wide distribution, extending from the mountain valleys and neighbouring plains to the edge of the glaciers; very few being found only in the mountain valleys, and one only, the common honey-bee, being peculiar to cultivated districts. None of the insects found belong to extra-Alpine species, none of the kinds peculiar to the warm valleys of the southern Alps are represented; and the inference is unavoidable, that all the animals found on the glaciers have either strayed voluntarily, or have been driven by the wind, from districts immediately adjacent to the glacier.

The task of determining the seeds found on the surface of the glacier was much more difficult. The seeds of many Alpine plants have hardly been described; and in other instances it is difficult to distinguish between those belonging to several different species of the same genus. Thirty-six species, however, were determined with tolerable certainty, the majority of which were identical with the species previously recorded as inhabitants of the moraines. Here again the same results are established: not a single seed is found on the glacier, as not a single plant on the moraine, which does not belong to a species inhabiting the immediately adjacent mountain slopes or valleys. The conclusion from these facts seems inevitable, that the conveyance of seeds, even when provided with apparatus calculated for being floated in the air by horizontal currents, takes place only within very circumscribed limits; and that the prevalent opinion that they may be thus carried for very great distances is not supported by facts.

M. Kerner thus sums up the results of his observations:—

1. Only dust-like substances, such as pollen, spores, diatom-scales, &c., can be distributed by currents of air over wide stretches of land and sea in uninterrupted flights, and thus be brought into the alpine regions.

2. Fruits and seeds of flowering plants which are provided with a web-like floating apparatus that distends itself in dry air in the form of a parachute, are carried upwards by the ascending current of air which arises on sunny days in alpine regions on the cessation of the horizontal wind; but after sunset they sink again to the ground at a short distance in a horizontal direction; and the object attained by this floating apparatus is not so much the adaptation of the seeds for long journeys, as to enable them to settle on the projections and in the crevices of steep precipices and rocks, and to clothe with vegetation these rock-walls which are not easily accessible by other seeds.

3. The presence of membranous margins and wings favours the transport of fruits and seeds by horizontal currents of air; the horizontal distance, however, over which these seeds are carried scarcely ever extends farther than from one side of a valley to the other, and the distribution of the fruits and seeds of flowering plants, in so far as this is caused by currents of air, can only proceed gradually and step by step.

4. Fruits and seeds which are deficient in any kind of appendages that facilitate flight are scarcely influenced by currents of air; it is only when these seeds are of very minute size and extremely small weight that they can be driven short distances by horizontal winds.

It appears, therefore, that the idea that seeds are distributed to great distances by the wind, if not to be treated as a popular error, at least requires a much larger foundation of fact than it at present possesses, in order to be accepted as a scientific truth. A series of observations of this nature, if carefully conducted, is a substantial gain to Science, and may assist the determination of great physiological questions in hundreds of ways. They are within reach of every intelligent resident in the country possessed of ordinary powers of observation; and yet how few interest themselves practically in carrying them out! A. W. B.

LYELL'S PRINCIPLES OF GEOLOGY*

IN our last notice, after a sketch of the methods of investigation employed by Sir Charles Lyell, and an outline of the principles deduced therefrom, we gave a few examples of the kind of proofs brought forward by him to show that the degrading and transporting forces which we see in operation are producing similar phenomena to those we observe in the sedimentary rocks, and that, given sufficient time only, effects on as great a scale must be the inevitable result.

We will now select some of the evidence adduced by him to show that the igneous forces also, the movements of upheaval and depression, are as active, and the products of eruption on as grand a scale, as we have any reason to believe they have ever been within the period over which our observations extend.

The consideration of what suggested the former greater intensity in the subterranean forces, viz., the supposed vast magnitude of the ancient igneous rocks, and the proofs of variations in climate, leads Sir Charles into an investigation of the astronomical and geographical causes of vicissitudes of climate, which involves an inquiry into the vexed questions of oceanic circulation, and the effect of various changes of conditions on the organic world in the extinction of species, and their replacement by new forms of life.

