

of Sumatra, this small island was really a piece of Malacca, having the same geological structure, and there could be no doubt that it was once joined to the peninsula of Malacca. Before the volcanoes originated, however, Sumatra must also have been joined to Malacca, the continent of Asia being extended so as to include Sumatra and the small islands beyond. The row of islands on the west coast also contained some peculiar animals, and were connected with Sumatra by a shallow sea, whereas immediately outside them the sea sank suddenly to the enormous depths of the Indian Ocean; and the wonderful similarity on the whole of the animals of Sumatra with those of the Malay Peninsula rendered it perfectly certain that the two countries were at one time joined, and at a not very remote period. Still it was remote enough for the intervening land to have sunk down, and then for the volcanoes to have arisen and poured such a mass of matter into the water as to form the enormous expanse of undulating country, which was largely formed of a red clayey substance such as was seen in almost all regions where volcanoes abound. It had been deposited in the sea, then uplifted, and then cut through by the rivers.

As the mountains were approached, the variety and beauty of the vegetation increased, and all the more remarkable birds and insects were found there, as well as the higher races of Malays. The whole of the southern portion of Sumatra was inhabited by a genuine Malay race; in fact, they were the originals of the Malays, speaking various dialects of the Malay language. Further north there were other races, which, though belonging to the Malay type, were not of the true Malay stock, and spoke different languages. No doubt, all these matters would be clearly explained in the work which Professor Veth had promised, and of which he supposed that the beautiful photographs now exhibited would form the illustrations.

Notes on the Cocos or Keeling Islands. By HENRY O. FORBES, F.Z.S.

Map, p. 816.

I LEFT England in October 1878 for the purpose of investigating the fauna and flora of certain districts of the Malay Archipelago. Arriving in Java in the middle of November, the rains set in in such good earnest that I was beginning to fear that I should be detained in a state of almost complete inactivity till the season was more advanced, when I was informed that a small trading brig belonging to the proprietor of the Keeling Islands, was lying in the roads on the point of sailing. I at once decided to pay a visit to this outlying spot, made classic by the visit of Mr. Darwin in the *Beagle*, and by his description of the atoll in his 'Coral Reefs,' to see what changes, if any, had occurred since 1836. Embarking on the 17th of December, 1878, I arrived, after a passage rendered dismally long by continual calms and contrary winds, on the 16th of January of this year. I was received by the present governor, George Clunies-Ross, Esq., with the greatest kindness. To him I am indebted for a vast deal of accurate information regarding the islands. He is a keen observer, and thoroughly acquainted with the manners and habits of every living thing, animal and vegetable, within his domains, as I had very frequent opportunities of verifying. The history of the island for the last twenty years, during the greater part of which it has been under the present direction, would form a most

interesting chapter in the history of colonisation. It is too long to enter into here, and must be left for a future occasion; meanwhile I shall confine myself to the observations I have made on its scientific aspects, and in noting these I have followed the narrative of Mr. Darwin in his 'Coral Reefs,' edition of 1874.

When the *Beagle* visited the South Keelings in 1836, both Captain Ross (R.I.N.) their discoverer (for as far as I can learn they were unknown till he, on his homeward voyage from Java after the rehoisting of the Netherlands flag in Batavia sighted and landed on them), and certainly their first occupier, as well as his son were absent; a circumstance greatly regretted by them on their return, the more so when they learned that Mr. Darwin had had to rely on the person left in charge of the settlement for some of his information. It will be seen below that this information was not altogether reliable.

