Coral reefs: types, distribution, importance and habitat requirements

Department of Zoology, Raiganj Surendranath Mahavidyalaya, Online Lecture Series

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What are coral reefs?

Coral reefs are diverse underwater ecosystems held together by calcium carbonate structures/exoskeletons secreted by colonial marine invertebrates called coral. The coral species that build reefs are known as "hard" corals because they extract calcium carbonate from seawater to create a hard, durable exoskeleton that protects their soft, sac-like bodies. Other species of corals that are not involved in reef building are known as "soft" corals.

Types of reefs:

Corals reefs are most often found in warm, clear, shallow water where there's plenty of sunlight to nurture the algae that the coral rely on for food.

Charles Darwin's theory of coral formation is widely accepted. This theory recognizes three types of reefs:

1. **Fringing reefs:** Fringing reefs are the most commonly seen reef and grow near coastlines. It extends to a distance of about 200-250 meters.

Photo 1

Photo 2

Fringing reefs near the Hawaii islands in the Pacific Ocean (Photo 1); and the city of Sharm el Sheikh in the Red Sea (Photo 2). The reefs are located in the shallow portions of the sea near the mainland where the colour of the water appears to be distinct from the deep blue waters far off the mainland. Photo 2 on the right was taken by the author himself (from the aeroplane) during his trip to Egypt in 2020. Photo 1 was collected from the net.

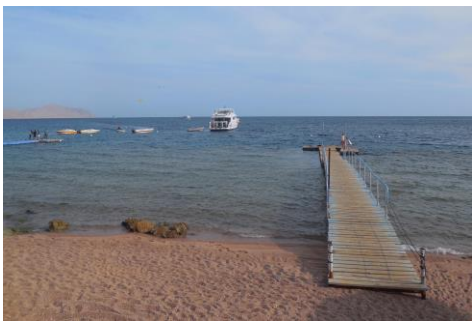


Photo 3

Photo 4

Photo 5

Fringing reefs near the Sharks Bay in the Red Sea. Notice the differences in water colour in Photo 3- due to the presence of fringing reefs, the water near the beach is shallow and a pier is needed to walk to the smaller boats. In Photo 4, the reefs can be seen under water (an underwater camera would have clicked it better). A snorkeler can be seen searching for corals and other underwater organisms in Photo 5. All photos were snapped by the author during his trip to Egypt in 2020.

Photo 6

A typical fringing reef. The underwater reefs can be seen alongwith the vegetation of the nearby mainland/island. Photo taken from the "Coral Reef Alliance" website: https://coral.org/coral-reefs-101/coral-reef-ecology/types-of-coral-reef-formations/

The fringing reef has three regions: Reef flat (area close to the main island and has a generally flat surface); reef edge (an elevated or uplifted ridge that is generally exposed during low tide; and seaward slope (this slope extends into the sea from the reef edge; Corals grow in this region, as well as in the reef flat). A shallow channel of sea water lies on the reef flat and only small boats can travel here.

2. **Barrier reefs** are also parallel to the coastline but are separated by deeper, wider lagoons. At their shallowest point, they can reach the water's surface forming a "barrier" to navigation. Barrier reefs form when land masses sink, and fringing reefs become separated from shorelines by wide channels. The Great Barrier Reef off northern Australia in the Indo-Pacific is the largest barrier reef in the world. This reef stretches more than 2,000 km.

   The barrier reef also has three regions: Reef flat, reef edge and seaward slope. The sea water lying between and continent and the reef is called lagoon. It is deep (about 90 to 110 meters) and ships can travel along this.

Photo 7

Photo of the Great Barrier Reef off the coast of Queensland, Australia. See the ship in the lagoon between the mainland and the reef. The deep blue sea is on the other side. This photo has been collected from the webpage: https://www.thetourspecialists.com.au/tours/great-barrier-reef-tours/great-barrier-reef-day-tours/cairns-helicopter-scenic-flight.557/

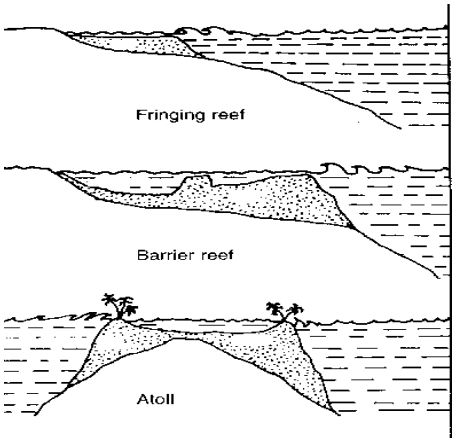


Figure 1: Understanding the different types of coral reefs. Figure was prepared by C. L. Rodrigues under the legend, "Types of reefs and their distribution" in the mss, "Biodiversity in the Western Ghats: An information kit", and was downloaded from the webpage: http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-ru-50---20-preferences---00-0-1-00-0--4----0-0-11-10-0windowsZz-1251-00&cl=CL1.2&d=HASHd10071ff5b9a81a2180c80&gt=2

3. **Atoll:** If the land mass is a small island, it may eventually sink below the sea surface, and the reef becomes an atoll reef. Atolls are reefs that surround a central lagoon. The result is several low coral islands around a lagoon. The largest atoll, named Kwajalein, surrounds a lagoon over 97 km long. There are 12 atolls and 3 reefs in Lakshwadeep islands, India.

