pays best under a given set of circumstances ; and this only shows the wide field open to British farmers for profiting by the laws of selection.

I look to the development of this great principle as one of the soundest and surest means of promoting the interests of the agricultural classes.

THOMAS BALDWIN

DARWIN'S "CORAL REEFS"

The Structure and Distribution of Coral Reefs. By Charles Darwin, M.A., F.R.S., &c. Second edition, revised. 1874 ; pp. 268. (Smith, Elder, and Co.)

THE rising generation of naturalists and geologists has not had, and most probably will never have, such feelings of intellectual pleasure as fell to the lot of the first readers of Charles Darwin's book on Coral Reefs, which was offered to science more than thirty years since. The recent researches into the nature of the deposits of the deep sea, and the discoveries of the bathymetrical zones of water of very different temperatures, are certainly full of vast interest, and will afford the data for the development of many a theory ; but the clear exposition of facts, and the bold theory which characterised the book on Coral Reefs, came unexpectedly and with overpowering force of conviction. The natural history of a zoophyte was brought into connection with the grandest phenomena of the globe—with the progressive subsidence of more or less submerged mountains, and with the distribution of volcanic foci. The forces of the organic and inorganic kingdoms were shown to unite in the production of those circular growths of coral which appeared to rise from profound oceanic depths ; and it was made evident that the existence and persistent growth of fragile Porites and *Madreporæ* were dependent upon movements of the crust of the globe, the result of forces acting almost from the beginning—upon movements so vast, equable and slow, that over thousands of square miles the coral grew upwards, whilst the supporting rock, its base, and the mother crust subsided in a wonderful unison. The pristine condition of the globe was in fact brought in relation with the formation of those beautiful islands, the theme of romance and poesy, the delight of the missionary, the dread of the navigator, and which should be, according to Dana, the luxurious home of enervated and used-up investigators.

The theory of the formation of barrier reefs and atolls is stated with Darwin's usual lucidity :—"From the limited depths at which reef-building polypifers can flourish, taken into consideration with certain other circumstances, we are compelled to conclude that both in atolls and barrier reefs the foundation to which the coral was primarily attached has subsided ; and that during this downward movement the reefs have grown upwards." "There is not one point of essential difference between encircling barrier reefs and atolls ; the latter enclose a simple sheet of water ; the former encircle an expanse with one or more islands rising from it. Remove the central land, and an annular reef like that of an atoll in an early stage of formation is left." It was necessary, in order that this theory should be valid, that the depth at which reef-building corals can exist below the surface should be ascertained, and also that direct or indirect proofs of subsidence over a vast area should be offered. The nature of the bottom of the sea immediately surrounding Keeling atoll was carefully examined, and moreover soundings with the wide bell-shaped lead, with tallow armings, were carefully taken, off the fringing reefs of Mauritius. In Keeling atoll outside the reef it was found, "to the depth of ten or twelve fathoms the bottom is exceedingly rugged and seems formed of great masses of living coral, similar to those on the margin. The arming of the lead here invariably came up quite clean, but deeply indented, and chains and anchors which were lowered in the hopes of tearing up the coral were broken." "Between 12 and 20 fathoms the arming came up an equal number of times smoothed with sand and indented with coral ; an anchor and lead were lost at the respective depths of 13 and 16 fathoms. Out of twenty-five soundings taken at a greater depth than 20 fathoms, every one showed that the bottom was covered with sand." Off the reef at Mauritius, "from 15 to 20 fathoms, the bottom was with few exceptions either formed of sand or thickly coated with Seriatopora (one of the Tabulata). At 20 fathoms one sounding brought up a fragment of Madrepora which I believe to be the same species as that which mainly forms the upper margin of the reef ; if so, it grows in depths varying from 0 to 20 fathoms. Between 20 and 23 fathoms I obtained several soundings, and they all showed a sandy bottom with one exception at 30 fathoms, when the arming came up scooped out as if by the margin of a large Caryophyllia." "The circumstance of the arming having invariably come up quite clean when sounding within a certain number of fathoms off the reef of Mauritius and Keeling atoll (8 fathoms in the former case and 12 in the latter), and of its having always come up (with one exception) smoothed and covered with sand when the depth exceeded 20 fathoms, probably indicate a criterion by which the limiting of the vigorous growth of coral might in all cases be ascertained." Darwin admits that this limit might be exceptionally transgressed, but insists upon the importance of the gradual change, as depth progresses, from living clean coral to a smooth sandy bottom, in endeavouring to fix the depth at which the reef-builders can grow.

