

CORAL REEFS: Types & theories



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Ocean



Corals: An Introduction



*Sea/ocean features are unique in nature. We are familiar with some of them and have seen also. Corals are one of them. Lime rich rock in shallow ocean water (feature) is called **Coral Reefs**. Coral Reefs are made of polyps which are tiny organisms that look like rocks. As they develop and grow, so does the reef. The corals which form colonies are hard in nature whereas those corals which do not form colony are soft in nature. Each individual coral is referred as a Polyp.*

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Coral reefs and atolls are formed by an accumulation of the skeleton remains of very small sea animals and plants which secrete lime. According to Arthur Holmes, the average rate of the growth of reefs is nearly 14 mm per year. Coral reefs are found between 30⁰ north to 30⁰ south latitudes. They developed their colonies on submarine platform. Large variations are found in coral reefs like tropical evergreen rain forest. Therefore, corals are termed as “Rainforest of the Oceans”. There are 1,000,000 varieties/ species of coral reefs out of which only 10% have been studied. Coral reefs first appeared 484 million years ago, at the dawn of the early Ordovician, displacing the microbial and sponge reefs of the Cambrian (“The middle- late Cambrian reef transition and related geological events: A review and new view,” earth science review, 145: 66-84).

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Corals are unique feature of oceans .It belongs to a group that includes jellyfish, anemones etc. type marine invertebrates. Corals life depends on mutual relationship with algae. These algae live inside the coral polyp's body. Here they produce energy by photosynthesis and provide energy to corals. On the other hand, corals provide home and carbon dioxide for the algae. Coral provide primary habitat for more than 3500 species of fish, and thousands of other marine flora and fauna .There are certain geographical factors which controls the growth of corals.

Geographical factors which controls the growth of corals.



1. **Shallow and marshy land** or shallow water up to 25-30 fathoms or 200-300' / 20-60 meters depth is ideal for the growth of corals. Beyond this depth the amount of calcium, the coral polyps and other sea creatures live on calcium carbonate do not thrive. Sub-marine platform near the sea shore or around an island is essential where corals build their permanent colonies.

2. **Temperature** plays an important role in the growth of corals. 18⁰ to 24⁰C (68-70⁰F) temperature means that for the growth of corals this is an ideal surface temperature of the ocean. Below this temperature corals cannot live. Tropical region oceans offer suitable temperature for the growth of corals.

3. Corals need **clear water** (devoid of sediments) for its growth. Due to sediments, corals growth ceased and they become dead. Therefore, corals cannot develop near the sea where rivers enter into the sea with muddy (coastal) water. These sediments closed the pores of polyps for their growth and corals die due to absence of solar energy and oxygen. This is the reason for the unavailability of corals on the coastal areas of monsoon region.

4. **Salinity** is essential for the development of coral reefs. 26-38 ‰ salinity is ideal for the growth of corals. The range of salinity is found in the eastern part of tropical continents, especially between 30⁰N.-30⁰S latitudes. Corals are not found in equatorial region oceans as fresh water (daily evening rain) creates obstacle in the growth of corals.

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5. **Plankton** is essential for the growth of corals. Plankton is very soft micro vegetation develops on shallow areas of oceans. These areas include the coasts of East Africa, South India, Australia, Florida, the Caribbean and Brazil.

6. Oceanic waves and ocean currents also determines the growth of corals. These currents and wave brings food for the corals. That's why, corals are found very least in enclosed sea. Live Corals are also not found in Lagoons. In lagoons corals tries to develops towards sea. Sea waves and ocean currents also determines the shape of corals.

7. Submarine platform is essential for the growth of corals. It is the base on which corals built their colony. Such platforms should be at 300 feet/ 50 fathom.

8. Urbanisation, industrialization, global warming and other human activities have greater negative impact on the growth of corals. Scientists claimed that 10% of corals are died due to global warming effect. Some 30% corals are under critical condition and another 30% are under threat. The 1⁰C rise in temperature starts coral bleaching leads to conversion of algae from green to white colour. Ultimately, algae become died and due to shortage of algae (food of corals) corals are died. Scientist claims that due to increase in the temperature of Indian Ocean, corals in this ocean have died on large scale.

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All Reefs are not same. Thomas David and Andrew Goudie has listed four types of corals- 1- the fringing reef, 2-barrier reefs, 3-atoll and 4-table reef (The dictionary of Physical Geography,3rd edn. Oxford Blackwell, p.403).

