Charles Darwin 1842

Summary after
Darwin, C. (1842)

Charles Darwin is most commonly known for his theories on natural selection that arose from observations made during his five-year voyage on the H.M.S beagle beginning in 1831. In addition to his observations on various animal species, Darwin made copious observations on coral reefs, atolls and ocean islands. In documenting the morphology and geology of the mid-ocean features Darwin defined parameters for specific features and hypothesized about their formation. The 1st edition of "The structure and Distribution of Coral Reefs" was published in 1842 and aimed to describe forms of coral reefs and their origination in each form. This work is a compilation of Darwin's observations as well as notes and observations from contemporaries. Coral reef formation falls into three categories: atolls (lagoon islands), barrier reefs (encircling reefs) and fringing reefs (shore reefs).

Favorable Growth Conditions

The reef building polypifers [corals] must be submerged at all times and if they are exposed to the sun directly, even for only a short time, the coral will die. There are, however, a few exceptions to this. Certain species of coral live in the breakers and reefs cannot flourish at great depths. Volcanic action seems to hinder coral reef growth though it does not stop it completely. Coral does not growth in areas with large flux of sedimentation such as river outlets. Also the input of freshwater from these outlets is also not favorable to coral growth. It is likely that conditions of the ocean (that have not be noticed at this time) in some way or another are responsible for coral growth or lack of growth.

Atolls

Pacific and Indian Ocean atolls tend to be an elongated shaped with fairly regular outline encircling a lagoon. The lagoons tend to have either sandy bottoms or bottoms filled with coral debris and delicate branched corals. Small islands or islets may form where the coral acts to accumulate matter during large swells. These islets range in size from just one point of the reef to

almost the entire way around the ringed reef with only a small inlet for the seawater to enter the lagoon. However the height of the islet never exceeds the height that could be reach by a strong swelling depositing material. The slopes of the reef gently enter deeper water for a short distance, then rapidly descents into the deep. These islets, in some cases, can be swept away entirely by the strong winds and waves of a hurricane or strong storm.

Barrier Reefs

Barrier reef is most commonly associated with the [great] barrier reef on the NE shore of Australia. Barrier reefs [other than the great barrier reef of Australia] in the pacific and Indian Ocean refer to a ring shaped coral feature circling a moderately sized, often mountainous, central island with a lagoon-channel between the island and reef. Generally, a barrier reef is comparable in width to an atoll reef. Similarly, the lagoon-channel is comparable to the lagoon within at atoll. Barrier reefs may also have a small islet, generally on the windward side. The islands encircled within the reef vary greatly in height and can be as high at 7,000 feet or as low at 50 feet. Observations made prior to Darwin's explorations hypothesized that the mountain islands have submerged flanks below the lagoon-channel and reef.

Fringing Reefs

Fringing reefs cling to the shore of islands or continents and have a smaller width than barrier reefs. The reef often fringes the majority of the island. The size and structure of fringing reefs is strongly dependent on the steepness of the slope of the mountain below sea level.

Origin of Coral Reef Forms

Subsidence is the result of storms and earthquakes. Atoll formation is attributed to growth of coral upon a submarine crater. One noted problem with this theory of formation is that we rarely see craters in the shape of the atoll reefs i.e. elongated oblong shape. Another (and better theory according to Darwin) theory is that the outer portions of the reef are the first to reach the surface and would form the ring. Thus, atoll reef grows on a submerged bank (steep slopes and a flat top) far below the surface. If the submerged base was a conical volcano then there is no reason

that the reef wouldn't form at the peak of the mountain. However, at this time it was thought that it was unlikely that there would be enough submerged banks in the Pacific and Indian Oceans to be the basis for all the known atolls. Fringing reefs form as corals grow along the submerged slopes of the island in water at the right depth for corals to thrive, not too shallow and not too deep. Observations of linear arrangements of the features lead to conclusions of the many features being part of one long chain. Darwin notes the presence of many sub aerial islands present in the Pacific and Indian Oceans. The foundation of the atolls and islets is unclear. Several theories are presented in this work as to the formation of the foundation of these features. One theory is that there is accumulation of sediments unable to reach the sea level because of surface currents. However this is unlikely because the regions of the Pacific where atolls form are free from necessary amounts of sediments. A more likely theory is that the atolls and islets have rocky bases. These rocky features were brought to their currents sub aerial positions through movements in the earth's crust. Uplift of the rocky bases does not work because then some would be well above sea level so Darwin concludes that the rocky bases are in their current positions because of subsidence. Darwin uses earthquakes as evidence that subsidence is taking place since the atolls are not near to any high ground (in which earthquakes would indicate uplift). In summary, many regions of the ocean are void of high ground which atolls and islets are abundant. Since coral cannot grow at great depths, the coral must be growing on rocky bases, which are slowly sinking as the coral is continuing to grow. With this explanation in place, Darwin explains that if you begin with a fringing reef and the mountain subsides you will eventually get a perfect barrier reef and after some more time a perfect atoll, as based on the subsidence of the base and continued growth of the coral upon itself. The existence of reefs that lie somewhere between a fringing reef and barrier reef give support to the progression of reef forms.

Reference:

Darwin, C. (1842). The Structure and Distribution of Coral Reefs: Being the First Part of the Geology of the Voyage of the Beagle, under the Command of Captain Fitzroy, R.N., During the Years 1832-1836. London: Smith, Elder and Co. 214 pp.