

damental unity of the great groups of the Malayan, Papua, and Australian, in opposition to the opinion of their separate character and origin, and of the isolation of the Australian languages in particular. We doubt not his being right in his view, that in this question, as in many analogous cases, grammatical differences are valued too highly—glossarial affinities too low; the relative value of the two tests not being constant, but varying for different languages. This, however, is a topic too copious, and too curious also, to be dealt with as a mere offset from other subjects.

In the foregoing part of this article we have drawn somewhat largely upon our readers' attention—perchance also a little on their patience—by the various facts connected with the coral ridges and reefs forming the vast and prolonged line of barrier on the Australian coast. We recur for a short while to the subject; not, however, in relation to particular localities, but to the general history and theory of these coral formations, as one of the great physical phenomena of the earth's surface: impressive, not merely from the enormous magnitude of these animal creations of the ocean, but also from the index and evidence they afford of past and progressive changes in the level of the solid crust of the globe. We have already referred to a former article in this Review, on the voyages of the *Adventure* and *Beagle*, in which we noticed the remarkable researches on these coral formations contained in Mr. Darwin's journal of the latter voyage. This gentleman has since published a separate volume, '*On the Structure and Distribution of Coral Reefs*,' which we have taken as one of the heads of the present article; wishing to complete the view of the subject, and seeing that to Mr. Darwin we owe not only the most extensive and exact observations upon it, but also certain general conclusions which are now in progress of adoption by men of science in every country. From this volume, which possesses the charm of a simple and perspicuous style, conjoined with great reasoning powers, we shall briefly extract some of these conclusions, as well as the more important facts from which they are deduced.

We have already noticed generally the three classes of atoll, barrier, and fringing reefs, including all the most characteristic varieties of coral formation on the globe. These varieties, however, owing to local or other conditions, are so multiplied in detail, that it would be almost as difficult to give a clear description of them, as to explain the circumstances in which they respectively originate. Without attempting to follow Mr. Darwin in his more ample survey, we may state that, as instances of the lagoon islands, or atolls, he selects Keeling Island, in the Indian Ocean, the

vast group of the Maldives, and the extraordinary submerged atoll called the Great Chagos Bank. The first is a single but characteristic specimen of its class. The Maldivé Islands form an archipelago of coral atolls, 470 miles in length and about 50 miles in breadth; the atolls ranged in a double line, and some of them of great size—as that of Suadiva, 44 miles by 34, with an included expanse of water nearly 300 feet deep, and not fewer than 42 channels through which a ship may enter this central lagoon. The Chagos Bank, in the centre of the Indian Ocean, rising abruptly from unfathomable depths to a level near the surface, its longest axis of 90 miles, its breadth from 50 to 70, is well described by Captain Moresby as ‘a half-drowned atoll;’ a view confirmed as well by soundings, as by the many similar reefs and atolls rising to the surface around it. To this officer we owe admirable surveys both of the Maldivé and Chagos groups, which have done much to illustrate the subject.

Of the ‘Barrier reef’ the most conspicuous instances selected are that great one, fronting the eastern coast of Australia, with which our readers are now acquainted, and a similar but shorter one on the western coast of New Caledonia. The term, however, has been fitly extended by Mr. Darwin to those reefs encircling smaller islands, which are so numerous in the Pacific, and familiar to us in the narratives of voyages in this ocean—coral walls, in fact, with a deep moat within, girdling round islands of every various dimension and height—some little raised above the sea—others, like Tahiti, having an elevation of many thousand feet.

‘Fringing or Shore reefs,’ whether encircling islands or portions of continents, differ from those just described in being less massive, in having no interior deep-water channel, and in sloping downwards into the sea upon the natural declivity of the shores. The reefs of the Mauritius furnish a well-marked insular example of them. The coasts of Brazil and Arabia afford instances, among many that might be quoted, of such coral fringes to continental lands.

Mr. Darwin has done much to simplify the view of the several coral formations just noted, by showing that they graduate into one another, and that the atolls, barriers, and encircling reefs are but modifications, deviating much in the extreme cases, of a common principle and manner of operation. A perfect series, in fact, can be traced from the simple linear or normal state of the reef, to the long linear lagoon, and thence to the oval or circular form of the encircling reef or the atoll. Again, if from the barrier reefs encircling small islands we abstract the land within (a legitimate speculation, as will hereafter be seen), we bring them to an almost complete identity with the simple atoll or

lagoon island, in form, dimensions, and grouping. The value of such generalisations as these to a just theory on the subject will be well understood, even without a full comprehension of the details on which they are founded.