Spalding has given fivefold classification-

- 1. Fringing reefs,*
- 2. Barrier reefs,*
- 3. Atoll,*
- 4. Platform reefs and*
- 5. Patch reef*

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*Corals differ according to the nature and **mode** of occurrences. Charles Darwin has divided the reefs into 3 broad categories.*

1. FRINGING REEF

2. BARRIER REEF

3. ATOLLS



1. FRINGING REEFS -

- It is also known as **coastal reefs** found near the coast. They simply grow towards the sea from the land. A shallow lagoon is formed between fringing reef and the coast. The shallow lagoon is also called **boat channel**. Fringing reef growth is more outwards than upwards. Its outer edge slopes downwards into the sea. The growth of such reef is continuous and uniform. Some time, a large river coming from the main land breaks its continuity. Sea waves deposits the broken pieces of corals in the form of a boulder zone (known as reef flat) on the rough and uneven surface of the fringing reef. It is observed that fringing reef can grow at a rate of 1-2 cm per year. Depth of lagoon in fringing reef is nearly up to 0.5-1.5 m. The lagoon is filled with water even during low tide. e.g. - Reefs in Gulf of Mannar (India), Eastern part of Andaman & Nicobar Island (India), near Florida Coast (U.S.A.), East of Timor Island, near the Coast of Papua-New-Guinea etc. Fringing reef of Red Sea is the best developed fringing reef in the world. Fringing reefs are commonly called shore reef.





2. BARRIER REEFS

- *Deep lagoons with 50-60m depth at some distance from the shore, barrier reef is found. It is the later stage of fringing reef. Its formation takes longer than a fringing reef. Hence, barrier reefs are rare in nature. e.g.–The Great Barrier Reefs near Eastern Australia. The Great Barrier Reefs is the longest/ largest known reef (2300 km.) system of the world. Barrier reefs are also found on the coast of Sulawesi, south-east of New Guinea, coasts of Providencia and south-east of Kalimantan. Belize barrier reef, New Caledonians Barrier reefs are also popular. Such type of reef is greatest and most extensive in nature. It contains 45° angles at outer slope. These barrier reefs are composed of many numerous reefs of different sizes extended over a submarine platform. They are connected to the sea through narrow and dangerous channels. Actually, barrier reefs are combination of several reefs hence their continuity is broken at many places.*

The Great Barrier Reef

- The Great Barrier Reef near Eastern Australian coast is extended between 9° to 24° south latitudes. It is 16 to 140 kms wide. It is seen as a wall for short duration during low / neap tide when water goes down. It is composed of thousands of individual coral reefs. This is one of the earth feature can be seen from outer space. Great Barrier Reef is the biggest living organism single structure on the globe. Composed and built by billions of tiny organism i.e. coral polyps. Wide variety/ diversity of life are supported on this reef, hence selected as **World Heritage Site** in 1981. It is also considered as seven natural wonders of the world too. At present the Queensland National Trust named it a state icon of Queensland.



3. ATOLLS



Atolls are developed around the island in ring /ox-bow shape or horse shoe shape enclosed within it a lagoon .The depth of lagoon in atoll is found up to 60-70m. Tahiti Island, Solomon Island, Palau Island, Bikini island, Marshall Island, Cook Island, Maldives, Chagos Islands, the Seychelles and in and around Coco Island etc. are the examples of atolls. Sometimes, an island found within the lagoon. There are opening in the circular reef through which the enclosed lagoon is connected with the open sea/ ocean. Atoll is formed by either rising of sea level or by sinking of seabed.

THEORIES REGARDING DEVELOPMENT OF CORAL REEFS

1. Subsidence theory of Darwin and Dana

2. Stand-still theory /Non-subsidence theory of Murrey (1880) supported by Semper and Augaseize (1906).

3. Glacial control theory of Daly (1915)



1. Subsidence Theory:

The subsidence theory of coral reef formation is based on the assumption that earth movement effects the growth and development of coral reefs. When coastal area submerges, coral organism develops a tendency to reach up to the new sea level. Therefore, new colony of coral organism develops over old coral colony. The process increases the height and thickness of coral reefs and their slope develops accordingly. The depth of lagoon becomes deeper. Darwin stated that, all corals begin as fringing reefs around an island or a continent. When there is change in sea level due to increase in sea level or submergence of coral platform, the corals tends to (continue to) grow upward. According to Darwin, coral growth is more on the outer side of the reef due to abundant supply or availability of food. Therefore, high rim is formed outer side in comparison to inner side.



