to steep walls to intense encounters with sharks and other large animals. **Kwajalein's Living Reef** concentrates on the reefs and marine life, showing 431 scenes of corals, fish, and other animals that live beneath the water's surface around Kwaj. But even this barely scratches the surface of the real Kwajalein's living reef.

The video is designed to move quickly from scene to scene and to be accompanied by music rather than narration. Therefore, this booklet is included to describe the scenes that make up the video.

In this booklet, the scenes are numbered in sequence, followed by the VCR count times (with the very beginning of the movie as 00:00) and the Kwajalein Atoll site where the scene was recorded. This is followed by an identification of the animal (if possible). Usually included is a general description of the activity or other interesting bit of information about the animals figured.

Animals are referred to using the common names most frequently used at Kwajalein. For many species, there is no local common name, and the common name listed here is either contrived or (for fish) taken from Robert F. Myers' **Micronesian Reef Fishes**. Scientific names in Latin are provided for most species (in italics) for anyone who is interested. The Latin names are far more precise than common names, which may change from location to location. For example, what we call a "Raccoon Wrasse" here is called a "Blackeye Thicklip" in **Micronesian Reef Fishes**. If I mentioned Raccoon Wrasse to someone from, for example, Guam, that person probably wouldn't know what I was talking about. But its Latin name, *Hemigymnus melapterus*, is accepted worldwide and specifically refers to that certain kind of fish. For unambiguous communication, you're better off learning the Latin names.

Place names used in this book all refer to locations within Kwajalein Atoll. The majority of scenes were filmed within the Kwajalein boating areas accessible to anyone with a boat license. The location called Oceanside West Reef refers to the open reef areas between Kwaj and Ennubuj or between Ennubuj and South Pass. For several islands, the Marshallese name

(or at least an approximation of it) was used in place of the generally used English name. These are translated in the list below:

Ebjadrik	Big Bustard
Ebwaj	Shell Island
Ennubuj	Carlson
Ennylabegan	Carlos
Orpap	Little Bustard

One location name used here is “Eniwetak Pinnacle.” This refers to a series of large lagoon pinnacle reefs (sometimes locally called coralheads) near the island of Eniwetak, which is just inside the lagoon from the pass that separates Meck and Kwadak. It does not refer to Enewetak Atoll, another Marshall Islands atoll about 350 miles northwest of Kwajalein.

Located between Kwajalein and Ennubuj Islands, Sar Pass is the route most marina boats take to get outside the lagoon. When it was built in the 1950s, SAR was an acronym meaning Search And Rescue. Over the years, Sar has become a word in itself, and is used here without the all-capitals usually used for acronyms.

To use this guide, reset your VCR counter to 0 just as the movie starts. Since different VCRs might give slightly different counts, the numbers may be off slightly, and may change more towards the end of the tape. I hope the description contains enough information to enable recognition of the scene.

1 00:00 – 00:14 Oceanside Legan Island

Diver swims down narrow surge channel over clean white sand bottom.

2 00:14 – 00:18 Oceanside Legan Island

Looking seaward through sandy bottom surge channel with reef overhang on each side. A single parrotfish swims through the channel. Surge channels are cuts in the oceanside reef that extend, often from the vicinity of the drop-off, back in towards the reef. They are found primarily along parts of the leeward atoll reefs. In the Kwaj boating areas, surge channels occur sporadically along the reef between Ennubuj and South Pass, along parts of Ennylabegan through Gea, and through most of Ninni. Many islands to the north of Ninni also possess surge channels. Why such channels develop is unknown, although occasional large swells generated from distant storms probably act to keep them from filling up with debris and coral.

3 00:18 – 00:25 Oceanside West Reef

Diver swims out sand and rubble surge channel to edge of steep oceanside drop-off. Part way through, several parrotfish swim in front of the camera.

4 00:25 – 00:29 Shark City Pinnacle

Looking up a sandy slope at several coralheads, including a dome-like colony of the lump coral *Porites* that was approximately 6 to 8 feet in diameter.

5 00:29 – 00:32 Oceanside West Reef

Small sand channel bordered by reef and corals.

6 00:32 – 00:36 Oceanside Bigej-Meck

A pair of algae and coral encrusted reef outcrops that nearly touch at the top. Various small tangs and parrotfish pass in front.

7 00:36 – 00:39 Oceanside Torouji Island

Lump coral *Porites* growing on top of a stalk, causing it to resemble a mushroom. A single feather star (crinoid) sits on top of the coral. This structure may not last through the next big storm.

8 00:39 – 00:43 Oceanside West Reef

Two adjacent yellow lump coral (*Porites*) domes in shallow water on the reeftop. Each of these measured about 5 feet in diameter.

9 00:43 – 00:46 Oceanside West Reef

Looking toward surface across a rounded colony of crinkly coral (*Porites rus*) through a school of small fish. A partial silhouette shot.

10 00:46 – 00:50 Oceanside West Reef

Looking along the drop-off at a round-topped colony of crinkly coral (*Porites rus*) surrounded by numerous erratically swimming fish, mostly purple fairy basslets (*Pseudanthias pascalus*). The coral mound is 5 to 6 feet in diameter.

11 00:50 – 00:54 Eniwetak Pinnacle

Various kinds of fish milling about over a reef thickly overgrown with a variety of corals. In the background, a small parrotfish suddenly zips away. It had probably just been nipped by a clumsy cleaner fish or by a cleaner fish mimic, the saber tooth blenny. Some saber tooth blennies are colored like cleaner fish and swim like cleaner fish, causing other fish to come in for cleaning. Instead of picking the parasites, however, the saber tooth bites off a chunk of flesh.

12 00:54 – 00:58 Oceanside Legan

Diver's bubbles rising from a surge channel hidden behind a table coral colony (*Acropora*).

13 00:58 – 01:02 Northern Lagoon Pinnacle

Various corals including small tables (*Acropora*) and some bumpy soft coral (*Lobophyton*) growing on top of a rocky mound.

14 01:02 – 01:05 Lagoonside Ebwaj

Various corals, including the branching yellowish green *Porites* in the middle surrounded by the fuzzy brown *Goniopora*.

15 01:05 – 01:09 R-Buoy Pinnacle

Various corals, including the dome-like stalk coral (*Lobophyllia corymbosa*). Each of the individual colonies of this coral grows out from the center, with the living coral tissue only on the end of a long stalk. As the coral grows, the stalks elongate and the dome gets larger. When it dies and breaks apart, it breaks into separate long spikes.

16 01:09 – 01:12 Shark City Pinnacle

Large colony of the greenish coral *Turbinaria retiformis*. A female bird wrasse (*Gomphosus varius*) swims into the scene at lower left. This particular group of *Turbinaria* colonies extends over a number of meters and is the largest such group I've seen.

17 01:12 – 01:16 Eniwetak Pinnacle

Colony of elkhorn-type coral (*Acropora*) on very small base. The colony measured 5 to 6 feet in diameter at the top. I think it is getting too top heavy to last much longer.

18 01:16 – 01:20 Oceanside Ennylabegan

Colony of elkhorn-type coral reaching towards surface, with a school of fish rising in the distance behind it.

19 01:20 – 01:23 Eniwetak Pinnacle

Reef thickly encrusted with coral and occupied by numerous fish. Looking over a large table coral partly visible in bottom of screen. Two cleaner wrasses (*Labroides dimidiatus*) swim close in front the camera. They were probably coming in to see if the photographer had any parasites that needed to be picked.

20 01:23 – 01:27 Northern Lagoon Pinnacle

Reef mounds with lots of large colonies of table coral (*Acropora*).

21 01:27 – 01:30 Northern Lagoon Pinnacle

Looking down from above on reef mound with large colonies of table coral (*Acropora*).

22 01:30 – 01:41 Eniwetak Pinnacle

Swimming across a row of large colonies of table coral (*Acropora*).

23 01:41 – 01:45 Northern Lagoon Pinnacle

Large table coral colony (*Acropora*). Light rays bending as they pass through the calm but ripply surface produce a constantly moving ripple pattern of light on the coral.

24 01:45 – 01:49 Eniwetak Pinnacle

Branching fire coral (*Millepora*) against blue background. This coral isn't called fire coral for nothing; it has very powerful stinging cells called nematocysts, which are capable of producing painful burning stings in human flesh.

25 01:49 – 01:52 Eniwetak Pinnacle

Two different kinds of large *Naso* tangs schooling along the slopes of a reef. The ones with the horns are *Naso brevirostris* and the round-headed ones are *Naso hexacanthus*.

26 01:52 – 01:56 Eniwetak Pinnacle

A school mostly made up of black-eyed *Naso* tangs, likely a juvenile or female of one of the larger species.

27 01:56 – 02:00 Oceanside Orpap

School of fish grazing algae from hard reef bottom in shallow water. Most of these are the orange-shouldered tangs (*Acanthurus olivaceus*). Also included are several white with black vertical bars convict tangs (*Acanthurus triostegus*), as well as a reddish brown female parrotfish (*Scarus forsteni*).

28 02:00 – 02:03 Shark City Pinnacle

School of whitecheek tangs (*Acanthurus nigricans*) feeding on algae growing on dead coral rocks in the midst of a living reef. There's a thick growth of staghorn coral (*Acropora*) behind them. Many different kinds of tangs are grazers on the thin layer of algae that coats dead coral rocks. Often they travel in schools and descend like locusts to pick areas clean of plant growth, usually to the dismay of resident damsels who normally try to defend their patches of territory from intruders but are overwhelmed by large schools of tangs.

29 02:03 – 02:07 Lagoonside West Reef

Small school of black-eyed squirrelfish (*Neoniphon sammara*) hanging nose down over a reef, ready to dive to safety if the photographer begins to look aggressive. A small bicolor cleaner wrasse (*Labroides bicolor*) appears in the right side of the screen.

30 02:07 – 02:11 Oceanside West Reef

Small school of yellowfin goatfish (*Mulloides vanikolensis*) swimming over a colony of staghorn coral (*Acropora*).

31 02:11 – 02:14 Lagoonside West Reef

Snappers (*Gnathodentex aureolineatus*) swimming over a coralhead.

32 02:14 – 02:18 Oceanside Ennubuj

Redfish or menpachi (*Myripristis*) in a surge channel cave. These fish are nocturnal and emerge from their caves at night to feed.

33 02:18 – 02:24 Mian Pass Pinnacle

Bigeyes or aweoweo (*Priacanthus*) approaching in a large school. Individuals are able to change color from red to silver to striped very quickly. These fish are nocturnal. Often they disperse during the day and rest nearly motionless above holes in the reef, which they enter if danger approaches. Around some lagoon pinnacles, they form large aggregations.

34 02:24 – 02:31 Victor Buoy Pinnacle

Gray reef shark (*Carcharhinus amblyrhynchos*) passing through a school of aweoweo. This was shot from a depth of about 100 feet, looking upward through the school toward the surface.

35 02:31 – 02:38 Oceanside Ennubuj

Soldierfish (*Sargocentron spiniferum*) in see-through cave on the oceanside drop-off. Around the edges of the cave are feather-like hydroids, which have powerful stinging cells called nematocysts. Stings from hydroids can raise painful welts, and will often itch for days.

36 02:38 – 02:42 Oceanside West Reef

Red parrotfish (*Scarus xanthopleura*). This is the female form. The male is mostly green with blue around the mouth. Parrots, like many other reef fish, undergo a sex change, being female first and becoming male later in life.

37 02:42 – 02:45 Oceanside Legan

Bumphead parrotfish (*Chlorurus microrhinos*). Older males develop the rounded bump on the head.

38 02:45 – 02:49 Oceanside Legan

Bumphead parrotfish, close of face as it passes by.

39 02:49 – 02:53 Northern Lagoon Pinnacle

Starts off with a group of parrotfish swimming around next to a coralhead. Then a school of gray forktail rabbitfish (*Siganus argenteus*) enters the scene from the right.

40 02:53 – 03:00 S-Buoy Pinnacle

School of forktail rabbitfish feeding on algae covered rocks. They rise up and over the rocks, and swim away. Some are still feeding as the rest go.

41 03:00 – 03:03 S-Buoy Pinnacle

Forktail rabbitfish swim over coral and turn around. Kind of interesting how they all know what to do at the same time.

42 03:03 – 03:07 Oceanside Bigej-Meck

School of snappers (*Lutjanus gibbus*) swim along bottom under a large snapper (*Macolor*).

43 03:07 – 03:10 Victor Buoy Pinnacle

Various parrotfish grazing algae from rocks. In the process of scraping the thin layer of algae from dead coral rocks, these parrots wear down both their teeth and the reef as well. With each bite, the parrot scraps off the top layer of rock in addition to the algae. The algae is digested, while the sand passes through the gut and is dropped out in the infamous parrotfish sand dumps

(see the next scene). Parrot “beaks” consist of several layers of fused teeth that are continually replaced from the bottom as the tops get worn away scraping the hard rocks.

44 03:10 – 03:14 Oceanside West Reef

Parrotfish swimming by along drop-off. One empties out the excess sand he has been picking up while scraping the algae off rocks.

45 03:14 – 03:18 Eniwetak Pinnacle

Coral covered slope with single parrotfish swimming across.

46 03:18 – 03:21 Oceanside West Reef

Seven sharpfin barracuda (*Sphyræna acutipinnis*) swimming well overhead.

47 03:21 – 03:25 Oceanside West Reef

Diver swims over drop-off, with sun in background.

48 03:25 – 03:31 Oceanside West Reef

Hole in a coralhead on the reeftop, sun behind and a parrot silhouette appearing through the hole.

49 03:31 – 03:37 Oceanside West Reef

Bent-over whip corals growing along a deep drop-off (about 120'). Shot from underneath, looking up at an angle toward the top of the drop-off and the surface.

50 03:37 – 03:39 Oceanside Gehh

Fan corals and other gorgonians along a deep drop-off. Although it looks pretty colorless at this depth, the fan in the center is bright orange if you shine a light on it or bring it to the surface. Unfortunately, many large bushes, up to 10 feet across, were brought to the surface as souvenirs during the early days of diving here in the 60s. Consequently, these fans, especially large ones, are no longer often found within the boating areas. And for the most part, they vanished in vain; these orange fans lose their color and become extremely brittle after drying, and have probably long ago fallen apart.

51 03:39 – 03:42 Oceanside West Reef

Small orange fan coral growing in a surge channel ledge. Orange sponge covers the ledge's rocky surface at right.

52 03:42 – 03:46 Oceanside Gehh

With artificial light, the vivid colors on some of the deep water gorgonians comes to life. This was taken along a short vertical section of the drop-off at a depth of about 100 feet.

53 03:46 – 03:50 Oceanside Gehh

Same gorgonian as in last sequence, but closer.

54 03:50 – 03:54 Oceanside West Reef

A small red branched gorgonian with white polyps. The white flowery polyps are the individual animals that make up a coral colony. They are all interconnected at their bases around the semi-rigid branching skeleton. Each polyp is not much more than a mouth surrounded by tentacles. They feed by snatching plankton from the water that flows by.

55 03:54 – 03:58 Oceanside West Reef

Colorful animals growing on a rocky outcrop just above a cave include red whip corals, fragile pink coral (*Stylaster*), and a large clam that snaps shut during the sequence.

