

## Science lecture #6: Coral Reef Facts

Coral reefs (*kohola*) are among the most productive ecosystems on earth, even more than the densest rainforests of Hawai'i and South America. *Kohola* support such an enormous amount of organisms that they are as much as 100 times more productive. It is estimated that coral reefs make up only two-tenths of a percent (0.2%) of the world's ocean, but provides 11% of the world's fish harvest. The Great Barrier Reef of Australia, which is approximately 2300 km. in length, is the largest single biological feature on earth. Some of these massive, living coral colonies are over 400 years old.

Of the 7500 known species of coral, nearly 5000 species are extinct. Fossil coral reefs have been located in such unlikely places as the tops of mountain ranges, and deep within a large continent. Surprisingly, large oil deposits are often found adjacent to fossil reefs.

Coral reefs can be classified into five discreet types, all of which occur within the Hawaiian Islands:

1. Reef Communities
2. Fringing Reefs
3. Barrier Reefs
4. Atolls
5. Patch Reefs

**Reef Communities** are non-structured reefs composed of a variety of unconnected, loose coral colonies. It often represents the beginning of a true coral reef or a habitat under intense disturbance (large waves) where an actual fringing reef cannot develop. Over time, a reef community may cement itself together, growing upward and outward from the submerged slope of the island to form a fringing reef and reef flat, with channels cutting through it.

**Fringing reefs** are the most common type seen in the Hawaiian Islands, being present on most of the main islands. The Island of Hawai'i, because of its relatively young age, has very few fringing reefs, but a large assortment of apron reefs (juvenile fringing reefs that eventually grow together to form fringing reefs). As islands get older, fringing reefs appear farther offshore. Well-developed fringing reefs can be seen along the entire southern side of Moloka'i, parts of O'ahu, Kaua'i, and Maui.

Most fringing reefs are made up of a **reef slope**, a **reef crest**, and a **reef flat**. The reef slope is often where the highest amount of coral exists. The reef crest is where the highest energy zone is. The reef flat has the lowest coral diversity and is usually the area most heavily impacted by runoff from the island's shoreline. As an island continues to erode and shrink, the fringing reefs will appear to move farther offshore. When this happens, a large body of water (lagoon) forms and separates the shoreline from the outer edges of the growing reef. This is known as a **barrier reef**.

Most **barrier reefs** are formed as fringing reefs continue to grow while the adjacent shoreline erodes away. As such, barrier reefs lie along shorelines but farther offshore than fringing reefs. In Hawaii there are 2 known barrier reefs: Mana Reef off the west side of Kaua'i, and Ahu O Laka in Kane'ohe Bay. The Kane'ohe Bay barrier reef is not a true barrier reef in terms of how it was formed, but fits the bill in terms of its location and function: It was formed during the Holocene era (more than 10,000 years ago) when a series of massive landslides put a large part of the Ko'olau volcano into the sea. The exposed floor of the crater was colonized by corals and an emerging reef was born. Secondary fringing reefs have formed along the shorelines fronting

Kane'ōhe Bay and patch reefs have formed within the Bay.

Passes or channels are usually formed in the barrier reef which allow water to be exchanged between the lagoon and the open ocean. Kane'ōhe Bay has 2 such channels, the Northwest (*Mokoli'i*) channel and the Southeast (*Sampan*) channel.

**Atolls** are rings or horseshoe-shaped reefs surrounding an isolated body of water (the lagoon). Its formation takes place when the surrounding coral reef grows equal to or faster than the shrinking rate of the island. As the volcanic island erodes and sinks beneath the sea, what remains is the coral reef ring or atoll.

The outer edge of an atoll often consists of a well-defined reef face, reef flat, and a back reef. Where tradewinds are prevalent, there are distinct differences in both the width and species composition of these three areas. Windward sides, with their heavier wave action, tend to have more massive corals. Leeward sides of atolls are often more sheltered and thus tend to not have massive coral formations making up the reef face. The reef flats on the leeward side also tend to have fewer coralline algae and more corals.

Atolls usually offer some of the most pristine of coral reef habitats, due primarily to the lack of land near most of these structures. (Major destruction to corals are a result from human presence.)

Because of their low elevation, waves from storms and hurricanes have easily impacted atolls. These storms will dislodge large chunks of reef substrate and wash them up onto the reef flat, where further wave action will erode them into coarse sediments. These sediments eventually accumulate to form flat islands, called a **Cay** or a **Motu** (also known as "Rubble Islands").

\*\*A recent concern for atolls and those who make atolls their home is the rising sea level due to global warming. The effects from countries on global temperatures is causing the partial melting of the polar ice caps, resulting in an elevation of the level of the sea. As a result, nations such as the Marshall Islands will cease to exist.

**Patch reefs** are small, isolated coral reef formations usually found on the reef flat. These isolated colonies develop well inside of the outer edge of the barrier reef, and can be seen clearly in protected bays such as Kane'ōhe Bay.

### Major Factors Limiting the Occurrence of Coral Reefs

Reef-building corals need light in order for their symbiotic plants to grow. Therefore, the **lack of adequate sunlight** poses a problem for coral growth, since the greater percentage of the world's oceans are relatively deep, where light levels are too low for zooxanthellae photosynthesis. Living corals are only found in shallow, clear water.

Corals require a hard substrate to attach itself to, like underwater lava rock formations, boulders, or other dead corals. **Soft substrates** such as sandy or muddy bottoms cannot support coral reefs.

Coral reefs only occur between certain latitudes and only within certain areas of the world because of **water temperatures** that allow coral survival. The zone known as the tropics (the area between the Tropic of Cancer and Tropic of Capricorn) at approx. 23.5 degrees north and south of the equator are the limiting lines for just about all the coral growth globally, where water temperatures rarely go below 18 degrees Celsius. Studies have shown that most reefs tend to grow well between temperatures of 23 – 25 degrees Celsius. The exception in the "Tropical Zone" is the absence of reefs off the west coast of South America due to the upwelling of cold

currents moving northward from the Antarctic region.

A fourth factor is the **saline requirement** corals require for optimum growth. The optimum saline environment for corals is 32 - 35 parts per thousand, but have been known to grow extremely well in higher-saline environments too, such as the Persian Gulf, at 42 parts per thousand. Areas where the salinity is low (due to the runoff of fresh water), no coral growth can be seen. These are areas such as the Mississippi Delta and the Amazon Delta.

A fifth factor is the **presence of sediments** in the water. Again, where there is a large volume of runoff (river mouths), the sediments will smother corals and their feeding structures, and reduce the amount of available light for photosynthesis.

In addition to these known factors, research has shown that northeastern parts of the Hawaiian Islands tend to have poor reef development due to **severe wave action** from the northeast trade-winds.