The fourth chapter of Mr. Darwin's volume relates to the distribution of coral formations, and their rate and manner of growth: including such knowledge as we possess regarding the species and habits of the polypifers, or coral animals, which have produced them. On the subject of these wonderful zoophytes, the details given are not perhaps as distinct as might have been desired for general information. It is Mr. Darwin's main object, in reference to his theory, to determine the rate as to time, and the depth below the surface of the sea, at which the workings of living coral can go on; and we do not find any consecutive description of the aspect, species, and habitudes of these active tenants of the deep. It must be admitted, indeed, that our knowledge on these points is very deficient. Exact observations are not easy where the animal works either below the surface of the water, or amidst the heaviest surf and breakers on the edge of the reef. Here, where all besides perishes, the zone of coralline life exists in its greatest activity; but hardly more accessible to observation than are the dead corals brought up by dredging—in such variety of species as to leave it uncertain which are the true artificers of the reef, and which contribute to it solely by being agglutinated, with broken coral, sand, shells, and other materials, into the common mass. Ehrenberg has described more than a hundred species of coral which he found in the reefs of the Red Sea. Some observers have believed that the genus *Astræa* is that most efficient in the formation of coral rocks; but the Madrepore, Millepore, Porites, Meandrina, Caryophyllia, and various other genera contribute largely to these vast and mysterious works—in what proportion, and under what laws or instincts of combination, we shall probably never be able fully to comprehend.

Other problems equally difficult embarrass this subject—and notably in the first place the question, why coral reefs should be so vast and numerous in certain tracts of ocean, while others are wholly destitute of them? The limitation to tropical latitudes is intelligible; but why, with the exception of the Bermudas, there should not be a single coral isle or reef in the great expanse of the Atlantic, it is hard to explain. Had the Bermudas themselves been absent, a certain general conjecture might have been hazarded, which their actual position and coralline structure render inadmissible. Volcanic action, ancient or recent, affords no explanation of this partial distribution; nor do any ascertained differences

differences in the depth or bottom of the sea, or in the mineral contents of different seas, come in aid of the solution. A supposition is still open, vague perhaps in its application to the present case, yet supported by many analogies drawn from other parts of the animal world. The corals, in their pulpy portion, afford food to several species of fish, and to the whole tribe of *Holothuriæ*; while they themselves, simple and minute though they be, must feed on some other kinds of organic life. There may be in certain seas a predominance of the animals destroying them, or a deficiency in those affording them nutriment; and in either of these conceivable cases we bring the question among those curious instances (now almost forming an especial branch of natural history) where we find the station, range, multiplication, or extinction of species, to be determined, not merely by inanimate agents around, but by the presence or absence, abundance or scarcity, of other species in the same regions and at the same periods of time. We might say much as to this interesting and prolific course of inquiry, did it come within our present subject.

The manner and rate of growth of corals offer other curious questions to the naturalist. The evidence as to the latter point is various, and on first view somewhat contradictory. With some well-attested examples of rapid growth,—the filling up of channels and lagoons, and enlargement of islands within human record—we have other instances where the same surface and elevation of living coral appears to have existed for ages unchanged. Ehrenberg found in the Red Sea vast globular masses of *Meandrina*, which, he says, are of such antiquity that ‘Pharaoh himself may have beheld them;’ and he gives evidence to show that various coral formations of this sea have undergone little or no change within the last two centuries. Captain Beechey furnishes similar proofs from different parts of the Pacific; and, leaning upon these and other instances, some naturalists have been led to view the growth of corals as the slow work of ages rather than of years, and to doubt the possibility of islands having been thus formed in the midst of the ocean.

These difficulties may, we think, be lessened, if not obviated, by a regard to the various conditions under which coral masses are formed; by the difference of the coral animals themselves in species, size, and habitudes of existence; by the succession of several species in the same mass; by the important fact (ascertained as far as negative proofs will carry us) that new coral does not form on the surface of that which is still living; by the various foundations on which the corals build their superstructure; and by the changes of level, sudden or slow, occurring in these foundations. We incline, therefore, to Mr. Darwin’s belief

that the formation of coral is still actively proceeding in numerous places over the globe, and find no reason to doubt that the atolls and reefs rising precipitously from the deep ocean around, whatever of increment they may receive to their growth from other sources, are mainly, as we see them, the creation of successive generations and species of these zoophytes. In the whole range of physical causes we find, in truth, none but this strange and instinctive workmanship—this antagonism and superiority of organic vital forces to the inanimate powers of nature—which can explain such phenomena as those of the Maldivé group; or the simple fact of the small circular coral islet rising up to the surface of the Pacific from unfathomed depths around it; or other singularities of these formations which we have no room to detail, but which are fully described by Mr. Darwin.