It certainly may at first seem difficult to believe that the forces which produce upheaval and eruption have not varied in intensity throughout the whole period of which we have any record, and yet that over many large tracts of country, where now the faintest vibration of the distant earthquake is exceptional and rare, we have thousands of feet of volcanic ash and lava, and great masses of matter which have apparently been injected in a molten state into the fissured rock. But this difficulty has arisen because the vastness of the ancient volcanic deposits has been assumed without sufficiently detailed observation, and the magnitude of modern igneous action has been underrated, while the most important point, the transference of paroxysmal action from one area to another, has been overlooked.

Speaking of contemporaneous volcanic deposits in the older rocks, Sir Charles Lyell says:—"If one of these igneous formations is examined in detail, we find it to be the product of many successive ejections or outpourings of volcanic matter. As we enlarge therefore our knowledge of the ancient rocks formed by subterranean heat, we find ourselves compelled to regard them as the aggregate effects of innumerable eruptions, each of which may have been comparable in violence to those now experienced in volcanic regions" (p. 114). This question, however, Sir Charles does not investigate in the "Principles," which deals with the modern changes of the earth; and we will pass on to notice some of the examples he gives to show the magnitude of modern igneous action.

First, as to the fact that changes of level are going on:—"Recent observations," says Sir Charles Lyell, "have disclosed to us the wonderful fact that not only the west coast of South America, but also other large areas, some of them several thousand miles in circumference, such as Scandinavia, and certain Archipelagos in the Pacific, are slowly and insensibly rising; while other regions, such as Greenland and parts of the Pacific and Indian Oceans, in which circular or coral islands abound, are as gradually sinking" (p. 128). The atolls are themselves a proof of oscillations of level. The coral zoophytes live only within certain distances from the surface, and, having com-

* "The Principles of Geology, or the Modern Changes of the Earth and its Inhabitants considered as Illustrative of Geology." By Sir Charles Lyell, Bart. Eleventh and entirely revised edition. (London: J. Murray, 1872.) (The Second Volume has been issued since the appearance of our last notice; see NATURE v. p. 456.)

menced nearly all round an island, keep building up as the island goes down till they have formed a ring of coral. The accompanying ideal section across such an island enables one to understand the mode of growth. A channel is kept open through one side, probably at first by the stream, which drains the island, and carries down mud and fresh water, and afterwards by the scour of the tide. Whenever an area covered by such islands is upheaved, and the reefs lifted up above the breakers, or the waves and wind have heaped up broken coral rock and shell around, the surface soon gets weathered, and forms a soil on which plants and animals settle and live. Sometimes the top of the island around which the coral was built is still seen; sometimes it has disappeared altogether beneath the sea. We subjoin a sketch of one of these circular reefs.

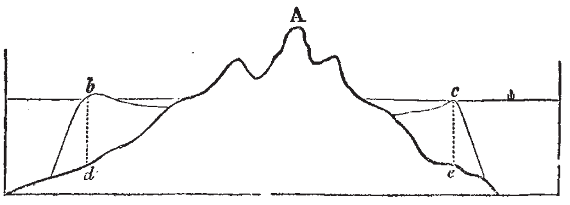

FIG. 1.—SUPPOSED SECTION OF AN ISLAND WITH AN ENCIRCLING REEF OF CORAL

A The Island; *b*, *c* highest points of the encircling reef between which and the coast is seen a space occupied by still water.

But besides such indirect evidence of gradual change of level, it is a matter of observation that as an accompaniment of volcanic action we frequently have sudden movements of small extent. For instance, in the destructive earthquake which visited Chili in 1822, the coast was raised from 2 ft. to 4 ft., while farther inland the rise was estimated at from 5 ft. to 7 ft., and off the port of Penco, if the reports of the inhabitants are to be believed, there was a rise of 24 ft. during the single earthquake of 1751. In New Zealand, during the earthquake of 1855, a fault 10 miles long, with a displacement of 9 ft., was produced.