The weather during my visit was not sufficiently favourable to enable me to examine the state of the outer margin, save on one occasion, and that only on the eastern shore of Direction Island. The margin was paved with huge pieces of natural concrete, made up of pieces of worn coral, and shells, not always broken, imbedded in a solid calcareous matrix; whereon was spread out a mass of rough shingle extending close to the foot of the bank, as it were, on which the trees are growing, and in breadth about five or six yards. Of this *loose* shingle or débris the whole island is composed; thus differing from all the others in possessing in its centre no *concrete floor*, wherever excavations have been made; and, as might be expected, this is the only island in which there is no fresh water, perhaps an indication that this particular islet is not so old as the others. I observed numerous mollusca boring in the hard barrier concrete on the southern edge of the island, in particular a species of *Trochus*, which had excavated deep pits over large tracts, especially over spots where a teredo had apparently made its canal, as if in pursuit of this borer. It was with much interest also that on one occasion I observed, as the tide was rising, and just where the surf breaks on the reef, hundreds of large *Scarus* feeding off the coral fields; their cushioned heads pressed hard against the rock the while they gnawed away the polyps with their powerful naked teeth.

Between Direction Island and the small spot next to it set down on the Admiralty Chart as *Workhouse Island*, there were indications of what appeared to me to be recent elevation. At the northern end of the latter island, it being then ebb tide, we walked over a portion of the margin on which was standing only an inch or two of quite warm water; here I observed Ostræidæ, small Chamidæ, and other shells, all dead *in situ*, doubtless killed by exposure to the sun and fresh water with which they would inevitably be flooded during heavy rains. At high tide they would be some depth under water. These shells did not present the same corroded and blackened appearance which others in the

lagoon did, and which were destroyed by a cause to which I shall presently refer; yet there is a *possibility* that the destructive agency was the same. This island has a high beach completely surrounding it of very fine white sand, composed almost entirely of the minute shells, nearly microscopic, but of exceeding beauty, of mollusca, of echini, and of crabs, with a small proportion of coral débris; quite different from the sand I saw anywhere else on the atoll.

In the lagoon I have to note that the channel referred to by Mr. Darwin, through which a vessel built on South East Islet was floated, is now entirely filled up, no trace being perceptible, as well as the "boat passage," dotted out on the Admiralty Chart, from the south-east extremity of Long Island, as is also the "small boat channel" from the old settlement.

I have had an opportunity of examining the original chart of these islands, made by Captain Ross, when he surveyed the group shortly after its discovery, in 1825, and there I can find no indication of South East Island having been divided by channels into islets, as stated by Mr. Darwin. There is scarcely any perceptible difference in the external configuration of the various islets. The soundings in the lagoon, however, show a greater continuous depth, and I am told that the *Borneo* sailed, on her first coming, far up the bay, and anchored where now no ships can nearly approach. The coco palms all along the margins of the islands are smaller than those in the interior, though in many cases they are much older, and Mr. Ross tells me that the rich soil of the interior, with a better supply of fresh water, and where the sun does not strike so strongly, is favourable to the production of larger and taller stems (some reach a length of 118 to 120 feet), while the amount of fruit is not more than from the shore-growing trees.

I was not able to satisfy myself as to what part of the lagoon Mr. Darwin refers when he says "the upper and south-eastern part." I did not see the dead field of coral mentioned at page 21 of his 'Reefs.' The explanation given by him does not seem to be well founded, viz. that since the closing of the above-mentioned channels, the water would not rise so high in the lagoon as before, and that the corals, which had attained the utmost possible limit of upward growth, would be occasionally exposed for a short time to the sun and be killed. Such a circumstance, however, as I describe below would be a sufficient explanation. I put the question to the present proprietor, if there was any difference in the rise and fall of the tide in the lagoon, and received the reply that as far as he had observed for the last twenty-five years there was no diminution of the rise at the head of the lagoon during a high south-east wind, compared with that at the mouth.

