

SCIENCE

Island Life; or, the Phenomena and Causes of Insular Faunas and Floras, including a Revision and Attempted Solution of the Problem of Geological Climates. By Alfred Russel Wallace. (Macmillan & Co.)

THE new science of zoological geography almost owes its existence to Mr. Wallace, and this his latest volume is a fresh and valuable contribution to the study for which he has already effected so much. Its title, indeed, like that of its predecessor, 'Tropical Nature,' is somewhat too unambitious and unassuming in the case of a work which covers so large a field, for only a little more than one-half the volume is devoted to the restricted question of insular Faunas and Floras, while the first two hundred pages are occupied with the discussion of the great problems of zoological and botanical distribution in their more general aspects. But it is easy to pardon so pleasant and genial a writer for giving a little more than he holds forth on his title-page, and the present volume, though in some respects intended as a popularization of Mr. Wallace's previous works on the distribution of animals, yet contains an immense amount of new and important matter for the man of science, as well as much delightful reading for the less instructed public. It is, in fact, the final outcome of its author's most mature thought and research on the special subject which he has made most peculiarly his own.

Mr. Wallace begins by pointing out a few of the most striking problems of distribution, which call for a solution even on the most casual survey. Why should the Fauna of remote Japan be so strikingly like that of Britain, while the Fauna of New Zealand is so totally unlike that of neighbouring Australia? Why should two islands of the Malay Archipelago, separated by a strait only fifteen miles wide, differ more from one another in their forms of life

than England and Yezo? Why should the animals of sunny Florida resemble those of frozen Canada more closely than they resemble those of neighbouring and tropical Cuba? Why should tapirs be found in Brazil and in Sumatra, while they occur in no intermediate country? To answer these questions requires a wide knowledge of physical conditions, as well as of local Faunas and Floras over the whole world, and perhaps the case of islands offers the best field for their solution and illustration within easy limits. After thus stating the scope of his inquiry, Mr. Wallace goes on to define the six great zoological regions with which his previous works have already made us familiar—the Palearctic region, including northern and eastern Asia, the whole of Europe, and northern Africa; the Ethiopian, lying in Africa south of the Sahara; the Oriental, in India and the Malay Archipelago; the Australian, whose name at once describes its limits; and the Nearctic and Neo-tropical, in North and South America respectively. Taking evolution as the key to distribution, he points out that discontinuity is a proof of antiquity. Hence we find few if any discontinuous species, because if sufficient time has elapsed to get rid of intermediate individuals the species will probably have varied at either end from diversity of circumstances and want of mutual intercourse. Discontinuous genera are more common, and discontinuous families frequently occur.

In dealing with the geographical and geological changes which have affected distribution, Mr. Wallace introduces much fresh matter. Arguing in favour of his old thesis, the relative permanence of continents throughout geological time, he points out, from the dredgings of the Challenger, that shore deposits, containing material denuded from the land and deposited as sediment, are almost always confined to a distance of fifty or a hundred miles from the coast. Beyond these limits the only deposits are organic, consisting of small calcareous or siliceous shells. Accordingly all stratified rocks which include sand or pebbles must have been formed in the neighbourhood of existing continents, and often in the beds of shallow inland seas. Now the stratified rocks in the very centre of the great continents are all of this class, being either sandstones, limestones, conglomerates, or shales. As Prof. Geikie maintains, the stratified rocks of the earth comprise no formations which can be legitimately regarded as deep-sea deposits. Thus, instead of believing, with the older geologists, that every now and then the basin of an ocean like the Pacific is lifted up to form a plateau like that of Central Asia, we must suppose that each part of each continent has at various times formed part of a sea or of the ocean, but at the same time has been not far from land. The present state of the Baltic, the Mediterranean, and the Caspian will best illustrate these conditions. As to the chalk, so long claimed as a deep-sea formation, Mr. Wallace shows with much care that it resembles rather shoal-water deposits of Globigerinæ than the similar oozes found at great depths,—an opinion corroborated by Mr. J. Murray from the results of dredgings, and by Dr. Gwyn Jeffreys from the character of the chalk fossils, which he

declares to be shallow, not deep, sea forms. Hence Mr. Wallace concludes that during the Cretaceous period the site of Europe was not occupied by the bed of a profound ocean, but that, on the contrary, only those portions of the continent were slightly submerged by local depression in which we now find Cretaceous deposits. Instead of being a vast expanse of water with a few scattered islands, it was just as much a part of the great northern continent as it is at the present day. The immense number of freshwater and shore deposits in all stratified formations, with remains of land animals and plants, he holds to be in like manner proofs of the comparative permanence of continents. On the other hand, the permanence of the great oceans is similarly vouched for by the absence of Palæozoic and Secondary formations, even in the merest fragments, on oceanic islands; while the want of terrestrial mammals on such islands clearly shows that they cannot be, as is often supposed by the ill-informed, small remaining portions of submerged continents. Mr. Darwin's facts and arguments with regard to the Fauna of the Azores have long since demolished the theory of "the lost Atlantis," while Mr. Wallace's reasoning in the present volume disposes of the hypothetical Lemuria in an equally satisfactory manner. Upon this question of the permanence of continents and oceans hangs the whole theory of zoological distribution.