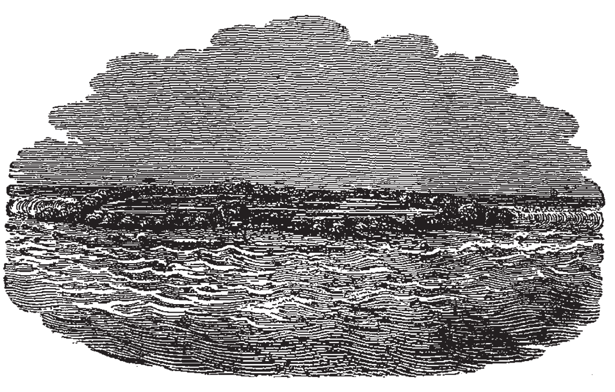

FIG. 2.—VIEW OF WHITSUNDAY ISLAND

Supposing an elevation of 7 ft. occurred only once every century, it would require less than 150,000 years to form a chain as high as the Pyrenees, and if repeated three times in a century would be sufficient to account for the Andes in the same time.

"It may be instructive," says Sir Charles, "to consider these results in connection with others already obtained from a different source, and to compare the working of two antagonistic forces—the levelling power of running water, and the expansive energy of subterranean heat. How long, it may be asked, would the Ganges require . . . . to transport to the sea a quantity of solid matter equal to that which may have been added to the land by the Chilian earthquake? The discharge of mud in one year by the Ganges at its mouth was estimated at 20,000,000,000 cubic feet. According to that estimate it would require about four centuries before the river could bear down from the continent into the sea a mass equal to that gained by the Chilian earthquake" (p. 97).

In volcanic districts especially we may expect evidence of recent upheaval and depression, and so we often have marine beds forming the base of a volcano, or submerged volcanos, whose leading features seem to be due to subaerial action. We may, for instance, mention the case of Etna, and refer our readers to the interesting line of reasoning by which our author works out the history of that mountain, showing that it was formed by degrees, of matter heaped up upon marine beds of comparatively recent age, which have now been lifted up to a considerable height above the sea, and further proves that at one time there were two principal craters from which matter was ejected, but that now, owing to subsequent explosions and denudation, an enormous valley occupies what was the top of the mountain.

As an example of a submerged volcano we may mention Santorin, with regard to which Sir Charles Lyell says:—

"We may conceive, therefore, if at some former time the whole mass of Santorin stood at a higher level by 1,200 feet, that this single ravine or narrow valley, now forming the northern entrance, was the passage by which the sea entered a circular bay. But at a still earlier period, when the ancient volcanic cone—of which the outer islands are the remains—was still more elevated above the level of the sea, there may have been a deep valley of subaerial erosion cut by the principal river which then drained Santorin, which may have consisted of one lofty volcanic cone, afterwards truncated by a paroxysmal explosion such as we have already spoken of in the case of Galongoon" (p. 72).

We subjoin Sir Charles Lyell's sketch (Fig. 3), which it will be interesting to compare with that of the unsubmerged summit of Etna.

We select also his ideal section across Barren Island (Fig. 4), to help to realise its manner of formation.

It may be worth calling attention to the similarity between the submerged crater, with its deep channel leading into it on one side, and the coral Atoll of which we have given figures above (Figs. 1 and 2). Nature has many ways of arriving at apparently analogous results; but close examination shows how varied are her methods.