I observed numerous trees undermined by the water both inside and outside the lagoon, some bending down close to the sea, others quite prostrate. Mr. Ross assured me that this really indicated no sign of

encroachment on the land, as all along the margins of the islets, spots here and there, according to the direction of the gales, are worked into by the tide, but the débris is carried a little further along, and re-deposited to the same amount; and what this year has been removed will at a future day be replaced at the expense of some adjacent spot. This I could see in the case of the small island already referred to—Work-house Island on the chart—which suffered severely during a cyclone in 1876, and of which one corner had been completely washed away, along with the trees growing on it, but now to a great extent replaced. It seemed to be the same all round the island, where the coco-nut trees grow to within a few feet of high-water mark. In regard to the “foundation posts of a shed now washed by every tide, but which the inhabitants stated had seven years before stood above high-water mark,” * Mr. Darwin seems to have been wrongly informed. These posts never belonged to any building, but were driven in by Captain Ross, in order at that point to make an artificial jetty or breakwater, which at the period of the *Beagle's* visit was uncompleted. It was subsequently finished, and now protects the landing-place from the current entering by the southern end, which otherwise would sweep round and deposit sediment in the baylet where the settlement stands.

In the year 1863 there occurred a cyclone which devastated the islands, sweeping down the coco-nut trees, and ruining all the houses. During its height the wind, which came in gusts, “could, as is described by all those who witnessed it, “be seen, as a thick mist, or broad belt of steam,” to whose violence everything yielded—trees, shrubs, grass! When the hurricane had passed, scarcely one green blade was to be found on any islet of the group. Following the tempest there was a period of drought extending over seven months, so severe that the trees which survived had not recovered the shock within ten years. To crown the disaster, myriads of locusts, which suddenly appeared, doubtless brought by the wind, devoured for a time every leaf as it came forth.

In 1866 there were many months of rain, so heavy that the fresh water stood several inches on the surface of the lagoon, causing the death of large numbers of fish.

The islands by degrees recovered the disaster of 1863, and the crop of nuts had again almost reached an average weekly rate as great as that before it (by this time, however, the whole of the islands had been cleared of brush, and were producing nuts). On the 25th of January, 1876, the mercurial barometer indicated some unusual atmospheric disturbance; the centre of the mercury became depressed into a deep hollow tube, without falling much, while the air felt extremely heavy and oppressive. The mercury remained stationary till the 28th, when it fell to a little above 28 inches. This timely warning gave opportunity for all boats to be

* ‘Coral Reefs,’ page 24, 1874 ed.

hauled up and doubly moored in a place of safety. In the forenoon of this day, the 28th, there appeared in the western sky an ominously dark bank of clouds; at 4 p.m. a cyclone of unwonted fury burst over this part of the Indian Ocean, commencing in the south-west and travelling round to the east.

The store-houses, engine-room, and mills, all built of stone, were completely gutted, and partially demolished; their squares of corrugated iron roofing were carried to distances of four and five miles, where they were afterwards recovered. One square I saw immovably imbedded in the trunk of a large tree. Every house in both villages was entirely destroyed. Among the palms, both on North and South Keelings, the wind seems to have played a frantic and capricious devil's dance, clearing long lanes, yards and sometimes miles in length, snapping the trees close to the ground; sometimes cutting out circular spots, many yards in diameter, without injuring the trees on the circumference or making an entrance or exit path; sometimes it has made long ovals, leaving unharmed the trees in the interior; not seldom it has twisted the stems in a locality, some of them of thirty years' growth, into perfect screws, without uprooting or in other ways damaging them. Everywhere the prevailing force seems to have been rotatory. The storm reached its height about one o'clock on the morning of the 29th, when everyone again avers that he could distinctly see the gusts of wind, condensed into steam, as it were, cutting asunder and demolishing, as it travelled, every opposing thing. To what distance the barometers fell it is impossible to tell, for the mercurial was broken, and the aneroids when once they had fallen below $27\frac{1}{2}$ inches suddenly ceased to register, and to this day stand mute witnesses of the strain they endured. In the former cyclone, also, the aneroids gave way at the height of the storm. About midnight of the 28th, when intense darkness would have prevailed, save for the incessant blaze of lightning, whose accompanying thunder was drowned by the roar of the tempest, when all were endeavouring to save as much rice—the only food left to them—as possible, Mr. Ross discovered to his horror the bowsprit of the schooner, which was lying at anchor some distance off, riding on the top of a great wave straight for the wall behind which they stood. There was only time to make themselves fast before the water washed over them, fortunately insufficient to carry the vessel through the wall! A second wave washed completely through Mr. Ross's own house, standing at a distance of about 150 yards from high-water mark. There was at least another similar wave; but whether there were more is uncertain, the occasion being scarcely favourable for accurate observation. The conglomerate round the whole atoll has been scooped under, broken up, and thrown in vast fragments on the beach. On the eastern shore of New Selima or Water Island, just opposite the settlement, I saw a wall of many yards breadth and several feet in height thrown up clean over the