The next ten scenes pass rapidly through a series of variably colored crinoids. Crinoids, also called feather stars, are the descendants of very ancient animals. Many species are preserved in the fossil record (although not here at Kwaj, of course), but fewer kinds are alive today. They can vary considerably in color, making the several species that occur at Kwajalein difficult to identify. Crinoids are filter feeders on plankton, and are often found perched atop rocks or coral to reach up into the current to snare passing food. Many more emerge at night than are observed during the day. Crinoids, related to starfish and other echinoderms, are fragile animals; their feathery arms break apart easily if handled. Although not dangerous, the little branches on the arms are hard and somewhat pointed, and can puncture or irritate bare skin.

56 03:58 – 04:01 Oceanside Gehh

Crinoids on a large fan coral.

57 04:01 – 04:03 Oceanside West Reef

Black crinoid with yellow ribs (*Oxycomantus bennettii*) on a bush of branch coral in a surge channel.

58 04:03 – 04:05 Oceanside West Reef

Crinoid (*Oxycomantus bennettii*) on branch coral on the ceiling of the mouth of a small surge channel cave.

59 04:05 – 04:07 Oceanside West Reef

Black crinoid (*Comanthus schlegeli*) with yellow ribs and flecks.

60 04:07 – 04:09 Eniwetak Pinnacle

Yellow crinoid (*Oxycomantus bennettii*).

61 04:09 – 04:11 Oceanside West Reef

White crinoid (*Comanthus schlegeli*) with dark colored ribs.

62 04:11 – 04:13 Oceanside West Reef

Orange brown crinoid with a white band, on a sheer wall.

63 04:13 – 04:15 Oceanside West Reef

White crinoid close up.

64 04:15 – 04:17 Oceanside West Reef

Black and yellow crinoid close up.

65 04:17 – 04:19 Oceanside West Reef

Reddish crinoid on red gorgonian.

66 04:19 – 04:22 Oceanside West Reef

Brown and yellow crinoid surrounded by school of small damselfish. Some small fish seek refuge among the arms of crinoids.

67 04:22 – 04:27 Victor Buoy Pinnacle

Two long-finned puppydog snappers (*Macolor macularis*) next to a crinoid. These inch-long fish are cute in aquariums when young, but grow into large aggressive snappers a couple of feet long. Juveniles, like these here, often live around crinoids, among whose branches they can hide when danger approaches.

68 04:27 – 04:31 Oceanside West Reef

Round-finned puppydog snapper (*Macolor niger*). We call this a puppydog because it always looks like it's wagging its tail.

69 04:31 – 04:35 Oceanside Gea

Larger, midsized puppydog snapper. This one, at about 6 inches long, is still a young one and possesses distinct black and white coloration. The full adults are mostly gray or black with a few less distinct white spots.

70 04:35 – 04:38 Northern Lagoon Pinnacle

Still larger puppydog snapper. This one is probably adult, although it has not reached full adult coloration. Here it swims over a coral-encrusted pinnacle slope.

71 04:38 – 04:41 Oceanside West Reef

Pair of humphead bannerfish (*Heniochus varius*) swimming over coral against the blue water. This is one of the five species of bannerfish found here at Kwajalein. The next two scenes show two of the others. The fourth is usually observed on deeper lagoon reefs and shipwrecks, and the fifth is quite rare, known from only a couple of sightings.

72 04:41 – 04:45 Eniwetak Pinnacle

Pair of horned masked bannerfish (*Heniochus monoceros*) over coral against the blue water. This is the largest of the bannerfish species at Kwajalein. They tend to be a bit shy and stay away from divers. Bannerfish, although they bear some resemblance to moorish idols in coloration, are actually related to butterflyfish.

73 04:45 – 04:48 Oceanside West Reef

Pair of pennant bannerfish (*Heniochus chrysostomus*) against blue.

74 04:48 – 04:51 Oceanside West Reef

Moorish idols (*Zanclus cornutus*) swim past over coral along drop-off. Although normally occurring in pairs or small groups, idols occasionally aggregate into large groups of large adult individuals and move as a school along the reef. The purpose of schooling is unknown, although it may be related to breeding.

75 04:51 – 04:54 Oceanside West Reef

Large school of moorish idols traveling along the drop-off. Some schools may be formed of hundreds of individuals.

76 04:54 – 04:57 Lagoonside West Reef

Pair of moorish idols seen through a cloud of small clear cardinalfish (*Apogon* species) and hovering over a brown sea anemone containing clownfish. In many areas of the atoll, the interface between the lagoon bottom and surrounding shallow reefs consist of a sandy slope with isolated coralheads. Sometimes these coralheads seem to act as oases in a desert, providing refuge for a myriad of small fish and their larger predators.

77 04:57 – 05:00 Lagoonside West Reef

Tightly packed school of cardinalfish (*Apogon*) in a small hole in a lagoon reef. The hole is surrounded with green, plate-like *Halimeda* algae. *Halimeda* algae produces a somewhat rigid, calcium carbonate skeleton. When the algae dies and the green flakes away, what's left is a small hard disk. These disks collect as flake sand. It has been estimated that this and other algae produce more calcium carbonate, the basic building block of coral reefs, than coral itself.

78 05:00 – 05:03 Lagoonside West Reef

Yellow cardinalfish (*Apogon cyanosoma*) over fingery soft coral (*Lobophyton*).

79 05:03 – 05:08 Lagoonside Ebwaj

Tiger cowry (*Cypraea tigris*) beginning to turn around. The cowry's spotted shell is visible at the very top; the rest is obscured by the mantle. The mantle is a thin sheet of the animal's tissue

that extends from the cowry's aperture and can cover the entire shell. This is the portion of the animal that actually creates the shell by depositing calcium carbonate taken up from the water or from the animal's diet. The mantle shell-production activity is also what keeps cowry shells so shiny. In most other kinds of shells, the mantle extends only to the edge of the aperture, right at the growing edge of the shell. Part of a second mantle covered tiger cowry is visible to the left.

80 05:08 – 05:12 Lagoonside Ebwaj

Close up shot of the anterior end of a tiger cowry. Here the mantle covers and camouflages most of the shell. Cowry mantles are usually covered with projections called papillae, which are thought to aid in camouflage by interfering with a potential predator's view of the smooth round shell shape. Papillae may also act to increase the mantle's surface area; if the mantle functions to absorb calcium carbonate from the water for shell deposition, increased surface area would allow more to be absorbed. Also visible in this picture are the two elongate feeler tentacles extending from the front, and between these is a fringed siphon tube that the animal uses to draw water into the vicinity of the gills for respiration.

81 05:12 – 05:15 Lagoonside Ebjadrik

Map cowry (*Cypraea mappa*) beginning to turn away from the lights of the camera. The mantle is only slightly visible at the bottom in this scene. To the left, the rocks are covered with orange sponge.

82 05:15 – 05:19 Lagoonside Ebjadrik

Map cowry continues turning away from light.

83 05:19 – 05:23 Oceanside West Reef

Eyed cowry (*Cypraea argus*) pair on dead coral with their mantles partially covering the shells.

84 05:23 – 05:27 Oceanside West Reef

Eyed cowry, same as last scene but closer. The eyed cowry mantle is very effective at hiding the color pattern of the shell. This brings to mind an interesting question. During the day, most cowries hide in dark caves or under rocks to avoid predators. At night, when they come out to feed, cowries keep their mantles closed over the shell. (In these scenes, the mantle is not completely covering the shell because the animal was disturbed by the photographer.) If the shell is hidden by being in the dark during the day, and is hidden by the mantle at night, what purpose does the pattern or coloration of the shell serve?

85 05:27 – 05:30 Oceanside West Reef

Tortoise cowry (*Cypraea testudinaria*) crawling in a ledge with the mantle partly extended.

86 05:30 – 05:35 Oceanside West Reef

Golden cowry (*Cypraea aurantium*) crawling along a ledge. The bright orange shell is visible at the top; most of the shell is hidden beneath the mottled black, white, and translucent mantle.

87 05:35 – 05:39 Oceanside West Reef

Same shell as the previous scene, slightly closer.

88 05:39 – 05:43 Oceanside West Reef

Geography cone (*Conus geographus*) crawling in a ledge. The shell is above a well extended crawling foot that has two distinct color patterns, one near the shell and the other more toward the bottom edge of the foot. From the right side extends the animal's siphon, through which water is drawn to flow over the internal gills. Below the siphon, small pointed tentacles are visible; the small black eyes are on the edges (not on the tip) of these stalks. The geography

cone feeds on sleeping fishes, which it paralyzes with a highly venomous harpoon that extends from the mouth (located right below the siphon). This cone has also been known to sting people who handled them carelessly, and some human fatalities have been reported.

89 05:43 – 05:47 Lagoonside Ebwaj

Omaria cone (*Conus omaria*) crawling across a rock. This species typically sleeps buried in sand during the day and emerges at night to feed. I had to wake this one up to take its picture. Like the geography cone, this species has a venomous harpoon and uses it to immobilize prey. Unlike the geography, it eats other snails, and its venom is not as virulent.

The following eight scenes show nudibranchs or sea slugs. Nudibranchs are closely related to the animals inhabiting seashells, but have lost their shells through evolution. Losing the protection of a hard shell, most nudibranchs have had to evolve some other means of defense against predators. John Steinbeck, referring to biologist Ed Ricketts in **The Log of the Sea of Cortez**, wrote “He reached under the water and picked up a lovely orange-colored nudibranch and put it in his mouth. And instantly he made a horrible face and spat and retched, but he had found out why fishes let these living tidbits completely alone.” Many nudibranchs, especially those that eat sponges, pick up toxic chemicals from the sponges they eat and store those chemicals in their own bodies, becoming very poisonous or distasteful to predators. At the same time, many nudibranchs have developed bright, easily recognized colors. Many nudibranch watchers believe that these bright colors function as “warning coloration” to protect the nudibranchs from predation. The theory can be simplified to this: When a naive predator, one who has not tried a particular kind of nudibranch before, decides to try one and takes a bite, the distasteful toxins cause the predator to spit the nudibranch out or perhaps even get violently sick from biting it. The negative experience is enough to make the predator remember the bright colors, causing him to avoid similarly colored slugs in the future.

90 05:47 – 05:51 Oceanside West Reef

Nudibranch (*Phyllidia*) crawling slowly over bottom. The nudibranchs in this family eat sponges from which they pick up potent toxins. These toxins are stored in the nudibranch’s body, making the nudibranch itself highly poisonous to eat. These nudibranchs can also secrete these toxins if disturbed, so it is not wise to try keeping them in aquariums. Many nudibranchs will eat only one or two kinds of marine sponges; it may be hard to find the proper sponges and would definitely be hard to keep them alive in an aquarium. If the nudibranch gets upset, as it probably will because it cannot find the correct food and is starving, it may release its toxins and kill everything else in the tank. The toxins of *Phyllidia* also have a powerful and wretched odor, and I guarantee (from personal experience) that you do not want one to release those toxins in an indoor aquarium.

91 05:51 – 05:55 Oceanside Gea

Nudibranch (*Dendrodoris carbunculosa*). This large (about 6 inches long) lumpy rubbery nudibranch is also poisonous to eat. On the right side of the body, you can see the feathery gills extending from the dorsum. These naked gills can be retracted into the body when the animal is disturbed. You can occasionally see this species on Kwaj’s intertidal reef. Be careful handling it; its defensive toxins are also apparently acidic, and can cause painful burning if you rub your eyes after handling the nudibranch.

92 05:55 – 05:59 Oceanside Ennylabegan

Nudibranch (*Glossodoris hikuensis*). Crawling across the sponge encrusted undersurface of a dead coral rock. This nudibranch continually jiggles its gills to help keep a fresh supply of water flowing across them.

93 05:59 – 06:03 Oceanside West Reef

Kunie's nudibranch (*Chromodoris kuniei*). This nudibranch is rare at Kwajalein; the few specimens found were exposed on the reef at 60 feet and deeper on the oceanside drop-off. The gills are waving in the water current on the left side of the spotted body.

94 06:03 – 06:07 Eniwetak Pinnacle

Christmas nudibranch (*Nembrotha kubaryana*) on dead coral. On this animal, the red fringed gills are just to the right of center, on the top. The two protrusions on the left are sensory structures called rhinophores, which are essentially the smelling organs. Odor detection is an important sense to a nudibranch, since this is how food is found. This nudibranch eats dark green colonial tunicates found in ledges and under rocks.

95 06:07 – 06:11 Oceanside West Reef

Green triton nudibranch (*Tritonia*). Nudibranchs in this family eat soft coral similar to that the green, branched nudibranch is crawling over. The nudibranch's head end is on the right, and it is in the process of crawling off the soft coral.

96 06:11 – 06:15 Lagoonside West Reef

Spanish dancer nudibranch (*Hexabranhus sanguineus*). While the pictured individual is only about 5 inches long, members of this species can grow to more than a foot in length. Here it is shown crawling across rocks encrusted with brown, flat, plate-like sea anemones. When disturbed, this species is capable of swimming up off the bottom by bending its body and twirling its thin flowing lateral margins, as shown in the next scene.

97 06:15 – 06:19 Lagoonside West Reef

Spanish dancer nudibranch swimming.

98 06:19 – 06:24 Oceanside West Reef

Jack or ulua (*Carangoides plagiotaenia*). This curious individual decided to take a close look at the photographer. This is a dangerous behavior, since ulua are sought after by spearfishermen. However, ulua in general are not always safe to eat. Many can be infected with a poisoning of reef fish called ciguatera, which can make people very ill and even kill in extreme cases. It would be wise to avoid eating ulua, especially larger ones weighing more than about 10 pounds, and even more especially the one known as the Black ulua, which is most often poisonous.

99 06:24 – 06:28 Lagoonside Bigej-Meck

Yellow spotted ulua (*Carangoides orthogrammus*). A small school passes by the photographer. This species has several yellow spots on each side of its body, a bit difficult to see in the image.

100 06:28 – 06:32 Oceanside West Reef

Adult silver pompano (*Trachinotus blochii*). This relatively uncommon ulua came in for a close look at the photographer.

101 06:32 – 06:36 Oceanside West Reef

Five silver pompano passing by above.

102 06:36 – 06:40 Oceanside West Reef

A dense school of sharpfin barracuda (*Sphyaena acutipinnus*). Despite the barracuda's fierce reputation, this species is harmless to divers. A single black bignose tang (*Naso vlamingi*), swims around in the school near the bottom of the screen.

103 06:40 – 06:49 Oceanside West Reef

School of sharpfin barracuda circles directly above the camera. This was shot from about 80 feet deep, looking straight up.

104 06:49 – 06:57 Oceanside West Reef

Large school of rainbow runner (*Elagatis bipinnulata*) slowly circling around and examining a diver.

105 06:57 – 07:01 Oceanside West Reef

A few rainbow runner silhouetted overhead. In the distance, a school of smaller fish swim upward at right.

106 07:01 – 07:05 Eniwetak Pinnacle

Many, many fish silhouetted against the surface.

107 07:05 – 07:09 Victor Buoy Pinnacle

Small school of blackfin barracuda (*Sphyaena qenie*). This larger species often shows interest in divers.

108 07:09 – 07:13 Victor Buoy Pinnacle

Blackfin barracuda comes in to look at the camera. Barracuda can be somewhat disconcerting, because they are quite curious. They will often hover motionless a short distance away and stare intently at a diver. Although their large pointed teeth are certainly capable of causing serious injury, to my knowledge no diver here has ever been bitten. Fishermen, however, have occasionally taken severe bites while trying to remove a hook from a barracuda's mouth.