Sir Charles also points out that, in the quantity of matter ejected, modern eruptions will bear comparison with any we know of in ancient times. In order to help us to realise the enormous volume of the lava poured out from Skaptar Jokul in 1783, he considers "how striking a feature" the two streams of lava then poured out "would now form in the geology of England, had they been poured out on the bottom of the sea after the deposition and before the elevation of our secondary and tertiary rocks." From one we should have a mass 100 ft. thick and 10 to 15 miles broad on the oolitic hills overlooking the vale of Gloucester. It would be traced for a distance of about 90 miles to the neighbourhood of London, where, "crowning the highest sands of Highgate and Hampstead, we might behold some remnants of the current some 500 ft. or 600 ft. in thickness, causing those hills to rival or even to surpass in height Salisbury Craigs and Arthur's Seat" (p. 52); while the other stream might be traced from London to the coasts of Devon and Dorset. The description given (pp. 104-106) of the volcanic outburst in the island of Sumbawa can hardly be read without our feeling that we know of no one ancient volcanic rock comparable in extent to the deposit of ash which must have resulted from the single eruption of 1815.

After having shown that these tremendous effects of volcanic action on the surface are "insignificant when contrasted with the products of heat in the nether regions," Sir Charles says (p. 211) :—"The continual transfer of the points of chief development of the earthquake and volcano from one part of the earth's crust to another is established as a general law by the clearest geological evidence. We have also seen that volcanic operations are now in progress on the grandest scale, and also that single currents of lava of modern date are as voluminous as any which can be shown to have ever poured out in the earliest eras to which our geological retrospect can be carried."

The doctrine of the former greater intensity of the igneous forces, connected as it generally was with the hypothesis of the primæval igneous fusion and gradual cooling down of the planet, of course involved the theory of the former higher temperature of the surface of our earth ; and therefore all indications of a warmer climate over any area in the ancient seas were supposed to point

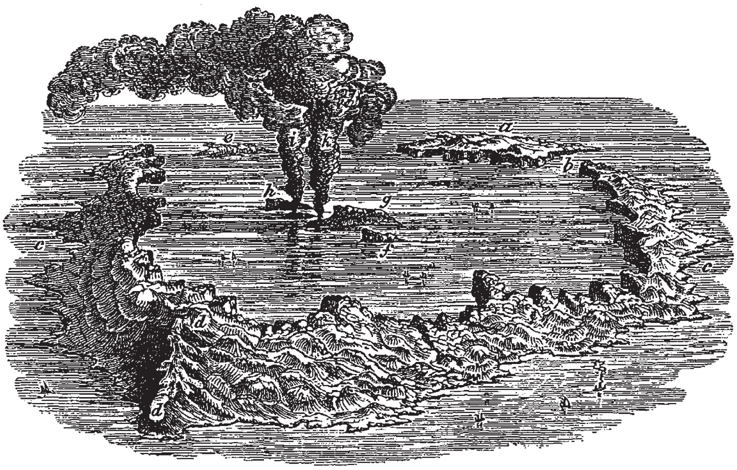

FIG. 3.—BIRD'S-EYE VIEW OF THE GULF OF SANTORIN DURING THE VOLCANIC ERUPTION OF FEBRUARY 1866

a Therasia ; *b* the northern entrance, 1,068 feet deep ; *c* Thera ; *d* Mount St. Elias, rising 1,887 feet above the sea, composed of granular limestone and clay-slate, the only non-volcanic rock in Santorin ; *e* Aspronisi ; *f* Little Kaimeni ; *g* New Kaimeni ; *h* Old Kaimeni ; *i* Aphroessa ; *k* George.

to a universal higher temperature over the globe. But Sir Charles Lyell points out that "the climate of the extratropical regions has been by no means always hotter than now ; but on the contrary, there has been at least one period when the temperature of those regions was much lower than at present" (p. 173).

Space will not allow us to follow our author while he proves, from an examination of the circumstances under which we find similar and dissimilar climates at the present day, that geographical conditions produce far greater effect upon climate than we have reason to believe would result from any astronomical combinations. Dependent to a great extent upon geographical conditions we have prevalent winds, which materially influence climate, and moreover give rise to most of the great ocean currents.