external high rim of the island several yards inwards over a thick hedge of redwood and *moncoodie*, in among the coco-nut trees, and this all along the island's margin.

The following morning broke with the calm and brightness of a summer day, but the sun shone only on stately widowed stems and leafless trees, and on incredible ruin and confusion—still too plainly to be seen. Within the compass of the islands not a speck of green could anywhere be found, not even among the blades of grass or among the fallen and scattered leaves; all were black and withering. Yet in six months every tree and shrub was clothed in green; and now, in three years, all are yielding their full crop again.

About thirty-six hours after the cyclone, the water on the eastern side of the lagoon was observed to be dark-coloured. Examination showed that the point of origin was somewhere about the southern end of New Selima and the northern end of Gooseberry Island, and, moreover, that it was coming up from below. The colour was of an inky hue, and the smell "like that of rotten eggs." From this point it spread south-westward as far as the deep baylet in South-East Island, where, meeting the currents flowing in at the westward and northern entrances, which run, the one round the western, the other round the eastern shores of the lagoon, its westward progress was stopped; whereupon, turning northwards through the middle of the lagoon, it debouched into the ocean by the northern channel, having become slightly less dark as it proceeded.

Within twenty-four hours every fish, coral, and mollusc in the part impregnated with this discolouring substance—almost certainly hydro-sulphuric acid—died. So great was the number of fish thrown on the beach, that it took three weeks of hard work to bury them in a vast trench dug in the sand. I am informed that many strange species were found which have not been seen since, nor had they been seen before. There was no time to spare to preserve them; it was feared the stench might breed a pestilence. After about ten to fourteen days the discoloured water ceased to ooze up.

I carefully examined that part of the lagoon over which the poisoned water spread. The day was so calm that I could see the minutest objects on the bottom. The sight was such that I could not resist the peculiar feeling of depression one experiences in passing through a forest over which the fire has passed; for the whole eastern half of the lagoon is one vast field of far-spreading corals, where stand now only blackened and lifeless stems; where once flourished thousands of giant clams and other mollusca, but occupied now by vacant, lustreless shells alone, in all stages of expansion. Everywhere both shells and coral are deeply corroded, the coral especially being in many places worn down to the solid base. For the past three years there has been until lately no sign of life; very few fishes even now are to be found

there; while here and there can be detected a new branch or two of *Madrepora* and *Porites*. I found only one chama alive, whose length was 12 and its breadth 13 inches.

Beyond the line of the dark water the coral is growing with great rapidity; but in thick clumps between which there are pits, of no great diameter, but extending to a depth of some eight or ten fathoms. Why it should grow thus it seems difficult to understand; and why in these pits the coral should be almost confined to a species growing in "three foliaceous fungus-like expansions covered with stars."

That an earthquake should have occurred on this reef two years before the visit of the *Beagle*, is an interesting fact. That an earthquake took place in 1876, I think can scarcely be doubted, although no tremor was detected by anyone on the island—scarcely to be wondered at during the war of the elements, and the crash of falling houses and trees. The tidal waves as well as the darkened water (issuing, without doubt, from some subaqueous rent in the earth) indicate the occurrence of an earthquake. The explanation, therefore, of the dead field of coral observed by Mr. Darwin may lie in the supposition that some such phenomenon accompanied the earthquake of 1834.