109 07:13 – 07:17 Shark City Pinnacle

Three species of the caesionid fish family, sometimes called fusiliers, schooling together over a live coral reef.

110 07:17 – 07:21 Victor Buoy Pinnacle

Green sea turtle (*Chelonia mydas*), coming out of a hole where he had been resting. There are two kinds of sea turtles seen regularly at Kwaj, the green and the hawksbill, which will be shown shortly. Some years ago, a turtle shell was a highly prized keepsake. Now, although the Republic of the Marshall Islands still permits its people to take them for food, to all Americans they are protected and cannot be taken. In fact, all the sea turtles are on the CITES List (Convention on International Trade in Endangered Species) and therefore turtles or their shells cannot be transported from one country to another. Turtle shells or items made from shells will be confiscated if you try to bring them into the U.S., and fines may be assessed. Protection is having a positive effect; green sea turtles in Hawaii, after declining in population and number of nestings for many years, are back on the rise again.

111 07:21 – 07:25 Victor Buoy Pinnacle

Green sea turtle swims out away from the reef.

112 07:25 – 07:29 Victor Buoy Pinnacle

Green sea turtle swims over reef.

113 07:29 – 07:33 Oceanside West Reef

Hawksbill sea turtle resting on the bottom. Hawksbill turtles can be distinguished from green turtles by their much sharper bills, shaped more like that of a hawk. The mottled pattern on the shell is also different.

114 07:33 – 07:39 Oceanside West Reef

Hawksbill sea turtle passing by camera over coral.

115 07:38 – 07:44 Eller Island U Pinnacle

Lots of fish swarming around on a reef slope covered by a dense growth of coral. The fish in the foreground are bluestreak fusiliers (*Pterocaesio tile*). In the background are various other fish, including numerous oval-shaped damsels.

116 07:44 – 07:48 Shark City Pinnacle

School of twinstripe fusiliers (*Pterocaesio marri*) swimming past.

117 07:48 – 07:56 Oceanside West Reef

Large school of blue ulua or bluefin trevally (*Caranx melampygus*) charging up drop-off directly at camera, then swirling around back and forth. The bubbles visible near the end of the sequence are from the fishes' gas bladders. Many fish have an internal organ or bladder that is something like a balloon full of air. The body automatically adjusts the amount of gas in the bladder to keep the fish neutrally buoyant at different depths. As these fish came charging up the reef from deeper water to the top of the drop-off, the gas in their bladder expanded because of the reduced water pressure in shallow water. In many fish, the fish's body must slowly reabsorb the excess gas. In others, such as these ulua, the gas bladder is connected to the gut, so the excess gas can bubble out the same way they get rid of their digestive wastes.

118 07:56 – 07:59 Oceanside West Reef

Large school of rainbow runner (*Elagatis bipinnulata*) swimming around along the drop-off. There are a few black bignose tangs (*Naso vlamingi*) mixed in with the school.

119 07:59 – 08:10 Eniwetak Pinnacle

School of bluestreak fusiliers (*Pterocaesio tile*) swimming in unison. Some appear to be opening their mouths and feeding on plankton as they race along.

120 08:10 – 08:13 Oceanside West Reef

Reef scene with lots of small schooling fish above and a longnose butterflyfish nosing around for food on the bottom.

121 08:13 – 08:17 Oceanside West Reef

Longnose butterflyfish (*Forcipiger longirostris*). This fish has its mouth on the end of an extremely long snout. This allows the fish to get his mouth into small cracks and crevices, and between branches of coral, to get the small crustaceans and other items that make up his diet.

122 08:17 – 08:20 Oceanside West Reef

Lined butterflyfish (*Chaetodon lineolatus*). This grows to be one of the largest butterflies. As it gets larger, it becomes rather shy and difficult to approach.

123 08:20 – 08:24 Lagoonside Ningi

Ornate butterflyfish (*Chaetodon ornatissimus*) swimming around over stalk and other corals. This species is pretty much strictly a live coral eater, and rarely can survive for long in an aquarium.

124 08:24 – 08:27 Oceanside West Reef

Merten's butterflyfish (*Chaetodon mertensii*), pair looking for food on dead coral rocks. Many butterflies, such as these, wander over the reef in pairs.

125 08:27 – 08:31 Oceanside West Reef

Bennett's butterflyfish (*Chaetodon bennetti*). Near the end of the scene, he stops to peck at some live *Porites* coral.

126 08:31 – 08:35 Oceanside West Reef

Threadfin butterflyfish (*Chaetodon auriga*) swims over coral and down.

127 08:35 – 08:39 Oceanside Ennylabegan

Raccoon butterflyfish (*Chaetodon lunula*) under a table coral.

128 08:39 – 08:42 Oceanside West Reef

Pyramid or black faced butterflyfish (*Hemitaenichthys polylepis*). Unlike most other butterflies, this species forms large schools and is a plankton feeder. In the scene, the fish can be seen pecking at something in the water that's not visible to the camera.

129 08:42 – 08:47 Mann Pass Pinnacle

Chevron butterflyfish (*Chaetodon trifascialis*). This is a highly territorial species that strictly eats live coral. Rarely will more than two share a small group of coralheads, and they will defend those coralheads against others of the same species and other coral eating fish of different species. In the sequence, an outsider chevron butterfly entered the territory of an established pair. After a short dancing display of aggression, the outsider leaves the area.

130 08:47 – 08:51 Oceanside West Reef

Double-saddle butterflyfish (*Chaetodon ulietensis*) pair foraging for food.

131 08:51 – 08:54 Oceanside West Reef

Pair of reticulated butterflyfish (*Chaetodon reticulatus*) pecking at a coral bush that has a number of black and white damselfish living in it. The reticulated is another of the strictly coral eating butterflies, and is very difficult to keep in an aquarium.

132 08:54 – 08:57 Oceanside West Reef

Young regal angelfish (*Pygoplites diacanthus*) turns around in a cave. The juveniles of this species are nearly always found in dark caves and ledges. The adult coloration (see the next scene) is quite different.

133 08:57 – 09:01 Oceanside Ennubuj

Regal angelfish, adult coloration, in ledge.

134 09:01 – 09:05 Oceanside West Reef

Emperor angelfish (*Pomacanthus imperator*). The emperor is the largest of the angelfish at Kwajalein. Their normal diet in the wild consists of sponges, but they can learn to eat other foods in a home aquarium. However, most emperors with adult coloration as shown are too large for most home aquariums.

135 09:05 – 09:09 Lagoonside West Reef

Emperor angelfish, juvenile coloration. Young emperors look very different from adults. At Kwaj, juvenile emperors are almost never found in the same areas as the large adults. Juveniles are most often seen in the reef quarries known as the Japanese and American Pools, and occasionally on shipwrecks or small isolated lagoon reefs. As they grow up and change to their adult coloration, they migrate to the oceanside drop-off or lagoon pinnacles where adults tend to live.

136 09:09 – 09:12 Oceanside Gea

Multibar angelfish (*Centropyge multifasciata*). The multibar is a secretive angelfish who prefers to remain in honeycomb cave areas where it is difficult to see. Although we have observed individuals as shallow as 28 feet in surge channel caves, they are more common deeper. They do well in aquariums, but they are difficult to catch and to bring to the surface. Angelfish, and most other fish for that matter, brought to the surface too quickly suffer internal damage from expansion of their buoyancy compensating gas bladder; this damage can kill the fish either right away or within a couple of weeks as the internal organs fail from pressure-related damage. Fish must be brought to the surface very slowly to equalize the pressure. A multibar angel caught at 120 feet, for example, might require 8 to 10 hours of constant attention to be brought to the surface in a healthy state.

137 09:12 – 09:16 Oceanside West Reef

Coral beauty angelfish (*Centropyge bispinosus*). This striking angelfish prefers areas with dead coral rubble on both oceanside and lagoon slopes.

138 09:16 – 09:20 Oceanside Kwajalein, west end

Hybrid pearl scale angelfish (cross between the lemon peel angel, *Centropyge flavissimus*, and the pearl scale angel, *C. vrolikii*). The true pearl scale, which is black in back and gray in front with red around the eye, is rare at Kwajalein. They are so rare that they apparently often cannot find another of the same species with which to mate. However, they are so closely related to the lemon peel angelfish that they are able to interbreed, and they do it often. Hybrids between the two species are relatively common on the reef; they vary in color but are usually yellowish in front, black in back, and blue or red around the eye, and occasionally have scattered small blue spots on the body.

139 09:20 – 09:25 Oceanside West Reef

Flame angelfish (*Centropyge loriculus*). The bright red flame is one of the prettiest little fish on the reef. It is common at the edge of the drop-off on oceanside reefs, and can occur, although rarely, on lagoon pinnacles. They usually live in pairs or small groups and are highly territorial. They will actively chase away intruding flames from other groups. This characteristic, common to other angels and many other territorial fish as well, makes it very difficult to return a fish that has been kept in an aquarium to the reef. For the most part, all the acceptable territories are taken, and any newcomer being released will usually simply be chased by the residents from territory to territory until it is eaten by a grouper, snapper, or moray eel.

140 09:25 – 09:31 Lagoonside Ennylabegan

Bicolor angelfish (*Centropyge bicolor*). Like the flame, the bicolor angel is highly territorial and aggressive towards intruders. In this sequence, a wandering bicolor is chased away by one of the residents. Bicolors are primarily lagoon angelfish, preferring rubbly lagoon slopes and pinnacles.

141 09:31 – 09:37 Oceanside Ennubuj

Multicolor angelfish (*Centropyge multicolor*). The multicolor is a deeper water angelfish found on oceanside slopes. Occasionally they can be seen as shallow as about 60 feet, but are more common down around 100 feet.

The next few sequences show what we call “Disappearing Fish.” These fish, when they feel threatened, dive quickly into holes. The name was coined by Kwaj divers in the early 70s who were attempting to take still photos of the fish. The photographer would slowly ease in on the fish, and just as the camera got close enough and the shutter was snapped, the fish would disappear into the hole, leaving only an image of sand and rubble on the film. Use of small telephoto lenses in underwater housings has made capturing images of disappearing fish much easier.

142 09:37 – 09:40 Oceanside West Reef

Black and white shrimp goby (*Lotilia graciliosa*). This little goby shares a hole with a shrimp (more on this later). In this sequence, the goby bites something on the sand and quickly dives back into the hole.

143 09:40 – 09:44 Eniwetak Pinnacle

Gravel gobbler (*Valenciennesa strigatus*). The gobbler gets its name from its habit of scooping up mouthfuls of sand and chewing it for bits of food while the excess sand drains out the gill openings. They are quite active in aquariums, and when in a nesting phase will dig out burrows and build large mounds of sand from the gravel on the tank’s bottom.

144 09:44 – 09:47 Oceanside Ennylabegan

Blackfin dartfish (*Ptereleotris evides*). Pair dive into hole.

145 09:47 – 09:50 Oceanside Gehh

Firefish (*Nemateleotris magnifica*). Pair diving into hole.

146 09:50 – 09:54 Oceanside West Reef

Helfrich’s firefish (*Nemateleotris helfrichi*). Pair diving into hole simultaneously. The purple Helfrich’s firefish lives in deeper water than its red and white relative in the previous scene. The firefish is common on the reeftop down to about 80 feet, and the helfrich’s take over below that. There is some overlap where both species coexist.

147 09:54 – 09:57 Oceanside West Reef

Tilefish or blue-headed disappearing fish (*Hoplolatilus starcki*). Tilefish live on the oceanside slope at depths of about 60 feet and deeper. Young specimens are all blue.

148 09:57 – 10:00 Oceanside Bigej-Meck

Zebra gobies (*Ptereleotris zebra*). Group of four diving into a hole.

149 10:00 – 10:03 Oceanside Gehh

Pavo razor wrasse or indianfish (*Iniistius pavo*). Swimming away from the photographer over sand dunes.

150 10:03 – 10:05 Oceanside Gehh

Pavo razor wrasse, swimming away from the photographer over sand dunes.

151 10:05 – 10:09 Oceanside Gehh

Pavo razor wrasse, swimming away from the photographer over sand dunes. Disappears into sand at end.

152 10:09 – 10:13 Oceanside Gea

Yellowblotch razor wrasse (*Iniistius aneitensis*), juvenile. Disappears into sand. Razor wrasses have laterally flattened bodies and are capable of diving into and actually swimming through loose sand at the approach of danger.

153 10:13 – 10:16 Oceanside Mann

Celebes razor wrasse (*Iniistius celebicus*). Swims away and dives in an explosion of sand.

154 10:16 – 10:20 Lagoonside Bigej-Meck

Yellowblotch razor wrasse, adult. Disappears into sand.

155 10:20 – 10:23 Lagoonside Bigej-Meck

Yellowblotch razor wrasse, adult. Disappears into sand.

156 10:23 – 10:27 Oceanside Gehh

Multibarréd goatfish (*Parupeneus multifasciatus*) followed by 3-spot wrasse (*Halichoeres trimaculatus*). The goatfish uses his barbels, small tentacle-like feelers attached to his chin, to dig around in the sand looking for crustaceans, worms, and small mollusks to eat. The wrasse is a freeloader; he's waiting for the goat to scare up something, which he'll then try to snag first.

157 10:27 – 10:31 Lagoonside West Reef

Dash & dot goatfish (*Parupeneus barberinus*), pair digging in sand for food. Goats are capable of considerable excavation work. Again, there are some opportunistic freeloading fish waiting around for an easy meal.

158 10:31 – 10:35 Lagoonside Ebwaj

Dragon wrasse (*Novaculichthys taeniourus*). This is close to the adult form. She is digging around in the rubble looking for food items such as small crabs, worms, or mollusks. For a small fish, she can turn pretty big rocks.

159 10:35 – 10:39 Oceanside Gehh

Dragon wrasse juvenile, swimming over coral.

160 10:39 – 10:43 Oceanside Gea

Dragon wrasse juvenile. This one appears to be in the final stages of eating something, probably a shrimp or shrimp shell.

160 10:43 – 10:47 Eniwetak Pinnacle

Blackfin hogfish (*Bodianus loxozonus*). This wrasse is a mollusk eater. In this scene, he is in the process of eating a seashell. After chewing on it, he spits it out and catches it again to try to get a better position for crushing the shell.

161 10:47 – 10:51 Northern Lagoon Pinnacle

Blackfin hogfish, swimming past camera.

162 10:51 – 10:58 Oceanside West Reef

Spitting wrasse (*Hemigymnus melapterus*). This wrasse spends her day biting off mouthfuls of sand and algae, chewing them up to remove anything edible, and spitting out the remnants. Usually after spitting, she will look at the falling debris to make sure she hasn't missed anything. One book says the common name for this one is the blackedge thicklip wrasse; I prefer calling it a spitter.

163 10:58 – 11:00 Oceanside West Reef

Spitting wrasse. Spitting again. This is the female form of this species. As it gets larger, it will turn into a male, changing color to that shown in the next scene.

164 11:00 – 11:02 Oceanside Ennubuj

Spitting wrasse. Spitting again. This is the male color form of this species.

165 11:02 – 11:04 Northern Lagoon Pinnacle

Bigeye or aweoweo (*Priacanthus?*) biting some almost invisible bit of floating debris.

166 11:04 – 11:06 Oceanside West Reef

Poison fang blenny (*Meiacanthus atrodorsalis?*) makes a quick bite at something on the bottom and goes back up.