Even at this period of Darwin's life, the importance of the struggle for existence had been recognised by him, and had influenced his thoughts. He remarks that "we can understand the gradation only as a prolonged struggle against unfavourable conditions." All subsequent investigations by many independent observers have proved the correctness of this bathymetrical limit of the flourishing of reef-builders, and of late years the general characters of the coral which can exist at a greater depth and even on oceanic floors have been shown to differ essentially from those of the forms which live and flourish amidst the rush of the wave and surf. Darwin notices that where the sea is very shallow, as in the Persian Gulf and in parts of the East Indian Archipelago, the reefs lose their fringing character and appear as separate and irregularly scattered patches, often of considerable area. Around the Philippines the bottom of the sea is "entirely coated by irregular masses of coral, which, although often of large size, do not reach the surface and form reefs." There are huge clumps of Porites and many sponges on the floor of the sea off Cuba, but although

these corals belong to reef-building genera, still as species they are not those which grow on flourishing reefs. The reef-builders evidently grow with great rapidity, and their struggle against the tide and currents and waves necessitates a constant process of reparation or of growth to replace fractured branches. They flourish in the warm, highly aërated, rushing water, which is full of living things—their proper food. Beyond the reach and influence of these conditions other species and genera exist, which add to the bulk of the coral mass, but which of themselves would never build up a reef, and it is some of these which have been dredged up from considerable depths. The simple corals and the branching forms without a cellular exotheca to hold them together have an enormous bathymetrical range, and can live in water of 76° F. close to the surface, and also at a depth of more than 1,000 fathoms in a temperature of less than 32°. But the true reef-builder requires a high temperature, and it therefore becomes very important to discover, as has been suggested by Dr. Carpenter, whether the vast sub-zone of cold water which underlies the superficial and heated water has not much to do with this restriction of certain species to definite depths. We must wait for the results of systematic dredging at great depths in the Pacific before this question can be for ever settled, but at present all our knowledge tends to prove that this deep stratum of cold water would prevent reef-builders from living at any considerable depth, and therefore that they never could have risen by growth from the ocean floor itself. Growing, therefore, on submerged rocks, the reef-builders must have their foundation slowly subsiding, if they are to attain a great thickness and to assume the bulk and the characters of atolls. The direct proofs of subsidence advanced by Mr. Darwin were noticed especially in Keeling atoll. "Appearances indicating a slight encroachment of the water on the level are plainer within the lagoon: I noticed in several places, both on its windward and leeward shores, old cocoa-nut trees falling with their roots undermined and the rotten stumps of others on the beach, where the inhabitants assured us the cocoa-nut would not grow. Capt. Fitzroy pointed out to me near the settlement the foundation-posts of a shed, now washed by every tide, but which the inhabitants stated had seven years ago stood above high-water mark." "From these considerations I inferred that probably the atoll had subsided to a small amount: and this inference was strengthened by the circumstance that in 1834, two years before our visit, the island had been shaken by a severe earthquake, and by two slighter ones during the ten previous years." The observations of such authorities as Williams, Kotzebue, and Stutchbury, respecting the encroachment of the sea on, and the destruction of parts or the whole of islands, were noticed by Darwin in his early edition, and comparisons were made, as in the case of Whitsunday Island, between old and new charts, in support of the evidence of subsidence. The existence of submerged or dead reefs is very properly advanced as an indirect proof of subsidence, and the condition of the Great Chagos bank was considered to explain the effects of a rapid subsidence which killed the corals. But the principal and most interesting evidence is afforded by the relative positions of active volcanic vents and barrier reefs and atolls. Darwin noticed the absence of active volcanoes in the presumed areas of subsidence, and their frequent presence in areas of elevation, the exceptions being very few. In acknowledging Dana's suggestive criticism that he had not laid sufficient weight on the mean temperature of the sea in determining the distribution of coral reefs, Darwin very properly urges that some other cause must account for the absence of coral growth in localities where the surface temperature of the sea is sufficient, and he refers especially to the islands which rise up from the abyssal sea in the Atlantic; but he indicates that temperature evidently has much to do with the absence of reefs on the west coast of Tropical America, the cold current reducing the mean emperature of the sea there below 68°.