In the small boat channel close to the settlement—where the coral has begun again to grow vigorously since 1876—the water at this spot was not so deeply impregnated with poison. I obtained several living bunches, easily dislodged by the root from the chalky bottom on which they grew, by the hand, without the aid of a crowbar. I found their average diameter across the top to be 12 inches, and their height from the centre to the top of the branches $6\frac{1}{4}$ inches. As this channel was thoroughly cleaned out down to the white mud on the 20th May, 1878, and as my measurements were made on the 30th January of this year, the age of these bunches was under eight months and ten days.

There is scarcely any perceptible increase in the length of the islands. On the eastern side there is some increase in breadth against the direction of the prevailing winds. Between Turtle Island (at the southern bay of Long or West Island) and the point opposite to it, the coral has grown up so that one can almost step across from one to the other; while a few yards northward there has been deposited within the last ten years, close to where the now obliterated boat channel began, a sandbank jutting out in a south-westerly direction. By and by there will be formed a second smaller lagoon, similar to the one a little to the northward.

The small islands between West and South-East Islands have each received slight additions on their northern aspects. On the western side, where the chart shows "channel," there is now no passage. A large sandbank has accumulated inside the lagoon. The long northern promontory of West Island has to some extent been worn away by the current sweeping round that point into the lagoon, and redeposited as

a long bank on its eastern shore ; some of it is also carried as far southward as the elbow opposite the top of the small lagoon, while some has been redeposited at the entrance. This little lagoon is becoming every year more and more shallow ; at ordinary tides a small portion only is covered, while the whole space is never submerged except by the extraordinary tides occurring twice a year. Portions of the northernmost end are already reclaimed ; coco-nuts are now fast taking root in the shallower parts, while the wonderfully adapted worm-substitute, the pomegranate crab (called by the natives Kapitang Dulima), with a greyish-white carapace, and an enormously developed, bright pink-coloured right-hand claw, is assiduously labouring to make the soft, pure-white calcareous mud, composed of fine coral detritus and their own cast-off claws and chelæ, into tree-inhabitable land. The whole of the little lagoon, over a mile in length and three-quarters in breadth, is crowded with the holes of this small crustacean ; a spot selected at random, measuring two square feet, contained more than 120 holes, each about from half to an eighth of an inch in diameter. Each hole is surmounted on the top by a small rim of mud just like the earthworm's at home, and reaches to a perpendicular depth of between two and three feet, but in a spiral manner. It was a most interesting sight to watch these busy pioneers of cultivation carrying down fucus and sea grass, scraps of coco-nut palm leaves, fibres of coir, and fragments of nuts as well as considerable branches, which, by scooping the soil from underneath them, they gradually bury completely out of sight. Being exceedingly timid, they are very difficult to catch. On the slightest sound there is a general retreat to their holes for safety ; the only portions exposed being the eyes at the end of long eye-stalks and part of the pink chela. As the footstep approaches, one's eye is conscious of a quick jerky movement about the mouth of the hole, and of the disappearance of areas of pink spots. To dig out the occupant, following its spiral stair-way, entails the excavation of several feet of tenacious pasty clay. From Horsburgh Island a spit of sand runs out in a direction more north-westerly than is laid down in the Admiralty chart, to meet another in a south-westerly direction from North Keeling, on which, at a spot half-way, the bottom can be seen in calm weather. Lastly, it is possible to walk at low tide, with some slight wading, all the way from Direction Island to West Island.

The climate is temperate and extremely healthy ; the average of the thermometer for the three weeks of my residence is the following :—Lowest in night 76°·12 Fahr., 8 A.M. 81°·59 ; highest 83°·7, 8 P.M. 80°·51. The barometer was almost stationary at sea-level pressure.

The inhabitants, all of Malay origin, are well developed, strong, and of a wonderfully healthy appearance ; the average height of fourteen selected at random was 5 feet 7·27 inches, and their weight 160·72 lbs.

I trust that these notes, rough and written in the hurry of travel, may not be without some interest.