167 11:06 – 11:10 Oceanside West Reef

Clown triggerfish (*Balistoides conspicillum*). This clown is pulling away some algae, hoping to expose some edible crabs or mollusks.

168 11:10 – 11:14 Oceanside West Reef

Mustache triggerfish (*Balistoides viridescens*). This is a large trigger with big, canine-like teeth. In this and the next few scenes, the fish is using his strong jaw and teeth to break off branches from the top of a bush of live coral. He's attempting to work his way down to the crabs and small fish that live between the branches. When you see bushes of branch coral with the top centers broken out, you can be sure that was done by this fish. Mustache triggers are usually rather shy and stay pretty far away from divers. It was unusual to get so close to this one. The other time you can get close to them is when you don't want to. When these triggers are guarding a nest, they can become very aggressive, charging, and in some cases, ramming or biting divers. Always be alert while diving; if you see one of these triggers darting rapidly around you, it would be best to retreat from the area.

169 11:14 – 11:16 Oceanside West Reef

Mustache triggerfish breaking coral. This shows you cannot be too quick to blame divers and boat anchors for every bit of broken coral out there. There are a lot of these triggerfish on the reef.

170 11:16 – 11:18 Oceanside West Reef

Mustache triggerfish breaking coral.

171 11:18 – 11:20 Oceanside West Reef

Mustache triggerfish breaking coral.

172 11:20 – 11:23 Oceanside West Reef

Mustache triggerfish breaking coral. Looks like he just got the little crab he was after.

173 11:23 – 11:26 Oceanside West Reef

Mustache Triggerfish smacking his lips after finishing a crab snack.

174 11:26 – 11:30 Oceanside West Reef

Clown triggerfish (*Balistoides conspicillum*) swimming past camera.

175 11:30 – 11:34 Oceanside Gehh

Blue-throat triggerfish (*Xanthichthys auromarginatus*). The blue-throat lives on oceanside slopes at depths of 60 feet and deeper. When threatened, they dive into holes in the reef. This is the male form; the female lacks the blue around the mouth and has black fringed fins instead of yellow.

176 11:34 – 11:38 Oceanside West Reef

Orange-spotted or longnose filefish (*Oxymonacanthus longirostris*). Group of six over a bush of coral. These files eat live coral on the reef, but can learn to eat other foods in aquariums.

177 11:38 – 11:42 Mian Pass Pinnacle

Brown filefish (*Cantherhinus dumerilii*), pair, turning to look at camera.

178 11:42 – 11:45 Marita Shoals Pinnacle

Netted leatherjacket filefish (*Aluterus scriptus*). This large filefish (over a foot in length) inhabits lagoon and ocean reefs. Usually they are relatively shy, but this one let the camera approach

very close. They often feed by biting off tips of coral branches, but are also occasionally observed eating passing jellyfish.

179 11:45 – 11:50 Marita Shoals Pinnacle

Netted leatherjacket filefish, eye and mouth.

180 11:50 – 11:53 Oceanside West Reef

Banded pipefish (*Doryrhamphus dactyliophorus*). This 6-inch long fish lives well back in dark caves.

181 11:53 – 11:58 Oceanside Ninni

Spotted boxfish (*Ostracion meleagris*). This is the male form. The females and juveniles are simply black with white spots.

182 11:58 – 12:02 Oceanside West Reef

Yellow puffer (*Arothron nigropunctatus*). This species is usually shades of gray with isolated small black spots. Occasionally, one is decorated by variable zones of yellow.

183 12:02 – 12:06 Oceanside West Reef

Giant or star puffer (*Arothron stellatus*), with small yellow pilot fish swimming around its head. This huge puffer can often be seen swimming off the reef over deep water.

184 12:06 – 12:08 Oceanside Ennubuj

Giant puffer, darker gray coloration than previous scene. The fish is looking right into the camera.

185 12:08 – 12:10 Oceanside Ennubuj

Giant puffer. Close up of the hard, sharp teeth.

186 12:10 – 12:13 Oceanside West Reef

Giant puffer. Looks like his mouth may have been damaged and healed. This one is being cleaned by a cleaner fish (*Labroides dimidiatus*).

The previous scene and most of the next few show instances of cleaning symbiosis. There are a number of fish and even some shrimp that make their living by eating the parasites off the bodies of other fish. While a number of different juvenile wrasses will pick parasites, most of the job here at Kwaj is done by three different species in the fish genus *Labroides*, who spend their entire day going from one fish to another to pick parasites. The fish being cleaned usually seem to enjoy the cleaning, almost as though the touch of the cleaner is pleasurable. Sometimes, however, the cleaner may peck a little too deep, causing some pain. Cleaners always have to be ready to dart away from an injured and angry client. What could make the job a bit more dangerous for the cleaner is the presence of false cleaner fish. There are saber tooth blennies that mimic cleaners; they are colored the same and swim in a similar manner. However, when a client fish comes up to be cleaned, instead of having its parasites picked, the cleaner mimic bites out a chunk of flesh. A client who has been so “betrayed” recently might have a tendency to swallow a clumsy cleaner.

187 12:13 – 12:17 Oceanside Gehh

Whitespotted puffer (*Arothron hispidus*) being picked free of parasites by a cleaner wrasse.

188 12:17 – 12:22 Oceanside Gehh

Porcupine puffer (*Diodon hystrix*), being cleaned. The porcupine puffer can gulp in water and swell up into a balloon covered with hard, sharp spines. It's quite an effective defense.

189 12:22 – 12:25 Oceanside West Reef

Unicorn tang (*Naso annulatus*), being cleaned.

190 12:25 – 12:30 Oceanside Ennubuj

Blue tang (*Paracanthurus hepatus*), being cleaned.

191 12:30 – 12:33 Oceanside West Reef

Sling-jaw wrasse (*Epibulus insidiator*). This peculiar wrasse is able to stretch (“sling”) its jaw out about half the length of its body. This stretching ability is used to snatch food items from crevices and between branches of coral. In this scene, the fish stretched out its jaw because it was being cleaned. At no time during this scene is the jaw completely retracted. (See scene 303 for a completely retracted jaw.)

192 12:33 – 12:37 Oceanside Gehh

Lizardfish (*Saurida gracilis?*), being cleaned by a juvenile cleaner fish.

193 12:37 – 12:41 Oceanside West Reef

Dogtooth tuna (*Gymnosarda unicolor*), swimming by.

194 12:41 – 12:45 Y-Buoy Pinnacle

Dogtooth tuna being cleaned by a pair of large bicolor cleaner fish (*Labroides bicolor*). These particular cleaners are referred to as “obligate;” their entire diet is made up of parasites picked off other fish. The other two cleaner fish species will eat other items as well.

195 12:45 – 12:53 Y-Buoy Pinnacle

Dogtooth tuna stands on its tail and wiggles its fins as it is being cleaned. Near the end, one of the cleaners nips a bit too deep, causing the tuna to jump.

196 12:53 – 12:56 Oceanside West Reef

Trumpetfish (*Aulostomus chinensis*). The trumpet comes in both gray and yellow forms.

197 12:56 – 13:01 Oceanside West Reef

Trumpetfish, yellow form.

198 13:01 – 13:04 Oceanside West Reef

Parrotfish being cleaned.

199 13:04 – 13:08 Lagoonside West Reef

Marbled Grouper (*Epinephelus polyphekadion*), being cleaned by a pair of bicolor cleaner wrasses.

The next few scenes show a symbiotic relationship between several different kinds of fish (gobies) and several different kinds of shrimp. A pair of shrimp, called bulldozer shrimp, spend all day maintaining a burrow in the bottom. They push sand out or carry it out on their flattened paddle-like claws. Although these shrimp do very well underground, their eyesight is poor. Left to themselves, they would be picked off quite easily by some passing predator as they brought up their loads of sand to dump them outside the burrow. Here’s where the goby comes in. The goby has excellent eyesight. It stands guard at the burrow’s entrance. At the approach of obvious danger, the goby dives into the hole, both protecting himself and blocking the shrimp inside so it too will be safe. If you carefully watch these partnerships, both in these sequences and out on the reef, you can see some interesting behavior. If the shrimp is getting ready to come out of the burrow but the goby is not sure it’s safe, the fish will wiggle its tail a bit right in front of the hole, warning the shrimp to stop. Any time the shrimp does come out, it keeps one

of its long, flexible antennae resting on the goby so it can feel if the goby darts away into the hole; the moving goby would cause the shrimp to quickly retreat as well. Each night, the shrimp collapse the hole's entrance to keep out marauding eels; each day, they rebuild it again.

200 13:08 – 13:12 Oceanside Gea

Orange-spotted shrimp goby (*Amblyeleotris guttata*) guarding burrow. A bulldozer shrimp (*Alpheus*) brings up a rock and places it outside the hole.

201 13:12 – 13:22 Oceanside West Reef

Black and white shrimp goby (*Lotilia graciliosa*) with its large bulldozer shrimp (*Alpheus*). The shrimp picks up a small rock on one side of the goby and moves it around to the other. I suppose he thought it looked better over there.

202 13:22 – 13:26 Oceanside West Reef

Black and white shrimp goby with its bulldozer shrimp. The bulldozer pushes a load of sand out the burrow.

203 13:26 – 13:30 Oceanside Gea

Orange-spotted shrimp goby guarding burrow. A bulldozer acts more like a front-end loader here, carrying up a load of sand and dumping it outside the hole.

204 13:30 – 13:34 Oceanside West Reef

Banded shrimp goby (*Amblyeleotris katherine*) with a bulldozer shrimp bringing up a load of sand.

205 13:34 – 13:38 Oceanside West Reef

Banded shrimp goby with a bulldozer shrimp bringing up a load of sand.

206 13:38 – 13:42 Oceanside West Reef

Orange-spotted shrimp goby with a bulldozer shrimp bringing up a load of sand.

207 13:42 – 13:46 Oceanside West Reef

Banded shrimp goby with a bulldozer shrimp bringing up a load of sand.

208 13:46 – 13:54 Oceanside West Reef

Black and white shrimp goby with a bulldozer shrimp bringing up a load of sand, which it tries to place up above the burrow.

209 13:54 – 14:05 Oceanside West Reef

Banded shrimp goby with a bulldozer shrimp pushing sand then retreating. The goby also dives into the hole.

210 14:05 – 14:08 Oceanside West Reef

Banded coral shrimp (*Stenopus hispidus*). These typically nocturnal shrimp usually spend their days in caves and ledges, coming closer to the outside at night to feed.

211 14:08 – 14:11 Oceanside West Reef

Banded coral shrimp, upside down on the ceiling of a cave. It grabs a passing planktonic shrimp and quickly eats it.

212 14:11 – 14:13 Oceanside West Reef

Saron shrimp (*Saron marmoratus*). The long forward appendages with tiny claws on the ends are traits of males of this species; females have short, hairy appendages. The shrimp, including claws, is about 5 to 6 inches long.

213 14:13 – 14:17 Oceanside Ennubuj Island

Anemone shrimp (*Periclimenes brevicarpalis*) on carpet sea anemone (*Stychodactyla mertensii*). The shrimp lives symbiotically with various sea anemones, and is apparently immune to the anemone's sting. It shares the anemone habitat with various clown and damselfish, who also live in the protection of the anemone's stinging tentacles.

214 14:17 – 14:19 Oceanside West Reef

Anemone shrimp on sticky sucker sea anemone (*Cryptodendrum adhesivum*). The shrimp reaches down between the short tentacles with her right claw and grabs some bit of detritus, which she then sticks in her mouth. Most individuals of this anemone will harbor a pair of this species of shrimp, and possibly other commensal shrimp and crabs as well. The female shrimp is the larger of the two, usually at least twice the size of the male. They may inhabit several kinds of anemones. This particular anemone, the sticky sucker, gets its common name from its two most distinctive characteristics: its very short tentacles are extremely adhesive, and when disturbed, it rapidly sucks back into a hole in the reef.

215 14:19 – 14:21 Oceanside West Reef

Bullseye red lobster (*Enoplometopus holthuisi*), backing into its hole at the approach of the camera. This is one of the local true or clawed lobsters. There are at least four different kinds of red lobsters here at Kwaj; the bullseye is one of the most common of them, but it is not often seen. They live deep inside holes and small caves on the oceanside drop-off and in surge channels, and retreat quickly at the approach of divers. The body (without claws) of the pictured individual was about 6 inches long.

216 14:21 – 14:26 Oceanside West Reef

Spiny lobster (*Panulirus versicolor*). This is one of at least three species of spiny lobster inhabiting the reefs around Kwajalein. On the oceanside drop-off, this is the one most often seen. They live in holes or "dens" during the day and emerge to wander over the reef and graze at night. Although the lobsters are not especially common, in some cave complexes there may be many individuals of different sizes, filling all the available nooks and crannies.

217 14:26 – 14:29 Oceanside West Reef

Turquoise kneepad hermit crab (*Dardanus guttatus*). Hermits are the mobile home dwellers of the sea. Unlike most crabs, the hermit's abdomen containing vital organs is soft and delicate, and not protected by the crab's shell. For protection, these crabs back into seashells from which the original mollusk inhabitant has died and disappeared. They drag these often heavy shells around with them everywhere. However, the crabs do grow. The mollusks that created the shell could generally make the shell larger to accommodate growth, but that is beyond the capabilities of the hermit. So when he gets too big for his present mobile home, he has to find another.

218 14:29 – 14:31 Oceanside West Reef

Red hermit crab (*Dardanus megistos*). This is one of the larger hermits out on the Kwaj reefs, so it often has to use some of the largest available shells. Here it inhabits a juvenile giant finger shell.

219 14:31 – 14:34 Oceanside West Reef

Seven-eleven crab (*Carpilus maculatus*). This large crab, named for the pattern of spots on the top of its shell, can grow to 10 or more inches across and has large powerful pincers. The pincers can be used to break apart seashells to get at the animal inside. This individual is

carrying around a shell containing a hermit crab, who is probably destined to become dinner. Or was. A few seconds after this sequence was filmed, the 7-11 crab, disturbed by the presence of the photographer, dropped his meal ticket, which rolled safely away.

220 14:34 – 14:37 Oceanside West Reef

Red crab (*Etisus dentatus*). This is another large crab from the oceanside reefs. In this face-on view, you can see the mouth parts, which are made up of many articulating parts that are actually modified legs. These parts act as the teeth; they are used to crush—essentially chew—their food. In this scene, the crab is chewing something up, and little bits of it are falling from the mouth as fine dust.

221 14:37 – 14:42 ER2 Pinnacle

Tarantula or decorator crab (*Camposia retusa?*). This long-legged small-bodied crab has the look of a tarantula spider when clomping around the reef. The “decorator” common name comes from its habit of covering its shell with sponges, algae, and bits of debris to become very well camouflaged in its natural habitat. These decorations don’t just grow on the shell; the crab actively places them there. A decorator crab maintained in an aquarium will decorate its shell with anything available, including little bits of colored cloth placed in the tank.

222 14:42 14:44 Lagoonside Ebwaj Island

Commensal shrimp (*Periclimenes*) on grape or bubble coral (*Pleurogyra sinuosa*). Like the little shrimp that lives with sea anemones seen earlier, these shrimp are always found around various corals that possess large polyps or tentacles. The tentacles of this coral form a cluster of water-filled balloons around the hard coral skeleton.