Photo 8: Photo of the Minicoy atoll in Lakshwadeep, India.

Source: Mary, A.G. and Shukla, R.D. 2014. *Biodiversity and distribution of octocorals of Minicoy atill, Lakshwadeep*. Atoll Research Bulletin No. 602. Smithsonial Institution Scholarly Press, Washington.

Distribution of coral reefs:

Reef-building corals are scattered throughout the tropical and subtropical Western Atlantic and Indo-Pacific oceans, generally within 30°N and 30°S latitudes.

Western Atlantic reefs include these areas: Bermuda, the Bahamas, the Caribbean Islands, Belize, Florida, and the Gulf of Mexico.

The Indo-Pacific ocean region extends from the Red Sea and the Persian Gulf through the Indian and Pacific oceans to the western coast of Panama. Corals grow on rocky outcrops in some areas of the Gulf of California. The great barrier reef as also the reefs near India (Lakshwadeep, Andaman and Nicobar, Gulf of Kutch, Gulf of Mannar) all belong to this region.

Figure 2

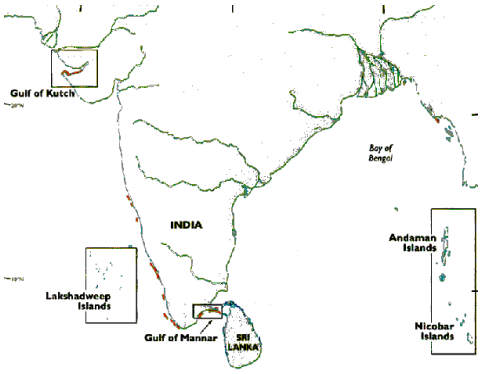


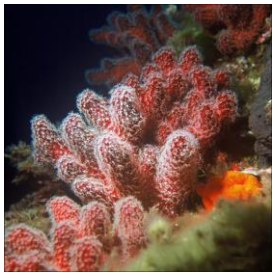
Figure 3

Distribution of the coral reefs around the world (notice the yellow patches in Figure 2) and around India (Figure 3). Figure 2 has been downloaded from: https://coral.org/coral-reefs-101/coral-reef-ecology/geography/ and Figure 3 from: http://missongreenenvironment.blogspot.com/2010/06/need-of-coral-reefs-conservation-in.html

Types of corals:

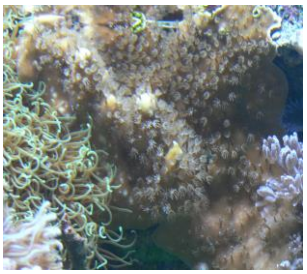
Millepora

Stylaster



Alcyonium

Tubipora



Heliopora

Gorgonia

Fungia

Corallium

Photos 9-16: Some coral species
(all photos barring the one of *Corallium* are collected from Wikipedia; photo of *Corallium* collected from arkive.org)

Corals are found in two classes of Cnidarians: Hydrozoa and Anthozoa.
Hydrozoan corals: They are called hydrocorallum. Some examples are: *Millepora* and *Stylaster*.
Anthozoan corals: There are 2 types:
Octocorallian corals: They are colonial polyp with 8 tentacles and mesentaries. The coral contains spicules of $CaCO_3$. Some examples are: *Tubipora*, *Alcyonium*, *Heliopora*, *Gorgonia*, etc.

Alcyonium are soft corals and the lower part of the polyp is fused to form a fleshy mass. They are also known as dead man's fingers.
In *Tubipora*, polyps are not fused and are connected by basal stolons. They are also known as organ pipe coral.
In *Heliopora*, the skeleton is massive, composed of crystalline calcareous fibres. Skeleton has many cavities, where the polyps are lodged. Also known as blue corals.
In *Gorgonia*, Colony plant like; main stem arises from a basal plate or
stolons, there are a number of branches bearing polyps. Axial skeleton contains calcareous and horny spicules.
Hexacorallian corals: They are colonial polyp with more than 8 tentacles and in multiples of 6. Similarly, mesenteries are either 6 or in multiples of 6. Mesenteries may be complete or incomplete. Spicules are absent. They are commonly known as stony corals. Some examples are: *Fungia, Madrepora, Corallium,* etc. In the order Madreporaria, the exoskeleton is calcareous. Polyps are small and enclosed in cup like cavities of the exoskeleton.