About the origin of these, however, there has been some controversy. Sir Charles considers the various theories very fully, and shows that the great currents are due to prevalent winds. "That movements," he writes, "of no inconsiderable magnitude should be impressed on a wide expanse of ocean by winds blowing for many months in one direction may easily be conceived, when we observe the effects produced in our own seas by the temporary action of the same cause. It is well known that a strong south-west or north-west wind invariably raises the tide to an unusual height along the west coast of England and in the Channel ; and that a north-west wind of any continuance causes the Baltic to rise 2 ft. and upwards above its ordinary level" (vol. i. p. 492).

It is clear that when the surface water is being thus driven continuously for a long time in one direction

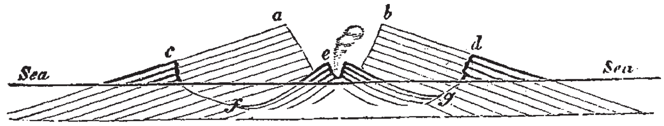

FIG. 4.—SUPPOSED SECTION OF BARREN ISLAND, IN THE BAY OF BENGAL

against a shore or into a *cul de sac*, there must be an undercurrent formed by the head of water thus produced. But in deep basins there is no reason why the water should not remain embayed for ages, and, having been at any time cold, should never receive sufficient from above or below to raise its temperature.

In the Mediterranean and the smaller seas connected with it there seems to be a great complication of current-producing causes, which have proved a fertile source of speculation and controversy ever since Aristotle puzzled over the currents of the Euripus. That land-locked sea is too small to have any considerable tide generated within itself, but the Atlantic tide rushes in and out with great force. The vast surface current of the Atlantic, and the prevailing westerly winds, increase the in-going tide, and check, and generally altogether overpower, the surface part of the out-going tide, so as to give rise to an upper and a lower current in opposite directions through the Straits of Gibraltar.

In addition to these causes, there is the enormous evaporation during the hot season and the excess of fresh water poured in during the rainy season, which must produce a great effect. But as each tide would, when there was a deficiency of water, bring a little more in, and when an excess of water, take a little more out, this adjustment being made twice every day it does not seem likely that either evaporation or rain would make any appreciable difference in the currents at the Straits. Some authors have referred oceanic circulation to difference of specific gravity, due to difference of temperature or amount of salinity; but, though this is a *vera causa* which might in some cases explain similar phenomena, Sir Charles shows, by reference to the observations of Captain Spratt and others, that the currents of the Mediterranean, and, indeed, all observed currents, are due to other causes.

The question of the dependence of climate, both subaerial and sub-aqueous, upon geographical conditions, is very important in its bearing upon the changes in the inorganic world. For those who believe that in the history of the crust of the earth we have evidence of alternate periods of universal catastrophic action and repose would be quite prepared to believe that in the world of life also there were alternations of destruction and creation; but to those who hold that the face of the globe has been, and is for ever being, modified by the gradual action of forces always in operation, it seems *a priori* probable that Nature should have provided the organisms which inhabit this ever-shifting earth with modifiability somewhat commensurate with the changes of the world in which they live.

A mountain has been raised and chiselled out into its present form by operations extending over a period so vast that no one can have witnessed them. A species has been changed into something quite different by processes requiring a length of time so great that no one can have watched them.

Whatever may have been the chief *causes* of the movements of upheaval, it is a *fact* that movements are going on which bring different parts of the crust within reach of denudation, and that, given sufficient time, mountain ranges must be the result.

So, whatever may be the *origin* of the variations, it is a thing definitely known that variations of the same kind as those which are considered to form specific differences do occur; it is a matter of experiment that these variations can be accumulated and perpetuated by selection; it is a matter of observation that Nature does select. The burden of proof that there are any limits to variation or natural selection rests with those who hold it.

It has been objected to the doctrine of the origin of species by natural selection that some totally distinct classes of animals have corresponding organs, so similar that it is difficult to suppose that they can "'have been brought about in two independent instances by merely indefinite and minute accidental variations.' Yet these organs in the two types must have been developed in entire and complete independence one of the other; for it would be impossible to find a common ancestor without going back to some very simple form not yet provided with even the rudiments of vision" (p. 498).