223 14:44 – 14:46 Lagoonside Ebwaj Island

Crown-of-thorns starfish (*Acanthaster planci*). The crown-of-thorns gained considerable notoriety during the late 1960s when it was discovered that aggregations of them were killing off large amounts of live coral at Guam and along parts of Australia’s Great Barrier Reef. This starfish eats live coral by crawling over it, extending its stomach out its mouth, and digesting the living coral tissue away, leaving only a pure white coral skeleton. For a few years, some feared that the crown-of-thorns might destroy coral reefs, killing off all the live coral and leaving reefs to slowly sink into the depths. Certainly large aggregations can wipe out a great deal of living coral, but it is now thought that this does not pose a great danger to the reef; new corals begin to settle out on the white skeletons immediately. Indeed, some have even suggested that it might be a healthy phenomenon, doing for the reef what a forest fire can do when it clears out an old thick forest and permits new and more diverse rapid growth and production. But even if this happier scenario is true, it can be disturbing to see lots of these starfish out on the reef devouring the beautiful corals. I’d recommend, however, not trying to kill off the starfish by stabbing or otherwise mutilating them. They regenerate very well, and it is possible that stressing them may only cause them to spawn sooner, which would actually increase the population.

224 14:46 – 14:49 Oceanside West Reef

Crown-of-thorns starfish. Closeup of the end of one of the arms. Starfish move around using tube feet: tentacles tipped with suction cups and powered by an internal hydraulic system. The tube feet extend from the opening in the bottom of the starfish that branches into each of the arms. The thorns that cover this starfish should be avoided. They are sharp and possess a venom is not only very painful but also inhibits blood coagulation. A small puncture wound from

a crown-of-thorns may trickle blood for hours. Serious wounds have put people into the hospital.

225 1449 – 14:51 Lagoonside Ebwaj Island

Red starfish (*Fromia?*). This small star is 2 or 3 inches across. Purists will tell you not to call these animals “starfish” because they are not really fish; you should call them “sea stars” instead. I disagree. If we’re going to get that nitpicky about semantics, we’d better stop using the name dogfish (it’s not a dog) or catfish (it’s not a cat) or lizardfish (it’s not a lizard) or bird wrasse (it’s not a bird) or whale shark (it’s not a whale) and so on.

226 14:51 – 14:54 Oceanside West Reef

Brown starfish (*Linckia laevigata*). This is a pretty large star, probably measuring close to two feet in diameter.

227 14:54 – 14:56 Lagoonside West Reef

Brittle star. Brittle stars are in a different group from the starfish we just looked at, but they are related. You can usually tell a brittle from a normal starfish using a couple of characteristics. Brittle stars usually have a distinct round central disk from which the arms extend; in normal stars, the arms usually (not always) seem to grow right out from the center without a central disk. Also, the arms of brittle stars are usually hard-surfaced but highly flexible and agile; they generally move much more rapidly than a normal star.

228 14:56 – 14:59 Oceanside West Reef

Lumpy sea cucumber (*Thelenota ananas*). Based on their internal anatomy, sea cucumbers are related to starfish and sea urchins. They are little more than a tube that processes sand. They ingest sand at one end, pass it through the tube of their gut, digesting out any potential food items, and dropping mucus-coated piles of sand out the other end. This species is common on shallow reefs.

229 14:59 – 15:01 Oceanside West Reef

Red-lined sea cucumber (*Thelenota rubrilineata*). This sea cucumber is not often seen. It lives on the oceanside drop-off at depths of 100 feet and deeper, where its brilliant red color is apparent only under artificial light.

230 15:01 – 15:03 Oceanside West Reef

Slate pencil sea urchin (*Heterocentrotus trigonarius*). This slate pencil urchin has thick, tough spines used for wedging itself into crevices and around coral on the reef. This helps keep the urchin from being knocked around by the strong surge in the shallow areas where it most often lives.

231 15:03 – 15:06 Oceanside West Reef

Spiral tubeworm (*Spirobranchus giganteus*). The species name here is a little misleading. It may be gigantic for a worm, but it’s still pretty small. These worms live in holes in live or sometimes dead coral. The only parts of the worm exposed are the twin spiral feeding trees, which can be many different colors.

232 15:06 – 15:08 Oceanside West Reef

Spiral tubeworm. The worm can retract the feeding crown in an instant if it senses danger.

233 15:08 – 15:11 Oceanside West Reef

Flatworm (*Thysanozoon*). Flatworms are extremely primitive animals that lack seemingly essential features such as a circulatory system (no blood vessels or heart) and a respiratory

system (no lungs or gills). Yet, like all animals, each cell in its body needs the oxygen that a respiratory system usually captures and a circulatory system distributes to all parts of the body. Flatworms get around needing these systems because they are extremely flat. Each cell in the body is close to the body's surface, and oxygen can reach each cell simply by diffusing in from the surrounding water.

234 15:11 – 15:14 Lagoonside Gugeegue

Yellow tunicate (*Phallusia julinea*) in a field of coral polyps. Tunicates are animals that give up a mobile existence for a quiet, immobile life. They start their lives as small, swimming, almost (but not quite) fish-like animals. As they mature, they find a suitable spot, settle down to the bottom, attach themselves to the substrate, and change their body form dramatically. Ultimately, a growing tunicate becomes little more than a perpetual filter bag with two openings; water is sucked in through one opening, filtered for planktonic food, and pumped back out the other.

235 15:14 – 15:16 R-Buoy Pinnacle

Razor or mushroom coral (*Fungia*). The razor corals are atypical of normal reef corals in two ways. Razors are loose on the bottom rather than cemented to the substrate. Also, razors are usually single individuals, rather than colonial the way most corals are. Razor corals get their name from the sharp, almost blade-like ribs emanating out from the central groove, where the mouth is located. The mushroom coral common name is derived from the way it looks as a juvenile. The loose razor disks start off by growing off the top of a small stalk; the razor on the stalk looks like a small mushroom. After a while, the razor disk drops off and a new one starts growing on the stalk. Since razor corals lie loose on the bottom, surge and currents can often flip them upside down. If they're lucky, they can right themselves by ballooning out their soft tissue enough to flip over.

236 15:16 – 15:19 Marita Shoals Pinnacle

White coral (*Goniopora*). This is a coral with a hard skeleton and elongate coral polyps, the actual animal tissue that makes up the coral organism. Each of these white flowers is a separate coral polyp; they all extend out of the same fused skeleton and together make up the coral colony. Coral colonies grow by budding off new polyps and depositing an ever larger skeleton. Normally, corals get their color from single-celled algae that actually live within the coral tissue. This particular colony is growing in a darkened cave where there is too little light to support the algae, so the algae-less animal shows up pure white.

237 15:19 – 15:21 Oceanside Kwajalein

Green tube coral (*Tubastraea micrantha*). This is a common coral in areas to the west, such as Pohnpei, Chuuk and the Solomon Islands. It is very rare, however, at Kwaj. I have seen only this one bush. It is a difficult coral to photograph; the dark green color of the coral sucks up the light from camera lights, often making the coral look black. Fortunately, the green is visible in this segment.

238 15:21 – 15:24 Tri-Top Pinnacle, Eller

Yellow and pink corals (*Distichopora* and *Stylaster*). The fragile pink coral is common throughout the atoll, usually growing out of direct sunlight in ledges and small caves. The yellow coral can be in ledges, but also grows more exposed to the light. Yellow coral is unevenly distributed at Kwaj. It is not present in the southern lagoon or along the east reef at all. As you

travel northward along the west reef, you start seeing small clumps appearing around Legan Island, both oceanside and on lagoon pinnacles. By the time you get to Nell, it is quite common.

239 15:24 – 15:26 Oceanside Gehh Island

Pink coral (*Stylaster*), on the edge of a small cave ceiling.

240 15:26 – 15:29 Eller Lagoon Pinnacle

Purple coral (*Distichopora fisheri?*). Small light purple colony growing in the space between two reef building corals. Although relate to the fire corals, the purple, yellow, and pink corals shown in the last three sequences do not sting.

241 15:29 15:32 Oceanside Torouji Island

Purple coral, small colony growing in ledge.

242 15:32 – 15:34 Eniwetak Pinnacle

Tree-like soft coral (*Dendronephthya*). This soft coral is not especially plentiful here at Kwaj, but it abounds around some higher islands such as Chuuk, Palau, and the Solomons. Although mostly soft, it is full of small sharp hard spicules that will puncture your skin. Best place to see it at Kwaj is on some lagoon pinnacles that get lots of current, particularly those near passes.

243 15:34 15:37 S-Buoy Pinnacle

Bubble or grape coral (*Pleurogyra sinuosa*) in a small ledge with some red sponge. These soft, balloon tentacles cover a hard skeleton composed of sharp, blade-like plates.

244 15:37 – 15:42 Lagoonside Bigej-Meck reef

Grasping soft coral (*Xenia*). This soft coral continually grasps at the water, probably catching floating plankton for food.

245 15:42 – 15:44 Y-Buoy Pinnacle

Sausage coral (*Euphyllia parancora*). These sausage-shaped tentacles hide a hard coral skeleton.

246 15:44 – 15:48 Oceanside West Reef

Tentacle coral (*Euphyllia glabrescens*). The ball-tipped tentacles of this coral extend from a hard skeleton.

Most of the next few scenes picture sea anemones with their associated anemonefish.

Anemones, like other corals and their relatives, have stinging cells called nematocysts in their tentacles. While most of these nematocysts are not harmful to humans, anemones are able to sting, kill, and eat most small fish. Exceptions with immunity to the anemone's sting are the anemonefish, which consist here at Kwaj of four species of clownfish and one species of damselfish. These fish apparently are able to secrete a mucus coat that prevents the nematocysts from firing, and are therefore able to remain unstung.

247 15:48 – 15:50 Oceanside West Reef

Sea anemone (*Heteractis crispa*) with symbiotic Two-stripe clownfish (*Amphiprion chrysopterus*). This anemone comes in a variety of colors, and its tentacles are often tipped with purple or pink. Also, the clownfish that live in this kind of anemone are a bit different in color than those of the same species who live in the carpet anemone (see the next scene).

248 15:50 – 15:52 Oceanside West Reef

Two-stripe clownfish nestled among the tentacles of a carpet anemone (*Stychodactyla mertensii*).

249 15:52 – 15:57 R-Buoy Pinnacle

Tomato clownfish (*Amphiprion melanopus*) in a sea anemone (*Entacmea quadricolor*). This large clown keeps chasing a juvenile of the same species back between two branches of coral.

250 15:57 – 16:00 Lagoonside West Reef

Three-stripe clownfish (*Amphiprion tricolor*) above its sea anemone (*Entacmea quadricolor*). This clown is quite orange for the species. Usually, they have more black coloration in the face. Sometimes, when they inhabit carpet anemones, this clown is all black and white (see the next scene).

251 16:00 – 16:02 T-Buoy Pinnacle

Three-stripe clownfish in carpet sea anemone (*Stychodactyla mertensii*). Three-stripe clowns in this species of anemone are usually nearly all black and white.

252 16:02 – 16:06 Lagoonside Ennubuj, near Prinz Eugen

Three-stripe clowns juveniles and domino damsels (*Dascyllus trimaculatus*) in a Haddon's sea anemone (*Stychodactyla haddoni*).

253 16:06 16:10 Lagoonside Ebwaj Island

Cauliflower anemone (*Actinodendron arboreum*) retracting into sand, leaving behind associated small cardinalfish and an anemone shrimp. These anemones have sticky tentacles that pack a powerful sting, even to humans. Even the clownfish never live in these.

254 16:10 – 16:13 Lagoonside West Reef

Magnificent sea anemone (*Heteractis magnifica*) with associated skunk clownfish (*Amphiprion perideraion*). These anemones come in a variety of colors, as can be seen in the next few scenes.

255 16:13 – 16:15 Victor Buoy Pinnacle

Skunk clownfish in a blue based magnificent sea anemone.

256 16:15 – 16:18 Victor Buoy Pinnacle

Skunk clownfish in a pink based magnificent sea anemone.

257 16:18 – 16:20 R-Buoy Pinnacle

Skunk clownfish in a magnificent sea anemone with blue-tipped tentacles.

258 16:20 – 16:23 R-Buoy Pinnacle

Skunk clownfish in a magnificent sea anemone with blue-tipped tentacles.

259 16:23 – 16:25 R-Buoy Pinnacle

Skunk clownfish in a magnificent sea anemone with green-tipped tentacles.

260 16:25 – 16:27 Lagoonside Ebwaj Island

Red-tentacled file clam (*Lima*). These tentacles do not belong to a sea anemone but to a clam. Certain groups of clams are characterized by small tentacles around the edge of the shell opening. In the file clams, these tentacles are long.

261 16:27 – 16:32 Lagoonside Ebwaj Island

Red-tentacled file clam. The file clams are active and capable of swimming by flapping their shell valves open and closed.

262 16:32 – 16:34 Oceanside West Reef

Electric clam (*Lima ales*). These file clams, which also have red tentacles, live deep in holes in the reef at depths deeper than 60 feet. When a light shines on them, it looks like they have an

electric arc within the clam. In this clip, the arc is visible near the upper portion of the red clam interior.

263 16:34 – 16:37 Oceanside West Reef

Electric clam with distinct electric arcs. It is really not an electric arc you're seeing here. I believe what you see is a bright white edging of the animal opening that is being waved rapidly back and forth into view, reflecting the camera's lights.

The following series of scenes shows three of the four species of killer clams found at Kwajalein. The first five scenes all show differently colored representatives of the smallest local killer clam. The next two show the intermediate sized fluted clam, while the last five show the true giant or killer clam, which can grow to four feet or more in length. The giant clams are now extremely rare within the Kwaj boating areas. Marshallese prize them for food, and past divers collected them for their shells. However, it should be noted that all members of this family are now on the CITES List (Convention on International Trade in Endangered Species), and it is illegal to transport their shells between countries. That means that if you collect one, you will not be allowed to bring it back into the U.S. once you leave here. And in truth, these things look a lot prettier when they contain an animal and are sitting out on the reef than when they are empty and in someone's front yard.

264 16:37 – 16:39 Oceanside Mann Island

Small killer clam (*Tridacna maxima*). These are the most abundant of the killer clam family here at Kwaj. They are commonly seen embedded in hard reef rock and have multicolored mantles. It is also the smallest of the local killer clams, attaining a maximum size of about 10 inches or less. They vary considerably in color, this one showing blotches of black, tan, and light purple. You can nearly always distinguish a *Tridacna maxima* from the other species of killer clam by one feature of its color pattern. Look at the very edge of the animal, right near where it meets the scalloped edge of the shell. If this is ornamented with a series of squarish black spots, it is *Tridacna maxima*. Sometimes the spots are hard to see, especially on a dark background, but they are usually present.

265 16:39 – 16:41 Oceanside Gehh Island

Small killer clam with green, black, and yellow coloration.

266 16:41 – 16:45 Oceanside West Reef

Small killer clam mostly blue and black embedded in a colony of live coral (*Porites rus*).

267 16:45 – 16:48 Oceanside Torouji Island

Small killer clam that is mostly black with iridescent blue dots within.

268 16:48 – 16:50 Oceanside West Reef

Small killer clam mostly green and black in coloration.

269 16:50 – 16:52 Northern Lagoon Pinnacle

Fluted clam (*Tridacna squamosa*). Fluted clams have distinct curved plate-like flutes along the ribs on the shell that are much larger than the flutes of any of the other Kwaj species. Unlike the small killers, they do not embed themselves into the reef rock; if they attach at all, it is only by fibrous threads called byssus. Often, especially as the shells get larger, they do not attach at all and simply rest on the bottom. The distinguishing color pattern character that distinguishes fluted clams is the presence of round or oval spots (not tiny rings) on the mantle. Sometimes these

stretch out into bands, but they are never thin iridescent blue or green rings. The one pictured here has yellowish dots.

