

cemented into a porous calcareous sandstone, or, where pebbly, into a coral pudding-stone. It forms layers, or a laminated bed, along the beach of the lagoon, and also on the seashore side, sloping generally at an angle of five to eight degrees toward the water, but sometimes at a larger angle, this depending on the slope of the beach at the place. The rock is sometimes an oölyte, owing to the coating of the grains with the calcareous cement as solidification goes on. Oölyte is especially common where accumulations of sand make large sand-flats partly emerged at low tide.

4. *Formation of the coral reef.*—A reef-region is a plantation of living corals, in which various species are growing together in crowded thickets, or in scattered clumps, over fields of coral sand. Besides corals and shells, there are also calcareous plants, called *Nullipores*, growing over the edge of the reef, in the face of the breakers, as shown by Darwin, and attaining considerable thickness. Even the delicate branching kinds sometimes make thick beds, as observed by Agassiz in the Florida seas. Bryozoans add a little to the material, occasionally making large massive corals. In Paleozoic time, both branching and massive kinds contributed largely to limestone formations.

5. *Action of the waves.*—The waves, especially in their heavier movements, sweeping over the coral plantations, may be as destructive as winds over forests. They tear up the corals, and, by incessant trituration, reduce the fragments to a great extent to sand; and the debris thus made and ever making is scattered over the bottom, or piled upon the coast by the tide, or swept over the lower parts of the reef into the lagoon, or drifted off by the currents for deposition elsewhere. The corals keep growing; and this sand and the fragments go on accumulating: the consolidation of the material thus accumulated makes the ordinary reef-rock. Thus, by the help of the waves, a solid reef-structure is formed from the sparsely growing corals.

Where the corals are protected from the waves, they grow up bodily to the surface, and make a weak, open structure, instead of the solid reef-rock; or, if it be a closely branching species, so as to be firm, it still wants the compactness of the reef that has been formed amid the waves.

6. *History of the emerging atoll.*—The growing corals and the accumulating debris reach, at last, low-tide level. The waves continue to pile up on the reef the sand and pebbles and broken masses of coral,—some of the masses even 200 or 300 cubic feet in size,—and a field of rough rocks begins to appear above the waves; and finally a beach is completed. The sands, now mostly above the salt water, are planted by the waves with seeds; trailing shrubs spring up; and afterward, as the soil deepens, palms and other trees rise into forests, and so the finished atoll receives its foliage.

The windward side of such islands is the highest, because here the winds and waves act most powerfully. But where the leeward side of one part of the year is the windward of another, the two may not differ much. The water that is driven by the winds or tides over the reef, into the lagoon,