The Evolution of Hawaii's Reefs

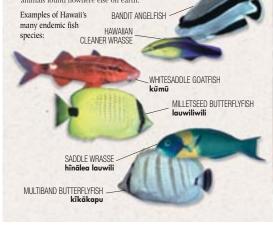
awai'i is one of the few places in the world where the majority of stages of reef evolution can be seen. Recently created lava flows on the Big Island gradually become home to new reefs and developing reef communities. Fringing reefs form near shore and can be seen throughout Hawai'i. Barrier reefs are formed as the nearby shoreline sinks over time, creating a wide gap (or lagoon) between the reef and shore. Hawaii's only barrier reefs are found off the islands of O'ahu and Kaua'i. Coral atolls, made of living coral and limestone coral fossils built on top of sunken volcanic islands, can be seen in parts of the Northwestern Hawaiian Islands.

Hawaii's Reefs Are Important

Without coral reefs, Hawai'i would be a very different place. Much of the white sand of our islands' beaches is gener-ated by the reef ecosystem. Reefs protect the shoreline from waves and storms, and even help create some of our famous surf breaks. Hawaii's reefs make up approximately 80% of all the reefs found in U.S. waters. Yet, Hawaii's reefs are fragile and vulnerable. Hawaii's water temperatures are on the cool side of the survival range for reefs. As a result, many corals grow less than 2 inches a year. Natural forces, such as storms, heavy rains, and sediment run-off can damage corals or hinder their ability to grow. Human-induced stresses, including overfishing, run-off of chemicals and nutrients, of the introduction of alien species, further threaten the reefs.

Hawaii's Unique Coral Reef Inhabitants

 \mathbf{F} ormed by volcanic activity in the middle of the ocean, Hawai'i is the most isolated island chain in the world, separated by more than 2,000 miles from any continent or other major island group. Located in the middle of the north Pacific Ocean, Hawai'i is upstream from the flow of major ocean currents, making it difficult for marine life to reach the Islands. The species that arrived here evolved over millions of years, adapting to meet the survival challenges posed by Hawaii's marine environment through an ongoing series of complex processes. Compared with many other reef communities in the Pacific, fewer marine species inhabit Hawaii's coral reefs. However, about 24% of Hawaii's fish species are endemic (found only in Hawai'i), along with 25% of Hawaii's reef building corals, 21% of marine snails and 25% of sponges. This offers snorkelers and divers the opportunity to view animals found nowhere else on earth.



Ways You Can Help Protect Hawaii's Coral Reefs

Hawaii's coral reefs are a fragile and wonderful natural resource. Please help protect our reefs as you enjoy snorkeling, diving or swimming around them.

1. Choose a snorkel or dive operator that undertakes sustainable diving practices. Take only photos, leave only bubbles, look don't touch. 2. Don't walk upon or stand on coral. This can kill living coral polyps

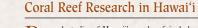
- that are builders of the reef structure. Snorkel in a horizontal position. 3. Anchors damage the reefs by breaking off coral. Tie up at mooring
- pins or anchor only in sand away from living reef. 4. Do not attempt to touch or break off pieces of coral. Taking live
- coral or rock with attached marine life is illegal in Hawai'i. 5. Please don't feed the fish. This changes the fish community structure and tames them. It also encourages the proliferation of more aggres-

sive species. 6. Don't touch, pick up or hold reef inhabitants. Animals such as sea urchins, sea stars or sea cucumbers have delicate suction feet that can be torn or injured when they are removed from their habitats. Don't pull octopuses from their habitats. They have sharp beaks and can bite. Their primary defenses include remaining camouflaged, being able to withdraw far into the reef, or inking to create a smoke screen if detected, all of which are undermined when they are removed from the reef.

7. Be an informed consumer when purchasing corals or fish for your home aquarium or fish for supper. Irresponsible collection of wild fish and overfishing threaten many of Hawaii's reef fishes and invertebrates

8. Please don't pollute. In the main Hawaiian Islands, pollution from land finds its way into our oceans and reefs. Use fewer household chemicals, especially on your lawn or garden.

- 9. Support the establishment of marine protected areas (including the Northwestern Hawaiian Islands National Marine Sanctuary) where fish
- and corals can replenish their populations.



D esearch studies of Hawaii's coral reefs include: Hawai'i Coral Reef Initiative (co-managed by the State of Hawai'i Department of Land and Natural Resources and the University of Hawai'i); Hawai'i Coral Reef Assessment and Monitoring Program managed by the Hawai'i Institute of Marine Biology) and Northwestern Hawaiian Islands Reef Assessment and Monitoring Program. Other research projects are sponsored or conducted by: the State of Hawai'i Coastal Zone Management Program and the Department of Land and Natural Resources: U.S. Geological Survey: U.S. Fish and Wildlife Service; National Marine Fisheries Service; National Ocean Service; University of Hawai'i; The Ocean Research Council of Hawai'i; and Pacific Whale Foundation



A diver documents the abundance and diversity of fish species at a

For more information about Hawaii's coral reefs, visit the Hawai'i Coral Reef Network at www.coralreefnetwork.com. For information on U.S. reefs, visit www.coral.noaa.gov or www.epa.gov/owow/oceansreef.