270 16:52 – 16:55 Eniwetak Pinnacle

Fluted clam decorated with greenish dots.

271 16:55 – 16:57 Oceanside Gehh Island

Giant clam (*Tridacna gigas*). These are the ones that can grow to four feet or more in length. When juveniles, they are attached to the reef, but as they get larger, they let loose and just rest on the substrate. These big clams are the ones that give the killers their common name; it was once feared that a clam could close its jaws on an unsuspecting swimmer or reefwalker and hold him down until he drowns. In fact, this is extremely unlikely. However, they are dangerous in that the edges of the shell can be very sharp and are capable of causing deep cuts if handled incorrectly. The color pattern character that distinguishes giant clams from the others is the typical presence of bright iridescent blue or green rings in the mantle. In this scene, a yellow wrasse swims over the open clam shell.

272 16:57 – 17:00 Northern Lagoon Pinnacle

Giant clam. A very large tan-colored specimen rests on the slope of a lagoon pinnacle.

273 17:00 – 17:03 Northern Lagoon Pinnacle

Giant clam. A wrasse swims over a 3-foot long clam.

274 17:03 – 17:06 Northern Lagoon Pinnacle

Giant clam. A large green and dark green individual who happened to be only a few feet away from the tan colored one shown in the scene before last.

275 17:06 – 17:10 Eniwetak Pinnacle

Giant clam. A distance shot of a large individual among live corals on a shallow reef.

276 17:10 – 17:15 Eniwetak Pinnacle

Electric blue damsels (*Pomacentrus coelestis*) and other fish among the corals on a shallow lagoon pinnacle reef.

277 17:15 – 17:18 Lagoonside West Reef

Various damselfish and wrasses near a colony of the gorgonian locally called “black coral.” This is not the true black coral from which black coral jewelry is made; this stuff is too porous to acquire a good enough shine. Once the brown outer covering is removed, it leaves a somewhat attractive black, shiny skeleton. However, when you show it to stateside friends, they ask what you’re doing with a dead bush. Ultimately, the bush ends up in the basement where it slowly turns brittle and disintegrates. This black coral was once abundant on oceanside reefs and on pinnacles, but it was extensively collected by divers on club dive boats during the 60s. Now it is relatively uncommon in the boating areas; fortunately, it is still plentiful in the northern part of the atoll.

278 17:18 – 17:22 Shark City Pinnacle

Green damselfish (*Chromis viridis*) clustered above and below a colony of table coral (*Acropora*).

279 17:22 – 17:26 Lagoonside West Reef

Green damselfish around branch coral (*Pocillopora eydouxi*). If you look closely, you can see some males with elongate back pectoral fins (side fins) swimming purposefully around and erecting their dorsal fins in courtship display. I’m sure the females are impressed.

280 17:26 – 17:33 Lagoonside Ebwaj Island

Green damselfish above colonies of branch coral (*Pocillopora* and *Goniopora*). The fish are being repeatedly startled into darting back toward the protection of the coral branches. However, they keep regaining their courage and coming back out again.

281 17:33 – 17:36 Oceanside West Reef

Banded damselfish (*Dascyllus reticulatus*) schooling around a bush of branch coral (*Pocillopora eydouxi*).

282 17:36 – 17:40 Lagoonside West Reef

Black-tipped damselfish (*Chromis lepidolepis*) over bubble coral (*Pleurogyra sinuosa*).

283 17:40 – 17:43 Oceanside West Reef

Golden damselfish (*Amblyglyphidodon aureus*) opens his mouth to yawn at the camera. I guess the photographer must have been pretty boring.

284 17:43 – 17:46 Oceanside West Reef

Dick's damselfish (*Plectroglyphidodon dickii*) darting among the spikes of a colony of *Acropora* coral.

285 17:46 – 17:49 Oceanside West Reef

White-tailed damselfish (*Chromis xanthurus*) with lots of purple fairy basslets (*Pseudanthias pascalus*) in the background.

286 17:49 – 17:51 Lagoonside Ebwaj Island

Blue damselfish (*Pomacentrus pavo*) with a single juvenile scopas tang (*Zebrasoma scopas*), near a colony of *Porites rus* coral on which is growing some blue-gray sponge (*Cribochalina olemda*).

287 17:51 – 17:55 Oceanside West Reef

Purple fairy basslets (*Pseudanthias pascalus*). These are males displaying at each other with their red dorsal fins.

288 17:55 – 17:59 Oceanside West Reef

Purple fairy basslets (*Pseudanthias pascalus*), small school of juveniles in an oceanside drop-off ledge.

289 17:59 – 18:02 Oceanside West Reef

Bartlett's fairy basslet (*Pseudanthias bartlettorum*) schooling over the coral *Porites rus*. The larger specimens swimming around in front are the males. This species was named for Nate and Pat Bartlett, Kwaj residents in the late 60s through mid 70s, who, through their excellent fish photography, brought this previously undiscovered fish to the attention of scientists.

290 18:02 – 18:06 Oceanside West Reef

Dispar fairy basslets (*Pseudanthias dispar*) emerging from a hole in the reef to look around.

291 18:06 – 18:10 Oceanside West Reef

Axilspot hogfish (*Bodianus axillaris*). This is the juvenile coloration of a wrasse that changes drastically as it matures. The adult is reddish brown on the front half and white on the rear with black spots at the base of the pectoral fins. (It looks a little like the different but related species shown in the next scene.) Juvenile axilspots live in dark ledges and caves; when you see them without an artificial light, it often looks like just a group of moving white spots.

292 18:10 – 18:13 Oceanside West Reef

Lyre tail hogfish (*Bodianus anthioides*). The lyre tail tends to inhabit deeper oceanside reefs below 60 feet. They are often found, especially the young ones, around the bushy gorgonians growing on the slope, such as those visible in the video. Although popular in aquariums, larger specimens in particular are difficult to bring to the surface; it takes them considerable time to equalize the pressure in their gas bladders, and bringing them up too quickly will usually kill them.

293 18:13 – 18:17 Lagoonside West Reef

Raccoon wrasse (*Hemigymnus melapterus*). This is the juvenile of the spitting wrasse shown earlier (scenes 162 - 164). These juveniles prefer shallow coral reefs such as those right off the shore in the Kwaj ski boat area or behind islands along the lagoonside of the east reef.

294 18:17 – 18:21 Oceanside West Reef

Pigmy wrasse (*Wetmorella nigropinnata*). You never see very much of this wrasse. It lives in dark honeycombed ledges and caves on the oceanside drop-off and surge channels. To see one, you usually have to surprise it: come quickly and quietly up to a dark surge channel honeycomb, then turn on your flashlight and look quickly around. By then, the fish is usually easing back into the tiny honeycombs, where it rapidly disappears.

295 18:21 – 18:27 Oceanside West Reef

Peacock flounder (*Bothus mancus*). Flounders are bizarre fish that have evolved to live with one side flat on the bottom. In the evolutionary process, the eye that would have been dragging along the sand and rocks migrated to the other side, so now both are on the “top” of the fish. They can change color rapidly and are often difficult to see on a typical sand or rubbly bottom.

296 18:27 – 18:29 Oceanside West Reef

Peacock flounder coming in for a landing.

297 18:29 – 18:32 Oceanside West Reef

Peacock flounder, close of eyes and mouth.

298 18:32 – 18:36 Oceanside West Reef

Humphead wrasse or napoleon wrasse (*Cheilinus undulatus*). The humphead is the largest wrasse and one of the largest fish you’ll see on the reefs. They are wary and keep their distance from divers, but will sometimes watch a diver from far away. They typically eat mollusks, whose shells they crush in powerful jaws, but are also reported to prey upon other items, such as crown-of-thorns starfish.

299 18:36 – 18:39 North Loi Pinnacle

Sixbar wrasse (*Thalassoma hardwicke*). During the day, this fast moving wrasse never seems to rest.

300 18:39 – 18:43 Lagoonside Ebwaj Island

Chomper fish or red breasted wrasse (*Cheilinus fasciatus*). The identification is questionable. It looks like what a juvenile chomper should look like, but I’m not certain.

301 18:43 – 18:47 Victor Buoy Pinnacle

Chomper fish or red breasted wrasse. The chomper was given its local common name by seashell hunting divers back in the 60s. The wrasse has a habit of following divers around waiting to take advantage of any potential food items the diver may dislodge. When the diver turns over a rock to look for shells underneath, the chomper is there, ready to nab anything it

can. More than one shell collector has had a prize snatched away by a chomper. The ones on lagoon pinnacles seem far more aggressive than their oceanside counterparts.

302 18:47 – 18:51 Lagoonside Ebwaj Island

Sling-jaw wrasse (*Epibulus insidiator*). This is the juvenile of the sling-jaw figured in the next scene (and in scene 191). As you can see, the color changes considerably as the fish ages.

303 18:51 – 18:54 Oceanside West Reef

Sling-jaw wrasse, adult.

304 18:54 – 18:58 Oceanside West Reef

Red or clown wrasse (*Coris gaimard*). The red wrasse is a juvenile of the yellowtail wrasse shown in the next sequence. It's a popular aquarium fish, but like many wrasses, requires relatively fine or loose sand in which to bury at night.

305 18:58 – 19:02 Oceanside West Reef

Yellowtail wrasse (*Coris gaimard*). This is the adult of the previous species. Like many wrasses, it changes in color dramatically from juvenile to adult. You can frequently see intermediates, where the red with white saddle pattern of the juvenile begins to be overlaid with the blue spots of the adult.

306 19:02 – 19:05 Oceanside West Reef

Needlefish (*Strongylura*) usually school near the water's surface. This scene was shot from below looking up.

307 19:05 – 19:07 Victor Buoy Pinnacle

Needlefish, closer but still looking up.

308 19:07 – 19:10 Victor Buoy Pinnacle

Needlefish, closer, looking from the side as the school passes by.

309 19:10 – 19:13 Oceanside West Reef

Coronetfish (*Fistularia commersonii*). This is an elongate fish with a whiplike tail. It lives on both oceanside and lagoon reefs.

310 19:13 – 19:16 Oceanside West Reef

Blue tangs (*Paracanthurus hepatus*). This pair has been grazing on the algae covered branches of dead coral. The blue tang is rare and sporadically distributed at Kwaj. You can always see a few large adults at the top of the oceanside reef midway between Sar Pass and Ennubuj. Rarely, one might be seen lagoonside along the same reef.

311 19:16 – 19:20 Oceanside West Reef

Chevron tang (*Ctenochaetus hawaiiensis*), pecking algae from rocks. This is a juvenile that turns into a rather nondescript mostly black tang. The drab adults are common but the attractive juveniles are rare.

312 19:20 – 19:24 Oceanside Gehh Island

Yellow tang (*Acanthurus*). This "yellow tang" is actually just a color form of a mostly black tang. Some of the juveniles of this species are yellow instead of black. Usually, they slowly turn black as they get older. Some, however, turn black in blotches, as seen in the next scene.

313 19:24 – 19:27 Oceanside West Reef

Calico tang (*Acanthurus*). As an adult, this tang is mostly black. Juveniles are sometimes all yellow. Some of these yellow juveniles, while changing to black as they get older, do so in a

splotchy pattern that varies from one fish to the next. The pattern changes over time, with the black covering more and more of the body as the fish ages.

314 19:27 – 19:31 K9 West Pinnacle

Foxface rabbitfish (*Siganus vulpinus*). These rabbitfish are typically seen only in the lagoon, usually on pinnacle reefs.

315 19:31 – 19:35 Oceanside West Reef

Whitecheek tang (*Acanthurus nigricans*). A common mostly black tang shown here crossing a colony of the coral *Porites rus*.

316 19:35 – 19:38 Oceanside West Reef

Bignose unicorn (*Naso vlamingii*). This large tang is common on some pinnacles and oceanside reefs. Normally dark in color, it flashes bright blue when courting females. In this sequence, a blue bar beneath the eye turns dark as it goes out of its courting behavior.

317 19:38 – 19:42 Oceanside West Reef

Bignose unicorn. This one is flashing some of its courting colors, making the front half of the body light.

318 19:42 – 19:45 K9 Pinnacle

Jellyfish (*Crambione mastigophora*). Large groups of these 6-inch diameter jellyfish tend to drift around together. Occasionally, they end up here in the southern Kwaj lagoon, where they wash ashore on the beaches in large numbers. Although this species has been reported to have a strong sting, that does not seem to be the case here; still, it would be wise to avoid contact with bare skin.

319 19:45 – 19:50 K9 Pinnacle

Jellyfish approaching the camera and turning.

320 19:50 – 19:55 Victor Buoy Pinnacle

Jellyfish rising into the sun.

321 19:55 – 20:01 Oceanside Ennubuj Island

Snorkeler passing by overhead with the sun's rays coming down.

322 20:01 – 20:04 Oceanside West Reef

Black coral (*Rumphella*). This is not the same black coral that jewelry is made from; the other one is only a very distant relative. *Rumphella* has a brown coating of animal tissue surrounding a deep black skeleton. This skeleton is not sufficiently dense or hard enough to polish up into jewelry. Frankly, I think it looks nicer out on the reef.

323 20:04 – 20:07 Oceanside West Reef

Blacksaddle mimic filefish (*Paraluteres prionurus*). This harmless filefish closely resembles the highly poisonous sharpnose puffer shown in the next sequence. Since the poisonous puffer is relatively common and very toxic, predators quickly learn to avoid them. Since the file and puffer look so much alike, predators cannot tell the difference, therefore avoid both. In this way, the file, although harmless and quite edible, freeloards on the immunity from predation that the puffer receives by being poisonous.

324 20:07 – 20:10 Oceanside West Reef

Blacksaddle sharpnose puffer (*Canthigaster valentini*). This is the poisonous puffer mimicked by the filefish shown previously.

325 20:10 – 20:13 Oceanside West Reef

Spotted sharpnose puffer (*Canthigaster solandri*). This is the most common of the sharpnose puffers and is also extremely poisonous. It can even be poisonous to land animals. One of these puffers once jumped out of a home aquarium, and a cat who simply picked it up in his mouth nearly died just from the poisonous secretions on the puffer's skin. If you have pets or small children, I'd recommend not keeping any of the sharpnose puffers in a home aquarium.

326 20:13 – 20:16 Victor Buoy Pinnacle

School of squid (*Sepioteuthis lessoniana*). These squid live near the surface of the water, but can often be found around reefs where they deposit their eggs.

327 20:16 – 20:20 Victor Buoy Pinnacle

Several squid close up.

328 20:20 – 20:26 Northern Lagoon Pinnacle

Octopus (*Octopus cyanea*) swims by and comes to rest on a rock.

329 20:26 – 20:32 Northern Lagoon Pinnacle

Octopus engaging in "ballooning" behavior. This probably has something to do with courtship, or perhaps with predator intimidation. Note the dark-colored grouper following the octopus around. I'm not sure if the grouper expects to try to dine on part of the octopus, or if it is waiting for the octopus to scare some small fish or crustacean out of its hole.

330 20:32 – 20:38 Northern Lagoon Pinnacle

Pair of mating octopus, the female continuing the "ballooning" behavior. When octopus mate, the male (on the right here) delivers a sperm packet through the female's gill opening using one of its arms.

