

HOW CORAL REEFS CAME

THE RESULT OF AGASSIZ'S LATEST INVESTIGATIONS.

Former Theories Upset and Nothing Satisfactory to Replace Them—Puzzling Differences in Various Regions of Coral Growth. Some Interesting Facts.

Prof. Alexander Agassiz has returned to his home in Cambridge after a five months' trip to the islands of the Pacific. It was made on the *Yaralla*, a twin-screw steamer of about 400 tons, and there was a full outfit of dredging, sounding, and deep sea instruments, as well as materials necessary to preserve the collections. The day before leaving Cambridge for the Pacific news had arrived that the expedition of Prof. David of the University of Sydney had bored into the atoll of Funafuti to the depth of nearly 600 feet, the bottom being still in coral. But later experience would seem to indicate that a general theory of the formation of coral reefs is as far removed as ever. Prof. Agassiz says: "I came to Fiji under the impression that we were to visit a characteristic area of subsidence.

Dana, in his last discussion of the coral reef question, states that it is impossible to find a better series of islands than those of the Fiji to illustrate the gradual changes brought about by subsidence, which transforms a volcanic island with a fringing reef to one with a barrier, and next to one with a circular reef ring, and finally to one in which the interior island has disappeared, and has left only a more or less circular reefing. For these reasons one of the Fiji atolls promised to be an admirable location for boring and settling the question of the thickness of the coral reef of an atoll. My surprise was great, therefore, to find within a mile from Suva an elevated reef about 50 feet thick and 120 feet above the level of the sea, the base of the reef being underlaid by what is locally called soapstone, probably stratified volcanic mud.

But the traces of extensive elevation are not limited to the larger island of Viti Levu. I found the islands on the rim of the atoll of Negele Levu to consist entirely of coral rock elevated to a height of over six feet on the larger island. In was found that at Vanua Moalvu the northern line of islands were parts of an elevated reef forming vertical bluffs of coral rock, raised by a central volcano mass of the main island to a height of from 500 to 600 feet. On the south of the main island they are much lower. At Mango the vertical bluffs are underlaid by volcanic rocks, which crop out at the sea level. At Tavuha the bluffs are probably 800 feet high, and at Lakemba about 250. On the island of Aiwa the elevated reef is fully 200 feet thick. On the three islands of the Yangasa group it attains a thickness of from 240 to 290 feet, and finally, on Ongea it attains a thickness of nearly 300 feet, and at Fulanga 360. At Vatu Leile, the most westerly island we examined, the elevated reef forming the island is 110 feet thick at its northern extremity.

As far as we can judge from the Fiji Islands the shape of the atolls and of the barrier reefs is due to causes during a period preceding our own. The islands of the whole group have been elevated, and have, like the northern part of Queensland remained nearly stationary and exposed to great and prolonged denudation and erosion, which have reduced the islands to their present height, the platforms upon which the barrier reef corals have grown being merely the flats left by the denudation and erosion of a central island of greater size than that now left, while the atolls are similar flats from the interior of which the islands have been eroded, and the lagoons of which have been continually scoured by the action of the sea, the incessant rollers pouring a huge mass of water into the lagoon, which finds its way out through the passages leading into it.

In the Fiji Islands the atolls and islands or islets, surrounded in part or wholly by barrier reefs, have not been formed by the subsidence and disappearance of this central island, as is claimed by Dana and Darwin. The Fiji Islands are not situated, as was supposed, on an area of subsidence; but on the contrary, they are in an area of elevation, so that the theory of Darwin and Dana is not applicable to the islands and atolls of the Fiji group.

What the age of the elevated reef of the Fiji is I am unable to state. Its aspect and position show it to be of considerable age, probably antecedent to the present period. In many ways it resembles some of the late tertiary elevated limestone which I have seen on the northern and southern coasts of Cuba. She great thickness which the elevated coral reefs attain in this group, at least 800 feet, also shows that they may have been deposited originally during a period of subsidence taking place in our epoch or which could have had any effect in shaping the outline of the islands of the Fiji group and their accompanying reefs.