Importance of coral reefs: Coral reefs are distributed throughout the world in 101 countries and covers an estimated 284,300 square kilometers, yet they make up only one-tenth of one percent of the total ocean area. Coral reefs are believed by many to have the highest biodiversity of any ecosystem on the planet- even more than a tropical rainforest. Occupying less than one percent of the ocean floor, coral reefs are home to more than twenty-five percent of marine life. This is the main contribution of the coral reefs. Some other factors too can be considered:

1) Reefs protect coastlines from harsh ocean storms and floods.
2) Coral reefs support a variety of fisheries including those for near-shore fishes, crustaceans, and molluscs.
3) Coral reefs attract millions of scuba divers, snorkelers, and other tourists every year- hence supports the local economy (tourism industry).
4) Some evidence suggests that corals and other reef inhabitants could potentially provide important medicines, including anti-cancer drugs, painkillers, and anti-inflammatory compounds.


Photos 17 & 18: Some coral and coral reef fishes of the Red Sea.
Photos were snapped by the author during his trip to Egypt in 2020

Photo 19: The author inside a submarine during his visit

Habitat requirements:

Although various types of corals can be found from the water's surface to depths of 6000 m, reef- building corals are generally found at depths of less than 46 m, where sunlight penetrates. Because reef- building corals have a symbiotic relationship with a type of microscopic algae, sunlight is necessary for these corals to thrive and grow.

Reef-building corals have a mutualistic relationship with *Zooxanthellae*, microscopic algae that live with coral polyp's tissues. Both the polyp and the *Zooanthellae* benefit. For this reason, reef-building corals are found only in areas where symbiotic *Zooxanthellae* can take in light for photosynthesis.
Through photosynthesis, *Zooxanthellae* convert carbon dioxide and water into oxygen and carbohydrates. The coral polyp uses carbohydrates as a food or nutrient. The polyp also uses oxygen for respiration and in turn, returns carbon dioxide to the *Zooxanthellae*. *Zooxanthellae* also take in ammonia given off as waste by the polyp, and return amino acids (protein). *Zooxanthellae* also promote polyp calcification by removing carbon dioxide during photosynthesis. Under optimum conditions, this enhanced calcification builds the reef faster.

Reefs tend to grow faster in clear water. Clear water allows light to reach the symbiotic algae living within the coral polyp's tissue. Reef-building corals require warm ocean temperatures (20° to 28° C). Reef development is generally more abundant in areas that are subject to strong wave action. Waves carry food, nutrients, and oxygen to the reef; distribute coral larvae; and prevent sediment from settling on the coral reef.

Precipitation of calcium from the water is necessary to form a coral polyp's skeleton. This precipitation occurs when water temperature and salinity are high and carbon dioxide concentrations are low. These conditions are typical of shallow, warm tropical waters. Most corals grow on a hard substrate.

Photo 20: *Zooxanthellae*
Image clicked by *Todd C. LaJeunesse, Penn State University*
available at:
https://news.psu.edu/photo/318035/2014/06/10/symbiodinium-fitti

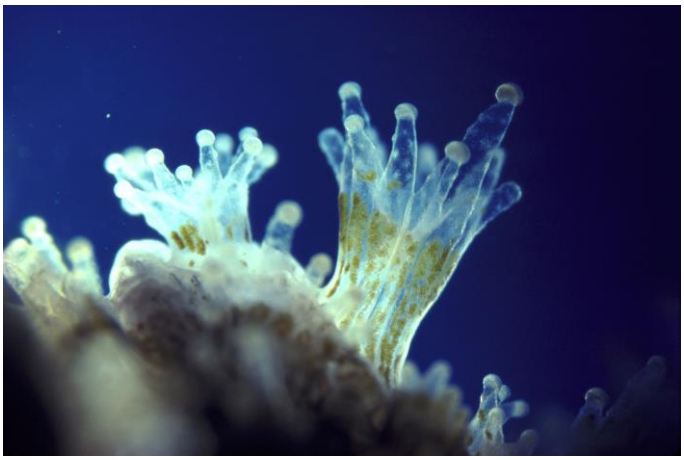


Photo 21: *Zooxanthellae* in a coral polyp
Image uploaded by Sheri Drabin
available at:
https://www.pinterest.com/pin/557601997607858653/

References:
Ross, R. 2018. What Are Coral Reefs? *Live Science Contributor* (September 24, 2018), details available in: www.livescience.com/40276-coral-reefs.html
Coral Reef Alliance. Saving the World's Coral Reefs, details available in: https://coral.org/coral-reefs-101/coral-reef-ecology/

Suggestions for further reading:
Sheppard, C. 2014. Coral Reefs: A Very Short Introduction. Oxford University Press, Oxford.
Spalding, M.D., Ravilious, C. and Green, E.P. 2001. World Atlas of Coral reefs. University of California Press, Berkeley.