331 20:38 – 20:43 Northern Lagoon Pinnacle

Pair of octopus, breaking off their mating with the female swimming away. The males often exhibit this lumpy texture during mating.

332 20:43 – 20:49 Oceanside Gehh Island

Octopus moving onto an old table coral and changing color instantly to try to blend in. "Don't look at me, I'm just a rock."

333 20:49 – 20:53 Oceanside Gehh Island

Octopus swimming away, flashing a "skunk stripe" as he lands and stretches out his arms.

334 20:53 – 21:07 Oceanside Gehh Island

Octopus. This time he must be trying to communicate with the photographer. In fact, those color changes look to me like he's saying "Hey, leave me alone!"

335 21:07 – 21:14 Oceanside West Reef

Stonefish (*Synanceia verrucosa*). It's tough to see this guy until he starts to move. This is the real stonefish. Many of the fish people think are stonefish are in fact simply a kind of scorpionfish—venomous, yes, but not nearly so virulent as this one. A bad sting from a true stonefish has been reported to cause intense pain, unconsciousness within seconds, and death within minutes. All of the spines on these fish are venomous. Fortunately, it takes a bit of pressure on the spine to cause the venom to be injected into a wound. The sacs containing the venom are in bulbs at the base of the spine. As the spine enters a wound (for example, if someone is stepping on it), the thick sheath of tissue around the spine is forced down, squeezing the venom bulb and causing venom to shoot up the spine and into the wound. A light prick of the spine on a finger may cause no reaction at all—and I should know, since I've done that

twice. These things often live in very shallow water. I have seen several around the shoreline at the Small Boat Marina, and even one in less than a foot of water at the edge of the boat ramp. Always wade carefully.

336 21:14 – 21:19 Oceanside Gea Island

Stonefish are the most insidious of hunters. Not only is the body extremely well camouflaged, but they can hide even that by burying it completely beneath the sand, leaving only the eyes and mouth exposed. When a hapless fish wanders along next to this innocent looking pile of rubble, the mouth opens rapidly and the fish is sucked into the gaping maw and devoured. It's a slurp gun more effective than any ever devised by an aquarium fish collector. In this scene, the mouth is on the right. Look for the eye.

337 21:19 – 21:22 Oceanside Gea Island

Stonefish. Same individual as the previous scene, with some of the sand swept away. Now he is buried only to the cheeks.

338 21:22 – 21:25 Oceanside Gea Island

Stonefish. Same individual as the previous two scenes, with more of the sand swept away. Now he is buried to the gills.

339 21:25 – 21:30 Oceanside Gea Island

Stonefish. Same individual as the previous three scenes, after he has been dug out of his hole. He is slowly hopping away by sucking water into his mouth, closing the mouth, and forcing the water out his gill openings in a kind of jet propulsion.

The next eight scenes show all five of the different species of lionfish inhabiting the waters around Kwajalein. Lionfish all have venomous dorsal spines whose sting can cause excruciating pain and (rarely) even death in humans. The venom is stored in sacs within the flag-like tissue that surrounds the spines. When the spine punctures the flesh of a diver, the fragile tissue tears as the spine enters, causing the venom to leak out into the wound. I know from personal experience that the venom causes pain; but in addition to this, it has been reported to be able to interfere with breathing. So if you're ever stung while diving, it would be prudent to get out of the water as soon as possible.

340 21:30 – 21:33 Oceanside West Reef

Fu manchu lionfish (*Dendrochirus biocellatus*). The fu manchu (also called the two-spot lionfish) derives its preferred common name from the fleshy barbels that extend down from each side of his upper jaw, looking somewhat like a fu manchu mustache. This lion usually hides during the day, emerging at night to feed, probably on small fish and shrimp.

341 21:33 – 21:36 Oceanside West Reef

Zebra lionfish (*Dendrochirus zebra*). This species and the fu manchu are the only two Kwaj lionfish with large, paddle-like pectoral (side) fins; those fins in the other three species are more drawn out into long rays. Although the zebra can be found in the same oceanside caves and ledges inhabited by the other lionfish, it is more common on shallow lagoon reefs such as that off Ebwaj or Bigej.

342 21:36 – 21:39 Oceanside Gehh Island

Clearfin lionfish (*Pterois radiata*). You can easily distinguish this lion from the next species by its tail; in the clearfin the tail is mostly clear, while in the spotfin, it's mostly spotted.

343 21:39 – 21:42 Oceanside West Reef

Spotfin lionfish (*Pterois antennata*). Lionfish are all predators upon living fish and shrimp. In an aquarium, they usually need to be provided with live food. Sometimes, with luck and considerable effort, you can teach one to eat dead food such as pieces of fish or shrimp.

344 21:42 – 21:45 Oceanside West Reef

Spotfin lionfish, close-up of head.

345 21:45 – 21:48 Oceanside Eller Island

Turkeyfish (*Pterois volitans*). The turkeyfish grows to be the largest of the lionfish, and has long, frilly pectoral fin rays and dorsal spines. The young ones, such as the one pictured, tend to have more elaborate fins for their body size than the elders. Large specimens commonly hang around some of the shipwrecks, where they feast on the numerous clear cardinalfish that congregate there. The turkeyfish may well be the most venomous of the lionfish at Kwaj; it would be wise to try to avoid being spined.

346 21:48 – 21:51 Lagoonside Ebwaj Island

Turkeyfish, a bit larger than the one in the previous scene.

347 21:51 – 21:54 Oceanside West Reef

Turkeyfish, large specimen nicely framed against blue water.

348 21:54 – 22:00 Oceanside West Reef

Leaffish (*Taenionotus triacanthus*). The leaf is a peculiar little scorpionfish. It is very laterally flattened, so that head on, it looks like little more than a sheet of paper with its two wide pectoral fins sticking out to prop it up. Even in areas with little current or surge, it tends to just sit on the bottom waving back and forth like a leaf or sheet of algae caught in a current. It blends into its surroundings very well, and when an ignorant little fish ventures too close, the leaf opens its large mouth and swallows it whole.

349 22:00 – 22:06 Oceanside West Reef

Leaffish come in several colors, including this red one and the yellow one we just saw. They can also be dark brown or white. Although not visible in these two scenes, leaffish have the most interesting eyes of all the fishes. Their pupils look like little mirrored pools.

350 22:06 – 22:09 Oceanside Gea Island

Arc-eye hawkfish (*Paracirrhites arcatus*). These hawks spend most of their time resting on coral or some other outcrop. This one is resting upside down on a colony of pink coral growing on a cave ceiling.

351 22:09 – 22:12 Oceanside West Reef

Freckled hawkfish (*Paracirrhites forsteri*). Like the previous hawk, this one spends most of its time sitting on colonies of coral.

352 22:12 – 22:15 Oceanside Gehh Island

Longnose hawkfish (*Oxycirrhites typus*). This pretty “plaid” fish lives on gorgonians and black corals relatively deep on the drop-off, usually 100 feet and deeper. It has also been occasionally spotted on some of the lagoon shipwrecks.

353 22:15 – 22:19 Oceanside Gehh Island

Longnose hawkfish, using natural light at about 120 feet down.

354 22:19 – 22:25 Lagoonside West Reef

Marbled grouper (*Epinephelus polyphemadion*). This is a fairly large species of grouper, and in unfished areas, is quite common. It is fairly trusting, and can often be approached quite closely. Unfortunately, in areas where spearfishing is common, this trusting behavior is often its demise, as it is easily speared. However, it occasionally gets partly even with the spearfisherman by making him deathly ill; **Micronesian Reef Fishes** reports that in the Marshall Islands, this kind of grouper is one of the most frequently reported fish causing ciguatera poisoning. In this scene, the camouflage coloration of the grouper keeps it almost unseen behind the schooling cardinalfish until it finally moves.

355 22:25 – 22:28 Lagoonside West Reef

Marbled grouper, same individual as in previous scene. This large fish allowed me to approach within inches of his head to shoot this sequence.

356 22:28 – 22:31 Oceanside West Reef

Spotted grouper (*Epinephelus?*). Grouper looking back at the camera from a small ledge.

357 22:31 – 22:34 Oceanside Gehh Island

Sharp-nose grouper (*Anyperodon leucogrammicus*). Sometimes called the white-lined grouper, even though it does not always have white lines. This one is breathing heavily in a small cave.

358 22:34 – 22:36 Northern Lagoon Pinnacle

Saddleback grouper (*Plectropomus laevis*). This grouper comes in the pictured color form as well as a dark form with blue spots and the hint of the saddles still visible. It gets quite large, but tends to be a bit shy of divers. Like the marbled grouper, this fish feeds on other reef fish and consequently can often cause ciguatera poisoning if eaten.

359 22:36 – 22:39 Oceanside West Reef

Black-tipped grouper (*Epinephelus fasciatus*). Looking head on in cave. The common name refers to the black tips of the dorsal fins.

360 22:39 – 22:41 Oceanside West Reef

Black-tipped grouper. Shot from the side.

361 22:41 – 22:48 Kwajalein Atoll

Giant grouper (*Epinephelus lanceolatus*). This is the big one. The giant grouper can grow as large as 8.5 feet long. This one reached 6 feet and looked like he could swallow the photographer whole. It is a magnificent fish, but the species is unfortunately in trouble. As Robert Myers states in **Micronesian Reef Fishes**, “In many places, it has all but disappeared, due primarily to the thoughtless efforts of a few overzealous spearfishermen. Large individuals may be ciguatoxic, and their flesh is of inferior quality, so there is little justification for their slaughter. Since they take decades to grow, and juveniles are rare to begin with, there is little chance of giant individuals reappearing in unprotected areas.” Let’s hope we can keep a few here.

362 22:48 – 22:53 Oceanside West Reef

Clown triggerfish (*Balistoides conspicillum*). A pair pass each other on the reef.

363 22:53 – 22:56 Oceanside West Reef

Pink-tailed triggerfish (*Melichthys vidua*). The pink-tail is a kind of shy trigger that often dives into holes in the reef (or sometimes backs in) at the approach of a diver.

364 22:56 – 22:59 Oceanside West Reef

Green-lined triggerfish (*Balistapus undulatus*).

365 22:59 – 23:02 Lagoonside West Reef

Humuhumu or picasso triggerfish (*Rhinecanthus aculeatus*). This distinctly marked trigger lives on shallow reefs. The full Hawaiian name for this beast is Humuhumu-nukunuku-a-pua'a.

366 23:02 – 23:06 Oceanside West Reef

Sickle triggerfish (*Sufflamen bursa*). This is a very young specimen trying to figure out which way to go to escape from the camera.

367 23:06 – 23:09 Lagoonside West Reef

Halfmoon triggerfish (*Sufflamen chrysoptera*), diving into the safety of a hole in coral at the approach of the photographer.

The next series of scenes shows various kinds of eels found at Kwajalein. Eels range from harmless plankton eaters to voracious predators. The predators, particularly the ones that eat fish, tend to have long jaws and numerous long sharp teeth. Eels do not eat prey as large as humans, so bites on divers are rare. Most bites are cases of mistaken identity, and happen when a diver places his hand in the wrong place or reaches into a dark hole that an eel happens to be in. The eel probably thinks he's getting a nice tasty fish and only finds out after the bite that the "fish" is attached to a much larger body. Bites I've seen have consisted of the eel biting a hand and pulling, often ripping the long sharp teeth through the flesh as it pulls back into its hole, shredding the skin in the process. Usually they let go when they find their prey is too large, but by then the diver has a pretty nasty wound, one that is said to be quite susceptible to infection. **Always** look where you put your hands, especially if you're reaching into that small cave for the golden cowry plastered on the back wall. An eel might be waiting. One of the biggest dangers from eels, though, comes from eating them. Eating moray eel flesh very often causes ciguatera poisoning. I remember hearing that a bad case of ciguatera was the cause of death of a number of people at Midway Island some years ago, after they feasted on a large moray. Never, ever, eat moray eels from this area. Eating them is a case of Russian roulette. You might get away with it once or even several times, but if you keep eating them, you will get ciguatera.

368 23:09 – 23:15 Oceanside Legan Island

Garden eels (*Gorgasia*), one emerging from its burrow. Garden eels always live in holes in the sand. Fields of them can be seen at a distance extending upwards from the burrow and waving around. They are picking off bits of plankton that float by. As a diver approaches, the eels sink down into the sand, leaving little trace. Sometimes, if you're patient and motionless, the eels will find the courage to rise up a bit from their holes while you're still quite close.

369 23:15 – 23:20 Oceanside Mann Island

Field of garden eels, waving around as they snatch plankton from the water.

370 23:20 – 23:24 Oceanside Gehh Island

Ribbon eel (*Rhinomuraena quaesita*). This is the tiny juvenile of a long slender eel that turns bright blue as an adult (although the oldest adults become yellow).

371 23:24 – 23:29 Lagoonside West Reef

Yellow-margined moray eel (*Gymnothorax flavimarginatus*), extending from underneath dead coral decorated with red sponge. The orange-yellow margins on this eel are on the fins, back a bit from the head and not visible in this picture.

372 23:29 – 23:34 Shark City Pinnacle

The giant moray (*Gymnothorax javanicus*) is the largest eel in the atoll. It is difficult to tell just how long an individual is because it rarely emerges completely from its hole. However, in other places, eels nearly 8 feet long have been captured, and individuals up to 10 feet reported. Although large and fierce-looking, the giant moray tends to have a somewhat mellow disposition. I know one diver who accidentally rested his elbow on a giant moray's head with no ill effects. In other areas, giants have been fed by divers and even learn to be safely handled. However, it's not something I'd recommend here unless you **really** know what you're doing. These morays are capable of very nasty bites. One scientist collecting fish using a poison station on Johnston Atoll found one of these, a very large one, lying apparently dead of the poison on the bottom. For safety, he speared it before attempting to collect it. Turned out the eel was not dead and the spear enraged it. It twisted itself off the spear and went for the scientist, who by this time was backpedaling on snorkel. He said he felt the eel sweep up his body. At the last minute, he put his arm in front of his face and the eel struck (apparently at his head), opening deep gashes in his elbow and requiring, if I remember correctly, over a hundred stitches. After delivering this "lesson," the eel swam off.

373 23:34 – 23:39 Oceanside West Reef

Giant moray. Part of the ferocious appearance of eels is the continual opening and closing of the mouth, revealing the long sharp teeth. But they're not threatening you; they are simply breathing, sucking water into the mouth and squeezing it out past the gills.

374 23:39 – 23:44 Oceanside West Reef

Fringed moray (*Gymnothorax fimbriatus*). A general (although not necessarily too exact) rule of thumb is that morays with the longer, sharper jaws tend to be more aggressive. The rule holds true with this one. In this scene, he shows how wide he can open his mouth, possibly trying to determine if he could swallow something as large as the photographer.

375 23:44 – 23:49 Oceanside West Reef

Fringed moray, same individual as in the previous scene. He twitches a couple of times. I'm not sure why, but it may be some kind of warning behavior, telling me to approach no closer.

376 23:49 – 23:52 Oceanside West Reef

Moray eel (*Gymnothorax*) in a hole with a pair of cleaner shrimp (*Lysmata amboinensis*) and several Bartlett's fairy basslets (*Pseudanthias bartlettorum*). The shrimp often live with these eels and pick parasites from their bodies. Interestingly, the fish also find refuge in the same hole; I'd think they would be tasty morsels for the eel.