Sir Charles quotes Mr. Darwin and others to prove that in some at least of the cases adduced the similarity of structure was exaggerated. Still it is undoubtedly very great, and the study of such cases and of the mimetic forms which Mr. Wallace has so well described, makes us feel that what we chiefly want to know more about, is the law which governs the first appearance of varieties. Such facts do not so much furnish arguments against the doctrine of the origin of species by natural selection, as in favour of the existence of some law according to which external conditions and the requirements of the individuals may tend to produce variation in a given direction.

How vast and how perplexing are the questions raised by the study of the modern changes of the earth and its inhabitants; but the calm philosophic spirit which pervades the "Principles of Geology" leads us to hope that it may promote in no small degree that education which will render it "possible to welcome new truths," although they may at first appear to be "out of harmony with cherished associations of thought."

T. McK. Hughes

NOTES

We are informed that the Directorship of the National Observatory at Marseilles has been offered to Dr. Janssen.

25,000 rupees have already been subscribed towards the Archdeacon Pratt Memorial Fund.

We are glad to hear that the local committee at Brighton are forming a temporary museum, to be opened during the Meeting of the British Association.

The prizes in the Faculties of Art, Science, and Fine Arts, of University College, London, were distributed by the Right Hon. S. Cave, M.P., in the Botanical Theatre of that institution on Tuesday last. The attendance was very small, and several even of the professors absented themselves; but, notwithstanding this bad management on the part of the authorities, the proceedings were exceedingly animated and highly interesting to those engaged in the advancement of education. The report of the Dean, Prof. Croom Robertson, showed a very marked improvement in the condition of the College as well as of the School, the number of students during the past session having been greater than in any previous year. Amongst those who distinguished themselves the most notable were four ladies: Miss Orme, who was presented with the first prize and the first certificate for Political Economy, the only class in the Faculty of Arts which has as yet been opened to ladies; Miss Lupton, Miss Malden, and Miss Wylde, who received medals in the Fine Arts Faculty. The third certificate in this class was also taken by a lady; the number in the class being about thirty gentlemen and six ladies. The genuine and enthusiastic applause of the students at these successes leaves nothing to be wished for, except the continuation of that liberal policy for which University College has always been remarkable. Miss Orme had previously greatly distinguished herself at the examinations of the University of London.

The following telegram has been received at the Admiralty from Aden, dated June 17:—"Dawson and party have returned to Zanzibar, Mr. Stanley having arrived with despatches from Livingstone: alive and well." Letters of that date from Aden are now due.

Besides the Minor Scholarships or Exhibitions at St. John's College, Cambridge, there will be offered for competition this year an Exhibition of 50*l.* per annum for proficiency in Natural Science, the Exhibition to be tenable for three years in case the Exhibitioner have passed within two years the previous xamination as required for candidates for honours; otherwise the Exhibition to cease at the end of two years. The Examination will commence on Friday, the 13th of December; in (1) Chemistry, including practical work in the laboratory; (2) Physics, viz., Electricity, Heat, Light; (3) Physiology; they will also have the opportunity of being examined in one or more of the following subjects: (4) Geology, (5) Anatomy, (6) Botany, provided that they give notice of the subjects in which they wish to be examined four weeks prior to the Examination. No candidate will be examined in more than three of these six subjects, whereof one at least must be chosen from the former group. It is the wish of the master and seniors that excellence in some single department should be specially regarded by the candidates. They may also, if they think fit, offer themselves for examination in any of the Classical or Mathematical subjects. Candidates must send their names to one of the tutors, Dr. Parkinson, Mr. Bonney, or Mr. Sandys, before the commencement of the Examination. The Minor Scholarships are open to all persons under twenty years of age, whether students in the University or not, who have not yet commenced residence in the University