These considerations bring us nearer to the actual theory of coral rocks, but with the intervention still of another question—of great moment, as we shall see, to any general conclusions—viz., the depth of sea at which the reef-building corals can live and work? This, it will be obvious, is a question distinct from that of the gross thickness or depth of coralline masses, and somewhat easier of solution, yet not without its appropriate difficulties. From a large collation of facts Mr. Darwin is led to conclude that, in ordinary cases, the corals which build reefs do not flourish at greater depths than from 20 to 30 fathoms, and that the greatest activity of their existence is on the surface and outer edges of reefs. Other observers have limited their range of operation still more closely to the surface; but take what estimate we may, it seems certain that no increment can take place to coral growth below a comparatively small depth—none whatsoever above the surface washed by the spray of the sea. Whence, then, the vast masses and lofty coral pinnacles which the sounding-line follows downwards to the depth of several hundred fathoms, with evidences of the same structure and origin, and leaving it uncertain whether they may not descend deeper still? If these zoophytes work only thus near to the surface, how are we to explain the origin and actual position of all that lies beneath this level? This is the problem most interesting in the theory of coral formations, and the solution of which, whatever it be, associates them most closely with the great geological phenomena of the globe. In the article before alluded to we have given an outline of the question and of Mr. Darwin's views upon it. In the short space now remaining to us we shall put before our readers a summary of the discussion as it at present stands, with such few remarks as we think more especially conclusive on the argument.

The hypotheses by which alone we can seek to solve the problem just stated are few in number. Either the corals constructing the lower parts of the reefs must be wholly distinct in species and habits from those which work near the surface;—or the reefs, atolls, and islets we see must be mere superficial coverings or cappings of points and ridges of land underneath; or there must have occurred such subsidence downwards of the land encircled by or supporting coral formations, as to leave the coral summits solely on the surface of the waters—with means of increment, where the subsidence further continues, by the superimposition of fresh layers, under the conditions of depth favourable to the living actions producing them. We are unable to find any other suppositions than these which will apply to the solution of the problem before us.

The first of them is negatived in great part by the improbability that there should be species of corals differing so widely as to one of the most important conditions and necessities of their existence; and further, by the negative fact that no examination of the dead coral taken up from great depths has disclosed such varieties.

The second hypothesis is of a more plausible kind, and was at one time adopted by Mr. Lyell, in common with many other naturalists; but subsequently relinquished by this eminent observer in favour of the last of the opinions just stated. It was, in truth, a natural and easy conception that the coral formations incrusting the upper surface might follow and depicture the outline of the submarine bottom, and the peaks and ridges rising from it. And this argument became more specious when considering the coral islets, with their circular and often deep lagoons within, as representing the cones and craters of ancient submarine volcanoes, their crests overgrown by the work of these zoophytes, which retained the form while altering the material of the surface exposed. On the other hand, the great superficial extent of some of the atolls and of their contained lagoons, remove from them all character of volcanic cones; and their close and peculiar arrangement in groups, like that of the Maldives, still more contradicted the resemblance. The difficulty of explaining why such numerous detached summits should rise so closely to the same level near the surface, formed another obvious objection to the theory; and a more cogent one arose when it was discovered that the reef-building corals worked only to a limited depth, and could not, below this level, have formed the coralline covering to the submarine peaks which the theory supposed.

Under the failure of these hypotheses, and pressed by other considerations, Mr. Darwin adopted what we have adverted to as
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the third solution of the question; viz., that the areas, greater or smaller, on which the coral reefs rest as a foundation—the flooring, in fact, of the seas—must have undergone progressive subsidence, such as utterly to withdraw islands or large tracts of land below the surface of the ocean, leaving the coral reefs which encircled or fringed their shores still on the water's level, and therefore under circumstances fitted to sustain their growth and position, even where the sinking of the foundation beneath them further continued. We must admit this hypothesis to be a bold and startling one, and such it appeared in the outset even to the most hardy of our geologists; yet it has rapidly gained ground, not merely as the only one fulfilling the conditions required, but further because it well illustrates the different modifications and peculiarities of the coral reefs, and accords at the same time with certain remarkable discoveries which have distinguished the progress of modern geology. Mr. Darwin's application of his views in detail is characterised by great ability; but we can afford room only for a summary of the few leading points.

Taking the theory first in its application to the *atoll*, or simple coral islet with its interior lagoon—instead of making this lagoon to represent a pre-existing cavity of the same form, as in the volcanic hypothesis, Mr. Darwin considers that it designates the place once occupied by a point of land more or less elevated, which has subsided downwards into the sea, leaving the coral reef circling round the centre, growing over its surface, and rising upwards by new constructions, where the subsidence has still continued. Let a mountain peak, like Tahiti, girt round with a coral-reef, sink downwards, from subsidence of the submarine area or other cause, and we should have the conditions just described taking place; and representing, by the various aspects of these islands, the stages of change from the lofty mountain to a few low points of land in the lagoon, and then to the simple coral islet, barely rising out of the sea. Let the subsidence elsewhere be sudden, instead of gradual—and we should find submerged atolls, like the Chagos Bank; the power of replacement upwards being lost by the depth to which the surface has sunk below the sea.