Although investigations made subsequently to those of Darwin add almost invariably to the proofs of his theory of atoll formation, and it is received as correct by every teacher, still there have been one or two able criticisms of its general applicability. For instance, Semper, in his description of the Pelew Islands, doubted the evidence of subsidence. His opponent, with his usual justice and candour, gives Semper's objections the most careful consideration, and indeed they deserved this treatment. "He (Semper) states that the southern islands consist of coral rock upraised to the height of from 400 to 500 feet; and some of them before their upheaval appear to have existed as atolls. They are now merely fringed by living reefs. The northern islands are volcanic, deeply indented by bays, and are fronted by barrier reefs. To the north there are three true atolls. Prof. Semper doubts whether the whole group has subsided, partly from the fact of the southern islands being formed of upraised coral rock; but there seems to me no improbability in their having originally subsided, then having been upraised (probably at the time when the volcanic rocks to the north were emptied), and again having subsided. The existence of atolls and barrier reefs in close proximity is manifestly not opposed to my views. On the other hand, the presence of reefs fringing the southern islands is opposed to my views, as such reefs generally indicate that the land has either remained stationary or has been upraised. It must, however, be borne in mind that when the land is prolonged beneath the sea in an extremely steep slope, reefs formed there during subsidence will remain closely attached to the shore and will be undistinguishable from fringing reefs. Now, the submarine flanks of most atolls are very steep; and if an atoll after upheaval and before the sea had eaten deeply into the land and had formed a broad flat surface, were again to subside, the reefs which grew to the surface during the subsiding movement would still closely skirt the coast." The appendix, which contains a detailed description of the reefs and islands in the well-known coloured map, is of the greatest value to the physical geographer, and it includes notices of nearly every known coral tract.

After reading and pondering over this long-prized work, there comes the feeling that Mr. Darwin should at some future time enlarge its scope and deal with the distribution of coral species, and trace back in time the reefs of old. Who would not be glad to be taught from the vigorous pen of the man whose theory has lasted more than thirty years, and will last as long as science, what was the condition of the vast Pacific area prior to the age of reefs

and atolls? Mountains of different heights are now more or less submerged, and either capped with vast thicknesses of coral, or their tops are girt with barrier and fringing reefs. Take away the sea and the coral growth, and imagine the conditions which prevailed during the slow piling up of these volcanic rocks, their denudation and final overwhelming by the inrush of the ocean incident to the first phase of subsidence. Little is known concerning the age of the raised reefs of the Pacific, and therefore of the duration of the existing state of things; but in the Caribbean there have been reefs in consecutive ages since the early Cretaceous period, and in that area there have been during past ages subsidences and upheavals with contemporaneous volcanic action, following the same laws as those so elaborately described by Darwin as influencing coral growth in the Pacific.

P. M. D.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Long Peruvian Skull

IT was not my intention to have replied to Dr. J. B. Davis's letter on "The Long Peruvian Skull" in NATURE, vol. x. p. 123, as I shall have an opportunity before long of presenting the subject in detail before scientific readers. I find, however, by letters from England that an answer is expected from me. To me, it seemed little more than a reiteration of his disbelief in the existence of such a type; while it leaves unnoticed what I specified as the main point in the discussion.

Dr. Davis demands the production of "half a score of ancient Peruvian dolichocephalic skulls, the appearance of which totally precludes the possibility of interference by art, or other deforming process." Had an anonymous correspondent so stated the issue, I should have supposed that the writer had never seen half a score of Peruvian skulls in his life. The collection presented by Mr. Hutchinson to Prof. Agassiz numbered 368; and out of this Prof. Wyman reports only *eleven* not flattened or distorted. Is Dr. Davis prepared to rule the remaining 357 out of court as of no value in relation to his brachycephalic type? This question of Peruvian long and short heads must be settled in connection with a deforming element affecting both types, or it cannot be settled at all. Hence my specification of the real issue. Keeping this in view, I must beg leave meanwhile to refer, for the sake of brevity, to my statements in NATURE, vol. x. p. 48, in reference to examples previously adduced; while I now point out others easily accessible to Dr. Davis.