Sponsored by:



Photos contributed by: A. Fielding, D. Fleetham, J. Maragos/U.S.F.W.S., R. Miller, Pacific Whale Foundation, E. Robinson, M. & P. Severns, and N. Wu, Special thanks to E. Brown, A. Clark, D. Gulko, C. Hopper, C. L. Hunter, C. Mahaney, C. Maxwell, Sr., L. Nakagawa, S. Olive, J. Randall, R.H. Richmond, and P. Severns for research and

Produced by Pacific Whale Foundation, 300 Ma'alaea Road, Suite 211 Wailuku, HI 96793 with support from sponsors listed above. Call (808) 249-8811 or visit www.paci-ficwhale.org. This is a publication of the State of Hawaii Office of Planning, Coastal Zone Man Zone Management Program pursuant to National Oceanic and Atmospheric Administration Award No. NA17OZ1600. To learn more about Hawaii Coastal Zone ment, visit www. czmhawaii.com.

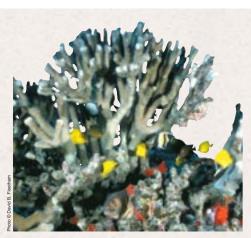
Not For Sale. Copyright © 2003 in all countries of the International Copyright Union by Pacific Whale Foundation. ALL RIGHTS RESERVED. Portions of this brochure may be ssion from the Pacific What duced for educational r

Printed on Recycled Paper with Soy-Based in

Exploring Hawaii's Coral Reefs







Voral reefs are among the world's richest and most diverse eco-Coral reets are among the works inclusion that has developed over the past 500 million years. The amazing biological diversity of coral reefs has earned them the nickname, "the rainforests of the sea," Coral reefs require special conditions to live and grow. They are generally found in tropical regions between 30°N and 30°S latitude, require warm salt water (greater than about 60°F.), and thrive in clear, shallow water (less than 330 feet in depth).

CAULIFLOWER CORAL ko'a



CAULIFLOWER (ROSE) CORAL (Pocillobora meandrina) is a sturdy coral that can tolerat trong water movement and is found on shallow lava flows in heavy surf down to depths of 100 feet. It dominates on surge-swept reefs

Coral Reefs: Rainforests of the Sea

Corals: Animals or Rocks?

orals look like rocks, but they are actually colonies of tiny animals that are related to, and resemble, sea anemones. Adult coral polyps have a cylindrical body; with the help of coralline algae, each one secretes a stony cup of limestone around itself as a skeleton. The polyps divide as they grow and form coral colonies. As many colonies build upon one another they gradually form a coral reef. Reef corals acquire part of their energy from photosynthesis, made possible by a mutually beneficial symbiotic relationship with microscopic plants (called zooxanthellae) that live within their tissues. These plants use sunlight and raw materials to produce food chemicals and oxygen used by the corals. They also give corals some of their color.

Corals are not the only reef builders. Other animals and especially plants (such as crustose coralline algae) secrete calcium carbonate and contribute substantially to the reef framework.

How Corals Reproduce

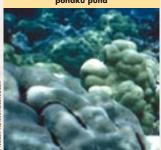
orals reproduce in a variety of ways. Some species release eggs and sperm into the water a certain time of year, usually coinciding with the lunar cycle. Some species brood eggs that are fertilized internally and release tiny microscopic larvae several times throughout the year, also on a lunar



cycle. These larvae are carried along by ocean currents to new locat thus creating new coral colonies. Corals can grow or repair damage they have experienced by budding - where polyps divide to create additional polyps. Budding can take place throughout the year. The rate of growth depends in part on the amount of sunlight received by the reef.