Next, as to the linear reefs, such as the great barrier fronting the N.E. Australian continent. We have already alluded to the intimate relation of these to the reefs encircling islands; and we shall find the conditions of the theory applying to both in the same manner, and with equal probability. Suppose a prolonged line of reef to be built up on the shelf of the coast, as it declines into the sea, leaving a narrow channel of water between. If the continental land gradually sinks, the line of coast will recede inwards, leaving

leaving a wider channel between it and the reef—the latter retaining its position, and being continually replaced upwards by fresh coral, as the lower portions of the mass subside. Sectional sketches would better illustrate these points; but even without such aid, we think there will be no difficulty in conceiving them; or in further applying the same views to the other peculiarities of these formations—the precipitous descent to vast depths of the outer side of the reef—the isles within the channel, seen as residual points of the old continent—the fringing reefs—the openings into the channels or lagoons, &c.

We have spoken of this as a bold hypothesis; and it will not appear less so when we look at the magnitudes, both of space and time, which are involved in such interpretation of the facts. The extent it is needful to assign to some of the areas of subsidence may well alarm an imagination not accustomed to deal with these subjects. Spaces of many hundred thousand square miles exist in the ocean, occupied by coral isles of such description as to admit of no other valid explanation than the sinking of the bottom of the sea over this extent. The length of the Australian barrier reef, 1200 miles, proves that at least an equivalent line of coast has been subsiding since its formation began. The same inference extends to the great island of New Caledonia, in relation to the reef half encircling it. Mr. Darwin has delineated these several areas, as far as at present known, in a map prefixed to his work; adding to its value by designating also the areas of upheaval in the same oceans; and the sites of active volcanoes, which, it may be, interpret some of the actions concerned in these phenomena. For both these great events, of subsidence and upheaval of the solid crust of the globe, are familiar to the speculations of modern geology, and variously attested in different parts of the globe by facts which, though recent in discovery, are unequivocal in the inferences they afford. The magnitude of these movements and changes may seem inconsistent with our ephemeral experience; but here, as in so many other cases, we are compelled to adopt new measures of time and space, when dealing with the physical conditions of the globe before man became a tenant of its surface.

If there be areas of upheaval as well as of subsidence in these coral seas, we may expect to find coral islands raised in places above the level at which these zoophytes effect their works. Accordingly, we have instances furnished by Captain Beechey, Mr. Jukes, and others, of coral masses some hundred feet above the sea; with the same assurance of their having been raised from below, that we possess in the case of any tertiary stratum containing sea-shells. In connexion with this topic, however, we must notice one objection to Mr. Darwin's views, which may seem to have some force, viz.,
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that if masses of coral of such enormous thickness exist under the sea, we might fully expect to discover them in some situation or other among the great strata of the globe; knowing, as we do, how large a portion of these have been submarine in origin, and raised afterwards into their present position.—Admitting the weight of the objection, that no such coral masses are found on our continents, we may qualify it by remarking, first, that we are not assured as to the relative period in the records of creation when the reef-building corals began their work in the seas; secondly, that it is not impossible that some of the great oolitic, cretaceous, or other calcareous formations may actually represent coral deposits—formed as these are by the agglutination of various materials, and exposed for ages to physical conditions of which we can scarcely appreciate all the effect; and thirdly, that the geological character of the lands in the coral oceans is still very imperfectly known, and we may yet discover such masses at greater elevation than any yet found, and exhibiting perchance gradations yet unsuspected into the character of the older calcareous rocks.

ART. VII.—*English Etymologies*. By H. Fox Talbot, Esq. 8vo. London, 1846.

WITHOUT venturing to say of Etymology what South said of the study of the Apocalypse, that ‘it found a man mad or made him so,’ we may say there is no walk of literature in which there have been exhibited more portentous aberrations from common sense. With whatever respect or wonder we may regard the labours of the modern Germans, who, as our readers are aware, have pushed their researches and theories more widely, as well as more systematically, than either the French or English Etymologists, we do not see that, as regards Europe, even they have added much to our stock of useful information. They have shown, no doubt, more extensive coincidences between the Northern and the Southern, and between them and certain Eastern languages, than had before been developed; but the earlier Etymologists proceeded generally on the same principle, though they had not worked it out in the same detail; and we must confess that we cannot concur in some of the theories built on this development, nor if we did, should we estimate their value so highly as young students are apt to do. However brilliant or startling, as we admit they sometimes are, they seem to us to lead to no practical conclusion; nay, to leave the origin of nations and their dialects in greater perplexity, if possible, than they were before;