The evidence thus far collected on the Fiji shows the futility of boring in this ground. Any result obtained would merely at some point indicate the thickness of a former elevated reef—a reef formed in a period preceding our own. We should obtain information which could have no bearing on the main question, if I am correct in the interpretation of what I have observed; information, in fact, which may be obtained as one steams along, without the trouble or cost of boring. Should I be correct, it would be natural to look upon the results of the boring at Funafuti much in the same light and assume that the island, as well as others in the Ellice group, is also in the area of elevation, and that the great thickness of coral obtained was reached by boring in the base of an ancient reef. So that the results obtained by Prof. David from the boring at Funafuti do not assist us in any way in corroborating the theory of subsidence as essential to the formation of atolls.

However that may be, it only emphasizes what has been said so often, that there is no general theory of the formation of coral reefs, either barrier or atolls, of universal application. Each district must be examined by itself—at least such has been my experience in Florida, in the Bermudas, in the Bahamas, in Cuba, in the West India Islands and in the Sandwich Islands. The results of this trip show plainly that the theory of Darwin and Dana of the formation of atolls and of barrier reefs by subsidence is not applicable to the Fiji Islands, notwithstanding the boring at Funafuti by Prof. David of the University of Sydney. In all the localities that I have visited the coral reefs form but a thin crust upon the underlying base—it is not more than fifty or sixty feet thick in Florida—and the shape and slope of the base is in no way due to the growth of the corals living upon it.

There are in Fiji a number of small atolls from one to three or four miles in circumference, the formation of which, it seems to me, can only be satisfactorily explained on the theory that they have been formed upon the eroded summits or rims of extinct craters, the rim of the volcano having been eroded either to a continuous flat or to flats separated by deeper passages forming entrances to the inclosed lagoons. The great variety of causes which have been active in shaping the present physiognomy of the reefs and atolls of Fiji shows the impossibility of assigning any one factor, like subsidence for instance, as is done by Dana and Darwin, as the single cause for the formation of the many different kinds of atolls and barrier-reef islands to be found in the Fiji group.

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After Carstairs became the private adviser of William he was presented with the instrument by which he had been tortured. The king, wishing to see the measure of fortitude necessary to endure the terrible torture, without making a confession of some sort, placed his thumbs in the machine and told Carstairs to turn the screw. He turned slowly and cautiously.

"It is unpleasant," said King William, "yet it might be endured. You are trifling with me; turn the screw so that I may really feel pain similar to that you felt." Carstairs turned the screw sharply. The king cried out, and when released said that under such pain he would have confessed to anything, true or false.

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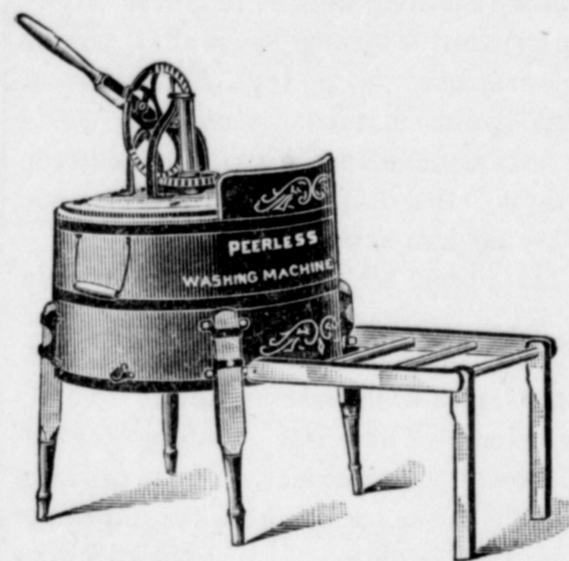
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