Some of Hawaii's Common Corals

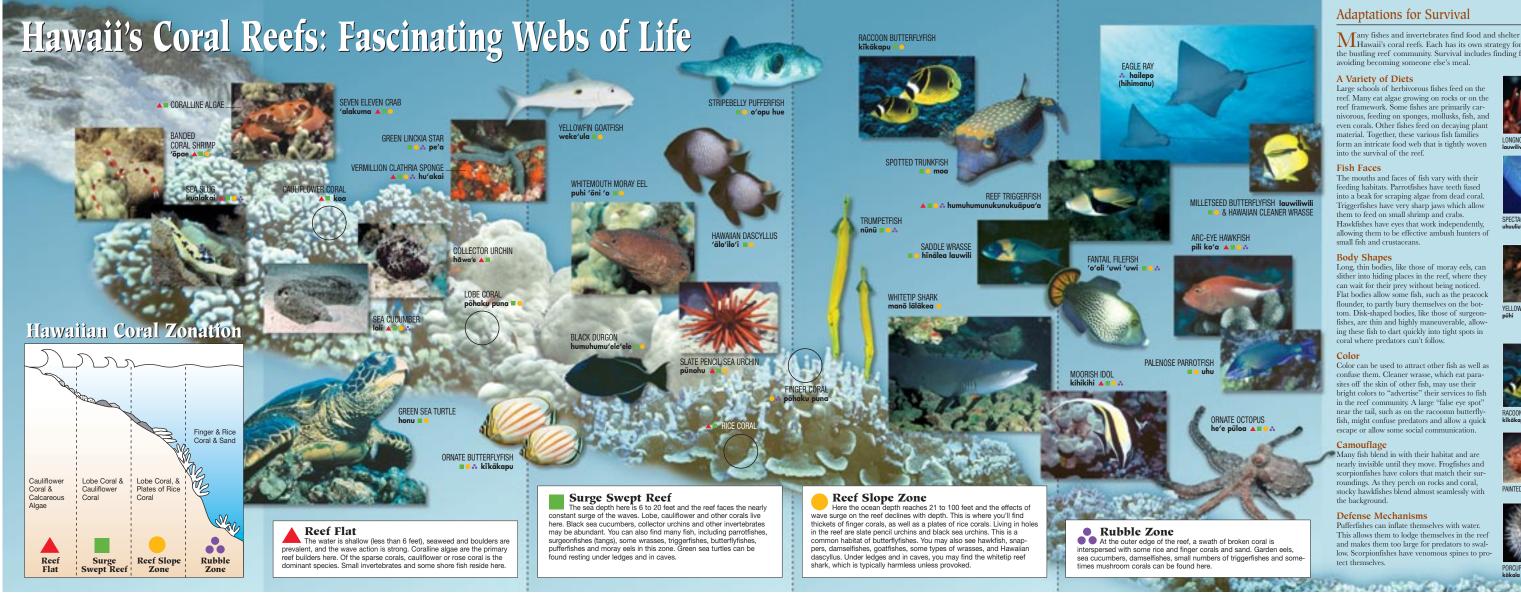
LOBE CORAL oōhaku pupa



LOBE CORAL (Parites labata) is found in both shalow and deeper water growing low and encrusting in surge areas, and blossoming into large mounds in calmer water. Many of the large massive colonies are over 200 years old lent of an old growth forest.



FINGER CORAL (Porites compressa) is endemic and is usually found well below the surge zone at depths greater than 15 feet. It grows quickly and forms dense thickets, often dominating Hawaiian reefs on the lower reef slope or in bays and lagoons.



Adaptations for Survival

Many fishes and invertebrates find food and shelter within Hawaii's coral reefs. Each has its own strategy for survival in the bustling reef community. Survival includes finding food and avoiding becoming someone else's meal.

A Variety of Diets

Large schools of herbivorous fishes feed on the reef. Many eat algae growing on rocks or on the reef. Many eat algae growing on rocks or on the reef framework. Some fishes are primarily car-nivorous, feeding on sponges, mollusks, fish, and even corals. Other fishes feed on decaying plant material. Together, these various fish families form an intricate food web that is tightly woven into the survival of the reef.

Fish Faces

The mouths and faces of fish vary with their feeding habitats. Parrotfishes have teeth fused into a beak for scraping algae from dead coral. Triggerfishes have very sharp jaws which allow them to feed on small shrimp and crabs. Hawkfishes have eyes that work independently, allowing them to be effective ambush hunters of small fish and crustaceans.

Body Shapes Long, thin bodies, like those of moray eels, can slither into hiding places in the reef, where they can wait for their prey without being noticed. Flat bodies allow some fish, such as the peacock flounder, to partly bury themselves on the bottom. Disk-shaped bodies, like those of surgeon fishes, are thin and highly maneuverable, allow ing these fish to dart quickly into tight spots in coral where predators can't follow.

Color

Color can be used to attract other fish as well as confuse them. Cleaner wrasse, which eat parasites off the skin of other fish, may use their bright colors to "advertise" their services to fish in the reef community. A large "false eye spot" near the tail, such as on the racoomn butterflyfish, might confuse predators and allow a quick escape or allow some social communication.

Camouflage

Many fish blend in with their habitat and are nearly invisible until they move. Frogfishes and scorpionfishes have colors that match their surroundings. As they perch on rocks and coral, stocky hawkfishes blend almost seamlessly with the background.

Defense Mechanisms

Pufferfishes can inflate themselves with water. This allows them to lodge themselves in the reef and makes them too large for predators to swa low. Scorpionfishes have venor tect themselves





SPECTACLED PARRO



YELLOWMARGIN MORAY EEL