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- *Darwin theory was put forward after his voyage in Beagle ship. During his voyage, he made a survey of Tahiti barrier reef and Atoll near Keeling. Darwin after his survey found that coral develops near shallow sea/depth but he found the corals at great depth which is not suitable for their life or growth too. Therefore, Darwin draws an assumption that the island or platforms on which coral develops are no longer in-situ/stand- still; it actually submerges. According to Darwin, Fringing, Barrier and Atoll reefs formation is the result of **successive evolutionary stages**.*
- *Davis had correlated the geological relation between coast and coral reefs. Davis found that wherever there is an evidence of subsidence; fringing and barrier reefs are there. The study of Davis was based on Tahiti island .During 1950-60 Davis studied about Bikini island (Atoll Island).Davis had found the coral rocks at 1300m depth. There he also found the evidence of the limestone and rocks of three (3) different geological periods. Davis suggested that all these are possible due to subsidence.*

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Darwin, Davis and Dana suggested that submerged platform remains the base of coral development. With the submergence of platform coral starts growing upward and outwards. Here the growth is restarted near the coast resulted into lagoon formation between reef and coast. The lagoon formation converted the fringing reef into barrier reef. If the submergence/subsidence continue further ahead than the outer rim grow fastly due to availability of coral foods as compare to inner part. At last, Atoll like structure develops. Darwin theory was supported by Dana. Darwin and Dana convinced that the presence of drowned valleys on the adjacent to a fringing reef proves subsidence. The shallowness of the lagoons associated with reefs is also a definite evidence of the subsidence process.

The study of Funafuti in 1896, Eniwitox in 1950-52 and Bikini atoll in 1947 supports the subsidence and formation of Atoll. In Narai Island of Fiji, fringing and barrier reefs are both found together against subsidence theory. There are some more evidences that create controversy against the subsidence theory.

Non-subsidence theory:

- *Non-subsidence or Stand still theory regarding formation of coral reefs is given by Sir John Murray in 1880 and later supported by Murray and Semper. After voyage in the Challenger in 1872, Murray put forward his theory regarding formation of fringing and barrier reefs against Darwin theory. Murray viewed that all reefs start their growth on a submarine platform. Some of them might have risen above the ocean surface. After that, sea waves attack on them and were cut down below sea level. According to Murray, neither sea level nor sea platforms are progressive or unstable in nature. He augmented that corals start growing on the platform which is situated at 60 meter of depth. Such platforms are provided by continental shelf or volcanic mountain tops. He also assumed that solution processes of ocean water are effective up to 60 meters of depth. Therefore, corals start their growth from the depth of 60 meters. Corals start growing towards seaward and upward side and solution process continued at sea level so central part becomes lower than outer parts. That central part is known as lagoon and outer rim is covered with corals known as atoll. Several corals and atoll exhibits evidences that their origin is non-subsidence in nature.*

Corals



Daly's Glacial Control Theory:



Glacial control theory regarding reef formation was put forward by Daly in 1915 after voyage to Hawaii Island. During his voyage, Daly observed about impact of glaciation on Mt. Mauna Kea. He correlates the relation between growth of coral and temperature of ocean water. Daly observed that during Pleistocene glaciation, temperature of ocean water fall considerably and sea level (30-50 fathoms) simultaneously. Due to ice age, all the corals were destroyed and became dead. The platforms were worn by ice and cut at converted into wave cut platform. After the end of glacial age, sea level comes back to their previous us level. All wave cut platform are now below sea level as submerged sea platforms. Those platforms are now new platforms or base for corals to grow with. Now new coral polyps developed their new colonies on these wave cut platforms. New corals recolonized themselves around the platform and grew gradually towards upward and seaward after post- glacial period.

Daly's theory becomes the part of criticism on following basis-

Maldweep, Sunda and near some other parts platforms are exhibits evidence against Daly's theory. They are very extensive/ large and high up to 1000-1200 mts. from sea level.

There is no uniformity in the lagoon depth as claimed by Daly. According to him lagoon depth should be 60-70 mts. whereas it is found 80- 100 mts.

Daly assumed that all the corals during ice age died due to very low temperature. Some other scientists believe that this is not possible all over the globe especially in tropical oceans.

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It is proven that there were four inter glacial periods during Pleistocene ice age. During that inter warm and cold period corals died and grow fresh every time. Most of the scientists especially, Davis has strongly criticized it and Daly has no reply on his objection.

Several died corals are found at the depth of 100 mts. in Pacific. Daly has never given satisfactory explanation to it.

This and many more criticism are given against Daly theory and have never tried to explain any objection.

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