The large collection furnished to Prof. Agassiz was obtained, apparently at one time, from a single locality, "Ancona and its neighbourhood." Hence no doubt the uniformity of type. Doubling this number of skulls from the same locality would add nothing to the evidence. It is otherwise with the London Anthropological Institute. Its collection was obtained at different times, partly from the same accessible locality; but also from Santos, Ica, Passamayo, and Cerro del Oro. These include places hundreds of miles apart; and Prof. Busk, after minute study, reports that the evidence of the existence of a dolichocephalic type afforded by the collection, though "not very abundant, *is nevertheless decisive.*"

It is a case precisely analogous to the remarkable dolichocephalic British type recognised by the acute sagacity of the late lamented Dr. Thurnam, in the Uley, Kennet, Littleton Drew, Rodmarten, and other long barrows in Wiltshire, &c., as illustrated in the *Crania Britannica*, for which so great a debt of gratitude is due to Dr. Davis and his gifted colleague. Those dolichocephalic skulls are exceedingly rare; they are found along with brachycephalic skulls; but, as Dr. Thurnam showed, accompanying elements suggestive of the latter as an inferior or servile class. Long ago, in a paper in the *Canadian Journal* of September 1862, I referred to the analogy this presents to the long Peruvian skull mingling in the ancient Inca cemeteries with crania of a markedly diverse type.

No multiplication of specimens of the less rare brachycephalic skull of the British cist or round barrow will invalidate this exceedingly rare but valuable dolichocephalic British type produced by Dr. Thurnam; and the exhibition of a whole ship's cargo of brachycephalic skulls from the accessible coast cemetery of Ancona is equally ineffective in disproof of the rare Peruvian dolichocephalic skull of Titicaca and other ancient burial-grounds.

Dr. Davis refers to an error in one of the woodcuts of my first edition of "Prehistoric Man." To anyone conversant with the difficulties of a Canadian author correcting proof-sheets for the London press, the chances of error, with proofs passing while the woodcut swere in the engraver's hands, and their mere titles or blank spaces in lieu of them, must be obvious enough. Dr. Davis will find the error pointed out in the preface to the second edition.

University College, Toronto, Aug. 6 DANIEL WILSON

Pollen-grains in the Air

I AM very sorry to find that, owing to my absence from home at the time, a question addressed to me by Mr. A. W. Bennett, in NATURE, vol. ix. p. 485, has escaped my notice hitherto and remained unanswered. Mr. Bennett, alluding to my letter on "Microscopic Examination of Air" (NATURE, vol. ix. p. 439), asks on what ground I refer the "triangular pollen" captured on my slide to the birch and hazel. The identification resulted from comparison under the microscope. The pollen-grains which I obtained from catkins of birch and hazel exhibited three conspicuous equidistant prominences (pores) giving each grain a triangular appearance. I cannot now remember if this appearance was equally distinct before and after immersion in glycerine: probably there was a change of shape due to osmosis. I confess that I used the word "triangular" not in its strict geometrical meaning, but in order to mark a feature which distinguished the pollen-grains of birch and hazel from those of poplar. Referring to my notes, I must admit that the shape of the grains which I identified with birch pollen would have been more accurately described as "spherical with three large protuberances." HUBERT AIRY

Blackheath, S.E., Aug. 31

Chrysomela Banksii

I SHOULD be much obliged if you would allow me to ask the following question of Coleopterists in the columns of NATURE:—

Does *Chrysomela Banksii* possess any quality, such as that of exuding an acrid liquid or the like, which would be likely to make it distasteful to spiders or other animals? I have seen it first taken and then rejected unharmed by a Trap-door Spider, and as these spiders feed largely on beetles, I am led to suppose that this particular beetle has some special protection.

J. TRAHERNE MOGGRIDGE

2, Foxton Villas, Richmond, Surrey, Aug. 27

The Aurora Borealis

MAY I ask the readers of NATURE for information on the following points:—

1. Where can I find references to any observations on the polarisation or otherwise of auroral light?

2. Are there any published lists of auroræ arranged with a view to determine the periodicity of its recurrence: or, if not so arranged, sufficiently extended for such an investigation?

3. Has any observer besides Mr. Backhouse noted the relative proportion between eastward and westward movement of auroral rays? HENRY R. PROCTER

North Shields, Aug. 29

ROBERT EDMOND GRANT, M.D., F.R.S.

ON Sunday, August 23, after an illness of about a fortnight, died Dr. R. E. Grant, for many years Professor of Zoology and Comparative Anatomy at University College, London. The family from which Dr. Grant was descended had its head-quarters in the county of Elgin, whence his father removed to Edinburgh, settling as an accountant and a writer to the signet in Argyll Square. He was one of fourteen children, twelve brothers and two sisters, being the seventh son, and the