With regard to glacial epochs, Mr. Wallace has a great deal to say that is new and interesting. Agreeing in the main with Dr. Croll's convincing astronomical explanation, that glacial periods depend upon the precession of the equinoxes and the motion of the aphelion, and tend specially to recur at the epochs of greatest eccentricity, he suggests that they are also largely influenced by the particular distribution of land and water which happens to prevail in either hemisphere at such exact moments of cosmical time. Without high land there can be no permanent snow and ice. Even in polar regions ice is found at sea level throughout the year only where glaciers descend to the water's edge from neighbouring mountains or elevated table-lands. Accordingly the alternate phases of precession could not produce a complete change of climate except in the case of a country which was partially snow-clad, while a totally glaciated area might continue its perpetual cold even with winter in perihelion. Mr. Wallace also argues *à priori* against the frequent existence of glacial conditions in earlier geological periods; but he does not refer at all to Prof. Ramsay's positive arguments on this subject in his Swansea address, which was probably not delivered till the present volume was ready for publication. This portion of his reasoning will doubtless meet with considerable criticism, but we think his general contention against the necessary recurrence of glacial phenomena with every recurrence of Dr. Croll's period is quite conclusive. The warm Arctic climates, which we know to have prevailed during the greater part of the Secondary and Tertiary periods, are similarly accounted for by the numerous currents of warm tropical water which are shown to have then penetrated the land of the northern hemisphere, and reached the polar sea by several channels.

Mr. Wallace thus reverses the parts ordinarily assigned to geographical and astronomical factors in the problem of geological climates, and his arguments seem for the most part satisfactory and convincing. More doubtful, we think, is his treatment of geological time, which he reduces within very slender limits. His modest estimate for the whole period covered by the fossiliferous formations, from the Cambrian upward, is no more than 28,000,000 years.

The second and larger portion of the work, dealing with insular Faunas and Floras, contains less that is at once novel and important, though it is worked out with the author's accustomed insight and wide grasp of facts. The oceanic islands are first passed in review, and it is shown that their zoology and botany depend wholly upon their relative position towards continents and the means of transport afforded by prevalent winds, hurricanes, or currents. None of them possesses any indigenous mammals. The Azores and Bermuda show the importance of a stormy position; for, though situated 900 and 700 miles from Europe and America respectively, the Fauna of each is essentially European or American in type, and constant new arrivals, blown by tempests, keep up the connexion with the parent species. Nevertheless, even here a few birds, beetles, and land-snails have varied specifically, and even in one case generically. The Galapagos Islands, though less distant from South America, are yet practically more inaccessible through their position in the stormless equatorial belt, and accordingly their Fauna, though still unmistakably South American in origin, displays far greater speciality of type. St. Helena and the Sandwich Islands, isolated in the midst of great oceans, show no such resemblance in Fauna and Flora to any one continent, but are peopled by waifs and strays from all quarters, some of which cannot be traced to their original habitat. The infrequency of fresh arrivals and the great antiquity of their first population have rendered their inhabitants generically distinct in a very high degree. Passing to continental islands, Mr. Wallace deals first with Britain, as an instance of a land recently isolated, and shows by a wide collection of instances that, though its species still remain for the most part identical with those of neighbouring Europe, a few peculiar species and several peculiar varieties have already begun to show themselves. This tendency to local differentiation is strongest in Ireland, and in the smaller islands—Wight, Man, Shetland, and Lundy. Borneo and Java, though not, perhaps, more anciently separated from their mainland than Britain, yet exhibit a higher degree of organic speciality, owing to their larger area, richer Fauna and Flora, and greater distance from the continent. The explanation now given of the peculiarities of Java in this respect is an advance and improvement upon that suggested by Mr. Wallace in his previous work. Japan and Formosa, again, are decidedly a little older islands, and show a corresponding peculiarity of organic forms; while Madagascar serves as an illustration of the very ancient continental islands, with a peculiar Fauna of an antiquated type, the relic of one which has long since died out in almost all other parts of the world, under the pres-

sure of competition from more advanced and successful forms originated in the great continents. As to the hypothetical Lemuria, Mr. Wallace urges against it that the outlying islands, such as Bourbon, Mauritius, and Rodriguez, are purely oceanic in their Fauna, and therefore not parts of a wider submerged land; while the existence among them of the wingless dodos and solitaires proves the antiquity of their present condition. Finally, New Zealand and Celebes are classed as anomalous islands, and various ingenious explanations are suggested of their peculiarities. The chapters on New Zealand in particular are full of clever theories, which certainly account admirably for the existing zoological and botanical features of that very puzzling country; but though the intricate series of changes which Mr. Wallace supposes to have taken place would amply and satisfactorily account for the actual anomalies, they are, perhaps, too hypothetical to be unreservedly accepted in the present state of our knowledge.

The work throughout abounds with interest, and even the facts themselves with which it is richly stored would be of high value without the theories which they enforce and illustrate. But, taken as a whole, 'Island Life' represents the very fullest outcome of its author's researches, and it cannot fail to add to his recognized position as the greatest living authority on the questions with which it deals. It may be read with equal pleasure by those who are already acquainted with the general principles of distribution and by those who wish for the first time to learn something about modern biological geography.