377 23:52 – 23:55 Oceanside West Reef

Spotted moray eel (*Gymnothorax meleagris*). This is a relatively common and attractively marked moray.

378 23:55 – 23:59 Eniwetak Pinnacle

Spotted moray eel, caught outside of its hole. It quickly retreats to safety.

379 23:59 – 24:03 Oceanside West Reef

Although spotted morays tend to have not too aggressive a disposition, this one apparently had enough of the camera in his face. Either that, or perhaps he saw his reflection in the camera's port and he was being aggressive to the "other" eel.

380 24:03 – 24:18 Oceanside West Reef

Fringed moray, making a meal on a black tang. It doesn't look like he'll be able to swallow it, but swallow it he does. It's amazing how much they can stretch out their jaws.

381 24:18 – 24:23 Oceanside West Reef

Fringed moray, turning around and heading back into its hole.

382 24:23 – 24:28 Oceanside Gea Island

Remora or sharksuckers (*Echeneis naucrates*). The flat adhesive pads on the tops of their heads enable these fish to cling to the bodies of larger fish such as sharks and rays, and to be carried along. You will occasionally see these remoras swimming free, perhaps looking for a new transportation vehicle. They have been known to occasionally attach to a diver's scuba tank. They have also been known to bite divers, but fortunately, they have very small, nearly harmless teeth. Still, it can be startling. I remember once nearly swallowing my mouthpiece when something suddenly grabbed the front locks of my hair and started violently jerking. When I looked up, one of these remoras was hovering a foot away, staring at me and apparently trying to figure out what I was.

383 24:28 – 24:32 Oceanside West Reef

Remora, one swimming by.

384 24:32 – 24:36 Oceanside Gea Island

Very tiny remora attached to the fin of a resting whitetip shark. Remember that the adhesive pad is on the top of the remora's head, and that pad is up against the shark's skin, so you're seeing the remora here from its underside. Its gills are visible.

The next few scenes show some of the sharks found around Kwajalein. First are shown some whitetip, blacktip, nurse, and leopard sharks. Then we will see a few eagle rays, followed by silvertip and gray reef sharks. Although different kinds of sharks vary widely in disposition, the old truism that all sharks are "unpredictable" is certainly **not** true. While it is possible to encounter an individual with aberrant behavior, one familiar with sharks can usually make a very good guess what a particular kind of shark will do in a given situation. There's no reason to believe that any shark you run into might attack without warning; but at the same time it's downright foolish to think that all sharks are safe and you can harass them with impunity. Some large species, like the fortunately uncommon tiger (not shown in this film), should probably be avoided at all times.

385 24:36 – 24:39 Oceanside Gea Island

Whitetip shark (*Triaenodon obesus*), resting on the bottom of a small cave. This is the individual to which the tiny remora seen in the previous scene was attached, and you can still see the remora on the shark's fin. Many sharks are not able to ever stop moving like this; they lack the means to pump water over their gills to continue to breathe. Whitetips, however, along with the nurse and leopard sharks seen later, are able to pump water and therefore can rest motionless on the bottom.

386 24:39 – 24:43 Oceanside Ennylabegan Island

Whitetip shark, resting in a cave. Closeup of head. You can see that sharks have several rows of teeth. As they lose the outer ones from feeding, the inner teeth move outward to replace them.

387 24:43 – 24:47 Oceanside West Reef

Whitetip shark, approaching and passing. Whitetips tend to be completely non-aggressive towards divers. Most of the time, they hardly pay any attention to us, maybe just altering their swimming path just enough to keep their distance. They can, however, become more agitated in the presence of spearfishing, and may get quite persistent in their efforts to relieve a diver of his speared fish. Although not particularly likely, it is possible that a diver could be bitten by a whitetip in such a situation. Whitetips also have the disconcerting habit of homing in on a flashlight beam at night, occasionally even bumping into the diver holding the light. There's no aggression here; the shark is simply blinded and unable to determine where it is going.

388 24:47 – 24:50 Oceanside Legan Island

Whitetip shark, swimming past over coral.

389 24:50 – 24:53 Oceanside West Reef

Whitetip shark, pair swim past each other in a cave.

390 24:53 – 24:56 Oceanside Gea

Whitetip shark, pair “dancing” over the reef. I'm not too sure what we're seeing here. I doubt if it is aggression. Perhaps this is part of the initial stages of courtship between sharks, prior to mating.

391 24:56 – 24:59 Oceanside Gea Island

Whitetip shark, in a cave, a bit unhappy about having his way out blocked by me.

392 24:59 – 25:02 Oceanside West Reef

Whitetip shark, also looking for the way out of his cave. Unfortunately for him, there is a camera in the doorway.

393 25:02 – 25:07 Oceanside West Reef

Whitetip shark, approaching and passing close.

394 25:07 – 25:11 Oceanside West Reef

Whitetip shark, approaching and passing close. Close view of the head and eye.

395 25:11 – 25:15 Oceanside West Reef

Blacktip shark (*Carcharhinus melanopterus*) and whitetip shark pass each other on the reef.

396 25:15 – 25:18 Oceanside Bigej Island

Blacktip shark approaches and turns away. Blacktips tend to live in very shallow water, although larger ones may move out to the edge of the reef. Fast moving and a bit skittish, they tend to avoid divers. Even so, they could become aggressive in the presence of spearfishing.

397 25:18 – 25:21 Oceanside Gehh Island

Blacktip shark, swims past close.

398 25:21 – 25:24 Oceanside West Reef

Nurse shark (*Nebrius concolor*), resting on the bottom in a sandy ledge. Nurse sharks can get quite large, and are usually seen resting on the bottom or in ledges or caves. Unlike members of the gray shark family (such as gray reefs, blacktips, or whitetips), their eyesight is rather poor. They can usually be approached quite closely, but will sometimes be startled and dart quickly away. Don't get in the way when that happens! They shouldn't bite, but the force of the large body may break some of your bones. Despite its relatively benign reputation, nurse sharks are responsible for a substantial number of bites on humans. A nurse shark may turn around and bite in response to being irritated, such as having its fins pulled by a diver.

399 25:24 – 25:27 Oceanside West Reef

Nurse shark, same individual as in previous scene, closer to head. Note the small eyes.

400 25:27 – 25:36 Eniwetak Pinnacle

Nurse shark, turning around in a ledge to avoid looking at the photographer.

401 25:36 – 25:39 Oceanside West Reef

Leopard shark (*Stegastoma varium*). The leopard is a rare species at Kwajalein. In 25 years of diving in the Marshalls, I've seen only two. At least three others have been spotted, one on the deck of a shipwreck, one near Gea Pass and one up near Roi. Juveniles of this species have dark bands, and then it is often called a zebra shark.

402 25:39 – 25:46 Oceanside West Reef

Leopard shark, same individual as previous scene. Gets up off the bottom and starts to swim away.

403 25:46 – Oceanside West Reef

Leopard shark, same individual as previous scene. Swims away over reef.

404 Oceanside West Reef

Eagle ray (*Aetobatis narinari*). Swimming slowly along. This is one of the sting rays. Note the multiple stingers at the base of the tail. These are a little easier to see in the next scene.

405 Oceanside West Reef

Eagle ray, same individual as previous scene.

406 Oceanside Mian Island

Eagle ray, digging in the bottom for food. These rays eat mollusks and burrowing sea urchins that live down in the sand.

407 Gellinam Pinnacle

Eagle ray, heavily spotted individual, swimming along.

408 Oceanside West Reef

Eagle ray, passing overhead. What a face!

409 Lagoonside Ennylabegan Island

Sting ray. These spend most of their time sitting on sandy bottoms, but occasionally will get up and swim.

410 Oceanside Eller Island

Silvertip shark (*Carcharhinus albimarginatus*). The silvertip can be distinguished from the whitetip by its shape, which is more like a blacktip or gray reef, and by the white tips on all the fins instead of just (in most cases) the dorsal and tail fins. Silvertips can also be large, much larger than the 6-foot maximum size for whitetips. The small silvertip in this scene is about 6 feet long. Generally, silvertips are deeper water sharks, usually seen only below 100 feet on the oceanside drop-off.

411 Oceanside West Reef

Silvertip shark, an 8-foot long individual.

412 Oceanside Eller Island

Gray reef shark (*Carcharhinus amblyrhynchos*). Probably the most dangerous shark most divers will see is the gray reef. The danger from the gray reef is not that it considers divers to be dinner, but rather it regards them as competitors. Under certain conditions, the gray reef exhibits territorial behavior; not defending a territory such as a particular section of reef, nor even a personal space kind of territory. The territoriality of gray reefs seems to vary from encounter to

encounter, possibly depending on such factors as familiarity with divers, recent experiences, mating, and so on. It's not seen often, but occasionally a diver will encounter a shark showing aggressive behavior. It is easy to spot, since under these conditions, the shark has a distinct and peculiar swimming behavior (Scene 422). It arches its back, sticks its nose up, points its pectoral fins down, and twists its body back and forth in an exaggerated S-shaped swimming pattern. This is called a Gray Reef Posture. There are different levels to the posture; sometimes you can barely tell the shark is posturing. For example, when a gray reef with little experience with divers first encounters one on a remote lagoon pinnacle, it might be a bit uncertain how to react, and it may show the beginning of a posture. This is sort of a low level aggression, getting ready to go to a full posture if it becomes necessary. At full posture, the swim is very distinctive and the danger level is high. A shark in this state could attack at what might seem a slight provocation, for example, swimming toward the shark, making sudden movements, banging on your tank, or even taking a flash picture. In nearly every case of a gray reef attack, the shark was in one of these high level postures and was goaded into the attack by something the diver did, even if inadvertently. It is said the shark will not attack unless it is first posturing. Might be a pretty good rule of thumb, but I'm not sure I'd trust it completely. A Marshallese spearfisherman at Enewetak Atoll was bitten badly by a shark that did not posture first, but he'd been carrying a stringer of speared fish and the shark probably came in for those and made a mistake. But if you're not spearing and you see gray reefs, you almost certainly will not be attacked unless the shark goes into a posture first. And if you see a gray reef in a posture, **do nothing**. Some earlier authors said divers could usually chase sharks away by swimming at them. **Absolutely do not** try this with posturing gray reefs. Your best bet is to remain still and even try to not obviously stare directly at the shark. If you do nothing, the shark will generally swim off or at least go out of its posture within a few seconds. At this point, it is probably safe to slowly retreat.

413 Oceanside Bigej Island

Gray reef shark. This kind of shark is very common, particularly outside the boating areas. During the 1960s, the only time divers got oceanside here was on club dive boats, so there was a lot less diving activity on the outer reef. Then, the gray reefs were very common even oceanside of Ennubuj, where you can hardly see one now. The same is true for some lagoon pinnacles. The few times I went to R-Buoy Pinnacle during the 60s I saw many gray reefs. R-Buoy became a popular dive spot in the 70s, and now I haven't seen a gray reef there for 9 years. Yet, an unmarked and nearly undove pinnacle not far from R-Buoy had seven or eight gray reefs around it the last and only time I was there. It appears that over time, the presence of divers tends to make the gray reefs move away.

414 Oceanside Eller Island

Gray reef shark. You can always tell a gray reef by looking at its tail. If the trailing edge of the tail is black, it's a gray reef. Fortunately, considering their pugnacious behavior, they do not get especially large. A 6-footer is a big one, and—very rarely—you might see one up to 7 feet. I've heard of 8-footers, but haven't encountered one among the thousands of gray reefs I've seen. If you see a shark bigger than 6 or 7 feet here, it's probably a silvertip (with white tips to all fins and no black on the tail), a Galapagos gray (large and all gray with no black on the tail), a nurse (usually sleeping on the bottom), a lemon (again, no black on the tail and two large dorsal fins),

or a tiger (with vertical stripes if small, or mostly dark gray or black above if large). But also remember that a shark always looks a lot bigger than it really is.

415 Northern Lagoon Pinnacle

Gray reef shark. Note the remora attached to this one.

416 Oceanside Bigej Island

Gray reef shark. Also with a remora.

417 Oceanside Eller Island

Gray reef shark.

418 Oceanside Bigej Island

Gray reef shark. This one gets disturbed by the bubbles from a diver.

419 Oceanside Bigej Island

Gray reef shark. This shark has a hole in its side. It kind of worried me since it was behaving a bit erratically. We here at Kwaj have been lucky to have had no gray reef attacks. At Enewetak Atoll, with fewer divers, there were four non-fatal attacks during the years the Mid-Pacific Research Lab was in operation. In one of those cases, a diver saw a gray reef in an apparent posture. Looking closer, he saw a hole in the shark's side. Thinking the shark was probably swimming funny due to its injury, he snapped a picture. But the shark **was** in an aggressive posture. The flash of light from the strobe triggered an attack. The photographer was badly bitten on his right arm, and his buddy, who came in to try to help, was bitten on the hand. Moral: don't do anything if you think a shark even might be posturing.

420 Northern Lagoon Pinnacle

Gray reef shark. I was filming some small coral on the wall when I turned around and had these two right behind me, plus two more further away.

421 Oceanside Bigej Island

Gray reef shark. This is a relatively small one coming in close.

422 Oceanside Legan Island

Gray reef shark. Coming down the drop-off and going into a posture just as it turns away. Note the arching of the back and the downward pointed pectorals, as well as the S-shaped swimming path. This was an individual I did not want to irritate any further.

423 Oceanside West Reef

Manta ray (*Manta alfredi*). Possibly one of the most impressive animals an average diver is likely to run into. These rays get big; the one in this scene measured probably 16 to 18 feet from wingtip to wingtip. The biggest ones I've seen have been oceanside, cruising along the reef just beyond the drop-off. The rest of the scenes were taken in the lagoon, where mantas are more common but tend to be smaller, only 6 to 12 feet tip to tip.

424 Lagoonside Ebwaj Island

Manta ray. Along the edge of the lagoon slope at North Loi, Ebwaj, and Gugeegue Islands, the mantas come in occasionally to have their parasites picked off by cleaner fish.

425 Lagoonside Ebwaj Island

Manta ray. Passing low over the reef to entice cleaner fish up.

426 Lagoonside Ebwaj Island

Manta Ray. Note the flaps around the large mouth. These help direct a stream of water into the mouth, where it is filtered for the manta's planktonic food. Also note the coloration on the

underside. We can recognize individuals by their color pattern, since it seems that no two are alike. The pattern of black marks differs, or in some cases, the underside is nearly all black with a pattern of white marks. We call this one V-Chest because of the V-shaped black mark between his gills.

427 Lagoonside Ebwaj Island

Manta ray. Here a manta opens its mouth so the cleaners can go inside and clean the interior.

428 Lagoonside Ebwaj Island

Manta ray, swimming past. Note the anterior flaps in this one. They are rolled up into points. Possibly this is to reduce drag when the animal is just swimming along and not feeding.

429 Lagoonside Ebwaj Island

Manta ray. A pair of large black individuals. Note that these are also black on the underside.

430 Lagoonside Ebwaj Island

Manta ray. A large one passing close over the camera. I practically had to lie flat on the bottom while taking this shot; the manta seemed to ignore my presence altogether and looked like he might have plowed right through me if I'd stayed upright. A remora is attached to the underside. I'm not sure what caused the scratch-like marks on the body.

431 Lagoonside Ebwaj Island

Manta ray. The grand finale. A manta dances upward, passes a diver's bubbles, the fades off into the sun.

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